WestConnex

Australian Government
BUILDING OUR FUTURE

NSW GOVERNMENT

M4-M5 Link

Environmental Impact Statement

August 2017

Appendix T

Volume 2I

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Arabic

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Chinese

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Hindi

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www.westconnex.com.au/yourlanguage व (हिन्दी) म इ ा न कजरें ामयब िदेखेंयप रविजक्टोंकॉनेक्स ` क ें म ब र औक सामिग्री पेंढ़ ि द ेयदुभाषपिया आ ए ोअिनुवाद वच दुभाषयिा सेवा ो **131 450** र फोन करें।

Greek

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Korean

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Volume 2I

Appendix

WestConnex

Appendix T

Technical working paper: Groundwater

WestConnex

Roads and Maritime Services

WestConnex – M4-M5 Link

Technical working paper: Groundwater

August 2017

Client: Roads and Maritime Services

ABN: 76 236 371 088

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Glossary of terms and abbreviations

Term	Definition
Aeolian	Clays, silts and sands that have been deposited by wind
AHD	Australian Height Datum. The standard reference level used to express the relative elevation of various features. A height in metres AHD is essentially the height above sea level
AIP	The *Aquifer Interference Policy* (AIP) is NSW government legislation administered by DPI-Water that explains the process of administering water policy under the *Water Management Act 2000* (WM Act) for activities that interfere with the aquifer
Alluvium	Sediments (clays, sands, gravels and other materials) deposited by flowing water. Deposits can be made by streams on river beds, floodplains and alluvial fans
Anisotropic	The condition under which one or more of the hydraulic properties of an aquifer varies according to the direction of flow
ANZECC	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
Aquiclude	An aquiclude is a geological material through which zero flow occurs
Aquifer	Geologic formation, group of formations, or part of a formation capable of transmitting and yielding quantities of water
Aquifer properties	The characteristics of an aquifer that determine its hydraulic behaviour and its response to abstraction
Aquitard	A low permeability unit that can store groundwater and also transmit it slowly from one aquifer to another
ARMCANZ	Agriculture and Resource Management Council of Australia and New
Arterial roads	The main or trunk roads of the state road network
Average recurrence interval (ARI)	An indicator used to describe the frequency of floods. The average period in years between the occurrence of a flood of a particular magnitude or greater. In a long period of say 1,000 years, a flood equivalent to or greater than a 100 year ARI event would occur 10 times. The 100 year ARI flood has a one per cent chance (i.e. a one-in-100 chance) of occurrence in any one year. Floods generated by runoff from the study catchments are referred to in terms of their ARI, for example the 100 year ARI flood
BoM	Bureau of Meteorology
Bore	A cylindrical drill hole sunk into the ground from which water is pumped for use or monitoring
Borehole	A hole produced in the ground by drilling for the investigation and assessment of soil and rock profiles
BTEXN	Benzene, toluene, ethylbenzene, xylene and naphthalene
Catchment	The area from which a surface watercourse or a groundwater system derives its water
CBD	Central business district
CEMP	Construction Environmental Management Plan. A plan developed for the construction phase of a project to ensure that all contractors and sub-contractors comply with the environmental conditions of approval for the project and that environmental risks are properly managed
Clearing	The removal of vegetation or other obstacles at or above ground level
Concept design	Initial functional layout of a road/road system or other infrastructure. Used to facilitate understanding of a project, establish feasibility and provide basis for estimating and to determine further investigations needed for detailed design
CSWMP	Construction Soil and Water Management Plan
Cumulative impacts	Combination of individual effects of the same kind due to multiple actions from various sources over time
Cut-and-cover	A method of tunnel construction whereby the structure is built in an open excavation and subsequently covered
DEC	(NSW) Department of Environment and Conservation

Term	Definition
DECC	(NSW) Department of Environment, Climate Change
Diaphragm wall	A diaphragm wall is constructed by excavating a trench to the bedrock and filling the trench with a cement slurry and reinforcing to form a barrier wall.
Discharge	A release of water from a particular source. The volume of water flowing in a stream or through an aquifer past a specific point over a given period of time
DIWA	Directory of Important Wetlands of Australia
DLWC	NSW Department of Land and Water Conservation
DoP	NSW Department of Planning. Predecessor agency to the NSW Department of Planning and Environment
DPI-Fisheries	NSW Department of Primary Industries – Fisheries. State agency responsible for managing fisheries
DPI-Water	NSW Department of Primary Industries – Water. State agency responsible for managing groundwater and surface water
Drainage	Natural or artificial means for the interception and removal of surface or subsurface water
Drained structure	Is an excavation or tunnel that allows groundwater to flow into the structure through defects in the rock. The groundwater is collected and pumped out. Drained tunnels are typically constructed in competent rock such as the Hawkesbury Sandstone and may be constructed with minimal water proofing to reduce groundwater inflows along some tunnel sections
Drawdown	A lowering of the water table in an unconfined aquifer or the potentiometric surface of a confined aquifer caused by the groundwater inflow to tunnels or pumping of groundwater from wells
Driven tunnel	Mechanical excavation of a tunnel through rock by a road header or tunnel boring machine, driven along the tunnel alignment from the tunnel entrance
DRN	Drain
DWE	NSW Department of Water and Energy
Dyke	A vertical or sub-vertical geological structure composed of igneous rock that typically cross cuts the host rock. The dyke is formed as magma from a larger igneous body intrudes the host rock typically along structural weaknesses
Earthworks	Operations involved in loosening, excavating, placing, shaping and compacting soil or rock
EC	Electrical Conductivity. A unit of measurement for water salinity. One EC equals one micro –Siemen per centimetre (µS/cm) measured at 25^{o}C
Ecology	The study of the relationship between living things and the environment
Ecosystem	As defined in the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth), an ecosystem is a 'dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit'
EEC	Endangered ecological community. An ecological community identified by the *Threatened Species Conservation Act 1995* (NSW) that is facing a very high risk of extinction in New South Wales in the near future, as determined in accordance with criteria prescribed by the regulations, and is not eligible to be listed as a critically endangered ecological community
EIS	Environmental impact statement
Emission	The discharge of a substance into the environment
EMS	Environmental management system. A quality system that enables an organisation to identify, monitor and control its environmental aspects. An EMS is part of an overall management system, which includes organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy
Environment	As defined within the *Environmental Planning and Assessment Act 1979* (NSW), all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings
EP&A Act	*Environmental Planning and Assessment Act (1979)* (NSW)

Term	Definition
Ephemeral	Existing for a short duration of time
ESD	Ecologically sustainable development. As defined by the *Protection of the Environment Administration Act 1991* (NSW), requires the effective integration of economic and environmental considerations in decision making processes including: • The precautionary principle • Inter-generational equity • Conservation of biological diversity and ecological integrity • Improved valuation, pricing and incentive mechanisms (includes polluter pays, full life cycle costs, cost effective pursuit of environmental goals)
ET, ETV	Evapotranspiration
FD	Finite difference
Fractured Rock Aquifer	Occur in sedimentary, igneous and metamorphosed rocks that have been subjected to disturbance, deformation or weathering, which allow water to move through joints, bedding planes and faults. Although fractured rock aquifers are found over a wide area, they generally contain much less groundwater than alluvial and porous sedimentary aquifers
GDEs	Groundwater dependent ecosystems. Refers to communities of plants, animals and other organisms whose extent and life process are dependent on groundwater, such as wetlands and vegetation on coastal sand dunes
GIS	Geographic information systems
GMP	Groundwater monitoring plan
Groundwater	Water located within an aquifer or aquitard that is held in the rocks and soil in interconnected pores or fractures located beneath the water table
Groundwater Flow System	A groundwater flow system is a model developed by hydrogeologists to describe and explain the behaviour of groundwater in response to recharge. It is similar to a conceptual model which considers the geology, hydrogeology, hydraulic properties of the landscape and the aquifer(s)
Groundwater Treatment Plant	A treatment plant to treat groundwater for the operational phase of the project. This differs from the water treatment plants which would be temporary during the construction phase and treat captured surface water and groundwater
Ha	Hectares
Habitat	The place where a species, population or ecological community lives (whether permanently, periodically or occasionally)
Holocene	A geological epoch or time period that extends from the Pleistocene epoch (11,700 years before present day to the present)
HQ	Refers to the diameter of drill core in the diamond drilling technique. HQ drilling produces a 96 mm borehole and 63.5 mm diameter drill core
Hydraulic conductivity	The rate at which water of a specified density and kinematic viscosity can move through a permeable medium (notionally equivalent to the permeability of an aquifer to fresh water)
Hydraulic gradient	The change in total groundwater head with a change in distance in a given direction, which yields a maximum rate of decrease in head
Hydrocarbon	Any organic compound – gaseous, liquid or solid – consisting only of carbon and hydrogen
Hydrogeology	The study of subsurface water in its geological context
Hydrology	The study of rainfall and surface water runoff processes
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment
K_h	Horizontal hydraulic conductivity
K_v	Vertical hydraulic conductivity
LGA	Local government area
Local road	A council controlled road which provides for local circulation and access
LTAAEL	Long Term Average Annual Extraction Limit as outlined in the water sharing plan

Term	Definition
Lugeon	The lugeon (L) is a unit of measure to quantify hydraulic conductivity, generally used by geotechnical engineers in describing packer tests. 1L represents 1 x 10^{-7} m/sec (8.6 x 10^{-3} m/day in a homogeneous isotropic medium)
Model area	Area covered by the groundwater model as shown on Figure 3-4
MODFLOW	A three-dimensional finite-difference groundwater model
NATA	National Association of Testing Authorities
NoW	NSW Office of Water
NSW EPA	Environmental Protection Authority (NSW)
OEH	Office of Environment and Heritage
OEMP	Operational Environment Management Plan. A plan developed for the operational phase of a project to ensure that the operator complies with the environmental conditions of approval for the project and that environmental risks are properly managed
Packer test	A packer test is a technique used during the drilling of a borehole to measure the hydraulic conductivity of the lithology. Inflatable packers are lowered down the borehole to isolate the depth interval to be measured
Palaeochannel	Ancient river systems eroded deeply into the landscape and infilled with alluvial sediments. These systems often underlie modern creek or river systems but not always
Palaeovalley	Palaeovalleys are broad ancient features that are formed by palaeochannels incising the valley through the host rock. A palaeovalley can contain numerous palaeochannels
PASS	Potential acid sulfate soils
Perched Water	Unconfined groundwater held above the water table by a layer of impermeable rock or sediment
PEST	Parameter Estimation
Piezometer (monitoring well)	A non-pumping monitoring well, generally of small diameter that is used to measure the elevation of the water table or potentiometric surface. A piezometer generally has a short well screen through which water can enter
Pleistocene	A geological epoch or time period that extends from the 2,6000,000 years before present to the Holocene epoch 11,700 years before present
Pollutant	Any matter that is not naturally present in the environment
Project footprint	The land required to construct and operate the project. This includes permanent operational infrastructure (including the tunnels), and land required temporarily for construction
RCH	Recharge. The process that replenishes groundwater usually by rainfall infiltration to the water table and by river water entering the saturated aquifer; the addition of water to an aquifer
REF	Review of environmental factors
Revegetation	Direct seeding or planting (generally with native species) within an area in order to re-establish vegetation that was previously removed from that area
Riparian	Relating to the banks of a natural waterway
RIV	Rivers
Roads and Maritime	Roads and Maritime Services
Runoff	The portion of water that drains away as surface flow
Salinity	The concentration of dissolved salts in water, usually expressed in EC units or milligrams of total dissolved solids per litre (mg/L TDS). The conversion factor between EC and mg/L is dependent on the chemical composition of the water, but a conversion factor of 0.6 mg/L TDS = 1EC unit is commonly used as an approximation
SEARs	Secretary's Environmental Assessment Requirements
Secant pile wall	A continuous barrier wall formed by constructing intersecting reinforced concrete piles socketed into bedrock
Sensitive receiver	A location where a person works or resides, including residential, hospitals, hotels, shopping centres, play grounds, recreational centres or similar

Term	Definition
Slug test	A hydraulic test conducted in a monitoring well to measure the hydraulic conductivity of the screened lithology. The test is conducted by adding or removing a slug of water and monitoring the response
SMC	Sydney Motorway Corporation
SSI	State significant infrastructure
Steady state	Steady state flow conditions occur when the magnitude and direction of flow is constant across the whole model domain. Compare to transient flow conditions
Storativity	The volume of water an aquifer releases from, or takes into storage, per unit surface area of the aquifer per unit change in head. It is equal to the product of specific storage and aquifer thickness. In an unconfined aquifer the storativity is known as the specific yield
Study area	The area which is included in the groundwater assessment and in which there may be groundwater interaction or potential groundwater impacts occur as a result of the project
Surface water	Water flowing or held in streams, rivers and other wetlands in the landscape
Tanked structure	A tanked structure is constructed with a fully impermeable casing or membrane that reduces inflows to such an extent that for all intents and purposes are considered negligible
THR	Total recoverable hydrocarbons
Transient conditions	During transient flow conditions the magnitude and direction of flow change with time in accordance with impacts imposed within the model domain
Tributary	A river or stream flowing into a larger river or lake
Trough structure	A construction technique at the transition from the portal to the tunnel, commonly constructed in poor ground conditions such as alluvium or weathered bedrock. The trough structure is a rectangular shape with no surface covering.
Tunnel portal	The entrance/exit to the tunnel
Vadose zone	Within an aquifer the vadose zone is the unsaturated zone between the water table and ground surface
Vulnerable	As defined under the *Threatened Species Conservation Act 1995* (NSW), a species that is facing a high risk of extinction in NSW in the medium-term future
VWP	Vibrating wire piezometers
Water table	The surface of saturation in an unconfined aquifer at which the pressure of the water is equal to that of the atmosphere
Waterway	Any flowing stream of water, whether naturally or artificially regulated (not necessarily permanent)
WM Act	*Water Management Act 2000* (NSW)

Executive summary

Project overview

NSW Roads and Maritime Services (Roads and Maritime) is seeking approval to construct and operate the WestConnex M4-M5 Link (the project), which would comprise a new, tolled multi-lane road link between the M4 East Motorway at Haberfield and the New M5 Motorway at St Peters. The project would also include an interchange at Lilyfield and Rozelle (the Rozelle interchange), including connections to the surface road network, a tunnel link to Victoria Road (the Iron Cove Link), and civil construction of connections to and parts of the proposed future Western Harbour Tunnel and Beaches Link project.

Approval is being sought under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act) for the project. A request has been made for the NSW Minister for Planning to specifically declare the project to be State significant infrastructure and also critical State significant infrastructure. An environmental impact statement (EIS) is therefore required.

This groundwater impact assessment will form part of the EIS and has been prepared in accordance with NSW water policy under the *Water Management Act 2000* (NSW), administering water policy under the *Aquifer Interference Policy 2012* (AIP) (NSW Office of Water (NoW) 2012) and the *Greater Metropolitan Region Groundwater Source Water Sharing Plan* (NoW 2011). This groundwater impact assessment has been prepared to meet the NSW Department of Planning and Environment Secretary's Environmental Assessment Requirements (SEARs) issued on 3 March 2016 and revised on 9 November 2016 and 3 May 2017. The impact assessment has also considered comments made by government agencies and addresses potential groundwater impacts during the construction and long term operational phases.

The project would include the following primary components (as related to the groundwater assessment):

- Twin mainline motorway tunnels between the M4 East at Haberfield and the New M5 at St Peters
- A new interchange at Lilyfield and Rozelle (the Rozelle interchange)
- Civil construction only of connections to and parts of the proposed future Western Harbour Tunnel and Beaches Link project, including tunnels that would allow for underground mainline connections between the M4 East and New M5 motorways and the proposed future Western Harbour Tunnel and Beaches Link
- Twin tunnels that would connect Victoria Road near the eastern abutment of Iron Cove Bridge and Anzac Bridge (the Iron Cove Link). Underground entry and exit ramps would also provide a tunnel connection between the Iron Cove Link and the New M5 / St Peters interchange (via the M4-M5 Link mainline tunnels and the Inner West subsurface interchange)
- Tunnel ventilation systems, including ventilation supply and exhaust facilities, axial fans, ventilation outlets and ventilation tunnels.

The tunnels are to be constructed to depths up to 60 metres below the ground surface with the deepest tunnel sections being at the proposed Rozelle interchange and beneath Newtown along the mainline tunnel. Tunnelling is expected to commence in 2018 and be completed by 2023. The majority of the tunnels are to be constructed below the water table predominately within the Hawkesbury Sandstone but also within the Ashfield Shale and alluvium.

The majority of the tunnels are to be constructed as drained tunnels to allow groundwater to leak into the tunnel from the sandstone.

During operation of the project, groundwater would be directed to water treatment plants at Darley Road, Leichhardt (part of the Darley Road motorway operations complex (MOC1)), and within the Rozelle Rail Yards site, Rozelle (part of the Rozelle East motorway operations complex (MOC3)). Treated water from the Darley Road treatment plant would be discharged via the stormwater system and Hawthorne Canal into Iron Cove. At Rozelle, treated water would be discharged via a constructed wetland and upgraded Easton Park drainage into Rozelle Bay. Undrained or tanked tunnel sections are to be constructed where the tunnel intersects unconsolidated saturated alluvium at Rozelle.

The project is designed to achieve a maximum inflow of one litre per second per kilometre for any kilometre of tunnel. To achieve this design criterion, waterproofing may be required in parts of the tunnels to reduce the bulk rock permeability. As such, the approach to the control of water inflow into the tunnel is proposed to consist of a suite of options, ranging from areas where no waterproofing would be required to areas where a membrane may need to be applied combined with shotcrete to undrained or tanked sections of tunnel. Water proofing options would be explored further during the detailed design phase.

Methodology

A desktop study was undertaken to describe the existing environment and characterise the geology and hydrogeology. In addition, other relevant environmental features including the existing infrastructure, rainfall and climate, physiography and surface water features were described. A combined hydrogeological and geotechnical field investigation was undertaken which included the excavation of over 200 geotechnical boreholes and the construction of 58 monitoring wells. During the drilling program, 220 packer tests were conducted in 94 boreholes to assess the hydraulic conductivity of the lithologies intersected. Core samples were collected and submitted to the laboratory to measure the hydraulic conductivity and porosity of the Hawkesbury Sandstone and Ashfield Shale. A monthly groundwater monitoring program commenced in June 2016 to monitor groundwater levels and groundwater quality to characterise the hydrogeology within the three aquifers identified, these being the alluvium, including palaeochannel sediments, Ashfield Shale and Hawkesbury Sandstone.

The hydraulic parameters identified within the field investigation were used to support the development of a three dimensional numerical groundwater model. The model domain extends over an area of approximately 11 x 11 kilometres, with the northern boundary represented by the central channel of Sydney Harbour/Parramatta River and includes the footprint of the New M5 and M4 East projects. The MODFLOW model was developed by HydroSimulations in accordance with the *Australian modelling guidelines* (Barnett *et al* 2012). The model was calibrated in steady state and transient modes to simulate the existing conditions and predict impacts during the construction and operations phases. The model was also used to predict cumulative impacts for the other WestConnex projects. The following three scenarios were modelled:

- Scenario 1: A 'Null' run (as per Barnett *et al* 2012) consists of no WestConnex impacts but does include the existing drained M5 East tunnels
- Scenario 2: The 'Null' run in Scenario 1, plus the approved WestConnex tunnel projects (M4 East and New M5)
- Scenario 3: The 'Null' run in Scenario 1, plus the approved WestConnex tunnel projects (M4 East and New M5) in Scenario 2, and the M4-M5 Link project.

Construction impacts

The findings of the groundwater impact assessment during construction of the project are as follows:

- Groundwater along the project footprint is present within the fill, alluvium (including palaeochannel sediments), Ashfield Shale and Hawkesbury Sandstone
- The majority of the tunnels are to be constructed within the competent Hawkesbury Sandstone, and below the water table
- Alluvium is to be intersected by the tunnels beneath the Rozelle Rail Yards, within the Whites Creek palaeochannel
- The Ashfield Shale is to be intersected by the tunnels to the south of the project alignment at Alexandria and at St Peters interchange
- The majority of tunnels would be constructed as drained tunnels with design criterion of a maximum of one litre per second per kilometre for any kilometre length of tunnel; of on-going groundwater leakage into each tunnel during operations. The tunnels have been designed to not

intersect the palaeochannels by diving beneath Hawthorne Canal and tanking the tunnel through the Whites Creek palaeochannel alluvium to minimise groundwater inflow. Appropriate waterproofing measures would be implemented during construction to permanently reduce the inflow into the tunnels to an acceptable inflow to meet the design criterion, such as where the project footprint passes close to watercourses and/or where higher than expected inflows are experienced. This may include the installation of shotcrete, grouting or the installation of a sheet membrane, for example. Strip drains or similar would be installed behind wall panels to assist in dissipating groundwater. At Rozelle tunnel lengths that intersect the alluvium are to be tanked.

- At the end of construction of the project (2023), the drawdown on the water table is expected to be up to 42 metres with major drawdown centred over the Rozelle interchange. Drawdown extends up to 500 metres either side of the tunnel corridor, with the widest areas being mid-way along the M4-M5 Link mainline tunnels around Newtown and at the interchanges
- At dive structures and shafts, groundwater flow within unconsolidated sediments, fill, alluvium and weathered shale or sandstone would be restricted by the construction of retaining walls such as secant pile, sheet pile walls or diaphragm walls founded in good quality Ashfield Shale or Hawkesbury Sandstone
- A review showed that tunnel inflows in existing drained tunnels in Sydney (Eastern Distributor, M5 East Motorway, Epping to Chatswood rail line, Lane Cove Tunnel and Northside Storage tunnel) excavated predominately within the Hawkesbury Sandstone range from 0.6 to 1.7 litre per second per kilometre. At the adjoining New M5 project, groundwater modelling predicted an average inflow rate over the full tunnel length of 0.63 litre per second along every kilometre of eastbound tunnel and 0.67 litre per second along every kilometre of the westbound tunnel.

Construction mitigation measures

- Throughout the construction phase of the project, water would be managed and monitored under a Construction Environmental Management Plan (CEMP) developed by the construction contractor. Performance outcomes and commitments will be managed under the CEMP and sub-plans with corresponding procedures. The CEMP would be a ‘live’ document with the capacity to be updated if conditions are different from those expected. As part of the CEMP, a Construction Soil and Water Management Plan would be developed that addresses:
  - Groundwater management including monitoring
  - Surface water management including monitoring
  - Acid sulfate soils
- Groundwater monitoring indicates that inflows to the tunnels are likely to be of poor quality due to elevated natural salinity and elevated background metal concentrations. Captured water from the tunnels would also have a high turbidity and pH due to the influence of tunnel grouting and would require treatment prior to discharge. Water captured during construction, would be tested and treated at construction water treatment plants prior to reuse or discharge, or disposal offsite if required.
- During construction, fuels, oils and wastes would be managed in appropriate bunded areas and managed under spill prevention protocols and response procedures.

Operational impacts

The findings of the groundwater impact assessment during operations phase of the project are as follows:

- After the commencement of operations in 2023 the estimated long term inflows into the motorway tunnels are predicted to be 0.47 litres per second per kilometre initially, reducing to 0.25 litres per second per kilometre in 2100
- The predicted long term tunnel inflow or ‘take’ (from the combined motorway tunnels and ventilation tunnels) is estimated to vary from 1.74 megalitres per day (635.1 megalitres per year) in 2023 reducing to 0.99 megalitres per day (361.4 megalitres per year) in 2100

- The predicted long term tunnel inflows represent a small percentage of the Long Term Average Annual Extraction Limit as outlined in the water sharing plan (LTAAEL) for the Sydney Basin Central which range from 0.7 per cent to 1.3 per cent
- Construction of drained tunnels beneath the water table is expected to cause long term ongoing groundwater inflow to the tunnels, inducing groundwater drawdown along the project footprint during its operation
- A review of the Greater Metropolitan Water Sharing Plan within five kilometres of the project footprint did not identify any priority groundwater dependent ecosystems (GDEs). Consequently, no priority groundwater dependent ecosystems are likely to be impacted by groundwater level decline associated with the long term impacts of the project
- Only one bore (GW110247) located in the University of Sydney grounds, registered for domestic use, is predicted to have a drawdown in excess of two metres that is directly attributable to the M4-M5 Link project. This 210-metre deep bore is located at Sydney University and is registered for domestic use. The piezometric head in the Hawkesbury Sandstone is predicted to be drawn down by about 2.4 metres by the end of the long term simulation in the year 2100.
- Although the Botany Sands are not proposed to be intersected by the tunnels, the model outcomes show that there is some hydraulic connection with the Ashfield Shale and Botany Sands. Groundwater modelling indicates the drawdown propagation into the Botany Sands at St Peters is minimal, resulting in a negligible change in natural groundwater flow direction within the Botany Sands. Therefore, groundwater take from the Botany Sands aquifer due to tunnelling is minimal
- Groundwater baseflow to creeks represents the occasions when groundwater reaches the ground surface and enters the drainage system, and is predicted to be reduced by between seven and 83 per cent due to the project. Although the baseflow component of Whites Creek and Hawthorne Canal would be substantially reduced, the overall reduction in river flow is small as baseflow only represents a small percentage of total stream flow in these two systems. . There is no impact on the baseflow of other major creeks along the broader WestConnex alignment including Cooks River, Wolli Creek and Bardwell Creek due to the project
- Saltwater intrusion would commence as soon as the hydraulic pressure within the aquifer declines due to groundwater drawdown via the tunnels causing the displacement of fresher water along the shoreline with more saline tidal water.

Operational mitigation measures

Throughout the operational phase of the project, water would be managed and monitored under an Operational Environmental and Management Plan (OEMP) or Environmental Management System (EMS) developed by the operations contractor. Performance outcomes and commitments would be managed by an OEMP and sub-plans or through an EMS with corresponding procedures. The OEMP or EMP would be a ‘live’ document with the capacity to be updated if conditions are different from those expected. As part of the OEMP, plans and protocols would be developed for:

- Groundwater management and monitoring
- Surface water management and monitoring
- Drainage system maintenance to remove build-up of precipitated iron (slimes), silt and sand due to slaking of the sandstone.

Potential mitigation measures identified for the operations phase are as follows:

- The tunnel operation water treatment facilities would be designed such that effluent will be of suitable quality for discharge to the receiving environment. The level of treatment would consider the characteristics of the discharge and receiving waterbody, any operational constraints or practicalities and associated environmental impacts and be developed in accordance with *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC) (2000) and with consideration to the relevant NSW Water Quality Objectives. Ultimately the water quality objectives would be set by the catchment manager of the receiving waters

- The tunnel drainage system would be regularly maintained in accordance with the protocols outlined in the OEMP to remove build-ups of precipitated iron (slimes) and silt and sand due to slaking of the sandstone, derived from groundwater with elevated natural concentrations of iron
- The groundwater aggressivity assessment indicates that some of the groundwater to be intersected is corrosive towards concrete and steel due to naturally low pH and elevated concentrations of sulfate and chloride. A more detailed aggressivity assessment should be undertaken by the tunnel construction contractor to assess the impact on building materials that may be used in the tunnel infrastructure such as concrete, steel, aluminium, stainless steel, galvanised steel and polyester resin anchors, building on the dataset collected in this assessment. Corrosion and other associated impacts of highly aggressive groundwater on the tunnel infrastructure would be monitored during regular routine inspections as outlined in the OEMP
- Groundwater drawdown may induce ground settlement with the potential to impact existing buildings. Localised settlement modelling including detailed calculated drawdown is recommended to be conducted as part of detailed design. Prior to the commencement of tunnelling, dilapidation assessments should be undertaken on buildings and structures that have been identified as potentially being adversely impacted by settlement due to tunnelling. Should excessive settlement that has the potential to impact on structures be predicted, then different construction techniques or ground preparation works could be explored to minimise settlement. Settlement monitoring would be undertaken in accordance with the protocols developed in the OEMP and may include the installation of settlement markers or inclinometers. The OEMP would also identify structures that could be impacted by settlement and set settlement trigger levels.
- In accordance with the AIP, if the performance of bore (GW110247) were adversely affected, measures would be taken to 'make good' the impact by restoring the water supply to pre-development levels. The measures taken in this case could include, for example, lowering the pump in the borehole or providing an alternative water supply
- The groundwater and surface water quality monitoring program would continue throughout the construction phase and continue for at least 12 months after the completion of construction. The program shall be developed by the contractors in consultation with the NSW Environment Protection Authority (NSW EPA), NSW Department of Primary Industries – Fisheries (DPI-Fisheries), DPI-Water and the Inner West and City of Sydney councils. Monitoring locations from the existing groundwater and surface water monitoring networks would form the basis of this monitoring program.

Cumulative impacts

The groundwater model was set up to predict cumulative impacts for the M4-M5 Link project, the New M5 project and M4 East project during the construction and operation phases. Once the full extent of the WestConnex projects is operational, groundwater drawdown due to the cumulative impact of the three tunnel projects is not expected to be greater than in any one section of the overall project footprint. This is because the tunnel projects do not overlap but are adjoining and thus the sum of impacts are similar to a continuous tunnel.

The tunnels and associated lining would be designed and constructed to comply with the groundwater inflow criterion of one litre per second per kilometre for any kilometre length of tunnel. Consequently the groundwater inflows along the tunnels would vary within a known range. A comprehensive groundwater monitoring program would be required for each project to confirm that the actual inflows do not exceed the criterion and drawdown does not exceed predictions. Provided that each project includes relevant monitoring and management measures into their respective CEMPs and OEMPs there is limited potential for increases in impacts due to the cumulative construction and operation of the three tunnels.

The Sydney Metro City and Southwest rail link is to be constructed as undrained (tanked) tunnels that will cross the M4-M5 Link project alignment near St Peters. As the twin Sydney Metro tunnels are to be constructed as tanked tunnels, there will be negligible impacts on groundwater draw down. The station boxes are to be constructed and operated as drained shafts and will extract groundwater from the local hydrogeological regime over time. The closest drained structure is proposed at Marrickville Station which is about 2.5 kilometres west of the M4-M5 Link, which is considered a sufficient distance not to substantially cumulatively impact groundwater drawdown.

1 Introduction

NSW Roads and Maritime Services (Roads and Maritime) is seeking approval to construct and operate the WestConnex M4-M5 Link (the project), which would comprise a new multi-lane road link between the M4 East Motorway at Haberfield and the New M5 Motorway at St Peters. The project would also include an interchange at Lilyfield and Rozelle (the Rozelle interchange) and a tunnel connection between Anzac Bridge and Victoria Road, east of Iron Cove Bridge (Iron Cove Link). In addition, construction of tunnels, ramps and associated infrastructure to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project would be carried out at the Rozelle interchange.

Together with the other components of the WestConnex program of works and the proposed future Sydney Gateway, the project would facilitate improved connections between western Sydney, Sydney Airport and Port Botany and south and south-western Sydney, as well as better connectivity between the important economic centres along Sydney's Global Economic Corridor and local communities.

Approval is being sought under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act) for the project. A request has been made for the NSW Minister for Planning to specifically declare the project to be State significant infrastructure and also critical State significant infrastructure. An environmental impact statement (EIS) is therefore required.

1.1 Overview of WestConnex and related projects

The M4-M5 Link is part of the WestConnex program of works. Separate planning applications and assessments have been completed for each of the approved WestConnex projects. Roads and Maritime has commissioned Sydney Motorway Corporation (SMC) to deliver WestConnex, on behalf of the NSW Government. However, Roads and Maritime is the proponent for the project.

In addition to linking to other WestConnex projects, the M4-M5 Link would provide connections to the proposed future Western Harbour Tunnel and Beaches Link, the Sydney Gateway (via the St Peters interchange) and the F6 Extension (via the New M5).

The WestConnex program of works, as well as related projects, are shown in **Figure 1-1** and described in **Table 1-1**.

Table 1-1 WestConnex and related component projects

Project	Description	Status
WestConnex program of works		
M4 Widening	Widening of the existing M4 Motorway from Parramatta to Homebush.	Planning approval under the EP&A Act granted on 21 December 2014. Open to traffic.
M4 East	Extension of the M4 Motorway in tunnels between Homebush and Haberfield via Concord. Includes provision for a future connection to the M4-M5 Link at the Wattle Street interchange.	Planning approval under the EP&A Act granted on 11 February 2016. Under construction.
King Georges Road Interchange Upgrade	Upgrade of the King Georges Road interchange between the M5 West and the M5 East at Beverly Hills, in preparation for the New M5 project.	Planning approval under the EP&A Act granted on 3 March 2015. Open to traffic.
New M5	Duplication of the M5 East from King Georges Road in Beverly Hills with tunnels from Kingsgrove to a new interchange at St Peters. The St Peters interchange allows for connections to the proposed future Sydney Gateway project and an underground connection to the M4-M5 Link. The New M5 tunnels also include provision for a future connection to the proposed future F6 Extension.	Planning approval under the EP&A Act granted on 20 April 2016. Commonwealth approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) granted on 11 July 2016. Under construction.

Project	Description	Status
M4-M5 Link (the project)	Tunnels connecting to the M4 East at Haberfield (via the Wattle Street interchange) and the New M5 at St Peters (via the St Peters interchange), a new interchange at Rozelle and a link to Victoria Road (the Iron Cove Link). The Rozelle interchange also includes ramps and tunnels for connections to the proposed future Western Harbour Tunnel and Beaches Link project.	The subject of this EIS.
Related projects		
Sydney Gateway	A high-capacity connection between the St Peters interchange (under construction as part of the New M5 project) and the Sydney Airport and Port Botany precinct.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval.
Western Harbour Tunnel and Beaches Link	The Western Harbour Tunnel component would connect to the M4-M5 Link at the Rozelle interchange, cross underneath Sydney Harbour between the Birchgrove and Waverton areas, and connect with the Warringah Freeway at North Sydney. The Beaches Link component would comprise a tunnel that would connect to the Warringah Freeway, cross underneath Middle Harbour and connect with the Burnt Bridge Creek Deviation at Balgowlah and Wakehurst Parkway at Seaforth. It would also involve the duplication of the Wakehurst Parkway between Seaforth and Frenchs Forest.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval.
F6 Extension	A proposed motorway link between the New M5 at Arncliffe and the existing M1 Princes Highway at Loftus, generally along the alignment known as the F6 corridor.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval.

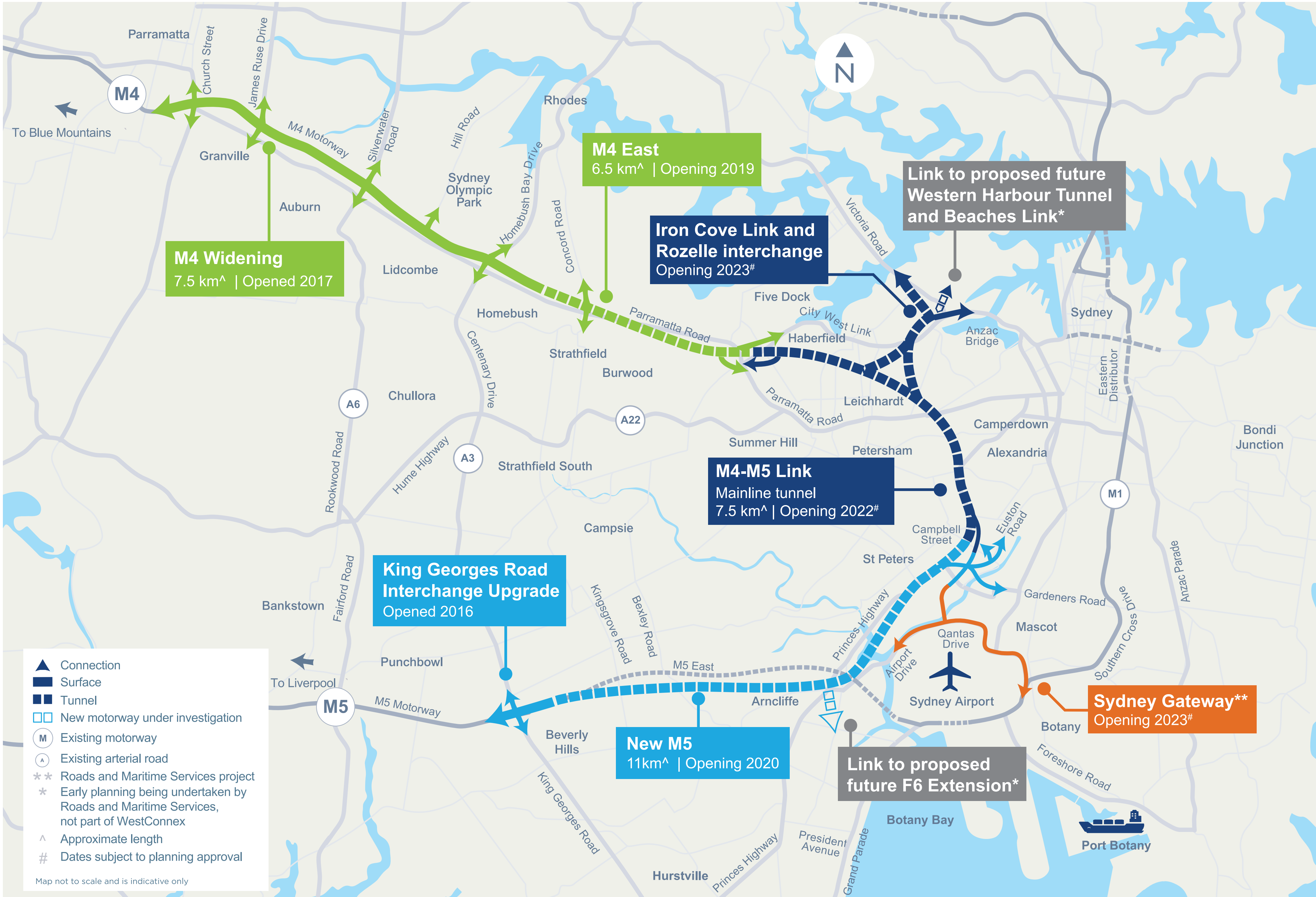


Figure 1-1 Overview of WestConnex and related projects

1.2 Purpose of this report

The purpose of this groundwater assessment report is to:

- Meet the requirements of the Secretary's Environmental Assessment Requirements (SEARs) and the *Aquifer Interference Policy 2012* (AIP) (NSW Office of Water (NoW) 2012
- Establish baseline conditions to inform the EIS and to assist with the development of mitigation measures
- Provide baseline conditions for input into the groundwater model
- Establish baseline conditions for comparison with water quality and water level conditions during the construction and operational phases, including identification of areas of potential groundwater contamination
- Characterise groundwater quality and identify potential aggressive groundwater to inform the development of the concept design for the project
- Assess the groundwater impacts during construction and operational phases
- Assess the cumulative impacts on the hydrogeological regime due to the project and other relevant projects
- Develop mitigation measures to eliminate or manage the potential impacts of the project on the hydrogeological regime during construction and operational phases.

1.3 SEARs and Agency comments

The SEARs were issued for the project by the NSW Department of Planning and Environment on the 3 March 2016, and revised on 9 November 2016 and 3 May 2017. The SEARs relating to hydrogeological impacts and where these requirements have been addressed in this report are summarised in **Table 1-1**. Details of hydrogeological comments outlined in agency letters received and where these requirements have been addressed in this report are summarised in **Table 1-2**.

Ongoing consultation with NSW Department of Primary Industries – Water (DPI-Water) has been undertaken during the preparation of this report and will continue as the design is further progressed.

Table 1-2 How SEARs have been addressed in this report

SEARs	
10. Water - Hydrology	
Requirement	**Section where addressed in report**
1. The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the project, including stream orders, as per the Framework for Biodiversity Assessment (FBA).	The existing hydrogeological environment and resources are described in **section 4.4** and **4.8**. The surface water and resources and biodiversity are described in **Appendix Q** (Technical working paper: Surface water and flooding) and **Appendix S** (Technical working paper: Biodiversity) of the EIS.
2. The Proponent must prepare a detailed water balance for ground and surface water including the proposed intake and discharge locations, volume, frequency and duration for both the construction and operational phases of the project.	**Section 5.9** Construction and **section 6.9** Operation. The surface water balance is outlined in sections 5.2.1, 5.2.2 and 6.3 of **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS.

SEARs	
3. The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including: (a) natural processes within rivers, wetlands, estuaries, marine waters and floodplains that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge;	Construction and operational impacts are outlined in **Chapters 5** and **6** and cumulative impacts in **Chapter 7**, as informed by numerical modelling **section 3.3.3**) and Annexure H. Impacts to surface water features including water courses, groundwater dependent ecosystems are discussed in **sections 5.4.2** and **6.3.5**). Existing surface water features are outlined for: water courses, estuaries and fluvial systems) (**section 4.4.1**) Marine waters and floodplains (**section 4.4.2**), groundwater dependent ecosystems (**section 4.4.3**) and wetlands (**section 4.4.4**) aquatic habitat (**section 4.4.5**)
(b) impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for settlement;	Impacts to temporary and permanent groundwater flow are outlined for construction and operation in **Chapters 5** and **6**. In particular, extent of drawdown (**sections 5.4** and **6.3**), ancillary infrastructure (**sections 5.6** and **6.5**) barriers to flows (**section 6.6**), implications for groundwater dependent surface flows (**sections 5.4.2** and **6.3.5**), groundwater dependent ecosystems (**sections 5.4.1** and **6.3.3**) and groundwater users (**sections 5.4.3** and **6.3.4**) and settlement (**sections 5.8** and **6.3.6**) are assessed.
(f) water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction and operation.	Groundwater take has been modelled (Annexure H) for the construction and operational phases and is discussed in **Chapters 5** and **6**. Surface water take is outlined in **Appendix Q** of the EIS.
5. The assessment must include details of proposed surface and groundwater monitoring.	Proposed groundwater monitoring is outlined in **Sections 5.5.7, 6.4.5, 8.1,** and **8.2**. Surface water monitoring is outlined **in section 4.16** and in more detail in **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS.
6. The proposed tunnels should be designed to prevent drainage of alluvium in the palaeochannels.	**Sections 5.4.2** and **6.2**. The project tunnels have been designed to avoid palaeochannels where possible. At the Rozelle Rail Yards tunnels intersecting the alluvium are to be fully lined to prevent direct inflow of groundwater from the alluvium.

SEARs	
11. Water Quality	
1. The Proponent must: i) identify proposed monitoring locations, monitoring frequency and indicators of surface and groundwater quality.	**Sections 3.3.2, 4.9, 4.13** and **4.14** outline the field investigations and groundwater monitoring undertaken to inform groundwater modelling for the project. These sections also outline the proposed groundwater monitoring for the project. Surface water monitoring is described in **Chapter 15** (Soil and water quality) of the EIS.
13. Soils	
4. The Proponent must assess whether salinity is likely to be an issue and if so, determine the presence, extent and severity of soil salinity within the project area.	An assessment of the likelihood of salinity and associated impacts is included in **sections 4.5, 5.5.5, 5.5.6** and **6.4.3**.
5. The Proponent must assess the impacts of the project on soil salinity and how it may affect groundwater resources and hydrology.	An assessment of the impacts of the project on soil salinity and how it may affect groundwater resources and hydrology is provided in **section 5.5.5**.
7. The Proponent must assess the impact of any disturbance of contaminated groundwater and the tunnels should be carefully designed so as to not exacerbate mobilisation of contaminated groundwater and/or prevent contaminated groundwater flow.	An assessment of the potential for the tunnels to intercept contaminated groundwater is included in **sections 5.5.2** and **6.4.1**.

Table 1-3 How agency comments been addressed in this report

Agency comments	Where addressed in the EIS
NSW Department of Primary Industries (Water)	
Summary of requirements	**Section(s) addressed in report**
• Tunnels should be designed to prevent drainage of alluvium in the palaeochannels • The potential of the intersection of polluted groundwater should be considered in the assessment • The tunnels should be designed so contaminated groundwater is not mobilised. Consider impacts on Zone 2 of the Botany Sands Source Management Zone • The EIS should include an assessment of the drainage volumes from of the groundwater resource in the Sydney Basin Central zone and the details of groundwater levels and potentiometric pressures • The EIS should assess the potential impacts on existing registered groundwater users due to the project • The groundwater assessment within the EIS should include a discussion on the following details: – The highest water table along the alignment – The works that would likely intersect, connect or infiltrate the groundwater resources – Any proposed groundwater extraction including purpose, location and annual extraction volumes – A description of the hydrogeological regime including groundwater pressures, flow directions physical and chemical properties	• **Sections 5.4.2** and **6.2** • **Sections 5.5.2** and **6.4.1** • **Sections 6.2.2** and **6.3.1** • **Sections 4.10**, **4.10.1** and **6.2** • **Sections 4.10**, **5.4.3**, **6.3.4**, **8.1** and **8.2** • **Section 4.9** • **Section 4.7** • **Sections 5.5.2**, **6.2**, **6.3.1**, **6.8** and **6.9** • **Sections 4.9**, **4.11** and **4.13** • **Sections 4.9** and **4.13** • **Section 6.7** • **Sections 4.4**, **4.10**, **5.4.3**, **6.3.4**, **8.1** and **8.2** • **Sections 4.13**, **5.5** and **6.4** • **Sections 4.14**, **5.5.2**, **6.4.1**, **8.1**,and **8.2** • **Sections 4.4**, **5.4.1**, **6.1**,

Agency comments	Where addressed in the EIS
– Groundwater baseline monitoring for groundwater quantity and quality sufficient to describe temporal and spatial variations – The predicted impacts of any final landform on the groundwater regime – The existing groundwater users along the alignment (including the environment), any potential impacts on these users and measures to mitigate impacts – An assessment of groundwater quality, its beneficial use classification and prediction of any impacts on groundwater quality – An assessment of groundwater contamination along the alignment outlining potential impacts and mitigation measures during the construction and operations phases – An assessment of groundwater dependent ecosystems including wetlands, recharge characteristics, potential impacts and mitigation measures during the construction and operations phases – Proposed methods of waste water collection and disposal – Outcomes of the groundwater model predictions.	**6.3.3**, **8.1**, and **8.2** • **Sections 4.13.8**, **5.5.2**, **6.8**, **8.1** and **8.2** • **Chapters 5** and **6**, **Annexure H**
Marrickville Council	
Requirement	**Section(s) addressed in report**
• The proposal may have a permanent impact on groundwater flow patterns and affect groundwater dependent ecosystems • The potential for the interception of contaminated groundwater from previous industrial sites via tunnel seepage should be considered. There is also a requirement for on-going monitoring, treatment and disposal of seepage including potential reuse that should be outlined. The seepage collection and treatment infrastructure should be described, outlining water quality objectives.	• **Sections 4.4**, **5.4.1**, **6.1**, **6.3.3**, **8.1** and **8.2** • **Sections 4.14**, **5.5.2**, **6.4.1**, **8.1**, and **8.2**

1.4 Structure of this report

This report is structured as follows:

- **Chapter 1** – **Introduction**
- **Chapter 2** – **The project** describes the project features, construction activities and geological features that relate to groundwater
- **Chapter 3** – **Assessment methodology** describes the methodology undertaken for the impact assessment
- **Chapter 4** – **Existing environment** describes the existing environment (natural and built) prior to project commencement
- **Chapter 5** – **Assessment of construction impacts** describes the potential impacts on groundwater inflow, groundwater drawdown and groundwater quality resulting from the proposed project, during the construction phase
- **Chapter 6** – **Assessment of operational impacts** describes the potential impacts on groundwater inflow, groundwater drawdown and groundwater quality resulting from the proposed project, during the ongoing operations phase
- **Chapter 7** – **Assessment of cumulative impacts** describes the cumulative groundwater impacts due to existing infrastructure that impact groundwater and the project
- **Chapter 8** – **Management of impacts** provides a summary of environmental safeguards, mitigation measures, management and monitoring responsibilities in relation to groundwater impacts for the project
- **Chapter 9** –**Policy compliance** describes how the project complies with the *NSW Aquifer Interference Policy* and the Water Sharing Plan
- **Chapter 10** – **Conclusions** summarises the outcomes of the groundwater impact assessment
- **Chapter 11** – **References**.

2 The project

2.1 Project location

The project would be generally located within the City of Sydney and Inner West local government areas (LGAs). The project is located about two to seven kilometres south, southwest and west of the Sydney central business district (CBD) and would cross the suburbs of Ashfield, Haberfield, Leichhardt, Lilyfield, Rozelle, Annandale, Stanmore, Camperdown, Newtown and St Peters. The local context of the project is shown in **Figure 2-1**.

2.2 Overview of the project

Key components of the project are shown in **Figure 2-1** and would include:

- Twin mainline motorway tunnels between the M4 East at Haberfield and the New M5 at St Peters. Each tunnel would be around 7.5 kilometres long and would generally accommodate up to four lanes of traffic in each direction
- Connections of the mainline tunnels to the M4 East project, comprising:
  - A tunnel-to-tunnel connection to the M4 East mainline stub tunnels east of Parramatta Road near Alt Street at Haberfield
  - Entry and exit ramp connections between the mainline tunnels and the Wattle Street interchange at Haberfield (which is currently being constructed as part of the M4 East project)
  - Minor physical integration works with the surface road network at the Wattle Street interchange including road pavement and line marking
- Connections of the mainline tunnels to the New M5 project, comprising:
  - A tunnel-to-tunnel connection to the New M5 mainline stub tunnels north of the Princes Highway near the intersection of Mary Street and Bakers Lane at St Peters
  - Entry and exit ramp connections between the mainline tunnels and the St Peters interchange at St Peters (which is currently being constructed as part of the New M5 project)
  - Minor physical integration works with the surface road network at the St Peters interchange including road pavement and line marking
- An underground interchange at Leichhardt and Annandale (the Inner West subsurface interchange) that would link the mainline tunnels with the Rozelle interchange and the Iron Cove Link (see below)
- A new interchange at Lilyfield and Rozelle (the Rozelle interchange) that would connect the M4-M5 Link mainline tunnels with:
  - City West Link
  - Anzac Bridge
  - The Iron Cove Link (see below)
  - The proposed future Western Harbour Tunnel and Beaches Link
- Construction of connections to the proposed future Western Harbour Tunnel and Beaches Link project as part of the Rozelle interchange, including:
  - Tunnels that would allow for underground mainline connections between the M4 East and New M5 motorways and the proposed future Western Harbour Tunnel and Beaches Link (via the M4-M5 Link mainline tunnels)
  - A dive structure and tunnel portals within the Rozelle Rail Yards, north of the City West Link / The Crescent intersection
  - Entry and exit ramps that would extend north underground from the tunnel portals in the

Rozelle Rail Yards to join the mainline connections to the proposed future Western Harbour Tunnel and Beaches Link

- A ventilation outlet and ancillary facilities as part of the Rozelle ventilation facility (see below)

- Twin tunnels that would connect Victoria Road near the eastern abutment of Iron Cove Bridge and Anzac Bridge (the Iron Cove Link). Underground entry and exit ramps would also provide a tunnel connection between the Iron Cove Link and the New M5 / St Peters interchange (via the M4-M5 Link mainline tunnels)
- The Rozelle surface works, including:
  - Realigning The Crescent at Annandale, including a new bridge over Whites Creek and modifications to the intersection with City West Link
  - A new intersection on City West Link around 300 metres west of the realigned position of The Crescent, which would provide a connection to and from the New M5/St Peters interchange (via the M4-M5 Link mainline tunnels)
  - Widening and improvement works to the channel and bank of Whites Creek between the light rail bridge and Rozelle Bay at Annandale, to manage flooding and drainage for the surface road network
  - Reconstructing the intersection of The Crescent and Victoria Road at Rozelle, including construction of a new bridge at Victoria Road
  - New and upgraded pedestrian and cyclist infrastructure
  - Landscaping, including the provision of new open space within the Rozelle Rail Yards
- The Iron Cove Link surface works, including:
  - Dive structures and tunnel portals between the westbound and eastbound Victoria Road carriageways, to connect Victoria Road east of Iron Cove Bridge with the Iron Cove Link
  - Realignment of the westbound (southern) carriageway of Victoria Road between Springside Street and the eastern abutment of Iron Cove Bridge
  - Modifications to the existing intersections between Victoria Road and Terry, Clubb, Toelle and Callan streets
  - Landscaping and the establishment of pedestrian and cycle infrastructure
- Five motorway operations complexes; one at Leichhardt (MOC1), three at Rozelle (Rozelle West (MOC2), Rozelle East (MOC3) and Iron Cove Link (MOC4)), and one at St Peters (MOC5). The types of facilities that would be contained within the motorway operations complexes would include substations, water treatment plants, ventilation facilities and outlets, offices, on-site storage and parking for employees
- Tunnel ventilation systems, including ventilation supply and exhaust facilities, axial fans, ventilation outlets and ventilation tunnels
- Three new ventilation facilities, including:
  - The Rozelle ventilation facility at Rozelle
  - The Iron Cove Link ventilation facility at Rozelle
  - The Campbell Road ventilation facility at St Peters
- Fitout (mechanical and electrical) of part of the Parramatta Road ventilation facility at Haberfield (which is currently being constructed as part of M4 East project) for use by the M4-M5 Link project
- Drainage infrastructure to collect surface and groundwater for treatment at dedicated facilities. Water treatment would occur at
  - Two operational water treatment facilities (at Leichhardt and Rozelle)
  - The constructed wetland within the Rozelle Rail Yards
  - A bioretention facility for stormwater runoff within the informal car park at King George Park at

Rozelle (adjacent to Manning Street). A section of the existing informal car park would also be upgraded, including sealing the car park surface and landscaping

- Treated water would flow back to existing watercourses via new, upgraded and existing infrastructure
- Ancillary infrastructure and operational facilities for electronic tolling and traffic control and signage (including electronic signage)
- Emergency access and evacuation facilities, including pedestrian and vehicular cross and long passages and fire and life safety systems
- Utility works, including protection and/or adjustment of existing utilities, removal of redundant utilities and installation of new utilities. A Utilities Management Strategy has been prepared for the project that identifies management options for utilities, including relocation or adjustment. Refer to **Appendix F** (Utilities Management Strategy) of the EIS.

The project does not include:

- Site management works at the Rozelle Rail Yards. These works were separately assessed and determined by Roads and Maritime through a Review of Environmental Factors under Part 5 of the EP&A Act (refer to **Chapter 2** (Assessment process) of the EIS)
- Ongoing motorway maintenance activities during operation
- Operation of the components of the Rozelle interchange which are the tunnels, ramps and associated infrastructure being constructed to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project.

Temporary construction ancillary facilities and temporary works to facilitate the construction of the project would also be required.

2.2.1 Staged construction and opening of the project

It is anticipated the project would be constructed and opened to traffic in two stages (as shown in **Figure 2-1**).

Stage 1 would include:

- Construction of the mainline tunnels between the M4 East at Haberfield and the New M5 at St Peters, stub tunnels to the Rozelle interchange (at the Inner West subsurface interchange) and ancillary infrastructure at the Darley Road motorway operations complex (MOC1) and Campbell Road motorway operations complex (MOC5)
- These works are anticipated to commence in 2018 with the mainline tunnels open to traffic in 2022. At the completion of Stage 1, the mainline tunnels would operate with two traffic lanes in each direction. This would increase to generally four lanes at the completion of Stage 2, when the full project is operational.

Stage 2 would include:

- Construction of the Rozelle interchange and Iron Cove Link including:
  - Connections to the stub tunnels at the Inner West subsurface interchange (built during Stage 1)
  - Ancillary infrastructure at the Rozelle West motorway operations complex (MOC2), Rozelle East motorway operations complex (MOC3) and Iron Cove Link motorway operations complex (MOC4)
  - Connections to the surface road network at Lilyfield and Rozelle
  - Construction of tunnels, ramps and associated infrastructure as part of the Rozelle interchange to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project
- Stage 2 works are expected to commence in 2019 with these components of the project open to traffic in 2023.

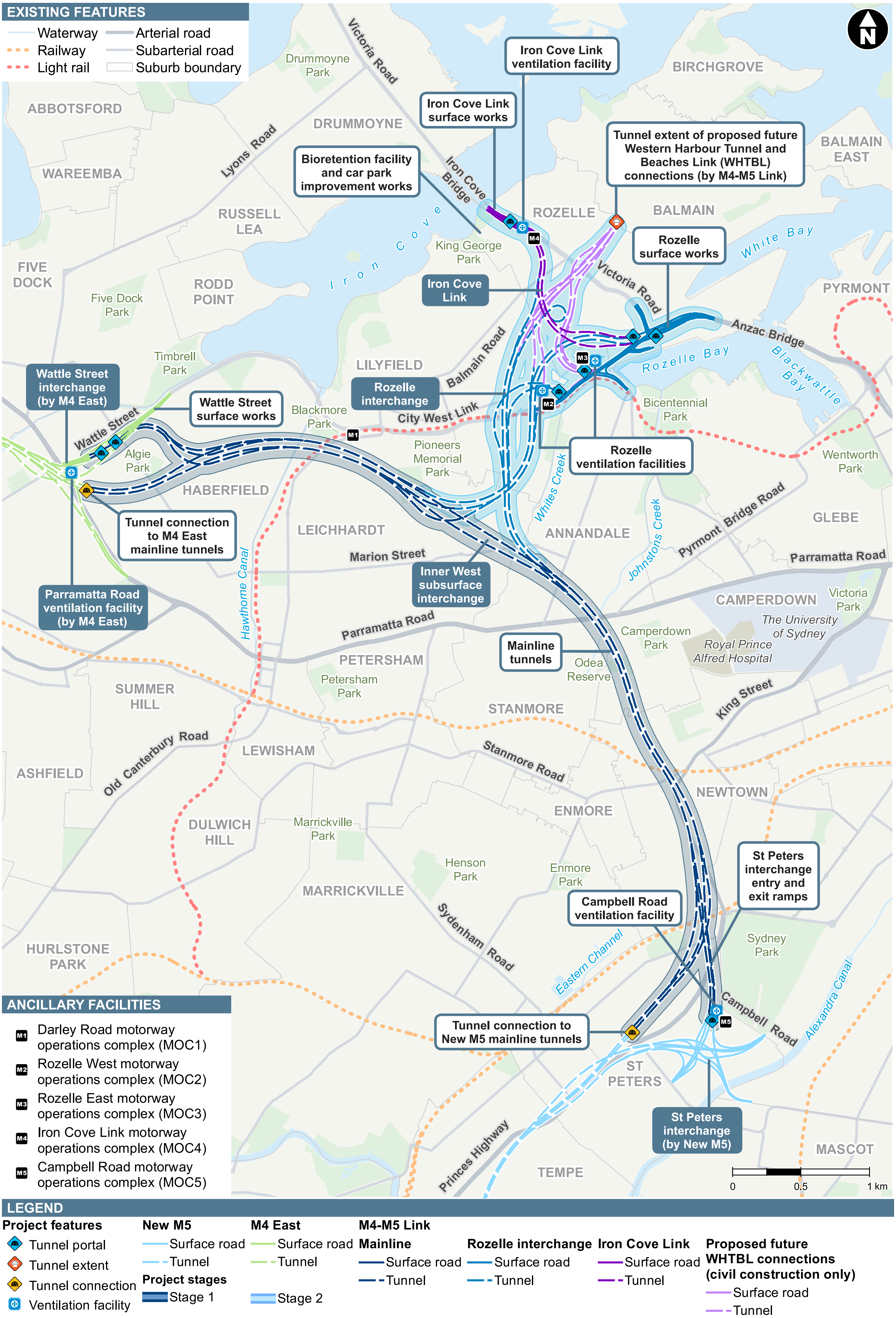


Figure 2-1 Overview of the project

2.3 Construction activities

An overview of the key construction features of the project is shown in **Figure 2-2** and would generally include:

- Enabling and temporary works, including provision of construction power and water supply, ancillary site establishment including establishment of acoustic sheds and construction hoarding, demolition works, property adjustments and public and active transport modifications (if required)
- Construction of the road tunnels, interchanges, intersections and roadside infrastructure
- Haulage of spoil generated during tunnelling and excavation activities
- Fitout of the road tunnels and support infrastructure, including ventilation and emergency response systems
- Construction and fitout of the motorway operations complexes and other ancillary operations buildings
- Realignment, modification or replacement of surface roads, bridges and underpasses
- Implementation of environmental management and pollution control facilities for the project.

A more detailed overview of construction activities is provided in **Table 2-1**.

Table 2-1 Overview of construction activities

Component	Typical activities
Site establishment and enabling works	• Vegetation clearing and removal • Utility works • Traffic management measures • Install safety and environmental controls • Install site fencing and hoarding • Establish temporary noise attenuation measures • Demolish buildings and structures • Carry out site clearing • Heritage salvage or conservation works (if required) • Establish construction ancillary facilities and access • Establish acoustic sheds • Supply utilities (including construction power) to construction facilities • Establish temporary pedestrian and cyclist diversions
Tunnelling	• Construct temporary access tunnels • Excavation of mainline tunnels, entry and exit ramps and associated tunnelled infrastructure and install ground support • Spoil management and haulage • Finishing works in tunnel and provision of permanent tunnel services • Test plant and equipment
Surface earthworks and structures	• Vegetation clearing and removal • Topsoil stripping • Excavate new cut and fill areas • Construct dive and cut-and-cover tunnel structures • Install stabilisation and excavation support (retention systems) such as sheet pile walls, diaphragm walls and secant pile walls (where required) • Construct required retaining structures • Excavate new road levels

Component	Typical activities
Bridge works	• Construct piers and abutments • Construct headstock • Construct bridge deck, slabs and girders • Demolish and remove redundant bridges
Drainage	• Construct new pits and pipes • Construct new groundwater drainage system • Connect drainage to existing network • Construct sumps in tunnels as required • Construct water quality basins, constructed wetland and bioretention facility and basin • Construct drainage channels • Construct spill containment basin • Construct onsite detention tanks • Adjustments to existing drainage infrastructure where impacted • Carry out widening and naturalisation of a section of Whites Creek • Demolish and remove redundant drainage
Pavement	• Lay select layers and base • Lay road pavement surfacing • Construct pavement drainage
Operational ancillary facilities	• Install ventilation systems and facilities • Construct water treatment facilities • Construct fire pump rooms and install water tanks • Test and commission plant and equipment • Construct electrical substations to supply permanent power to the project
Finishing works	• Line mark to new road surfaces • Erect directional and other signage and other roadside furniture such as street lighting • Erect toll gantries and other control systems • Construct pedestrian and cycle paths • Carry out earthworks at disturbed areas to establish the finished landform • Carry out landscaping • Closure and backfill of temporary access tunnels (except where these are to be used for inspection and/or maintenance purposes) • Site demobilisation and preparation of the site for a future use

Twelve construction ancillary facilities are described in this EIS (as listed below). To assist in informing the development of a construction methodology that would manage constructability constraints and the need for construction to occur in a safe and efficient manner, while minimising impacts on local communities, the environment, and users of the surrounding road and other transport networks, two possible combinations of construction ancillary facilities at Haberfield and Ashfield have been assessed in this EIS. The construction ancillary facilities that comprise these options have been grouped together in this EIS and are denoted by the suffix a (for Option A) or b (for Option B).

The construction ancillary facilities required to support construction of the project include:

- Construction ancillary facilities at Haberfield (Option A), comprising:
  - Wattle Street civil and tunnel site (C1a)
  - Haberfield civil and tunnel site (C2a)

  - Northcote Street civil site (C3a)
- Construction ancillary facilities at Ashfield and Haberfield (Option B), comprising:
  - Parramatta Road West civil and tunnel site (C1b)
  - Haberfield civil site (C2b)
  - Parramatta Road East civil site (C3b)
- Darley Road civil and tunnel site (C4)
- Rozelle civil and tunnel site (C5)
- The Crescent civil site (C6)
- Victoria Road civil site (C7)
- Iron Cove Link civil site (C8)
- Pyrmont Bridge Road tunnel site (C9)
- Campbell Road civil and tunnel site (C10).

The number, location and layout of construction ancillary facilities would be finalised as part of detailed construction planning during detailed design and would meet the environmental performance outcomes stated in the EIS and the Submissions and Preferred Infrastructure Report and satisfy criteria identified in any relevant conditions of approval.

The construction ancillary facilities would be used for a mix of civil surface works, tunnelling support, construction workforce parking and administrative purposes. Wherever possible, construction sites would be co-located with the operational footprint to minimise property acquisition and temporary disruption. The layout and access arrangements for the construction ancillary facilities are based on the concept design only and would be confirmed and refined in response to submissions received during the exhibition of this EIS and during detailed design.

2.3.1 Construction program

The total period of construction works for the project is expected to be around five years, with commissioning occurring concurrently with the final stages of construction. An indicative construction program is shown in **Table 2-2**.

Groundwater modelling predictions for the project have been based on an earlier project program and not the program in **Table 2-2**. The current indicative program shows construction of the mainline tunnels starting in Q3 2018 and finishing in Q4 2022 and the Rozelle interchange starting in Q4 2018 and finishing in Q3 2023. This change has no material impact on the findings of the groundwater assessment.

Table 2-2 Construction program overview

Construction activity	Indicative construction timeframe																							
	2018				2019				2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Mainline tunnels																								
Site establishment and establishment of construction ancillary facilities			■	■	■	■	■	■	■	■														
Utility works and connections			■	■	■	■	■	■																
Tunnel construction				■	■	■	■	■	■	■	■	■	■											
Portal construction				■	■	■	■	■																
Construction of permanent operational facilities												■	■	■	■	■								
Mechanical and electrical fitout works														■	■	■								
Establishment of tolling facilities															■	■								
Site rehabilitation and landscaping																■	■	■	■					
Surface road works																	■	■	■					
Demobilisation and rehabilitation																			■	■				
Testing and commissioning																■	■	■	■	■				
Rozelle interchange and Iron Cove Link																								
Site establishment and establishment of construction ancillary facilities				■	■	■	■	■	■															
Utility works and connections and site remediation				■	■	■	■	■																
Tunnel construction									■	■	■	■	■	■	■	■	■							
Portal construction						■	■	■	■															
Construction of surface road works						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
Construction of permanent operational facilities						■	■	■	■	■	■	■	■	■	■	■								
Mechanical and electrical fitout works													■	■	■	■	■	■	■	■				
Establishment of tolling facilities																		■	■					
Site rehabilitation and landscaping																			■	■	■			
Demobilisation and rehabilitation																						■	■	
Testing and commissioning																			■	■	■	■	■	

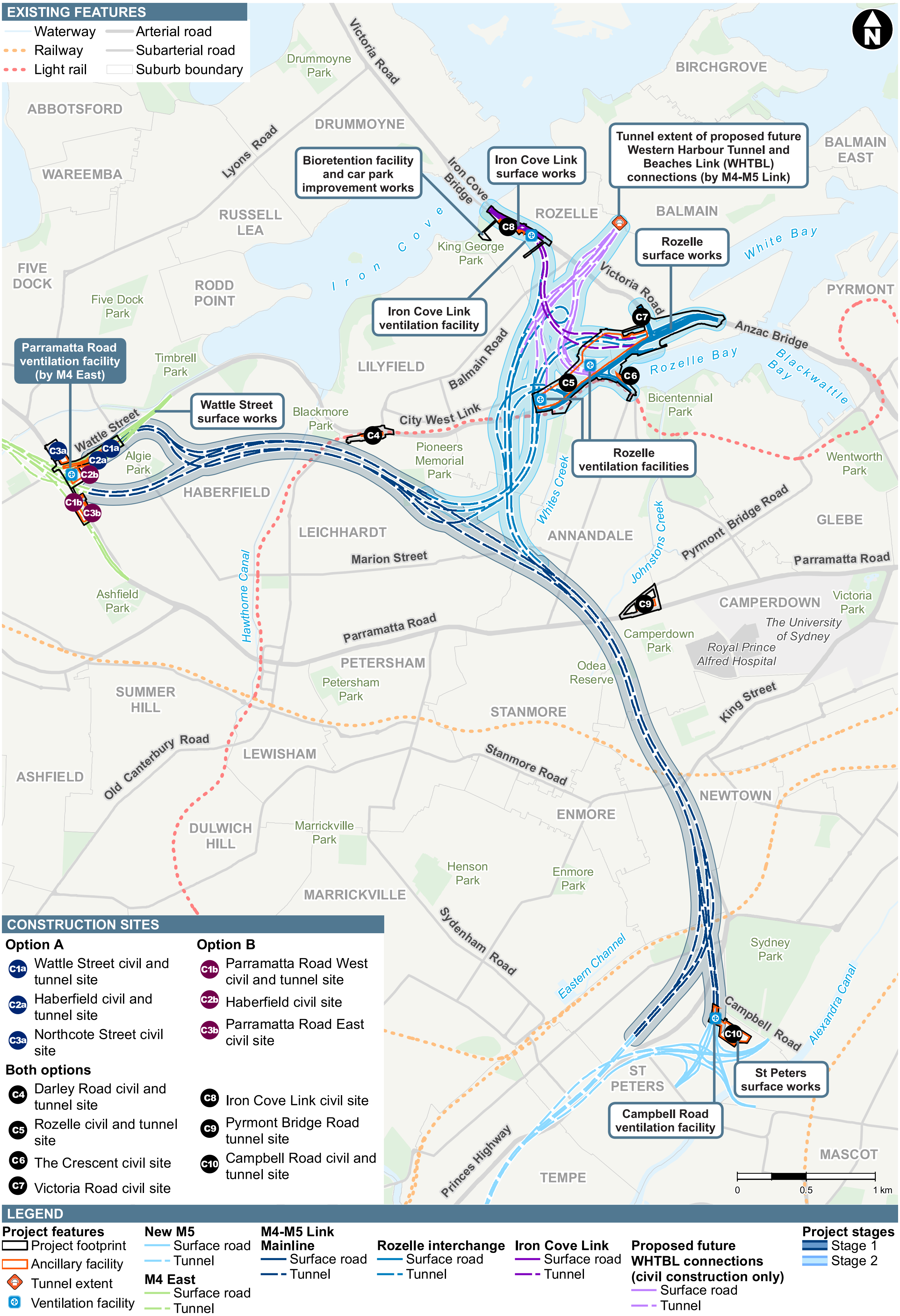


Figure 2-2 Overview of project footprint and ancillary facilities

2.3.2 Other project specific aspects

Construction program for M4 East and New M5

The construction programs for the M4 East and New M5 as outlined in their respective EIS's commenced in 2016 and are planned for completion in 2019 and 2020 respectively as outlined in **Table 2-3** and **Table 2-4**. These construction programs overlap with the M4-M5 Link construction program and have been included in the groundwater model to assess cumulative construction impacts.

Table 2-3 M4 East Construction program overview

Construction Activity	Indicative construction timeframe															
	2016				2017				2018				2019			
Shaft and decline excavations (all sites)		■	■	■												
Tunnelling (excavation)			■	■	■	■	■	■								
Tunnel drainage and pavement works						■	■	■	■	■						
Tunnel mechanical and electrical fitout								■	■	■	■					
Tunnel completion works											■	■	■			
Homebush Bay Drive ramps			■	■	■	■	■	■	■	■						
M4 Surface works		■	■	■	■	■	■	■	■	■	■	■				
Western ventilation facility							■	■	■	■	■					
Powells Creek on-ramp		■	■	■	■	■										
Concord Road interchange			■	■	■	■	■	■	■	■	■	■				
Wattle Street interchange		■	■	■	■	■	■	■	■	■	■	■	■			
Parramatta Road interchange		■	■	■	■	■	■	■	■	■	■	■	■			
Eastern ventilation facility		■	■	■	■	■	■	■	■	■	■	■				
Cintra Park fresh air supply facility				■	■	■	■	■	■	■	■	■	■			
Cintra Park water treatment facility										■	■	■				
Motorway operations complex						■	■	■								
Mechanical and electrical fitout works							■	■	■	■	■	■				
Site rehabilitation and landscaping						■	■	■	■	■	■	■	■			

Source: WestConnex Delivery Authority 2015

Table 2-4 New M5 Construction program overview

Construction Activity	Indicative construction timeframe															
	2016				2017				2018				2019			
Site establishment and establishment of construction ancillary facilities			■	■												
Landfill closure works			■	■	■	■	■	■								
Construction of western surface works			■	■	■	■	■	■	■	■	■	■	■			
Tunnel construction					■	■	■	■	■	■	■	■	■	■		
Construction of St Peters Interchange				■	■	■	■	■	■	■	■	■	■	■	■	
Portal construction					■	■	■	■	■	■						
Construction of local road upgrades				■	■	■	■	■	■	■	■	■	■	■		
Construction of permanent operational facilities							■	■	■	■	■	■	■	■	■	
Mechanical and electrical fitout works									■	■	■	■	■	■	■	■
Establishment of tolling facilities													■	■	■	■
Demobilisation and rehabilitation											■	■	■	■	■	■

Source: Roads and Maritime 2015

Tunnel lining

The project is designed predominately as a drained tunnel. That is, the tunnel would allow groundwater to seep into the tunnel with the water being collected in the tunnel drainage system, draining to sumps where the water is pumped to the surface for treatment. Drained tunnels are typically constructed in competent rock such as the Hawkesbury Sandstone and are typically constructed with some waterproofing to reduce groundwater inflows along particular tunnel sections. Allowing groundwater flow into the tunnel reduces an external hydrostatic pressure building up behind any tunnel lining in an undrained scenario, placing less stress on the underground infrastructure. It is intended that the waterproofing and drainage requirements for the M4-M5 Link tunnels would be consistent, as far as possible, the adjoining New M5 and M4 East tunnels. The exception is that at that tunnels intersecting alluvium beneath the Rozelle Rail Yards are to be constructed as tanked (undrained) tunnels to prevent alluvial groundwater inflow to the tunnels.

Where the tunnels or cut-and-cover sections intersect alluvium, or deeply weathered sandstone, groundwater inflows are likely to exceed inflow from the sandstone without the use of water proofing. To restrict groundwater inflow and potentially contaminated groundwater inflow into the tunnels, driven tunnel sections and cut-and-cover sections excavated within the alluvium and poor quality sandstone are to be tanked. Cut-and-cover sections through the alluvium would be constructed with diaphragm walls or secant pile walls, for example. This approach of restricting groundwater flow from the alluvium to minimise any contaminant migration is in accordance with the recommendations of DPI-Water.

The decision whether to tank parts of the tunnel or to construct an undrained tunnel is based on the lithology intersected, and whether to restrict potentially large groundwater inflows to mitigate potential impacts. Other considerations as to whether or not to tank the tunnels are to compare the two options through a whole of life cost assessment. Under a tanking scenario, the construction costs are substantially higher but ongoing maintenance and operation costs associated with corrosion of drainage and treatment systems are reduced. Conversely in a predominately un-tanked scenario, the construction costs would be lower but the ongoing maintenance costs of water collection and ongoing treatment and disposal of groundwater would be higher.

Based on the current design, the total length of tunnel sections, including ventilation shafts, for the Rozelle interchange, Iron Cove Link, Western Harbour Link stub tunnels and mainline tunnels is

47,943 metres. Of this total 44,951 metres are drained tunnels and 2,992 metres are undrained tunnels as summarised in **Table 2-5** The tunnel sections at Rozelle outlining lengths of drained tunnels, tanked tunnels, cut and cover sections, trough structures and ventilation tunnels is shown on **Figure 2-3**. The design, and subsequent length of tunnel sections, may change during detailed design. A detailed groundwater model will be developed by the construction contractor.

The tunnel lengths for the mainline tunnel and Rozelle interchange are summarised in **Table 2-5**. In the Rozelle interchange, the percentage of tanked tunnel (6.2 per cent) is higher than along the mainline tunnel (1.8 per cent) due to the presence of alluvium associated with the Whites Creek palaeochannel at Rozelle.

Table 2-5 Indicative tunnel lengths along the mainline tunnel and Rozelle interchange

Tunnel elements	Mainline tunnel (m)		Rozelle interchange (m)		Total
	Drained	Undrained	Drained	Undrained	
Motorway tunnel length	19,556	2,006	19,504	986	42,052
Other tunnel length (ventilation tunnels and construction access tunnels)	1,248	-	4,643	-	5,891
Total	**20,804**	**2,006**	**24,147**	**986**	**47,943**
Total drained					**44,951**
Total undrained					**2,992**

During construction, local grouting may be required in some sections of the tunnels to reduce rock permeability in order to meet the groundwater inflow criterion of one litre per second per kilometre for any kilometre length of tunnel. As such, the approach to control water ingress into the undrained tunnel through rock defects consists of a suite of options, ranging from areas where no waterproofing may be required to areas where grouting or tanking may be required and/or a membrane may need to be applied to divert water into the drainage system.

There are some parts of the tunnel that would intersect fractured shale and secondary geological structural features such as faults, joint sets, dykes and shear zones, which without waterproofing, could result in higher groundwater ingress to the tunnel above the design criterion. At the portals, where the tunnels dive below the ground surface, cut-off walls would be installed along cut-and-cover sections to reduce groundwater ingress into the portals. At the Wattle Street interchange, portal cut-off walls would be required to reduce groundwater ingress from the alluvium. Similarly, at the Rozelle interchange, the cut-and-cover approaches from the west and some portals would be constructed within saturated alluvium and would require excavation support options such as diaphragm walls or a cut-off wall option (for example) to control groundwater. During construction, localised dewatering within the alluvium may also be required. In this case dewatering is the process of removing groundwater from part of an aquifer, by pumping or some other mechanism, to produce temporary dry conditions during construction. Once the dewatering is completed and the pumps are switched off, groundwater levels would return to their natural pre-construction conditions.

In areas of high local hydraulic conductivity and elevated groundwater ingress, the natural rock mass permeability would be reduced during construction, for example by the use of shotcrete and grout. Various construction methodologies would be required to reduce groundwater ingress to below the limit of one litre per second across any given kilometre of tunnel. The methods to reduce groundwater ingress would be confirmed during detailed design and potentially include the option of installation of tunnel lining progressively as the roadheaders advance.

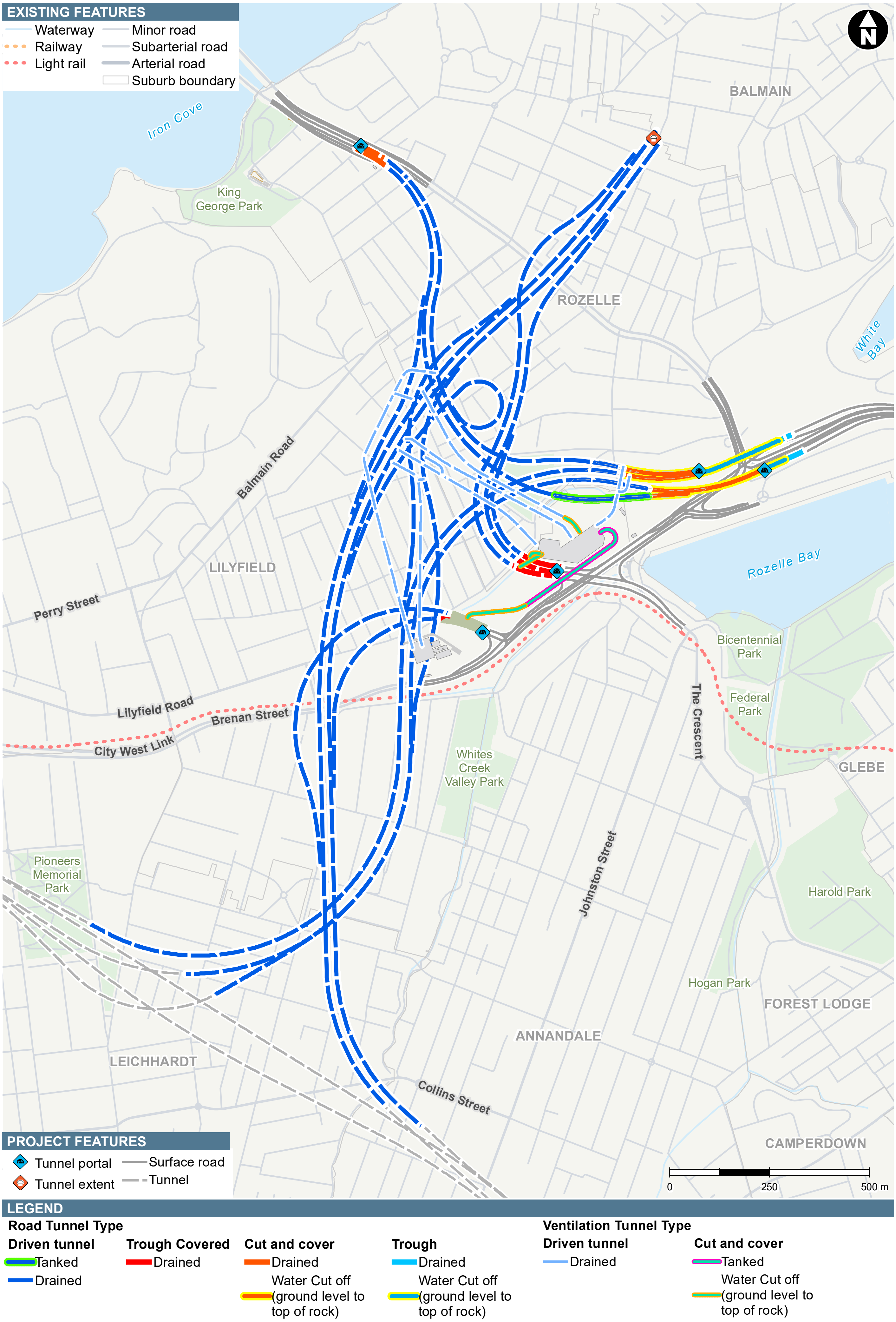


Figure 2-3 Indicative extent of drained and undrained tunnel sections at Rozelle

During operation of the tunnel, groundwater management would be controlled under low and medium groundwater inflow conditions (AECOM 2016f). For tunnel sections with low groundwater inflows and where water ingress is observed, strip drains at regular spacing and/or across the roof of the tunnel may be incorporated within a permanent tunnel drainage system. If required, the strip drains would be incorporated in the shotcrete lining. A similar detail would apply to the tunnel walls.

Groundwater inflows are more likely to be higher in tunnel sections with non-localised inflows from discontinuities such as shear zones or faults, or where the drainage capacity of strip drains is exceeded. In this instance, full coverage by a waterproof geomembrane from the tunnel crown to the invert level, for example, may be required to be incorporated with the permanent tunnel drainage system. The tunnel structure would be designed as 'drained' allowing the external groundwater to flow into the tunnel void and prevent the build-up of hydrostatic pressure. The waterproof membrane would be incorporated between the initial shotcrete layer and the final shotcrete or cast *in situ* concrete lining. In general, the waterproof membrane would be either a spray-applied membrane or pre-formed sheets or geo-membranes fixed to the tunnel excavation.

Fully tanked tunnels are required in areas where the estimated groundwater inflow is expected to exceed the design criterion of one litre per second per kilometre for any kilometre length of tunnel) due to high ground mass permeability and high groundwater levels. An option in such tunnels is to install a full perimeter waterproofing membrane around the exterior of the tunnel lining, including the invert, to form an 'undrained' tunnel. In this case the undrained tunnel is designed for the exterior hydrostatic pressure.

Groundwater collection and treatment system

During construction, groundwater inflows would be directed behind the roadheader and collected via a temporary tunnel drainage system and pumped to the surface for water quality treatment prior to discharge. Water treatment would address a series of analytes as outlined in the Construction Environment Management Plan (CEMP), to reduce turbidity, salinity and identified contamination.

During construction, the wastewater generated in the tunnel would be captured, tested and treated at a construction water treatment plant (if required) prior to reuse or discharge, or disposal offsite if required (refer to **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS).

Monitoring of groundwater flows and water quality would be undertaken during construction in accordance with a Construction Soil and Water Management Plan (CSWMP) which would form part of the CEMP and would address groundwater management and monitoring. The monitoring would be used to inform the operators of the water treatment plant of water quality.

The primary features of the drainage design for the collection of groundwater during operation of the tunnels include:

- Provide for the collection of sub-surface water seepage
- Collect water from ventilation shafts and tunnels
- Allow for cleaning and maintenance of the drainage system.

The operational tunnel design would incorporate a permanent drainage system and sumps at low points to capture groundwater ingress. The proposed water infrastructure for the operation of the project includes constructed wetlands and water treatment facilities for the management of surface and groundwater. Groundwater is to be treated at the permanent water treatment plants to be construction at the Darley Road motorway operations complex (MOC1) in Leichhardt, and at the Rozelle East motorway operations complex (MOC 3).

Water treatment and the advantages of discharge to the proposed wetlands at Rozelle are discussed further in sections 2.4.2, 6.3.3 and 9.2 of **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS.

Tunnel design

The M4-M5 Link project has been designed primarily as a drained tunnel. The design of the project has had consideration to minimising water inflow into the tunnels whereby:

- The vertical alignment of the proposed tunnels would dive beneath palaeochannels where possible to reduce groundwater and surface water inflows into the tunnels. Where the project footprint intersects palaeochannels, the tunnels would be tanked to prevent groundwater inflow in these areas
- The horizontal alignment maximises the extent of the project footprint within competent Hawkesbury Sandstone and minimises the alignment traversing immediately beneath sensitive environmental areas, creeks and wetlands to reduce the risk of surface water leakage.

Undrained (tanked) tunnels

Undrained or tanked tunnels limit the groundwater ingress into the tunnel to small inflows (typically resulting in minor seepage into the tunnel) by the installation of a structural lining which can resist the groundwater pore pressure, combined with a waterproofing system.

Undrained (tanked) tunnels are typically specified to achieve one or more of the following objectives:

- Limit drawdown of the water table to mitigate:
  1) Loss of baseflow to creeks that may adversely affect sensitive groundwater dependent ecosystems (GDEs)
  2) Reduction in groundwater levels in registered boreholes used for water supply
  3) Damage to existing infrastructure due to the settlement of compressible soils
  4) Reduction in surface subsidence due to groundwater drawdown.
- Limit groundwater ingress into the tunnel to mitigate:
  1) Corrosion which may damage internal tunnel assets, drainage and treatment systems due to corrosive groundwater
  2) Blockage of tunnel drainage systems and high maintenance requirements due to sludge precipitating from groundwater with high natural iron and manganese concentrations
  3) Treatment and discharge of potentially saline or low pH groundwater.

Ground conditions within the project footprint are expected to have similar hydrogeological conditions to those experienced by other major Sydney drained tunnels that have been successfully constructed. Other WestConnex tunnels including the New M5 are to be constructed as drained (un-tanked) tunnels. With the exception of Lane Cove Tunnel and the Cross City Tunnel, long term monitored groundwater inflows along other tunnels (Eastern Distributor, M5 East Motorway, Epping to Chatswood Rail, Northside storage tunnel, Cross City Tunnel) have averaged below one litre per second per kilometre.

In general, NSW DPI-Water does not support an activity that causes perpetual inflow volumes, so as to protect the sustainability of the natural resource. To minimise groundwater impacts within the alluvium beneath the Rozelle Rail Yards, sections of the tunnel are to be tanked. Within this EIS, the potential impacts of the drained (un-tanked) tunnels on the natural and built environments are fully assessed. Alteration of the tunnel design from a drained tunnel to an undrained (fully tanked) tunnel is feasible, however would potentially prohibitively increase project construction costs.

3 Assessment methodology

3.1 Relevant guidelines and policies

Groundwater in NSW is managed by DPI-Water under the *Water Act 1912* (NSW) (Water Act) and the *Water Management Act 2000* (NSW) (WM Act). The WM Act is gradually replacing the planning and management frameworks in the Water Act although some provisions of the Water Act remain in operation. The WM Act regulates water use for rivers and aquifers where water sharing plans have commenced, while the Water Act continues to operate in the remaining areas of the state. If an activity results in a nett loss of either groundwater or surface water from a source covered by a water sharing plan, then an approval and/or license is required. The WM Act requires:

- A water access licence to take water
- A water supply works approval to construct a work
- A water use approval to use the water.

The AIP (NoW 2012) explains the process of administering water policy under the WM Act for activities that interfere with the aquifer. The AIP outlines the assessment process and modelling criteria that DPI-Water apply to assess aquifer interference projects. This assessment process and modelling criteria have been adopted for this hydrogeological assessment. Minimum impact considerations required under the AIP, for example, have been assessed for the project and are outlined in **section 9** of this report.

Key components of the AIP are:

- Where an activity results in the loss of water from the environment, a water access licence (WAL) is required under the WM Act to account for this water take
- An activity must address minimal impact considerations in relation to the water table, groundwater pressure and groundwater quality
- Where the actual impacts of an activity are greater than predicted, planning measures must be put in place ensuring there is sufficient monitoring.

The project footprint is located in the *Greater Metropolitan Region Groundwater Source Water Sharing Plan* (the Plan) (NoW 2011) which commenced on 1 July 2011. Within the Plan, the project footprint is subject to the rules of the Sydney Basin Central Groundwater Source which outline the recommended management approaches of surface and groundwater connectivity, minimisation of interference between neighbouring water supply works, protection of water quality and sensitive environmental areas and limitations to the availability of water. The Sydney Basin Central Groundwater Source covers the majority of the project footprint and is a porous hard rock aquifer. Any minor groundwater within alluvium or the regolith overlying the Hawkesbury Sandstone or Ashfield Shale is considered to be part of the porous rock groundwater source. Therefore, the un-mapped alluvium does not have an assigned extraction limit and any ‘take’ would come from the underlying porous rock source (NoW 2011).

Groundwater within the Sydney Basin Central Groundwater Source is declared a less productive groundwater source by NoW and thus the less productive minimal impact considerations of the AIP with respect to porous and fractured rock water sources apply. Key considerations for the Sydney Basin Central Groundwater Source with respect to the level 1 minimal harm considerations of the AIP are:

- Water table impacts:
  - Less than or equal to 10 per cent cumulative variation in the water table allowing for typical climatic ‘post-water sharing plan’ variations, 40 metres from any high priority groundwater dependent ecosystem or high priority culturally significant site listed in the Schedule of the water sharing plan
  - A maximum of two metres cumulative decline at any water supply works

- Water pressure impacts:
  - A cumulative pressure head decline of not more than two metres at any supply work
- Water quality impacts:
  - Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.

These impacts are specifically addressed in **section 9.2**.

The project footprint flanks the Botany Sands aquifer, an alluvial and coastal sand bed located to the east of the project footprint near St Peters, extending to the north and south along the coastal fringe. The aquifer is managed under Zone 2 of the Botany Sands Groundwater Source Management Zone. Although the tunnels do not intersect the Botany Sands, it is possible the project could impact the hydrogeological regime of the Botany Sands due to hydraulic connection with the Ashfield Shale or Hawkesbury Sandstone. Consequently, the potential impacts on the Botany Sands Groundwater Source have been assessed in this investigation.

Groundwater within Zone 2 of the Botany Sands Groundwater Source Management Zone is declared a highly productive groundwater source by DPI-Water despite the considerable contamination and groundwater extraction embargos due to this contamination. Consequently, the highly productive minimal impact considerations of the AIP with respect to coastal aquifer water sources apply. The location of the Groundwater Management Areas relative to the WestConnex projects is shown on **Figure 3-1**.

Developments conducted on waterfront land, such as adjacent to Sydney Harbour and along major creeks and canals, are regulated by the WM Act in accordance with the *Guidelines for riparian corridors on waterfront land* (DPI-Water 2012). These guidelines state that waterfront land includes the bed and bank of any river, lake or estuary and all land within 40 metres of the highest bank of the waterbody. The project footprint includes waterfront land as defined by the guidelines, as it is within 40 metres of Rozelle Bay and Iron Cove. Controlled activities on waterfront land are administered by DPI-Water and include removal of vegetation, earthworks and construction of temporary detention basins. A controlled activity approval must be obtained from DPI-Water prior to commencing the controlled activity, however a water use approval under section 89, a water management work approval under section 90 or an activity approval (other than an aquifer interference approval) under section 91 of the WM Act are not required for SSI projects.

An overview of the relevant legislation and policy and their project implications is provided in **Table 3-1**.

Figure 3-1 Groundwater management areas (from HydroSimulations 2017)

Table 3-1 Overview of relevant groundwater legislation and policy

Policy	Relevance
Water Management Act 2000 (NSW)	• State significant infrastructure projects are exempt from requiring some water supply works approvals and controlled activity approvals • Aquifer interference activity approval provisions have not yet commenced but are administered under the (WM Act) • Water sharing plans are administered under this Act.
Water Act 1912 (NSW)	• Administration of water access licences and the trade of water licences and allocations.
NSW Aquifer Interference Policy (NoW 2012)	• Manages the impacts of aquifer interference activities in accordance with the (WM Act) *2000* and Water Sharing Plans • Aquifer interference activities must address minimal impact considerations as outlined in the policy • In the event that actual impacts are greater than predicted there should be sufficient monitoring in place.
Water Sharing Plan, Greater Metropolitan Region Groundwater Sources (NoW 2011)	• Water Sharing Plans manage the long term surface and groundwater resources of a defined area • The plan outlines rules for the sharing and sustainability of water between various uses such as town water supply, stock and domestic, industry and irrigation.

This report has been prepared with reference to the following applicable documents:

- *NSW State Groundwater Policy Framework Document* (NSW Department of Land and Water Conservation (DLWC) 1998)
- *NSW Groundwater Quality Protection Policy* (DLWC 1998)
- *NSW Groundwater Dependent Ecosystems Policy* (DLWC 2002)
- *NSW Groundwater Quantity Management Policy* (DLWC undated)
- *Risk assessment guidelines for groundwater dependent ecosystems* (NSW Office of Water (NoW) 2013a)
- Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) *National Water Quality Management Strategy Australian Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000)
- *NSW Water Extraction Monitoring Policy* (NSW Department of Water and Energy (DWE) 2007)
- *NSW Aquifer Interference Policy* (NoW 2012)
- *Guidelines for riparian corridors on waterfront land* (DPI 2012)
- *Acid Sulfate Soils Assessment Guidelines* (NSW Department of Planning (DoP) 2008)
- *Acid Sulfate Soils Manual* (Acid Sulfate Soils Management Advisory Committee 1998)
- *Framework for Biodiversity Assessment – Appendix 2* (NSW Office of Environment and Heritage (OEH) 2014)
- *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom 2004) *and Volume 2* (A. Installation of Services; B. Waste Landfills; C. Unsealed Roads; D. Main Roads; Mines and Quarries) (NSW Department of Environment, Climate Change (DECC) 2008)
- *NSW Sustainable Design Guidelines Version 3.0* (Transport for NSW 2013)
- *WestConnex Sustainability Strategy* (SMC 2015)

- *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (NoW 2012)
- *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (NSW Department of Environment and Conservation (DEC) 2006)
- *Approved Methods for sampling and Analysis of Water Pollutants in NSW* (DECC 2008).
- *Overview of the Australian Guidelines for Water Recycling: Managing Health and the Environmental Risks. National Resource Management Ministerial Council Environmental Protection and Heritage Council. Australian Health Ministers Conference, 2006.*

3.2 Key assumptions

The following key assumptions have been made in relation to this assessment:

- A worst case inflow rate to the tunnels of one litre per second per kilometre for any kilometre length of tunnel has been assumed, which is consistent with the maximum allowed design inflow criterion for the project
- The amount of baseline monitoring data available at the time of preparing the EIS (12 months of monitoring data since June 2016) satisfies the conditions of the AIP. Additional time series groundwater monitoring data from the edges of the project footprint from the M4 East and New M5 WestConnex projects has been collated for this impact assessment. At the time of groundwater modelling calibration, nine months of transient water level data was available
- The hydrogeological properties used in the impact assessment are based on bulk average hydrogeological properties derived from desktop investigations and from field data collected during the hydrogeological investigations conducted to support this impact assessment
- Surface water in the Parramatta River, Rozelle Bay and Sydney Harbour would control groundwater levels in the study area and prevent large scale lowering of the water table
- The M4-M5 Link mainline tunnels are mostly below sea level and thus groundwater gradients from the surface waterbodies would be towards the tunnels
- The cumulative impact assessment considers potential impacts from the existing M5 East tunnels and the proposed M4 East and New M5 tunnels which are under construction
- A qualitative assessment on the cumulative impacts for future and current tunnel projects has been considered, including Sydney Metro, and the proposed future Western Harbour Tunnel and Beaches Link and F6 Extension projects.

3.3 Assessment methodology

To satisfy the SEARs, the groundwater assessment methodology for the hydrogeological impact assessment has been prepared to consider the regulatory aspects of the Greater Sydney regional groundwater resources as follows:

- Collation of available geological and hydrogeological data including monitoring data for input into the numerical groundwater model
- Desktop investigation to describe the existing environment, accessing government databases as required and reviewing existing reports
- Preparation of a description of the major features of the project and potential impacts on groundwater in terms of quality and groundwater levels
- Identification of groundwater dependent ecosystems and groundwater users
- Preparation of a calibrated numerical groundwater model (steady state and transient models) to simulate the hydrogeological conditions along the project footprint, predict impacts on groundwater dependencies and users, calculate groundwater drawdown and prepare a water balance
- Quantification of potential impacts during construction and the operation of the project, through the groundwater model, including groundwater drawdown at groundwater dependencies and

groundwater users, groundwater inflows and changes to groundwater quality due to potential saltwater intrusion

- Qualitative assessment of design refinements made post groundwater modelling, including assessment of the EIS construction “Option B” at Haberfield, which proposes construction access tunnelling at Parramatta Road rather than at Wattle Street, and the proposed bifurcation of the proposed Inner West subsurface interchange located underground at Leichhardt and Annandale
- Preparation of an outline of a groundwater monitoring and management plan for the construction and operational phases of the project with consideration of the requirements of the AIP
- Conducting a minimal impact assessment in accordance with the AIP
- Assess cumulative impacts of the project on the local hydrogeological regime taking into account the construction and operation of other infrastructure including the New M5, M4 East, and existing M5 East tunnels
- Outlining appropriate mitigation and management measures to eliminate or reduce the potential impact on the groundwater regime.

3.3.1 Desktop assessment

The following database searches were conducted to summarise the existing environment:

- *Australian Soils Resource Information System acid sulfate soils*, accessed December 2016
- Bureau of Meteorology (BoM) 2016 *Australian Groundwater Explorer*, (formerly DPI-Water groundwater database) accessed December 2016
- *Greater Metropolitan Regional Groundwater Sources Water Sharing Plan*, Appendix 4
- BoM 2016 *Atlas of Groundwater Dependent Ecosystems*, accessed October 2016
- BoM 2017 online climate data, accessed March 2017
- NSW EPA Contaminated Land Record, accessed November 2016.

3.3.2 Field investigation

A field program was conducted by AECOM to construct a groundwater monitoring network and collect baseline data as follows:

Monitoring well installation

The M4-M5 Link geotechnical drilling program was undertaken between May 2016 and May 2017. During the drilling program, 58 selected boreholes were converted to monitoring wells. The locations of monitoring wells constructed throughout this investigation are presented on **Figure 3-2**. Monitoring well location selection was based on the initial project design and subsequent changes to during design development. Consequently, some monitoring wells have become redundant as the alignment has changed during the development of the concept. Screen sections were selected in the expected tunnel zone over lithologies that displayed the most secondary structural features to provide a good connection between the monitoring well and screened aquifer. At some locations where alluvium was present, nested monitoring wells were constructed. A schematic diagram of the monitoring well construction is shown on **Figure 3-3**. Monitoring wells were constructed with bentonite seals either side of the well screen and at ground surface to minimise the risk of groundwater migration from other aquifers and surface water ingress. At the completion of the monitoring well installation, airlift development was conducted to remove silt and clay particles from the well and to ensure good hydraulic connection between the well and the aquifer.

The majority of monitoring wells targeted the Hawkesbury Sandstone (39). Eight wells targeted the Ashfield Shale, one targeted the Mittagong Formation and ten intersect the alluvial sediments flanking creeks and canals. Monitoring wells have been constructed within the Botany Sands aquifer as part of the New M5 project and would be monitored during the New M5 and M4-M5 Link construction phases. All monitoring wells were completed with a three metre well screen installed opposite the expected tunnel zone to depths up to 59 metres (RZ_BH60, Rozelle interchange). Monitoring well construction details are summarised in Table B1, **Annexure B** and project borelogs are presented in **Annexure F**.

Packer tests

Packer tests or *in situ* water pressure tests were conducted on selected boreholes to calculate the bulk hydraulic conductivity of the test interval during the drilling program. The packer testing involves hydraulically isolating an interval within the borehole up to 10 metres thick with inflatable packers and injecting water into the interval under various pressures. The water flow into the borehole is recorded over a range of ascending and descending water pressures. The packer test analysis is based on the flow of water into the test section with the measured water inflow being proportional to the hydraulic conductivity. The packer test results were interpreted in accordance with the British Standards and Houlsby (1976).

Laboratory testing of hydraulic conductivity and porosity

Selected HQ core samples (63.5 millimetre diameter) about 0.25 metres long were collected during the field program for laboratory testing of vertical hydraulic conductivity (K_v) and porosity. The data was used to support the groundwater modelling. The packer test data provided horizontal hydraulic conductivity (K_h) data. Laboratory testing was undertaken by Macquarie Geotech at their National Association of Testing Authorities (NATA) accredited Alexandria laboratory in accordance with Australian Standards. Hydraulic conductivity testing was conducted by the constant head method using a flexible wall permeameter AS1289 6.7.3. Porosity testing was conducted by the saturation and calliper techniques AS4133 2.1.1.

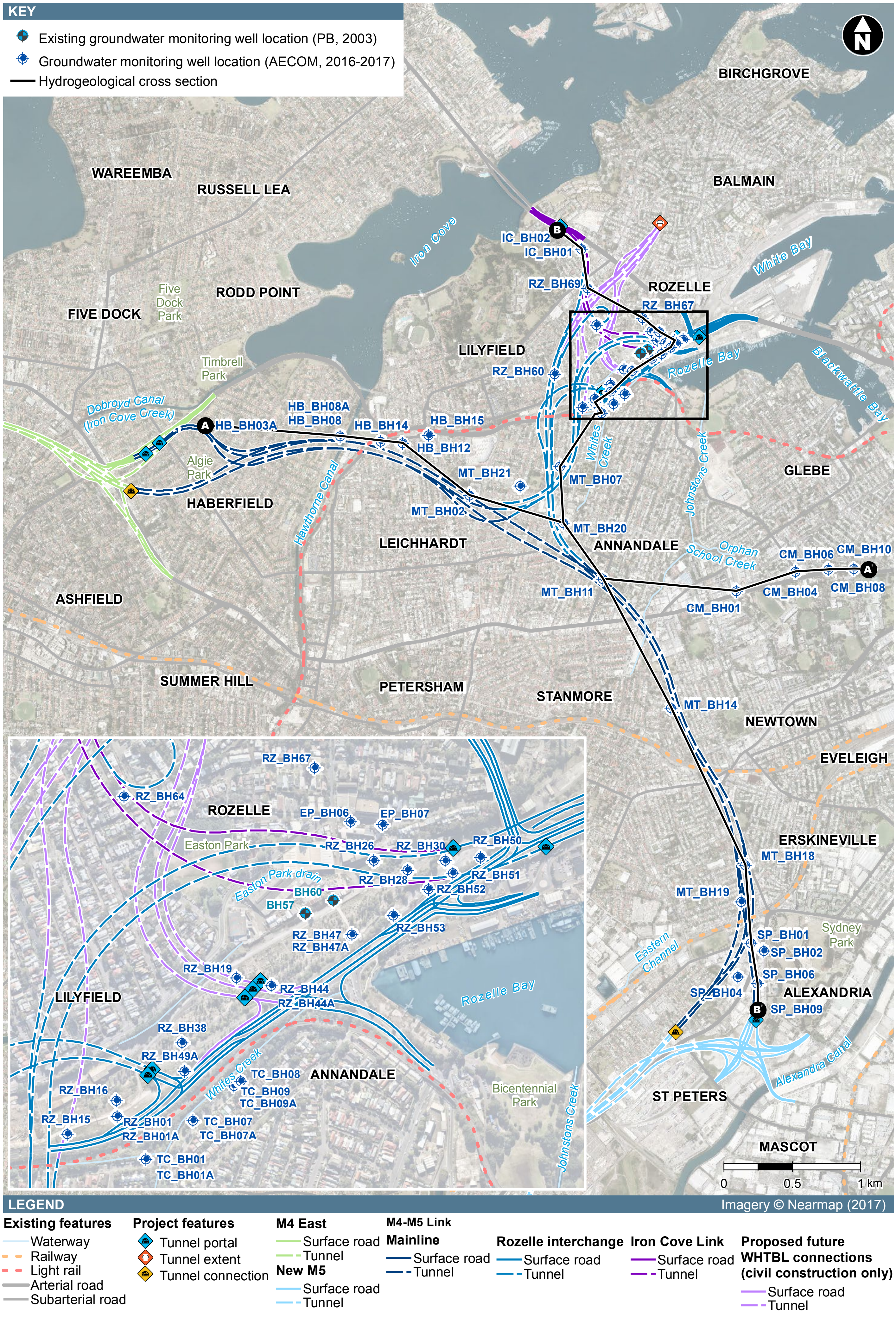


Figure 3-2 Location of monitoring wells

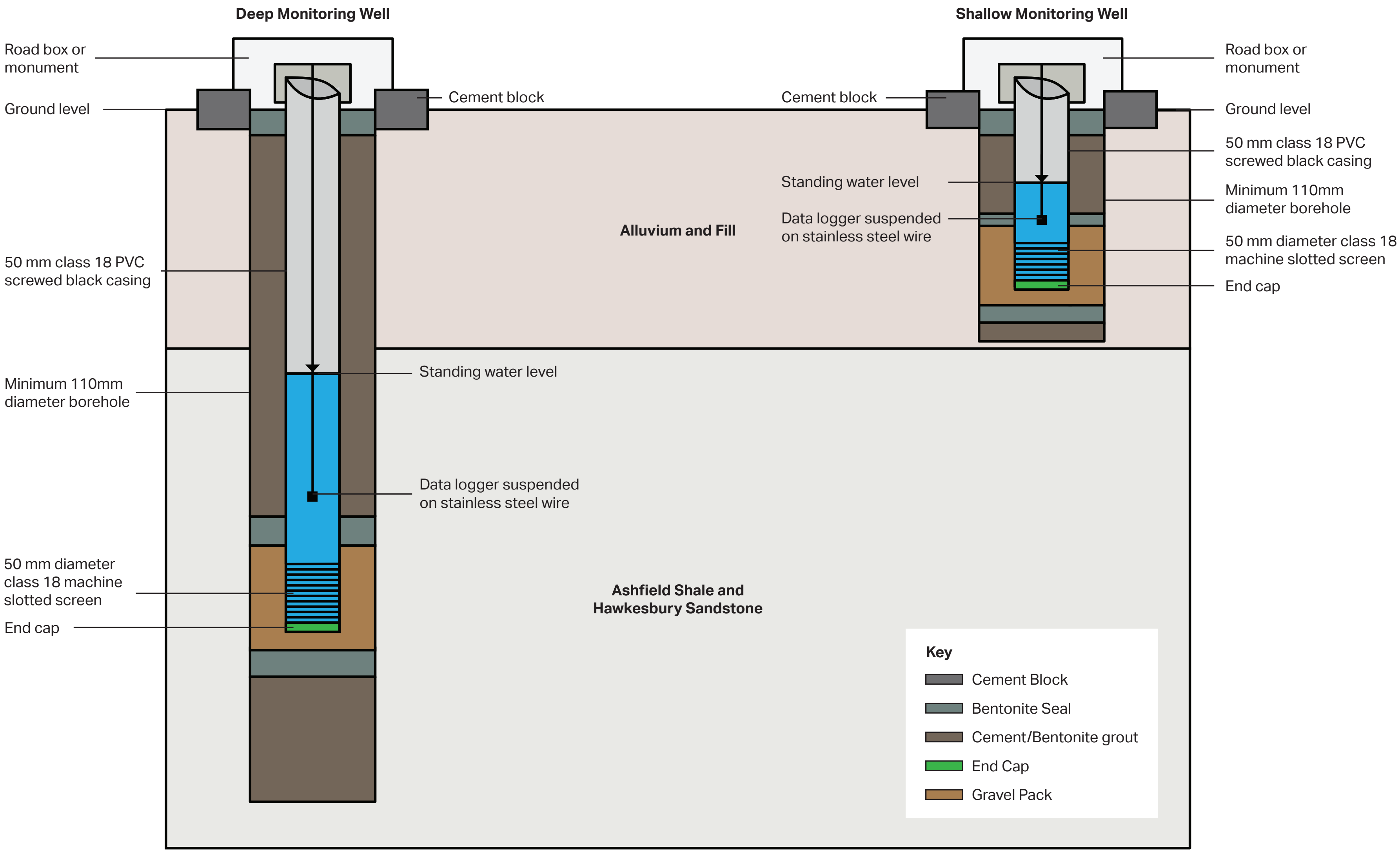


Figure 3-3 Monitoring well construction - schematic diagram

Groundwater gauging

Groundwater gauging was conducted throughout the field program, measuring standing water levels manually with an electronic dipper monthly since July 2016. Data loggers were installed in each of the monitoring wells after well development. The data loggers were installed to measure groundwater level fluctuations automatically at one hourly intervals. The loggers were suspended in each borehole at a depth of about five metres below the standing water level. Once collated, the data is presented in hydrographs and compared to daily rainfall measured at Sydney Observatory (**Annexure C**).

Groundwater sampling and hydrogeochemical analysis

Groundwater samples were collected from the monitoring well network for laboratory analysis (AECOM 2016c,e, AECOM 2017c,e) following development. Analytes included: heavy metals and metalloids (arsenic, cadmium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel and zinc), nutrients (nitrate, nitrite, ammonia and reactive phosphorous), total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene, xylene and naphthalene (BTEXN), polycyclic aromatic hydrocarbons (PAHs), inorganics (including major anions and cations, alkalinity, electrical conductivity, ionic balance, total dissolved solids, pH and hardness), organochlorine pesticides (OCPs), organophosphate pesticides (OPPs), semi volatile organic hydrocarbons (SVOCs) and volatile organic compounds (VOCs).

The monitoring wells were sampled monthly using low flow sampling or a double valve stainless steel bailer. Sampling was typically scheduled for the middle of the month. During groundwater sampling, discharge water was directed through a flow cell to measure the field parameters including dissolved oxygen, electrical conductivity, pH, temperature and redox conditions.

3.3.3 Groundwater numerical modelling

A three-dimensional numerical groundwater model was developed to simulate existing groundwater conditions, project footprint, caverns and associated subsurface ancillary infrastructure. The model domain extends over a study area of 121 square kilometres, with the northern boundary represented by the central channel of Sydney Harbour/Parramatta River. The active domain is centred on the project, and partially includes neighbouring M4 East and New M5 projects. The model domain is shown on **Figure 3-4**. The groundwater model was used to predict future groundwater conditions and potential impacts related to the project. Both steady state and transient models were developed and calibrated.

The groundwater model was prepared by HydroSimulations (HydroSimulations 2017). The groundwater modelling report, which describes the model design, parameters, grid, hydraulic boundaries and assumptions, is provided in **Annexure H**. The groundwater model was peer reviewed in accordance with Australian Groundwater Modelling Guidelines (Barnett *et al* 2012).

Groundwater model development methodology

The model was developed in accordance with Barnett *et al* 2012 as follows:

- Review of appropriate modelling platforms best suited to the required predictive modelling along a linear feature
- Desktop review of relevant geological and hydrogeological reports within the Sydney Basin
- Desktop review of recent tunnelling projects within the Sydney region
- Collation of data and analysis of aquifer parameters
- Development of a hydrogeological conceptual model
- Model development including setting model boundaries, layers, model discretisation and selection of interfaces to simulate surface waterbodies and the interaction with groundwater
- Model calibration
- Sensitivity analysis
- Model predictions.

Numerical modelling has been undertaken using geographic information systems (GIS) in conjunction with MODFLOW-USG (Version 1.2), which is distributed by the United States Geological Survey (USGS). MODFLOW-USG is a relatively new version of the popular MODFLOW code (McDonald and Harbaugh 1988) developed by the USGS. MODFLOW is the most widely used code for groundwater modelling and is presently considered an industry standard. MODFLOW applies a series of modules to simulate hydrogeological conditions such as recharge (RCH), rivers (RIV), drains (DRN) and evapotranspiration (ET, EVT). MODFLOW is the industry standard groundwater modelling platform and was used for the M4 East and New M5 groundwater impact assessments.

MODFLOW-USG represents a major revision of the MODFLOW code, in that it uses a different underlying numerical scheme: control volume finite difference (CVFD), rather than traditional MODFLOW's finite difference (FD) scheme. 'USG' is an acronym for unstructured grid, meaning that MODFLOW-USG supports a variety of structured and unstructured model grids, including those based on cell shapes including prismatic triangles, rectangles, hexagons, and other cell shapes. In accordance with Barnett *et al* 2012 the model has been constructed as a Confidence Level 2 (Class 2) model.

The model domain is discretised into eight layers with the upper three layers representing fill, alluvium, Botany Sands (layer 1), upper Ashfield Shale (layer 2), lower Ashfield Shale/Mittagong Formation (layer 3). The lower five layers represent the Hawkesbury Sandstone.

The groundwater model for the project:

- Simulated rainfall recharge using the RCH module
- Prescribed head boundary conditions at the coastline and along tidal rivers using constant head boundary conditions or general head boundaries
- Simulated watercourses using the RIV module with minor drainage lines simulated by the DRN module
- Used 'drain' cells to represent the project footprint
- Applied evapotranspiration (ET or EVT) boundary conditions along drainage lines
- Applied horizontal and vertical hydraulic conductivities and storage properties for alluvium, shale and sandstone.

Rates of flow from rivers to project tunnels in the model was controlled by the geometry of the system and by the spatial distribution of hydraulic conductivities (both horizontal and vertical) between the rivers and project tunnels across the model domain. Simulated groundwater levels and volumetric flows were calibrated by a combination of trial and error process against the observed data and by applying the Parameter Estimation (PEST) module. Model calibration was undertaken under steady state and transient conditions to historical groundwater levels.

The modelling methodology is outlined in more detail in the Groundwater Modelling Report (HydroSimulations 2017) presented in **Annexure H**.

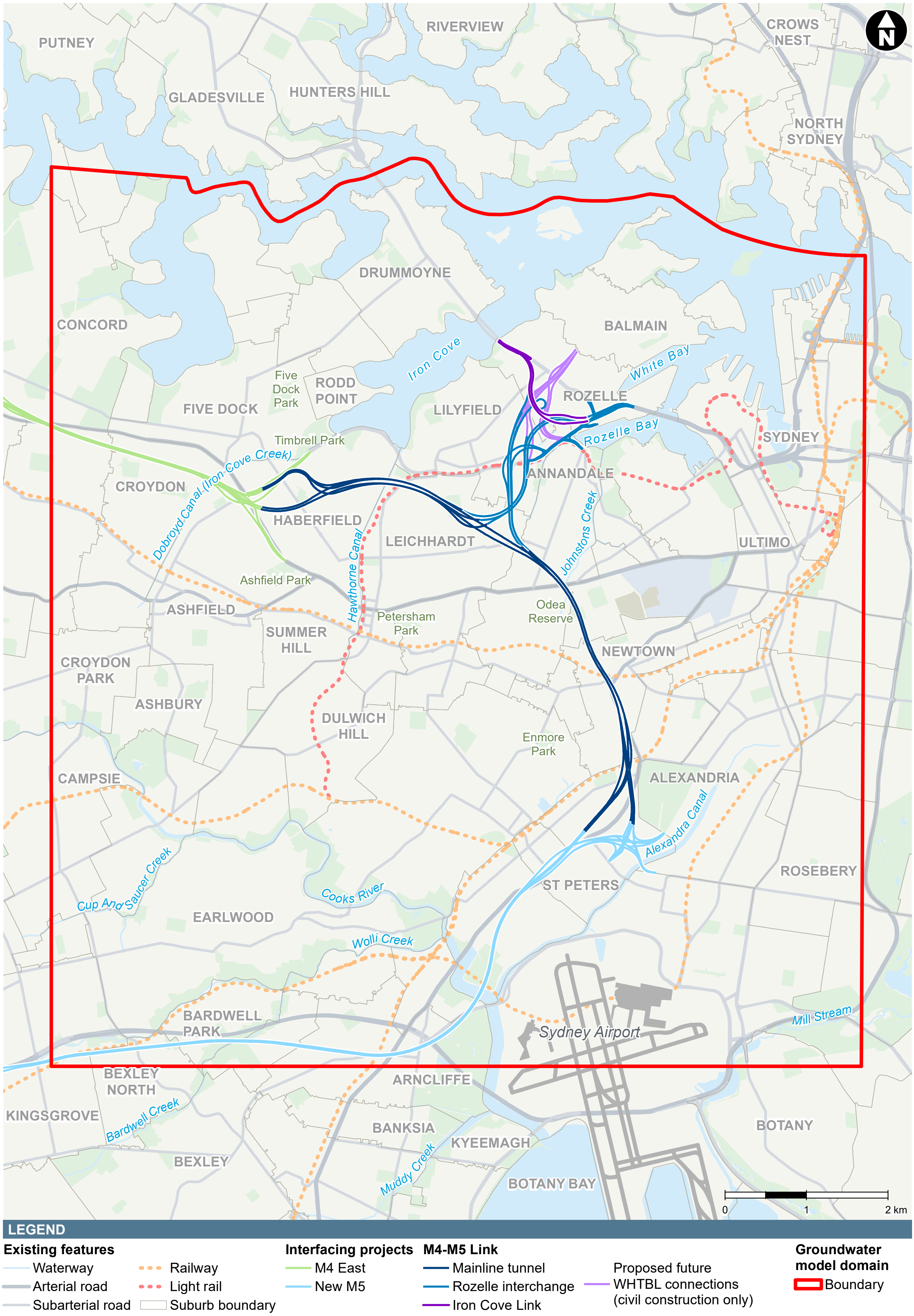


Figure 3-4 Groundwater model domain

Model assumptions

The following assumptions were made in preparing the numerical groundwater model:

- Surface water in Alexandra Canal, Parramatta River, Rozelle Bay, Whites Bay, Iron Cove, and Sydney Harbour would control groundwater levels and prevent large scale lowering of the water table
- Groundwater inflows to the tunnel are based on the project design criterion of no more than one litre per second per kilometre for each kilometre length of tunnel
- The hydrogeological properties used in the model are based on bulk average hydrogeological properties derived from desktop analysis and packer test data
- The vertical hydraulic conductivity within the Hawkesbury Sandstone (Kv) is considerably lower than the horizontal hydraulic conductivity (Kh), typically by between one and two orders of magnitude, due to the horizontal bedding being more developed than vertical defects
- Prescribed head and no flow boundaries were assumed on model boundaries
- The base of the model is assumed to be horizontal at an elevation of -100 metres Australian Height Datum (AHD)
- The proposed M4-M5 Link main tunnels are mostly below sea level and therefore groundwater gradients from the surface waterbodies would be towards the tunnels
- Rainfall recharge has been applied to the upper most model layer at a constant rate
- A model has been prepared and calibrated and run in steady state and transient modes
- Other major existing tunnel infrastructure that may influence groundwater levels and quality including the M5 East Motorway tunnels, and New M5 and M4 East tunnels have been simulated in the model
- The model domain does not include the Cross City Tunnel, Eastern Distributor and the Cooks River Tunnel. It was deemed not necessary to simulate the Airport Rail Tunnel as this tunnel is fully tanked. These tunnels were excluded as they are not considered close enough to the areas of interest and inclusion of these features would have increased model uncertainty.

Detailed model limitations are outlined in (HydroSimulations 2017).

Modelling objectives

The numerical groundwater model was developed and calibrated to simulate the existing hydrogeological regime within the alluvium associated with the creeks and palaeochannels, Botany Sands, Ashfield Shale and Hawkesbury Sandstone and existing infrastructure including the M5 East Motorway and the New M5 and M4 East tunnels which are under construction. The model objectives were to:

- Predict groundwater drawdown due to drainage into the tunnel during construction and long term operations
- Predict potential impacts on nearby registered groundwater users and groundwater dependent ecosystems, in terms of groundwater drawdown and groundwater quality, in accordance with the AIP
- Predict the impacts on water quality from salt intrusion within the drawdown impact zones.

Modelling scenarios

Three predictive model scenarios were run to replicate the construction and long term operations groundwater impacts of the project as follows:

- **Scenario 1:** A ‘Null’ run (as per Barnett *et al* 2012), which does not include any WestConnex projects but does include the existing drained M5 tunnels

- **Scenario 2:** The ‘Null’ run plus the current approved WestConnex tunnel projects (M4 East and New M5), with construction scheduling included as per **Table 2-3** and **Table 2-4**, ie Scenario 1 plus the M4 East and New M5 projects
- **Scenario 3:** The ‘Null’ run plus the approved WestConnex projects (M4 East and New M5) and the proposed project (M4-M5 Link), with construction scheduling as per **Table 2-2**, ie Scenario 2 plus the M4-M5 Link project.

The impacts of the M4-M5 Link project were computed by the model by subtracting the Scenario 3 impacts from those of Scenario 2.

4 Existing environment

4.1 Infrastructure

4.1.1 Existing infrastructure

The project footprint transects an urban environment that consists of established industrial, commercial, recreational and residential areas. In some areas, there is major existing or proposed infrastructure that has deep foundations that may influence the project or the local hydrogeological regime. This includes the Alexandria landfill, Rozelle Rail Yards, White Bay redevelopment precinct and parks. These features are described further below and shown on **Figure 4-1**.

Sydney Park is located north of the St Peters interchange (part of the New M5 project) and the project footprint would flank the western park perimeter. The park is a former quarry where weathered shale and clay was excavated for brickmaking. The former quarry was infilled with municipal waste and then capped to create the current parkland. Sydney Park consists of open recreation spaces, playing fields and wetlands.

King George Park is a foreshore park in Rozelle located next to Iron Cove Bridge and Rozelle Bay. The park has a range of sporting facilities, picnic areas and playgrounds.

Easton Park is a public park located in Rozelle to the north of the Rozelle Rail Yards. The park has a range of sporting facilities established trees and picnic areas and playgrounds.

Rozelle Rail Yards is located in Lilyfield and Rozelle, north and west of Rozelle Bay, flanked by Lilyfield Road to the north and the Inner West Light Rail line to the south. In the 1900s, the wetland valley was covered with fill during reclamation works associated with the formation of the Rozelle Rail Yards. Excavation of sandstone along the northern boundary may have been a source of some of this fill. Once established, the rail yards were used for the storage and loading and unloading of various goods transported by rail until the late 1990s. After this, the rail yards fell into disrepair and were used for industrial purposes and the storage of disused railway wagons.

Bicentennial Park is located on the Glebe foreshore and was formed on reclaimed land. The swampy land and shallow marshes were infilled indiscriminately over the years. For the majority of the 20th century, the land was owned by the Maritime Services Board and leased to timber companies and, after their decline, the land was converted to parklands and playing fields in 1988.

Existing tunnels – major existing tunnels in Sydney are described as follows:

- **The Cross City Tunnel**: a 2.1 kilometre twin drained road tunnel oriented east–west and located about three kilometres south-east of the proposed Rozelle interchange
- **The Eastern Distributor**: a 1.7 kilometre three lane double deck drained road tunnel oriented north–south and parallel to the proposed M4-M5 Link, around 3.3 kilometres to the east of the proposed M4-M5 Link project footprint
- **The M5 East Motorway tunnels**: are a pair of undrained twin road tunnels located beneath Arncliffe (between Bexley Road in Bexley North) to the western side of Sydney Airport (about four kilometres in length), with a shorter tunnel (about one kilometre in length) beneath the Cooks River at Arncliffe
- **The Airport Link rail tunnel**: consists of four kilometres of tunnel in rock and another six kilometres of tunnel in soft ground. The fully tanked tunnel extends from Green Square Station in the north, and passes beneath the domestic and international terminals at Sydney Airport, beneath the Cooks River and eventually joining the above ground rail system near Wolli Creek Station.

Surface roads and rail – The proposed tunnels are cross-cut by major road and rail infrastructure on the surface. The major roads include the Princes Highway, Parramatta Road, Victoria Road, City West Link and the Western Distributor, parts of which are to be upgraded or partially bypassed by the project. Heavy rail crosses the project footprint at Newtown (Inner West Line) and Sydney Park

(Bankstown Line). The Inner West Light Rail line travels above the project footprint at Haberfield and Lilyfield.

4.1.2 Other proposed and approved infrastructure projects

A number of other proposed and approved infrastructure projects in the vicinity of the proposed M4-M5 Link project have the potential to cause cumulative impacts on the local environment. These projects are outlined as follows:

New M5 will consist of about nine kilometres of twin motorway drained tunnels between the existing M5 East Motorway (between King Georges Road and Bexley Road) and St Peters. An interchange is to be constructed at Arncliffe to link the proposed southern extension tunnels (the F6 Extension) that would extend through Rockdale and Brighton-Le-Sands. The twin mainline tunnels would consist of three traffic lanes, in each direction. The M4-M5 Link project would join the New M5 at the St Peters interchange. Construction of the New M5 project has commenced and is due for completion in 2020.

M4 East will extend from the widened M4 Motorway at Homebush to Haberfield consisting of 5.5 kilometres of three lane twin drained tunnel. The M4 East would join the M4-M5 Link at Wattle Street, Haberfield. Interchanges are being constructed at Concord Road, North Strathfield, and Wattle Street, Haberfield. The twin mainline tunnels would consist of three traffic lanes, in each direction and would join the M4-M5 Link at Haberfield. Construction of the M4 East project has commenced and is due for completion in 2019.

Proposed future Sydney Gateway is a proposed project consisting of ungraded roads and new infrastructure that will link the New M5 at St Peters interchange with Sydney Airport and the Port Botany precincts. The new infrastructure may include new bridges across Alexandra Canal that may require temporary dewatering during construction. Sydney Gateway is subject to a separate environmental impact assessment and approval process.

Proposed future F6 Extension is a proposed project linking the F6 Motorway to the New M5 at Arncliffe. The design is yet to be finalised and may include twin drained tunnels emanating from the Arncliffe interchange. The F6 Extension project is subject to a separate environmental impact assessment and approval process.

Proposed future Western Harbour Tunnel and Beaches Link project would direct traffic from the proposed Rozelle interchange at the Rozelle Rail Yards to the north and north-west through tunnels beneath the Balmain peninsula and Sydney Harbour. If approved, it is expected that the tunnels for the future Western Harbour Tunnel and Beaches Link project would be constructed predominately within the Hawkesbury Sandstone. The project is subject to a separate environmental impact assessment and approval process.

Sydney Metro is a proposed rail alignment linking the north-west region to the Sydney CBD and further south to Bankstown. The Chatswood to Sydenham portion of the project was approved in early January 2017. The alignment would consist of 15.5 kilometre twin railway tunnels extending from Chatswood, beneath Sydney Harbour to Sydenham. Rail tunnels and some cross passages and underground stations would be fully tanked and consequently any groundwater ingress would be negligible. Construction is expected to commence in late 2018. The Metro tunnels emerge to ground surface at Sydenham Station located west of Sydney Park.

White Bay Power Station Redevelopment is a disused heritage precinct, covering 38,000 square metres in White Bay at Rozelle, which is located on the edge of the proposed M4-M5 Link project footprint between the Rozelle interchange and Anzac Bridge. The State government owned site is proposed for redevelopment in accordance with The Bays Precinct master plan. Redevelopment of the site may include the provision of a transport interchange, including an underground rail line and platforms.

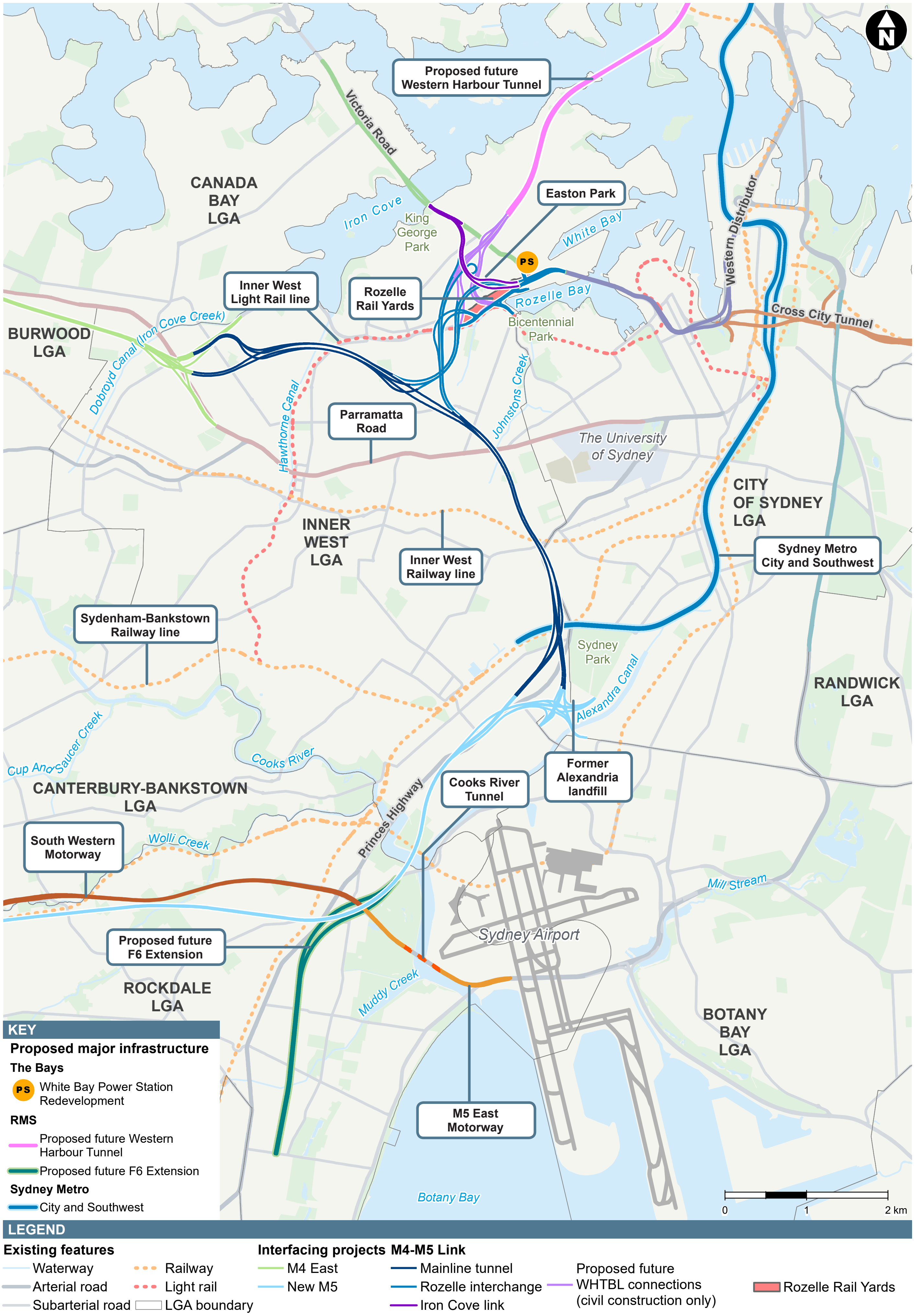


Figure 4-1 Existing and proposed major infrastructure

4.2 Rainfall and climate

Sydney's climate is characterised as temperate, having no dry season with a slight predominance of rainfall throughout the autumn and winter months. Rainfall data has been obtained from BoM Station 66062 located at Sydney Observatory Hill near the north-eastern fringe of the project footprint. Rainfall has been measured at this station since 1858. Evaporation data is derived from the BoM website that presents Australia's open pan evaporation on a detailed contoured map based on data collected between 1975 and 2005. Monthly rainfall, evaporation and the rainfall difference is summarised on **Table 4-1**. The monthly rainfall difference is the deficit or surplus difference between monthly rainfall and the combined results is representative of the long term average.

Table 4-1 Summary of monthly rainfall and average evaporation (Station 66062)

Month	Rainfall mean (mm)	Rainfall 2016 (mm)	Rainfall difference (mm)	Evaporation (mm)
January	7	249.8	147.3	160
February	117	25.8	-91.2	110
March	129.6	193.2	63.6	140
April	119.2	155	35.8	110
May	133	7.2	-125.8	70
June	97.1	305	207.9	55
July	81.1	104.6	23.5	70
August	68.4	151.4	83	90
September	76.7	70	-6.7	110
October	76.4	31.4	-45	160
November	83.8	27.2	-56.6	180
December	77.6	65	-12.3	180
Total	**1162.4**	**1385.6**	**223.2**	**1500**

Note:

Rainfall averages from 1858 to 2016

Mean rainfall is highest during late summer and early autumn peaking in March and May. The lowest average rainfall is in late winter and early spring. Evaporation is highest in November and December and lowest in June, and exceeds mean rainfall for the months of February, April, May, June and July. Average monthly rainfall and recorded 2016 monthly rainfall from the Sydney Observatory are shown in **Figure 4-2**.

Mean monthly rainfall (since 1858) has been compared to the recorded 2016 monthly rainfall. Overall 2016 was a wetter year with 1385.6 millimetres recorded compared to a mean annual rainfall of 1161.3 millimetres, a difference of 224.3 millimetres. January and June were very wet months with rainfall exceeding the monthly average by 143.7 millimetres and 208 millimetres respectively. Conversely, the latter part of the year was drier than average with the months of September, October, November and December being in deficit in comparison to the monthly averages by 6.7 millimetres, 45.0 millimetres, 56.6 millimetres and 12.3 millimetres respectively.

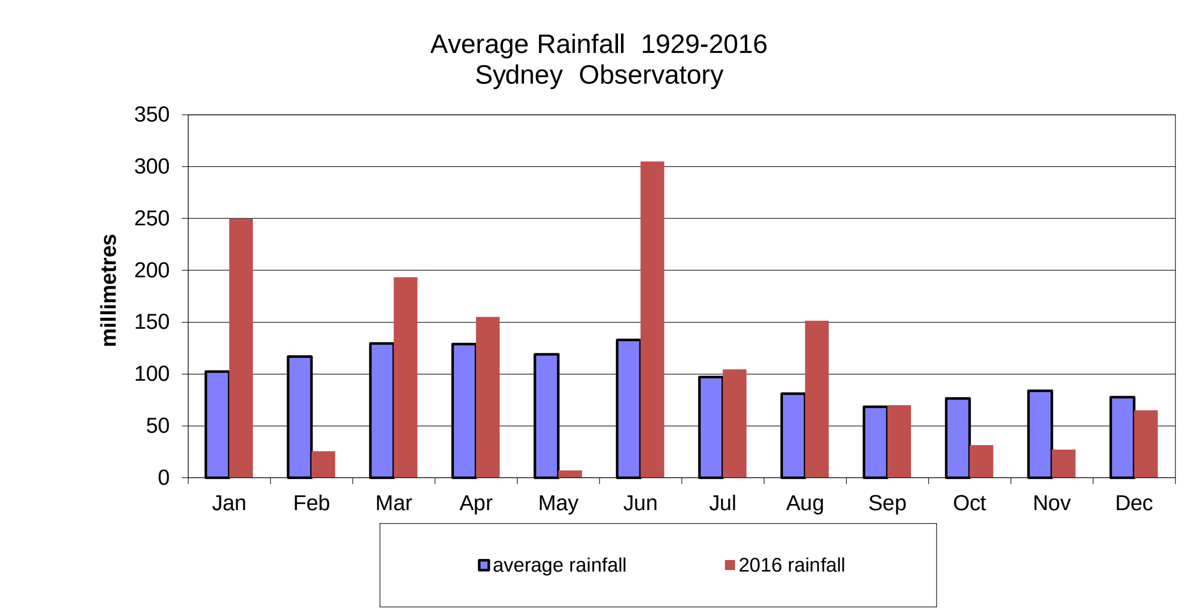


Figure 4-2 Average monthly rainfall compared to 2016 rainfall at Sydney Observatory

The long term data has been collated to calculate a cumulative residual rainfall analysis to assist in the identification of rainfall trends. Time series graphs of cumulative residual rainfall allow long term rainfall patterns to be assessed, with periods of above average rainfall indicated by upward trends and periods of below average rainfall by downward trends. A plot of rainfall residual mass from the Sydney Observatory for the period 1860 to the end of 2016 is presented as **Figure 4-3**.

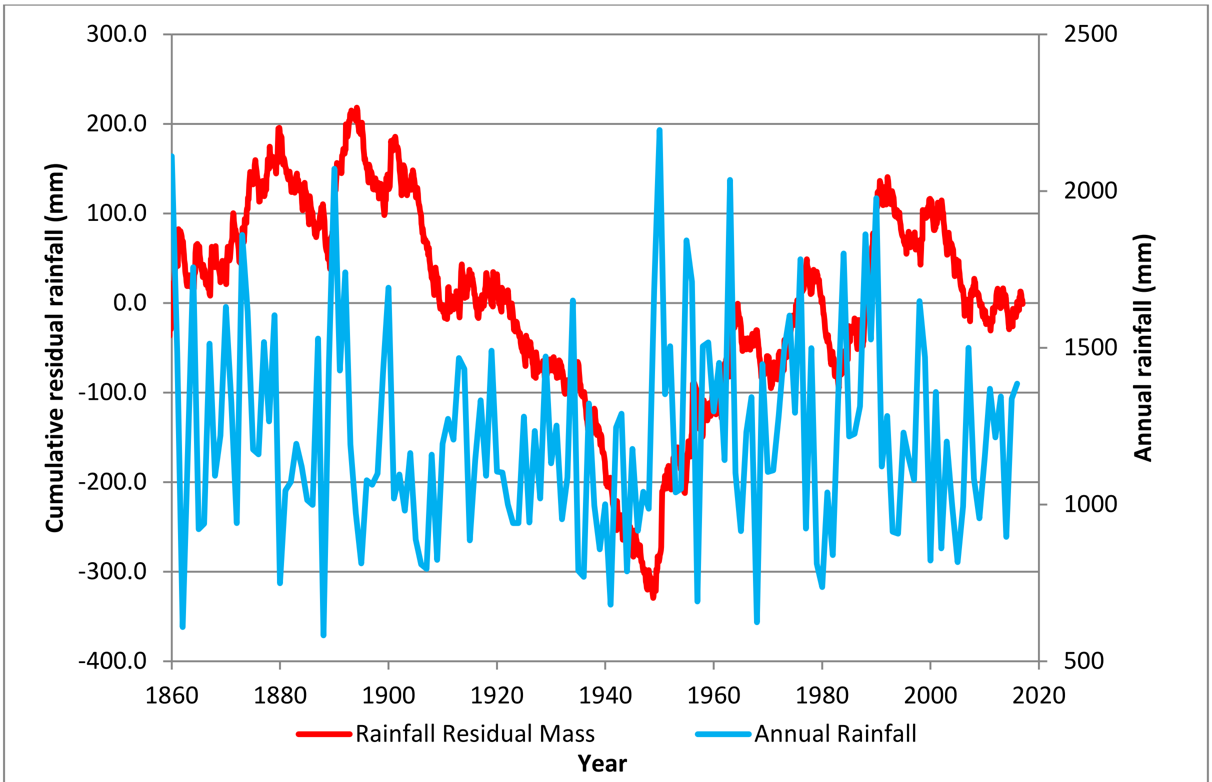


Figure 4-3 Sydney rainfall residual mass – Sydney Observatory 1860 to 2016

The rainfall residual mass curve shows Sydney was subjected to relatively wet years from 1860 to the 1890s followed by a relatively dry period until the late 1940s. The period between the 1940s and 1980s was a relatively wet period followed by a dry period. Following the millennium drought (2001–

2009) the rainfall residual mass has approximated average conditions suggesting natural groundwater levels during this period (2010 to present) would approximate long term average conditions.

4.3 Physiography

The project would be generally located within the City of Sydney Council and Inner West Council local government areas (LGAs). The project is located about two to seven kilometres south, southwest and west of the Sydney central business district (CBD) and would cross the suburbs of Ashfield, Haberfield, Leichhardt, Lilyfield, Rozelle, Annandale, Stanmore, Camperdown, Newtown and St Peters.

The project footprint extends from the M4 East in Haberfield through proposed interchanges at Rozelle emerging at the St Peters interchange. The topography of the project footprint is relatively flat and low lying, ranging from sea level, adjacent to Sydney Harbour and Rozelle Bay, up to 33 metres AHD in Lilyfield where the Hawkesbury Sandstone outcrops. Areas of physiographical interest along the project footprint are the Rozelle Rail Yards and Alexandria Landfill. At the Rozelle Rail Yards, the sandstone cutting is about six metres high but is not considered an escarpment for the purposes of Part 9 Rule 41 of the Greater Metropolitan Region Groundwater Sources Water Sharing Plan since the cliffs are artificial and do not form a water shed.

The Rozelle Rail Yards are highly disturbed and have the potential to contain contaminated soil and groundwater due to previous land-use practices. The Rozelle Rail Yards are located in Lilyfield and Rozelle and are generally bordered by City West Link, Victoria Road and Lilyfield Road. Some of the ramps and tunnels for the proposed Rozelle interchange are to be constructed beneath the former Rozelle Rail Yards and a large proportion of the tunnelling is to be to the north within the sandstone.

The Alexandria Landfill is a former brickworks quarry that after its closure in 1988 was converted to a landfill. The landfill is unlined and generates leachate that requires treatment prior to off-site discharge. The former landfill is the location of the proposed St Peters interchange which is being constructed as part of the New M5 project. As part of the WestConnex construction program, a cut-off wall is being constructed as part of the New M5 to reduce leachate generation in addition to landfill capping to reduce rainfall infiltration. Leachate capture and treatment will be on-going. The Alexandria Landfill is located at Albert Street in St Peters, adjacent to Alexandra Canal.

4.4 Existing surface water features

4.4.1 Watercourses

Surface water features along the project footprint are detailed in **Appendix Q** of the EIS (Technical working paper: Surface water and flooding) and relevant details are summarised as follows:

The majority of the project footprint is located in a heavily urbanised area and is drained by the stormwater network. The primary surface water features in the project footprint are the creeks, infilled creeks and canals. The project footprint is covered by five catchments that are drained by canals and creeks into Sydney Harbour and Botany Bay as shown in **Figure 4-4**. The creeks and canals are heavily modified, which impacts discharge volumes, durations and velocities. These processes are discussed for each catchment in in **Appendix Q** of the EIS (Technical working paper: Surface water and flooding).

Draining Haberfield and Leichhardt is Hawthorne Canal, a lined channel that discharges into Iron Cove. Johnstons Creek is a lined channels that drain Annandale and Glebe discharging into Rozelle Bay. Similarly Whites Creek is a brick and concrete-lined channel that flows through the suburbs of Leichardt and Marrickville, discharging to Rozelle Bay. Iron Cove Creek, is a lined channel and drains Haberfield, discharging into Iron Cove on the Parramatta River. The lower tidal section of Iron Cove Creek is known as Dobroyd Canal.

Major watercourses within or in close proximity to the project footprint including Dobroyd Canal, Hawthorne Canal, Whites Creek, Easton Park drain, Johnstons Creek, Iron Cove Creek and Alexandria Canal are either first or second order streams. The project footprint is within 40 metres of Hawthorne Canal, Whites Creek, Easton Park drain and Johnstons Creek. Alexandra Canal is the main waterway downstream of the project footprint to the south within the Cooks River catchment. The canal, originally a natural watercourse named Sheas Creek, flows into the Cooks River near the north-western corner of Sydney Airport. Sediments in the canal are contaminated and it has been declared a remediation site by the NSW EPA.

Patches of coastal saltmarsh occur along the edge of Rozelle Bay and Johnstons Creek. To the south the suburbs of Newtown, Enmore and St Peters are drained by the lined Eastern Channel that discharges to the Cooks River. Wolli Creek, Bardwell Creek and Mill Stream are unlined and are outside the immediate project footprint, though are included in the groundwater model domain.

Despite the majority of the creeks and canals in the model domain being concrete lined, the alluvium beneath the channels is saturated with groundwater. In the concrete lined creeks, seepage to groundwater is limited to water flowing through fractures within the concrete lining, and along unlined stretches or naturalised areas. Lower reaches of the concrete lined channels are expected to leak more where the channels are tidally influenced and receive more water than the upper reaches. Sydney Water is in the process of naturalising some creeks and canals by replacing the concrete lining with a natural permeable stream base, planting natural vegetation and recontouring river banks. Parts of the Cooks River have been naturalised and it is proposed to naturalise parts of Johnstons Creek, Iron Cove Creek and Whites Creek in the near future. The groundwater model modelled the creeks as being lined as at the time of modelling the proposed naturalisation projects were in the concept design phase. Should the creeks be naturalised it is expected the groundwater recharge would increase and the impact of groundwater drawdown due to tunnel leakage would slightly decrease.

At a macro scale, surface water and groundwater in the Central Sydney Basin is described in the Water Sharing Plan, Greater Metropolitan Regional Groundwater Sources Background Document (NoW 2011). Within the porous rock aquifer, the level of connection between groundwater and surface water is stated as low to moderate with the estimated travel time between groundwater and unregulated rivers being in the order of years to decades.

Fluvial groundwater systems are located up gradient from the alluvial systems flanking the natural creek systems. The distinction between the two systems is minor as they are part of the same aquifer system. The water quality in these systems is slightly brackish and would sustain salt tolerant flora species. These creeks would receive base flow when the natural groundwater level is higher than the creek stage. Under natural conditions recharge to fluvial systems would be also received via floodwaters from floodplains, however the discharge volumes, duration and velocities are altered due to the modified urban environment. Typically the floodwaters would flow into the fluvial systems more quickly due to the increased run-off caused by paved areas and concrete lined drains.

4.4.2 Riparian corridors

A riparian corridor is a transition zone between the land and a river or watercourse or aquatic environment and is discussed in more detail in to **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS. Calculation of the riparian zone and vegetated buffer from an activity is required to assess compliance with controlled activities on water front land (DPI 2012) and the FBA (OEH 2014). The Parramatta River is defined as an estuary which has implications when assessing the biodiversity offsets policy for major projects. Refer to **Appendix S** (Technical working paper: Biodiversity) of the EIS for additional information on the biodiversity assessment carried out for the project in accordance with the FBA.

The lower reaches of Parramatta River, Iron Cove, Rozelle Bay and Whites Bay are infilled with saline marine water. These creek systems in the riparian zone are tidal, causing the groundwater within the alluvium to mix with saline tidal water. The mixing process is influenced by the tides, currents and seasonal variation within the marine waters and the quality and volume of water entering the alluvium via groundwater. On a daily basis there is a tidal prism which moves the saline water within the alluvium in accordance with tidal movements. The movement of saline water within the alluvium is also subject to seasonal fluctuations where the saline prism is forced downstream following heavy rainfall events and the influx of low salinity runoff and groundwater flowing within the alluvium. The water salinity varies due to climatic conditions becoming less saline following high rainfall events and low salinity runoff.

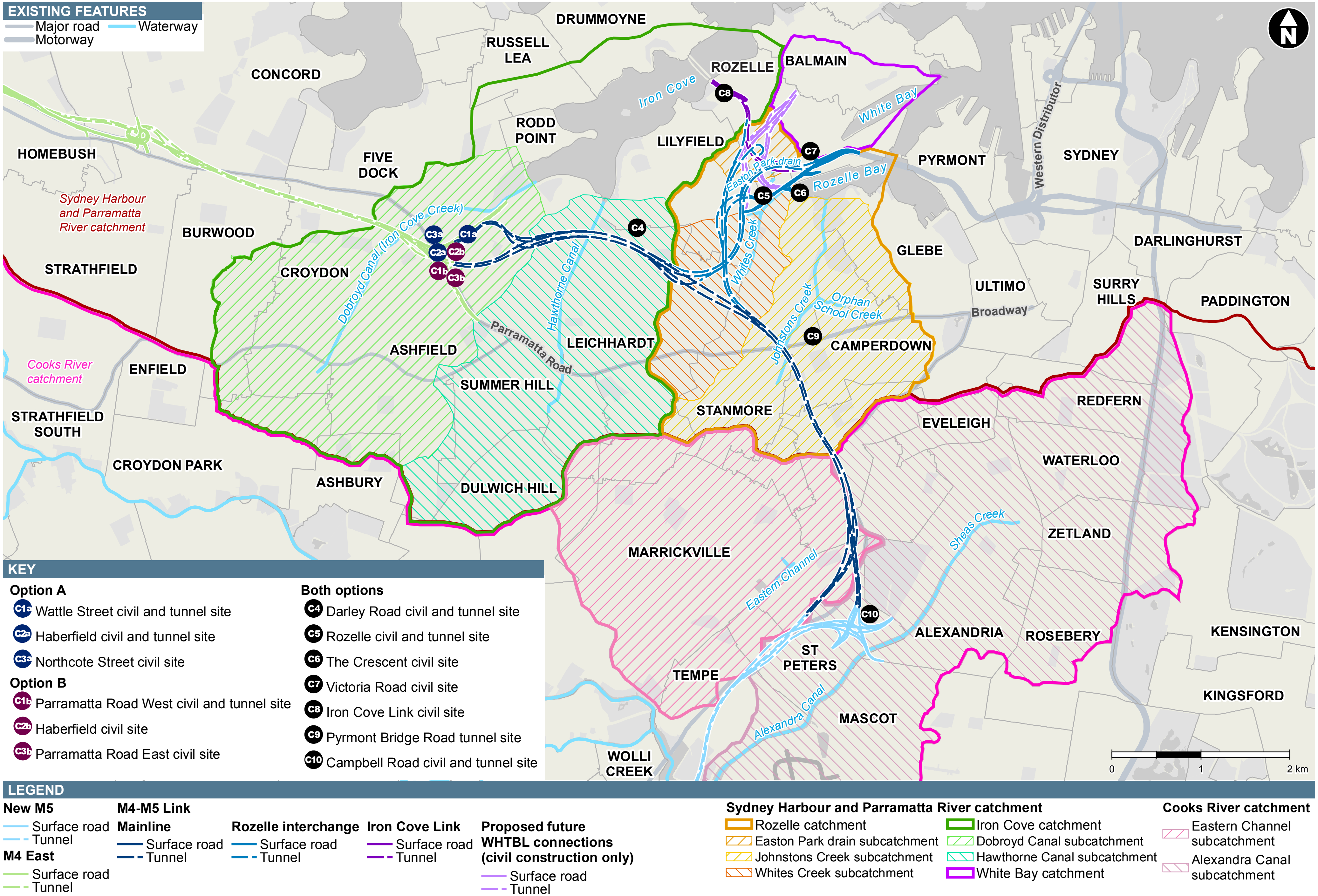


Figure 4-4 Catchments and watercourses within the project footprint

As the Rozelle Rail Yards is within a topographic low, it receives runoff from relatively steep contributing catchments to the north and west. This, combined with the limited capacity of the local drainage network, means that the existing site functions as a floodway for overland flow and provides a significant area for floodwater storage. Floodways are areas of the floodplain where a significant discharge of water occurs during floods. They are areas that, even if only partially blocked, would cause a significant redistribution of flood flow or a significant increase in flood levels. The existing flood behaviour in the various catchments intersected by the project footprint is discussed in detail in **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS. **Appendix S** (Technical working paper: Biodiversity) of the EIS indicates that sections of the riparian buffer zone of Whites Creek and Rozelle Bay are located within the surface works area at Rozelle and a small portion of the riparian buffer of Iron Cove touches the western edge of the surface works area at Iron Cove. No other construction ancillary facilities or operational areas of the project are within riparian corridors.

An assessment of compliance with the FBA, in accordance the water sharing plan and potential impacts on the riparian corridor is outlined in **section 9.4**.

4.4.3 Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) are communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater, such as wetlands and vegetation on coastal sand dunes. The presence or absence of GDEs within or near to the project footprint has been determined following a review of:

- *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* (the Plan). Schedule 4 of the Plan identifies high priority GDEs and Appendix 2 identifies GDEs
- National Atlas of Groundwater Dependent Ecosystems (Australian Bureau of Meteorology).

Review of these resources (viewed 22 August 2016) indicated there are no high priority groundwater dependent ecosystems within the project footprint. The nearest high priority wetlands (as defined in the Water Sharing Plan) are the Botany Wetlands and Lachlan Swamps within the Botany Sands, located in Centennial Park about five kilometres east of the project footprint, outside of the model area domain.

With reference to the BoM Atlas, the closest GDEs to the M4-M5 Link are a series of wetlands associated with Wolli Creek at Turrella, located about 1.5 kilometres west of the St Peters interchange. Potential groundwater impacts on these GDEs were considered in the New M5 EIS, (Roads and Maritime, 2015) and the cumulative impacts are outlined in **Chapter 7**.

Appendix S (Technical working paper: Biodiversity) of the EIS states that waterways in or adjacent to the proposed works are not suitable habitat for threatened fish species and there are no SEPP 14 wetlands in the study area. It is also unlikely that there is valuable or specific aquatic habitat for threatened aquatic/estuarine species, populations or communities listed under the *Fisheries Management Act 1994* (NSW), *Threatened Species Conservation Act 1995* (NSW) or *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) present within the project footprint. It is possible some species may opportunistically pass through the estuarine bays within the study area (Whites Bay, Rozelle Bay and Iron Cove) given the connectivity to the broader harbour and coastal habitats, but the species are unlikely to depend on the habitat adjacent to the project footprint.

4.4.4 Wetlands

Reference to the Directory of Important Wetlands of Australia (DIWA) and SEPP 14 wetland data indicates no natural wetlands have been identified within the project footprint. However the waterways of Hawthorne Canal, Rozelle Bay and saltmarshes flanking Rozelle Bay near the confluence with Johnstons Creek are recognised as sensitive areas. A man-made wetland was constructed in Annandale in 2002, located upstream adjacent to Whites Creek and discharges into Rozelle Bay. The wetland covers an area of 1200 square metres and consists of five ponds and a settling pond.

No natural springs have been identified within the project footprint, which is attributed to the relatively flat topography. Groundwater periodically flows from the sandstone cutting at the Rozelle Rail Yards following large rainfall events but no groundwater dependent ecosystems were identified within

Appendix S (Technical working paper: Biodiversity) of the EIS. Flora within the Rozelle Rail Yards was described as being dominated by exotic vegetation or disturbed tolerant species within a highly disturbed and degraded environment.

4.4.5 Aquatic habitat

Rozelle Bay, Iron Cove, White Bay, Alexandra Canal and downstream portions of Dobroyd Canal and Hawthorne Canal have been mapped as Class 1 Major key fish habitat, as defined in the *Fisheries Policy and Guidelines for Fish Habitat Conservation and Management* (Fairfull 2013). The project's receiving waters are marine environments which include the intertidal and subtidal ecosystems of the harbour and its estuarine tributaries. Within these environments there are no weirs or fish barriers. Marine vegetation includes mangroves, seagrasses and marine microalgae which provide an important habitat for spawning and refuge. **Appendix S** (Technical working paper: Biodiversity) of the EIS states that waterways in or adjacent to the proposed works are not suitable habitat for threatened fish species.

Aquatic habitats of catchments, watercourses and surface water bodies are outlined in **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS and are summarised as follows:

- Dobroyd Canal (Iron Cove Creek) is mapped as key fish habitat downstream of Ramsay Street, Haberfield
- Hawthorne Canal is mapped as key fish habitat downstream of Marion Street, Leichhardt
- Whites Creek is mapped as a first order stream
- Easton Park drain is mapped as a first order stream
- Johnstons Creek is mapped as a first order stream
- Rozelle Bay is mapped as key fish habitat and is an estuarine environment
- Iron Cove is a bay within the Parramatta River estuary mapped as key fish habitat
- White Bay is mapped as key fish habitat and is an estuarine environment
- Alexandra Canal is a constructed canal originally a natural watercourse named Sheas Creek and is a second order stream.

4.5 Soils

Soils within the project footprint are identified from the Soil Landscapes of the Sydney 1:100,000 Sheet (Chapman, G.A and Murphy, C.L. 1989) and are presented on **Figure 4-5**. Six major soil profiles have been identified along the project footprint as follows:

- The **Blacktown (bt)** soil landscape is a red and brown podzolic soil that covers the majority of the project footprint. It represents a residual soil profile overlying the Wianamatta Group and Hawkesbury Sandstone
- The **Gymea (gy)** soil profile outcrops around the edge of the harbour near the Rozelle Rail Yards. This unit is an erosional soil profile consisting of yellow earths and earthy sands overlying the Hawkesbury Sandstone
- Along the south-eastern shores of Iron Cove, the **Hawkesbury (ha)** soil landscape unit flanks the harbour. The Hawkesbury unit is shallow and is composed of yellow earths and some yellow podzolic soils sometimes with sandstone outcropping
- In the eastern part of the project footprint at Alexandria, the **Tuggerah (tg)** soil profile outcrops over Botany Sands. The aeolian soil profile is deep
- The **Birrong (bg)** soil profile flanks the upper reaches of Hawthorne Canal and Johnstons Creek. The fluvial unit drains the Wianamatta Shale and is composed of yellow soils that are seasonally waterlogged
- **Disturbed terrain (xx)** is common in low lying areas adjacent to the harbour due to the historic indiscriminate infilling of wetlands. Often the original soil has been removed and the fill is capped with a clay layer to form sports grounds and parks.

A search of the Australian Soils Resource Information System indicated that the majority of the project footprint has a low to extremely low probability of occurrence of acid sulfate soils. Land adjacent to watercourses, namely Hawthorne Canal, Johnstons Creek, Whites Creek and Alexandra Canal were identified as having a high probability of being potential acid sulfate soils (PASS). In addition, estuarine soils were sampled above bedrock but below the fill at the Rozelle Rail Yards were shown to be PASS (AECOM 2016a). These areas correspond to land identified as containing Class 1, 2 and 3 acid sulfate soils. Areas within the project footprint showing a high and low probability of occurrence of acid sulfate soils, extracted from the *NSW Department of Land and Water Conservation Acid Sulfate Soil Risk Map for Botany Bay,* are presented in **Figure 4-6**. The disturbance of acid sulfate soil has the potential to generate acidic groundwater that would require treatment prior to discharge. Consequently, procedures for the management of acid sulfate soils would be required during construction works. Site specific acid sulfate soil investigations undertaken at the Rozelle Rail Yards are discussed further in **section 4.14**.

Salinity hazard mapping for Western Sydney (NSW Department of Infrastructure, Planning and Natural Resources 2002) extends as far east as Homebush Bay but does not extend into the project footprint such as Whites Creek near Rozelle Bay. However, many of the mapped geological and soil units in Western Sydney extend into the project footprint. The salinity potential mapping is based on soil salinity, topography, geometry of the landscape geology and soil and groundwater settings. The majority of the project footprint is underlain by Hawkesbury Sandstone which is considered to have a very low salinity potential. Areas underlain by the Wianamatta Shale on which the Blacktown soil unit has developed are considered to have a moderate salinity potential. There is a high salinity potential within the alluvium flanking creeks in low lying areas. Along the project footprint there are no known salt scald occurrences suggesting that if saline soils are present, the salts have not reached the ground surface.

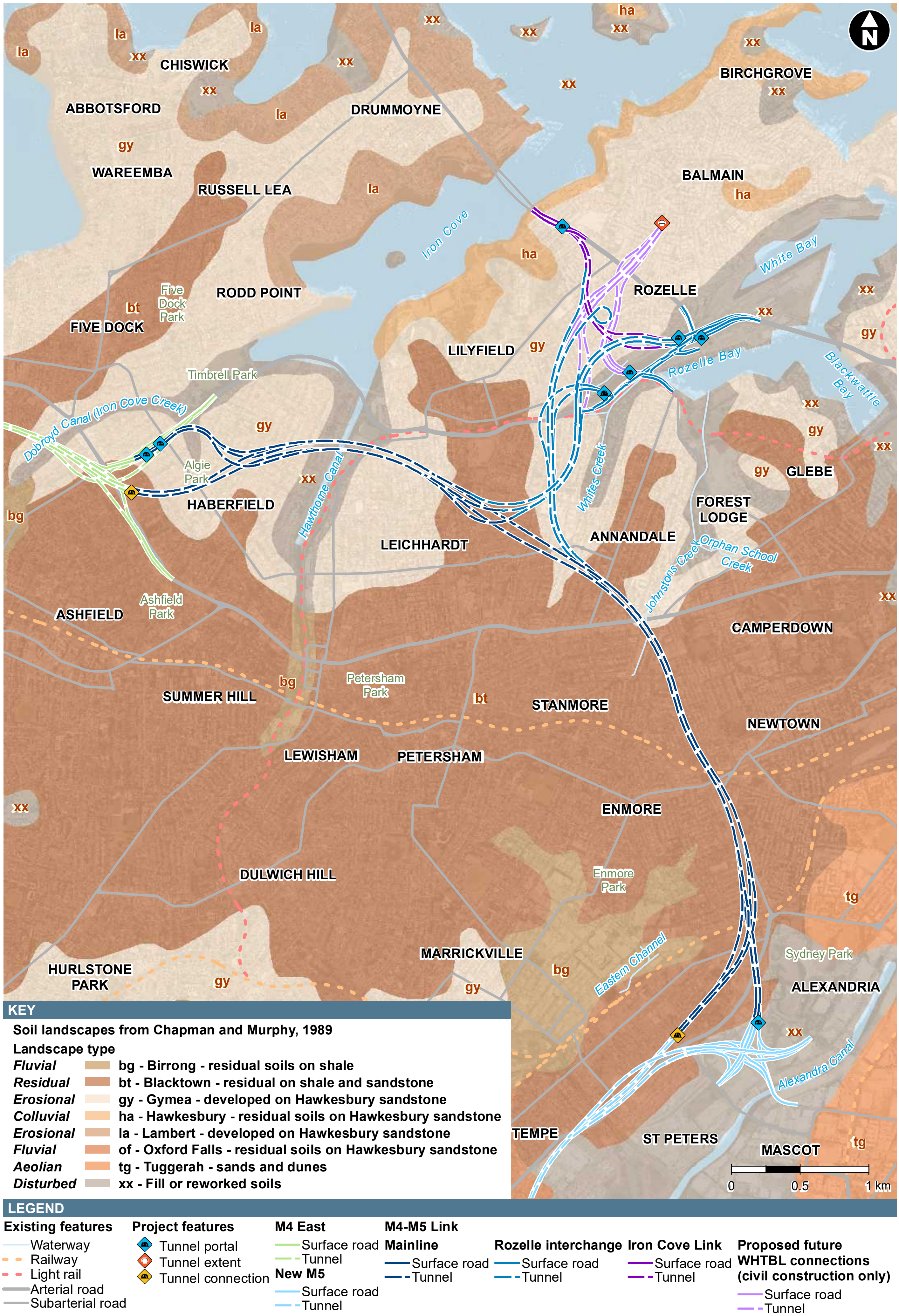


Figure 4-5 Soils within the project corridor

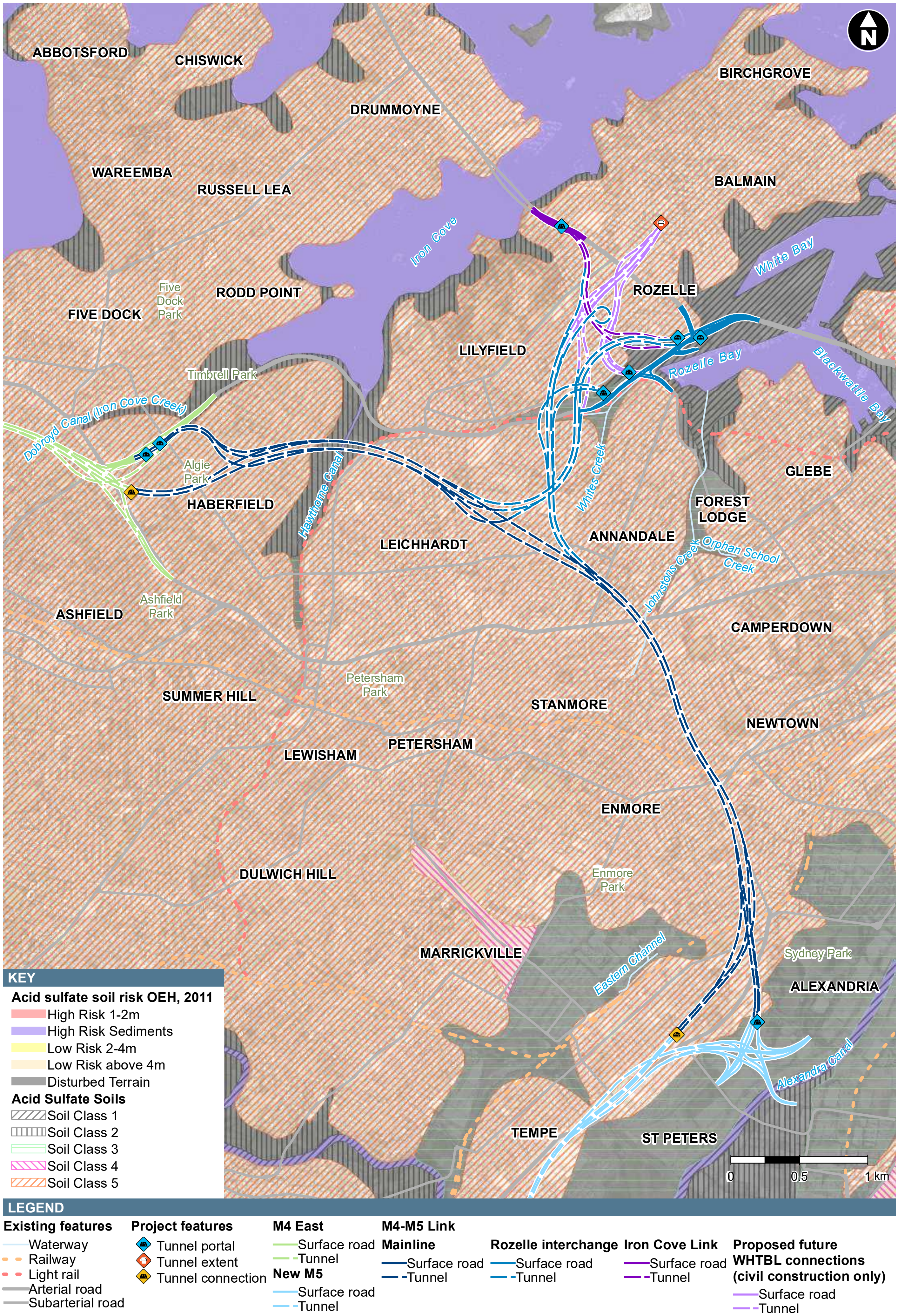


Figure 4-6 Acid sulfate soil risk map

4.6 Geology

4.6.1 Geological setting

Regionally, the study area is located within the Permo-Triassic Sydney Basin that is characterised by sub-horizontal lying sedimentary sequence, mainly sandstone and shale. The published 1:100,000 series geological map for Sydney, Sheet 9130 (Herbert 1983) indicates that the proposed M4-M5 Link project footprint is underlain by two main geological units, the Ashfield Shale and the Hawkesbury Sandstone (**Figure 4-7**). The Ashfield Shale and Hawkesbury Sandstone are sometimes separated by the transitional Mittagong Formation. To the east of the project footprint, the unconsolidated Quaternary-aged Botany Sands onlap the basin and unconformably overlie the bedrock.

The main stratigraphic units that have been encountered along the project footprint comprise of the following from youngest to oldest:

- Anthropogenic fill
- Quaternary Alluvium (recent beneath rivers, palaeochannels and Botany Sands)
- Jurassic Intrusions (volcanics)
- Triassic Ashfield Shale (Wianamatta Group)
- Triassic Mittagong Formation
- Triassic Hawkesbury Sandstone Formation.

The project footprint is located within the central part of the Sydney Basin commonly known as the Fairfield Basin where the greatest thicknesses of sediments are encountered. Regionally, the sediments gently dip to the west, typically less than five degrees.

Large scale penetrative faulting is rare in the Sydney Basin (AECOM 2017d). Structurally there are major faults oriented north-north-east to south-south-west that cross-cut the basement rocks. These fault zones are represented as zones of increased joint frequency that are referred to as joint swarms.

Palaeovalleys or palaeochannels have also been mapped in the project footprint (Och *et al* 2009). These alluvial infilled deeply incised palaeochannels of Pleistocene age are carved into the sandstone and shale bedrock to depths up to 25 metres. At the edge of the harbour, alluvium and colluvium is present along with man-made fill. Beneath the major drainage lines discharging into Rozelle Bay, deep alluvium up to 20 to 25 metres below ground level is present as palaeochannels. Also at the edge of the harbour, wetlands and swamps have historically been infilled to ‘reclaim’ the land to create parks and playing fields.

The geology of the project footprint is presented in more detail in the geotechnical preliminary reference design report (AECOM 2017d).

4.6.2 Fill materials

As the project footprint is located within an urban environment, fill materials are common and range from minor landscaping to extensive fill for construction of major buildings and infrastructure. The fill consists of locally excavated and imported materials.

More substantial filling has occurred along low lying areas such as reclamation works associated with the perimeter of Rozelle Bay and Iron Cove, Rozelle Rail Yards, Hawthorne Canal and Alexandra Canal. Fill materials typically consist of locally dredged material and imported rubble and waste. Compaction levels may range from uncompacted associated with reclamation works to engineered and certified fill at development sites. Unconsolidated man-made fill has been placed periodically over the years around Rozelle Bay up to three to four metres thick.

The most substantial fill deposits are at the Alexandria Landfill which has been infilled with uncompacted waste to depths of 35 to 40 metres.

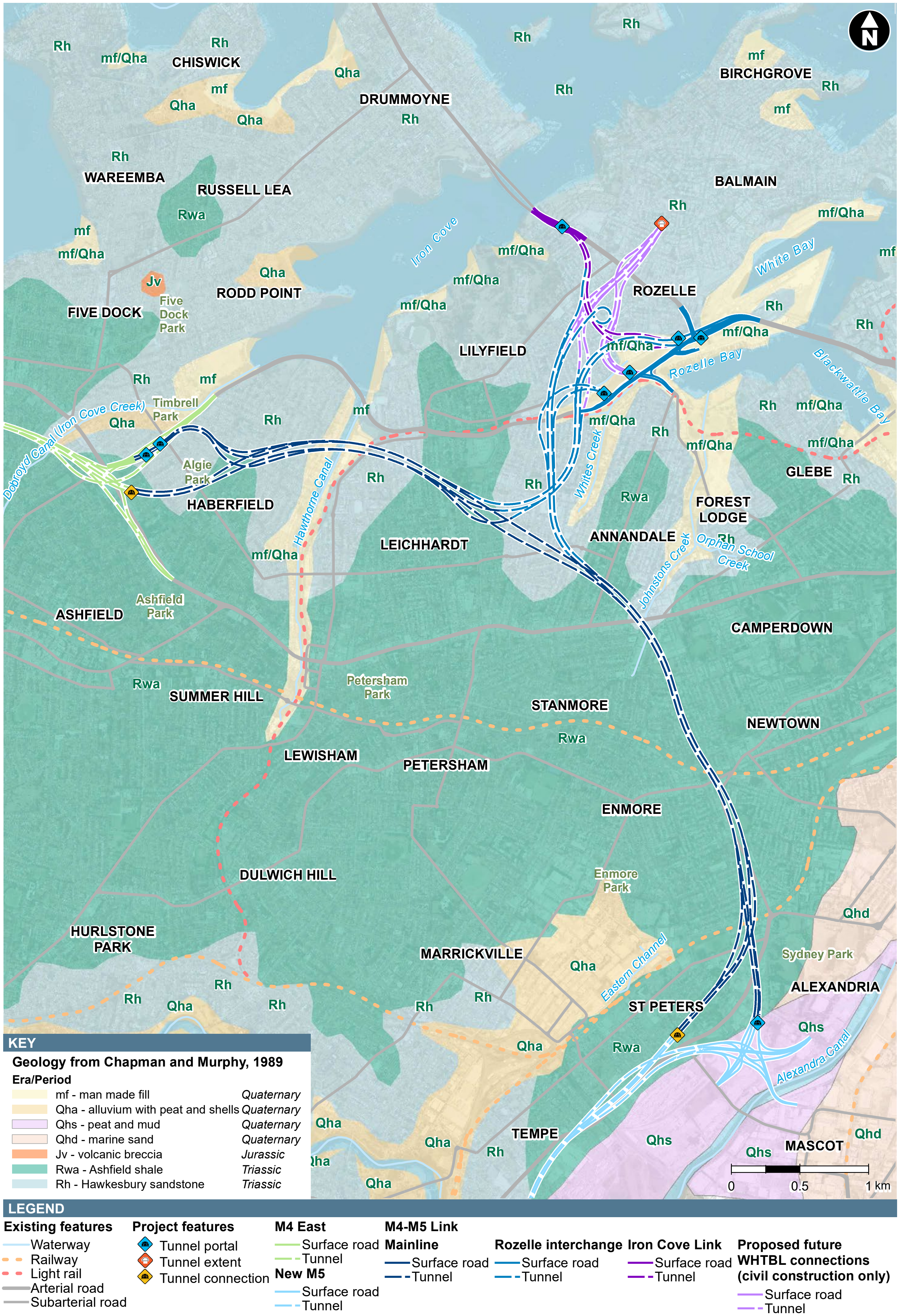


Figure 4-7 Geology of the project footprint

4.6.3 Alluvium

Deposits of alluvial and fluvial sediments are located beneath fill around Rozelle Bay, White Bay and Iron Cove and flank the major creeks and gullies including Hawthorne Canal, Johnstons Creek and Whites Creek. Often these alluvial sediments are overlain by reclamation fill. The alluvial sediments consist of sand, silt, clay, gravels and some peat with a basal clay occasionally defining the base of the sequence. Some of the alluvium contains shells and marine muds. The thickness of the alluvium is variable and can be up to 25 metres deep within palaeochannels such as beneath Hawthorne Canal and Whites Creek. Fill and alluvium at the Rozelle Rail Yards potentially contaminated from previous light industrial land-uses, identified during contaminated land investigations, remains at the site.

4.6.4 Botany Sands

The Botany Sands occur along the eastern perimeter of the project footprint in the eastern part of the Alexandria Landfill at the proposed St Peters interchange. The alluvial, aeolian and estuarine deposits of the Botany Sands onlap the Ashfield Shale in the project footprint, and extend along the eastern coastal strip of Sydney. Inland extensions of the Botany Sands estuarine deposition along valleys are considered as palaeochannel deposits. Lithologically the Botany Sands consists of unconsolidated clayey sand, silty sand, and muds with occasional gravel (Hatley 2004). At the base of the Botany Sands there is a residual alluvial clay that separates the sands from the underlying bedrock, restricting groundwater leakage to or from the bedrock.

4.6.5 Palaeochannels

Deeply incised palaeochannels have carved out narrow drainage channels into the sandstone and shale bedrock associated with a network of ancient river channels. These palaeochannels are infilled with up to 25 metres of saturated sediments comprised of alluvium, estuarine and marine deposits. The depth of some of the palaeochannels is unknown. The palaeochannels typically underlie alluvium associated with structural features such as rivers or gullies and drain to the north into Sydney Harbour.

Palaeochannels have been identified within the project footprint at the following locations:

- Hawthorne Canal
- Whites Creek
- Johnstons Creek
- Rozelle Rail Yards
- Alexandra Canal.

4.6.6 Volcanic intrusions

Intrusive volcanic dykes of Jurassic age intrude and cross-cut the bedrock shale and sandstone of the Sydney Basin. The dykes are basaltic and are typically oriented between 090 degrees and 120 degrees and between 005 degrees and 035 degrees, which is consistent with the dominant orientation of faults and joints within the Sydney Basin. The dykes are of variable width ranging from less than three metres, up to 16 metres wide such as the Great Sydney Dyke (Davies 2002). The Great Sydney Dyke extends from Centennial Park, through Sydney's southern CBD to the Balmain area. The dykes are typically variably weathered and in some cases are altered to white kaolinitic clay to a depth of some 10 to 20 metres below ground level. Elsewhere, swarms of dykes can occur that may represent stringers or off-shoots from a main intrusion. Within the project footprint three to four dykes parallel to the Great Sydney Dyke have been identified within the Rozelle Rail Yards. One single north–south trending dyke has been identified at the Wattle Street ramps, Haberfield. Similarly a 12 metre wide dyke intruding the Hawkesbury Sandstone was identified 10 metres below ground level at Iron Cove in monitoring well IC_BH02.

The frequency of the occurrence of dykes along a linear feature is difficult to assess due to the difficulty in mapping poorly defined outcrops in an urban environment. Based on the geological mapping along coastal exposures in the Botany Basin, the dyke frequency within the project footprint could be expected to be one in every 150 to 200 metres, although the distance between dykes may vary from less than 20 metres to in excess of 500 metres. The host rock adjacent to the dyke may be fractured and metamorphosed for a distance of up to two metres from the dyke interface. Where the dyke has intruded into the sandstone, there is commonly a metamorphosed aureole that can be more resistant to weathering than the surrounding sandstone or shale.

4.6.7 Ashfield Shale

The Ashfield Shale is the lowest member of the Wianamatta Group of sedimentary rocks that also consists of the Bringelly Shale and Minchinbury Sandstone. The project footprint only intersects the lowest member of this unit, the Ashfield Shale. The Ashfield Shale outcrops in the southern portion of the project footprint between St Peters and Camperdown, and again capping the higher topographic areas of Annandale and Leichhardt. The shale is a marine deposited sequence consisting of fine grained particles including clay, silt and sand that has undergone minor deformation and developed into a laminated shale.

The Ashfield Shale unit is about 60 to 70 metres thick and consists of four siltstone and laminate members, from youngest to oldest as follows:

- Mulgoa Laminite
- Regentville Siltstone
- Kellyville Laminite
- Rouse Hill Siltstone.

Lithologically the Ashfield Shale is a dark grey to black siltstone/mudstone or laminate (thin alternating layers of siltstone and sandstone) that is sometimes carbonaceous with variable silt and clay particles throughout. The shale grades upwards into partly carbonaceous silty shale with siderite nodules and ironstone bands. Structurally the unit is laminated but still retains bedding planes at some locations. The rock structure also contains faulting, fracturing, shears, bedding planes and displays slickensided (evidence of geological faulting) features along some surfaces. Where exposed, the Ashfield Shale weathers to a stiff to hard clay with medium to high plasticity. The shale weathered profile typically extends to a depth of three to 10 metres, although within the former brick pits at the Alexandria Landfill the weathered clay has extended to depths in excess of 40 metres.

4.6.8 Mittagong Formation

The Mittagong Formation represents the transition unit from the fluvial/terrestrial environment of the Hawkesbury Sandstone deposition to the marine delta depositional environment of the Ashfield Shale. The formation is composed of a series of interbedded dark shale and sandstone of variable thicknesses. The shale beds are lithologically similar to those of the Ashfield Shale but typically no more than 0.5 metres thick. The fine to medium grained sandstone beds are up to five metres thick but contain more silt than the Hawkesbury Sandstone giving the sandstone a more ‘dirty’ appearance. Across the Sydney Basin the Mittagong Formation has largely been eroded, rarely outcrops and within the project footprint is not known to extend beyond a thickness of 10 metres. The Mittagong Formation has been identified in boreholes across most of the project footprint but is not known to outcrop.

4.6.9 Hawkesbury Sandstone

The Hawkesbury Sandstone is the dominant lithology across the project footprint and is present beneath the entire length of the proposed M4-M5 Link project footprint, albeit at depth in the southern portion, beneath the Ashfield Shale. Lithologically the Hawkesbury Sandstone is described as a medium to coarse grained quartzose sandstone. The formation extends across the whole Sydney Basin and is up to 290 metres thick. The sandstone has been deposited in a fluvial environment and consists of three main depositional environments, namely massive sandstone facies, cross-bedded or sheet facies, and shale/siltstone interbedded facies.

The Hawkesbury Sandstone displays bedding but also contains secondary structural features such as joints, fractures and faults. The sandstone weathers to a clayey sand residual skeletal soil profile typically one to two metres deep. Within the upper 10 metres of the profile, a duricrust can sometimes be present where iron cementation has caused the development of ferricrete or coffee rock, or silica cementation has caused the development of silcrete. Iron staining is characterised by deep orange and red colouration throughout the rock mass that can be concentrated along water bearing fractures.

4.7 Geological features along the project footprint

4.7.1 Mainline tunnels

The twin mainline tunnels are about 7.5 kilometres in length extending from Haberfield under Leichhardt, Annandale, Newtown and emerging at St Peters. Ramp tunnels would provide surface connections to St Peters interchange, Rozelle interchange, Iron Cove Link and the M4 East interchange at Wattle Street, Haberfield. The shallow ramp tunnels would intersect a combination of weathered Hawkesbury Sandstone, Mittagong Formation, Ashfield Shale and residual and alluvial soil profiles depending on the location.

The mainline tunnels are to be generally constructed in good quality Hawkesbury Sandstone with the project footprint remaining predominately below the Ashfield Shale. Groundwater within the unconsolidated saturated sediments beneath creek crossings at Johnstons Creek, Iron Cove Creek, Whites Creek and Hawthorne Canal would be managed by the tunnels diving beneath the underlying palaeochannels and remaining within the competent Hawkesbury Sandstone. Within the Whites Creek palaeochannel at the Rozelle Rail Yards the tunnels would be tanked to limit groundwater ingress from the alluvium.

4.7.2 New M5 interface (St Peters interchange)

St Peters interchange forms the interface between the New M5 and M4-M5 Link projects and consists of two tunnels, northbound and southbound. There is also a surface interface between the New M5 project and the north facing ramps of the M4-M5 Link project at the northern corner of the St Peters interchange.

The ground conditions at St Peters are dominated by thick residual clay soils over weathered shale. The St Peters interchange has been approved to be constructed at the former Alexandria Landfill, a former brickworks quarry that was excavated to a depth of about 35 metres to near the top of the Hawkesbury Sandstone and subsequently infilled with uncontrolled waste material. The proposed M4-M5 Link project footprint commences in weathered shale exposed in the western wall of the former brickpit and descends through shale and sandstone to the main project footprint.

Near Canal Road, the Mittagong Formation is encountered which has a higher siltstone content than the Hawkesbury Sandstone but groundwater inflows are expected to be similar. During excavation of the TransGrid Cable tunnel (AECOM 2016f) a joint swarm trending 040 (parallel to Mitchell Road) was encountered. The width and extent of this joint swarm is not known, but extrapolated north, the joint swarm may intersect the ramps. The presence of joints can act as a conduit for groundwater flow directing groundwater along the lineament impacting groundwater flow patterns.

Groundwater levels at St Peters interchange are influenced locally by leachate pumping from the former Alexandria Landfill, which is hydraulically connected to the shale. Although the former landfill is to be rehabilitated as part of the St Peters interchange construction, it would still require ongoing leachate pumping during operation of the interchange.

4.7.3 Rozelle interchange

The Rozelle interchange is a complex major project feature forming the interface for the mainline tunnels of the M4-M5 Link project with City West Link and Anzac Bridge, Victoria Road, via the Iron Cove Link, and stub tunnels for the future connection with the proposed future Western Harbour Tunnel and Beaches Link project. The majority of the proposed Rozelle interchange would be constructed beneath the ground surface within the Hawkesbury Sandstone, with invert levels at a maximum of 60 metres below ground level.

The ground conditions at the Rozelle interchange are predominately good quality Hawkesbury Sandstone beneath the residential area of Rozelle. The geology beneath the adjacent Rozelle Rail Yards is complex as it is underlain by a deep palaeochannel sequence that is composed of saturated sand, silts and clay. Several basalt dykes trending to the north-west have been mapped cross-cutting the sandstone and outcropping in the sandstone cutting north of the Rozelle Rail Yards. Minor seepage has been observed (particularly after rainfall events) from fractures and bedding planes within these sandstone cliffs.

4.7.4 Iron Cove Link

The proposed Iron Cove Link would consist of twin two lane, one kilometre long tunnels extending from the Rozelle interchange beneath Easton Park linking with Victoria Road south of Iron Cove Bridge. At Iron Cove, ramps and tunnel portals would be excavated from the shallow Hawkesbury Sandstone that would transition into cut-and-cover tunnels before diving into the twin tunnels to the south.

The Iron Cove Link tunnels are to be constructed in good quality saturated Hawkesbury Sandstone. The soil profile is thin and typically less than two metres thick. At the Iron Cove Link portal there is up to five metres of fill overlying the Hawkesbury Sandstone that is likely to contain minor perched water at the interface with the sandstone. At Iron Cove, a basalt dyke was intersected in borehole IC_BH02 at 11 metres below ground level.

4.7.5 M4 East interface and ramps (Wattle Street interchange)

The Wattle Street interchange and associated ramps at Haberfield are being constructed as part of the M4 East project. The eastbound and westbound cut-and-cover structures would extend over 150 and 280 metres respectively before diving deep into the sandstone.

The ground conditions at the Wattle Street interchange are challenging with a palaeovalley located 100 metres east of the proposed driven tunnel portals. The top of rock in the base of the palaeovalley is up to eight metres below ground level while the crown of the tunnels are located less than eight metres below ground. The palaeovalley is infilled with a combination of soft estuarine clays and firm, water saturated clayey sands which are alluvial in origin.

Around 150 metres to the east of the palaeovalley, a dolerite dyke crosses the project footprint which is about 12 metres thick. The dyke can act as either a barrier to groundwater flow or a conduit for flow depending on the hydraulic properties of the weathered dolerite. The remainder of the tunnel intersects good quality sandstone at depth.

4.8 Hydrogeological setting

The majority of the project footprint, caverns and associated tunnel infrastructure are to be constructed beneath the water table within the saturated rock mass. Groundwater across the project footprint is present in the following three broad units:

- Alluvium around the edges of Rozelle Bay, White Bay and Iron Cove
- Palaeochannels beneath creeks
- Ashfield Shale and Hawkesbury Sandstone.

Across the project footprint, the water table generally reflects a subdued shape of the topography the groundwater being deeper beneath hills and shallowest beneath creeks or gullies. Groundwater along the project footprint is recharged by infiltration of rainfall and runoff.

Groundwater flow through the Ashfield Shale and Hawkesbury Sandstone is variable with the majority of groundwater flowing along secondary structural features rather than the primary matrix. The hydraulic conductivity of the sandstone tends to be higher than the shale due to the increased number of saturated fractures, joints and fissures. The fill and alluvium form an unconfined highly permeable aquifer. Groundwater quality within the Ashfield Shale is typically brackish and aggressive due to its marine origin. The underlying Hawkesbury Sandstone is typically of lower salinity but immediately below the Ashfield Shale the salinity within the sandstone can be elevated due to leakage from the shale. Groundwater within the alluvium and fill is typically of low salinity in the upper reaches of the creeks although becomes more saline down gradient with increased tidal influences and mixing.

The project is located in an urbanised part of Sydney where rainfall recharge has been reduced by hard stand captured runoff and roof runoff being directed to stormwater. The majority of groundwater recharge occurs in parks, gardens and bushland. Alluvium flanking the Parramatta River and Sydney Harbour is recharged daily by tidal fluctuations.

4.8.1 Quaternary alluvium

Modern alluvium outcrops around the edge of the harbour at Rozelle Bay and is present beneath fill and infilling palaeochannels forming an unconfined aquifer. The alluvium surrounding creeks is generally of high permeability. Typical hydraulic conductivity values are between 0.01 and 1 metre per day and the horizontal hydraulic conductivity (K_h) is typically higher than the vertical hydraulic conductivity (K_v) due to sub-horizontal bedding. Groundwater within the alluvium can be a source of either recharge or discharge to the creeks depending on whether upward or downward hydraulic gradients are present. As the alluvium is hydraulically connected to the creeks the groundwater levels are shallow and typically within one metre of ground level Hawthorne Canal, Whites Creek and Johnstons Creek are concrete lined limiting the hydraulic connection between surface water and groundwater. Recharge to the alluvium is via direct rainfall recharge and runoff or surface water inflow.

The palaeochannels that occur beneath some of the major creeks or valleys and extend to depths of up to 25 metres are saturated with groundwater. Groundwater quality within the palaeochannels is typically saline due to recharge from the Ashfield Shale and leakage from tidally flushed rivers and tributaries. The alluvium infilling the palaeochannels is highly transmissive due to the coarse sands and gravels present and a low clay content.

4.8.2 Botany Sands aquifer

Groundwater is present within the Botany Sands as a shallow unconfined aquifer. Groundwater levels are variable but are typically within five metres of the ground surface when not influenced by localised pumping. Regionally groundwater flow is eastward discharging into Botany Bay and Alexandria Canal. The Botany Sands aquifer naturally contains moderately low salinity groundwater (generally less than 2000 milligrams per litre) and is moderately acidic but in many areas has been contaminated by industrial activities, most notably in the southern portion of the aquifer near the Botany Industrial Park where groundwater use has been embargoed due to contamination.

Recharge to the Botany Sands aquifer is via direct rainfall, locally enhanced by rainfall runoff and by rainfall infiltration in green spaces such as parks, gardens and golf courses. Groundwater recharge has typically decreased as the urbanisation increased due to enhanced runoff from hard stand areas directing stormwater directly into Botany Bay. Discharge is via localised pumping or natural discharge to Botany Bay, Sydney Harbour and associated canals.

Groundwater from the Botany Sands aquifer has historically been used beneficially for a number of purposes including irrigation, watering market gardens and domestic use. Groundwater is typically extracted from shallow spearpoints via vacuum extraction systems at groundwater yields typically up to two litres per second. DPI-Water advise that the whole Botany Sands hydrogeological unit is over allocated and to extract groundwater a water allocation must be bought on the open market. Since 2007 residents are no longer allowed to extract groundwater for domestic use in the ‘Zone 2 area’ adjacent to the project footprint due to extensive groundwater contamination.

While the Botany Sands are not intersected by the project footprint, groundwater from the Botany Sands may be hydraulically linked with the drained tunnels. The residual alluvial clay that separates the sands from the underlying bedrock forms a hydraulic seal or aquitard that would reduce vertical leakage restricting groundwater drawdown due to the project. Lateral groundwater flow to the Ashfield Shale is also expected to be low due to the poor water transmitting properties of the Ashfield Shale.

4.8.3 Ashfield Shale

Groundwater flow within the Ashfield Shale is low 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 also reduce groundwater flow locally, if infilled with secondary mineralisation. The bulk hydraulic conductivity is typically low. Regionally the Ashfield Shale forms an aquitard reducing groundwater infiltration to the underlying Mittagong and Hawkesbury Sandstone Formations. Groundwater quality within the shale is highly variable but is typically brackish or saline, due to the marine salts contained within the shale. The shale aquifer is characterised by low yields, limited storage and poor groundwater quality. Due to elevated salinity, low pH and the presence of sulphides the groundwater can be corrosive to the tunnel and associated infrastructure. Recharge to the shale is via direct rainfall recharge and runoff in elevated areas where the shale outcrops.

4.8.4 Mittagong Formation

The Mittagong Formation is a relatively thin transition unit, where present, between the Ashfield Shale and Hawkesbury Sandstone. Although the Mittagong Formation is siltier than the Hawkesbury Sandstone the hydraulic properties of the two formations are similar. The Hawkesbury Sandstone and Mittagong Formation are hydraulically connected. Groundwater quality is generally poor due to leakage from the Ashfield Shale and the high clay content. Recharge is via leakage from the Ashfield Shale or direct rainfall infiltration where the formation outcrops.

4.8.5 Hawkesbury Sandstone

The Hawkesbury Sandstone is characterised as a dual porosity aquifer whereby groundwater is transmitted by both the primary porosity or interconnected void space between grains of the rock matrix and the secondary porosity which is due to secondary structural features such as joints, fractures, faults, shear zones and bedding planes. The Hawkesbury Sandstone is not one aquifer but several ‘stacked aquifers’ due to the heterogeneous and layered nature of the unit. Interbedded shale lenses can provide local or extensive confining layers creating separate aquifers with different hydraulic properties including hydraulic heads. The hydraulic conductivity of the Hawkesbury Sandstone is low in the order of 10^{-3} to 10^{-1} metres per day and fracture related storage is less than two per cent although unconfined matrix storage can be higher. High groundwater yields can sometimes be pumped from the Hawkesbury Sandstone particularly when saturated fractures are intersected (Hawkes *et al* 2009). Increased groundwater flow to tunnels is typically associated with the intersection of such major fractures.

Groundwater flow within the Hawkesbury Sandstone is dominated by secondary fracture flow. Regionally groundwater flow is eastward discharging into the Tasman Sea. Recharge is via rainfall infiltration on fractured outcrop and through leakage from the Ashfield Shale, soil profile and alluvium. Discharge is via seepage to cuttings such as the exposed quarried sandstone at the Rozelle Rail Yards, creeks and evapotranspiration.

Groundwater within the Hawkesbury Sandstone is generally acidic but of low salinity, however the salinity of the upper part of the aquifer can be elevated due to leakage from the Ashfield Shale. A basin wide salinity map (Russell 2007) indicates that groundwater within the Hawkesbury Sandstone in the study area is of much poorer quality water than in other areas of the basin. Elevated concentrations of dissolved iron and manganese naturally occur within the Hawkesbury Sandstone which can cause staining when discharged and oxidised. In tunnels groundwater ingress becomes oxidised causing the dissolved iron and manganese to precipitate forming sludge in drainage lines.

4.8.6 Structural features

The solid geology along the project footprint is cross-cut by a number of structural features including dykes, joint swarms and limited faults that may impact groundwater flow. Increased groundwater ingress to tunnels is typically associated with major fractures or fault zones, although not all structural features are saturated and hence transmissive. Increased tunnel inflows can result from a higher hydraulic conductivity associated with the structure. Increased tunnel inflows can also result because of a reduced hydraulic conductivity, as the structure can act as a barrier causing higher heads on one side of the structure. When intersected by a tunnel, the higher hydraulic head on the other side of the structure could result in higher inflows than were occurring before the structure was intersected. During construction, water-bearing fractures and faults can release groundwater initially, which declines as the storage is depleted. Fractures, faults and dykes within the project footprint are typically oriented between 090 degrees and 120 degrees and between 005 degrees and 035 degrees which influences the predominant groundwater flow directions within the Hawkesbury Sandstone.

The intersection of dykes during tunnel construction can either increase or decrease groundwater ingress to the tunnel depending on the weathering of the dyke and what units or structures it cross-cuts. Unweathered and non-fractured dykes or dykes that have been weathered to kaolinite can create a hydraulic barrier impeding groundwater flow. This can cause differential groundwater pressure across the dyke and potential groundwater ingress to the tunnel through the fractured sandstone or limited flow to the tunnel where the sandstone is not fractured. A fractured dyke cross-cutting water bearing structural features can provide a conduit for groundwater to flow directly into the tunnel.

4.8.7 Hydrogeological cross-sections

Two hydrogeological cross-sections A-A’ and B-B’ based on boreholes and monitoring wells constructed during the investigation are presented as **Figure 4-8** and **Figure 4-9** respectively. The cross-sections present the simplified geology, the water table or potentiometric surface, monitoring wells showing the screened intervals and the project footprint. The cross-section transects are shown on **Figure 3-2**.

Cross-section A-A’ is east–west oriented extending from Haberfield through Leichhardt and Annandale to Camperdown. The tunnel is shown diving beneath Hawthorne Canal and extending as far as Camperdown at MT_BH11 after which the tunnel is oriented southwards. Cross-section A-A’ primarily intersects the Hawkesbury Sandstone with Ashfield Shale capping higher elevation areas at Leichhardt (MT_BH02) and to the east outcropping at Camperdown. A thin veneer of unsaturated soil and colluvium covers the majority of the cross-section, although the alluvium contains significant groundwater within the Hawthorne Canal palaeochannel. The Hawthorne Canal palaeochannel extends to an elevation of -11.6 metres AHD (HB_BH8d) and is interpreted to be about 400 metres wide. The piezometric head within the alluvium at Hawthorne Canal is shown at similar elevations to the potentiometric head within the Hawkesbury Sandstone. To the east the potentiometric head within the Hawkesbury Sandstone and Ashfield Shale becomes deeper as the topography increases.

Cross-section B-B’ is north–south oriented extending from the Iron Cove Link at Iron Cove and Rozelle extending along the Main Line Tunnel through Annandale, Camperdown, Newtown to the St Peters interchange near Alexandria. Cross-section B-B’ primarily intersects the Hawkesbury Sandstone with Ashfield Shale outcropping to the south at Newtown and St Peters. Adjacent to Iron Cove a dolerite dyke has been intersected 10 metres below ground level. Beneath the Rozelle Rail Yards the White Creek palaeochannel has been intersected and extends to a depth of -17.8 metres AHD. Groundwater levels are represented as a piezometric head within the alluvium and a potentionmetric head with in the sandstone and shale. The piezometric head within the alluvium is shown at a slightly lower elevation than the potentiometric head confirming the upward pressure head from the Hawkesbury Sandstone. The tunnels are shown as being below the water table indicating that the sandstone and alluvium intersected would be saturated.

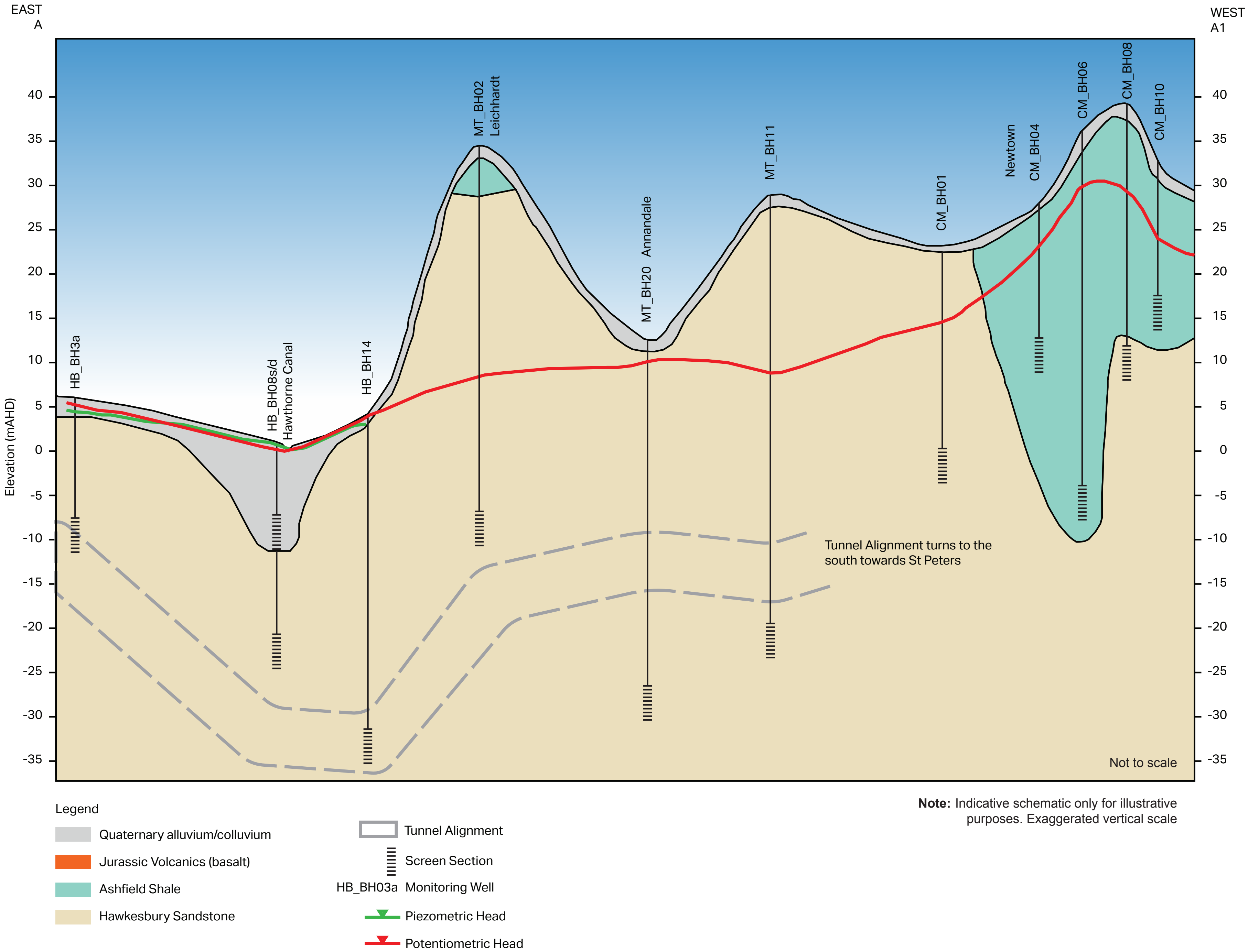


Figure 4-8 Hydrogeological cross section A-A'

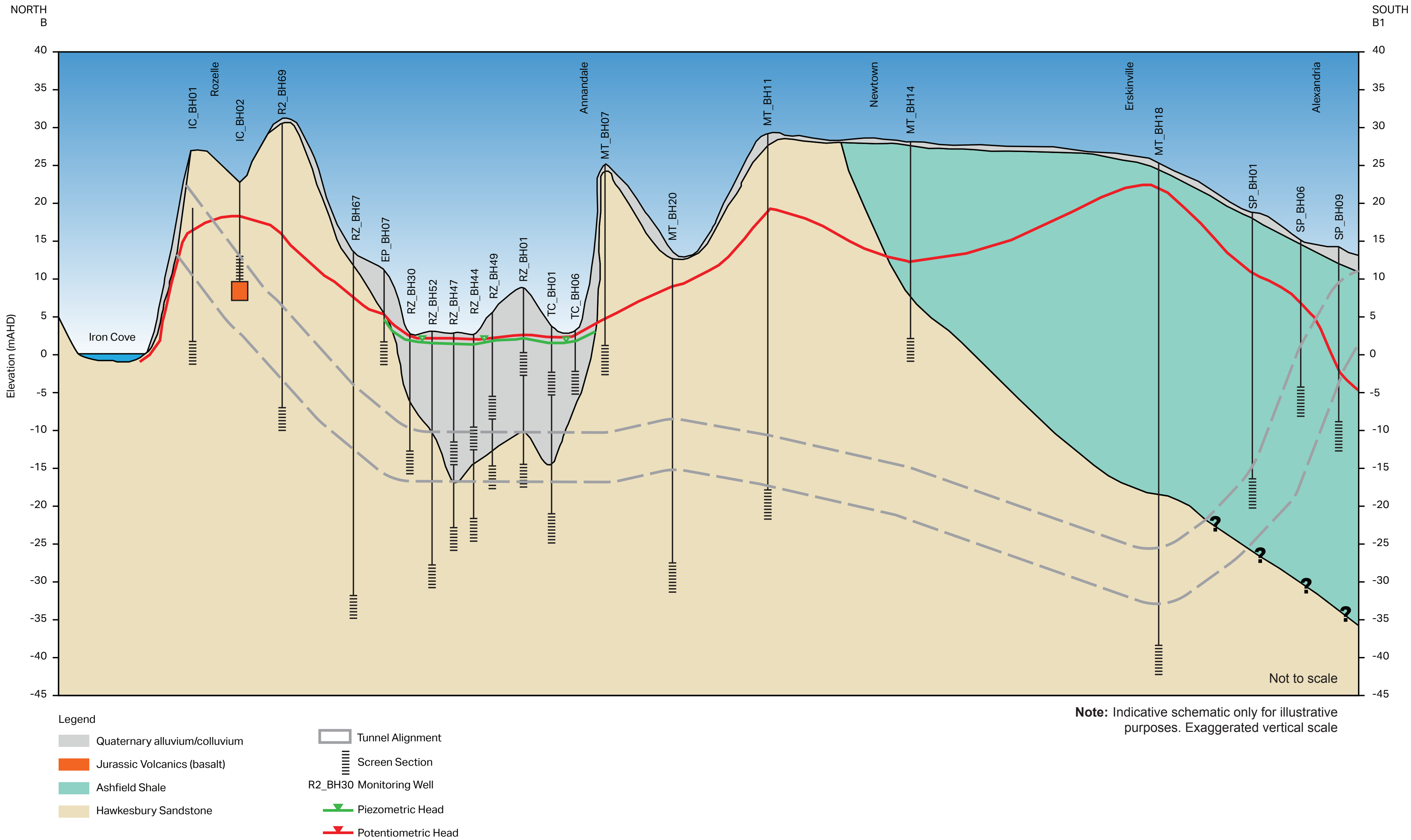


Figure 4-9 Hydrogeological cross section B-B'

4.9 Groundwater levels and movement

Baseline groundwater level data has been collected in the groundwater monitoring network installed along the proposed project footprint. The monitoring network consists of 58 monitoring wells intersecting groundwater from the alluvium, Ashfield Shale and Hawkesbury Sandstone as summarised in Table B1, **Annexure B**. The baseline monitoring is based on manual groundwater level data collected monthly from June 2016 and time series data collected from dataloggers and compared to rainfall. The monitoring wells have been surveyed and groundwater levels converted to metre AHD as summarised in Table B2, **Annexure B**. Based on these reduced levels, groundwater contours have been interpolated in key areas for each aquifer.

Natural groundwater levels are influenced by topography, creeks, rainfall, recharge, evapotranspiration and man-made structures. Groundwater levels are related to the position of a well in the landscape, with the groundwater table generally displaying gentler gradients but similar flow directions to the surface topography. Locally, the water table is impacted by infrastructure such as pumping (leachate pumping from landfills), groundwater resource pumping or localised temporary dewatering. Conversely in some areas the local water table may be elevated above natural conditions due to irrigation, such as at Sydney or Bicentennial Parks, or subsurface structures including infrastructure or building foundations that restrict groundwater flow causing localised groundwater mounding.

The depth to groundwater, groundwater flow directions, the distribution of piezometric and potentiometric heads for each aquifer is discussed in more detail in **sections 4.9.2** to **4.9.4**.

4.9.1 Regional groundwater flow

Groundwater flow within the Sydney Basin is complex and is controlled by many geological features including lithology, structural features and basin morphology. Regionally, groundwater flow within the Hawkesbury Sandstone and the Wianamatta Group is predominately fracture controlled. Flow is directed towards the central part of the basin that is generally beneath Sydney Harbour and the Sydney CBD (McKibbin and Smith 2000). Thus in general, the regional groundwater flow direction through the proposed project footprint would be expected to be northwards or north easterly with groundwater ultimately discharging offshore into the Pacific Ocean. On a more localised scale, groundwater movement is controlled by the elevation of the water table (hydraulic head), potentiometric heads and the hydraulic gradient which is a subdued expression of the topography.

The Hawkesbury Sandstone is a series of sandstone layers interbedded with low permeability shales and siltstones that form a series of partially confined or confined localised aquifers rather than a massive 300 metre thick sandstone unit. Groundwater can flow between these layers via fractures and joints hydraulically linking these units, however the degree of connectivity is variable with different sandstone layers exhibiting different hydraulic heads throughout the whole sandstone sequence. The groundwater within the upper unconfined layer of the sandstone is known as the water table, whereas the lower partially confined sub-aquifers with variable hydraulic heads are more correctly known as the potentiometric surface. Groundwater movement is anisotropic due to the groundwater flow being dominated by vertical flow rather than horizontal flow due to the fracture controlled systems.

Along the proposed project footprint alluvium flanks the creeks and Sydney Harbour, and is more widespread where deep palaeochannels have been identified, such as beneath Hawthorne Canal and the Rozelle Rail Yards. Within the alluvium, groundwater is typically unconfined and flowing along the axis of the palaeochannel or, in the case of alluvium flanking the harbour, towards the closest surface waterbody. In areas of widespread filling, such as the foreshore of Rozelle Bay, there may be some perched groundwater within the fill, however discharge to Rozelle Bay would be controlled by local discharge and drainage zones that are likely to respond to rapid, short term, rainfall events.

4.9.2 Alluvium

Groundwater levels within the alluvium are monitored in 10 monitoring wells installed for the project. Groundwater levels are primarily controlled by local recharge and discharge conditions. Since the alluvium is typically low lying and connected to surface water within creeks or Sydney Harbour, the elevation of the water table within the unconfined aquifers is typically less than one metre AHD. Monitored tidal oscillations within the alluvium indicate hydraulic connectivity with surface waterbodies including the canals, creeks and Sydney Harbour (see **section 4.9.5**).

Nested wells have been constructed at seven locations where alluvium overlies the Hawkesbury Sandstone to investigate differences in groundwater levels and quality. The hydrogeological technical details based on August 2016 gauging are summarised in **Table 4-2**.

HydroSimulations 2017, have compared hydrographs RZ_BH47s and RZ_BH49 with the rainfall residual mass curve (**Figure 4-3**) to compare groundwater trends with the long term rainfall average for the same period. In each case rainfall residual mass curve approximates the groundwater level trend suggesting that the alluvium responds in general accordance with long term rainfall and is not influenced substantially by any other factor.

Table 4-2 Summary of groundwater levels measured in nested wells

Precinct	Borehole Nest (shallow and deep)	Alluvial aquifer (s)		Hawkesbury Sandstone (d)		SWL[1] mAHD
		Screen interval (m)	SWL[1] m AHD (Aug 2016)	Screen interval (m)	SWL[1] m AHD (Aug 2016)	Difference (m)
Haberfield	HB_BH08	10 – 13	1.04	22 – 25	1.49[2]	0.45[2]
Rozelle	RZ_BH01	7 – 10	2.04	22 – 25	1.56	-0.48
Rozelle	RZ_BH44	12 – 15	1.11	25 – 28	1.87	0.76
Rozelle	RZ_BH47	15 – 18	1.16	27 – 30	1.55	0.39
The Crescent	TC_BH01	3 – 6	1.00	25 – 28	1.65	0.65
The Crescent	TC_BH07	3 – 6	0.47	19 – 22	1.63	1.16
The Crescent	TC_BH09	2 – 5	0.69	21 – 24	1.61	0.92

Notes:

1 SWL Standing water level

2 HB_BH08d is artesian and thus the pressure head is greater than 1.49 metre

With one exception, groundwater levels measured in nested monitoring wells have demonstrated that groundwater levels in the alluvium are typically lower than those in the underlying Hawkesbury Sandstone. The difference in pressure heads between the alluvium and Hawkesbury Sandstone varies from -0.48 to 1.16 metre. Since HB_BH08d is artesian and the well cap prevents water from discharging from the well the pressure head is greater than 0.45 metre. Hence, overall there is upward pressure from the Hawkesbury Sandstone to the alluvium where groundwater from the Hawkesbury Sandstone could be discharging into the alluvium if there is hydraulic connection. This upward pressure gradient may not be indicative of the whole sandstone unit along the proposed project footprint as the Hawkesbury Sandstone is often compartmentalised due to stratigraphic confining layers and structural defects creating different hydraulic conditions throughout the aquifer. The one exception is RZ_BH01 at Rozelle where the pressure head in the alluvium is 0.48 metres higher than the underlying Hawkesbury Sandstone. This pressure head differential is attributed to local conditions, as the alluvium associated with Whites Creek is located 50 metres up-gradient from the bore and is topographically higher which may be providing the higher hydraulic head in the alluvium.

Groundwater contours within the alluvium have been interpolated and are presented in **Figure 4-10** and **Figure 4-11**. Along Hawthorne Canal, alluvial groundwater is shallow and flowing northward, discharging into Parramatta River. Collation of groundwater levels beneath Whites Creek and the Rozelle Rail Yards indicates there are two alluvial sub-aquifers; one shallow sub-aquifer that is 10 metres or less thick and a deeper palaeochannel greater than 10 metres thick. Reference to the borelogs for the Rozelle area (AECOM 2017a) indicates there is a clay layer that is providing a confining layer between the upper and lower alluvial aquifers. Groundwater levels measured within the shallow alluvium (around The Crescent at Annandale) measured from 0.47 metres AHD to 1.08 metres AHD. Similarly the groundwater levels measured within the deep palaeochannel (within the

Rozelle Rail Yards at Rozelle) range from 1.11 metres AHD to 2.04 metres AHD. Comparison of the two sets of groundwater levels indicate the water levels in the palaeochannel are higher by about 0.5 metres than the shallow alluvium indicating there is upward pressure from the palaeochannel into the shallow alluvium, and groundwater from the palaeochannel may be discharging into the shallow alluvium. In each case, groundwater within the alluvium is flowing eastward discharging into Rozelle Bay.

On a regional scale the groundwater flow direction is controlled by topography with drainage towards Parramatta River and Sydney Harbour in the north, and Cooks River in the south.

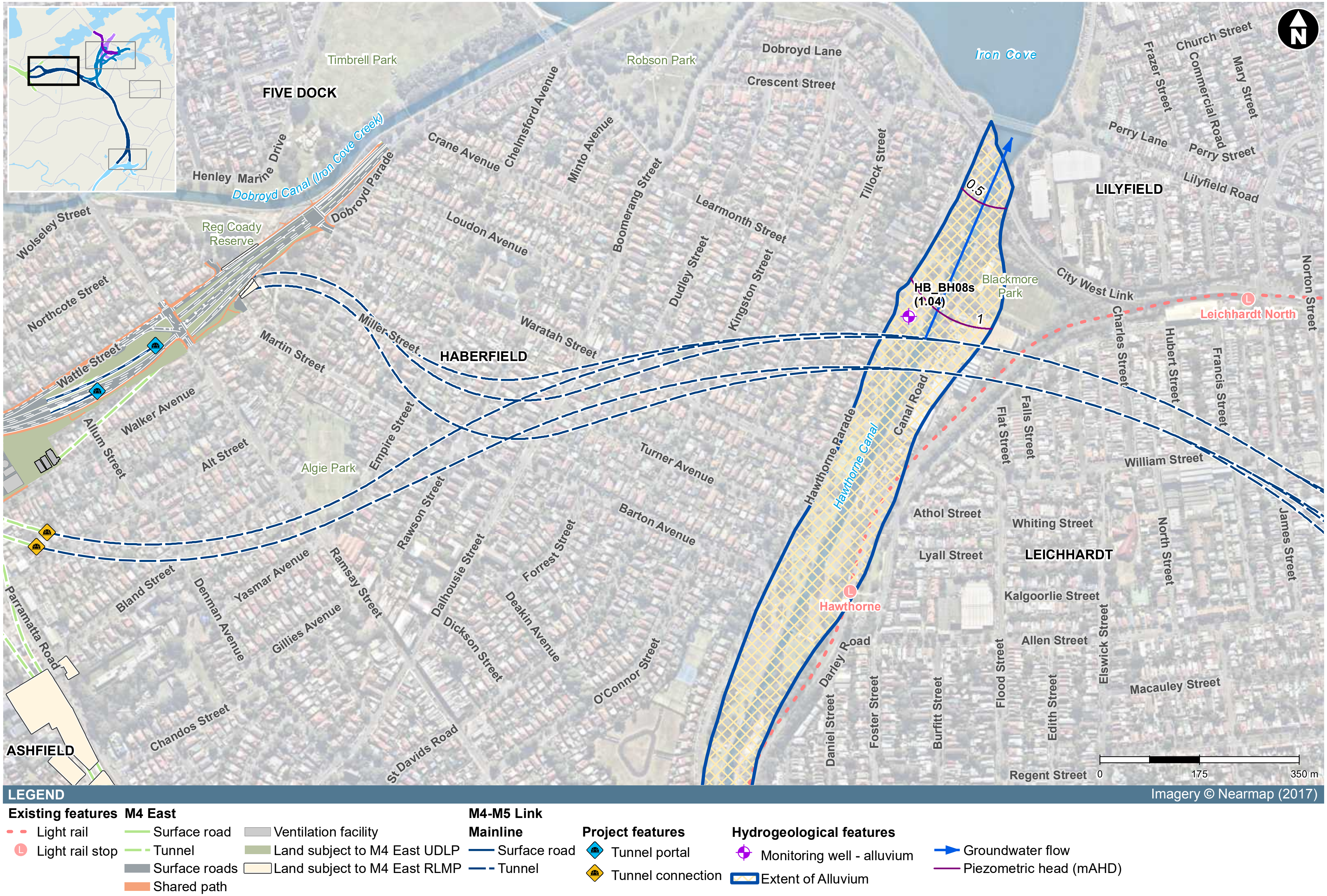
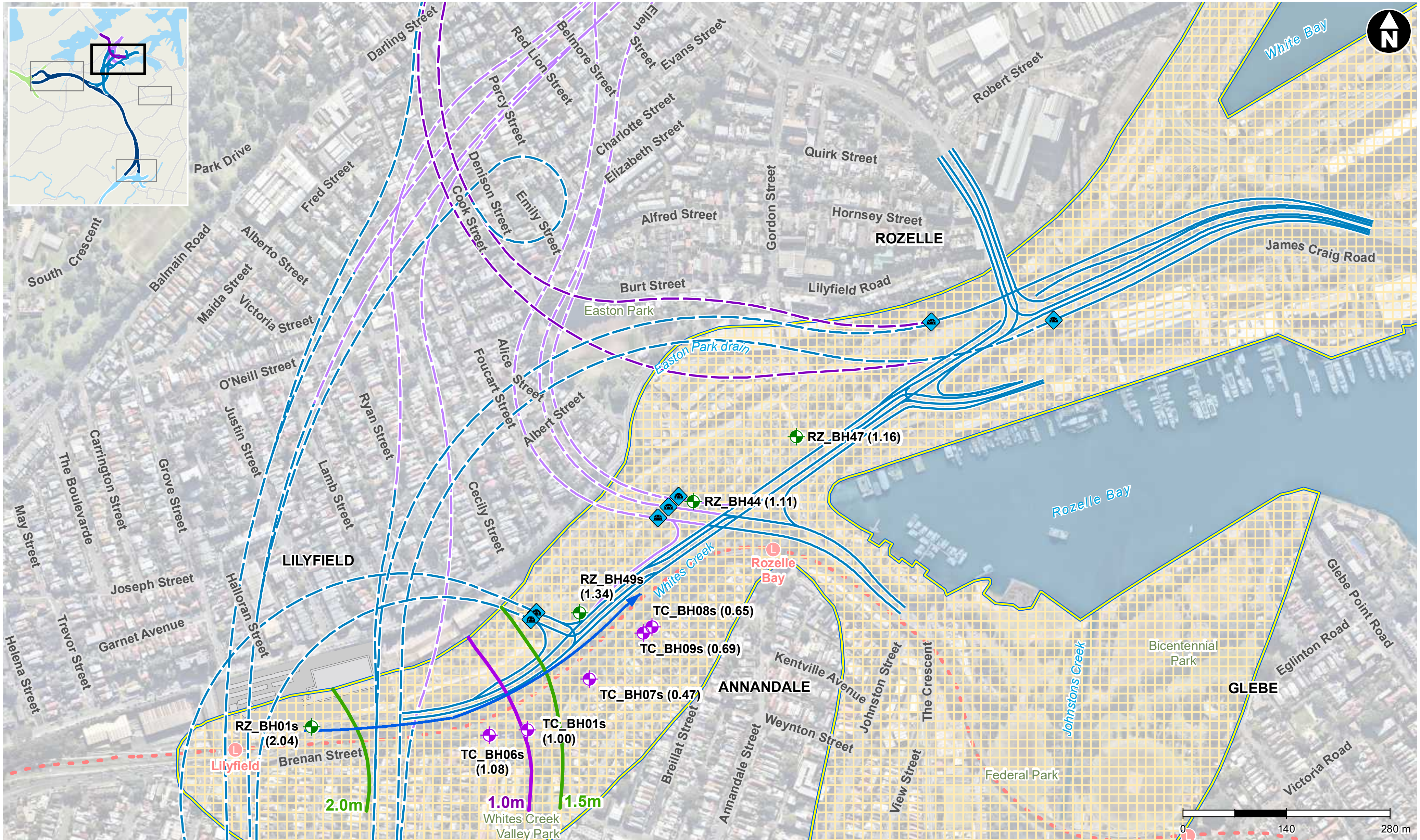


Figure 4-10 Groundwater contours - alluvium (Hawthorne Canal)



LEGEND — Imagery © Nearmap (2017)

Existing features
- Light rail
- Light rail stop

M4-M5 Link

Rozelle interchange
- Surface road
- Tunnel

Iron Cove Link
- Tunnel

Proposed future WHTBL connections (civil construction only)
- Surface road
- Tunnel

Project features
- Tunnel portal

Hydrogeological features
- Monitoring well - alluvium
- Monitoring well - palaeochannel
- Alluvium groundwater piezometric contour (mAHD)
- Palaeochannel groundwater potentiometric contour (mAHD)
- Groundwater flow
- Extent of Alluvium based on drilling and Herbert, 1983

Figure 4-11 Groundwater contours - alluvium (Whites Creek)

4.9.3 Ashfield Shale

Groundwater levels within the Ashfield Shale are monitored within the Camperdown and St Peters precincts of the project in eight monitoring wells. At St Peters, groundwater levels are influenced by ongoing leachate pumping from the former Alexandria Landfill (Hawkes and Evans 2016). Although no longer receiving waste and while undergoing rehabilitation, the former landfill still generates leachate that requires extraction via pumping, followed by on-site treatment, then discharge into Alexandra Canal. Groundwater monitoring undertaken as part of the WestConnex New M5 hydrogeological investigation confirmed that there is radial flow within the Ashfield Shale centred on the landfill caused by leachate pumping.

Potentiometric heads measured within the Ashfield Shale in the St Peters and Camperdown areas are presented in **Figure 4-12** and **Figure 4-13**. The highest groundwater level measured in the Ashfield Shale was measured in monitoring well CM_BH04, located at Camperdown at an elevation of 22.1 metre AHD, where the topography along the project footprint is at a high point. At the southern part of the project footprint next to the St Peters interchange, groundwater flows radially towards the western part of the landfill due to ongoing leachate pumping. This radial flow pattern and reversed hydraulic gradients prevents contamination from dispersing into the Ashfield Shale. Within the Sydney Basin, perched groundwater is typically present within the residual soil profile or where jointing and bedding plane partings are well developed but not infilled with clay of the Ashfield Shale. The monitoring wells have been constructed to extend beyond any perched aquifers to intersect the regional aquifer. Consequently, the data collected during this program is considered suitable for inclusion in the groundwater model calibration.

HydroSimulations 2017 have compared hydrograph SP_BH06 with the rainfall residual mass curve (see **Figure 4-3**) to compare groundwater trends with the long term rainfall average for the same period. Groundwater levels within the Ashfield Shale at this location closely follow the rainfall residual mass curve for the same period indicating that rainfall recharge is the primary mechanism in maintaining the hydraulic head within the shale.

On a regional scale, the natural groundwater level contours within the Ashfield Shale have been simulated as part of the groundwater model development based on groundwater level measurements (see **Figure 4-14**). Review of the groundwater level contours shows the dominant groundwater flow direction is towards Botany Bay and Sydney Harbour.

4.9.4 Hawkesbury Sandstone

Groundwater levels within the Hawkesbury Sandstone are monitored in 40 monitoring wells across the project footprint. The elevation of measured groundwater levels ranges from 0.63 metre AHD (RZ_BH47d) beneath the Rozelle Rail Yards to 20.27 metre AHD (CM_BH01) beneath Camperdown. Artesian groundwater within the Hawkesbury Sandstone has been intersected in two monitoring wells in the low lying areas beneath Hawthorne Parade and Darley Road, Leichhardt. The distribution of potentiometric heads measured within the Hawkesbury Sandstone at Haberfield and Rozelle are shown on **Figure 4-15** and **Figure 4-16** respectively.

HydroSimulations 2017 have compared two hydrographs screened in the Hawkesbury Sandstone that have produced different trends. Monitoring well RZ_BH28 located within the Rozelle Rail Yards displays a declining groundwater trend from August 2016 through to February 2017 and rising after a large February 2017 rainfall event. This trend mimics the rainfall residual mass curve suggesting rainfall recharge is the primary mechanism maintaining hydraulic heads at this location. In contrast, the groundwater level trend in monitoring well SP_BH04, screened within the Hawkesbury Sandstone does not appear to respond to rainfall recharge and does not follow the rainfall residual mass curve. These trends are attributed to external influences which could be a combination of the commencement of the New M5 tunnel construction and leachate pumping at St Peters from the former Alexandria Landfill.

At Haberfield, measured groundwater levels within the Hawkesbury Sandstone are variable and range from 0.5 to 8 metre AHD. The groundwater elevation tends to reflect the position of the monitoring well in the landscape with the hydraulic head increasing with distance from Rozelle Bay. Along Hawthorne Parade, since early June 2016, the potentiometric head (measured in HB_BH08d at a depth interval of 22–25 metres) has been artesian and on 28 October 2016 the head was measured at 0.16 metres above ground level (or 1.65 metre AHD). Similarly, at HB_BH12, located at Darley

Road, Leichhardt, the well was flowing when completed in June 2016 but in October 2016 the standing water level was measured at 0.05 metres below the top of casing. At Haberfield and Rozelle, groundwater contours for the potentiometric head within the Hawkesbury Sandstone have not been constructed due to the flat hydraulic gradients.

On a regional scale, the natural groundwater level contours within the Hawkesbury Sandstone have been simulated as part of the groundwater model development based on groundwater level measurements (see **Figure 4-17**). Review of the groundwater level contours shows the dominant groundwater flow direction is similar to the Ashfield Shale, flowing towards Botany Bay and Sydney Harbour. Depressed groundwater levels exist along the existing M5 East alignment due to groundwater leakage to the M5 East tunnels.

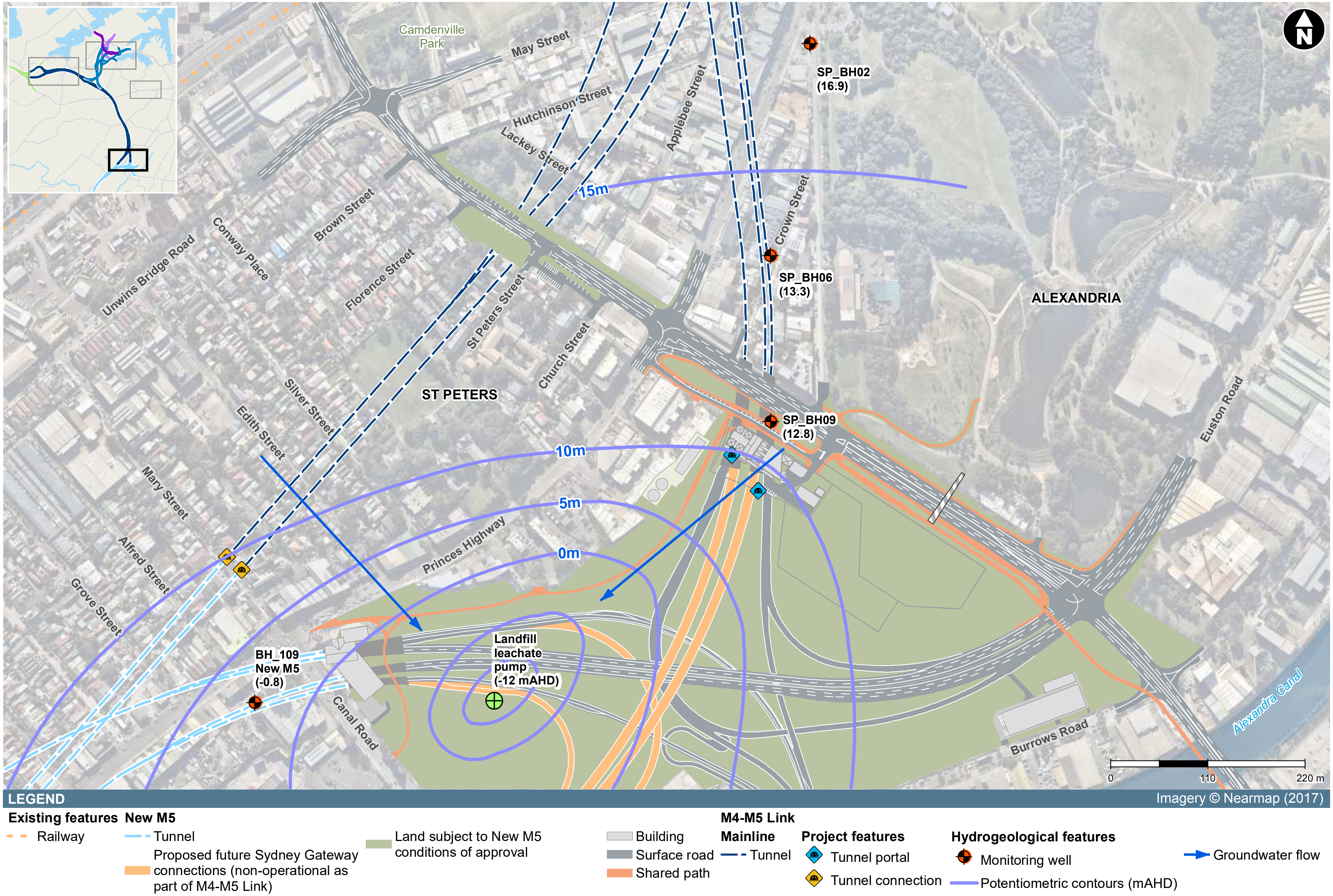


Figure 4-12 Groundwater contours - Ashfield Shale (St Peters)

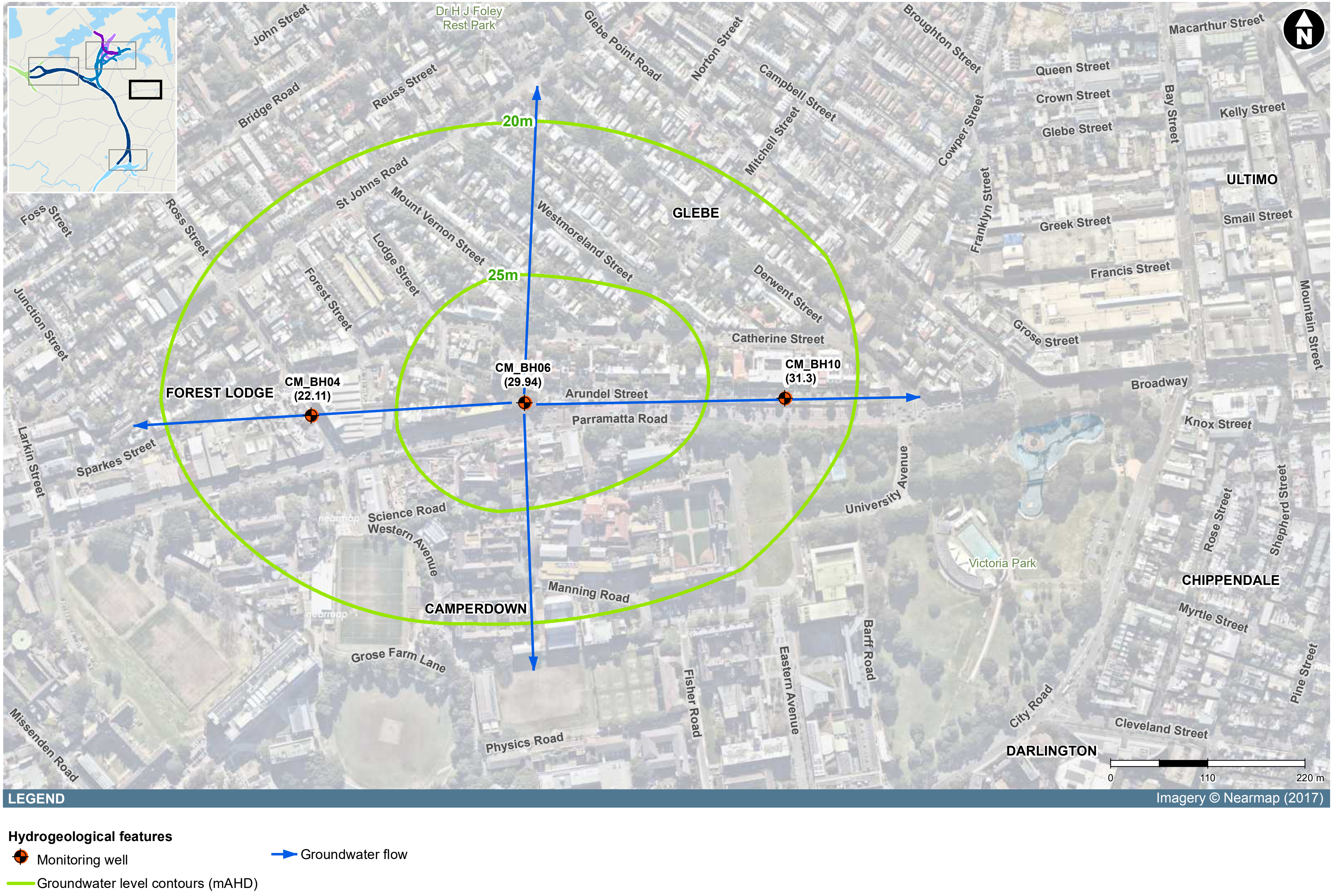
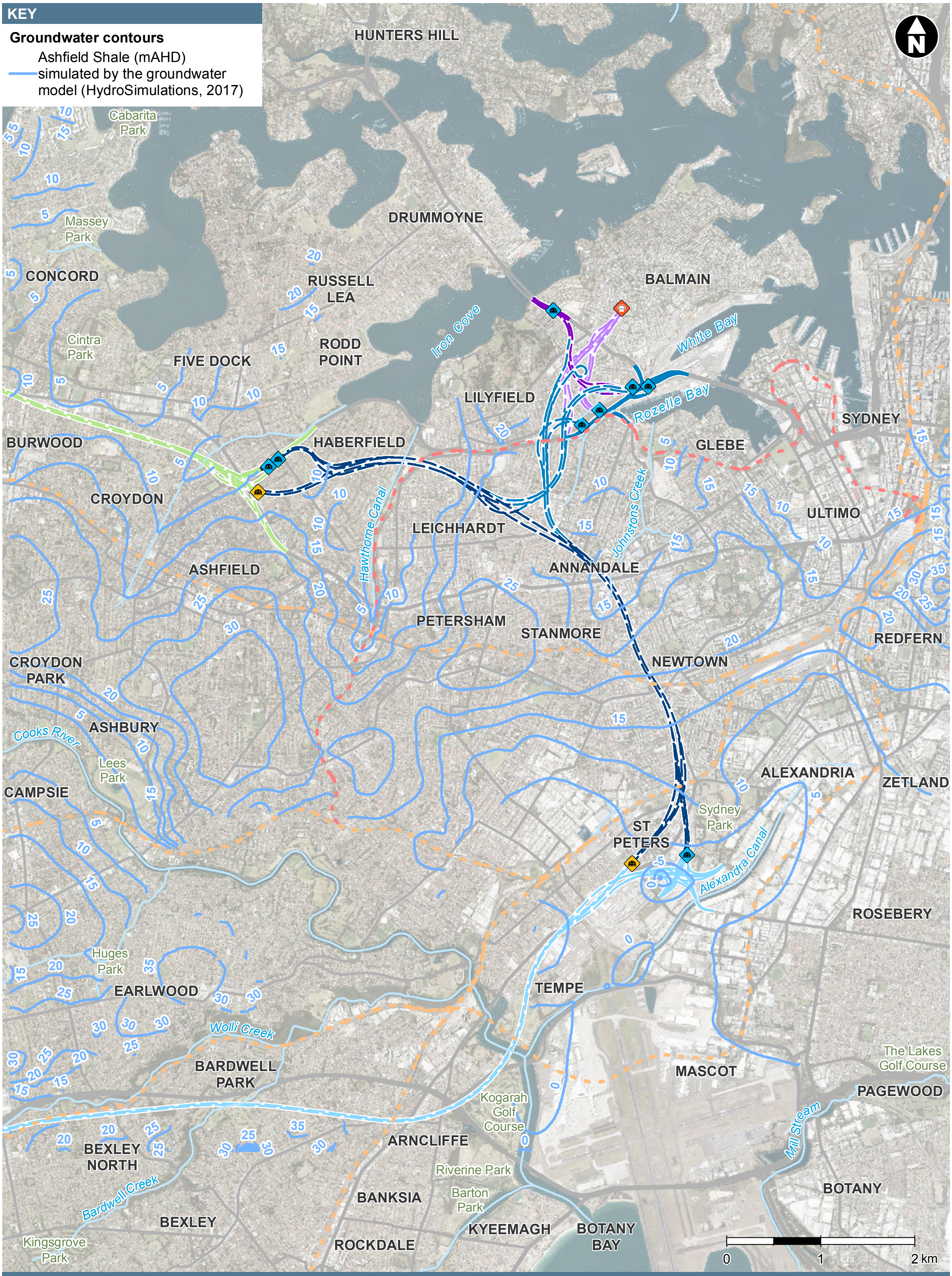


Figure 4-13 Groundwater contours - Ashfield Shale (Camperdown)



LEGEND

Existing features
- Waterway
- Railway
- Light rail
- Arterial road
- Subarterial road

Project features
- Tunnel portal
- Tunnel extent
- Tunnel connection

M4 East
- Surface road
- Tunnel

New M5
- Surface road
- Tunnel

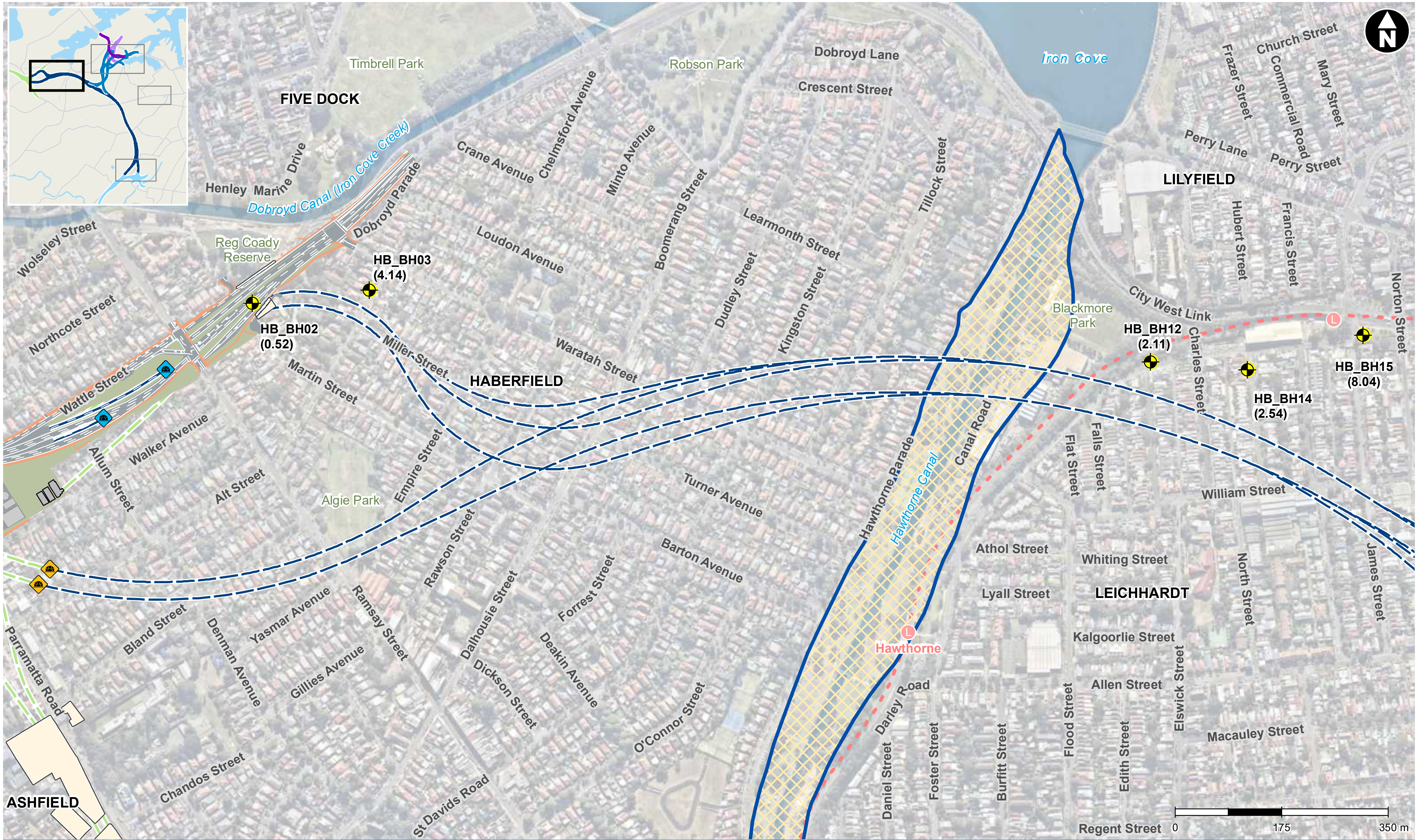
M4-M5 Link Mainline
- Surface road
- Tunnel

Rozelle interchange
- Surface road
- Tunnel

Iron Cove Link
- Surface road
- Tunnel

Proposed future WHTBL connections (civil construction only)
- Surface road
- Tunnel

Figure 4-14 Groundwater contours - Ashfield Shale



LEGEND

Imagery © Nearmap (2017)

Existing features
- Light rail
- Light rail stop

M4 East
- Surface road
- Tunnel
- Surface roads
- Shared path
- Ventilation facility
- Land subject to M4 East UDLP
- Land subject to M4 East RLMP

M4-M5 Link

Mainline
- Surface road
- Tunnel

Project features
- Tunnel portal
- Tunnel connection

Hydrogeological features
- Monitoring well - Hawkesbury sandstone
- Extent of Alluvium

Figure 4-15 Measured potentiometric heads - Hawkesbury Sandstone (Haberfield)

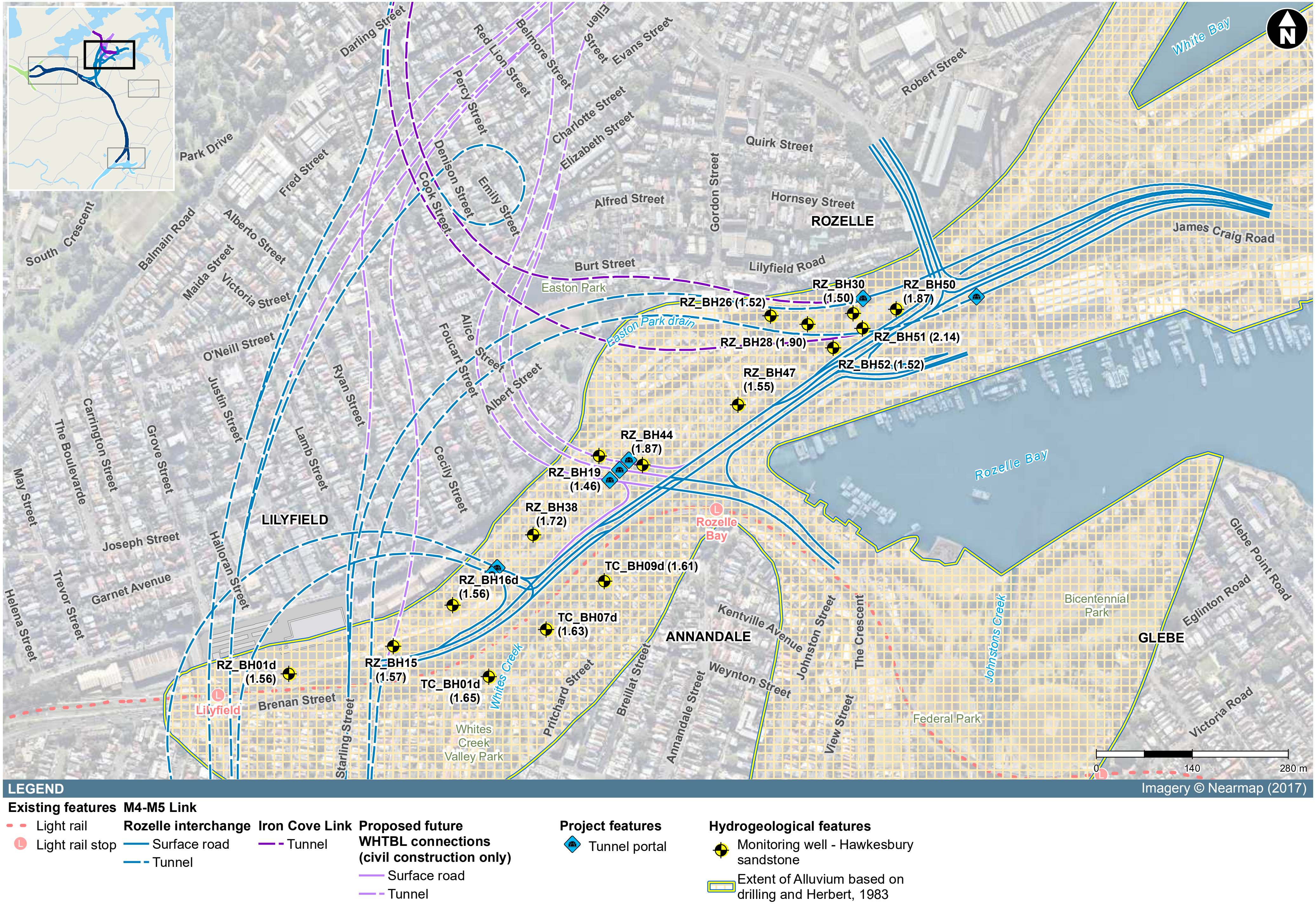


Figure 4-16 Measured potentiometric heads - Hawkesbury Sandstone (Rozelle)

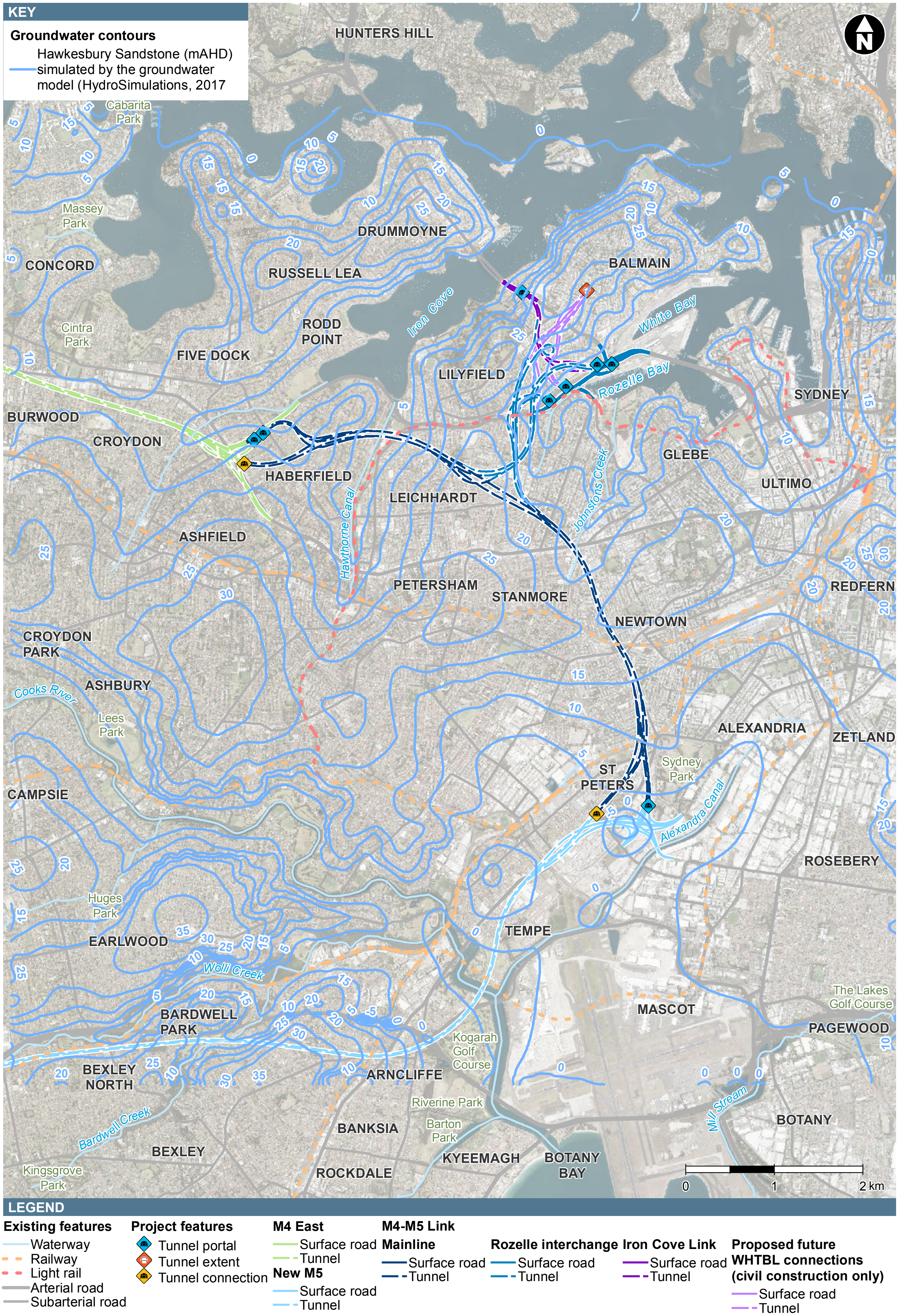


Figure 4-17 Groundwater contours - Hawkesbury Sandstone

4.9.5 Time series groundwater level trends

Groundwater levels have been monitored on an hourly basis by data loggers since June 2016, in monitoring wells constructed within the project footprint within the alluvium, Ashfield Shale and Hawkesbury Sandstone. The data has been corrected for barometric pressure effects. The resultant hydrographs, plotted with daily rainfall for comparison, are presented in **Annexure C**.

Review of the hydrographs indicates there are at least three natural processes that influence the plots as follows:

- Diurnal fluctuations due to tidal or barometric pressure fluctuations
- Short term response to specific rainfall events
- Long term trends related to the departure of rainfall trends from average conditions.

No anthropogenic features such as impacts due to irrigation, pumping or passive discharge to unlined subsurface structures were detected.

Groundwater level fluctuations within the alluvium are monitored in 10 monitoring wells in Haberfield and Rozelle. At Haberfield (HB_BH8s), groundwater fluctuations oscillate over an amplitude of about 0.35 metres which appears related to rainfall recharge and with tidal influences of about 0.10 metres. Similarly at Rozelle, groundwater is shallow ranging from one to 4.5 metres AHD, and increase following rainfall events and rainfall recharge and decline following periods of low rainfall. The largest recharge events follow high rainfall recorded in early and late August 2016. Superimposed over the climatic and seasonal fluctuations are variable tidal fluctuations ranging from 1 to 2 millimetres that increase closer to Rozelle Bay.

Similarly, time series groundwater levels measured in the shale generally increased between early July and September 2016 and then declined for the remainder of 2016 reflecting the impacts of rainfall and recharge conditions. Superimposed over the climatic trends are minor daily fluctuations that could be related to the leachate pumping or hydraulic tidal influences from Alexandra Canal. Natural groundwater fluctuations within the shale are typically over a low amplitude between 10 to 20 millimetres which are attributed to the low bulk hydraulic conductivity within the weathered shale profiles.

Time series groundwater level fluctuations measured in the Hawkesbury Sandstone at Haberfield and Rozelle ranged over a short amplitude of less than one metre, responding to rainfall recharge and periods of low rainfall. Superimposed over the climatic trends are tidal fluctuations that vary from 30 to 50 millimetres that diminish with increasing distance from the Parramatta River and Rozelle Bay. With the exception of the influences of variable tidal oscillations and rainfall recharge on groundwater levels, there does not seem to be any other external influences on the aquifer such as pumping or localised dewatering. Measured groundwater level fluctuations indicate that the oscillations are less than one metre, suggesting that the Hawkesbury Sandstone groundwater system is in equilibrium. This means that the components of the hydrogeological regime including recharge (primarily rainfall infiltration) and discharge (primarily discharge to creeks, Sydney Harbour and evapotranspiration) are balanced. There are clear correlations with rainfall, with the groundwater level rising generally in excess of 10 millimetres following a rainfall event.

4.10 Groundwater extraction

A review of bores registered with DPI-Water accessed through the Bureau of Meteorology (9 May 2016) and the PINNEENA groundwater database identified 197 boreholes within a two kilometre radius of the project footprint. There may also be other private bores present within the two kilometre radius that have not been registered with DPI-Water. The distribution of registered boreholes extracted from the database is shown in **Annexure D**. In analysing the data, there are two distinct types of bores: bores with recorded hydrogeological data (66), and bores with only the borehole number and coordinates recorded (131). The results of this search are summarised in Table D1 and D2 in **Annexure D**.

Typically, boreholes with only coordinates recorded are monitoring wells constructed as part of contamination investigation programs. Contamination investigation areas identified include Green Square, a former brewery at Camperdown, Ramsay Street at Haberfield, Barangaroo and Blackwattle

Bay northern foreshore as outlined in Table B7b in **Annexure D**. In most cases these monitoring wells would no longer be monitored as the site investigation or remediation programs are completed and the sites redeveloped.

In addition, HydroSimulations 2017, extracted data from the Bureau of Meteorology (September 2016) and the PINNEENA groundwater database across the 121 square kilometres model domain, identifying 398 registered groundwater works. The majority of these bores are shallow monitoring wells constructed within the Botany Sands. The groundwater modelling has been applied to quantify potential impacts on these registered bores due to the project (see **Chapters 5** and **6**).

Analysis of the remaining data indicates that the majority of registered wells are constructed for monitoring purposes with the minority developed for recreation, irrigation and domestic water supply purposes (see **Table 4-3**).

Table 4-3 Summary of DPI-Water registered bores within two kilometres of the project footprint

Purpose	Number of bores	Predominant lithology	SWL min	SWL max	Bore depth min	Bore depth max
Recreation	1	Sandstone	11.6	11.6	180	180
Domestic	4	Sand	4	31	2.5	210
Monitoring	61	shale/sandstone	0.4	7.7	1.3	48

Note: SWL = Standing Water Level (metres below ground level)

Review of the lithological data indicates that the majority of boreholes are shallow (less than 10 metres) and monitor groundwater in the sand, clay, shallow sandstone or shale. The majority of monitoring wells are clustered at various investigation sites along the project footprint. A 180 metre deep recreation bore is located at Redfern Park within the Hawkesbury Sandstone, and is used to irrigate Redfern Oval. Four domestic bores are located along the project footprint ranging in distance between 210 and 1480 metres from the project footprint. It is not known if these bores are still used for domestic use or have been abandoned. A 210 metre deep bore (GW110247) at Sydney University extracts groundwater from the Hawkesbury Sandstone is registered for domestic use.

Even though groundwater quality is generally good within the Hawkesbury Sandstone, groundwater use across most of the project footprint is low as bore yields are typically low and the area has access to reticulated water.

At Rozelle Rail Yards, there are few registered monitoring wells suggesting that there has been limited historical groundwater investigations undertaken at this former industrial site (prior to the investigations undertaken for this assessment), or monitoring wells have not been registered.

The project does not propose to extract groundwater during the construction or operational phases for project purposes. Groundwater reuse will be considered in accordance with policies of sustainable water use of DPI-Water (National Water Quality Management Strategy, 2006).

4.10.1 Groundwater extraction entitlements

At a macro scale, the project footprint is located within Sydney Basin Central as part of the Greater Metropolitan Region Groundwater Resources Water Sharing Plan (NoW 2011). The Botany Sands aquifer flanks the project footprint to the east and has been included in the discussion as the aquifer may be impacted by the project. Within the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources, groundwater is to be extracted from the Sydney Basin Central and the Botany Sands aquifer as outlined in **Table 5-1** and **Table 6-2**. The AIP (NoW 2012) is addressed in **sections 9.1** and **9.2**.

The Sydney Basin Central Water Source covers an area of 3,758 square kilometres, receives an annual rainfall of 3,820,386 megalitres per year and, with an estimated infiltration rate of 6 per cent, the estimated average annual rainfall recharge is 229,223 megalitres per year (Table 7, NoW 2011). Based on water that is potentially available for extraction, NoW (2011) assessed that the sustainability of groundwater extraction from the Sydney Basin Central is of moderate environmental risk.

By contrast, the Botany Sands Water Source covers an area of 91 square kilometres, receives an annual rainfall of 101,413 megalitres per year and, with an estimated infiltration rate of 3 per cent, the estimated average annual rainfall recharge is 30,424 megalitres per year (Table 7, NoW 2011). The sustainability of groundwater that is potentially available for extraction within the Botany Sands groundwater resource has been assessed as to be of moderate environmental risk.

Based on the estimated recharge and the existing groundwater extraction licences at the commencement of the water sharing plan (July 2011), the long term average annual extraction limits (LTAAEL) have been calculated by NoW and are presented in **Table 4-4**. The LTAAEL is an estimated sustainable extraction limit for each of the groundwater sources, based on the annual rainfall recharge that may be sustainably released for use.

Table 4-4 Groundwater extraction entitlement and limit

Groundwater source	Entitlement (ML/unit share/yr)	LTAAEL (ML/yr)	Approximate number of existing licences*
Sydney Basin Central	2,592	45,915	120
Botany Sands	11,156	14,684	80

Note: * Based on the commencement of the WSP (July 2011)

4.11 Regional hydraulic parameters

The hydraulic properties across the project footprint within the Sydney Basin have been collated from previous investigations and published data. Realistic hydraulic parameters are required for input into the numerical groundwater modelling and then these are refined as the model is calibrated. The hydraulic properties of the various hydrogeological units are discussed below and the model ranges are presented in HydroSimulations 2017.

4.11.1 Alluvium and fill

Alluvium along the rivers and creeks are composed of silts and clays weathered from the Hawkesbury Sandstone and Ashfield Shale. No site specific data has been collected during these investigations for hydraulic conductivity. Typical hydraulic conductivity values for similar lithologies across the Sydney Basin would be expected to range from 0.001 metres per day for clayey alluvium up to 1 metre per day for sandy alluvium. The hydraulic conductivity of alluvium in a similar depositional environment associated with Wolli Creek is noted to be between 0.2 and 0.8 metres per day based on slug tests (CDM Smith 2016).

4.11.2 Wianamatta Group Shale

The bulk hydraulic conductivity range of the Wianamatta Group Shale varies from 0.0001 to 0.01 metres per day for fresh rock, increasing to 0.0001 to 0.1 metres per day for weathered shale (Hewitt 2005). Russell *et al* 2009 indicates there is a general lack of hydrogeological permeability data for the Ashfield Shale possibly due to the unit having poor resource potential.

4.11.3 Hawkesbury Sandstone

The hydraulic properties of the Hawkesbury Sandstone are reasonably well known because it has been investigated by many hydrogeologists over the years due to its high resource potential. The hydraulic conductivity within the Hawkesbury Sandstone is related to defect characteristics which are influenced by depth and *in situ* stress conditions. Hydraulic conductivity tends to decrease with depth mainly due to decreasing sub-horizontal defect apertures Tammetta and Hewitt (2004). An analysis of packer test data for the Hawkesbury Sandstone confirms the relationship of a reduction in geometric mean hydraulic conductivity with depth (Tammetta and Hawkes 2009). More recently, groundwater resource investigations initiated by the Millennium Drought and centred on the Hawkesbury Sandstone have identified structurally deformed areas which have bore yields up to 30 litres per second (Ross 2014).

Hewitt (2005) estimates the hydraulic conductivity of the Hawkesbury Sandstone ranges from 0.1 metres per day at ground surface decreasing to around 0.001 metres per day at a depth of around 50 metres. McKibbin and Smith (2000) quote a hydraulic conductivity range for the Hawkesbury Sandstone between 0.01 and one metre per day and note that values in excess of 0.1 metres per day are probably associated with fracture permeability. Values of hydraulic conductivity within the NoW database may be on average higher as quoted hydraulic parameters are often associated with resource works which are typically higher yielding.

Regionally there is a hydraulic conductivity anisotropy where the horizontal (K_h) is typically greater than the vertical (K_v) by up to two orders of magnitude or more. In the groundwater model developed for the adjacent New M5 project (CDM Smith 2015) the hydraulic conductivity parameters for K_h and K_v were 0.01 and 0.0005 metres per day respectively. Literature values for specific storage range from $1x10^{-5}$ to $1x10^{-4}$ (Hawkes, Ross and Gleeson 2009) and $3.7x10^{-3}$ to $1x10^{-1}$ (Tammetta and Hewitt 2004).

4.11.4 Hydraulic conductivity and porosity

Hydraulic conductivity and porosity testing was conducted during the field investigation program to provide parameters to support the groundwater modelling. Hydraulic conductivity was measured *in situ* by water pressure (packer) testing and by the laboratory testing of drill core. Porosity was also measured in the laboratory from core samples.

The packer test results provide estimates of hydraulic conductivity for the intervals measured, for the effects of horizontal (Kh) features whereas the laboratory results provide estimates for vertical (Kv) features in the rock matrix. Horizontal and sub-horizontal hydraulic conductivities are expected to be higher than vertical hydraulic conductivity because horizontal defects tend to be more extensive, numerous and wider than vertical defects in the Hawkesbury Sandstone and Ashfield Shale.

Domenico and Schwartz (1990) state that hydraulic conductivity data is typically represented as a log normal distribution where the calculated average is more suited to the harmonic mean rather than the arithmetic mean. That is by calculating the harmonic mean the impacts of outliers are removed. In contrast to hydraulic conductivity, porosity values have a normal rather than a log normal distribution and the average population is better represented as the arithmetic mean. Consequently, hydraulic conductivity and porosity averages in this report are described by the harmonic mean and arithmetic mean respectively.

A comparison of the average packer test results for the Hawkesbury Sandstone (K_h = 0.093 metres per day) and laboratory hydraulic conductivity (K_v = 0.0031 m/day) confirms K_h is greater than K_v by about two orders of magnitude. Hydraulic conductivity statistics are summarised on Table B4a in **Annexure B**.

No site specific data was collected during the groundwater investigations for the hydraulic conductivity of the alluvium. Typical hydraulic conductivity values for similar lithologies across the Sydney Basin would be expected to range from 0.001 metres per day for clayey alluvium up to 1 metre per day for sandy alluvium.

Laboratory testing

Throughout the drilling program core samples were selected from the Hawkesbury Sandstone and Ashfield Shale for laboratory testing for hydraulic conductivity and porosity. Thirteen core samples were tested for hydraulic conductivity and porosity, 11 from the Hawkesbury Sandstone and two from the Ashfield Shale. The results are summarised in Table B11 in **Annexure B** and the laboratory output is presented in **Annexure G**.

Porosity results within the Hawkesbury Sandstone range from 11.3 to 19.2 per cent and 5.6 per cent for the Ashfield Shale. Laboratory hydraulic conductivity results for the Hawkesbury Sandstone represent vertical hydraulic conductivity (K_v) through the aquifer. The K_v results vary over a narrow range between 0.00008 to 0.0055 metres per day.

Water pressure testing

In situ water pressure (packer) testing was undertaken in selected boreholes to assess hydraulic conductivity along the project footprint. The packer tests also give an indication where groundwater inflows into the tunnels could be expected. *In situ* hydraulic conductivity results predominately represent horizontal water movement (K_h) through the aquifer. The water pressure testing was carried out in accordance with established procedures set out in Fell, MacGregor, Stapledon and Bell (2005). Packer tests are conducted by the drilling contractors by injecting water under pressure into a rock mass interval and measuring the water ingress over a given time period. The amount of water injected is proportional to the hydraulic conductivity.

Packer testing was performed in selected cored sections using a single stage pneumatic HQ packer and calibrated flow meters provided by the drilling contractor. Water pressure testing was carried out in 94 boreholes (uncased as distinct from monitoring wells) with multiple tests performed in each borehole. Each test was typically carried out in five different pressure stages (three increasing and two decreasing stages), at the nominated test interval (typically about three, six, nine or 12 metres). Where angle holes were tested (MT_BH08, MT_BH16 and MT_BH22) the test section was corrected to represent the vertical depth interval.

The packer test results provide a bulk hydraulic conductivity for the intervals measured including horizontal and vertical features and the rock matrix. Horizontal and sub-horizontal permeability is expected to be higher than vertical permeability because the horizontal defects tend to be more extensive, numerous and wider in the Hawkesbury Sandstone and Ashfield Shale. The defects tend to decrease with depth as the surficial pressure influences decrease.

The hydraulic conductivity has been measured by conducting 220 packer tests in 94 boreholes. The location of boreholes where packer tests were conducted is shown on **Figure 4-18**. The packer test results are presented in Table B4, **Annexure B**. Results of the packer tests are expressed as lugeon units where a lugeon (L) is equivalent to a hydraulic conductivity of $1x10^{-7}$ metres per second ($8.8x10^{-3}$ metres per day). The location of packer test results for all lithologies are presented in **Table 4-5** and show the majority of the rock mass results are of low permeability, suggesting that inflows along the majority of the proposed tunnel would be low.

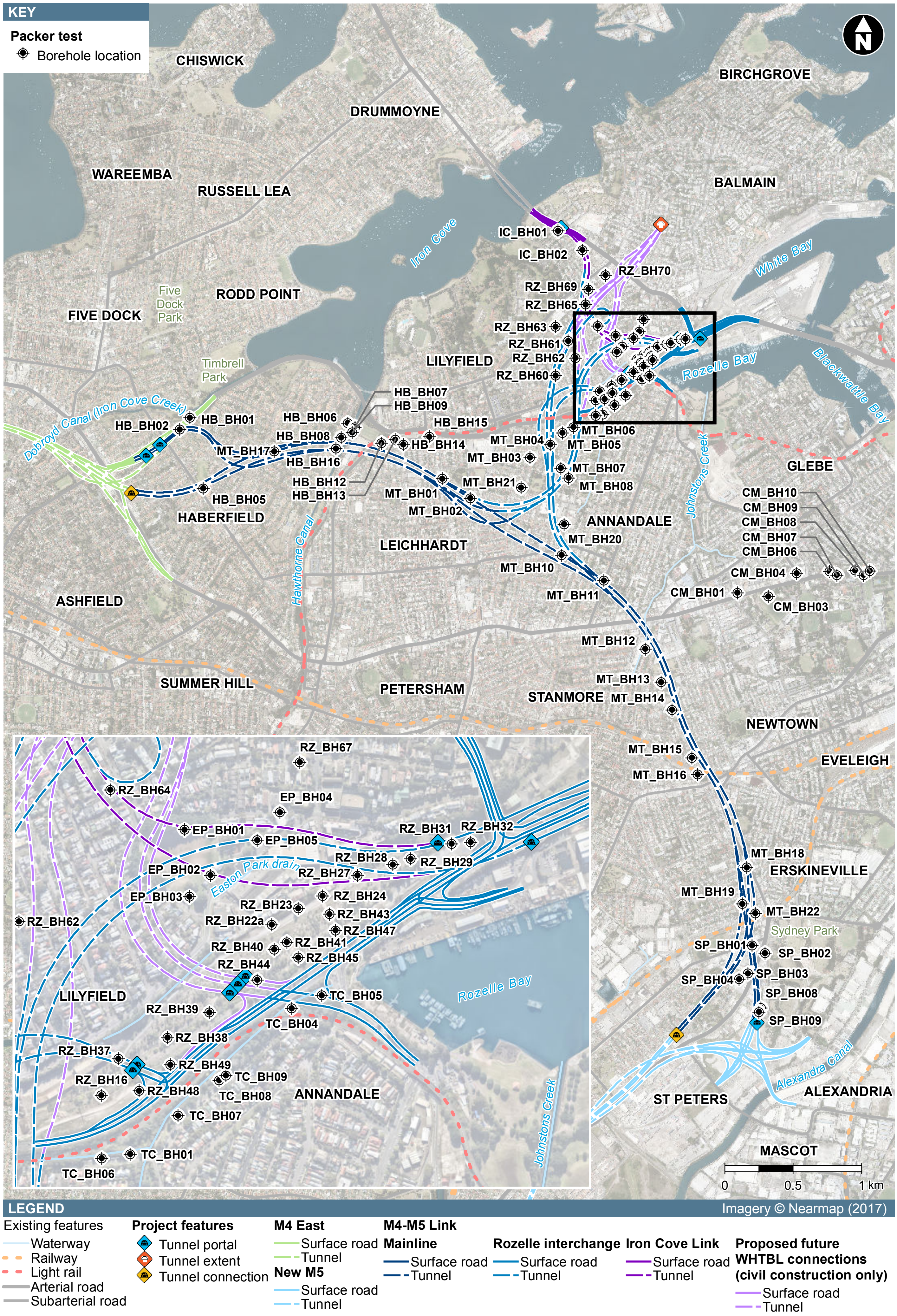


Figure 4-18 Locations of packer tests

Table 4-5 Distribution of rock mass permeability

Relative permeability	Permeability range		Measurements	
	Lugeons	m/day	Ashfield Shale	Hawkesbury Sandstone
N/A[1]			1	8
Low	<1 Lugeon	<0.0086	13	102
Moderate	1 to 5 Lugeons	0.0086 – 0.043	7	51
High	5 to 20 Lugeons	0.043 – 0.17	2	6
Very high	20 to 50 Lugeons	0.17 – 0.43	0	14
Extremely high	>50 Lugeons	>0.43	1	9
Total			**24**	**196**

Notes:

1 N/A Packer Test conducted but no results due to difficult field conditions

To provide an understanding of the measured bulk hydraulic conductivity within each lithology, statistics including mean, maximum, minimum, median and standard deviation are presented in **Table 4-6**. The majority (89 per cent) of packer tests were conducted within the Hawkesbury Sandstone which is reflective of the majority of the project footprint being located within this stratigraphic unit. For comparison, hydraulic conductivity values within the Hawkesbury Sandstone across the whole Sydney Basin were compiled by McKibbin and Smith (2000) from the DPI-Water groundwater database with results ranging between 0.01 and 0.15 metres per day. This range is higher than the packer test results which is attributed to the results being derived from test pumping results data, obtained from successful production bores that intersect highly permeable faults and fractures.

Table 4-6 Rock mass permeability statistics

Lithology/Statistics	Ashfield Shale	Hawkesbury Sandstone
Units	**m/day**	**m/day**
Arithmetic mean	0.017	0.10
Harmonic mean	0.010	0.012
Minimum	0.0086	0.0086
Maximum	0.12	1.17
Standard deviation	0.024	0.21
Total number of packer tests	24	181

The distribution of hydraulic conductivity results and the 10 point geometric mean plotted against depth are presented in **Figure 4-19**. The plot shows a wide variation in hydraulic conductivity values, with the overall trend of decreasing hydraulic conductivity with depth. The log-average hydraulic conductivity varies from about 0.1 metres per day at 10 metres to about 0.01 metres per day below 50 metres. The large scatter is caused by the variation in defect spacing which tends to decline with depth due to an increased influence of overburden pressure.

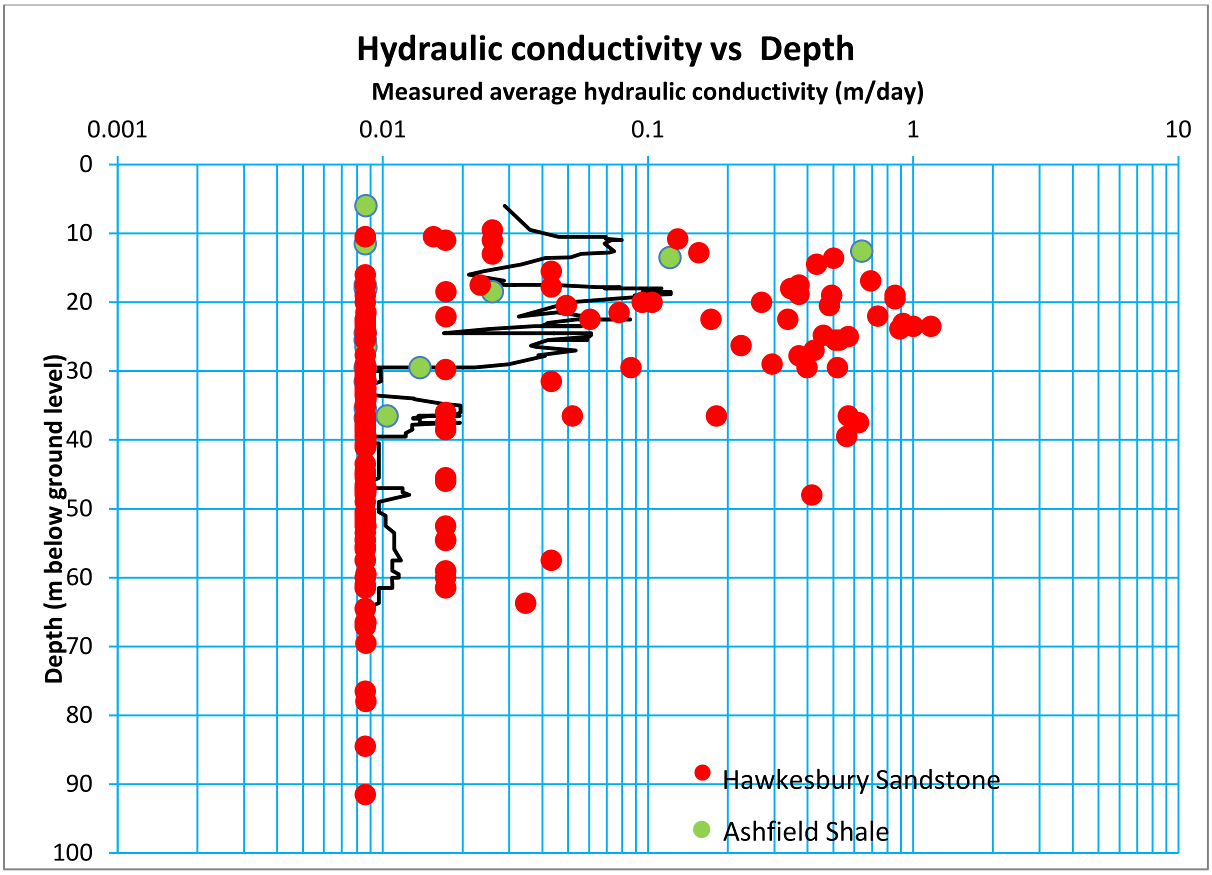


Figure 4-19 Hydraulic conductivity value vs depth from packer tests

4.12 Groundwater inflow in other tunnels

Within the Hawkesbury Sandstone, Mittagong Formation and Ashfield Shale, water inflow is dependent upon the number and aperture of saturated secondary structural features intersected. Rates of water inflows have been monitored in recent years from several unlined tunnels in the Sydney area with similar geology, hydrogeology and construction to that proposed by the M4-M5 Link project. These inflow rates are considered long term flow rates throughout the operational life of the infrastructure, and are summarised in **Table 4-7** (after Hewitt 2005).

Drainage inflow as summarised in **Table 4-7** varies from 0.6 litres per second per kilometre to up to 1.7 litres per second per kilometre.

Table 4-7 Measured drainage rates from other Sydney tunnels

Tunnel	Year Opened	Type	Width (m)	Length km	Drainage inflow (L/sec/km)	Reference
Eastern Distributor	1999	3 lane road (twin)	12 (Double deck)	1.7	1	Hewitt 2005
M5 East Motorway	2001	Twin 2 lane road	8 (twin)	3.8	0.9	Tammetta and Hewitt 2004
Epping to Chatswood	2009	Twin rail	7.2 (twin)	13	0.9	Best and Parker 2005
Lane Cove	2007	Twin 3 lane road	9 (twin)	3.6	0.6/1.7*	Coffey 2012
Northside Storage	2000	Sewer storage	6	20	0.9	Coffey 2012
Cross City Tunnel	2005	Twin 2 lane road	8 (twin)	2.1	>3	Hewitt 2005

Note: * measured inflow in Lane Cove Tunnel varied from 1.7 L/s/km (2001 – mid-2004) to 0.6 L/s/km (2011)

Predicted inflows to the proposed M4 East and New M5 tunnels have been calculated by numerical modelling published in the respective environmental impact statements. At the New M5, groundwater modelling predicted an average inflow rate over the full length of the tunnel of 0.63 L/sec along the eastbound tunnel and 0.67 L/sec along the westbound tunnel (CDM Smith 2015).

Similarly, for the M4 East, groundwater modelling was undertaken to predict inflows to the drained tunnels. The M4 East tunnels extend over a combined length of 17 kilometres. Groundwater modelling predicted inflow rates between 0.3 and 0.9 litres per second per kilometre of tunnel (WestConnex Delivery Authority 2015).

4.13 Hydrogeochemistry

Routine project monthly groundwater quality monitoring, commenced in June 2016 and continued throughout the EIS assessment period. Monitoring will continue during construction and into the operations phase for at least one year or as directed by project approvals. The laboratory analytical results of routine monthly groundwater monitoring program are presented for the June 2016 to May 2017 monitoring events in AECOM 2016c,e and AECOM 2017c,e and discussed herein.

The purpose of the groundwater quality monitoring program is to:

- Characterise the existing hydrogeochemistry in the three main aquifers along the project footprint
- Establish the environmental value and beneficial use of groundwater along the project footprint under existing conditions
- Develop a groundwater quality baseline dataset along the project footprint to inform the EIS
- Characterise the potential aggressiveness of the native groundwater to the building material used to construct the project infrastructure
- Obtain a preliminary understanding of the groundwater and surface water treatment requirements required prior to discharge during the construction and operation phases.

Monthly groundwater samples collected for laboratory analysis initially increased each month as more monitoring wells were added to the groundwater monitoring network as outlined in **Table 4-8**.

Table 4-8 Groundwater quality sampling program

Month	Groundwater samples collected			
2016/2017	Alluvium	Ashfield Shale	Hawkesbury Sandstone	Total
June	1	2	3	**6**
July	10	3	19	**32**
August	9	4	23	**36**
September	10	3	19	**32**
October	10	2	23	**35**
November	8	4	21	**33**
December	9	4	20	**33**
January	10	2	28	**40**
February	10	3	29	**42**
March	9	3	30	**42**
April	10	1	30	**41**
May	10	3	30	**43**
Total	**106**	**34**	**275**	**415**

The groundwater quality sampling program included the following analytes:

- Field parameters (temperature, dissolved oxygen, electrical conductivity, pH and redox conditions)
- Major ions (calcium, magnesium, sodium, potassium, chloride, sulfate, carbonate and bicarbonate)
- Metals (arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc)
- Nutrients (nitrite as N, nitrate as N, reactive phosphorus and ammonia)
- Sulfate reducing bacteria.

The hydrogeochemistry has been characterised for each of the major aquifers (alluvium, Ashfield Shale and Hawkesbury Sandstone) along the project footprint based on the results from the above suite.

4.13.1 Groundwater assessment criteria

The groundwater quality criteria have been developed in accordance with guidelines from the Australian and New Zealand Environment Conservation Council (ANZECC 2000). For highly disturbed receiving environments such as those that could be impacted by the project, ANZECC (2000) recommends that suitable guidelines for groundwater quality trigger values can be derived from a local reference data set for nutrients, dissolved oxygen and pH. For toxicants (such as heavy metals or organic chemical compounds), the water quality requirements should be consistent with the 95 per cent protection level for freshwater ecosystems (Table 3.4.1, ANZECC 2000). For analytes not covered by the ANZECC (2000) guidelines the amended National Health and Medical Research Council (NHMRC) *Australian Drinking Water Guidelines* (2015) have been adopted. The adopted guideline values are presented in Table ST7, ST8 and ST9 in **Annexure B**.

To assess the potential impacts of groundwater to building materials, dissolved sulfate, chloride and pH values are assessed against the aggressivity criteria outlined in the exposure classification criteria for concrete and steel piles presented in Australian Standard 2159-2009 Piling, Design and Installation (2010).

4.13.2 Field parameters

Measured groundwater temperatures varied over a narrow range between 14 and 26.5°C. Seasonally, groundwater temperatures tended to vary by one or two degrees, although there was no variation between lithologies. The average temperature of monthly water samples tended to increase between July and December. Dissolved oxygen values varied along the project footprint although there were no spatial or temporal trends identified within the major lithologies. Redox conditions were also variable along the project footprint but for each lithology had a relatively short range with negative values indicating a robust data set.

Measurement of the electrical conductivity and calculation of average values confirmed that the groundwater from the Ashfield Shale (2860 microsiemens per centimetre) is more saline than from the Hawkesbury Sandstone (1700 microsiemens per centimetre). Elevated electrical conductivity values within the Ashfield Shale is attributed to connate salts within the sediments of marine origin (Old 1942). The electrical conductivity measured within the alluvium is variable, ranging from 328 to 34,900 microsiemens per centimetre. The alluvial groundwater variability is due to groundwater in the upper reaches being predominately derived from rainfall recharge and increasing in salinity downstream as tidal mixing increases.

Some elevated pH levels have been recorded in monitoring wells, which has been attributed to cement grout entering the well screen through the bentonite seal that had not formed a sufficient hydraulic seal. In most cases, additional well development was successful in reducing pH levels. Natural pH levels within the Hawkesbury Sandstone and Ashfield Shale are acidic, ranging from pH 5 to 6.5. The pH of groundwater in the Ashfield Shale is sometimes low due to sulphides naturally occurring within the shale. pH levels within the alluvium was also weakly acidic to neutral.

4.13.3 Major ions

Major cations (calcium, magnesium, sodium and potassium) and major anions (chloride, sulfate, carbonate and bicarbonate) have been routinely sampled and are tabulated in Table B6, **Annexure B**. The data has also been plotted on Piper diagrams for each month and each lithology to assess the hydrogeochemical distribution of major ions to assess if there are any temporal or spatial variations. Piper diagrams from the three major aquifers are presented in **Annexure E**.

Groundwater within the alluvium is dominated by sodium, magnesium, chloride and bicarbonate. The dominance of sodium and chloride is attributed to tidal influences and interaction with sea water in Rozelle Bay. Although the majority of alluvial samples cluster in the sodium and chloride sector of the Piper diagram there are some outliers with elevated calcium and carbonate. These outliers (with elevated electrical conductivity values) are likely to be due to groundwater derived from marine sediments that contain shells. Overall there is upward hydraulic pressure measured from the potentiometric heads from the Hawkesbury Sandstone to the alluvium. Therefore, groundwater from the Hawkesbury Sandstone may be discharging into the alluvium influencing the groundwater inorganic chemistry.

The hydrogeochemical signature of groundwater from the Ashfield Shale is highly variable which may be due to the intermittent development of secondary mineralisation such as calcite (calcium carbonate) and siderite (iron carbonate) and the variable flushing of connate salts of marine origin. The hydrogeochemical signature of the Ashfield Shale is not similar to seawater further suggesting that the flushing of marine salts has occurred since the sediments were deposited in the Triassic period. Comparison of monthly groundwater data from the Ashfield Shale over six months presented on Figure E5.2, **Annexure E**, confirms the variable nature of the shale, although there does not appear to be any seasonal trends.

Groundwater derived from the Hawkesbury Sandstone is dominated by sodium and chloride and may be in part due to evaporation and/or the influence of saline harbour water. As for the shale, the hydrogeochemical signature of Hawkesbury Sandstone groundwater is different to that of seawater indicating there are other influences on the groundwater chemical evolution. In topographically high areas where the Ashfield Shale overlies the Hawkesbury Sandstone, leakage from the shale influences the hydrogeochemical signature of shallow groundwater within the Hawkesbury Sandstone.

4.13.4 Heavy metals

Groundwater has been monitored monthly for 10 dissolved metals including arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc since June 2016. The analytical results have been presented in Table B7 in **Annexure B** along with the adopted groundwater guidelines. Since groundwater discharges into Sydney Harbour and the lower lying areas are tidal, the ANZECC 2000 guidelines for freshwater (95 per cent level of protection) are considered the most appropriate. Schoeller diagrams have been prepared for selected monitoring wells for each lithology and sampling event and are presented in **Annexure E**.

Within the alluvial groundwater the maximum recorded value has exceeded the guideline concentration value for metals As, Cr, Cu, Fe, Pb, Mn, Hg and Zn. In most cases the guidelines have been marginally exceeded, indicating that background levels are elevated, which is consistent with the low standard deviation recorded for these metals. However the alluvial groundwater consistently has elevated iron, lead and zinc.

Within the groundwater derived from the Ashfield Shale, the maximum recorded value has exceeded the guideline concentration value for metals Cr, Cu, Fe, Mn, Ni and Zn. Iron and manganese are commonly elevated within the Ashfield Shale, often causing red-brown or black staining when the groundwater becomes oxidised and the metals precipitate as oxides. Pyrite is a common secondary mineral in shale and is likely to be a partial source of iron (McLean and Ross 2009). Although average chromium and copper concentrations exceed the guidelines the low standard deviation of 0.038 and 0.001 respectively suggests the metal concentrations are at background levels.

Within the groundwater derived from the Hawkesbury Sandstone, the maximum recorded value has exceeded the guideline concentration value for metals Cr, Cu, Fe, Pb, Mn, Ni and Zn. In most cases the guidelines have been marginally exceeded however the groundwater consistently has elevated iron and manganese. Iron and manganese are known to be elevated within the Hawkesbury Sandstone, McKibbin and Smith 2000. Sources of iron include siderite (iron carbonate) and iron oxyhydroxides and oxides (McLean and Ross 2009). Although average chromium, copper and zinc concentrations exceed the guidelines, the low standard deviation of 0.026, 0.0056 and 0.67 respectively suggests the metal concentrations are at background levels.

4.13.5 Nutrients

Nutrients including nitrite as N, nitrate as N and reactive phosphorus have been measured monthly since June 2016 for each major lithology and have been tabulated in Table B6 in **Annexure B**. Analytes ammonia, total nitrogen and total Kjeldahl nitrogen have been monitored periodically throughout the EIS investigation period.

Within the alluvium, nitrite and nitrate concentrations ranged from below detection limits to 0.31 and 2.38 milligrams per litre respectively. In comparing these results to the amended *Australian Drinking Water Guidelines* (NHMRC 2015) nitrite and nitrate concentrations are below the health criteria of three and 50 milligrams per litre indicating background nutrient levels are low. Reactive phosphorous as P ranged from below detection limits to 0.04 milligrams per litre indicating phosphorous levels are also low. Ammonia values range from 3.81 to 5.76 exceeding the guideline value of 0.91 milligrams per litre. Although the alluvium flanks some parklands, the impact of nutrient runoff from fertilisers (with the exception of ammonia) appears to be minimal.

Dissolved nitrite and nitrate concentrations in groundwater derived from the Ashfield Shale ranged from below detection limits to 0.1 and 1.17 milligrams per litre respectively. In comparing these results to the *Australian Drinking Water Guidelines* (NHMRC 2015) nitrite and nitrate concentrations are below the health criteria of 3 and 50 milligrams per litre indicating background nutrient levels are low. Reactive phosphorous as P ranged from below detection limits to 0.67 milligrams per litre indicating reactive phosphorous levels are low. Ammonia values range from 0.2 to 3.19 milligrams per litre averaging 1.2 milligrams per litre exceeding the guideline value of 0.91 milligrams per litre. Dissolved background nitrite and nitrate concentrations within the shale were higher than those measured in the alluvium but still remain relatively low. Ammonia concentrations may be elevated due to the natural degradation of organic material within the alluvium or the application of nitrogen fertilisers.

Dissolved nitrite and nitrate concentrations in groundwater derived from the Hawkesbury Sandstone ranged from below detection limits to 1.18 and 1.31 milligrams per litre respectively. In comparing these results to the *Australian Drinking Water Guidelines* (NHMRC 2015) nitrite and nitrate are below the health criteria of 3 and 50 milligrams per litre indicating nutrient levels are low. Ammonia values range from 0.2 to 3.41 milligrams per litre averaging 0.93 milligrams per litre marginally exceeding the guideline value of 0.91 milligrams per litre. Reactive phosphorous as P ranged from below detection limits to 0.16 milligrams per litre indicating reactive phosphorous levels are very low.

4.13.6 Groundwater aggressivity

An assessment of groundwater aggressivity has been conducted to better understand the corrosive nature of the natural groundwater intersected to assist in selecting building materials to minimise corrosive impacts on the tunnel and its infrastructure. The corrosion assessment applies to infrastructure to be constructed with concrete and steel below the water table. The assessment has been conducted by collating the major ion chemistry and hydrogeochemical parameters including salinity, pH, sulfate and chloride concentrations by application of the exposure classification in the Australian Standard AS2159-2009 (AS2159-2009) for piling. The average primary parameters of groundwater aggressivity are presented in Table ST10 in **Annexure B** for Ashfield Shale and Table ST11 in **Annexure B** for Hawkesbury Sandstone. To assess groundwater aggressivity average concentrations of relevant analytes has been applied.

By application of the water classification for concrete piles in AS2159-2009 and applying the average values from Table ST10 in **Annexure B** groundwater aggressiveness has been assessed and the results are summarised in **Table 4-9** for the Ashfield Shale, Hawkesbury Sandstone and alluvium. The aggressivity assessment indicates that groundwater within the Ashfield Shale is non aggressive with respect to average chloride, pH and sulfate for concrete piles. Similarly the average values from Table ST11 in **Annexure B** for groundwater within the Hawkesbury Sandstone indicate the groundwater is mildly aggressive to concrete piles with respect to average chloride, pH and sulfate. Average values for groundwater aggressivity in the alluvium presented in Table ST12 in **Annexure B** are similar to the properties of groundwater within the Hawkesbury Sandstone, although the alluvial groundwater is moderately aggressive to chloride in cement grout.

The aggressivity of groundwater to steel piles has also been assessed by application of the water classification for steel piles in AS2159-2009. With reference to the average values from Table ST 10 in **Annexure B** the groundwater within the Ashfield Shale is non aggressive with respect to average chloride and pH, however the groundwater is moderately aggressive with respect to resistivity. Similarly the average values from Table ST11 in **Annexure B** for groundwater within the Hawkesbury Sandstone indicate the groundwater is mildly aggressive to steel piles with respect to average chloride, pH but is severely aggressive with respect to resistivity. Average values from Table ST12 in **Annexure B** for groundwater within the alluvium indicate the groundwater is mildly aggressive to steel piles with respect to average chloride, non-aggressive to pH but is severely aggressive with respect to resistivity.

Further assessment would be required at locations where infrastructure sensitive to groundwater would be constructed.

Table 4-9 Groundwater aggressivity assessment

Aquifer	Cement grout			Steel		
	Chloride	pH	Sulfate	Chloride	pH	Resistivity
Ashfield Shale	Non-aggressive	Non-aggressive	Non-aggressive	Non-aggressive	Non-aggressive	Moderate
Hawkesbury Sandstone	Mild	Mild	Mild	Mild	Mild	Severe
Alluvium	Moderate	Mild	Mild	Mild	Non-aggressive	Severe

4.13.7 Sulfate reducing bacteria

Sulfate reducing bacteria (SRB) is measured as a colony forming unit (CFU) per 100 millilitres. The presence of SRB promotes the increased corrosion of metals as does elevated sulfate concentrations. SRB are anaerobic but can cause severe corrosion of iron material in the groundwater as enzymes are produced which can accelerate the reduction of sulfate compounds to corrosive hydrogen sulphide. Sulfate reduction by bacteria can increase in the presence of elevated dissolved organic carbon.

Twenty groundwater samples have been collected from the Ashfield Shale (2) and Hawkesbury Sandstone (18) and analysed during the October and December 2016 monitoring events. The groundwater within the alluvium was not tested as it typically does not have elevated iron or manganese to the extent of the bedrock aquifers. The results vary from five CFU per millilitre to the maximum laboratory measurement limit of 500,000 CFU per millilitre. Of the 20 groundwater samples analysed, five samples had more than 500,000 CFU per millilitre, seven samples had a count of 115,000 CFU per millilitre and the remaining nine samples had an average count of 8,500 CFU per millilitre. No pattern with lithology was assessed because many samples were above the measurement limit. Seawater is a known prime habitat for SRB, and it is possible that the dissolution of marine salts from the Ashfield Shale into the Hawkesbury Sandstone makes the groundwater prone to SRB growth. Summary statistics have not been calculated for SRB as the maximum measurement limit of 500,000 CFU per millilitre skews the results.

4.13.8 Groundwater treatment

The majority of project tunnels are designed to be drained during operation and would require groundwater seepage, tunnel wash or deluge system water to be collected, treated and discharged. Water treatment may involve:

- Flocculation to reduce total suspended solids
- Ion exchange to reduce salinity, nutrients and dissolved solids
- Reduction of iron and manganese concentrations
- Reverse osmosis to reduce salinity and remove organic impurities
- pH correction through the addition of lime or acid.

Permanent water treatment plants are to be constructed at Rozelle, adjacent to Rozelle Bay in the Rozelle Rail Yards and Darley Road, Leichhardt, with discharge directed into Rozelle Bay and Iron Cove under the same discharge conditions as collected surface water. The tunnel operation water treatment facilities would be designed such that effluent will be of suitable quality for discharge to the receiving environment (refer to **Appendix Q** (Technical working paper: Surface water and flooding)) of the EIS.

In tunnels, iron or manganese sludges are formed naturally where there is elevated dissolved iron and manganese in the groundwater. These sludges are often a residue accumulated by bacteria that develops as the bacteria dies. The growth of iron bacteria such as *Crenothrix*, *Gallionella* and *Leptothrix* thrive best in low light conditions with little or no oxygen but with considerable carbon dioxide and dissolved iron. Iron commonly precipitates as a red-brown ferric (Fe^{3+}) deposit upon reaching oxic conditions. Similarly manganese bicarbonate precipitates as a black sooty deposit. These precipitates have the potential to block internal drainage infrastructure within the tunnel. The water treatment process is discussed in more detail in **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS.

4.14 Contamination

An assessment of contaminated land risk is provided in **Appendix R** (Technical working paper: Contamination) of the EIS. Areas located above the project footprint that may contain contaminated soil and/or groundwater due to past or present land-use practices has been investigated. During routine monthly groundwater monitoring as part of the hydrogeological investigation a suite of contaminants was assessed for laboratory analysis including cations and anions, heavy metals and nutrients. Groundwater contamination monitoring was conducted in September and November 2016 to support the site contamination investigation. Key sites investigated are discussed in the following sections.

4.14.1 Rozelle Rail Yards

The Rozelle Rail Yards are located to the north and north-west of Rozelle Bay. Parts of the site are contaminated due to historical filling and use for railway and industrial/commercial activities. Roads and Maritime is planning to carry out a limited suite of site management works on part of the Rozelle Rail Yards site. The works are needed to manage the existing environmental and safety issues at the site and would also improve access to surface conditions, which would allow for further investigation into the location of utilities and the presence of contamination and waste. The works would benefit future uses of the site (including construction of the M4-M5 Link project if it is approved) because the works would remove material and redundant facilities associated with rail and rail related infrastructure from the site.

The site management works were subject to a separate environmental assessment. The works were assessed in a review of environmental factors (REF) which was approved by Roads and Maritime under Part 5 of the EP&A Act on 10 April 2017. It is anticipated that the site management works would be conducted over a period of 12 months and would commence in mid-2017.

Contamination investigations undertaken at the Rozelle Rail Yards as part of the REF and for this EIS have confirmed varying concentrations and types of contamination at a number of locations across the site. The contamination is considered likely to be related to historical land uses and the importation of fill materials of unknown origin. This has resulted in the presence of variable concentrations of heavy metals, PAHs, TRH, and bonded and friable asbestos in the soils, fill, ballast and existing stockpiles. However, elevated concentrations of these contaminants are not found in all locations across the site. Further investigation of the site would be completed once infrastructure and vegetation has been cleared as part of the site management works.

Contaminated groundwater has also been identified; however, this contamination is relatively minor and limited to exceedances of:

- Zinc and copper in one location
- Zinc in one other location
- TRH, naphthalene and Bis(2-ethylhexyl) phthalate in one location.

The excavation of low lying natural soil during the tunnel excavation program may also uncover PASS. Consequently, the risks associated with PASS and other contaminants of concern would be managed under acid sulfate soil management procedures which would form part of the CSWMP.

The primary risk to groundwater is the migration of contaminated groundwater due to altered groundwater flow paths from tunnel construction. Through the Whites Creek alluvium beneath the Rozelle Rail Yards, tunnel and cut-and-cover sections would be constructed as undrained (tanked) (ie concrete lined) to avoid the ingress of groundwater from the palaeochannels, minimising the potential for contaminated groundwater migration.

4.14.2 Leichhardt

The Hawthorne Canal and Leichhardt North area have undergone historic, widespread land reclamation with fill from unknown sources, indicating that subsurface soil contamination could be present in some areas. Other potential soil contamination sources include the storage and use of chemicals, pesticides, fuels and oils and hazardous building materials in the former Public Works Depot and the former Ordnance Depot within Blackmore Park. There are potentially pockets of soil contamination present across these areas that could contaminate groundwater within the underlying palaeochannels. The tunnels are to be constructed either at depth, to extend beneath the palaeochannels, or through the palaeochannels as undrained (tanked) tunnels so the local groundwater does not seep into the tunnels. PASS have been mapped across the majority of this area. PASS have been mapped across the majority of this area. The risks associated with ASS would be managed under the CSWMP.

At The Crescent (TC_BH07s) shallow alluvial groundwater may have become contaminated with hydrocarbons via hydraulic connection with Whites Creek or activities associated with the Inner West Light Rail line and former freight line.

4.14.3 Haberfield and St Peters

Contamination investigations undertaken for the M4 East and New M5 projects have been reviewed to provide an understanding of potential groundwater contamination in the vicinity of the Wattle Street interchange at Haberfield and the St Peters interchange, respectively.

Wattle Street Interchange

It was determined that the risk of potential groundwater contamination in the vicinity of the Wattle Street interchange at Haberfield is low. Potential contaminating land uses were identified as being located topographically down-gradient of the project and therefore would be unlikely to impact groundwater within the project footprint.

St Peters interchange

The St Peters interchange is to be constructed on a rehabilitated Alexandria Landfill as part of the New M5 project. Leachate is still generated from the former landfill and would continue to be pumped and treated on-site prior to off-site disposal. Leachate generation is to be reduced by improving internal drainage and capping of the landfill. A cut-off wall is to be constructed along the eastern perimeter of the landfill to reduce groundwater inflow from the Botany Sands aquifer.

The New M5 tunnels and access portals through the former landfill are to be undrained (tanked), preventing the ingress of contaminated groundwater into the tunnel drainage system. The deeper tunnels constructed in the Hawkesbury Sandstone or Ashfield Shale are to be drained, but are unlikely to intersect contaminated groundwater. The risk of contaminated groundwater entering the M4-M5 Link tunnel from leachate derived from the landfill is low because leachate would continue to be pumped, collected and treated in a newly constructed water treatment plant as part of the New M5 project. Pumping the leachate would locally reverse groundwater flows, creating an internal flow network centred on the sump in the former landfill, drawing groundwater away from the tunnels. Thus groundwater flow would be directed away from the M4-M5 Link and New M5 tunnels due to the ongoing leachate pumping system. Leachate generation is to be reduced due to the cut-off wall that is to be constructed along the eastern perimeter of the landfill to reduce groundwater inflow and capping the former landfill to reduce rainfall infiltration.

Hydrocarbon contamination within the weathered clay and residual shale (SP_BH02) is attributed to fuel leaks and spills from the nearby service station.

4.15 Hydrogeological features along the project footprint

The natural geological and hydrogeological conditions impose a series of considerations that require addressing in the design phase. These considerations and implications are summarised for the various components of the project.

4.15.1 Hawthorne Canal

At Hawthorne Canal groundwater is present within the alluvium and underlying Hawkesbury Sandstone. Beneath Hawthorne Canal a palaeovalley is carved into the Hawkesbury Sandstone at depths of up to 20 metres. The project corridor has been designed to dive beneath the unconsolidated saturated sediments and constructed within the more competent Hawkesbury Sandstone. Groundwater ingress from the Hawkesbury Sandstone would be predominately via saturated secondary structural features such as fractures and joints rather than from the primary matrix. Groundwater ingress from the overlying alluvium would be dependent upon the hydraulic connection between the Hawkesbury Sandstone and the alluvium.

Typically the Hawkesbury Sandstone has a higher percentage of fractures beneath a palaeovalley as the structural weaknesses in the sandstone are the main reason the palaeovalley developed in that location. Hence surface water from Hawthorne Canal could enter the tunnel via fractures within the sandstone connected to the alluvium. Analysis of rock core and packer test data collected during the geotechnical investigation program provides an indication of the degree of fracturing within the

Hawkesbury Sandstone and potential hydraulic connection with the infilled palaeovalley sediments and surface water within the canal.

Other creek crossings along Rozelle Bay are Johnstons Creek and Whites Creek where the top of rock is at -8 metres AHD and 0 metres AHD respectively. The tunnels are to be constructed below these creeks within the Hawkesbury Sandstone to minimise groundwater ingress from the alluvium.

4.15.2 St Peters interchange

The ground conditions at St Peters are dominated by thick residual clay soils over shale, modified by the excavation of several large former brick pits. These brick pits were excavated into a residual shale soil profile about 30 metres below ground surface to the near top of the underlying Hawkesbury Sandstone. Following the completion of quarrying, the pits were then backfilled with uncontrolled fill material (typically waste). The proposed tunnel ramps at St Peters interchange commences in weathered shale exposed in the wall of a former brick pit and descends through shale and sandstone to merge with the main line tunnel project corridor.

At the future St Peters interchange, groundwater is present within the Ashfield Shale and Hawkesbury Sandstone. Immediately east of the St Peters interchange, groundwater is present within the Botany Sands. At Alexandria, the tunnel portal is located at the edge of the Botany Sands aquifer. Surface water flows would be directed towards Alexandra Canal. The Ashfield Shale is the dominant lithology where groundwater flows along secondary structures such as laminations, fissures and joints rather than the primary matrix. Groundwater levels are low and typically three to five metres below ground level at elevations of around three to five metres AHD. Groundwater levels are also influenced locally by leachate pumping from the Alexandria Landfill which is hydraulically connected to the shale. The former landfill is to be rehabilitated to form the St Peters interchange but would still require ongoing leachate pumping. The cut-off wall to be constructed as part of the St Peters interchange design around the eastern side of the landfill would prevent inflow from the Botany Sands discharging into the former landfill to reduce leachate generation. The Hawkesbury Sandstone underlies the Ashfield Shale at an elevation of around -35 metres AHD and is not likely to be intersected by the St Peters interchange tunnel ramps.

4.15.3 Rozelle interchange

The ground conditions at the proposed Rozelle interchange are dominated by a deep palaeovalley eroded into Hawkesbury Sandstone by Whites Creek. This palaeovalley was filled with soft, water saturated estuarine sediments, which were then covered by fill during reclamation works associated with the formation of the Rozelle Rail Yards in the mid-1910s. Excavation of sandstone along the northern site boundary may have been a source of some of this fill. The fill comprises generally granular material including sand, railway ballast, and sandstone cobbles. A layer of sandstone boulders and cobbles appears to be present immediately above the estuarine sediments. The estuarine sediments comprise very soft to soft organic clays interbedded with loose clayey sands. The depth to bedrock ranges from less than one metre to over 20 metres. Several dykes have been mapped crossing the site trending north-west. Groundwater is present within the fill, within the alluvium of the deep palaeovalley associated with Whites Creek, and within the underlying Hawkesbury Sandstone. Thus large scale dewatering of the alluvium during construction would be impractical due to the large volumes required to be pumped. Groundwater elevations within the alluvium and Hawkesbury Sandstone are shallow and about one metre below the current ground level, or one to two metres AHD, indicating groundwater flow is eastward and discharging into Rozelle Bay

4.15.4 M4 East interface

The ground conditions at the M4 East interface are challenging, with a palaeovalley associated with Iron Cove Creek located 100 metres east of the approved driven tunnel portals. The top of rock in the base of the palaeovalley is up to eight metres below ground surface, while the crown of the tunnels are located less than eight metres below ground. The palaeovalley is infilled with a combination of soft estuarine clays and firm, water saturated clayey sands which are alluvial in origin. Some 150 metres to the east of the palaeovalley, an igneous dyke crosses the project footprint.

Groundwater is present within the fill, and within the alluvium of a palaeovalley associated with Iron Cove Creek, carved into the underlying Hawkesbury Sandstone. The water table within the sandstone, outside the palaeochannel is shallow in this area, measured at about three metres below ground level or 0.8 metres AHD (HB_BH03). Groundwater levels within the alluvium are expected to be at similar depths. The approved M4 East tunnel alignment near the Wattle Street interchange intersects a dolerite dyke about 12 metres thick. The dolerite dyke can act as either a barrier to groundwater flow or a conduit for flow depending on the hydraulic properties of the basalt. Given the weathered nature of the dolerite, the dyke is more likely to act as a barrier than a conduit for groundwater flow and if intersected by the tunnel could increase groundwater inflow to the tunnels. Long term the dyke is likely to require rock support in which case the tunnel intersected by the dyke could be waterproofed as part of the support structures by the installation of shotcrete and a membrane to reduce long term groundwater ingress.

The remainder of the M4 East interface tunnels intersects good quality sandstone and would be constructed as a drained tunnel. During construction, increased groundwater inflows to the tunnels can occur when saturated fractures, fissures, faults and joints are intersected. Such flows are reduced by decreasing the bulk hydraulic conductivity by the addition of shotcrete during construction. The electrical conductivity was measured in the Hawkesbury Sandstone at 5574 microsiemens per centimetre indicating the groundwater quality is of low to moderate salinity. Groundwater quality in the overlying alluvium is expected to be similar, suggesting that groundwater quality at this location should not pose constraints on building materials.

4.15.5 Iron Cove

Ground conditions comprise a thin cover of residual soils or fill over Hawkesbury Sandstone. Good quality, relatively unweathered sandstone is generally several meters below the top of rock, although some boreholes contain thin seams of poorer quality rock. The twin Iron Cove Link tunnels are proposed to be constructed within good quality saturated Hawkesbury Sandstone. At the Iron Cove Link portal there is up to five metres of fill overlying Hawkesbury Sandstone. The fill is likely to contain minor perched water at the interface with the sandstone. Waterproofing would be required around the portal during construction and long term to prevent the ingress of perched groundwater. A 1.3 metres thick deeply weathered dolerite dyke was intersected in borehole IC_BH02, located on the western side of Victoria Road at Booth Street. Due to the weathered nature of the dolerite, the dyke is likely to behave as a barrier with the clays restricting groundwater flow.

4.16 Surface water monitoring

Surface water monitoring has been undertaken to characterise the existing water quality of the waterways within the vicinity of the project to inform the EIS and to provide a baseline of environmental conditions against which compliance can be measured during construction and operation. Dry weather sampling has been conducted monthly for surface water since July 2016. A dry weather event is defined as no heavy rainfall (greater than 15 millimetres) for three days prior to sampling. Wet weather sampling is conducted periodically when rainfall exceeds 15 millimetres over a 24 hour period.

The surface water samples were monitored for field parameters including turbidity, temperature, dissolved oxygen, electrical conductivity, redox conditions and pH. Water samples were submitted to the laboratory for total metals, nutrients and TRH, semi volatiles and volatiles (BTEXN).

The surface water monitoring sites are summarised in **Table 4-10** and their location is presented on **Figure 4-20**.

Table 4-10 Surface water monitoring locations

Site reference	Water course	Location	Easting and northing	Monitoring purpose
Tidal locations				
SW01	Rozelle Bay	Whites Creek outlet at City West Link/The Crescent, Rozelle	331068.514 6250619.522	Down-stream of construction
SW02	Whites Creek	Whites Creek Valley Park, Railway Parade Annandale	330675.138 6250214.659	Down-stream of construction
SW03	Johnstons Creek	Smith Park pedestrian bridge, Neilson Lane Annandale	331348.646 6249812.856	Down-stream of construction

Site reference	Water course	Location	Easting and northing	Monitoring purpose
SW05	Hawthorne Canal	Hawthorne Canal Reserve, Canal Road, Leichardt	328710.519 6249937.233	Up-stream of construction
SW06	Hawthorne Canal	Canal Road (between City West Link and Lilyfield Road) Lilyfield	328944.974 6250424.174	Down-stream of construction
SW07	Open stormwater channel	Adjacent to 88-90 Lilyfield Road, Lilyfield	330816.164 6250769.419	Down-stream of construction
SW08	Iron Cove Creek	Pedestrian bridge between Timbrell Park and Reg Coady Reserve, Dobroyd Parade, Haberfield	327694.599 6250353.662	Down-stream of construction
SW09	Iron Cove Creek	West of Ramsey Road bridge at Dobroyd Parade, Haberfield	327295.048 6250337.517	Up-stream of construction
SW11	Rozelle Bay	Iron Cove Bridge	330030.753 6251603.377	Down-stream of construction
SW12	Rozelle Bay	Iron Cove King George Park	330123.434 6251830.863	Down-stream of construction
SW14	Johnstons Creek	Johnstons Creek (South)	330955.253 6248607.264	Down-stream of construction
Non-tidal locations				
SW04	Johnstons Creek	Adjacent to playground, Chester Street,	331137.734 6249151.793	Down-stream of construction
SW10	Sheas Creek	South side of Huntley Street, Alexandria	332868.793 6246433.815	Up-stream of construction

Note:

SW13 was monitored as part of the contamination assessment (refer to **Appendix R** (Technical working paper: Contamination)) and is not relevant to the groundwater assessment

The surface water monitoring program is discussed further in the surface water monitoring report (AECOM 2016f) and surface water impacts are discussed in **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS.. Results of the surface water monitoring program are summarised in **Table 4-11** along with exceedances with reference to the ANZECC (2000) guidelines for estuarine and marine waters.

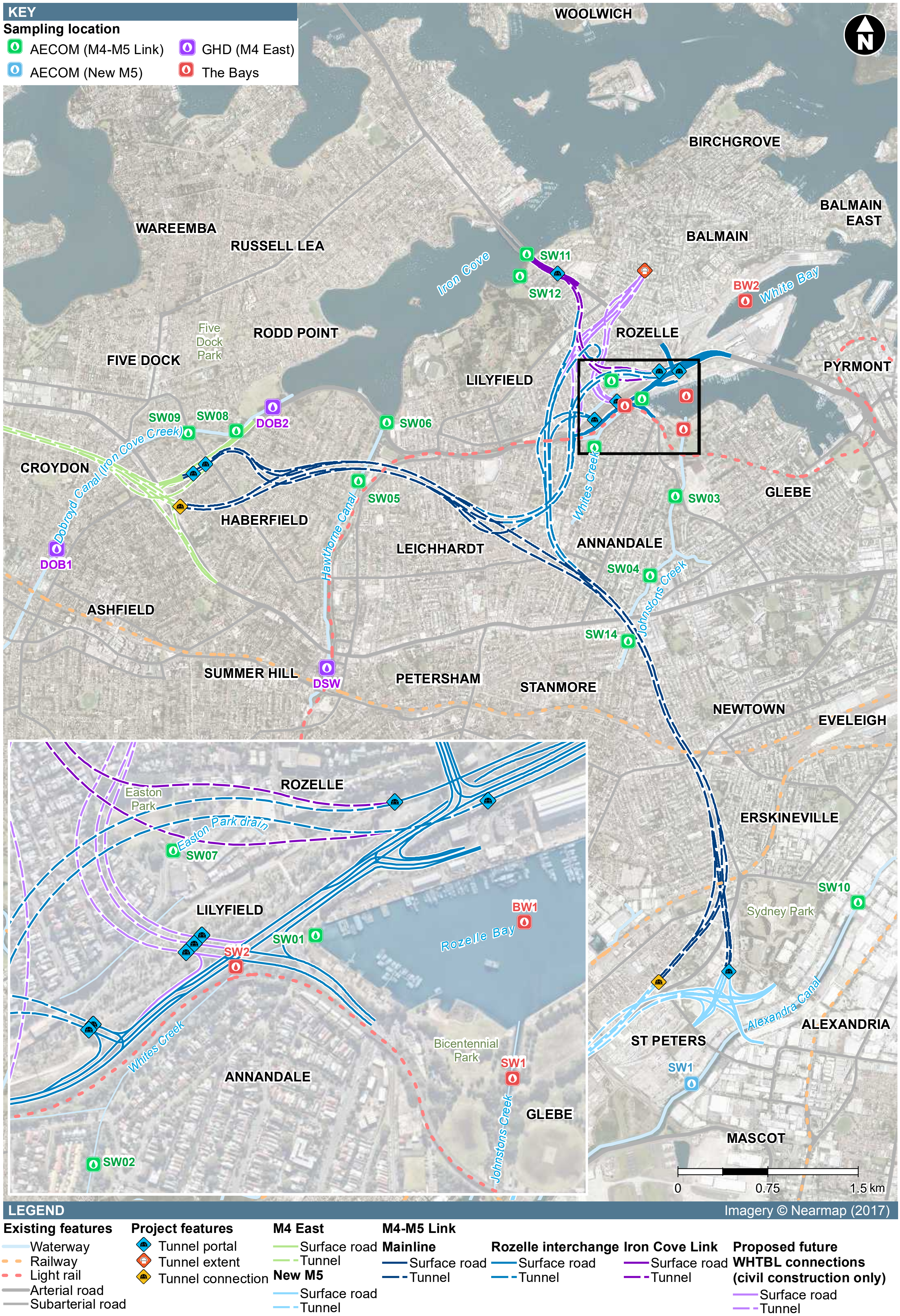


Figure 4-20 Location of surface water monitoring sites

Table 4-11 Summary of the water monitoring program

Waterway	Waterway influences	Exceedances (ANZECC (2000)
Dobroyd Canal	Tidal and non-tidal	• Heavy Metals (Cu, Cr, Pb, Ni, Zn) • Nutrients (nitrate, nitrogen and phosphorus) • pH and turbidity • Total recoverable hydrocarbons detected
Hawthorne Canal	Tidal	• Heavy Metals (Cu, Cr, Pb, Zn) • Nutrients (nitrate, nitrogen and phosphorus) • pH and turbidity
Whites Creek	Tidal	• Heavy Metals (Cu, Pb, Zn) • Nutrients (nitrate, nitrogen, phosphorus, ammonia) • pH and turbidity
Easton Park drain	Tidal	• Heavy Metals (Cu, Pb, Zn) • Nutrients (nitrate, nitrogen, phosphorus) • pH and turbidity
Johnstons Creek	Tidal and non-tidal	• Heavy Metals (Cu, Cr, Pb, Ni, Zn) • Nutrients (nitrate, nitrogen and phosphorus) • pH and turbidity • Total recoverable hydrocarbons detected
Rozelle Bay	Tidal	• Heavy Metals (Cu, Cr, Pb, Zn) • Nutrients (nitrate, nitrogen, phosphorus, ammonia, chlorophyll) • pH and turbidity
Iron Cove	Tidal	• Heavy Metals (Cu, Cr, Pb, Zn. Hg) • Nutrients (nitrogen, phosphorus) • Turbidity
White Bay	Tidal	• Heavy Metals (Cu, Zn) • Nutrients (nitrate, nitrogen and phosphorus) • Turbidity
Alexandra Canal	Tidal	• Heavy Metals (Cu, Pb, Zn, Cr^{3+}, Cr^{6+}, Ni, Mn, Zn) • Nutrients (nitrate, nitrogen and phosphorus) • Turbidity

5 Assessment of construction impacts

A numerical groundwater model as outlined in **section 3.3.3** has been developed to quantify potential impacts. Groundwater levels and/or quality along the project footprint during construction could be impacted due to the project. Mitigation measures and management strategies to eliminate, reduce or manage potential impacts are outlined in **Chapter 8**.

The potential impacts on the hydrogeological regime during construction of the M4-M5 Link project are:

- Reduced groundwater recharge
- Loss of groundwater due to inflows to the tunnels
- Localised groundwater drawdown
- Reduction in groundwater quality due to tunnelling related activities.

Each of these potential impacts is discussed in the following sections, with specific discussion regarding identified environmentally sensitive areas outlined in **Chapter 4**.

5.1 Reduced groundwater recharge

Surface disturbance due to the project construction would include paved construction ancillary facilities, acoustic sheds, cut-and-cover tunnel sections leading to the tunnel portals and approach roads which could temporarily alter or reduce groundwater recharge. Construction ancillary facilities would create additional temporary impervious surfaces during construction; however, the impacts of these surfaces are considered minor and would not significantly reduce groundwater recharge during construction. In many instances construction ancillary facilities would be located on existing impervious surfaces and would therefore not impact local groundwater recharge during construction.

The risks during construction would be that access roads, tracks and the bunded isolation areas for stockpiling of construction materials could alter or reduce groundwater recharge. These impacts are considered minimal, as the affected area is small compared to the overall project footprint, and temporary, as the various structures would be removed at the end of the construction phase.

5.2 Tunnel inflow

The short term inflow during construction would be dependent upon a number of factors including tunnelling progress, tunnelling construction methodology (including the success of pre-grouting), fractured zones intersected, localised groundwater gradients and storativity. Initial inflows to tunnels can be large, because of the large hydraulic gradients that initially develop near the tunnel walls, however these gradients will reduce in time as drawdown impacts extend to greater distances from the tunnels and inflows approach steady state conditions. Higher inflow rates are likely from zones of higher permeability, where saturated geological structural features are intersected by the tunnels. During construction these high inflow zones are to be grouted to reduce the inflow rate to below the one litre per second per any kilometre length of tunnel criterion.

Inflows from the Hawkesbury Sandstone and Ashfield Shale are expected to be highest during construction, as hydraulic gradients would be at their highest and then would decline as equilibrium is reached. Groundwater modelling has predicted groundwater inflows after grouting to the tunnels during construction to range between 0.45 megalitres per day (M5 East tunnel scenario only) and 2.87 megalitres per day (M4-M5 Link) as reflected in the groundwater modelling construction water balance.

During construction, groundwater would be intersected and managed by either capturing the water that enters the tunnels, caverns and portals or by restricting inflow, through temporary dewatering or the installation of cut-off walls (which limit the movement of groundwater) in cut-and-cover sections. The volume of groundwater and treatment requirements would differ depending on the depth of the tunnel to be constructed, and the geological units through which it passes. It is recognised that high groundwater inflow during excavation is possible in faulted or fractured zones such as beneath the Hawthorne Canal palaeochannel and in the alluvium. Groundwater intersected during the construction of the tunnels will be the primary source of wastewater. The wastewater management system is designed to treat and discharge groundwater as well as stormwater and other intersected water streams.

During construction, long term water management solutions would also be constructed such as the installation of water proofing membranes. Groundwater inflows would be collected via a temporary drainage system collecting water from the road header or tunnel boring machine and pumping it to the surface for treatment and discharge. Water inflows, treatment and discharge would be managed in accordance with a water management plan that would form part of the CEMP.

The predicted water take during construction (Year 2023) from each of the Greater Metropolitan Regional resource due to tunnel inflows is compared to the LTAAEL and is summarised in Table 5-1. Comparison of predicted tunnel inflows indicates the reduction in the groundwater availability within the Botany Sands during construction will be reduced by 0.004 per cent of the LTAAEL. Similarly the predicted reduction in the groundwater availability during construction will be reduced by 661 ML/year or 1.4 per cent of the LTAAEL for the Sydney Basin Central groundwater resource.

Table 5-1 Groundwater extraction from the Metropolitan Regional Groundwater Resources during construction

Aquifer	LTAAEL	Water take - year 2023	Percentage of LTAAEL
Units	**ML/year**	**ML/year**	**(%)**
Botany Sands	14,684	0.62	0.004
Sydney Basin Central	45,915	661	1.4

Source: NoW, 2011 and HydroSimulations(2017)

5.2.1 Connection to Wattle Street

The modelling has been undertaken for construction Option A at Haberfield, therefore the above results reflect tunnelling from Wattle Street civil and tunnel site (C1a) and Haberfield civil and tunnel site (C2a).

If Option B for the construction configuration at Haberfield occurs where tunnelling would be undertaken from Parramatta Road West civil and tunnel site (C1b), there will likely be a slight increase in inflow volume due to the increased construction access tunnel length required. It is expected that the change to the rate of inflow (in litres per second per kilometre) would be low, as this additional tunnelling would be through good quality Hawkesbury Sandstone and would not intersect alluvium.

5.3 Predicted groundwater level decline

Groundwater modelling has been used to predict groundwater levels at the end of the construction period within the alluvium, Ashfield Shale and Hawkesbury Sandstone. Within the alluvium, the groundwater levels are predicted to form a steep elongated cone of depression along the project footprint indicating a good hydraulic connection with the Hawkesbury Sandstone. The depressed groundwater contours however are localised extending no further than about 500 metres from the tunnels indicating localised changes to groundwater flow patterns with negligible impacts on the regional groundwater flow.

At the end of construction, steep localised cones of depression are predicted to develop beneath Newtown and St Peters within the Ashfield Shale. Local groundwater sinks are created at these locations due to the low hydraulic conductivity of the shale and the influence of the leachate pumping at the former Alexandria Landfill.

As for the alluvium and shale, the groundwater levels within the Hawkesbury Sandstone are predicted to be depressed along the tunnels at the end of the construction period. While the impacts are localised extending no further than about 600 metres from the tunnels, the groundwater sink developed creates a barrier along the length of the project footprint to the base of the tunnel. At some point below the tunnel invert, groundwater flow would cease being drawn upwards and groundwater flow within the sandstone would continue uninterrupted.

The predicted groundwater elevations (metres AHD) at the end of the construction phase (2023) are presented for the project in **Figure 5-1**. The drawdown presented in is the total drawdown for all three aquifers. Predicted drawdown for each individual aquifer including the alluvium, Ashfield Shale and Hawkesbury Sandstone is presented in **Figure 5-2**, **Figure 5-3** and **Figure 5-4** respectively. In **Figure 5-4** the Ashfield Shale drawdown is presented from the top of the shale extending into the underlying Hawkesbury Sandstone.

5.4 Groundwater level drawdown

Groundwater drawdown due to construction activities and temporary dewatering could impact the local water table, potentiometric pressures or surface water features where there is hydraulic connectivity. As the majority of the tunnel lengths are drained structures (ie not tanked), the tunnel inflows could impact the natural groundwater system and potentially alter regional hydrogeological conditions.

During construction, the regional extent of drawdown impacts due to tunnel construction would be minimal even though groundwater inflows are high. This is due to groundwater storage depletion from the immediate vicinity of the tunnel restricting the lateral extent of drawdown and the relatively short construction timeframe. As construction continues the inflows would decrease but the depressurisation caused by the tunnel inflows would propagate to the surface causing the water table to decline and would extend outwards to progressively greater distances until steady state conditions are reached, which is expected to be well after the completion of construction. The longer term regional impacts on groundwater levels would therefore be greater and would progressively increase until steady state conditions are reached as outlined in **section 6.3**.

Grouting will be undertaken throughout the construction program which will reduce groundwater inflows and hence limit the groundwater level decline. Groundwater levels would be monitored throughout the construction phase in accordance with a CSWMP to be developed as part of the CEMP. Additional groundwater modelling is proposed to be conducted by the contractors during the construction program using measured tunnel inflow rates and monitored groundwater drawdown to better calibrate the model and predict impacts.

The predicted groundwater drawdown (metres AHD) at the end of the construction phase (2023) is presented for the project in **Figure 5-1** and represents the total drawdown within three aquifers. Predicted drawdown for each individual aquifer including the alluvium, Ashfield Shale and Hawkesbury Sandstone after construction are presented in **Figure 5-2** to **Figure 5-4** respectively.

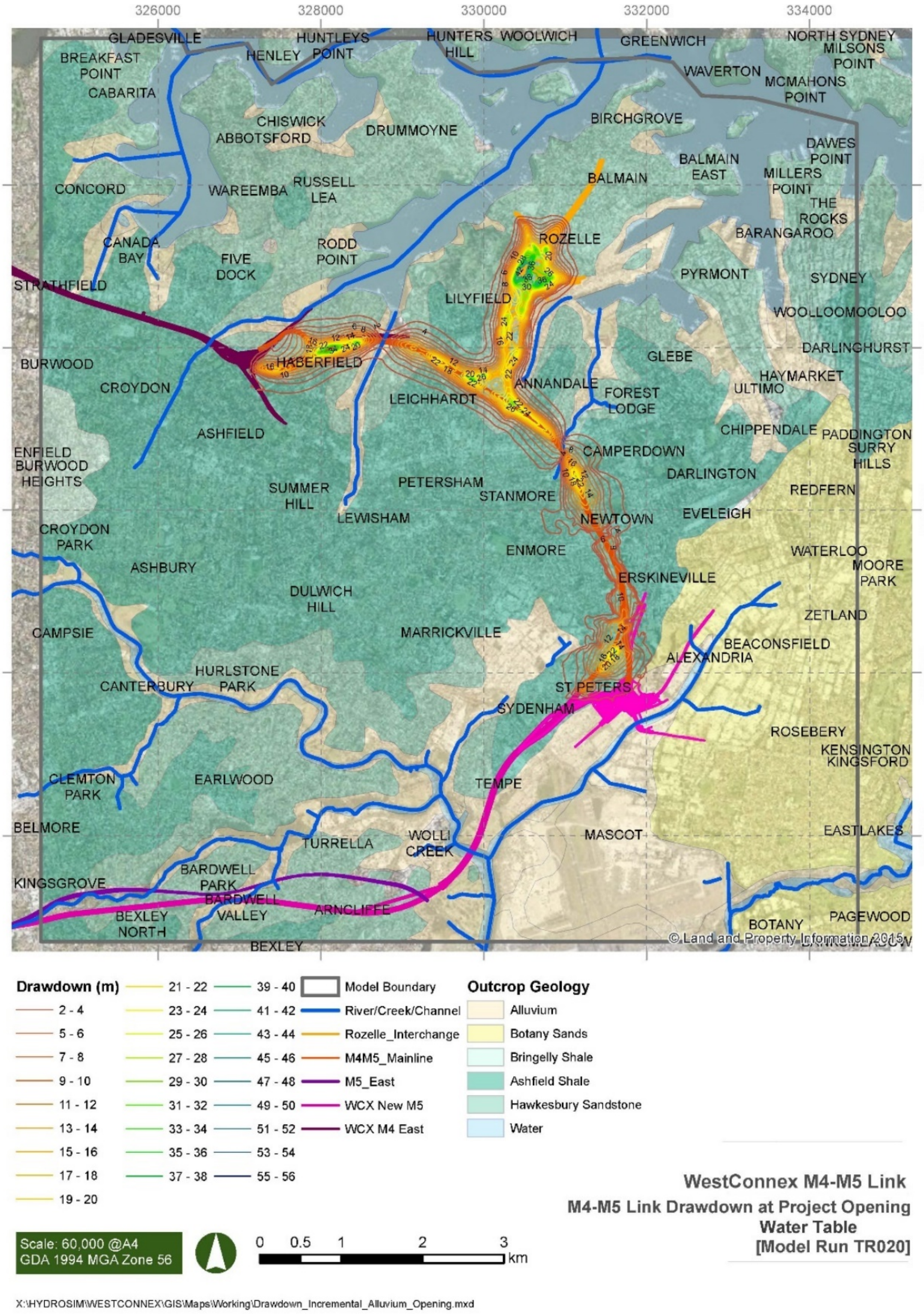


Figure 5-1 Predicted water table drawdown for the project after construction – 2023 (from HydroSimulations 2017)

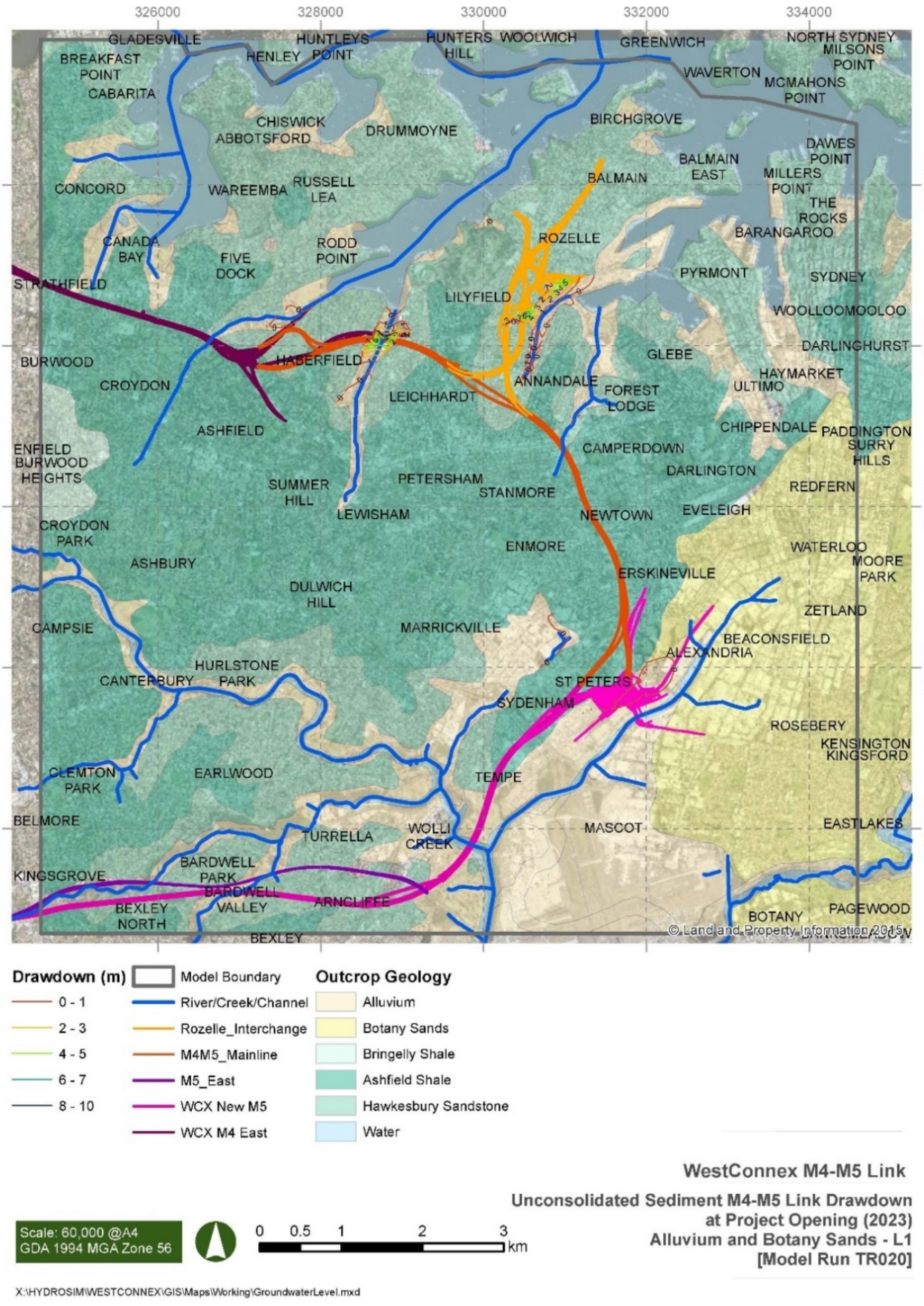


Figure 5-2 **Predicted drawdown in the alluvium after construction – 2023 (from HydroSimulations 2017)**

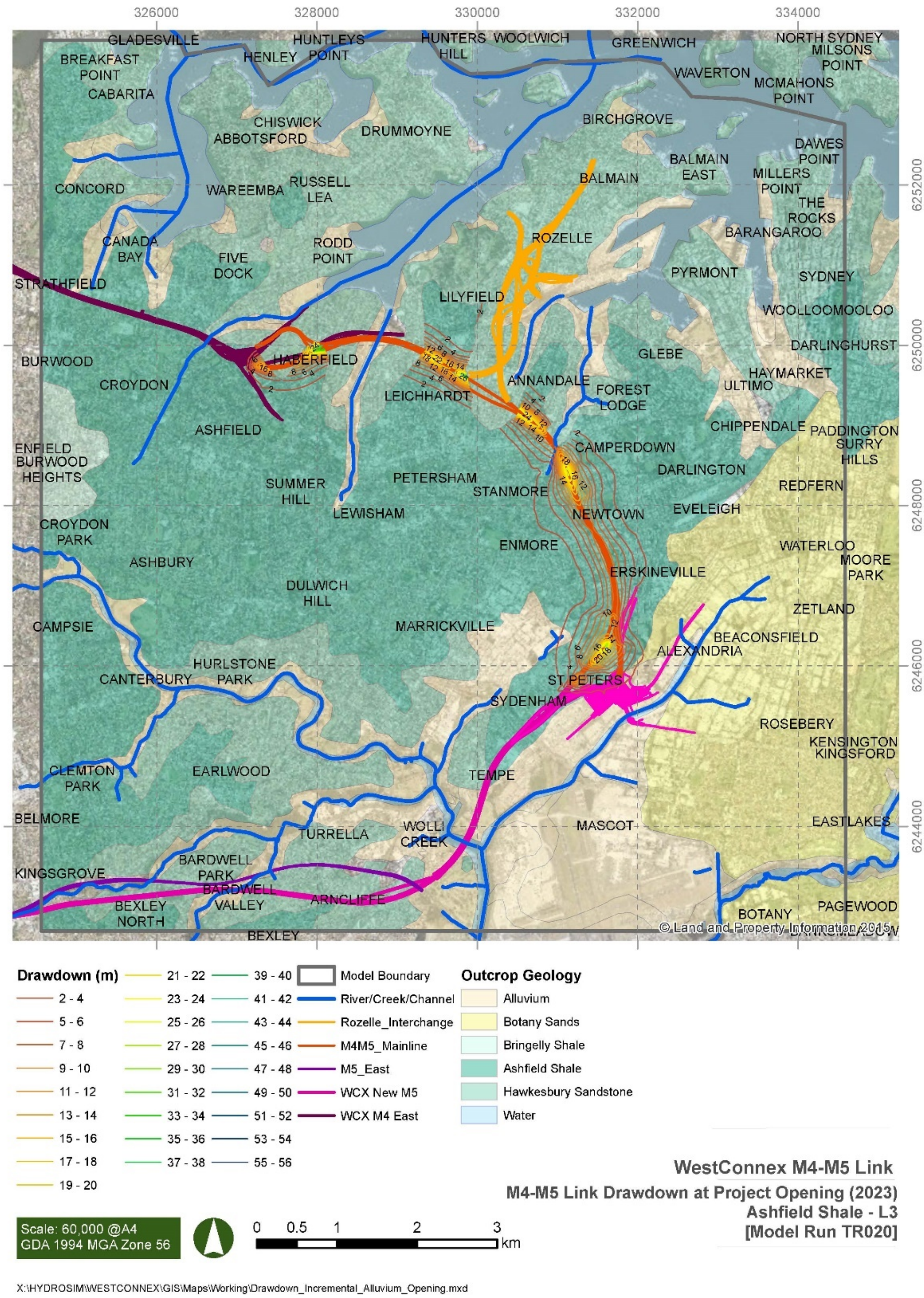


Figure 5-3 Predicted groundwater drawdown in the Ashfield Shale after construction – 2023 (from HydroSimulations 2017)

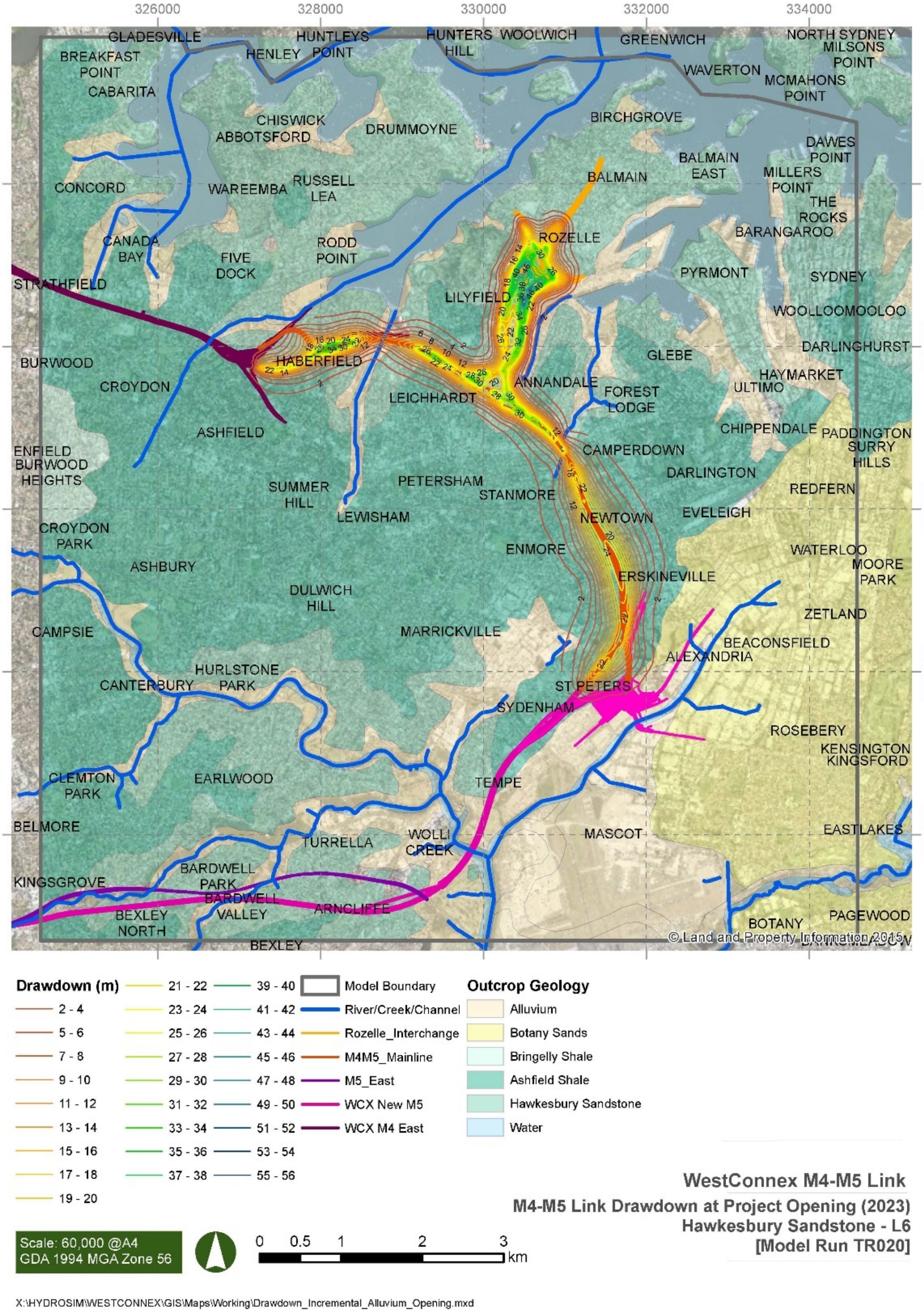


Figure 5-4 Predicted groundwater drawdown in the Hawkesbury Sandstone after construction – 2023 (from HydroSimulations 2017)

5.4.1 Potential impacts on groundwater dependent ecosystems

In accordance with the AIP, groundwater drawdown must be within an allowable range of 10 per cent of baseline levels within 40 metres of a significant GDE. No priority GDEs have been identified within the project footprint. The closest priority GDEs are the Botany Wetlands and Lachlan Swamps within the Botany Sands, located in Centennial Park around five kilometres east of the project footprint. These wetlands are at a sufficient distance from the project footprint to not be impacted by the project. Potential impacts to these wetlands and GDEs due to the New M5 were assessed in the New M5 EIS.

There is a man-made wetland constructed in Annandale at Whites Creek Valley Park in 2002, located immediately before Whites Creek. Groundwater levels within the alluvium associated with Whites Creek are unlikely to be adversely impacted during construction because the tunnels are below the alluvium. Groundwater levels are predicted to be drawn down in the Hawkesbury Sandstone but are unlikely to have any groundwater dependence in this area.

Waterways in or adjacent to the proposed works (Whites Bay, Rozelle Bay and Iron Cove) are not suitable habitat for threatened fish species and there are no SEPP 14 wetlands in the study area (refer to **Appendix S** (Technical working paper: Biodiversity)) of the EIS. It is also unlikely that there is valuable or specific aquatic habitat for threatened aquatic/estuarine species, populations or communities listed under the *Fisheries Management Act 1994* (NSW), *Threatened Species Conservation Act 1995* (NSW) or *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) present within the project footprint.

Groundwater dependence of ecosystems is unlikely to be adversely impacted by groundwater level decline associated with the construction phase of the project.

An assessment of the impacts to natural processes as a result of the operational discharges which may affect the health of the fluvial, riparian and estuarine systems and landscape health within the study area is provided in **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS. These natural processes are outlined in **section 4.4**. In summary, no wetlands, marine waters or natural floodplain systems are considered to be affected by the project. Impacts to fish habitat are considered in **Appendix S** (Technical working paper: Biodiversity) of the EIS.

5.4.2 Potential impacts on surface water and baseflow

Surface water features within or in proximity to the project footprint are described in **section 4.4**. There is unlikely to be any direct surface water inflow to the tunnels from the alluvium since sections of the tunnels are designed as undrained (tanked) tunnels through the Whites Creek alluvium beneath the Rozelle Rail Yards or are designed to dive beneath the palaeochannels such as beneath Hawthorne Canal. Since the majority of the creeks and canals are concrete lined, the risk for surface water from creeks or canals to seep into the tunnels via leakage to the alluvium is considered low. There may be some seepage from the canals as a result of cracks in the aged concrete.

Surface water quality would be monitored throughout the construction phase in accordance with a surface water management plan (CSWMP) to be developed as part of the CEMP. The Sydney Water proposal to naturalise sections of Whites Creek, Johnstons Creek and Iron Cove Creek (Dobroyd Canal) is likely to increase groundwater recharge and may partially increase the baseflow to these creeks. Surface water monitoring is discussed in more detail in **section 4.16** and in **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS.

Surface water can only flow to the groundwater system as baseflow when the groundwater levels are lower than the surface water levels or when the alluvial water table falls below the surface water level in the creeks. In the lower catchment reaches, if brackish water from Whites Creek or Johnstons Creek replaces groundwater lost from the alluvium, the groundwater quality may become degraded. Under conditions when groundwater levels are higher than surface water levels and creeks are not concrete lined, groundwater would naturally discharge into Whites Creek, Johnstons Creek or Iron Cove Creek.

Where the channels are concrete lined, groundwater would be expected to flow within the alluvium surrounding the channel, discharging downstream directly into Rozelle Bay or Parramatta River. However, if groundwater levels are lowered, due to tunnel inflows, then groundwater flow could be reduced or reversed. Therefore, there is potential for groundwater quality to decline as a result of the groundwater drawdown of the brackish water. The natural groundwater is already known to be brackish in the lower lying reaches of the catchment where there is natural tidal interaction. Higher in the catchments, any groundwater loss from the creeks to groundwater via leakage is unlikely to degrade groundwater quality as the surface water would be of lower salinity.

Predicted impacts of construction on baseflow for major creeks has been modelled (**Annexure H**). For the purposes of modelling, baseflow is considered to be the groundwater that discharges to a creek or river and is simulated in the model only when groundwater reaches the ground surface and enters the drainage system. The majority of river flow would be derived from stormwater runoff rather than baseflow as indicated by the surface water monitoring investigation (AECOM 2017b). Predicted changes in baseflow at the end of construction are summarised in **Table 5-2**.

Table 5-2 Predicted changes in baseflow at the end of construction (2023)

2023	Hawthorne Canal	Dobroyd Canal (Iron Cove Creek)	Whites Creek	Johnstons Creek
Existing baseflow (m^3/day)	298	281	177	289
Reduction in baseflow due to M4-M5 Link project (m^3/day)	96	14	132	59
% reduction	32	5	75	20

During construction, the baseflow to major non-tidal creeks is predicted to be reduced by between 5 and 75 per cent. These predicted baseflow reductions are unlikely to substantially impact the local environment as the majority of baseflow is anticipated to be derived from surface water runoff and since the groundwater baseflow volumes only represent the periods when groundwater levels are higher than creek levels and the assessment therefore represents a worst case scenario. Consequently groundwater is unlikely to sustain ecosystems before discharging into Rozelle Bay or Parramatta River. There may be some leakage through the aged cracked concrete that could sustain groundwater however this leakage would be minor. Although the base flow component of streamflow in Whites Creek is substantially reduced, it is expected that the overall contribution to river flow from groundwater input is relatively small due to Whites Creek being lined, tidally influenced and the catchment being heavily urbanised. There is no predicted impact due to the project during construction on other major creeks along the New M5 corridor including Cooks River, Wolli Creek and Bardwell Creek.

5.4.3 Impacts on existing groundwater users

A review of current groundwater use has been conducted to identify registered groundwater users and the environment (GDEs) within a two kilometre buffer of the project footprint. In accordance with the AIP, existing groundwater bores impacted by the lowering of groundwater levels in excess of two metres due to the project would be protected by to the ‘make good’ provisions. This would require the project to restore supply to pre-development levels. The measures taken to ‘make good’ would be dependent upon the location of the impacted bore but could include deepening the bore, providing a new bore, providing an alternative water supply, or alternatively providing appropriate monetary compensation. A review of existing users within and adjacent to the project footprint is summarised in **section 4.10**.

The groundwater model has been used to assess the potential groundwater level drawdown at sensitive areas, registered groundwater users and where the impacts are expected to be in excess of minimal impact considerations as specified in the AIP, mitigation measures have been recommended. Potential impacts on existing users during construction include drawdown in registered wells due to the extraction of groundwater during tunnelling. Registered users within two kilometres of the project alignment were input into the groundwater model and none were predicted to be drawn down in excess of two metres during the project construction program.

Groundwater drawdown is expected to be less during the construction phase than during the operational phase, since long term groundwater levels would continue to decline until steady state conditions are reached. These impacts are discussed in **Chapter 6**.

5.5 Groundwater quality

Groundwater quality risks from construction activities include the potential to contaminate groundwater from fuel, oil, other chemical spills and from the captured groundwater intersected during tunnelling. There is also potential to intersect acid sulfate soils and contaminated groundwater due to previous industrial land use. Contaminants within soil at the Rozelle Rail Yards could be mobilised due to altered groundwater flow paths. As groundwater drawdown increases due to tunnel inflows there is the potential for tidal waters to be drawn into the tunnels causing saltwater intrusion. Groundwater quality would be monitored throughout the construction phase in accordance with the CSWMP to be developed as part of the CEMP. These potential risks to groundwater quality are discussed further.

5.5.1 Spills and incidents

There is potential to contaminate groundwater through incidents within the construction ancillary facilities during the storage of hazardous materials or refuelling operations. Groundwater could become contaminated via fuel and chemical spills, petrol, diesel, hydraulic fluids and lubricants particularly if a leak or incident occurs over the alluvium, palaeochannel or fractured sandstone. Stockpiling of construction materials may also introduce contaminants to the groundwater of the project footprint by the leaching of contaminants followed by run-off and accession to the water table.

The risks to groundwater as a result of such incidents would be managed through standard construction management procedures in accordance with site specific CEMP developed for the project. Further, emergency spill kits would be available on site during construction and staff would be trained in their use. All liquid dangerous goods and hazardous chemicals would be stored within a bunded storage container or spill tray within the construction ancillary facilities. Where possible, refuelling of vehicles or plant equipment would take place on hardstand or bunded areas.

Runoff from high rainfall events that occur during construction would be managed in accordance with the protocols outlined in the Technical working paper: Surface water and flooding (**Appendix Q** (Technical working paper: Surface water and flooding) of the EIS) and the surface water management plan to be prepared as part of the CEMP. Following high rainfall events groundwater quality impacts would be reduced, as the majority of run-off would discharge to receiving waters.

5.5.2 Intercepting contaminated groundwater

A number of sites with the potential for groundwater contamination due to various current and historical land-uses are located along the project footprint as outlined in **section 4.14** and in **Appendix R** (Technical working paper: Contamination) of the EIS. A potential contamination risk would be associated with the migration of contaminated groundwater plumes towards the tunnels.

The majority of the tunnels are to be constructed within the Hawkesbury Sandstone at depths greater than 20 metres (at the western and eastern ends) and up to 50 metres beneath Newtown.

There is potential to intersect contaminated groundwater during construction while excavating the portals and dive structures that are constructed from the top down, although groundwater would typically be isolated from these structures by cut-off walls such as diaphragm walls or secant piled walls.

Groundwater contamination investigations have been conducted as part of EIS investigations and have identified some areas where contaminated groundwater may occur, such as St Peters Landfill, Rozelle Rail Yards and former industrial sites in areas such as Alexandria and Haberfield. Contaminated groundwater, if intersected, will enter the tunnels and will be treated prior to discharge at one of the water treatment plants. It is not considered feasible to estimate the concentration of contaminants with any certainty due to significant variabilities and associated uncertainties. An approach which is consistent with the two previous WestConnex projects is to provide management measures and treatment to control pollutants.

The primary risk to groundwater quality is the migration of contaminated groundwater through altered groundwater flow paths due to the tunnel construction. At the Rozelle Rail Yards, groundwater beneath the site within the alluvium is shallow and impacted by historical industrial land uses. Potential contaminants of concern include heavy metals (arsenic, cadmium, copper, lead, nickel and zinc) and hydrocarbons. The tunnels through the alluvium are to be constructed as undrained (tanked) tunnels to reduce the ingress of groundwater from the palaeochannels, minimising potential contaminated groundwater migration, and addressing the requirements of DPI-Water. In addition, cut-and-cover sections that intersect the alluvium are to be constructed with secant pile walls or diaphragm walls founded in competent sandstone, for example, to reduce groundwater inflow from the alluvium.

During ground excavation works associated with the construction of the tunnel access decline, shallow groundwater is likely to be encountered within the alluvium and would require management during construction. It is also possible that un-predicted localised perched groundwater may be intersected. At Rozelle, localised temporary dewatering may be required which would be decided during the detailed design phase (**sections 2.3.2**, **5.2**, and **5.7**). The volume of shallow groundwater to be extracted has been accounted for in the groundwater modelling predictions.

Potential contaminated groundwater inflows could be derived from industrial sites that overlie the tunnels at Alexandria and St Peters where the tunnels are relatively shallow (about 20 metres below ground surface) but constructed within the Ashfield Shale. This area historically contained potentially contaminating operations such as petrol stations, several vehicle service centres, dry cleaners, car manufacturing, mechanical workshops and dry cleaning. The risk of intersecting shallow contaminated groundwater, however, is considered low because the tunnels would be constructed within the Ashfield Shale where the hydraulic conductivity and groundwater leakage would be low.

At Hawthorne Canal and Leichhardt North, the fill from unknown sources flanking Iron Cove deposited during historical land reclamation works is potentially contaminated and may have impacted local groundwater. Similarly, there are other potential soil contamination sources, such as the storage and use of chemicals, pesticides, fuels and oils and hazardous building materials in the former Public Works Depot at Blackmore Park, which may have impacted shallow groundwater quality within the alluvium and palaeochannels. The risk of intersecting shallow contaminated groundwater, however, is considered low because the tunnels are to be constructed below the potentially contaminated fill and alluvium within the Hawkesbury Sandstone.

Groundwater and surface water captured as a result of tunnelling are likely to be contaminated with suspended solids and increased pH due to tunnel grouting activities. These flows would be captured and treated prior to discharge via water treatment plants located at construction ancillary facilities. Where possible, the treated water would be reused during construction for purposes such as dust suppression, wheel washing and plant washing, rock bolting, earthworks or irrigation before discharge. Groundwater reuse would be undertaken in accordance with the policies of sustainable water use of DPI-Water (National Water Quality Management Strategy, 2006). The volume of recycled water required for beneficial use will be variable and dependent on site conditions and will be likely be driven by a demand for beneficial use water. The estimated total volume of water required during construction is not available at this stage of the project and will be determined during detailed design. It is expected that there will be a water surplus during construction and recycled water for operational purposes would be used in preference to potable water where possible.

At St Peters interchange there is known groundwater contamination including elevated ammonia associated with the former landfill. Geotechnical drilling as part of the project did not identify localised faulting or fracturing which could provide leachate conduits to the tunnels. Although the tunnel depths are shallow near the portals, the risk of landfill contaminated groundwater being intersected by the tunnels is considered low as continual leachate pumping from the former landfill would locally reverse groundwater gradients and pumped groundwater would be treated by the landfill water treatment plant.

Large portions of the Botany Sands are known to be contaminated from a variety of sources primarily related to previous industrial land-use. Groundwater from the Botany sands aquifer is likely to enter the tunnel indirectly through hydraulic connection with the Hawkesbury Sandstone, however a capture zone analysis undertaken as part of the groundwater modelling confirms the Botany Sands would not be a dominant source of water to the tunnels during construction.

Given the tunnel depth, location of the tunnel in relation to the contaminant source and low inflow rates, the risk of intercepting contaminated groundwater from the sandstone and shale is considered to be low. The risk of contaminated groundwater ingress from the alluvium is also considered low because the tunnel is to be tanked in the alluvium, restricting groundwater movement from the alluvium. All groundwater captured during construction would be directed to water treatment plants at the following construction ancillary facilities:

- Haberfield civil and tunnel site (C2a)
- Parramatta Road West civil and tunnel site (C1b)
- Darley Road civil and tunnel site (C4)
- Rozelle civil and tunnel site (C5)
- Iron Cove Link civil site (C8)
- Pyrmont Bridge Road tunnel site (C9)
- Campbell Road civil and tunnel site (C10).

5.5.3 Groundwater treatment

The volume of groundwater and treatment requirements will differ depending on the depth of the tunnel to be constructed, and the geological units through which the tunnel passes. Groundwater and surface water captured as a result of tunnelling are likely to be contaminated with suspended solids and increased pH due to tunnel grouting activities. During construction, the wastewater generated in the tunnel would be captured, tested and treated at a construction water treatment plant (if required) prior to reuse or discharge, or disposal offsite if required.

Based on the knowledge gained from the adjoining projects (M4 East and New M5) it is likely that the water treatment plants will be required to include pH correction as well as the ability to remove iron, manganese, suspended solids, hydrocarbons and other settleable compounds. The results collected as part of this project as outlined in **section 4.13** indicate that groundwater in the study area may also be impacted by elevated levels of ammonia, total nitrogen and total phosphorus compared to ANZECC (2000) guideline levels (marine, freshwater and recreational protection levels). Other metals including copper, chromium, lead, nickel and zinc were also recorded at elevated levels on a limited number of occasions. The type, arrangement and performance of construction water treatment facilities will be developed and finalised during detailed design.

The receiving waterways and ambient water quality are all highly disturbed compared to the water discharge quality. Given the nature of the receiving waterways and temporary nature of the construction phase the ANZECC 90 per cent protection level for discharge quality could be adopted in accordance with guidelines. The 99 per cent protection level would apply to analytes that bio-accumulate such as heavy metals.

The assessment of the potential impacts of the quality of water discharged from the water treatment plants during construction is discussed in **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS.

5.5.4 Acid sulfate soils

Potential acid sulfate soils (PASS) have been identified within natural alluvium beneath the former Rozelle Rail Yards and possibly within the alluvium along Hawthorne Canal. When exposed to air, the iron sulphides (commonly pyrite) within acid sulfate soils can oxidise, producing sulphuric acid. The soils become exposed to air by either excavation or dewatering. At Rozelle Rail Yards the excavation of low-lying natural soil may uncover PASS during the excavation for tunnel infrastructure which will require treatment and removal under the CEMP. However the majority of the tunnels would be deep and well below the areas where PASS may be expected. The only expected intersection of PASS would be during the construction of tunnel portals or cut-and-cover sections in areas of known PASS.

Acid sulfate soils could be disturbed by the project and may cause the generation of acidic runoff and/or the increased acidity of groundwater. The risks associated with PASS and acid sulfate soil would be managed under a CSWMP as part of the CEMP prepared in accordance with *NSW Acid Sulfate Soils Manual* (Stone *et al* 1998). The CSWMP would include water quality monitoring and acid sulfate soil management.

5.5.5 Soil salinity

Salts naturally present in soil and rock are mobilised in the subsurface by the movement of groundwater. The concentration of salts within the soil is related to the geological unit from which the soil is derived. Along the project footprint, soils derived from the Ashfield Shale typically have a high salt content due to the presence of connate marine salts. Salt concentrations within soils derived from the Hawkesbury Sandstone and alluvium are variable, and within the alluvium are impacted by tidal influences. Under shallow groundwater conditions, saline groundwater may be drawn to the ground surface by capillary action or altered recharge/discharge conditions, precipitating the salts as the water evaporates.

Urban salinity becomes a problem when the natural hydrogeological balance is disturbed by human interaction through the removal of deep rooted trees (causing groundwater levels to rise and potentially dissolve and mobilise salts from the soil profile) or construction of structures that intersect the water table. Since the majority of deep rooted trees were removed from the study area over 150 years ago a new equilibrium has been established and the removal of any further remaining trees on the new equilibrium would not be substantial. The development of urban salinity may cause corrosion of building materials, degrade surface water quality or prevent the growth of all but highly salt tolerant vegetation.

During construction of the M4-M5 Link project, there is potential for salts within the alluvium to be mobilised by local dewatering or associated with the tunnel construction program. Tunnels constructed within the alluvium are to be undrained (tanked), and consequently could alter local flow paths creating groundwater mounding causing the dissolution of soil salts. Beneath the Rozelle Rail Yards area, where the tanked, undrained (tanked) tunnels are to be constructed in the Whites Creek alluvium, saline groundwater reaching the ground surface would be directed towards the modified drainage system removing the mobilised salts from the system. It is unlikely the salts with Ashfield Shale would become mobilised as the short and long term impacts due to the drained tunnels are expected to draw down the water table preventing the groundwater reaching the ground surface. Hence the impact of the project on the groundwater resources or hydrology based on the mobilisation of saline soils is likely to be negligible.

5.5.6 Saltwater intrusion

During construction there are unlikely to be any impacts associated with saline groundwater entering the tunnels. Saltwater intrusion would commence as soon as the drawdown cone of depression reaches the shoreline of nearby tidal surface waterbodies which would start to impact groundwater close to the shoreline. However during construction, saline groundwater would not inflow to the tunnels from tidal areas because the tidal surface waterbodies are a considerable distance from the tunnels. The calculated groundwater travel times from these waterbodies are too long for saline water to reach the tunnels. Close to the shoreline, groundwater quality would become more saline during the construction period due to saltwater intrusion however the slight salinity increase is unlikely to impact on the environment since the groundwater along the tidal fringe is naturally saline due to tidal mixing. In addition there are no registered water supply wells or priority groundwater dependent ecosystems along this tidal fringe.

In HydroSimulations 2017) travel times for saline water to enter the tunnels within the alluvium have been tabulated for minimum, maximum and average times. The minimum travel times for saltwater to enter the tunnels at Alexandra Canal and Whites Creek are predicted to be 2 days and 8 days respectively, although after these times the volume to saline water entering the tunnels would be negligible. Initially (minimum travel time), the saline water would be a small fraction of total groundwater entering the tunnel but this is expected to increase over time as water is drawn from further afield. Average travel times are computed to be 30 years and 13 years respectively although the saline water entering the tunnels would always be a minor component of total inflow.

5.5.7 Groundwater monitoring

Groundwater monitoring would be carried out during construction. The monitoring program would be designed to monitor:

- Groundwater levels (manual monitoring and automatic monitoring by data loggers)

- Groundwater quality (within key boreholes and tunnel inflows)
- Groundwater inflows to the tunnels.

Groundwater would be monitored in the alluvium, Hawkesbury Sandstone and Ashfield Shale. The monitoring wells in the monitoring program used to inform this assessment would be used as required for monitoring. It may be necessary to construct additional monitoring wells if some of the existing wells are damaged during construction or other key areas are identified during the detailed design phase where monitoring is required.

It is expected that manual groundwater level monitoring and groundwater quality monitoring would be undertaken monthly. The quality and volume of tunnel inflows are expected to be monitored weekly.

The following analytes are likely to be sampled:

- Field Parameters (pH, electrical conductivity, dissolved oxygen, temperature and redox conditions)
- Metals (arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc)
- Nutrients (nutrients (nitrate, nitrite, Total Kjeldahl Nitrogen (TKN), ammonia and reactive phosphorous)
- Major cations (sodium, potassium, calcium, magnesium) and anions (chloride, sulphate, carbonate, bi-carbonate).

The analytes to be sampled and the frequency and type of reporting will be confirmed by the construction contractors.

The monitoring program would be developed in consultation with the NSW EPA, DPI-Fisheries, DPI-Water and the Inner West and City of Sydney councils and documented in the CSWMP.

5.6 Construction of ancillary infrastructure and facilities

The majority of ancillary infrastructure proposed as part of the project are above ground and would not impact the hydrogeological regime. Ancillary infrastructure that may impact groundwater during construction includes:

- Tunnel portals
- Ventilation systems
- Water treatment facilities
- Construction of ancillary facilities
- Drainage channels and wetland areas.

During the construction of below ground tunnel ancillary infrastructure such as ventilation shafts or tunnel portals, sheet piling may be installed to assist temporary dewatering. Construction barrier structures such as sheet piling would be in place temporarily and groundwater levels would be restored after the barriers are removed. The tunnel portals and cut-and-cover construction options may include secant piled walls or diaphragm walls socketed into the underlying bedrock to prevent the ingress of alluvial or perched groundwater into the tunnels. Ventilation tunnels and facilities are to be constructed as drained tunnels. This infrastructure has been included in the groundwater model so consequently impacts such as groundwater drawdown or groundwater ingress due to tunnel seepage is considered in the model discussions.

The water treatment facilities are to be constructed to enable captured groundwater and surface water to be treated and discharged within the appropriate guideline concentration values. The water treatment plants are not expected to impact groundwater other than groundwater being taken from the local hydrogeological system which is covered elsewhere in this impact assessment. Potential surface water impacts such as discharge from the water treatment plant that could increase flows to local waterways are discussed in **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS.

5.7 Utility adjustments

Utility adjustments would be required during the construction phase. These would include the protection of existing utilities, construction of new utilities and relocation of existing utilities. The majority of the utility adjustments would occur in new utility service corridors at the Iron Cove Link, parallel to Victoria Road and within and surrounding the Rozelle Rail Yards. The utilities to be impacted include:

- Sewer
- Water mains
- Electricity cables
- Telecommunications including fibre optic cables
- Gas mains
- Sydney trains electrical infrastructure.

These works would involve excavating trenches to varying depths and may intersect the water table. At the Iron Cove Link impact to groundwater is expected to be minimal as the groundwater level is typically below the expected depth of utility trenches. In contrast at the Rozelle Rail Yards the water table is shallow and within one metre of the ground surface indicating that utility trenches are likely to intersect the groundwater. During trench excavations sheet piling may be required to temporarily provide support in the alluvium and to restrict groundwater inflows to the trench. Once the sheet piling is removed, groundwater levels would return to pre excavation levels. The trenches may be encased in concrete or plastic pipes to water proof the utility service corridors. Deeper trenches or excavations may require temporary dewatering during the construction phase.

Where feasible the new utility corridors are designed to contain multiple utilities to minimise the project footprint. These works will be undertaken in accordance with **Appendix F** (Utilities Management Strategy) and the CSWMP.

5.8 Ground movement (settlement)

When groundwater levels are drawn down, the unconsolidated sediments hosting the groundwater are subjected to an increase in effective stress. The increase in stress is analogous to additional load being applied to sediment, and the sediment would experience settlement. The magnitude of the resulting settlement can induce damage to structures within the groundwater drawdown zone of influence. Settlement associated with groundwater drawdown is different from settlement associated with construction tunnelling. Settlement associated with construction tunnelling occurs within a shorter timeframe compared to settlement associated with groundwater drawdown, which occurs over a longer timeframe.

Residual soil profiles developed on the weathered sandstone and shale bedrock are typically relatively thin, stiff and of low compressibility. The risks associated with water table drawdown and associated dewatering induced settlement is dependent upon the amount of drawdown within the alluvium and could be considerable. Settlement within the Hawkesbury Sandstone would be expected to be less than that within the alluvium due to the competent nature and geotechnical properties of the sandstone.

Since ground settlement is more likely to occur within the alluvium where tunnels are constructed, design measures have been instigated to minimise settlement at those locations. Where alluvium is intersected the tunnels would be tanked to minimise groundwater ingress. In addition, beneath Hawthorne Canal and Johnstons Creek the tunnels have been designed to dive beneath the alluvium to reduce groundwater ingress to the tunnels from the alluvium and hence reduce settlement. During tunnel construction the bulk hydraulic conductivity of the sandstone will be decreased by grouting, decreasing groundwater inflow and hence reducing settlement.

Monitoring of settlement throughout the construction program would be included as part of the CEMP. The groundwater drawdown computed in this investigation has been calculated on a regional scale and consequently due to the lithological and hydrogeological assumptions made the model output is unsuitable for calculating settlement at a detailed localised scale. Detailed settlement modelling would be required to be undertaken by the construction contractors as part of the detailed design within the Rozelle Rail Yards area where the water table within alluvium may be drawn down.

Small scale dewatering of the alluvium and Hawkesbury Sandstone may be required during construction that would result in an increase in effective stress potentially leading to ground settlement. It is anticipated that dewatering the Hawkesbury Sandstone would result in negligible settlement. Resultant movement in the clay soils would result in consolidation settlement and creep settlement which may result in settlement continuing over a long period of time.

Although the groundwater model has predicted groundwater drawdown within the alluvium and Botany Sands, it is not considered appropriate to use these regional results to calculate localised ground settlement. The model is a regional groundwater model and is not considered appropriate for use in estimating groundwater induced settlement at a more localised level. A preliminary assessment based on geotechnical conditions has been carried out to assess the potential for ground movement as a result of the project and the results of this assessment are provided in **Chapter 12** (Land use and property) of the EIS. A geotechnical model of representative geological and groundwater conditions would be prepared by the construction contractor prior to excavation and tunnelling for the project. The model would be used to assess predicted settlement impacts and ground movement caused by excavation and tunnelling on adjacent property and infrastructure.

Environmental management measures to control groundwater inflows (which influence groundwater drawdown and therefore ground movement) during construction are outlined in **section 8**.

Pre-construction condition surveys of potentially impacted property and infrastructure would be undertaken before the commencement of construction activities that would pose a settlement risk, to determine appropriate settlement criteria to prevent damage. In the event that the geotechnical model identifies potential exceedances of settlement criteria, management measures such as appropriate support and stabilisation structures would be implemented to minimise settlement impacts on property and infrastructure.

Settlement monitoring would be undertaken during construction and may include the installation of settlement markers or inclinometers. In the event that settlement criteria are exceeded during construction for property and infrastructure, measures would be taken to 'make good' or to manage the impact.

Further details regarding settlement are provided in **Chapter 12** (Land use and property) of the EIS.

5.9 Groundwater balance

The simulated groundwater balance computed for the end of construction (year 2023) is summarised in **Table 5-3** based on the water balance presented in the groundwater modelling report (**Annexure H**).

Table 5-3 Simulated groundwater balance – construction (2023)

Water component	Inputs (Recharge)	Output (Discharge)
	ML/day	
Rainfall infiltration (Rf)	9.52	0.0
Evapotranspiration (Et)	0.0	1.53
River inflow/outflow (Ri/Ro)	1.60	12.44
Tunnels (M4-M5 Link) (T)	0.0	2.87
Pumping wells (Pw)	0.0	0.05
Regional boundary flow (RBi/RBo)	24.95	21.40
Tidal seepage (TSi/TSo)	1.43	0.88
Storage (Si/So)	3.26	1.59
TOTAL	40.75	40.75
% Error	0.0	0.0

The groundwater balance confirms that the major water inflows to the model during the construction phase would be derived from regional boundary flow and rainfall infiltration. Conversely, major model outflows are regional boundary flow and river outflow. The total inputs and outputs indicate that the water components are balanced.

At the completion of construction in 2023 there would be a net loss in storage of 1.67 megalitres per day (3.26 megalitres per day storage input and 1.59 megalitres per day storage discharge) indicating that water is being drained from the system. The water 'take' or loss to the local hydrogeological regime is the water lost to tunnel drainage that would not be returned including direct tunnel seepage, storage loss and river loss. Review of the total inputs and outputs for each scenario indicates the water components are balanced.

The water balance includes the above groundwater components but would also include some surface water components not included in the groundwater balance such as rainfall runoff in facility enclosures (RO) or water treatment discharges (SWo).

In summary the water balance can be summarised as follows:

Inputs = Outputs; where

Rf + Ri + RBi + TSi + Si + RO = Et + Ro + T + Pw + RBo + Tso + So + SWo

6 Assessment of operational impacts

Potential impacts on groundwater due to the operation of the project are discussed in this chapter and mitigation measures to eliminate or manage impacts are outlined in **Chapter 8**. The potential impacts include reduced groundwater recharge, tunnel inflow, groundwater drawdown and reduction in groundwater quality. Each of these potential impacts is discussed, with specific reference to environmentally sensitive areas where applicable.

6.1 Reduced groundwater recharge

The Rozelle Rail Yards are underlain by alluvium where groundwater recharge would be expected to be higher than areas underlain by sandstone and shale. The Rozelle Rail Yards currently behave as a flood storage area where much of the floodwaters would recharge the alluvium, which is attributed to the site being low lying and poorly drained. Post construction of the project, the area is to be drained by flood channels to minimise flooding, which may result in a reduction of natural groundwater recharge. Sections of the Rozelle Rail Yards are also to be capped to further reduce recharge. Parts of the Rozelle railyards not used for road infrastructure would be converted to open space or project landscaping. These areas would continue to receive rainfall recharge albeit less due to improved drainage. A reduction in groundwater recharge at the Rozelle Rail Yards is considered beneficial as it will locally reduce groundwater levels within the alluvium reducing the risk of mobilising legacy groundwater contamination (see **section 6.4.1**).

Elsewhere across the project footprint there are areas where buildings and paved areas are to be temporarily used for construction purposes such as those at Haberfield, Darley Road, Iron Cove and Pyrmont. At construction completion if these areas no longer feature buildings or structures and are no longer paved then groundwater recharge could be enhanced.

The majority of the project is below ground surface and is unlikely to directly impact groundwater recharge. Above ground, the surface area of the road network would slightly increase with additions in some key areas such as City West Link, Victoria Road, Anzac Bridge and The Crescent. Given the limited increase in surface area of the surface road infrastructure, including operational infrastructure such as the motorway operations complexes, ventilation infrastructure, substations and water treatment plants, the reduction in rainfall recharge across the project footprint is considered negligible.

6.2 Tunnel inflow

Inflow to the drained tunnel is influenced by the geology, structural geology and hydrogeological features of the intersected lithologies. This includes the hydraulic conductivity, storativity and hydraulic connectivity.

The project tunnels are to be constructed predominantly through the Hawkesbury Sandstone and, to a lesser extent, through the Mittagong Formation and Ashfield Shale. To minimise groundwater inflow, the tunnels are designed to avoid the palaeochannels by diving beneath Hawthorne Canal and tanking (ie concrete lining to prevent groundwater ingress) sections of the tunnel through the Whites Creek alluvium beneath the Rozelle Rail Yards. Long term tunnel inflows are also dependent upon the construction methods selected.

Conservative estimates of tunnel inflows can be made by assuming a uniform groundwater inflow rate of one litre per second per kilometre along the whole drained tunnel length during operation of the project even though there will be sections of the tunnels where inflow rates will be less than the maximum allowed rate of inflow. The total tunnel length including motorway and ventilation tunnels is around 47,940 metres. The total tunnel length of drained tunnel is around 44,950 metres.

Assuming a worst case scenario of a uniform groundwater inflow rate of one litre per second per kilometre along the whole tunnel length, a groundwater inflow of around 44.95 litres per second (3.9 megalitres per day) would be expected. This calculated inflow however is an over estimate as the tunnels are designed to restrict groundwater inflow to below one litre per second per kilometre. At the Rozelle interchange, groundwater inflows in each tunnel would be further restricted due to the number of tunnels in close proximity to each other and the associated interference of available groundwater flowing into these multiple tunnels.

Long term groundwater inflows have been modelled and vary over time as local conditions change. After the commencement of operations in 2023 the estimated long term inflows into the motorway tunnels are predicted to be 0.47 litres per second per kilometre initially, reducing to 0.25 litres per second per kilometre in 2100. Similarly the groundwater inflows into the ventilation tunnels are predicted to be 0.25 litres per second per kilometre in 2023 reducing to 0.18 litres per second per kilometre in 2100.

Groundwater inflow from the Hawkesbury Sandstone is expected to be low due to low bulk hydraulic conductivity values typically 0.008 metres per day (see **Table 4-5**). The Ashfield Shale overlying the Hawkesbury Sandstone typically has a lower hydraulic conductivity in the order of $1x10^{-3}$ to $1x10^{-2}$ metre per day (Hewitt 2005) indicating groundwater inflow is expected to be lower in the shale than sandstone.

The regional impact on the Sydney Basin Central of long term groundwater inflow (or 'take') as a result of the project has been estimated by comparing the annual recharge with the modelled long term inflow. Annual rainfall recharge to Sydney Basin Central is 229,223 ML (NoW 2011). The predicted long term tunnel inflow or 'take' (from the combined motorway tunnels and ventilation tunnels) is estimated to vary from 1.74 megalitres per day (635.1 megalitres per year) in 2023 reducing to 0.99 megalitres per day (361.4 megalitres per year) in 2100. Consequently the groundwater 'take' due to long term groundwater inflow to the tunnels represents 0.27 per cent of the annual recharge across the Central Sydney Basin in 2024 and 0.15 per cent in 2100. Although the groundwater 'take' from the local hydrogeological system is considerable in volume terms, when compared with regional recharge across Sydney Basin Central, the groundwater 'take' is less than 0.3 per cent of the annual rainfall recharge.

Groundwater modelling (HydroSimulations 2017) has predicted inflows over the six kilometres length of the existing M5 East tunnels. Modelling Scenario 1 presents the base case and predicts the inflow to the M5 East tunnels to range between 0.86 and 0.73 litres per second per kilometre, gradually declining over time. These results are consistent with the long term inflow of 0.8 to 0.9 litres per second per kilometre reported by Hewitt (2005) confirming the model accurately predicts tunnel groundwater inflow. It should be noted that while groundwater inflows are calculated as accurately as possible within the model confines, the inflows are averages along the alignment and actual inflow rates could be highly variable and dependent upon local geological features and the success of grouting during construction. Consequently the long term inflow rates should not be used for the purpose of planning water management during construction.

The predicted long term water take from each of the Greater Metropolitan Regional resource due to tunnel inflows and compared to the LTAAEL is summarised in **Table 6-1**. Comparison of predicted tunnel inflows indicates the long term reduction in the groundwater availability within the Botany Sands over the life of the project will vary from 0.005 per cent to 0.019 per cent. Similarly the predicted long term tunnel inflows represent a small percentage of the LTAAEL for the Sydney Basin Central which range from 0.7per cent to 1.3 per cent. Long term the predicted take from the Botany Sands aquifer increases with time due to the increasing extent of drawdown associated with tunnel operational inflows. Long term inflows to the Sydney Basin Central Regional Groundwater Resource decline as storage declines, almost halving over the project life.

Table 6-1 Long term groundwater extraction from the Metropolitan Regional Groundwater Resources

Aquifer	LTAAEL	Water take maximum (year 2024)	Water take minimum (year 2100)	Percentage reduction of LTAAEL
Units	**ML/year**	**ML/year**	**ML/year**	**(%)**
Botany Sands	14,684	0.76	2.78	0.005 – 0.019
Sydney Basin Central	45,915	582	323	0.70 - 1.3

Source: NoW, 2011 and HydroSimulations, 2017

6.2.1 Mainline tunnel refinements

Design refinements at the proposed Inner West subsurface interchange located underground at Leichhardt and Annandale bifurcate a three lane tunnel on the approach to the subsurface interchange into a two lane tunnel and a one lane tunnel. These separate tunnels would extend south and southwest for a distance of around one kilometre, joining with the northbound mainline tunnel generally at a point below Norton Street at Leichhardt. This, along with the bifurcation of tunnels north of the St Peters interchange are likely to increase the total volume of inflow over a given time period due to the addition of extra length of drained tunnels. This will be partly offset by a reduction in inflow to the mainline tunnels due to a decreased tunnel width, however it is qualitatively expected that there will be an overall net increase in flow due to an increased extent of tunnelling leading to (minimally) increased groundwater drainage. The entire proposed bifurcation tunnel lanes are to be constructed in Hawkesbury Sandstone and Ashfield Shale therefore no increased connectivity of the project to the alluvium or unconsolidated sediments is expected.

6.2.2 Botany Sands

The tunnels do not pass through the Botany Sands or Zone 2 of the Botany Sands Source Management Zone so there would be no direct inflow of groundwater from the Botany Sands into the drained tunnels. The sandstone and shale surrounding the tunnels, however, are likely to be hydraulically connected to the Botany Sands. Hydraulic connection would however be limited due to a basal residual alluvial clay layer (reducing vertical flow) and the poor water transmitting properties of the Ashfield Shale (reducing horizontal flow). If there are locations where the basal clay has been eroded then there is potential for groundwater from the Botany Sands aquifer to enter the tunnel via fractured rock or downward leakage induced by drawdowns in the underlying Hawkesbury Sandstone. This downward leakage of groundwater from the Botany Sands to the Hawkesbury Sandstone could potentially occur anywhere within the area of drawdown in the Hawkesbury Sandstone where the sandstone is overlain by the Botany Sands.

Groundwater inflow from the Botany Sands is currently a major contributor to leachate generation at the Alexandria Landfill, as the landfill was excavated partly into the Botany Sands on its south-eastern side. Groundwater inflows at the former landfill are currently managed by a pump and treat system, which discharges to sewer. Leachate generation is to be reduced by the installation of a cut-off wall and a landfill capping that will reduce groundwater flow from the Botany Sands into the former Alexandria Landfill, as part of the New M5 project (Roads and Maritime 2015).

6.2.3 Alluvium

As with the Botany Sands aquifer, alluvium associated with the creeks, canals and edge of the Sydney Harbour and Parramatta River in the project footprint are partly saturated. Since the alluvium is hydraulically connected to surface waterbodies, water can potentially flow from Rozelle Bay or the Parramatta River via the alluvium and fractured sandstone or shale into the project footprint. Although the majority of the creeks and canals are concrete lined, there remains good hydraulic connection with the groundwater within the alluvium outside the main channels. There is no direct inflow to the tunnels from the alluvium since the tunnels are designed as tanked where the alluvium is intersected,

6.2.4 Palaeochannels

Deep incised palaeochannels infilled with saturated sediments are present beneath Whites Creek, Hawthorne Canal and Iron Cove Creek and extend up to 25 metres below the ground surface. To reduce the risk of large groundwater inflows to the tunnel from the palaeochannels, it is proposed to construct the tunnels beneath the palaeochannels at Hawthorne Canal and Iron Cove Creek. Beneath the Rozelle Rail Yards, the tunnels would be constructed as un-drained (tanked) tunnels through the Whites Creek palaeochannel to prevent seepage of the alluvial groundwater into the tunnels. In addition, cut-and-cover sections that intersect the saturated alluvium at Rozelle Rail Yards and Haberfield are likely to be constructed would with cut-off walls such as diaphragm walls or cut-off walls to minimise long term tunnel leakage. Where a tunnel portal intersects alluvium, the tunnel is to be tanked (undrained) and would continue beyond the portal as a cut-and-cover section with cut-off walls.

6.2.5 Dykes

Dykes such as those identified within the sandstone cutting north of the Rozelle Rail Yards and 150 metres east of the Rozelle Rail Yards cross-cut the Hawkesbury Sandstone and Ashfield Shale. The dykes may affect tunnel drainage in the short term as competent (fresh) dykes or dykes weathered to clay can form natural hydraulic barriers. Alternatively the metamorphosed zone around the volcanic intrusion within the sandstone or shale can be fractured causing a conduit for preferred groundwater flow. Several dykes have been identified along the project footprint.

6.2.6 Management of groundwater inflows during operation

Groundwater inflows to the tunnel are influenced by the geology intersected and the water bearing structural features encountered. Once constructed, the drained tunnels would behave as longitudinal drains at atmospheric pressure, allowing groundwater leakage into the tunnels. Groundwater intersected during the operations phase would be the primary source of wastewater. The wastewater management system would be designed to treat and discharge groundwater as well as stormwater and other intersected water streams.

To reduce long term groundwater inflows, pre-excavation pressure grouting may be undertaken, for example, to allow groundwater inflows to be more easily managed. This technique is undertaken by drilling a pattern of holes in advance of the excavation to conduct packer tests and calculate the hydraulic conductivity. Grout is then injected at a pre-determined pressure to reduce the bulk rock mass permeability. The implementation of this technique is dependent upon the local geology, in particularly the orientation and density of water bearing rock defects.

Another option to reduce the bulk rock mass permeability and long term inflows is the installation of water proofing membranes during construction.

At the dive structures, ventilation shafts and cut-and-cover sections, groundwater flow within unconsolidated saturated sediments, fill, alluvium and weathered shale or sandstone would be restricted by the construction of diaphragm walls and cut-off walls founded in good quality Ashfield Shale or Hawkesbury Sandstone.

At the former Alexandria Landfill and quarry, water entering the former landfill is to be restricted by engineering solutions associated with the landfill rehabilitation. Rainfall infiltration into the former landfill is to be reduced by capping the landfill and directing captured rainfall runoff off-site. Groundwater flow into the landfill from the Botany Sands is to be restricted by the construction of a cut-off wall around the southern perimeter of the landfill as part of the New M5 project. This would locally reverse groundwater gradients away from the landfill and towards Alexandra Canal restoring pre-quarry hydrogeological flow conditions. Ongoing pumping would still be required to collect and treat leachate generated from within the landfill and the shale.

6.3 Groundwater level decline

6.3.1 Long term groundwater inflow

Previous tunnelling in the Hawkesbury Sandstone in the Sydney region has shown that groundwater inflow is typically highest during construction and then steadily reduces as the cone of drawdown expands and an equilibrium or steady state conditions are reached. This equilibrium is achieved when the tunnel inflow is matched by rainfall recharge via infiltration and/or surface water inflows. Long term groundwater inflows to the tunnels are influenced by the geology intersected (see **section 5.2**) and the tunnel construction method to reduce the bulk hydraulic conductivity. Long term groundwater inflow rates are expected to be lower than construction inflow rates. The reduction in long term inflow rates is due to the "cone" of drawdown depression expanding laterally at a rate that is proportional to the log of time. As the cone of depression expands further, the hydraulic gradients towards the tunnels reduce, and as inflow rates are directly proportional to the hydraulic gradient, inflow rates would decline. Water is derived from storage depletion but will be partly offset by recharge, both in the short term and long term.

Based on historical groundwater inflows to other drained Sydney tunnels, the long term inflow rate into the M4-M5 Link tunnels is expected to be below the one litre per second per kilometre for any kilometre tunnel length. Specific zones capable of higher rates of inflow identified during construction would require treatment such as grouting to reduce the bulk permeability of the rock mass to reduce inflow rates to meet the design inflow criterion.

Groundwater modelling has calculated inflows for the construction and operations phases. At project opening (2023) tunnel inflows are estimated to be 441 megalitres per year, declining to 267 megalitres per year at the end of the model simulation in 2100. As observed in other Sydney tunnels, inflow is likely to decrease with time. This is primarily due to the groundwater levels drawing down and inducing flow towards the tunnels from an increasingly broader region, as the cone of depression expands over time. Inflows would also decline over time as groundwater pressures around the tunnel decline as the storages of higher inflow features are drained. Similarly, siltation, chemical induration and organic slimes that accumulate in the tunnel defects may reduce the surrounding rock mass permeability, further reducing inflows.

Groundwater modelling assumes that the overall groundwater inflow for the project would achieve less than one litre per second per kilometre for any kilometre length of tunnel, and would be substantially less in some tunnel sections post grouting. Groundwater inflow is dependent upon the final construction methodology and water proofing solutions determined during detailed design. Tunnel inflows would be monitored in accordance with an Operational Environmental Management Plan (OEMP). The OEMP would outline the monitoring and management measures for groundwater inflows, treatment, discharge and settlement.

The regional impact of the project to the Zone 2 Botany Sands Management Zone for long term groundwater inflow (or 'take') has been estimated by the groundwater model. The Ashfield Shale is present in the areas where the New M5 project tunnelling occurs in the vicinity of the Botany Sands (at St Peters interchange) which, combined with the high hydraulic conductivity and rainfall recharge in the Botany Sands, appears to minimise the propagation of drawdown. This in turn indicates there is a negligible change in natural groundwater flow direction within the Botany Sands as a result of the project, therefore groundwater take from the Botany Sands aquifer due to tunnelling for the M4-M5 Link is minimal. Estimates of the groundwater 'take' from the Botany Sands due to tunnel inflows range from 1.7 kilolitres per day (year 2023) to 7.6 kilolitres per day (year 2100) or up to 2.8 megalitres per year (year 2100). Annual rainfall recharge to the Botany Sands Aquifer is 30,424 megalitres (NoW 2011). Consequently the groundwater 'take' due to long term groundwater inflow to the M4-M5 Link tunnels represents 0.009 per cent of the annual recharge within the Botany Sands aquifer, indicating the take would be negligible.

6.3.2 Predicted groundwater drawdown

Construction of drained tunnels beneath the water table is expected to cause long term ongoing groundwater inflow to the tunnels, inducing groundwater drawdown along the project footprint during its operation.

There are two main mechanisms that influence groundwater drawdown: the actual water table drawdown and the hydraulic pressure drawdown. Actual groundwater drawdown of the water table would be dependent on a number of factors including hydraulic parameters and proximity to the project footprint. Immediately after tunnelling is completed, groundwater inflows would be at their highest. With time, groundwater inflow to the tunnel would decrease while the water table would gradually decline until equilibrium is reached. In zones where the inflow rates are likely to exceed one litre per second per kilometre for any kilometre length of tunnel, the fractured lithology would be pre-treated or have waterproof membranes installed to reduce permeability during construction to reduce on-going groundwater inflow and drawdown in operation.

Since the Hawkesbury Sandstone is interbedded with shale lenses that locally act as aquicludes or aquitards, groundwater movement is restricted.

Groundwater drawdown within the palaeochannels and river alluvium within the project footprint would be minimal or not likely to occur as the hydraulic heads within saturated sediments are maintained by direct hydraulic continuity with surface water, supported by a reduction in stream baseflow (refer to **section 6.3.5**).

The predicted drawdown at the various creeks varies depending on local geology, horizontal distance from the tunnel, depth to the tunnel and tunnel design. The tunnels have been designed so there would be no direct inflow from the alluvium into the tunnels. This would be achieved by:

- Tanking the tunnels where the alluvium is intersected, such as beneath the Rozelle Rail Yards
- Designing the tunnels to dive beneath the alluvium, such as at Hawthorne Canal
- Constructing cut-off walls where the portals and cut-and-cover sections intersect alluvium, such as at Haberfield.

Drawdown within the alluvium is variable as it is dependent on a number of factors including leakage to the underlying Hawkesbury Sandstone, rainfall recharge and surface water interaction.

Groundwater drawdown due to the M4-M5 Link has been calculated by subtracting the results of modelling Scenario 3 (M5 East, M4 East, New M5 and M4-M5 Link) from Scenario 2 (M5 East, M4 East and New M5). Calculated long term (Year 2100) drawdown for the project is presented in **Figure 6-1**. The drawdown in **Figure 6-1** is the total drawdown for all three aquifers. Predicted drawdown for each individual aquifer including the alluvium and Botany Sands, Ashfield Shale and Hawkesbury Sandstone is presented in in **Figure 6-2**, **Figure 6-3** and **Figure 6-4** respectively. Within **Figure 6-3** the Ashfield Shale drawdown is presented from the top of the shale extending into the underlying Hawkesbury Sandstone to show the full extent of the drawdown in the bedrock.

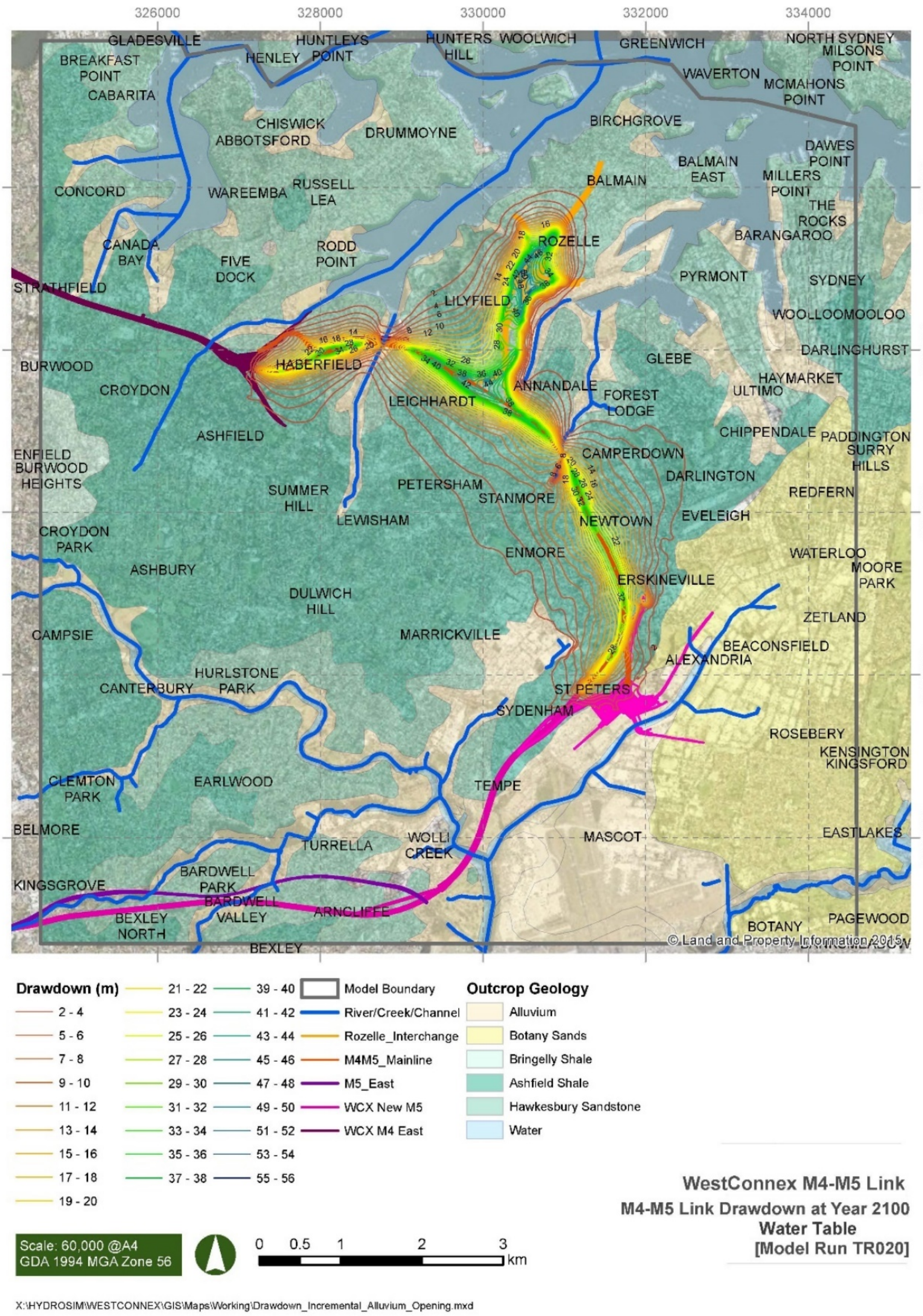


Figure 6-1 Predicted drawdown during operations for the project (Year 2100) (from HydroSimulations 2017)

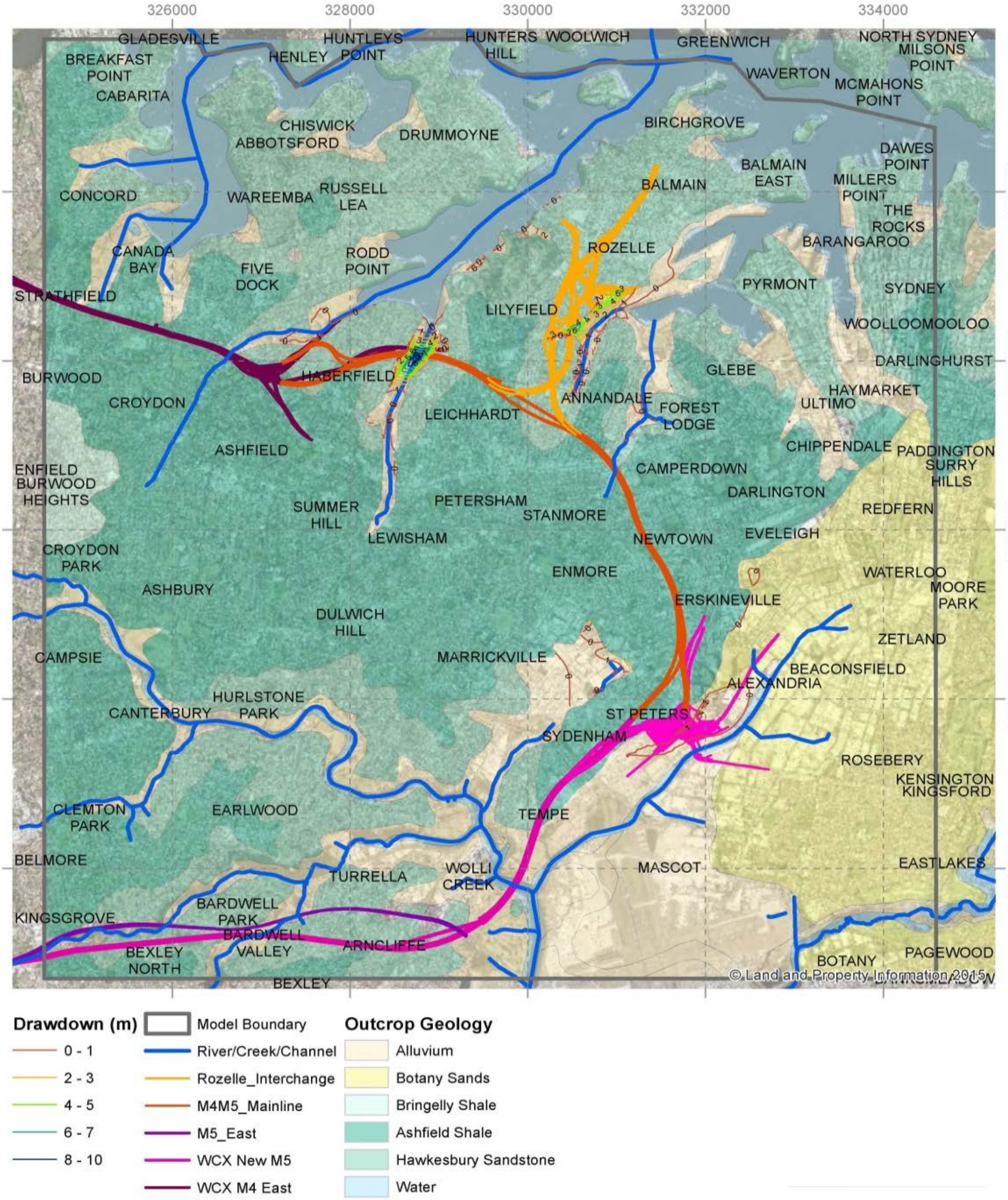


Figure 6-2 Predicted drawdown in the alluvium during operations for the project (Year 2100) (from HydroSimulations 2017)

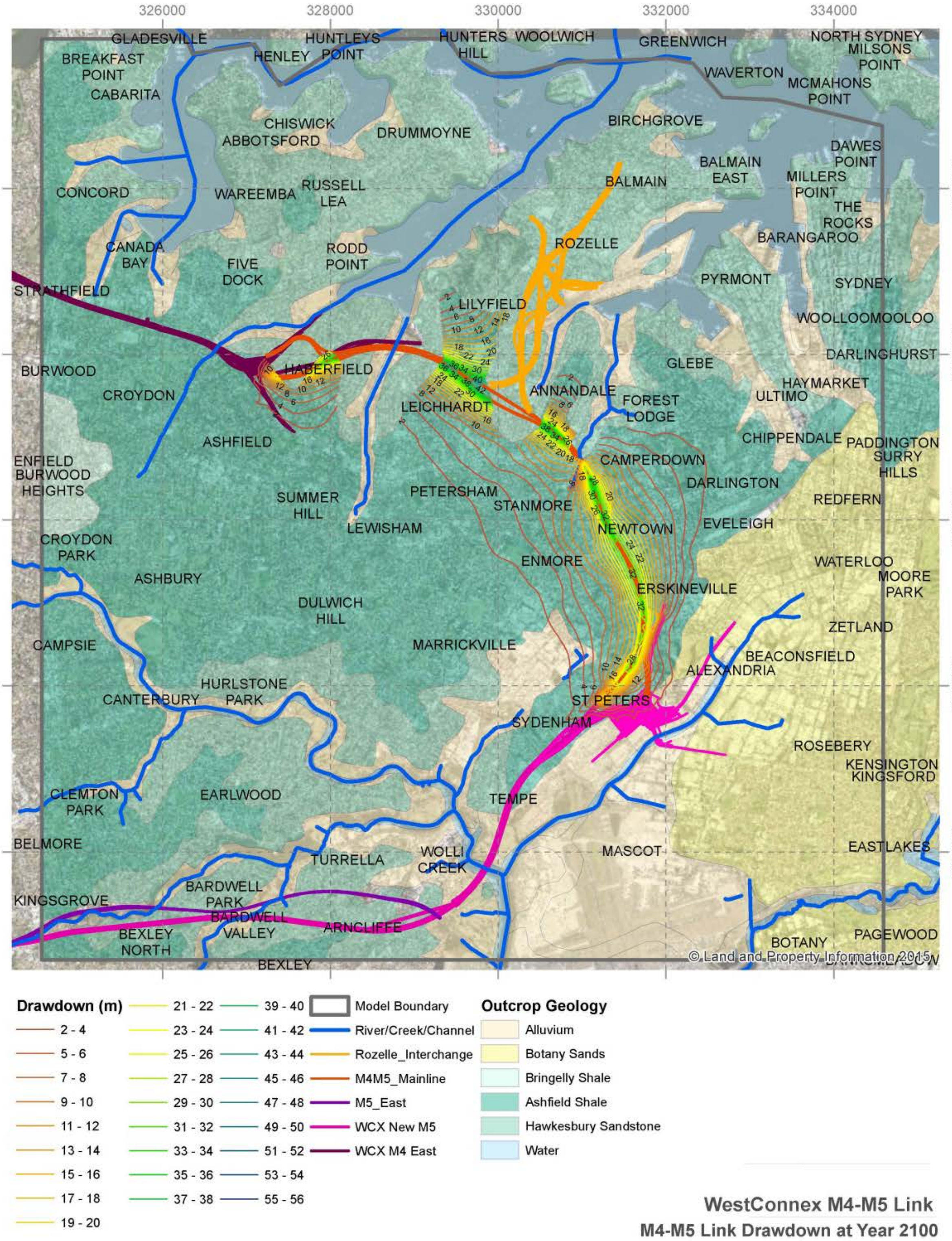


Figure 6-3 **Predicted groundwater drawdown in the Ashfield Shale during operations for the project (Year 2100) (from HydroSimulations 2017)**

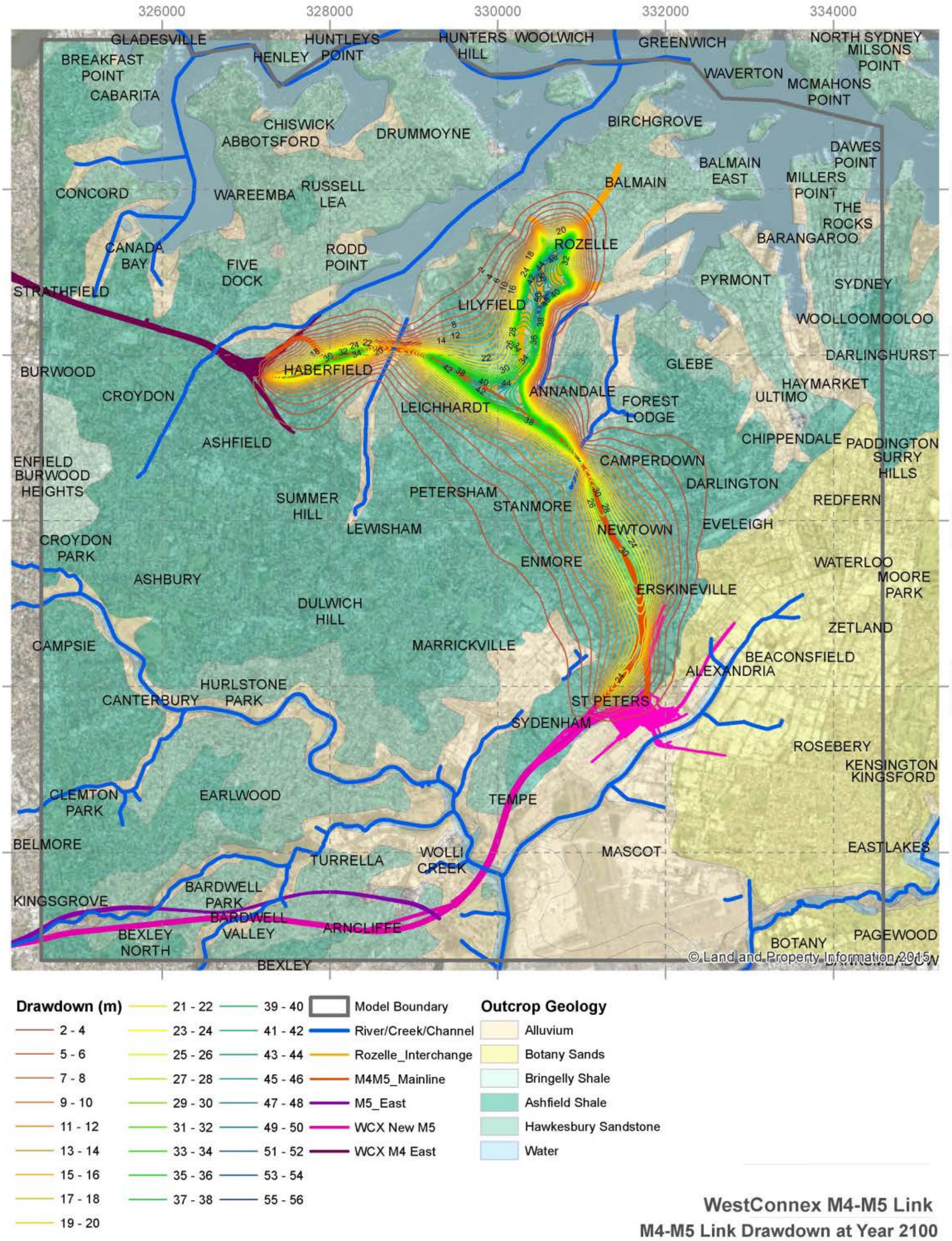


Figure 6-4 Predicted groundwater drawdown in the Hawkesbury Sandstone during operations for the project in (Year 2100) (from HydroSimulations 2017)

It is noted that although the tunnels constructed within the alluvium are proposed to be tanked, groundwater is predicted to leak from the alluvium into the underlying sandstone resulting in a decline in the water table within the alluvium. When there is insufficient rainfall recharge or surface water inflows, at locations where the alluvium is shallow, the alluvium may be drawn down due to the induced tunnel leakage.

Long term drawdown (Year 2100) within the Ashfield Shale (see **Figure 6-3**) and Hawkesbury Sandstone (see **Figure 6-4**) extends to the tunnel invert and continues to spread laterally over time. Predicted drawdown in the Hawkesbury Sandstone at Rozelle is a maximum depth of 55 metres, extending laterally 1.4 kilometres either side of the tunnel to the two metre drawdown contour. Similarly near St Peters interchange within the Ashfield Shale groundwater is predicted to be drawdown to the tunnel invert to a depth of 44 metres and extending laterally extending laterally 0.5 kilometres either side of the tunnel to the two metre drawdown contour. The reduction is the lateral extend of drawdown within the Ashfield Shale in comparison to the Hawkesbury Sandstone is consistent with the sandstone being more permeable than the shale.

Groundwater levels would be monitored periodically during the operations phase in accordance with OEMP. Additional groundwater monitoring wells are likely to be required once the tunnels are constructed and some would be located directly over the project footprint to monitor the groundwater levels/pressures. Long term groundwater levels/pressures would also be measured by the installation of vibrating wire piezometers (VWP) which would allow for the measurement of pore pressures at various depths. It is recommended that at one selected location both a standpipe monitoring well and VWP well are constructed to allow for the comparison of groundwater levels and pore pressures.

6.3.3 Potential impacts on groundwater dependent ecosystems

There are no priority GDEs identified within the Greater Metropolitan Water Sharing Plan within five kilometres of the project footprint. The closest priority GDEs are the Botany Wetlands and Lachlan Swamps within the Botany Sands, located at Centennial Park, around five kilometres east of the project footprint. These wetlands are at a sufficient distance from the project footprint not to be impacted by the project. Potential impacts on these wetlands and GDEs due to the New M5 project were assessed in the New M5 EIS.

Consequently, no priority GDEs are likely to be impacted by groundwater level decline associated with the long term impacts of the project. The closest priority GDEs are the Botany Wetlands and Lachlan Swamps within the Botany Sands, located in Centennial Park around five kilometres east of the project footprint. These wetlands are at a sufficient distance from the project footprint to not be impacted by the project.

Long term dewatering caused by tunnel drainage could lower the water table and potentiometric heads within the Hawkesbury Sandstone, reducing the amount of groundwater available for shallow rooted plants. The minimum depth of the water table underlying the majority of the project footprint is on average two metres below ground surface. Areas where the water table is shallow, such as at the Rozelle Rail Yards, are typically subjected to periodic flood inundation which would provide water for shallow rooted plants that may have some groundwater dependence. At other more elevated topographic areas such as Rozelle, Leichhardt and Newtown the water table is much deeper below ground surface and consequently flora is unlikely to be dependent on groundwater.

Post tunnel construction, groundwater would be available for partially groundwater dependent flora as the vadose (unsaturated) zone would not be affected by the project as it would continue to receive rain infiltration. Shallow perched water over shale lenses (recharged by rainfall) are present along the eastern and southern parts of the project footprint at St Peters and Alexandria. The perched groundwater could partially sustain surface ecosystems, if any exist, however they would be mainly dependent upon rainfall recharge and moisture within the vadose zone. In low lying areas, the project is not expected to change availability of water for plants due to the low permeability of the clayey soils in combination with frequent rainfall events and higher recharge than elevated sites.

An assessment of the impacts to natural processes as a result of the operational discharges which may affect the health of the fluvial, riparian and estuarine systems and landscape health within the study area is provided in **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS. These natural processes are outlined in **section 4.4**. In summary, no wetlands, marine waters or natural floodplain systems are considered to be affected by the project.

6.3.4 Potential impacts on existing groundwater users

Existing groundwater use and extraction is outlined in **section 4.10.1**. Long term tunnel drainage could impact existing groundwater users registered with DPI-Water. A review of the DPI-Water groundwater database indicates that of the registered bores within two kilometres of the project footprint, the majority are registered as monitoring wells. Only five bores are registered for water supply or irrigation. Of these five wells, four are domestic wells and the fifth is registered for irrigation. Two of the domestic wells are located within the Botany Sands and are no longer permitted to be used for domestic purposes due to embargos imposed by DPI-Water.

Groundwater modelling has been used to predict drawdown at the location of registered bores across the project footprint. Only one bore (GW110247) located in the Sydney University grounds, registered for domestic use, is predicted to have a drawdown in excess of two metres that is directly attributable to the M4-M5 Link project. This bore is predicted to have a drawdown of about 2.4 metres to the piezometric head in the Hawkesbury Sandstone by the end of the long term simulation in the year 2100. Given the standing water level is recorded as 31 metres below ground level and the bore is 210 metres deep, the drawdown is likely to have a negligible impact on the bore capacity however the drawdown in excess of two metres triggers 'make good provisions' in accordance with the AIP. The capture analysis predicts that in 2100 the impact on water quality in GW110247 due to saltwater intrusion would be negligible since the bore is at least two kilometres from the nearest salt waterbody at Rozelle Bay and predicted saline water travel times are in excess of 1,000 years.

6.3.5 Potential impacts on baseflow

Within the Hawkesbury Sandstone and to a lesser extent the Ashfield Shale, saturated secondary structural features can be hydraulically connected to the creeks and canals or their associated alluvium providing a pathway for surface water to seep into the tunnels.

Losses to stream flows can occur either as a reduction in baseflow, or as streambed leakage from the creeks and canals, and are dependent on the hydraulic connection between the stream channel and alluvium, the underlying sandstone or shale, and the relative water levels of the creek and groundwater. Baseflow to creeks occurs only when the water table elevation is above the creek bed allowing groundwater to flow to the creek. Conversely stream bed leakage occurs when the water table elevation is below the creek bed level and groundwater seeps into the underlying lithologies. The concrete lining of creeks reduces stream bed leakage and baseflow.

Predicted impacts on baseflow of major non-tidal creeks within the project footprint during the operations phase has been modelled (**Annexure H**). Baseflow, as simulated in the model, only represents the occasions when groundwater reaches the ground surface or the streambed and enters the drainage system. Predicted long term changes in baseflow as a result of the project are summarised in **Table 6-1**.

Although the baseflow component of river flow is reduced in several of the water courses, the volumes are small and it is possible that the overall contribution to river flow from groundwater input is even smaller due to the rivers being mostly lined channels. It has not been possible to quantify the proportion of stream flow that is baseflow due to the lack of gauging data, however it is likely that the majority of stream flow would be derived from stormwater runoff. The reduction in baseflow in Whites Creek and Hawthorne Canal are higher due to the creek morphology. Base flow in the model occurs when groundwater reaches ground surface and enters the channel are higher. Hence the occasions when groundwater reaches the ground surface at Iron Cove Creek and Johnstons Creek are limited.

Table 6-2 Predicted long term changes in baseflow

January 2100	Hawthorne Canal	Dobroyd Canal (Iron Cove Creek)	Whites Creek	Johnstons Creek
Existing base flow (m^3/day)	291	274	174	282
Reduction in baseflow (m^3/day)	136	20	145	79
% Reduction	**47**	**7**	**83**	**28**

A water quality objective outlined in **Chapter 15** (Soil and water quality) of the EIS is to “maintain groundwater within natural levels and variability that are critical to surface flows and ecosystems of the upper estuary” in the Sydney Harbour and Parramatta River Catchment. The long term drawdown due to tunnel inflows has been modelled and the groundwater drawdown contours are presented in **Figure 6-2**, **Figure 6-3** and **Figure 6-4** for the alluvium, Ashfield Shale and Hawkesbury Sandstone respectively. These figures show that groundwater drawdown will not extend as far to the north as Rozelle Bay so consequently the natural variability of groundwater levels adjacent to Sydney Harbour and the Parramatta estuary would not be impacted by the project. Groundwater modelling has predicted varying decreases in creek base flow, however under current conditions these creeks are concrete lined, restricting groundwater entering the surface water flow during high flow conditions. Thus it is expected that these reductions in base flow will not substantially impact the ecosystems of the upper estuary catchment. If sections of these creeks are naturalised, groundwater recharge will be enhanced increasing the groundwater component available for surface water availability.

Long term, the baseflow to major non-tidal creeks is predicted to be reduced by between seven and 83 per cent. Although the predicted percentage reduction in baseflow in Hawthorne Canal and Whites Creek is substantial, this reduction represents a small reduction in stream flow since baseflow as simulated in the model only represents the occasions when the groundwater reaches ground level and enters the channels. There is no impact predicted on the baseflow of other major creeks along the New M5 corridor including Cooks River, Wolli Creek and Bardwell Creek due to the M4-M5 Link project. It is expected that the majority of stream flow would be derived from rainfall runoff and tidal inflow.

Sydney Water is proposing to naturalise parts of creek channels within the project footprint, including sections of Whites Creek, Johnstons Creek in Annandale and Iron Cove Creek in Haberfield. Removal of sections of the concrete-lined base would allow more groundwater and surface water interaction leading to a higher contribution of baseflow to surface water flow in the creeks. Hence the impact of a reduction in baseflow due to the project and a reduction in hydraulic heads would be in part balanced by the proposed naturalisation works resulting in future additional surface water recharge via bed leakage when the water table is below the creek bed.

No permanent springs that contribute to surface flow or river baseflow have been identified within the project footprint. Intermittent springs have been reported to occur within the Hawkesbury Sandstone in the Rozelle and Lilyfield area following prolonged periods of rainfall. These springs are not known to support any ecosystems but instead tend to cause problematic water flows within the urban area sometimes inundating basements or back yards.

6.3.6 Ground settlement

Residual soil profiles developed on the weathered sandstone and shale bedrock are typically relatively thin, stiff and of low compressibility and as such would be less susceptible to ground settlement from groundwater drawdown. The risks associated with water table drawdown within the alluvium beneath the Rozelle Rail Yards and associated dewatering induced settlement is dependent upon the amount of groundwater drawdown within the alluvium and the geotechnical properties of the soil. Settlement caused directly by tunnelling occurs within days of the tunnel opening and is localised whereas groundwater induced drawdown is typically spread over a large area and can take years to occur. The tunnels have been designed to reduce groundwater drawdown within the unconsolidated sediments by constructing tanked (undrained) tunnel sections through the alluvium which would also minimise settlement in these areas.

A geotechnical model of representative geological and groundwater conditions would be prepared by the construction contractor during the detailed design phase prior to and the commencement of tunnelling. The model would be used to assess predicted settlement impacts and ground movement during the construction and operation of the project.

Environmental management measures to control groundwater inflows (which influence groundwater drawdown and therefore ground movement) during the operation of the project are outlined in **section 8.2.**

As with construction, settlement monitoring would be undertaken during operation at properties and infrastructure where exceedances of the settlement criteria are predicted. Settlement monitoring may include the installation of settlement markers or inclinometers. In the event that settlement criteria are exceeded during operation for property and infrastructure, measures would be taken to ‘make good’ the impact. These measures would be included as part of the OEMP.

Further details regarding settlement are provided in **Chapter 12** (Land use and property) of the EIS.

6.4 Groundwater quality

6.4.1 Intercepting contaminated groundwater

There is a risk that contaminated groundwater along the project footprint (such as a hydrocarbon plume emanating from a former service station or industrial site, for example) could be intercepted during operation of the project, as groundwater is induced to flow towards the tunnel. Altered groundwater flow paths due to the tunnels construction and hydraulic gradient changes may locally cause existing contaminant plumes (if present) to migrate towards the project footprint. During the operational phase these risks would be managed as outlined in **section 8.2**.

Leachate and elevated concentrations of ammonia are generated at the former Alexandria Landfill. The risk of contaminated groundwater entering the M4-M5 Link tunnels from leachate derived from the former landfill is considered low, since groundwater flow would be directed away from the M4-M5 Link tunnel due to the ongoing leachate pumping system to be operated as part of the New M5 project. Pumping the leachate would locally reverse groundwater gradients creating an internal flow network centred on the sump in the former landfill, minimising the risk of leachate migration to the M4-M5 Link tunnel. Leachate generation was further reduced by constructing a capping layer across the former landfill to reduce rainfall infiltration. In the New M5 EIS (Roads and Maritime 2015) a secondary leachate pump at the former landfill was additionally recommended to reduce the risk of leachate migration towards the New M5 and M4-M5 Link tunnels in the event of a mechanical breakdown or during periods of maintenance. Groundwater contamination at the former Alexandria Landfill at St Peters is to be managed as part of the New M5 project.

Contamination generated within the M4-M5 Link tunnels during operations is unlikely to impact the local hydrogeological regime as groundwater gradients are towards the tunnel. The contamination would be captured within the tunnel drainage system and removed during the water treatment process prior to discharge.

At the Rozelle Rail Yards, there is a risk that the groundwater within the alluvium is contaminated from a variety of previous industrial activities. The risk of intersecting shallow contaminated groundwater during operation of the project is considered to be low because the tunnels intersecting the alluvium are to be tanked. However there may be hydraulic connection between the Hawkesbury Sandstone and alluvium, through which potentially contaminated groundwater could enter the unlined section of the tunnel. Also at Rozelle Rail Yards there is potential for contaminated groundwater to recharge surface water. This may occur after high rainfall events cause shallow groundwater levels to reach the ground surface that has been impacted by legacy contamination. To reduce recharge and the risk of mobilising legacy contamination at the Rozelle Rail Yards a number of mitigation measures are to be put in place including removing some of the contamination during site works, improving groundwater quality by managing the legacy groundwater contamination by the installation of additional drainage and capping the surface to reduce rainfall infiltration. Lowering the water table within the alluvium at Rozelle will reduce the risk of groundwater intersecting point source contamination.

Groundwater from the Botany Sands aquifer has potential to enter the tunnel through hydraulic connection with the Ashfield Shale and Hawkesbury Sandstone. At Alexandria however the capture zone analysis undertaken as part of the groundwater modelling indicates the Botany Sands would not be a dominant long term source of water to the tunnels. Groundwater from the Botany Sands near Alexandria has the potential to be contaminated but the groundwater entering the tunnel would be treated prior to discharge.

Captured contaminated groundwater through tunnel inflows will be treated in water treatment plants in water treatment plants proposed at Rozelle and Darley Road at Leichhardt in accordance with the discharge criteria. Groundwater quality of tunnel inflows would be monitored throughout the operation phase in accordance with the OEMP to detect changes in water quality and treat as needed.

6.4.2 Groundwater treatment

Treated flows from the Rozelle water treatment plant would drain via a constructed wetland to Rozelle Bay. Treated flows from the Darley Road water treatment plant would be discharged to Hawthorne Canal. A small portion (around 1.6 kilometres) of the M4–M5 Link tunnel would also drain to the New M5 operational water treatment plant at Arncliffe.

Groundwater monitoring (see **section 4.13**) indicates the groundwater is brackish with elevated metals and nutrients recorded during groundwater sampling. Metal, nutrient and ammonia loading to Hawthorne Canal and Rozelle Bay is likely to increase as a result of the continuous treated groundwater discharges. In order to prevent adverse impacts on downstream water quality within Rozelle Bay and Hawthorne Canal, treatment facilities would be designed so that the effluent would be of suitable quality for discharge to the receiving environment.

The operation water treatment plant at Rozelle and Darley Road would treat iron and manganese. The proposed constructed wetland at Rozelle would provide 'polishing' treatment to the treated groundwater flows removing a proportion of the nutrient and metal load. As no constructed wetland is proposed at Darley Road, opportunities to incorporate other forms of nutrient treatment (for example ion exchange or reverse osmosis) within the plant at Darley Road would be investigated during detailed design with consideration to other factors such as available space, increased power requirements and increased waste production.

With consideration to groundwater quality, receiving water quality and proposed treatment the concentration of the key constituents in the treated discharge to Rozelle Bay are unlikely to be significantly higher than the baseline concentration of the constituents in Rozelle Bay. Due to the mixing and dilution affect which would occur at the outlet to the receiving waters, impacts on ambient water quality are likely to be negligible and localised to near the outlet.

The tunnel operation water treatment facilities would be designed such that effluent will be of suitable quality for discharge to the receiving environment. Thus the ANZECC (2000) marine' default trigger values for 95 per cent level of species protection are considered the most appropriate guideline with reference to the NSW Water Quality Objectives. The 99 per cent protection level would apply to analytes that bio-accumulate such as heavy metals. Details of the adopted guideline values are provided in **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS.

6.4.3 Saltwater intrusion

Saltwater intrusion would commence as soon as the hydraulic pressure within the aquifer declines due to groundwater drawdown via the tunnels causing the displacement of fresher water along the shoreline with more saline tidal water. In some locations, saline intrusion could cause saline water to reach the tunnels.

A capture zone analysis has been undertaken as part of the groundwater modelling to investigate tunnel catchment areas. From this analysis it is not possible to quantify volumes or concentrations of saline water entering the tunnels so consequently the following discussion is qualitative. Backward particle tracking analysis has been used via MODPATH3DU to determine the capture zone of the tunnels during operation and the potential for water to be drawn from the tidal regions into the tunnels. The calculated travel time is sensitive to the porosity applied in the model so total porosity values, obtained during the field program (**Annexure G**), were used to generate values of effective porosity.

The capture zone analysis indicates that groundwater from the tidal zones associated with Sydney Harbour and the Parramatta River would enter the project tunnels at the proposed Rozelle interchange. Similarly groundwater from the alluvium associated with the Cooks River would enter the project tunnels near the St Peters interchange. As groundwater levels are drawn down below sea level, saline waters from tidal water bodies would start flowing towards the tunnels, and would ultimately enter the tunnels via hydraulic connection with the alluvium.

Travel times for tidal water to enter the tunnels have been computed by the groundwater model and the average timeframes range from 13 years (Rozelle interchange from Whites Creek) to in excess of 1,000 years (mainline tunnel from Parramatta River and Botany Sands at St Peters interchange).

Early saline inflows would occur when water in the alluvium directly above and adjacent to the proposed tunnels rapidly drain into the tunnels. Initially, the saline water would be a small fraction of total groundwater entering the tunnel but this is expected to increase over time as water is drawn from further afield, although it will always be a minor component of total inflow.

Even though at Rozelle interchange for example the first saline groundwater is modelled to enter the interchange after year 13, this represents an extremely small inflow which will slowly become a larger proportion of flow over time. Thus groundwater quality in the tunnel catchment zones would slowly become more saline over thousands of years. Since the operational lifetime for major infrastructure is in the order of 100 years the slow salinity increase should have minimal impacts on the tunnels, infrastructure and the environment in the short term. Similarly there is the potential to increase the salinity in registered bores due to saltwater intrusion however the slow progress is expected to have a minimal impact on these bores over a period of 100 years as the registered bores are a considerable distance from Rozelle Bay.

Under natural conditions within the Hawkesbury Sandstone, a low salinity water lens towards the top of the aquifer is often present, unless there is nearby leakage from the typically more saline Ashfield Shale. Shallow rooted plants may have a partial dependency on the low salinity groundwater lens however it is expected that the plants would be sustained primarily through rainfall recharge and soil moisture within the vadose zone. In a coastal environment the relationship between the depth of the fresh/saltwater interface is defined by the Ghyben-Herzberg Principle which is dependent upon water density contrast and thickness of fresh groundwater above sea level. In summary, the Principle indicates that for every metre of freshwater in an unconfined aquifer above sea level there would be 40 metres of fresh water in the aquifer below sea level. Thus as groundwater levels decrease over time so would the fresh water lens decrease but would be in part balanced by rainfall recharge.

In accordance with the OEMP, groundwater quality and inflow would be routinely monitored and treated as required prior to discharge.

6.4.4 Groundwater aggressivity

Tunnel infrastructure including the construction of interchanges, installation of water proofing, drains and tanked sections would be mostly located below the water table and the building materials would be subjected to corrosion due to interaction with groundwater. There are a number of factors that contribute to corrosion, which are related to groundwater aggressivity and include chloride, sulfate, pH and resistivity. The presence of dissolved chloride and sulfate in groundwater is one of the main factors contributing to corrosion potential of concrete and steel.

The aggressivity assessment (see **section 4.13.6**) indicates that groundwater within the Ashfield Shale is non aggressive with respect to average chloride, pH and sulfate for concrete piles. For steel piles groundwater within the Ashfield Shale is non aggressive with respect to average chloride and pH, however the groundwater is moderately aggressive with respect to resistivity. Similarly groundwater within the Hawkesbury Sandstone indicates the groundwater is mildly aggressive to concrete piles with respect to average chloride, pH and sulfate. For steel piles groundwater within the Hawkesbury Sandstone is mildly aggressive to steel piles with respect to average chloride, pH but is severely aggressive with respect to resistivity.

6.4.5 Groundwater monitoring

The groundwater monitoring program prepared and implemented during construction (see **section 5.5.7**) would be augmented and continued during the operational phase. Groundwater would be monitored during the operations phase for three years or as otherwise required by the project conditions of approval and would include trigger levels for response or remedial action based on monitoring results and relevant performance criteria.

At least three monitoring wells and VWPs should be constructed as close as possible to the tunnel centrelines to allow for the comparison of pore pressures and standing water levels. The wells could be constructed about five to ten metres above the top of the tunnel crown to allow for groundwater drawdown monitoring in the Hawkesbury Sandstone.

The exact nature and frequency of the ongoing groundwater monitoring during operation would be determined by the project operator. The operational groundwater monitoring program would be developed in consultation with the NSW EPA, DPI-Fisheries, DPI-Water and the Inner West and City of Sydney councils and documented in the OEMP or EMS.

6.5 Impacts due to ancillary facilities and infrastructure

Ancillary infrastructure constructed to support the project is outlined in **section 5.6**. The following ancillary infrastructure may impact groundwater during operation of the project:

- Tunnel portals
- Ventilation tunnels and systems
- Water treatment facilities
- Utility adjustments
- Drainage channels and wetland areas.

Options for the construction of tunnel portals and cut-and-cover structures include secant piled walls or diaphragm walls socketed into the underlying bedrock to prevent the long term ingress of alluvial or perched groundwater into the tunnels. The construction of these structures would potentially alter local groundwater flow directions and could create groundwater mounding if the structures behave as barriers to groundwater flow. Mitigation measures such as the installation of drainage blankets to direct groundwater around these barriers would be explored during the detailed design phase. These impacts are discussed further in **section 6.6** and potential impacts to the final landform are discussed in **section 6.7**.

Ventilation tunnels are likely to be constructed as drained tunnels. This infrastructure has been included in the groundwater model so consequently long term impacts, such as groundwater drawdown and groundwater ingress due to tunnel seepage, is considered in the model discussions. Impacts to the hydrogeological regime due to additional drained tunnels are likely to slightly increase groundwater inflows and the lateral extent of groundwater drawdown.

The water treatment facilities are to be constructed to enable captured groundwater and surface water that enters the tunnels to be treated and discharged within the appropriate guideline concentration values. The water treatment plant is not expected to impact groundwater since it will be above ground level and have no interaction with the water table. Utility corridors, drainage channels and wetland areas are unlikely to be constructed at a depth to impact groundwater. Potential impacts due to discharge are discussed in **Appendix Q** (Technical working paper: Surface water and flooding) of the EIS.

6.6 Barriers to groundwater flow

Below ground infrastructure such as a tunnel below the water table can create physical barriers causing temporary or permanent interruptions to groundwater flow. Temporary impacts may occur after heavy rainfall, with infiltration to the water table and lateral flow being slowed due to the barrier, creating a groundwater mound behind the barrier. Permanent impacts may be caused by the compartmentalisation of an aquifer caused by the construction of a barrier boundary impacting groundwater flow patterns.

In the case of the operation of the tunnels, there are unlikely to be physical barriers to groundwater flow created for a number of reasons. Firstly the majority of the tunnels are designed to be drained, allowing groundwater to seep into the tunnel and thus not creating a physical barrier to groundwater flow. Secondly, only limited sections of the tunnels are to be undrained (tanked), and not allowing groundwater ingress. These sections of the tunnels are to be constructed within alluvium and are unlikely to create a physical barrier as the tunnels would not fully penetrate the alluvium allowing groundwater to flow around (above or below) the tunnel. Grouting of highly permeable zones to reduce the bulk hydraulic conductivity and tunnel inflows are unlikely to create hydraulic barriers to regional flow, as the grouting would be localised and not applied through the full thickness of the aquifer, thus allowing groundwater to continue to flow through the ungrouted part of the aquifer.

Although the proposed M4-M5 Link project tunnels are unlikely to create physical barriers, drained tunnels may create hydraulic barriers impacting local groundwater flow patterns. The hydraulic barrier is formed by the lowering of groundwater levels centred on the project footprint and in some cases as a result of locally reversing the groundwater flow direction. Permanent drawdown around the drained tunnels for the M4-M5 Link project is likely to occur and the impacts are discussed in **sections 5.4** and **6.3**. The creation of this groundwater sink would occur along the project footprint and extend to a depth beneath the tunnel invert. Below this depth, there will be no discernible lowering of groundwater pressures and the groundwater flow pattern would remain unchanged. The groundwater model prepared for the project has simulated the effects of the hydraulic barrier due to tunnel seepage, allowing potential impacts to be predicted.

At tunnel portals or cut-and-cover sections the potential interruption of groundwater and possible groundwater mounding caused by the installation of cut-off walls would be avoided by the inclusion of drainage blankets or drains in the detailed design. The installation of pumping equipment to periodically lower groundwater levels or to reduce hydrostatic pressures would not be recommended due to continued maintenance requirements.

6.7 Impact to the final landform

The primary impact on the final landform is likely to be due to groundwater drawdown in the alluvium, Botany Sands and bedrock aquifers. Drawdown in the unconsolidated alluvial sediments and Botany Sands could result in ground settlement, which is discussed in **Chapter 12** (Land use and property) of the EIS. Groundwater drawdown in the Hawkesbury Sandstone at Rozelle interchange and other areas along the alignment is unlikely to cause substantial settlement due to the competent nature and the geotechnical properties of the sandstone. Ongoing groundwater inflow near tidal surface water features may cause localised saltwater intrusion over time, resulting in an increase in groundwater salinity.

Groundwater settlement within the alluvium is likely to be more substantial than the sandstone because of the unconsolidated complex lithology within the alluvium.

Induced groundwater drawdown may impact the environment or groundwater users. The environment may be impacted by reducing the base flow to creeks or restricting flow to high priority groundwater dependent ecosystems as discussed in **sections 6.3.5** and **6.3.3** respectively. Lowering potentiometric heads may result in a reduced registered bore capacity as described in **section 6.3.4.**

6.8 Groundwater management

Where higher long-term groundwater inflows into the proposed tunnels are identified during construction, these could be reduced by a combination of pre-grouting and the installation of waterproofing. However, because the proposed tunnels are designed as drained tunnels, with groundwater being captured, treated and discharged at the surface, the need for this measure is likely to be minimal. Strip drains or similar would be installed behind wall panels to assist in dissipating groundwater. Tunnel drainage and treatment infrastructure would be designed to accommodate groundwater ingress. Separate sumps would be provided at tunnel low points to collect tunnel drainage from groundwater ingress.

Groundwater would be pumped from the sumps to a water treatment plant at the Darley Road motorway operations complex (MOC1) at Leichhardt, with treated flows ultimately discharged to Hawthorne Canal and at the Rozelle East motorway operations complex (MOC3) with treated flows discharged to a constructed wetland within the Rozelle Rail Yards.

Groundwater seepage would flow into the drainage system and then via gravity to the sumps near the proposed water treatment plants at Darley Road motorway operations complex (MOC1) at Leichhardt, or at Rozelle East motorway operations complex (MOC3). The groundwater is to be pumped to the surface, treated and discharged to a constructed wetland and channel to Rozelle Bay. The beneficial reuse of the treated water would also be considered, the most likely reuse option being the irrigation of parks and playing fields, for example at the Rozelle Rail Yards. Groundwater reuse would be in accordance with DPI-Water policies for sustainable water use.

6.9 Groundwater balance

A groundwater balance for the long term operational phase (Year 2100) of the groundwater model has been conducted by HydroSimulations 2017. The water balance has been developed based on the transient model mass balance, averaged over the calibration period, and is summarised in **Table 6-3** is based on the water balance presented in the groundwater modelling report (**Annexure H**).

Table 6-3 Estimated water balance – operational phase

Water component	Inputs (recharge)	Output (discharge)
Unit	**ML/day**	**ML/day**
Rainfall infiltration	10.8	0.0
Evapotranspiration	0.0	1.61
River inflow/outflow	1.44	12.8
Tunnels (M4-M5 Link)	0.0	0.67
Pumping wells (Alexandria Landfill)	0.0	0.08
Regional Boundary Flow	24.6	21.1
Tidal Seepage	1.2	0.89
Storage	2.87	3.58
TOTAL	**40.9**	**40.7**

The transient water balance confirms that regional boundary flows and rainfall infiltration is the primary recharge parameter and the primary discharge parameters are river leakage and regional outflow. Throughout the transient calibration period, the average leakage into the tunnels (M5 East, M4 East, New M5 and M4-M5 Link) is 0.8 litres per second. The total recharge and discharge components match within an acceptable margin of error, indicating that the water components of the model balance.

6.10 Climate change

The effects of climate change that may impact the groundwater regime are increased rainfall, increased rainfall intensity and sea level rises. The *Floodplain Risk Management Guideline - Practical Consideration of Climate Change* (DECC 2007) suggests values of sea level rises of 0.4 metre (Year 2050) and 0.9 metres (Year 2100). Similarly for the 200 year and 500 year average recurrence interval (ARI) rainfall intensities are predicted to represent 10 per cent or 30 per cent increase in 2016 (present day) rainfall intensities, respectively.

Increased rainfall and rainfall intensity would ultimately add more water to the hydrogeological system beneath the project footprint via increased rainfall recharge. This would result in slightly more water available for tunnel inflows but conversely with additional recharge the effects of groundwater drawdown would be slightly reduced.

Increased sea level rises would alter hydraulic gradients slowing groundwater discharge and river base flow to the upper estuaries of the Parramatta River, Iron Cove and Rozelle Bay. The sea level rises would also alter groundwater salinity in tidal zones causing the displacement of low salinity groundwater up gradient with more saline water derived from tidal zones. No registered water supply bores have been identified in this tidal area that could become more saline. Any impacts to travel times for saline intrusion would be negligible.

Increased rainfall across the project footprint due to climate change would cause more freshwater recharge to the aquifers which may slightly increase groundwater quality although the impacts would be negligible.

The proposed impacts of climate change are expected to be minimal on the predicted outcomes due to the conservative nature of the modelling and model assumptions. Consequently the climate impact changes are not expected to alter the proposed mitigation and management measures.

7 Assessment of cumulative impacts

7.1 Requirement for an assessment of cumulative impacts

Cumulative impacts are those that act together with other impacts to affect the same resources or receptors in a way where the sum of the impacts is greater than the individual. Cumulative groundwater impacts can be related to groundwater extraction, groundwater drawdown, and groundwater quality.

Where drawdown occurs, for example, the drawdown cone of depression from a tunnel section may intersect with a drawdown cone from a neighbouring tunnel section or neighbouring activity such as the New M5, M4 East, Sydney Metro City and Southwest and the proposed future Western Harbour Tunnel and Beaches Link and F6 Extension. The cumulative effect of overlapping drawdown cones results in a greater overall total drawdown, which may increase impacts on groundwater dependent receptors in the areas of overlap. Similarly, cumulative effects to groundwater quality may occur where the groundwater has been impacted by previous or current land use practices and/or saltwater intrusion.

A cumulative impact assessment has been conducted as part of the groundwater modelling (**Annexure H**) on the local hydrogeological regime taking into account other relevant infrastructure including the New M5, M4 East tunnels and the existing M5 East tunnels. In addition the cumulative impacts of other projects including the Sydney Metro and southwest (focusing on the Chatswood to Sydenham section), the proposed future Western Harbour Tunnel Beaches Link and the F6 Extension have been qualitatively assessed. The proposed future Sydney Gateway project has not been included in the groundwater cumulative impact assessment because the updated road infrastructure is to be constructed along the ground surface and is unlikely to substantially impact groundwater.

7.2 Quantitative cumulative impact assessment for the WestConnex projects

The groundwater model (**Annexure H**) has been used to quantify cumulative impacts of the WestConnex projects on the hydrogeological regime. The modelling scenario runs were as follows:

- Scenario 1 – 'Null Run' (includes existing M5 East tunnel)
- Scenario 2 – 'Null Run' plus M4 East and New M5
- Scenario 3 – Scenario 2 plus the M4-M5 Link.

Scenario 3 represents the cumulative impact assessment scenario including 'Null' run plus the approved WestConnex projects (M4 East and New M5) and the proposed project (M4-M5 Link)

The groundwater model has been used to predict groundwater inflows to the WestConnex tunnels at the end of construction (Year 2023) and throughout the operations phase (to Year 2100) for the three scenarios. The maximum calculated inflow rates are summarised in **Table 7-1**.

Inflow rates are predicted to decline over time and by Year 2100 would have almost halved since the end of construction (Year 2023). The declining inflow rate over time indicates that the modelled recharge does not supply enough water to the system to maintain the initial flow rates. For the Null Run (Scenario 1) the maximum inflow is calculated as 0.45 megalitres per day in 2016 and is predicted to gradually decline over time with drawdown being spread from the nearby New M5 drained tunnels. Cumulative inflows for scenarios 2 and 3 peak at 2.2 megalitres per day in 2019 and 4.3 megalitres per day in 2021 respectively. The predicted tunnel inflows remain below the overall WestConnex tunnel inflow criterion of one litre per second per kilometre for any kilometre length of tunnel.

Table 7-1 Predicted maximum cumulative WestConnex tunnel inflows

Tunnel scenario	Combined tunnel length	Max inflow		
Units	(km)	Year	ML/day	L/sec/km
1.M5 East (pre project)	6	2016	0.45	0.86
2. M4-M5 Link (project) plus M5 East	32.5	2019	2.2	0.79
3. Project plus M4 East and New M5	74.15	2021	4.3	0.68
(3-2) M4-M5 Link (project)	39.83*	2021	2.55	0.71

Note:

* At this stage the drained ventilation tunnels are incomplete

Cumulative impacts during construction are impacts caused by the groundwater being extracted by the tunnelling process plus groundwater leakage into the WestConnex drained tunnels for the New M5 and M4 East. These potential impacts are an increased groundwater 'take', increased drawdown and a reduction in groundwater quality due to increased saltwater intrusion.

During construction, cumulative impacts on groundwater would be greatest at the extremities of the project near the St Peters interchange in the south for the New M5 overlap and the Wattle Street interchange in the north-west, where the M4-M5 Link project overlaps with the New M5. The consecutive construction period for these projects would extend over several years between 2016 and 2021. Cumulative impacts on groundwater drawdown are predicted to be localised to areas where the adjoining tunnels connect: at St Peters interchange and Wattle Street interchange. Once all WestConnex projects are operational, groundwater drawdown due to the cumulative impact of the three tunnel projects is not expected to be greater than in any one section of the overall project footprint.

At the St Peters interchange there will be influences to the groundwater levels due to on-going leachate extraction from the former Alexandria Landfill, depressing the local groundwater levels. Leachate production is to be reduced by the installation of a groundwater cut-off wall, capping of the former landfill which will be managed under a landfill closure plan.

Cumulative groundwater drawdown for the three WestConnex tunnel projects representing the total drawdown for the three aquifers is presented in **Figure 7-1.** Predicted drawdown for each individual aquifer including the alluvium, Ashfield Shale and Hawkesbury Sandstone in Year 2100 is presented in **Figure 7-2** to **Figure 7-4** respectively. Drawdown within the alluvium (**Figure 7-2**) is limited by the aquifer thickness with a maximum of seven metres predicted at the Rozelle interchange. Water table drawdown does not extend into the Botany Sands where higher hydraulic conductivity and recharge replenish any removal of water due to tunnel drainage.

Drawdown within the Ashfield Shale (see **Figure 7-3**) and Hawkesbury Sandstone (see **Figure 7-4**), at Year 2100 extends to the tunnel invert levels. Within the Ashfield Shale (see **Figure 7-3**) the drawdown is presented from the top of the shale extending into the underlying Hawkesbury Sandstone. Drawdown in the Ashfield Shale is predicted to be greatest at Sydenham where 44 metres of drawdown is predicted. Other deep areas of drawdown within the Ashfield Shale occur at St Peters, Strathfield and Haberfield. The largest lateral extent of groundwater drawdown within the Ashfield Shale extends 1400 metres from the project footprint to the 2 metres drawdown contour at Newtown and Enmore. Drawdown in the Hawkesbury Sandstone shows a more continuous pattern along the project footprint with the greatest drawdown predicted at Rozelle. Other deep areas of drawdown within the Hawkesbury Sandstone occur in the deepest parts of the New M5 at Arncliffe and at St Peters. The largest lateral extent of groundwater drawdown within the Hawkesbury Sandstone extends 1200 metres from the project footprint to the two metres drawdown contour at Camperdown and Petersham. The cumulative impact trends are similar to those predictions for the construction phase where drawdown does not extend much deeper, however the cumulative lateral drawdown extends further over time.

Cumulative groundwater drawdown has the potential to cause settlement. Settlement within the sandstone and shale is not expected to exceed the settlement criteria due to the geotechnical properties of these geological formations. Settlement within the Botany Sands aquifer is not expected since groundwater modelling has predicted the water level would not decline as a result of groundwater ingress to the tunnels. Beneath the Rozelle Rail Yards additional settlement due to cumulative impacts are not expected since none of the neighbouring projects are likely to extract any additional groundwater from the alluvium. Localised groundwater modelling in the Rozelle area would be undertaken to support a detailed settlement analysis. This would be undertaken during the detailed design phase.

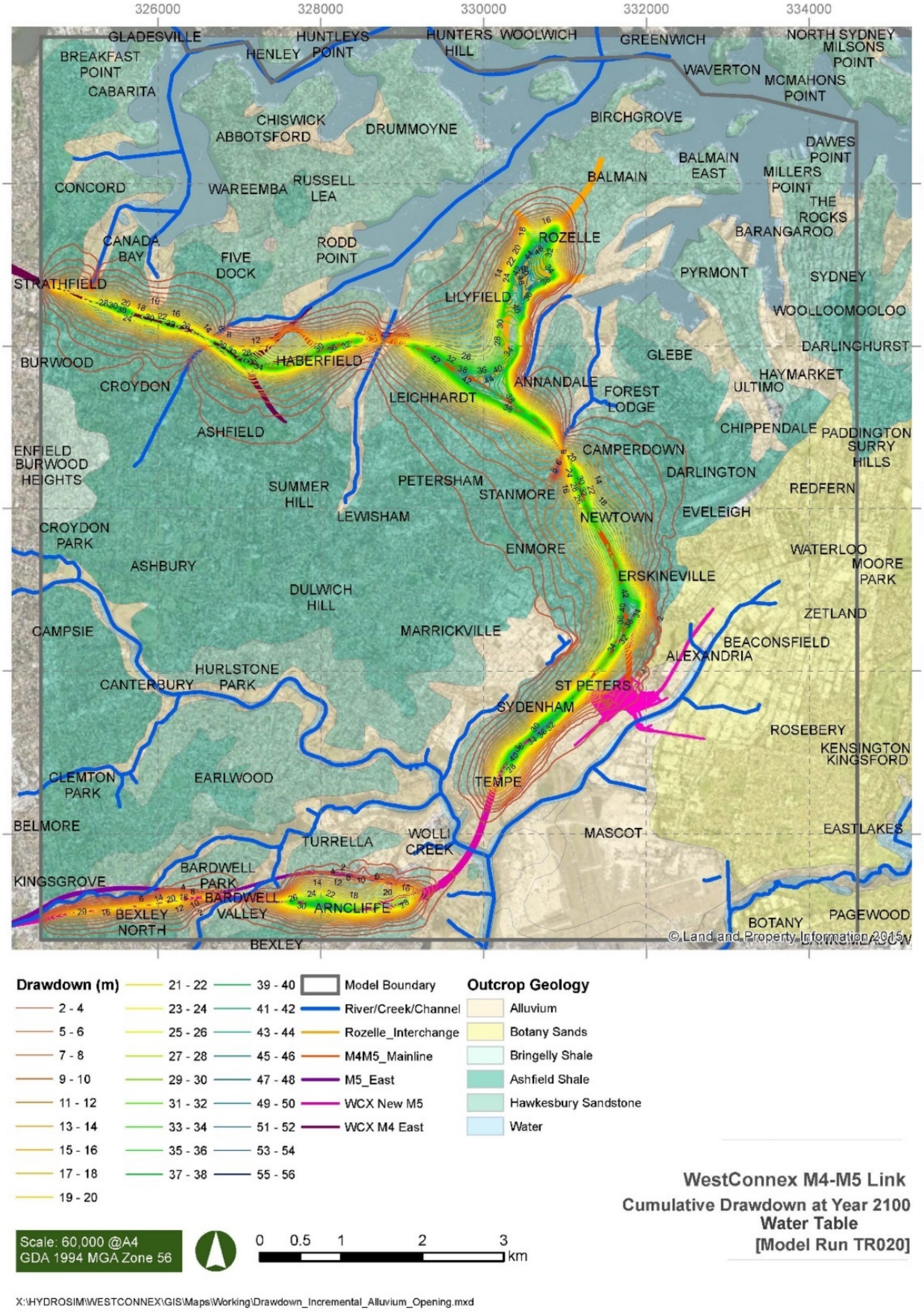


Figure 7-1 Predicted cumulative groundwater drawdown for the project (Year 2100) (from HydroSimulations 2017)

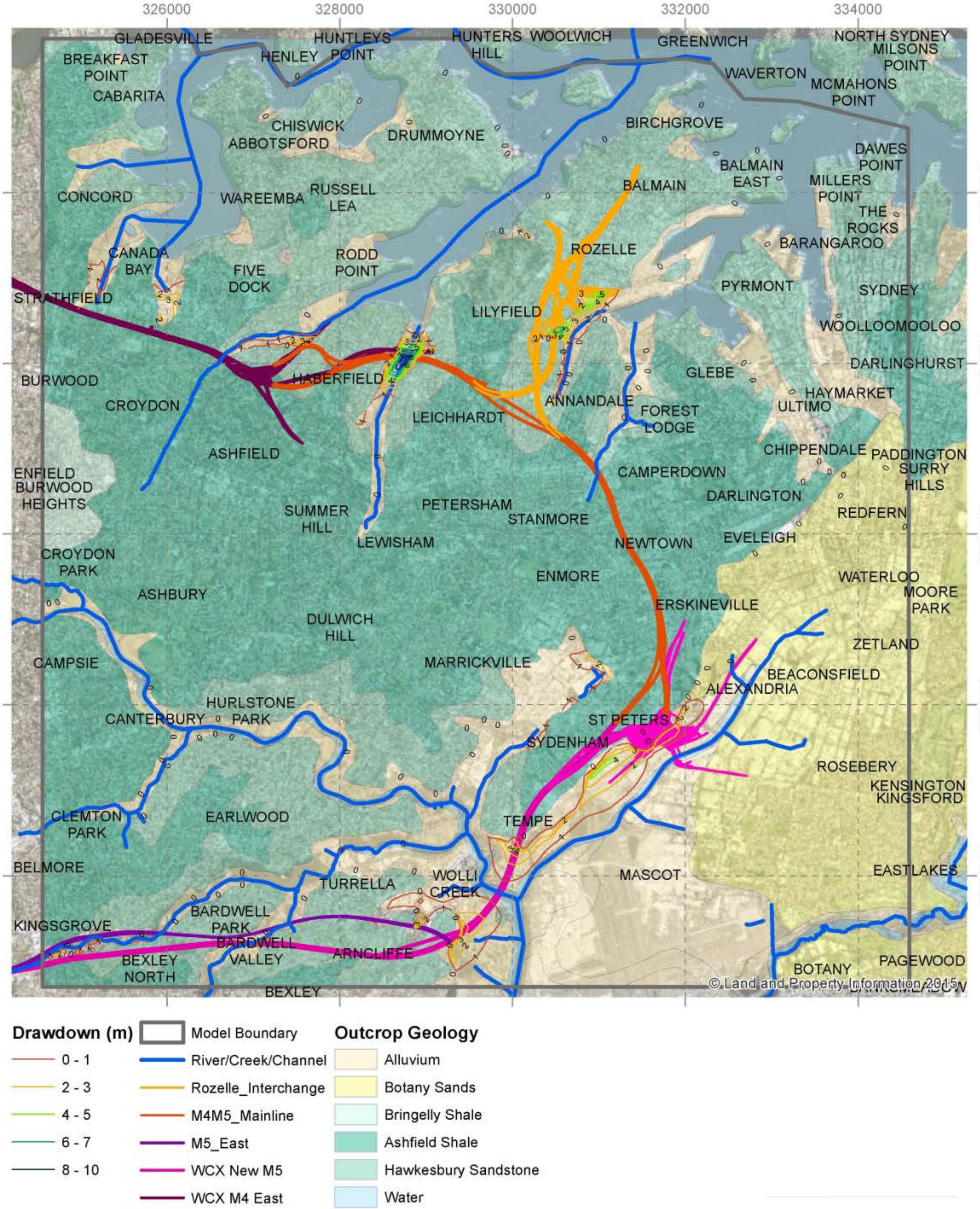


Figure 7-2 Predicted cumulative groundwater drawdown in the alluvium (Year 2100) (from HydroSimulations 2017)

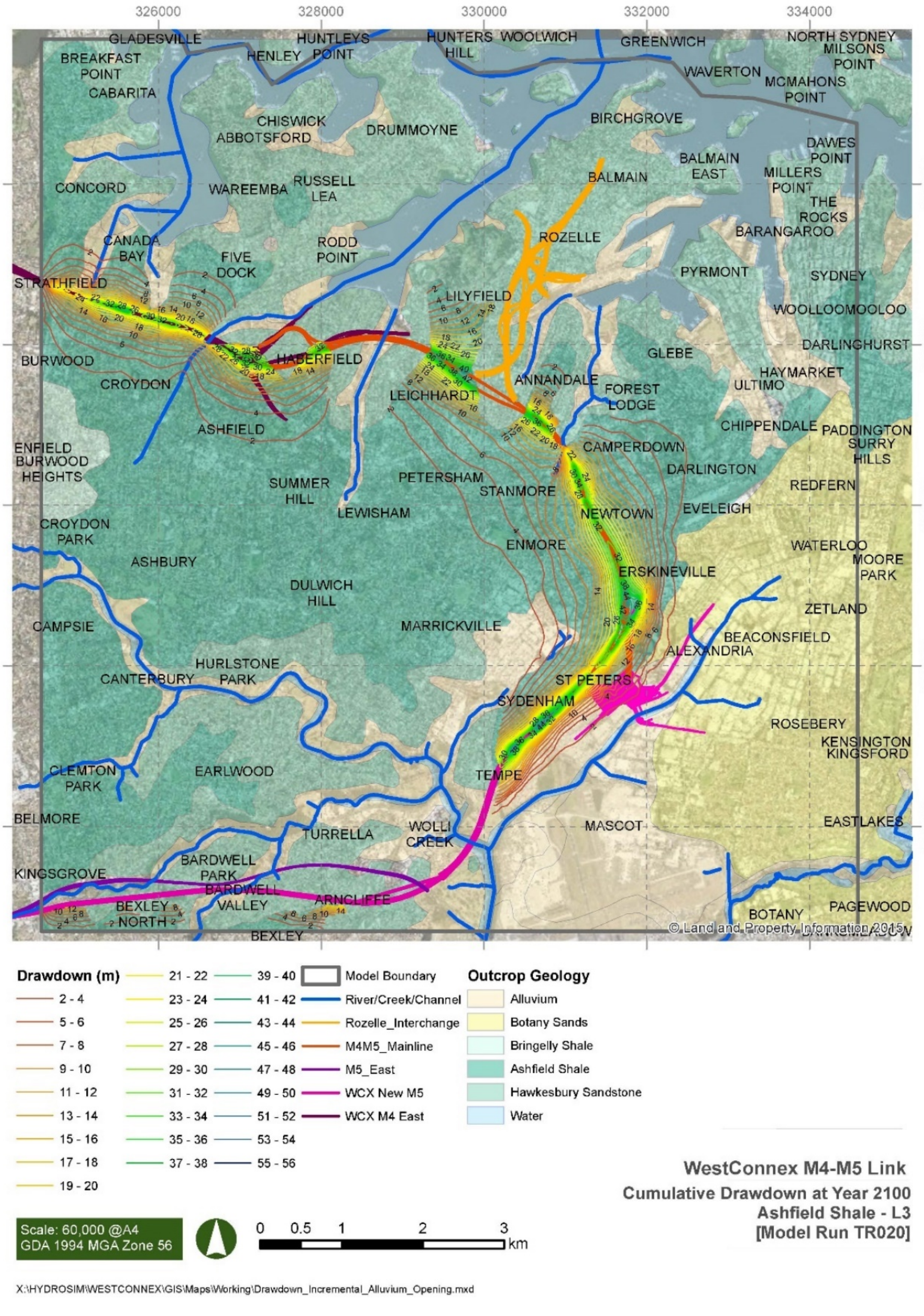


Figure 7-3 Predicted cumulative groundwater drawdown in the Ashfield Shale (Year 2100) (from HydroSimulations 2017)

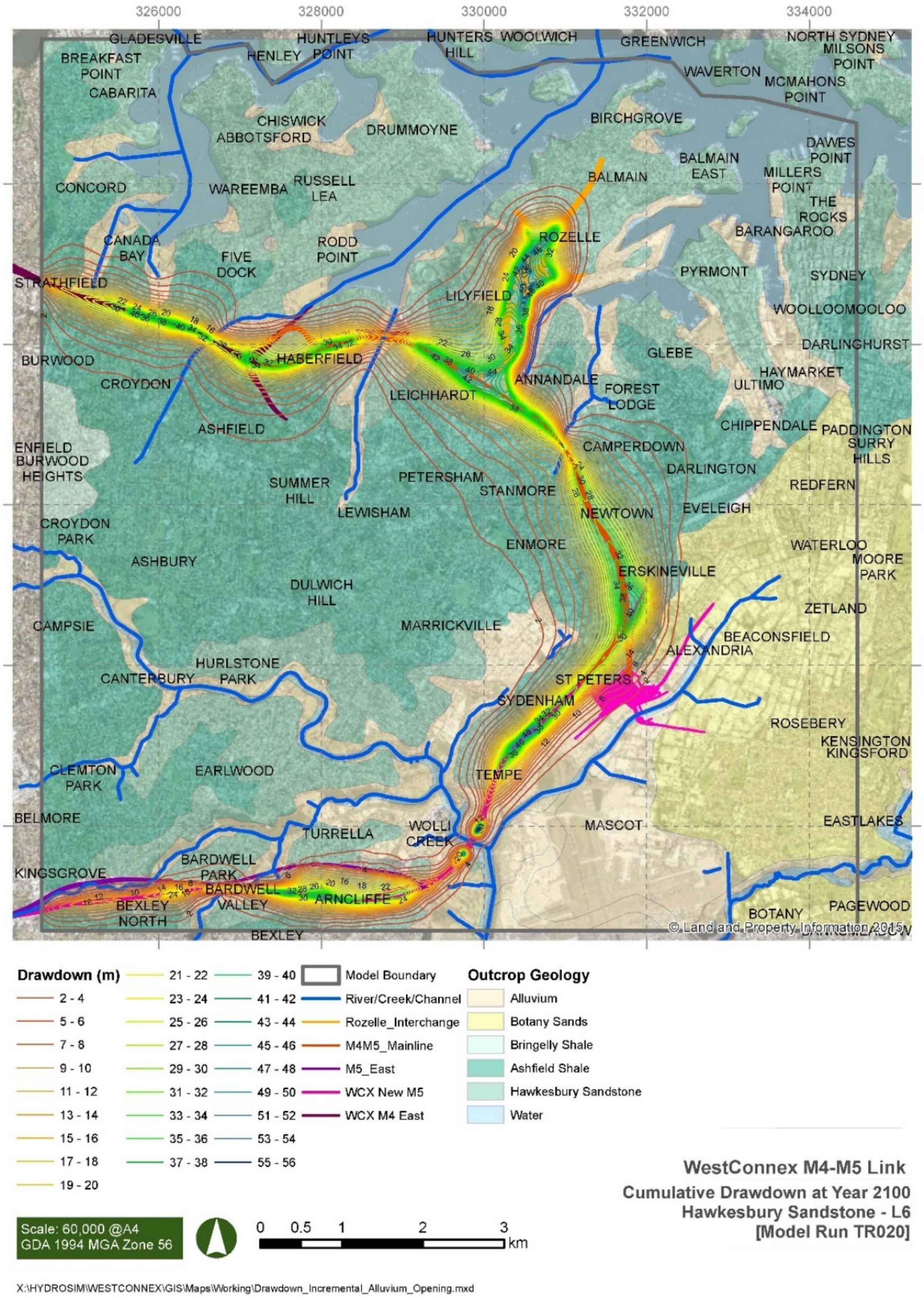


Figure 7-4 Predicted cumulative groundwater drawdown in the Hawkesbury Sandstone (Year 2100) (from HydroSimulations 2017)

Groundwater inflow rates would increase during construction of the M4-M5 Link but would decline after completion of construction as the cone of depression extends to greater distance thus causing the hydraulic gradient towards the tunnel to decrease over time. Reduction of groundwater storage would continue to reduce throughout the tunnel project until equilibrium is reached with recharge, if that ever occurs. Throughout the operation phase, the groundwater inflow rate at the confluence with the New M5 and M5 East tunnels would reach an equilibrium which is dependent upon the hydrogeological conditions that the tunnel has intersected.

The groundwater modelling has predicted that only one registered bore would be drawn down in excess of two metres due to the cumulative impacts of the WestConnex tunnels along the project footprint. This is generally the same as the impact identified in the assessment for the M4-M5 Link project only. Mitigation measures for this bore (GW110247), located at Sydney University are outlined in this assessment (see **section 4.10**). Ten other registered bores are predicted to be impacted by the New M5 project however these impacts along with mitigation measures were discussed in the New M5 EIS. Groundwater modelling has predicted that the drawdown in these bores would not be increased due to cumulative impacts. This is attributed to the tunnels being linear infrastructure and the drawdown impacts being similar along the route within each geological unit.

The cumulative impacts of the three WestConnex tunnels are predicted to impact groundwater quality due to saline intrusion. That is, depressurisation of the Hawkesbury Sandstone aquifer due to groundwater ingress into the tunnels would cause saline tidal waters to flow slowly towards the tunnels impacting groundwater salinity between the tunnels and estuary's. Groundwater modelling of the cumulative scenario has indicated that the degradation of water quality by saltwater intrusion is likely to occur in an average timeframe of between 26 years and in excess of 1,000 years HydroSimulations 2017. This is generally the same as the impact identified in the assessment for the M4-M5 Link project only (which is an average timeframe of 13 years and excess of 1,000 years). Consequently, cumulative groundwater quality impacts are unlikely to be of concern in the short to medium term and any impacts would be managed in accordance with the 'make good' provisions outlined in the AIP. Make good provisions could include providing treated water from the water treatment plants or the installation of a reticulated water supply.

7.3 Quantitative assessment of future and current tunnel infrastructure projects

Three major tunnel infrastructure projects (Sydney Metro City and South-west–Chatswood to Sydenham section, the proposed future Western Harbour Tunnel and Beaches Link and the F6 Extension) have been considered in the cumulative impact assessment for the M4-M5 Link. However, at the time of groundwater modelling there was insufficient publically available data on these three projects and as such the potential cumulative impact of these projects are discussed qualitatively based on the information available.

7.3.1 Sydney Metro City and Southwest

The proposed Sydney Metro City and Southwest project is a proposed rail alignment linking Sydney's north-western suburbs to the Sydney CBD and continuing further south to Bankstown. The northern section of the project, Chatswood to Sydenham, was approved in early January 2017, while the southern section of the project, Sydenham to Bankstown, is currently under assessment. The approved northern alignment consists of 15.5 kilometres of twin railway tunnels extending from Chatswood, beneath Sydney Harbour to Sydenham. Tunnelling is expected to commence in late 2018 and be completed by 2021.

The alignment of the Sydney Metro City and Southwest project would be closest to the M4-M5 Link project at St Peters where it is proposed to cut into the Ashfield Shale immediately north and north-west of Sydney Park. The metro tunnels are to be constructed as concrete lined undrained (tanked) tunnels. Consequently there would be some groundwater extraction and drawdown during construction, however these impacts would be temporary and groundwater levels are not expected to be drawn down long term by the project. The groundwater impact assessment for the northern section of Sydney Metro (Transport for NSW 2016) Chatswood to Sydenham outlined that the project is unlikely to trigger significant impacts to groundwater as the metro tunnels are predominately tanked.

Since the twin metro tunnels would be constructed as tanked tunnels, there would be negligible impacts on groundwater as the undrained tunnels are designed to prevent groundwater ingress. The stations are to be constructed as drained shafts and would extract groundwater from the local hydrogeological regime over time. The closest proposed drained structure is at Marrickville Station, about 2.5 kilometres west of the M4-M5 Link which is considered a sufficient distance not to substantially impact the project. There is potential for the concrete lined tunnels of the Sydney Metro City and Southwest project to create a partial hydraulic barrier to groundwater flow, however the risk is considered low since the tunnels are constructed below the water table and groundwater is expected to be able to flow above and below the tunnels.

7.3.2 Western Harbour Tunnel and Beaches Link

The proposed future Western Harbour Tunnel and Beaches Link would include tunnelling which is likely to impact groundwater during the construction and operation phases. The M4-M5 Link project would construct tunnels and on-ramps that will link the Rozelle interchange with the proposed future Western Harbour and Beaches Link tunnels. These structures have been included in the current groundwater model. At the time of preparing this impact assessment there were insufficient project details regarding the alignment, construction program and construction technique of the proposed future Western Harbour Tunnel and Beaches Link available to assess potential cumulative groundwater impacts with the M4-M5 Link project. The proposed future Western Harbour Tunnel and Beaches Link project will be subject to a separate environmental impact assessment in which it is expected that the EIS would include a cumulative impact assessment that would include potential impacts to groundwater as a result of both projects.

7.3.3 Proposed future F6 Extension

The F6 Extension project (formerly called SouthLink) may include tunnelling that is likely to impact groundwater during the construction and operations phases of the M4-M5 Link project. The F6 Extension would extend from the New M5 Motorway south of the Cooks River, southwards underground through Rockdale, Brighton Le Sands, Sans Souci and beyond. At the time of preparing this impact assessment there were insufficient project details available regarding the F6 Extension, including the potential alignment, construction program and construction technique, to be able to assess potential groundwater cumulative impacts. This project would be subject to a separate environmental impact assessment and it is expected that the EIS will include a cumulative impact assessment that would include potential cumulative impacts to groundwater in addition to the M4-M5 Link project.

7.4 Summary

A cumulative impact assessment has been conducted to assess the cumulative groundwater impacts of the M4-M5 Link project and other WestConnex projects including the M4 East and New M5. The groundwater model predicts the combined groundwater impacts of these projects during the construction (to Year 2023) and long term operations phase (to Year 2100). Other WestConnex projects including the M4 widening and King Georges Road Interchange Upgrade were not included in this assessment because these works do not impact the groundwater during operation. Groundwater modelling has been used to predict potential cumulative groundwater impacts during construction and operations of the WestConnex projects.

The groundwater cumulative impacts for other major tunnel infrastructure projects including the Sydney Metro City and South-west (Chatswood to Sydenham section), the proposed future Western Harbour Tunnel and Beaches Link and proposed future F6 Extension have been considered qualitatively since there was insufficient publically available information available for inclusion in the M4-M5 Link groundwater model. The proposed future Sydney Gateway project has not been included in the groundwater cumulative impact assessment because the updated road infrastructure is to be constructed along the ground surface and is unlikely to substantially impact groundwater.

During construction, cumulative impacts on groundwater would be greatest at the extremities of the project near the St Peters interchange in the south and the Wattle Street interchange in the north-west, where the M4-M5 Link project overlaps with the adjoining sections of WestConnex. At St Peters interchange there will be influences to the groundwater levels due to on-going leachate extraction from the former Alexandria Landfill, depressing the local groundwater levels. Leachate production is to be reduced by the installation of a groundwater cut-off wall, capping of the former landfill which will be managed under a landfill closure plan.

Once the full extent of the WestConnex projects is operational, groundwater drawdown due to the cumulative impact of the three tunnel projects is not expected to be greater than in any one section of the overall project footprint.

Long term cumulative groundwater tunnel inflows due to the WestConnex tunnel projects may cause groundwater salinity to increase due to surface water from tidal reaches being drawn into or towards the tunnels. Initially, the saline water would be a small fraction of total tunnel ingress but this is expected to increase over time as water is drawn from further afield, although it will always be a minor component of total inflow. The groundwater modelling has predicted that only one registered bore would be drawn down in excess of two metres due to the cumulative impacts of the WestConnex tunnels along the project footprint.

Cumulative groundwater impacts of other future and current tunnelling projects have been considered including Sydney Metro City and Southwest, the proposed future Western Harbour Tunnel and Beaches Link and the proposed future F6 Extension. The Metro twin tunnels are to be constructed as tanked tunnels and consequently there will be negligible impacts on groundwater due to the tunnels. The closest drained structure is proposed around 2.5 kilometres west of the M4-M5 Link, which is considered a sufficient distance to the M4-M5 Link so as to not substantially cumulatively impact groundwater. There is insufficient data available to quantitatively assess the cumulative impacts of the proposed future Western Harbour Tunnel and Beaches Link and F6 Extension as the construction technique, alignment, construction program were unknown at the time of modelling, however it is likely that these projects would contribute to the cumulative impact to groundwater during their construction and operation phases. It is expected that these other projects will assess the cumulative effects on groundwater.

8 Management of impacts

The following mitigation measures are proposed, to reduce or eliminate the risk posed by potential impacts on the existing groundwater regime from the construction and operation of the project. Environmental mitigation measures including management, engineering solutions and monitoring and have been developed to minimise impacts on the local hydrogeological regime.

8.1 Management of construction impacts

Mitigation measures to manage potential impacts on the existing hydrogeological regime during construction are outlined in **Table 8-1**.

Table 8-1 Construction mitigation and management measures

Potential impact	Mitigation and management measures
High groundwater inflows which would cause significant groundwater inflows and groundwater drawdown	Groundwater inflows within the tunnels will be minimised by designing the final tunnel alignment to minimise intersections with known palaeochannels and alluvium present in the project footprint. Tunnel sections intersecting the alluvium at the Rozelle Rail Yards are to be tanked to minimise groundwater inflows from the alluvium. Pre-excavation pressure grouting will be used in locations that are suspected of being more permeable to reduce groundwater inflows to an acceptable level. Post grouting may also be required to further reduce groundwater inflows.
	Appropriate waterproofing measures will be identified and included in the detailed design to permanently reduce the inflow into the tunnels to below one litre per second per kilometre for any kilometre length of the tunnel.
	Appropriate measures will be investigated and implemented at dive structures and shafts and for cut-and-cover sections of the tunnel to minimise groundwater inflow. These measures could include but are not limited to retaining walls such as secant pile, sheet pile walls or diaphragm walls founded in good quality Ashfield Shale or Hawkesbury Sandstone.
Corrosion of building materials by sulfate reducing bacteria	Further assessment of the risk posed by the presence of sulfate reducing bacteria and groundwater aggressivity will be undertaken prior to construction. A corrosion assessment will be undertaken by the construction contractor to assess the impact on building materials that may be used in the tunnel infrastructure such as concrete, steel, aluminium, stainless steel, galvanised steel and polyester resin anchors. The outcomes of the corrosion assessment will be considered when selecting building materials likely to encounter groundwater.
Groundwater drawdown impacting a water supply well water level by more than two metres	In accordance with the AIP, measures will be taken to ‘make good’ the impact to an impacted water supply bore by restoring the water supply to pre-development levels. The measures taken will be dependent upon the location of the impacted bore but could include, for example, deepening the bore, providing a new bore or providing an alternative water supply.
Alteration of groundwater flows and levels due to the installation of subsurface project components	Potential impacts associated with subsurface components of the project intercepting and altering groundwater flows and levels will be considered during detailed design. Measures to reduce potential impacts will be identified and included in the detailed construction methodology and the detailed design as relevant. Re-injection of treated groundwater is a high management activity and that could be considered during the construction phase to reduce

Potential impact	Mitigation and management measures
	groundwater drawdown. It is not considered suitable as a long term operational solution due to on-going maintenance and clogging of the well screens due to the oxidation of iron and manganese. Discussions with DPI-Water will be required to consider the feasibility of injecting relatively high quality water into the aquifer.
Poor water management could lead to adverse impacts on the environment	A CEMP will be developed to manage potential impacts on groundwater and soil. The CEMP will be a 'live' document with the capacity to be updated if conditions are different to those expected. As part of the CEMP a CSWMP will prepared by the contractor to manage soil and water impacts during construction, identifying potential impacts and recommending mitigation measures to eliminate or reduce the identified risks. The CSWMP will outline the groundwater monitoring plan that will include: • Groundwater levels (manual monitoring and automatic monitoring by data loggers) • Groundwater quality (within key boreholes and tunnel inflows) • Groundwater inflows to the tunnels. Trigger levels would be established that if exceeded would instigate mitigation measures. Water quality trigger levels will be based on the ANZECC 2000 marine and non-marine guidelines in accordance with the 90 percent level of protection during construction. The monitoring will be used to inform the operators of the water treatment plant which contaminants require treatment. The CEMP would also manage the following potential groundwater impacts: • Spill prevention and response procedures. • Management measures for the storage and stockpiling of materials, fuel and wastes during construction to contain spills and reduce the risk of contaminating groundwater • A protocol for the management of acid sulfate soils during bulk earthworks that will include the types of treatment required for ASS, leachate, bunding and requirement for treatment pond • A protocol to address unexpected contaminated finds or unforeseen contamination issues during surface works and tunnelling. This will consider approaches to remove the source of contamination by excavation, or an engineering solution to prevent the migration of contaminated groundwater into the tunnels.
Actual groundwater inflows and drawdown in adjacent areas exceed expectations	A detailed groundwater model will be developed by the construction contractor. The model will be used to predict groundwater inflow rates and volumes within the tunnels and groundwater levels (including drawdown) in adjacent areas during construction and operation of the project.
	Groundwater inflow within and groundwater levels in the vicinity of the tunnels will be monitored during construction and compared to model predictions and groundwater performance criteria applied to the project. The groundwater model will be updated based on the results of the monitoring as required and proposed management measures to minimise potential groundwater impacts adjusted accordingly.

Potential impact	Mitigation and management measures
	Groundwater quality monitoring will be conducted.
Potential impacts on existing buildings and infrastructure due to settlement	Groundwater drawdown may induce ground settlement and impact existing and future infrastructure. Detailed settlement modelling will be carried out during detailed design. If excessive settlement is predicted then construction methodologies would be revised to minimise impacts. Settlement monitoring would be undertaken in accordance with the protocols developed in the CEMP and may include the installation of settlement markers or inclinometers. Before the commencement of tunnelling, dilapidation assessments would be undertaken on buildings and structures which may be impacted by settlement. A post construction inspection will also be conducted to identify any building defects that could be attributed to the project so make good provisions could be initiated.

Based on these mitigation and management measures it is considered that potential groundwater impacts that may arise during the construction phase can be effectively managed for the project.

8.2 Management of operational impacts

Mitigation measures to manage potential impacts on the existing hydrogeological regime during the operation phase are outlined in **Table 8-2**.

Table 8-2 Operational mitigation and management measures

Potential impact	Mitigation and management measures
Impacts to groundwater quality or groundwater levels	A groundwater monitoring program will be prepared and implemented to monitor groundwater inflows in the tunnels, groundwater levels and groundwater quality in the three main aquifers at the commencement of the operations phase. during construction. The monitoring program will be developed in consultation with the EPA, DPI-Fisheries, DPI-Water and the Inner West and Sydney City Councils.
	The program will identify groundwater monitoring locations, performance criteria in relation to groundwater inflow and groundwater quality and potential remedial actions that would manage or mitigate any non-compliances with performance criteria. In addition the monitoring program will include the manual and automatic (using dataloggers) groundwater level monitoring and groundwater quality monitoring from selected monitoring wells intersecting groundwater from the alluvium, Ashfield Shale and Hawkesbury Sandstone The monitoring frequency is likely to be six monthly for three years or as stated in the conditions of project approval.
Poor water management could lead to adverse impacts on the environment	An OEMP will be developed by the tunnel operators to manage potential impacts to groundwater. The OEMP will be a 'live' document with the capacity to be updated if conditions are different to those expected. As part of the OEMP the following will be addressed: • Groundwater management and monitoring • Surface water management and monitoring • Drainage system maintenance, eg to remove build-up of precipitated iron (slimes) and silt and sand due to slaking of the sandstone • Settlement monitoring may include the installation of settlement

Potential impact	Mitigation and management measures
	markers or inclinometers.
Adverse impacts on the local hydrogeological regime due to groundwater discharge	Long term groundwater inflows will be pumped to the surface, treated and discharged to Rozelle Bay via Hawthorne Canal or a constructed wetland and channel at Rozelle. The tunnel operation water treatment facilities would be designed such that effluent will be of suitable quality for discharge to the receiving environment. The level of treatment will consider the characteristics of the discharge and receiving waterbody, any operational constraints or practicalities and associated environmental impacts and be developed in accordance with ANZECC (2000) and with consideration to the relevant NSW Water Quality Objectives. Ultimately the water quality objectives would be set by the catchment manager of the receiving waters in consultation with the EPA.
Corrosive groundwater could adversely impact the tunnel and associated infrastructure	Where the corrosion assessment that will be carried out prior to construction indicates potential issues, corrosion and other associated impacts of highly aggressive groundwater on the tunnel infrastructure will be monitored during operations. The monitoring program will be documented in the OEMP or EMS. Corroded or otherwise impacted infrastructure will be repaired or replaced as required to maintain operational integrity of the road infrastructure.
Groundwater drawdown due to the project may exceed two metres in registered bores or at other receptors	In accordance with the AIP, measures will be taken to ‘make good’ the impact to an impacted water supply bore by restoring the water supply to pre-development levels. The measures taken will be dependent upon the location of the impacted bore but could include, for example, deepening the bore, providing a new bore or providing an alternative water supply.
Treated groundwater may be discharged to stormwater without consideration to a suitable sustainable use.	Sustainable water re-use options will be considered for treated groundwater during operations. Re-use options may include the irrigation of open space at the Rozelle interchange or discharge into artificial wetlands. Groundwater reuse will be undertaken in accordance with the policies of sustainable water use of DPI-Water.

Based on the above mitigation and management measures it is considered that potential groundwater impacts that may arise as a result of operation the project can be effectively managed.

8.3 Management of cumulative impacts

As noted in **section 7.4**, once the full extent of the WestConnex projects is operational, groundwater drawdown due to the cumulative impact of the three tunnel projects is not expected to be greater than in any one section of the overall project footprint.

The tunnels and associated lining would be designed and constructed to comply with the groundwater inflow criterion of one litre per second per kilometre for any kilometre length of tunnel. Consequently the groundwater inflows along the tunnels would vary within a known range. A comprehensive groundwater monitoring program would be required for each project to confirm that the actual inflows do not exceed the criterion and drawdown does not exceed predictions. Provided that each project includes relevant monitoring and management measures into their respective CEMPs and OEMPs there is limited potential for increases in impacts due to the cumulative construction and operation of the three tunnels.

9 Policy compliance

9.1 Aquifer Interference Policy

The *Water Act 1912* (NSW) has been replaced by the (WM Act) and does not apply to areas of the state where water sharing plans are in place. Groundwater and surface water within the project footprint are covered by the Groundwater Metropolitan Region Groundwater Sources and the Greater Metropolitan region Unregulated River Water Sources.

The AIP explains the requirements of the WM Act. It clarifies the requirements for licences for aquifer interference activities and establishes the considerations required for assessing potential impacts on key water dependent assets. Any potential impact on local aquifers would be assessed under this policy.

Under this policy, a controlled activity approval (such as a water access licence or aquifer access licence) and/or an aquifer interference approval is required under the for any activity that results in interference to an aquifer. Under section 91F of the WM Act, approval is required for aquifer interference activities. These activities include the taking of groundwater. The policy applies to all aquifer interference activities, but has been developed to address a range of high risk activities.

Road authorities including RMS are exempt (under Schedule 5, Part 1, clause 2 of the Water Management (General) Regulation 2011) from the requirement to hold a water access license to access water during the construction and operational phases including major tunnelling projects.

9.2 Minimal impact assessment

The AIP outlines minimal impact considerations that must be met as a result of the proposal. The minimal impact considerations are dependent upon the impacted aquifer type (alluvial, coastal, fractured rock or special cases such as the Great Artesian Basin) and whether the aquifer is 'highly productive' or 'less productive groundwater'. The impacts on be considered are to groundwater levels (or water pressure in artesian basins) and water quality as follows:

- **Water table** (drawdown) – impact is considered to be minimal where there is less than a cumulative two metre decline at any water supply work. If the impact is greater than two metres than make good provisions apply
- **Water table** (receptors) – impact is considered to be minimal where the water table change is less than 10 percent of the cumulative variation in the water table 40 metres from any high priority GDE or high priority culturally significant site listed in the water sharing plan
- **Water pressure** – impact is considered to be minimal where the cumulative decline in head is less than two metres at any water supply work
- **Water quality** – impact is considered to be minimal where the change in groundwater quality is within the current beneficial use category of the groundwater beyond the 40 metres of the activity.

If the predicted impacts are less than Level 1 minimal impact considerations (as defined in the AIP) then these impacts are considered acceptable. If, however, the impacts are assessed as greater than Level 1 but these predicted impacts exceed the Level 1 thresholds by no more than the accuracy of a robust model, the project would be accepted as suitable with appropriate monitoring during operation. To reduce the impacts, mitigation measures such as make good provisions may be required to protect a resource or receptors. Where the groundwater impacts are deemed not acceptable the project may have to be modified to reduce the groundwater impacts on an acceptable level.

The majority of the project footprint is considered to be within a 'Less Productive Groundwater Source' within fractured rock, based on the low number of registered bores in the area. In outlining the Minimal Impact Considerations (Table 1, AIP) the policy considers porous and fractured rock water resources together. The groundwater is administered under the *Greater Metropolitan Regional Groundwater Sources Groundwater Water Sharing Plan 2012*.

The Botany Sands are not intersected by the tunnel but it is close by to the east and is likely to be impacted by the project. Potential impacts of the M4-M5 Link project to the Botany Sands were assessed in this assessment. The groundwater within the Botany Sands is considered to be in a 'Highly Productive Groundwater Source' despite the groundwater being highly contaminated.

A minimal impact assessment has been conducted for the groundwater potentially impacted by the project in accordance with the NSW Aquifer Interference Policy Step by Step Guide,(NoW, 2013b). The minimal impact considerations for 'less productive groundwater' in a fractured rock aquifer are presented in **Table 9-1**. The minimal impact considerations for 'Highly productive groundwater' in a coastal aquifer are presented in **Table 9-2.**

Table 9-1 Minimal Impact Considerations for a 'Less Productive Fractured Rock Aquifer'

Minimal impact considerations	Response
<u>Water Table – Level 1</u> 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: (a) High priority groundwater dependent ecosystem; or (b) High priority culturally significant site listed in the schedule of the relevant water sharing plan, or (c) A maximum of a 2 m decline cumulatively at any water supply work.	There are no high priority groundwater dependent ecosystems listed under Schedule 4 of the *Greater Metropolitan Regional Groundwater Sources Water Sharing Plan* that are within the Hawkesbury Sandstone or Ashfield Shale. No culturally significant sites were identified within the *Greater Metropolitan Regional Groundwater Water Sharing Plan*. Groundwater modelling has indicated there is one registered bore within a 2 km radius of the tunnels registered for water supply purposes (domestic) where the long term drawdown is predicted to exceed two metres. The approach to minimising impacts is outlined below.
<u>Water Table – Level 2</u> If more than 10% cumulative variation in the water table, allowing for typical climatic 'post water sharing plan' variations, 40 m from any: (a) High priority groundwater dependent ecosystem; or (b) High priority culturally significant site; (c) listed in the schedule of the relevant water sharing plan, if appropriate studies demonstrate to the Minister's satisfaction that the variation will not prevent the long term viability of the dependent ecosystem or significant site. If more than a 2 m decline cumulatively at any water supply work then make good provisions should apply.	The predicted long term drawdown in domestic bore GW110247 is 2.4 m. The bore is 210 m deep with water table depth recorded at 31 m below ground level. Given the standing water level is recorded as 31 m below ground level and the bore is 210 m deep, the 2.4 m of drawdown is likely to have a negligible impact on the bore yield capacity. The approach to 'make good' the supply to predevelopment levels would be adopted. This approach would commence with discussions with the bore owner about 'make good' options. Mitigation options would include lowering the pump or providing an alternative water supply (such as mains water).
<u>Water Pressure – Level 1</u> A cumulative pressure head decline of not more than a two metre decline, at any water supply work.	Mitigation measures have been recommended for one bore (GW110247) located at Sydney University where it has been predicted that the drawdown exceeds a water level decline of more than 2 m.

Minimal impact considerations	Response
<u>Water Pressure – Level 2</u> If the predicted pressure head decline is greater than condition 1 above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long term viability of the affected water supply works unless make good provisions apply.	The predicted groundwater level decline will not prevent the long term viability of the bore and make good provisions are proposed.
<u>Water Quality – Level 1</u> Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	Groundwater within the study area has limited beneficial use potential due to the quality of the water and presence of a Sydney Water reticulated water supply across the study area. The Ashfield Shale groundwater is typically of poor quality and of low hydraulic conductivity limiting the beneficial use potential. Groundwater from the Hawkesbury Sandstone is used for domestic and irrigation purposes. Groundwater modelling predicts there is likely to be saline water ingress from Rozelle Bay and Iron Cove to the project footprint over time (**section 5.5.6**), which may increase the salinity of groundwater between the project footprint and Sydney Harbour. Given the low level of groundwater use, elevated metals and ongoing pollution potential within an urban environment, the lowering of the aquifer system beneficial use category is unlikely.
<u>Water Quality – Level 2</u> If condition 1 is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long term viability of the dependent ecosystem, significant site or affected water supply works.	Level 2 does not apply as Level 1 criteria are not exceeded.

Table 9-2 Minimal Impact Considerations for a 'Highly Productive Coastal Aquifer'

Minimal impact considerations	Response
<u>Water Table – Level 1</u> 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: (a) High priority groundwater dependent ecosystem; or (b) High priority culturally significant site listed in the schedule of the relevant water sharing plan; or (c) A maximum of a 2 m decline cumulatively at any water supply work.	The closest high priority ecosystems listed under Schedule 4 of the *Greater Metropolitan Regional Groundwater Sources Water Sharing Plan* are the Botany Wetlands including the Lachlan Swamps, Mill Pond, Mill Stream and Engine Pond located within the Botany Sands. These ecosystems are located more than 2 km from the project footprint. Groundwater modelling conducted as part of this investigation indicates that the water table at these wetlands is unlikely to undergo a water level decline of more than 2 m (**section 5.4.1**). No culturally significant sites were identified within the *Greater Metropolitan Regional Groundwater Water Sharing Plan*. Groundwater modelling predicted that no registered bores a 2 km radius of the tunnels that intersect alluvium are likely to be drawn down by

Minimal impact considerations	Response
	more than 2 m. Given the primary beneficial use of groundwater in the Botany Sands is for domestic use and within Zone 2 of the Botany Sands Source Management Zone domestic use is banned the drawdown impacts are not considered significant.
<u>Water Table – Level 2</u> If more than 10% cumulative variation in the water table, allowing for typical climatic 'post water sharing plan' variations, 40 m from any: (a) High priority groundwater dependent ecosystem; or (b) High priority culturally significant site; listed in the schedule of the relevant water sharing plan, if appropriate studies demonstrate to the Minister's satisfaction that the variation will not prevent the long term viability of the dependent ecosystem or significant site. If more than a 2 m decline cumulatively at any water supply work then make good provisions should apply.	Level 2 does not apply as Level 1 criteria are not exceeded.
<u>Water Pressure – Level 1</u> A cumulative pressure head decline of not more than a 2 m decline, at any water supply work.	Groundwater modelling predicted that potentiometric pressures within the Botany Sands are unlikely to exceed more than a two metre decline at registered bores (**section 5.4.3**).
<u>Water Pressure – Level 2</u> 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 will not prevent the long term viability of the affected water supply works unless make good provisions apply.	Level 2 does not apply as Level 1 criteria are not exceeded.
<u>Water Quality – Level 1</u> Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	Groundwater within the study area has limited beneficial use potential due to the water quality and since the study area has a reticulated water supply provided by Sydney Water. The Botany Sands aquifer contains a significant groundwater resource under natural conditions, however due to contamination, DPI-Water has embargoed domestic groundwater use under the Metropolitan Water Sharing Plan. Groundwater modelling predicts there is likely be saline water ingress from Alexandria Canal to the project footprint which may increase the salinity of groundwater between the project footprint and Sydney Harbour. Since groundwater from the Botany Sands can no longer be used for domestic and ongoing pollution potential within an urban environment the lowering of the aquifer system beneficial use category is unlikely.

Minimal impact considerations	Response
Water Quality – Level 2 If condition 1 is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.	Level 2 does not apply as Level 1 criteria are not exceeded.

9.3 Licensing

An aquifer interference approval under the WM Act is required if the project intersects a groundwater source. The AIP documents the NSW Government's intention to implement the requirement for the approval of 'aquifer interference activities' under the WM Act. Although the project would affect a groundwater aquifer, the requirement for an aquifer interference approval has not yet commenced. As such, this approval is not required.

In general DPI-Water does not support an activity that causes perpetual inflow volumes, although in the case of constructing important major infrastructure exemptions can be granted. Ongoing tunnel inflows are designed to be less than one litre per second per kilometre for any kilometre length of tunnel. Currently road authorities are exempt (under Schedule 5, Part 1, clause 2 of the Water Management (General) Regulation 2011) from the requirement to hold a water access license to access water during the construction and operations phases including major tunnelling projects.

9.4 Compliance with the Water Sharing Plan

The project is covered by the Water Sharing Plan (WSP) for the Greater Metropolitan Region Groundwater Sources 2011, which applies to 13 groundwater sources. The WSP outlines a series of rules for granting access licences (Part 7), managing access licences (Part 8), water supply works approvals (Part 9), access licence dealings (Part 10) and mandatory conditions (Part 11). A summary of relevant rules and an assessment of project compliance are provided in **Table 9-3**.

Table 9-3 Project compliance with the Water Sharing Plan

Rule	Assessment
Part 7 – Rules for granting access licences	Road authorities are exempt (under Schedule 5, Part 1, clause 2 of the Water Management (General) Regulation 2011) from the requirement to hold a water access license to access water during the construction and operation of projects.
Part 8 – Rules for managing access licences	Refer to the assessment for Part 7.
Part 9 – 39 Distance restrictions to minimise interference between supply works	As outlined in section 3.1 under the WM Act road authorities are not exempt for the requirement of obtaining a water supply work approval. An approval would be required for this project for the water ingress to the drained tunnels.
Distance restriction from the property boundary is 50 m	The drained tunnels would in many cases be within 50 m of property boundaries and hence the project would not comply with this rule. However this non-compliance is considered acceptable since the tunnels are at depth in a highly urbanised area with a reticulated water supply and limited water supply works in the immediate vicinity of the project footprint.
Distance restriction from an approved water supply work is 100 m	Ten registered boreholes have been identified within 100 m of the project footprint and hence the project would not comply with this rule. However this non-compliance is considered acceptable since all these boreholes are registered as monitoring wells associated with

Rule	Assessment
	development sites in Lilyfield, Glebe and Haberfield that are unlikely to require on-going monitoring.
Distance restriction from a Department observation bore is 200 metres	There are no DPI-Water observation bores within 200 m of the project footprint.
Distance restriction from an approved work nominated by another access license is 400 m.	There are no water supply works nominated by another access licence within 400 m of the project footprint.
Distance restriction from an approved water supply work nominated by a local water utility or major utility access licence is 1,000 m	There are no local or major water utilities within 1,000 m of the project footprint.
Part 9 – 40 Rules for water supply works located near contaminated sources	Contaminated groundwater has been identified within the alluvium beneath the Rozelle Rail Yards. To minimise the migration of contaminated groundwater, the tunnels, portals and cut-and-cover sections within the alluvium are to be tanked preventing groundwater ingress to the tunnels.
Part 9 – 41 Rules for water supply works located near sensitive environmental areas	The project footprint is located outside the required distance for the following sensitive environmental areas: 1. 200 m of a high priority groundwater dependent ecosystem 2. 500 m of a karst groundwater dependent ecosystem 3. 40 m from a lagoon or escarpment (**section 4.3**). The project footprint is not located outside the required distance of the following sensitive environmental areas: 1. 40 m from third order streams or above. The non-compliance of the third order streams as discussed in **section 4.4.1** is considered acceptable since the creeks are concrete lined and the tunnels are to be excavated within the Hawkesbury Sandstone.
Part 9 – 42 Rules for water supply works located near groundwater dependent culturally significant sites	The project footprint is not located near a groundwater dependent culturally significant site.
Part 9 – 44 Rules for water supply works located within distance restrictions	There are no water supply works that are located within restricted distances along the project footprint.
Part 10 – Access dealing rules	Refer to the assessment for Part 7.

10 Conclusions

This groundwater impact assessment has been prepared to support the EIS for the project and was prepared in accordance with NSW water policy under the WM Act, administering water policy under the AIP and the *Greater Metropolitan Region Groundwater Source Water Sharing Plan.* The objectives of the groundwater impact assessment are outlined in the SEARs issued on 26 August 2015 which, in summary, must address the following:

- Extent of drawdown
- Impacts on groundwater quality
- Volume of groundwater that would be taken (including inflows)
- Discharge requirements
- Location and details of groundwater management and implications for groundwater dependent surface flows
- Groundwater-dependent ecological communities
- Groundwater users
- Proposed groundwater monitoring
- Cumulative impacts from other WestConnex projects.

The methodology to conduct the groundwater impact assessment included outlining the existing environmental conditions from available reports, maps and databases. A field investigation was conducted to investigate the geology along the tunnel alignment, assess the hydraulic conductivity by packer tests and laboratory testing of core, laboratory testing of porosity, install monitoring wells along the tunnel alignment, conduct monthly hydrogeochemical sampling and groundwater gauging to establish background conditions. Data loggers have been installed in the majority of the monitoring wells to monitor groundwater levels. A three dimensional numerical groundwater model (using MODFLOW-USG) has been developed to simulate existing groundwater conditions. By simulating the project footprint the groundwater model has also been used to predict future groundwater conditions and impacts related to the project.

The tunnels would be excavated predominately through competent Hawkesbury Sandstone and Ashfield Shale with parts of the tunnels intersecting alluvium. The majority of the tunnels would be constructed as drained (untanked) tunnels that would allow groundwater to leak into the tunnel from the sandstone. Groundwater would be directed into the drainage system, pumped to the water treatment plants at Rozelle and Leichhardt, eventually discharging into Rozelle Bay and to Iron Cove via Hawthorne Canal. Undrained (tanked) tunnel sections would be constructed where the tunnel intersects unconsolidated saturated alluvium at Rozelle. The project is designed achieve a maximum groundwater inflow of one litre per second per kilometre for any kilometre length of tunnel during its operation. To achieve this design criterion, water proofing may be required in parts of the tunnels to reduce the bulk rock permeability.

10.1 Potential impacts

Potential impacts due to the construction and operation of the project have been identified. Impacts during construction are likely to include:

- Reduced groundwater recharge, caused by the temporary construction of paved ancillary facilities
- Tunnel inflows and associated groundwater drawdown. Tunnel inflows and drawdown have been predicted by groundwater modelling. Peak tunnel inflows occur for the project in 2021 at 1.8 megalitres per day. Drawdown within the Hawkesbury Sandstone at the end of construction in 2023 is predicted to be a maximum of 55 metres at St Peters. Drawdown exceeding two metres would extend approximately 500 metres from the tunnel
- Degradation of groundwater quality during the tunnel construction program as a result of:
  - The intersection of acid sulfate soils during excavation works that could cause the production

  of acidic groundwater
  - The spilling of hazardous materials such as fuels and oils
  - The intersection of contaminated groundwater during tunnelling that could further spread the contamination
  - The natural groundwater may be aggressive to tunnel building materials and cause corrosion of the tunnel structures.

Operational impacts are likely to include:

- Flood mitigation and reduction of water logging at the Rozelle Rail due to the installation of stormwater drainage to drain the former flood storage area. Runoff from additional road infrastructure would be directed to stormwater drainage
- Tunnel inflows and associated groundwater drawdown. Tunnel inflows are limited by the design criterion of one litre per second per kilometre for any kilometre length of tunnel. Drawdown is likely to eventually extend to the tunnel invert extending to depths of up to 60 metres at Rozelle. The extent of predicted drawdown of two metres or more extends up to a maximum of 1.2 kilometres at Camperdown within the Hawkesbury Sandstone
- Groundwater drawdown that impacts the natural environments
- No impacts on groundwater dependent ecosystems were identified
- Potential impacts on river or stream baseflow
- Only one water supply bore was identified where the drawdown was predicted to be in excess of two metres
- Groundwater quality could be degraded through:
  - Intersection of contaminated groundwater
  - Saltwater intrusion
  - Natural groundwater aggressivity to tunnel building materials that could cause corrosion of the tunnel structures
  - Drainage lines within the tunnel could become blocked due to the natural iron and manganese oxidising within the drains causing sludges
  - Tunnel inflows could include leachate derived from the Alexandria Landfill
- Barriers to groundwater flow. caused by ancillary infrastructure extending into the water table and the groundwater sinks created by tunnel drainage induced drawdown
- Long term cumulative groundwater drawdown or groundwater inflows due to the WestConnex tunnel projects are minimal as the tunnel projects do not overlap spatially but are adjoining and thus the sum of impacts are similar to a continuous tunnel
- The cumulative impacts on groundwater drawdown or groundwater inflows due to the WestConnex tunnel projects are minimal in terms of the timing of the projects overlapping since construction is staged with the maximum cumulative impact occurring at the end of construction in 2023.

10.2 Mitigation and management measures

To mitigate and manage the potential impacts during construction, the following measures will be implemented:

- Preparation and implementation of a CEMP by the contractors that addresses the hazards associated with soil and groundwater contamination and groundwater management. The CEMP will include a CSWMP that addresses:
  - Groundwater management and monitoring
  - Surface water management and monitoring
  - Acid sulfate soils
- Management measures for the storage and stockpiling of materials, fuel and wastes during construction including spill prevention and response procedures
- Waterproofing would be installed during construction in areas identified that could have potential higher inflows. Post- grouting may also be required to further reduce groundwater inflows if monitoring indicates excessive inflows.
- Water from within the tunnels would be collected and treated prior to discharge at temporary water treatment plants prior to discharge to White Bay and Iron Cove
- Building materials that are resistant to aggressive groundwater conditions would be selected
- In accordance with the AIP, measures will be taken to 'make good' the impact to an impacted water supply bore by restoring the water supply to pre-development levels. The measures taken will be dependent upon the location of the impacted bore but could include, for example, deepening the bore, providing a new bore or providing an alternative water supply
- A groundwater monitoring program is to be prepared and implemented to monitor groundwater quality impacts during construction. The program shall be developed in consultation with the NSW EPA, DPI-Fisheries, DPI-Water and the Inner West and City of Sydney councils. Strategies would to be developed and implemented to reduce adverse impacts on groundwater quality due to construction activity if they are identified by the monitoring program. The monitoring program would include groundwater inflows, groundwater quality and groundwater levels.
- A detailed groundwater model will be developed by the construction contractor. The model will be used to predict groundwater inflow rates and volumes within the tunnels and groundwater levels (including drawdown) in adjacent areas during construction and operation of the project.
- Groundwater drawdown may induce ground settlement and impact existing and future infrastructure. Detailed settlement modelling will be carried out during detailed design. Settlement monitoring would be undertaken in accordance with the protocols developed in the CEMP. In addition structural inspections of buildings and infrastructure in areas identified that may be susceptible to settlement would be conducted. This would identify any structural defects that could be attributed to the project so make good provisions could be initiated.

To mitigate and manage potential operational impacts the following measures may be implemented:

- A groundwater monitoring program will be prepared and implemented to monitor groundwater inflows in the tunnels, groundwater levels and groundwater quality in the three main aquifers at the commencement of the operations phase. during construction. The monitoring program will be developed in consultation with the EPA, DPI-Fisheries, DPI-Water and the Inner West and Sydney City Councils.
- An OEMP will be developed by the tunnel operators to manage potential impacts to groundwater. The OEMP will be a 'live' document with the capacity to be updated if conditions are different to those expected. The OEMP would include the management of groundwater monitoring, surface water monitoring, drainage system maintenance and settlement monitoring.
- Long term groundwater inflows will be pumped to the surface, treated and discharged to Rozelle Bay via Hawthorne Canal or a constructed wetland and channel at Rozelle. The tunnel operation water treatment facilities would be designed such that effluent will be of suitable quality for

discharge to the receiving environment. Ultimately the water quality objectives would be set by the catchment manager of the receiving waters in consultation with the EPA.

- To reduce the impacts of water level decline in existing water supply wells mitigation measures would be taken to 'make good' the impact by restoring the water supply to pre-development levels. The measures taken would be dependent upon the location of the impacted bore but could include, deepening the bore, providing a new bore or providing an alternative water supply

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Annexures

Annexure A – Site plans

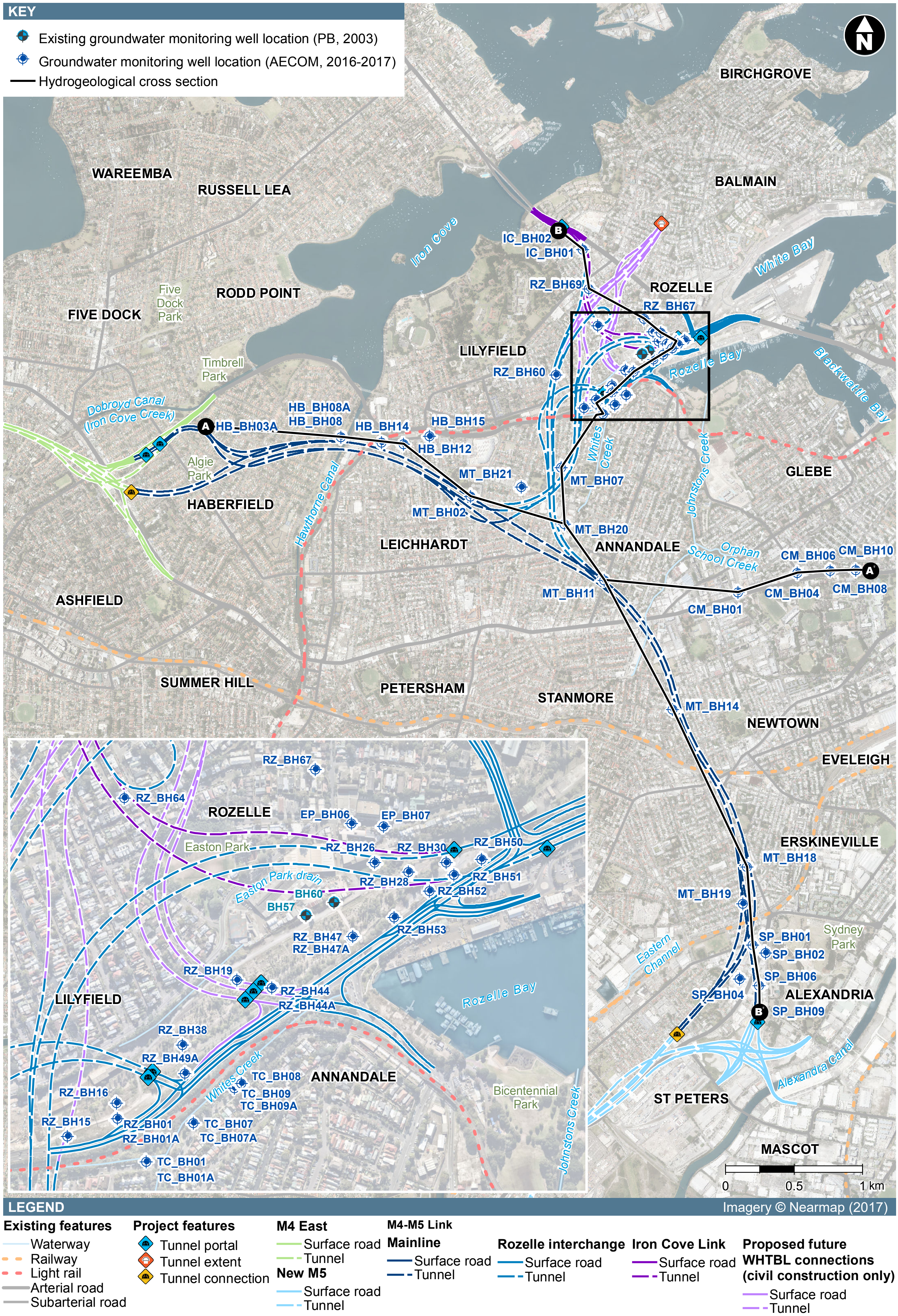


Figure A-1 Location of monitoring wells

LEGEND

Imagery © Nearmap (2017)

Existing features
- Light rail
- Light rail stop

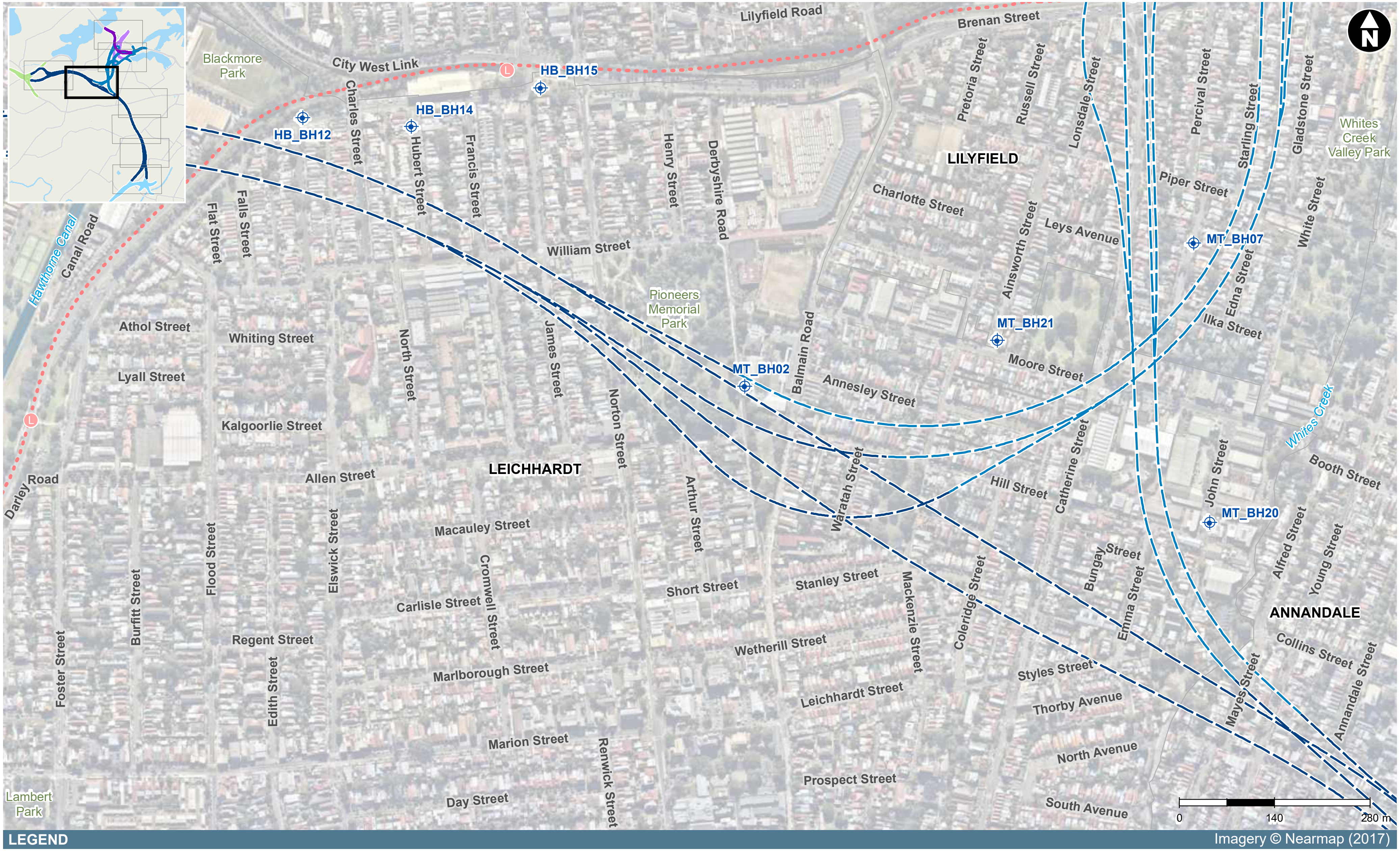
M4 East
- Surface road
- Tunnel

M4-M5 Link Mainline
- Surface road
- Tunnel

Project features
- Tunnel portal
- Tunnel connection

Monitoring well locations
- Groundwater monitoring well location (AECOM, 2016-2017)

Figure A-2 Location of monitoring wells - Map 1



LEGEND

Existing features
- Light rail
- Light rail stop

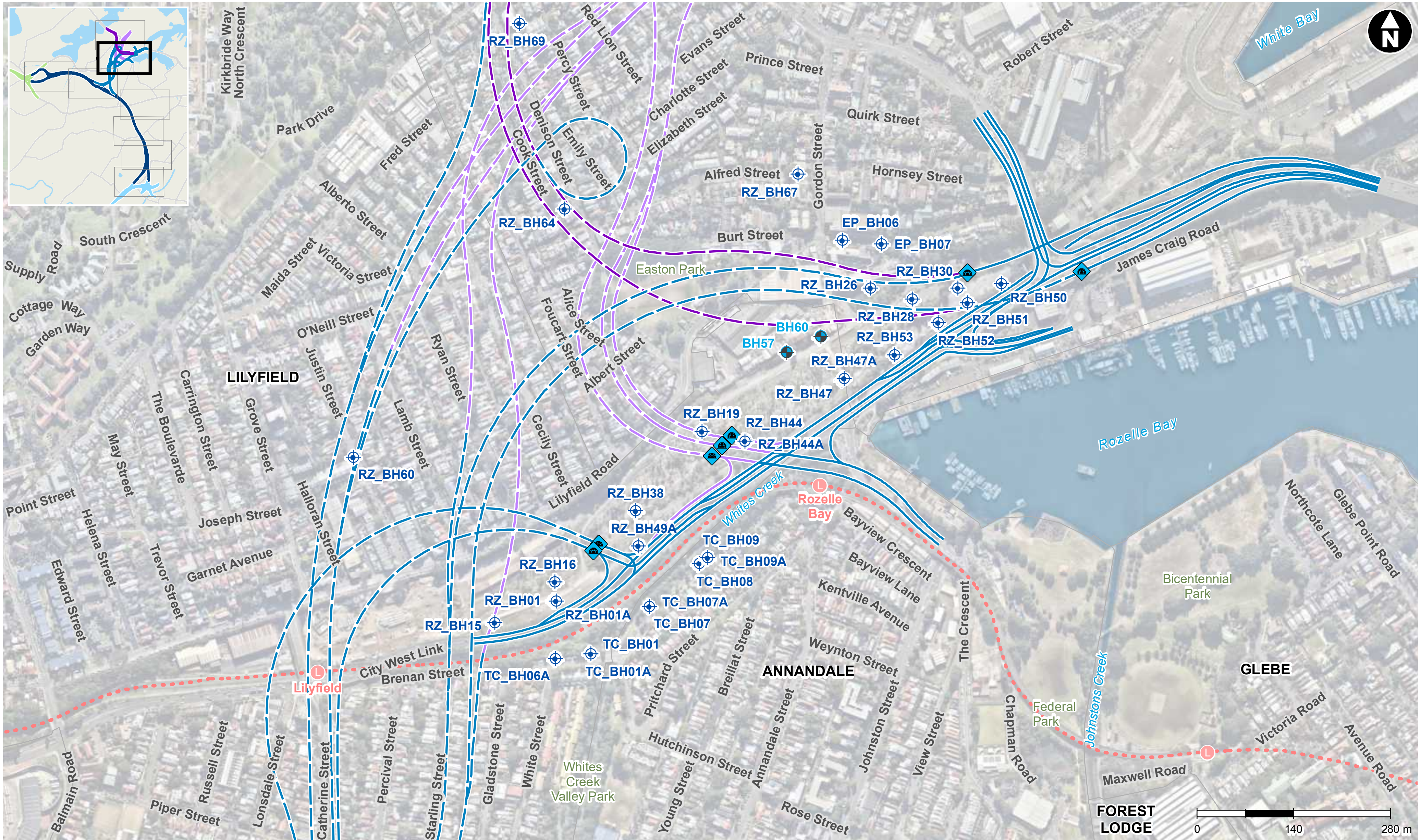
M4-M5 Link

Mainline
- Tunnel

Rozelle interchange
- Tunnel

Monitoring well locations
- Groundwater monitoring well location (AECOM, 2016-2017)

Figure A-3 Location of monitoring wells - Map 2



LEGEND

Imagery © Nearmap (2017)

Existing features

- Light rail
- Light rail stop

M4-M5 Link

Rozelle interchange

- Surface road
- Tunnel

Iron Cove Link

- Tunnel

Proposed future WHTBL connections (civil construction only)

- Surface road
- Tunnel

Project features

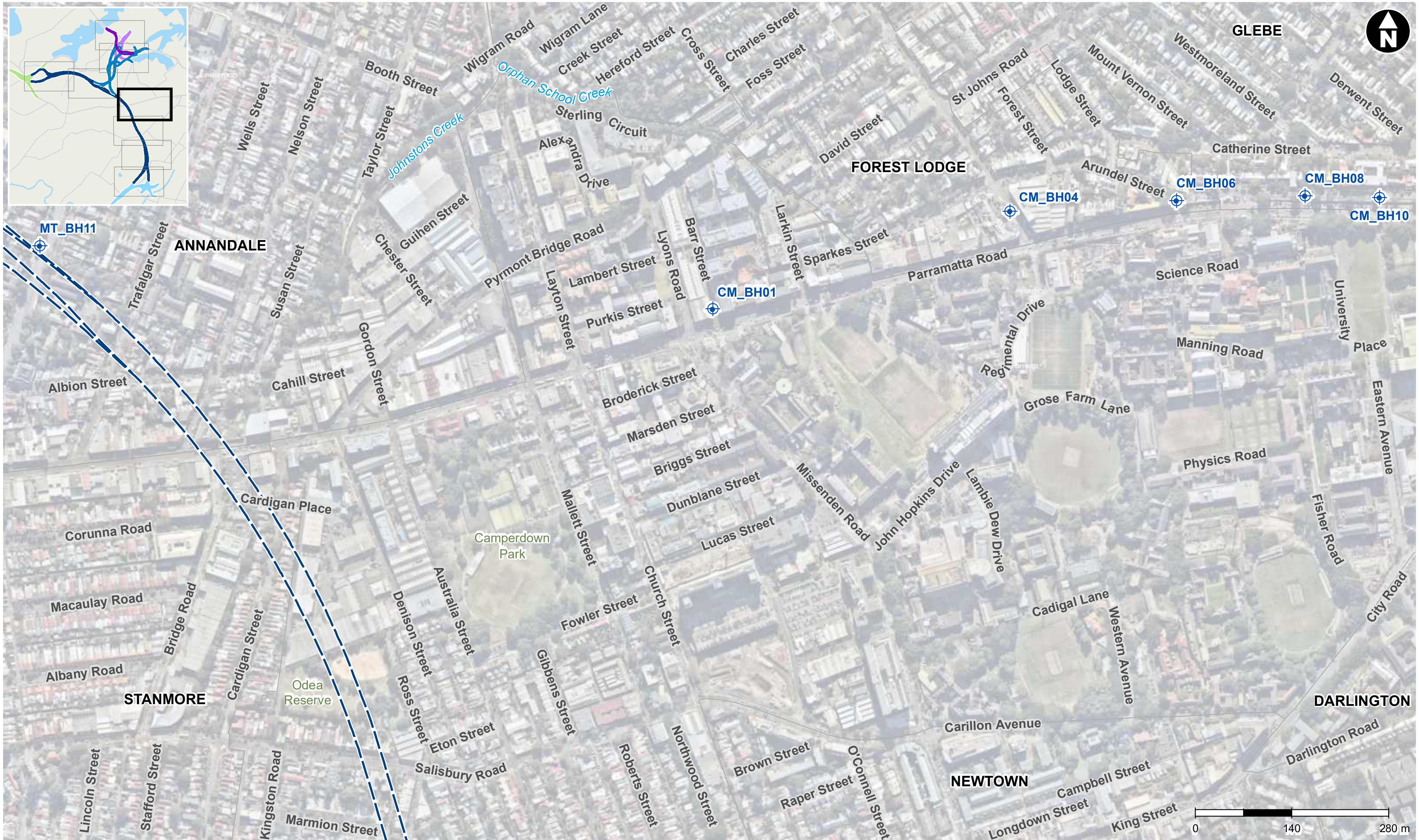
- Tunnel portal

Monitoring well locations

- Groundwater monitoring well location (AECOM, 2016-2017)
- Existing groundwater monitoring well location (PB, 2003)

Figure A-4 Location of monitoring wells - Map 3

Figure A-5 Location of monitoring wells - Map 4



LEGEND

Imagery © Nearmap (2017)

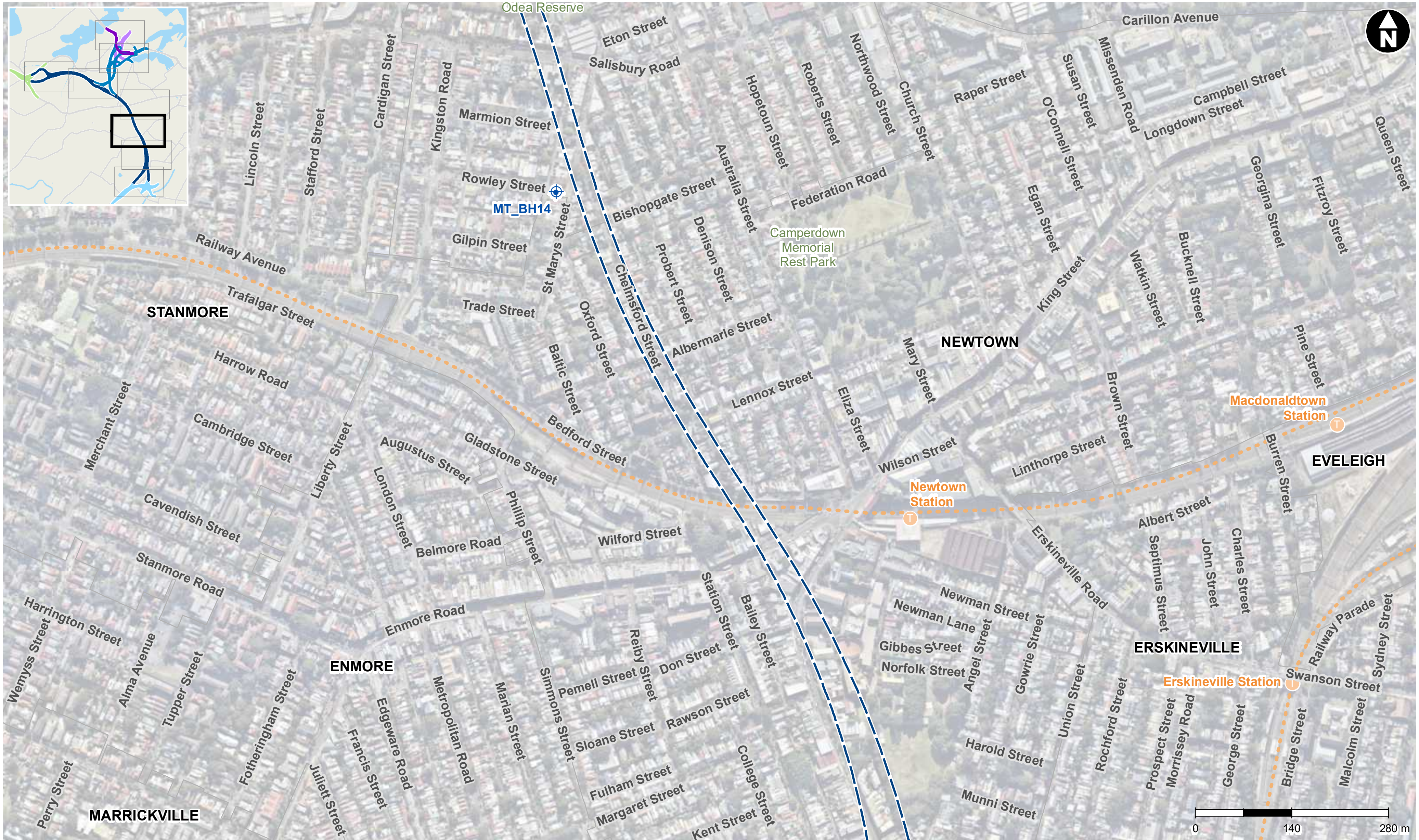
M4-M5 Link Mainline

Tunnel

Monitoring well locations

Groundwater monitoring well location (AECOM, 2016-2017)

Figure A-6 Location of monitoring wells - Map 5



LEGEND

Imagery © Nearmap (2017)

Existing features
- Railway
- Railway station

M4-M5 Link
Mainline
- Tunnel

Monitoring well locations
- Groundwater monitoring well location (AECOM, 2016-2017)

Figure A-7 Location of monitoring wells - Map 6

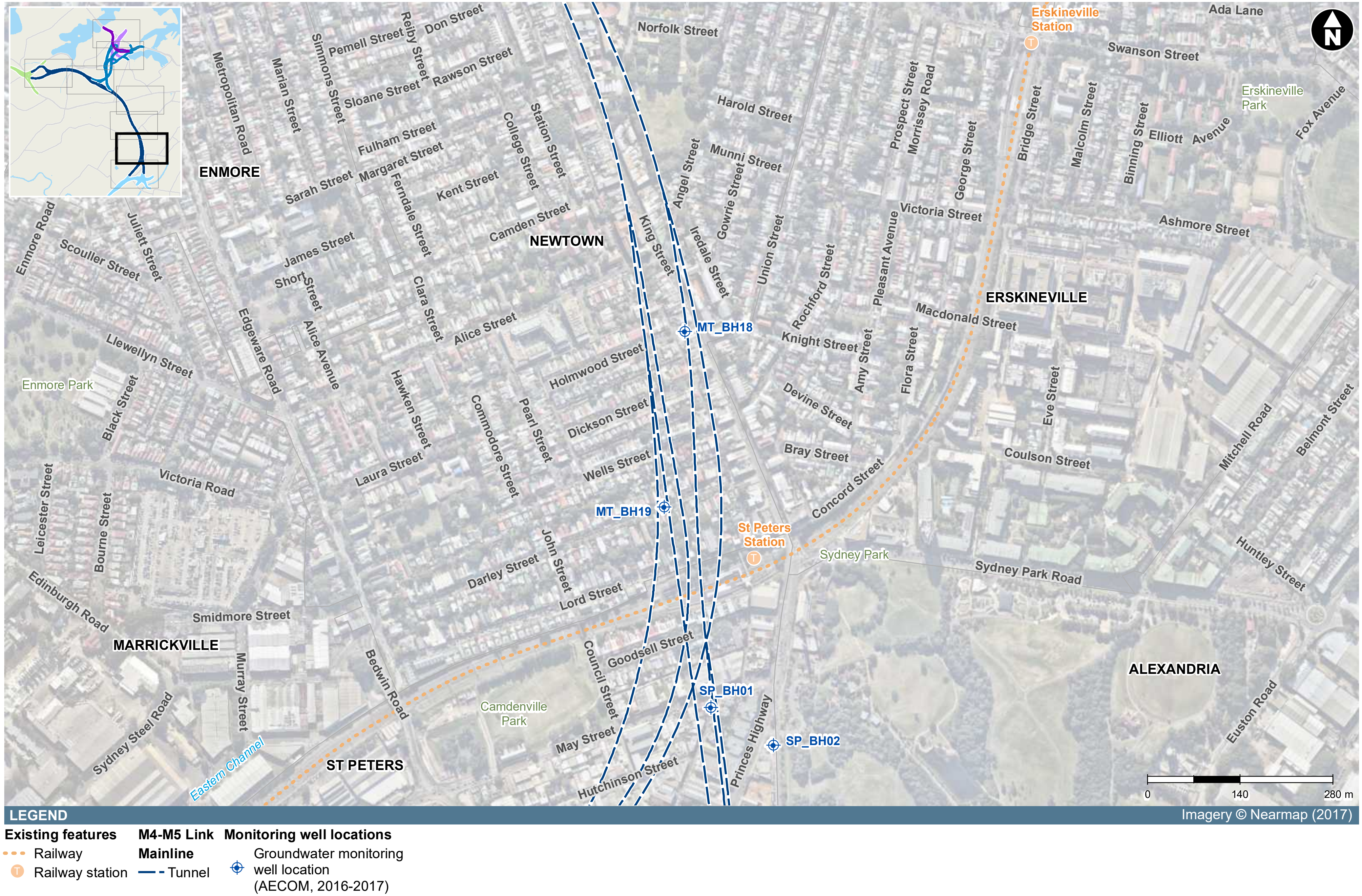


Figure A-8 Location of monitoring wells - Map 7

Figure A-9 Location of monitoring wells - Map 8

Annexure B – Summary tables

Annexure B – Summary tables

Summary Table B1
M4-M5 Link WestConnex
Groundwater Monitoring Well construction and monitoring details

Monitoring Well	Precinct	Location	Target Depth (m)	deep/ Shallow	RL toc^ mAHD	Date Completed	Co-ordinates		Screen Interval (m)	Lithology Screened	Data Logger Installed	Groundwater Quality Monitoring											
							Easting	Northing				Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17
CM_BH01	CAMPERDOWN	Barr St (west side) Camperdown	50	d	22.56	30-Aug-16	331645.53	6249003.82	23-26	Hawkesbury Sandstone					x								
CM_BH04	CAMPERDOWN	West side Ross Street, Toyota dealership, Camperdown	40	d	24.39	22-Aug-16	332076.52	6249145.78	16 - 19	Ashfield Shale	31-Aug-16			x			x						
CM_BH06	CAMPERDOWN	Opp 71 Arundel St, Camperdown	50	d	36.92	18-May-16	332317.67	6249160.53	25-28	Ashfield Shale	28-Jun-16	x	x	x	x								
CM_BH08	CAMPERDOWN	Road, opp 37A Arundel St, Camperdown	30	d	37.73	31-May-16	332503.60	6249167.77	27-30	Mittagong Formation				x									
CM_BH10	CAMPERDOWN	Road, opp 21 Arundel St, Camperdown	30	d	31.30	12-May-16	332612.02	6249165.47	17-20	Ashfield Shale	28-Jun-16	x			x								
HB_BH02	HABERFIELD	Grassed Verge, Cnr Dobroyd parade and Martin Street, Haberfield	50	d	2.80	04-May-16	327574.77	6250197.42	14-17	Hawkesbury Sandstone	08-Jun-16	x		x									
HB_BH03	HABERFIELD	Parking lane outside 236 Alternate St, Haberfield	50	d	6.15	30-Jun-16	327764.93	6250217.19	14-17	Hawkesbury Sandstone	10-Aug-16			x	x		x	x		x	x	x	x
HB_BH08d	HABERFIELD	Richard Murden Reserve, Hawthorne Parade, Haberfield	40	d	1.49	10-May-16	328751.96	6250138.18	22-25	Hawkesbury Sandstone	08-Jun-16	x	x	x	x		x	x	x	x	x	x	x
HB_BH08s	HABERFIELD	Richard Murden Reserve, Hawthorne Parade, Haberfield	13	s	1.43	10-May-16	328750.60	6250135.51	10-13	Alluvium	08-Jun-16	x	x	x	x		x	x	x	x	x	x	x
HB_BH12	HABERFIELD	Road Verge/ car park lane, Darley Rd, Leichhardt	40	d	2.13	21-Jun-16	329047.41	6250099.10	27-30	Hawkesbury Sandstone	14-Jul-16		x	x	x	x				x	x	x	x
HB_BH14	HABERFIELD	Parking outside 54-56 Hubert St, Leichhardt	40	d	4.20	25-May-16	329206.55	6250086.27	37-40	Hawkesbury Sandstone	14-Jul-16		x	x	x					x	x		x
HB_BH15	HABERFIELD	Traffic Island, Corner Darley Rd - James Rd	40	d	17.80	13-May-16	329396.41	6250142.83	19-22	Hawkesbury Sandstone	08-Jun-16	x	x	x	x	x	x	x	x	x	x	x	x
SP_BH01	ST PETERS	Parking Lane Western side, Applebee street, near No3, St Peters	40	d	17.71	07-Sep-16	331750.58	6246432.73	36 - 39	Ashfield Shale	13-Sep-16				x		x	x	x	x	x		x
SP_BH02	ST PETERS	Barwon Park Rd, parking Lane, next to service station, St Peters	46	s	19.42	26-May-16	331844.84	6246375.94	4-10	Residual Clay (Shale)	28-Jun-16	x	x	x	x		x	x		x	x		x
SP_BH04	ST PETERS	Corner Lackey St, Applebee St, St Peters	40	d	12.23	25-Jul-16	331657.95	6246185.60	32 - 35	Ashfield Shale	10-Aug-16			x			x	x	x	x	x	x	x
SP_BH06	ST PETERS	In Parking Lane, Opp 57 Crown St, St Peters	40	d	13.28	06-Jun-16	331800.08	6246136.08	20-23	Ashfield Shale	09-Jun-16	x			x			x					
SP_BH09	ST PETERS	Vacant lot, 4-16 Campbell St, St Peters	30	d	12.84	23-May-16	331800.90	6245948.32	23-26	Ashfield Shale	08-Jun-16	x	x										
RZ_BH01d	ROZELLE	Rozelle Rail Yards	30	d	6.30	23-May-16	330608.87	6250381.26	22-25	Hawkesbury Sandstone	28-Jun-16	x	x	x		x	x	x	x	x	x	x	x
RZ_BH01s	ROZELLE	Rozelle Rail Yards	10	s	6.39	23-May-16	330611.47	6250381.61	7-10	alluvium	28-Jun-16	x	x	x	x		x	x	x	x	x	x	x
RZ_BH15	ROZELLE	Rozelle Rail Yards	35	d	6.02	09-Jun-16	330522.59	6250349.91	18-21	Hawkesbury Sandstone	28-Jun-16	x	x	x		x	x	x	x	x	x	x	x
RZ_BH16d	ROZELLE	Rozelle Rail Yards	35	d	5.82	15-Jun-16	330609.43	6250409.41	17-20	Hawkesbury Sandstone	14-Jul-16		x	x		x	x	x	x	x	x	x	x
RZ_BH19	ROZELLE	Rozelle Rail Yards	35	d	2.46	21-Jul-16	330822.45	6250626.95	19-22	Hawkesbury Sandstone	11-Aug-16			x		x	x	x	x	x	x	x	x
RZ_BH26	ROZELLE	east of Rozelle Rail Yards	35	d	2.84	12-Jul-16	331066.28	6250835.05	20 - 23	Hawkesbury Sandstone	14-Jul-16		x	x		x	x	x	x	x	x	x	x
RZ_BH28d	ROZELLE	Rozelle Rail Yards	35	d	2.83	28-Jul-16	331126.56	6250818.78	27-30	Hawkesbury Sandstone	11-Aug-16			x		x	x	x	x	x	x	x	x
RZ_BH30	ROZELLE	Rozelle Rail Yards, near off ramp to ANZAC Bridge	35	d	2.04	13-Jul-16	331192.90	6250834.96	16 - 19	Hawkesbury Sandstone	27-Jul-16		x	x	x	x			x			x	x
RZ_BH38	ROZELLE	Rozelle Rail Yards	35	d	2.27	01-Aug-16	330726.61	625012.07	28 - 31	Hawkesbury Sandstone	10-Aug-16			x		x	x	x	x	x	x	x	x
RZ_BH44d	ROZELLE	Rozelle Rail Yards	35	d	2.29	08-Aug-16	330885.77	6250613.96	25 - 28	Hawkesbury Sandstone	10-Aug-16			x	x	x	x	x	x	x	x	x	x
RZ_BH44s	ROZELLE	Rozelle Rail Yards	10	s	2.25	09-Aug-16	330884.43	6250613.29	12-15	Alluvium	10-Aug-16			x			x	x	x	x	x	x	x
RZ_BH47d	ROZELLE	Rozelle Rail Yards, adjacent Rozelle Bay	35	d	2.30	08-Aug-16	331025.23	6250701.67	27 - 30	Hawkesbury Sandstone	10-Aug-16			x	x		x	x	x	x	x	x	x
RZ_BH47s	ROZELLE	Rozelle Rail Yards, adjacent Rozelle Bay	20	s	2.50	04-Aug-16	331027.87	6250703.96	15 - 18	Alluvium	31-Aug-16			x	x		x	x	x	x	x	x	x
RZ_BH49s	ROZELLE	Rozelle Rail Yards	16	s	5.99	28-Jun-16	330730.38	6250461.58	13-16	alluvium	14-Jul-16		x	x	x		x	x		x	x	x	x
RZ_BH50	ROZELLE	Rozelle Rail Yards - Marrs Cranes	30	d	1.92	10-Aug-16	331255.63	6250841.07	22-25	Hawkesbury Sandstone	31-Aug-16			x		x	x	x	x	x	x	x	x
RZ_BH51	ROZELLE	Rozelle Rail Yards - Marrs Cranes	30	d	2.15	08-Aug-16	331206.58	6250813.32	19-22	Hawkesbury Sandstone	10-Aug-16			x		x	x	x	x	x		x	x
RZ_BH52	ROZELLE	Rozelle Rail Yards - Marrs Cranes	40	d	2.53	03-Aug-16	331163.77	6250784.58	32 - 35	Hawkesbury Sandstone	10-Aug-16			x		x	x	x		x	x	x	x
RZ_BH53	ROZELLE	SHFA	40	d	2.67	06-Sep-16	331100.88	6250738.06	18 - 21	Hawkesbury Sandstone													
RZ_BH60	Rozelle Interchange	Opposite 46 Justin St, Lilyfield - west parking lane	70	d	24.96	07-Dec-16	330317.83	6250589.57	56-59	Hawkesbury Sandstone	22-Dec-16								x	x	x	x	x
RZ_BH64	Rozelle Interchange	Brockley Street, Rozelle - south parking lane adjacent to 59 Deniso	60	d	10.38	20-Dec-16	330623.5	6250949	46-49	Hawkesbury Sandstone													x
RZ_BH67	Rozelle Interchange	Alfred St, Rozelle - north parking lane adjacent to 27 Gordon street	60	d	12.84	14-Dec-16	330961.48	6250999.73	46-49	Hawkesbury Sandstone	11-Jan-17								x	x	x	x	x
RZ_BH69	Rozelle Interchange	Opposite 1 Albion Street, rozelle - north parking lane	50	d	30.29	23-Jan-17	330558.2	6251218	38 - 41	Hawkesbury Sandstone											x		
TC_BH01d	THE CRESCENT	RailCorp Property, corner Brennan ST, Railway Pde, Lilyfield	50	d	2.54	28-May-16	330661.99	6250305.25	25-28	Hawkesbury Sandstone	08-Jul-16	x	x	x	x	x	x	x	x	x	x	x	x
TC_BH01s	THE CRESCENT	RailCorp Property, corner Brennan ST, Railway Pde, Lilyfield	10	s	2.55	28-May-16	330660.57	6250304.92	3-6	alluvium	08-Jul-16	x	x	x	x		x	x	x	x	x	x	x
TC_BH06s	THE CRESCENT	Grass Verge, Opposite White Street, Brenan Street, Railway Parad	40	s	2.65	05-Jul-16	330610.16	6250298.14	4.5-7.5	alluvium	08-Jul-16	x	x	x			x	x	x	x	x	x	x
TC_BH07d	THE CRESCENT	Grass Verge, Opposite No. 62 Railway Parade, Annandale	40	d	2.03	05-Jul-16	330746.03	6250373.57	19-22	Hawkesbury Sandstone	08-Jul-16	x	x	x	x				x	x	x	x	x
TC_BH07s	THE CRESCENT	Grass Verge, Opposite No. 62 Railway Parade, Annandale	10	s	2.06	05-Jul-16	330747.41	6250374.95	3-6	Alluvium	08-Jul-16	x	x	x	x		x		x	x	x	x	x
TC_BH08s	THE CRESCENT	Grass verge, Opposite No. 44-46 Railway Parade, Annandale	35	s	2.24	11-Jul-16	330818.34	6250435.89	5-8	Alluvium	27-Jul-16		x	x	x		x	x	x	x	x	x	x
TC_BH09d	THE CRESCENT	Grass Verge,Opposite No. 38-40 Railway Parade, Annandale	40	d	2.25	01-Jul-16	330830.31	6250444.46	21-24	Hawkesbury Sandstone	27-Jul-16		x	x	x	x	x	x	x	x	x	x	x
TC_BH09s	THE CRESCENT	Grass Verge,Opposite No. 38-40 Railway Parade, Annandale	10	s	2.29	04-Jul-16	330832.70	6250445.81	2-5	alluvium	27-Jul-16		x	x	x		x	x	x	x		x	x
IC_BH01	IRON COVE	Parking lane outside 46 Waterloo St, Rozelle, corner of Moodie St	30	d	26.77	17-Oct-16	330514.22	6251504.54	23-26	Hawkesbury Sandstone	14-Oct-16					x		x	x		x	x	
IC_BH02	IRON COVE	North parking Lane, Toelle St, outside 242 Victoria Road	35	d	20.77	19-Oct-16	330334.97	6251646.37	8-11	Hawkesbury Sandstone	20-Oct-16								x		x	x	x
EP_BH06	EASTON PARK	Opposite 55 Lilyfield Road, Rozelle	15	d	7.60	24-Oct-16	331025.39	6250903.92	10-13	Hawkesbury Sandstone	27-Oct-16							x	x	x	x	x	x
EP_BH07	EASTON PARK	Opposite 50 Starling St Lilyfield - parking lane	15	d	10.48	26-Oct-16	331082.28	6250898.80	10-13	Hawkesbury Sandstone	27-Oct-16							x	x	x	x	x	x
MT_BH02	Main Line Tunnel	Derbyshire Rd, Leichhardt adjacent to 183 Balmain Rd	70	d	34.10	24-Jan-17	329696.1	6249704.0	42-45	Hawkesbury Sandstone	28-Apr-17										x	x	x
MT_BH07	Main Line Tunnel	White Creek Reserve, opp 22 White Street, Lilyfield	60	d	24.41	21-Nov-16	330355.81	6249914.91	43-46	Hawkesbury Sandstone	12-Jan-17								x	x	x	x	x
MT_BH11	Main Line Tunnel	68 Johnstone St, Annandale - parking lane	70	d	28.67	30-Nov-16	330670.67	6249095.13	48-51	Hawkesbury Sandstone	12-Jan-17								x				
MT_BH14	Main Line Tunnel	no 4 Marmion St, Camperdown, north parking lane	73	d	27.31	10-Nov-16	331168.37	6248149.99	27-30	Hawkesbury Sandstone	22-Dec-16								x	x	x	x	
MT_BH19	Main Line Tunnel	34 Darley Road Newtown	70	d	16.07	14-Dec-16	331680.25	6246735.87	55-58	Hawkesbury Sandstone	22-Dec-16								x	x			x
MT_BH20	Main Line Tunnel	John Street, Leichhardt - east parking lan adjacent to 19 Hill Street	55	d	12.27	20-Dec-16	330379.4	6249503	41-44	Hawkesbury Sandstone										x			
MT_BH21	Main Line Tunnel	Ainsworth Street, Lilyfield, - east parking	70	d	25.05	13-Dec-16	330066.72	6249771	47-50	Hawkesbury Sandstone	12-Jan-17								x		x		

Notes: SWL - standing water level, toc - top of casing, mbtoc - metres below top of casing

Summary Table B2
M4M5 Link WestConnex
Manual groundwater level monitoring
Measured Standing Water Level (SWL)

Monitoring Well	Lithology	screen interval	RL toc	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD	SWL mbtoc	SWL mAHD
	Screened	(m)	mAHD	Jun-16		Jul-16		Aug-16		Sep-16		Oct-16		Nov-16		Dec-16		Jan-17		Feb-17		Mar-17		Apr-17		May-17	
CM_BH01	Hawkesbury Sandstone	23 - 26	22.56					2.29	20.27	8.01	14.55																
CM_BH04	Ashfield Shale	16 - 19	24.39											2.28	22.11												
CM_BH06	Ashfield Shale	25-28	36.92	7.13	29.79	6.99	29.93	6.97	29.95	6.98	29.94																
CM_BH08	Mittagong Formation	27-30	37.73																								
CM_BH10	Ashfield Shale	17-20	31.30	8.71	22.59																						
HB_BH02	Hawkesbury Sandstone	14-17	2.80	2.19	0.61			2.28	0.52																		
HB_BH03	Hawkesbury Sandstone	14-17	6.15					2.01	4.14	2.06	4.09	2.25	3.90	2.504	3.65					2.73	3.42	0.578	5.57	2.20	3.95	2.475	3.68
HB_BH08d	Hawkesbury Sandstone	22-25	1.49	flowing	1.49+	flowing	1.49+	flowing	1.49+					flowing	1.49+									flowing	1.49+		
HB_BH08s	Alluvium	10-13	1.43	0.31	1.12	0.37	1.06	0.39	1.04	0.45	0.98	0.52	0.92	0.626	0.80	0.60	0.83	0.64	0.79	0.60	0.83	0.503	0.93	0.28	1.15	0.505	0.93
HB_BH12	Hawkesbury Sandstone	27-30	2.13			0.02	2.11	0.02	2.11			0.05	2.08			0.05	2.08			0.08	2.05	0.02	2.11	0.02	2.11	0.2	1.93
HB_BH14	Hawkesbury Sandstone	37-40	4.20			1.69	2.51	1.66	2.54							1.73	2.47			1.73	2.47	1.538	2.66			1.518	2.68
HB_BH15	Hawkesbury Sandstone	19-22	17.80	9.6	8.20	9.66	8.14	9.76	8.04	9.327	8.47	9.60	8.20	9.695	8.11	9.68	8.12	9.66	8.14	9.62	8.18	9.674	8.13	9.64	8.16	9.677	8.12
SP_BH01	Ashfield Shale	36 - 39	17.71							8.27	9.44			9.028	8.68	9.05	8.66	9.06	8.65	9.066	8.64	9.069	8.64	9.10	8.61	9.091	8.62
SP_BH02	Residual Clay (Shale)	4-10	19.42	2.39	17.03	2.75	16.67	2.50	16.92	2.552	16.87	9.00	10.43	3.082	16.34					3.454	15.97					3.239	16.18
SP_BH04	Ashfield Shale	32 - 35	12.23					8.55	3.68	7.86	4.37	8.10	4.13	8.023	4.21	8.03	4.20	7.95	4.28	7.975	4.26	7.961	4.27	7.51	4.72	8.786	3.44
SP_BH06	Ashfield Shale	20-23	13.28	2.4	10.88									6.055	7.23	6.59	6.69										
SP_BH09	Ashfield Shale	23-26	12.84	3.82	9.02	16.37	-3.53																				
RZ_BH01d	Hawkesbury Sandstone	22-25	6.30	3.91	2.39	4.31	1.99	4.74	1.56	4.71	1.59	5.11	1.20	4.745	1.56	4.91	1.39	4.86	1.44	4.71	1.59	4.573	1.73	4.56	1.75	4.771	1.53
RZ_BH01s	alluvium	7-10	6.39	4.39	2.00	4.36	2.03	4.35	2.04	4.422	1.97	4.56	1.83	4.669	1.72	4.72	1.67	4.76	1.64	4.50	1.89	4.421	1.97	4.39	2.00	4.537	1.85
RZ_BH15	Hawkesbury Sandstone	18-21	6.02	3.55	2.47	4	2.02	4.45	1.57	4.38	1.64	4.57	1.45	4.439	1.58	4.46	1.56	4.55	1.47	4.45	1.57	4.243	1.78	4.27	1.75	4.483	1.54
RZ_BH16d	Hawkesbury Sandstone	17-20	5.82			4.11	1.71	4.26	1.56	4.257	1.56	4.37	1.45	4.223	1.60	3.29	2.53	4.39	1.43	4.22	1.60	4.102	1.72	4.05	1.77	4.335	1.49
RZ_BH19	Hawkesbury Sandstone	19-22	2.46					1.00	1.46	0.956	1.50	1.02	1.44	1.083	1.38	1.01	1.45	0.84	1.62	0.81	1.65	0.853	1.61	0.76	1.70	1.021	1.44
RZ_BH26	Hawkesbury Sandstone	20 - 23	2.84			1.1	1.74	1.32	1.52	1.335	1.51	1.60	1.24	1.443	1.40	1.42	1.42	1.20	1.64	1.52	1.32	1.314	1.53	0.22	2.62	1.328	1.51
RZ_BH28d	Hawkesbury Sandstone	27-30	2.83					0.93	1.90	1.06	1.77	1.64	1.19	1.194	1.64	1.20	1.63	1.08	1.75	1.07	1.76	1.059	1.77	0.95	1.88	1.15	1.68
RZ_BH30	Hawkesbury Sandstone	16 - 19	2.04			0.02	2.02	0.54	1.50	0.473	1.57							0.57	1.47	#				0.46	1.59	0.555	1.49
RZ_BH38	Hawkesbury Sandstone	28 - 31	2.27					0.55	1.72	0.69	1.58	0.71	1.57	1.49	0.78	0.79	1.48	0.92	1.35	0.65	1.62	0.638	1.63	0.54	1.73	0.793	1.48
RZ_BH44d	Hawkesbury Sandstone	25 - 28	2.29					0.42	1.87	0.67	1.62	0.76	1.53	0.78	1.51	0.90	1.39	0.56	1.73	0.56	1.73	0.602	1.69	0.53	1.76	1.267	1.02
RZ_BH44s	Alluvium	12-15	2.25					1.14	1.11	1.298	0.95	1.36	0.89	1.431	0.82	1.49	0.76	1.44	0.81	1.35	0.90	1.214	1.04	1.18	1.07	1.331	0.92
RZ_BH47d	Hawkesbury Sandstone	27 - 30	2.30					0.75	1.55	0.783	1.52	1.67	0.63	0.891	1.41	0.99	1.31	0.62	1.69	0.61	1.69	0.751	1.55	0.64	1.66	0.831	1.47
RZ_BH47s	Alluvium	15 - 18	2.50					1.34	1.16	1.393	1.11	1.38	1.12	1.434	1.07	1.49	1.01	1.36	1.14	1.32	1.19	1.294	1.21	1.23	1.27	1.382	1.12
RZ_BH49s	alluvium	13-16	5.99			4.64	1.35	4.65	1.34	4.694	1.30	4.81	1.19	4.73	1.26	4.95	1.04	4.91	1.08	4.79	1.20	4.534	1.46	4.57	1.42	4.763	1.23
RZ_BH50	Hawkesbury Sandstone	22-25	1.92					0.05	1.87	0.455	1.47	0.60	1.32	0.914	1.01	0.53	1.39	0.47	1.45	0.62	1.30	0.662	1.26	0.68	1.24	0.969	0.95
RZ_BH51	Hawkesbury Sandstone	19-22	2.15					0.01	2.14	0.704	1.45	0.60	1.55	0.766	1.38	0.80	1.35	0.69	1.46	0.49	1.66	0.504	1.65	0.59	1.57	0.671	1.48
RZ_BH52	Hawkesbury Sandstone	32 - 35	2.53					1.01	1.52	1.304	1.23	1.12	1.41	1.523	1.01	1.11	1.42			0.97	1.56	0.989	1.54	0.87	1.66	1.057	1.47
RZ_BH60	Hawkesbury Sandstone	56-59	24.96																	12.50	12.46	12.391	12.57	12.22	12.74	12.395	12.57
RZ_BH64	Hawkesbury Sandstone	46-49	10.38																	15.24	-4.86					1.318	9.06
RZ_BH67	Hawkesbury Sandstone	46-49	12.84																	4.03	8.81	5.049	7.79	4.20	8.64	4.392	8.45
RZ_BH69	Hawkesbury Sandstone	38-41	30.29																	15.236	15.05	15.023	15.27				
TC_BH01d	Hawkesbury Sandstone	25-28	2.54			0.77	1.77	0.89	1.65	0.994	1.55	1.06	1.48	0.73	1.81	1.02	1.52	1.05	1.49	0.97	1.57	1.821	0.72	0.55	1.99	1.026	1.51
TC_BH01s	alluvium	3-6	2.55			1.53	1.02	1.55	1.00	1.637	0.91	1.78	0.77	1.915	0.64	1.93	0.62	1.94	0.61	1.83	0.72	1.727	0.823	1.61	0.94	1.745	0.81
TC_BH06s	alluvium	4.5-7.5	2.65							1.57	1.08	1.50	1.15	1.62	1.03	1.63	1.02	1.69	0.96	1.50	1.15	1.421	1.229	1.46	1.19	1.476	1.17
TC_BH07d	Hawkesbury Sandstone	19-22	2.03			1.06	0.97	0.40	1.63									0.68	1.35	0.40	1.63	0.304	1.726	0.38	1.65	0.529	1.50
TC_BH07s	Alluvium	3-6	2.06			1.06	1.00	1.59	0.47	1.655	0.41	1.72	0.34	0.744	1.32	1.75	0.31	1.70	0.36	1.57	0.49	1.634	0.426	1.60	0.46	1.724	0.34
TC_BH08s	Alluvium	5-8	2.24			1.58	0.66	1.59	0.65	1.655	0.59	1.76	0.48	0.785	1.46	1.80	0.44	1.74	0.51	1.66	0.58	1.639	0.601	1.65	0.59	1.738	0.50
TC_BH09d	Hawkesbury Sandstone	21-24	2.25			0.61	1.64	0.64	1.61	0.675	1.58	0.80	1.45	0.69	1.56	0.84	1.41	0.74	1.51	0.67	1.58	0.559	1.691	0.65	1.60	0.836	1.41
TC_BH09s	alluvium	2-5	2.29			1.61	0.68	1.60	0.69			1.75	0.54	0.85	1.44	1.78	0.51	1.75	0.54	1.71	0.58		2.29	1.66	0.63	1.724	0.57
IC_BH01	Hawkesbury Sandstone	23-26	26.77									7.51	19.26	7.54	19.23	7.86	18.91	7.80	18.97			8.029	18.74	7.91	18.86		
IC_BH02	Hawkesbury Sandstone	8-11	20.77													4.03	16.74					3.342	17.43	2.91	17.86	3.32	17.45
EP_BH06	Hawkesbury Sandstone	10-13	7.60									3.48	4.12	3.77	3.83	3.80	3.80	3.78	3.82	3.754	3.85	3.555	4.046	3.56	4.04	3.763	3.84
EP_BH07	Hawkesbury Sandstone	10-13	10.48									7.02	3.46	7.46	3.02	7.08	3.40	7.57	2.91	7.726	2.75	7.704	2.774	7.44	3.03	7.613	2.87
MT_BH02	Hawkesbury Sandstone	42-45	34.10																	25.79	8.31	25.431	8.669	25.50	8.60	25.258	8.84
MT_BH07	Hawkesbury Sandstone	43-46	24.41																	19.01	5.40	18.837	5.573	18.78	5.63	17.918	6.49
MT_BH11	Hawkesbury Sandstone	48-51	28.67																			19.706	8.96				
MT_BH14	Hawkesbury Sandstone	27-30	27.31															16.71	10.60	3.591	23.72	16.726	10.584	16.61	10.70		
MT_BH18	Hawkesbury Sandstone	55-58	24.66																	16.772	7.89					12.049	12.61
MT_BH20	Hawkesbury Sandstone	41-44	12.27																			1.956	10.31				
MT_BH21	Hawkesbury Sandstone	47-50	25.05																	10.51	14.54	10.26	14.79				
BH57	alluvium	2-5	^							1.82				2.19		2.21								1.47		2.097	
BH60	alluvium	1-4	^							2.64						2.68		2.66						2.88		2.686	

Note: ^ not surveyed

Summary Table B3
M4M5 Link WestConnex
Historical Groundwater Level Monitoring

Monitoring Well	Co-ordinates		Location	Lithology	screen	RL toc		swl		data source
	Easting	Northing			interval		sample			
				Screened	(m)	mAHD	date	mbtoc	mAHD	
BH3103_141d	327085.4	6250739.8	Cashman Ln, Five Dock		19.9-25.9	16.80	13-Aug-15	12.870	3.93	Sydney Metro - Douglas Partners
BH3103_141d	327085.4	6250739.8	Cashman Ln, Five Dock		19.9-25.9	16.80	24-Sep-15	13.000	3.80	Sydney Metro - Douglas Partners
BH3103_141d	327085.4	6250739.8	Cashman Ln, Five Dock		19.9-25.9	16.80	14-Oct-15	13.050	3.75	Sydney Metro - Douglas Partners
BH3103_141d	327085.4	6250739.8	Cashman Ln, Five Dock		19.9-25.9	16.80	17-Nov-15	13.180	3.62	Sydney Metro - Douglas Partners
BH3103_141d	327085.4	6250739.8	Cashman Ln, Five Dock		19.9-25.9	16.80	17-Dec-15	13.050	3.75	Sydney Metro - Douglas Partners
BH3103_141d	327085.4	6250739.8	Cashman Ln, Five Dock		19.9-25.9	16.80	21-Jan-16	12.945	3.86	Sydney Metro - Douglas Partners
BH3103_141d	327085.4	6250739.8	Cashman Ln, Five Dock		19.9-25.9	16.80	18-Feb-16	12.940	3.86	Sydney Metro - Douglas Partners
BH3103_141d	327085.4	6250739.8	Cashman Ln, Five Dock		19.9-25.9	16.80	23-Mar-16	12.960	3.84	Sydney Metro - Douglas Partners
BH3103_141d	327085.4	6250739.8	Cashman Ln, Five Dock		19.9-25.9	16.80	12-Apr-16	13.150	3.65	Sydney Metro - Douglas Partners
BH3103_141d	327085.4	6250739.8	Cashman Ln, Five Dock		19.9-25.9	16.80	11-May-16	13.140	3.66	Sydney Metro - Douglas Partners
BH3103_141s	327084.6	6250739.6	Cashman Ln, Five Dock		4.1-7.1	16.80	13-Aug-15	2.830	13.97	Sydney Metro - Douglas Partners
BH2103_WM2_BH2	325351.6	6250821.9	Cintra Park, Canada Bay	Hawkesbury Sst	25m deep	4.26	13-Aug-15	1.120	3.14	West Metro - Coffey
BH2103_WM2_BH2	325351.6	6250821.9	Cintra Park, Canada Bay		25m deep	4.26	23-Sep-15	1.100	3.16	West Metro - Coffey
BH2103_WM2_BH2	325351.6	6250821.9	Cintra Park, Canada Bay		25m deep	4.26	14-Oct-15	1.170	3.09	West Metro - Coffey
BH2103_WM2_BH2	325351.6	6250821.9	Cintra Park, Canada Bay		25m deep	4.26	17-Nov-15	1.020	3.24	West Metro - Coffey
BH2103_WM2_BH2	325351.6	6250821.9	Cintra Park, Canada Bay		25m deep	4.26	16-Dec-15	1.110	3.15	West Metro - Coffey
BH2103_WM2_BH2	325351.6	6250821.9	Cintra Park, Canada Bay		25m deep	4.26	19-Jan-16	0.770	3.49	West Metro - Coffey
BH209	321821.1	6251845.8	adjacent to M4, Homebush		15-18m	10.573	23-Jun-15	5.900	4.67	M4East investigations
BH209	321821.1	6251845.8	adjacent to M4, Homebush		15-18m	10.573	28-Jul-15	6.060	4.51	M4East investigations
BH214	321920.3	6251894.0	adjacent to M4, Homebush		6 - 9.5m	6.049	24-Jun-15	4.550	1.50	M4East investigations
BH214	321920.3	6251894.0	adjacent to M4, Homebush		6 - 9.5m	6.049	30-Jul-15	4.931	1.12	M4East investigations
BH220	322042.3	6251745.8	adjacent to M4, Homebush		21-24m	3.352	23-Jun-15	2.690	0.66	M4East investigations
BH220	322042.3	6251745.8	adjacent to M4, Homebush		21-24m	3.352	28-Jul-15	2.500	0.85	M4East investigations
BH225	322207.8	6251636.6	Park Rd, Homebush		9-12	9.903	23-Jun-15	6.580	3.32	M4East investigations
BH225	322207.8	6251636.6	Park Rd, Homebush		9-12m	9.903	28-Jul-15	6.800	3.10	M4East investigations
BH225	322207.8	6251636.6	Park Rd, Homebush		9-12	9.903	11-Aug-15	6.740	3.16	M4East investigations
BH225	322207.8	6251636.6	Park Rd, Homebush		9-12	9.903	23-Sep-15	6.760	3.14	M4East investigations
BH225	322207.8	6251636.6	Park Rd, Homebush		9-12	9.903	15-Oct-15	6.870	3.03	M4East investigations
BH225	322207.8	6251636.6	Park Rd, Homebush		9-12	9.903	17-Nov-15	6.897	3.01	M4East investigations
BH225	322207.8	6251636.6	Park Rd, Homebush		9-12	9.903	15-Dec-15	6.989	2.91	M4East investigations
BH225	322207.8	6251636.6	Park Rd, Homebush		9-12	9.903	19-Jan-16	6.477	3.43	M4East investigations
BH225	322207.8	6251636.6	Park Rd, Homebush		9-12	9.903	16-Feb-16	6.760	3.14	M4East investigations
BH225	322207.8	6251636.6	Park Rd, Homebush		9-12	9.903	21-Mar-16	7.225	2.68	M4East investigations
BH225	322207.8	6251636.6	Park Rd, Homebush		9-12	9.903	12-Apr-15	6.910	2.99	M4East investigations
BH225	322207.8	6251636.6	Park Rd, Homebush		9-12	9.903	9-May-16	6.930	2.97	M4East investigations
BH235	322508.0	6251588.5	Bill Boyce Reserve, Homebush		9-12	14.131	23-Jun-15	5.960	8.17	M4East investigations
BH235	322508.0	6251588.5	Bill Boyce Reserve, Homebush		9-12	14.131	30-Jul-15	8.950	5.18	M4East investigations

swl - standing water level
ND - not done
mbtoc - metres below top of casing
RL toc - relative level top of casing

Summary Table B3
M4M5 Link WestConnex
Historical Groundwater Level Monitoring

Monitoring Well	Co-ordinates Easting	Co-ordinates Northing	Location	Lithology Screened	screen interval (m)	RL toc mAHD	sample date	swl mbtoc	swl mAHD	data source
BH235	322508.0	6251588.5	Bill Boyce Reserve, Homebush		9-12	14.131	11-Aug-15	8.900	5.23	M4East investigations
BH235	322508.0	6251588.5	Bill Boyce Reserve, Homebush		9-12	14.131	23-Sep-15	8.930	5.20	M4East investigations
BH235	322508.0	6251588.5	Bill Boyce Reserve, Homebush		9-12	14.131	15-Oct-15	8.950	5.18	M4East investigations
BH235	322508.0	6251588.5	Bill Boyce Reserve, Homebush		9-12	14.131	17-Nov-15	8.982	5.15	M4East investigations
BH235	322508.0	6251588.5	Bill Boyce Reserve, Homebush		9-12	14.131	15-Dec-15	8.890	5.24	M4East investigations
BH235	322508.0	6251588.5	Bill Boyce Reserve, Homebush		9-12	14.131	19-Jan-16	9.010	5.12	M4East investigations
BH235	322508.0	6251588.5	Bill Boyce Reserve, Homebush		9-12	14.131	16-Feb-16	8.920	5.21	M4East investigations
BH235	322508.0	6251588.5	Bill Boyce Reserve, Homebush		9-12	14.131	21-Mar-16	8.930	5.20	M4East investigations
BH235	322508.0	6251588.5	Bill Boyce Reserve, Homebush		9-12	14.131	12-Apr-16	8.950	5.18	M4East investigations
BH235	322508.0	6251588.5	Bill Boyce Reserve, Homebush		9-12	14.131	9-May-16	8.900	5.23	M4East investigations
BH246	323031.0	6251330.1	Ismay Reserve, Homebush		6-9	5.458	28-Jul-15	3.918	1.54	M4East investigations
BH246	323031.0	6251330.1	Ismay Reserve, Homebush		6-9	5.458	13-Aug-15	6.360	-0.90	M4East investigations
BH246	323031.0	6251330.1	Ismay Reserve, Homebush		6-9	5.458	23-Sep-15	7.480	-2.02	M4East investigations
BH246	323031.0	6251330.1	Ismay Reserve, Homebush		6-9	5.458	15-Oct-15	8.410	-2.95	M4East investigations
BH246	323031.0	6251330.1	Ismay Reserve, Homebush		6-9	5.458	18-Nov-15	9.350	-3.89	M4East investigations
BH246	323031.0	6251330.1	Ismay Reserve, Homebush		6-9	5.458	16-Dec-15	9.650	-4.19	M4East investigations
BH246	323031.0	6251330.1	Ismay Reserve, Homebush		6-9	5.458	19-Jan-16	9.790	-4.33	M4East investigations
BH246	323031.0	6251330.1	Ismay Reserve, Homebush		6-9	5.458	16-Feb-16	Dry		M4East investigations
BH246	323031.0	6251330.1	Ismay Reserve, Homebush		6-9	5.458	22-Mar-16	Dry		M4East investigations
BH246	323031.0	6251330.1	Ismay Reserve, Homebush		6-9	5.458	13-Apr-16	9.590	-4.13	M4East investigations
BH246	323031.0	6251330.1	Ismay Reserve, Homebush		6-9	5.458	9-May-16	dry		M4East investigations
BH254	323294.3	6251270.2	Taylor Lane, North Strathfield		17-20	10.491	24-Jun-15	3.180	7.31	M4East investigations
BH254	323294.3	6251270.2	Taylor Lane, North Strathfield		17-20	10.491	28-Jul-15	3.630	6.86	M4East investigations
BH254	323294.3	6251270.2	Taylor Lane, North Strathfield		17-20	10.491	11-Aug-15	3.670	6.82	M4East investigations
BH254	323294.3	6251270.2	Taylor Lane, North Strathfield		17-20	10.491	23-Sep-15	3.770	6.72	M4East investigations
BH254	323294.3	6251270.2	Taylor Lane, North Strathfield		17-20	10.491	15-Oct-15	3.790	6.70	M4East investigations
BH254	323294.3	6251270.2	Taylor Lane, North Strathfield		17-20	10.491	17-Nov-15	3.855	6.64	M4East investigations
BH254	323294.3	6251270.2	Taylor Lane, North Strathfield		17-20	10.491	15-Dec-15	4.063	6.43	M4East investigations
BH254	323294.3	6251270.2	Taylor Lane, North Strathfield		17-20	10.491	19-Jan-16	4.120	6.37	M4East investigations
BH254	323294.3	6251270.2	Taylor Lane, North Strathfield		17-20	10.491	16-Feb-16	4.080	6.41	M4East investigations
BH254	323294.3	6251270.2	Taylor Lane, North Strathfield		17-20	10.491	21-Mar-16	4.370	6.12	M4East investigations
BH254	323294.3	6251270.2	Taylor Lane, North Strathfield		17-20	10.491	12-Apr-16	4.390	6.10	M4East investigations
BH254	323294.3	6251270.2	Taylor Lane, North Strathfield		17-20	10.491	9-May-16	4.510	5.98	M4East investigations
BH260	323868.8	6251140.4	Alexandra St, Concord		29-32	23.214	24-Jun-15	2.280	20.93	M4East investigations
BH260	323868.8	6251140.4	Alexandra St, Concord		29-32	23.214	29-Jul-15	2.240	20.97	M4East investigations
BH260	323868.8	6251140.4	Alexandra St, Concord		29-32	23.214	12-Aug-15	2.190	21.02	M4East investigations
BH260	323868.8	6251140.4	Alexandra St, Concord		29-32	23.214	24-Sep-15	2.370	20.84	M4East investigations

swl - standing water level
ND - not done
mbtoc - metres below top of casing
RL toc - relative level top of casing

Summary Table B3
M4M5 Link WestConnex
Historical Groundwater Level Monitoring

Monitoring Well	Co-ordinates		Location	Lithology	screen	RL toc		swl		data source
	Easting	Northing			interval		sample			
				Screened	(m)	mAHD	date	mbtoc	mAHD	
BH260	323868.8	6251140.4	Alexandra St, Concord		29-32	23.214	14-Oct-15	2.470	20.74	M4East investigations
BH260	323868.8	6251140.4	Alexandra St, Concord		29-32	23.214	18-Nov-15	2.290	20.92	M4East investigations
BH260	323868.8	6251140.4	Alexandra St, Concord		29-32	23.214	16-Dec-15	2.580	20.63	M4East investigations
BH260	323868.8	6251140.4	Alexandra St, Concord		29-32	23.214	21-Jan-16	1.830	21.38	M4East investigations
BH260	323868.8	6251140.4	Alexandra St, Concord		29-32	23.214	17-Feb-16	2.760	20.45	M4East investigations
BH260	323868.8	6251140.4	Alexandra St, Concord		29-32	23.214	22-Mar-16	2.410	20.80	M4East investigations
BH260	323868.8	6251140.4	Alexandra St, Concord		29-32	23.214	13-Apr-16	3.410	19.80	M4East investigations
BH260	323868.8	6251140.4	Alexandra St, Concord		29-32	23.214	10-May-16	3.090	20.12	M4East investigations
BH264	323950.2	6251059.7	Daly Ave Concord		15-18	18.887	24-Jun-15	3.850	15.04	M4East investigations
BH264	323950.2	6251059.7	Daly Ave Concord		15-18	18.887	29-Jul-15	3.910	14.98	M4East investigations
BH264	323950.2	6251059.7	Daly Ave Concord		15-18	18.887	11-Aug-15	4.000	14.89	M4East investigations
BH264	323950.2	6251059.7	Daly Ave Concord		15-18	18.887	24-Sep-15	4.280	14.61	M4East investigations
BH264	323950.2	6251059.7	Daly Ave Concord		15-18	18.887	15-Oct-15	4.200	14.69	M4East investigations
BH264	323950.2	6251059.7	Daly Ave Concord		15-18	18.887	18-Nov-15	3.982	14.91	M4East investigations
BH264	323950.2	6251059.7	Daly Ave Concord		15-18	18.887	16-Dec-15	3.940	14.95	M4East investigations
BH264	323950.2	6251059.7	Daly Ave Concord		15-18	18.887	21-Jan-16	3.915	14.97	M4East investigations
BH264	323950.2	6251059.7	Daly Ave Concord		15-18	18.887	17-Feb-16	4.300	14.59	M4East investigations
BH264	323950.2	6251059.7	Daly Ave Concord		15-18	18.887	22-Mar-16	4.490	14.40	M4East investigations
BH264	323950.2	6251059.7	Daly Ave Concord		15-18	18.887	14-Apr-16	4.440	14.45	M4East investigations
BH264	323950.2	6251059.7	Daly Ave Concord		15-18	18.887	10-May-16	4.350	14.54	M4East investigations
BH290	323651.5	6251341.1	Carrington St, North Strathfield		17-20	32.92	25-Jun-15	3.980	28.94	M4East investigations
BH290	323651.5	6251341.1	Carrington St, North Strathfield		17-20	32.92	28-Jul-15	3.770	29.15	M4East investigations
BH290	323651.5	6251341.1	Carrington St, North Strathfield		17-20	32.92	11-Aug-15	4.130	28.79	M4East investigations
BH290	323651.5	6251341.1	Carrington St, North Strathfield		17-20	32.92	23-Sep-15	4.270	28.65	M4East investigations
BH290	323651.5	6251341.1	Carrington St, North Strathfield		17-20	32.92	15-Oct-15	4.350	28.57	M4East investigations
BH290	323651.5	6251341.1	Carrington St, North Strathfield		17-20	32.92	17-Nov-15	4.250	28.67	M4East investigations
BH290	323651.5	6251341.1	Carrington St, North Strathfield		17-20	32.92	15-Dec-15	4.170	28.75	M4East investigations
BH290	323651.5	6251341.1	Carrington St, North Strathfield		17-20	32.92	19-Jan-16	4.073	28.85	M4East investigations
BH290	323651.5	6251341.1	Carrington St, North Strathfield		17-20	32.92	16-Feb-16	3.880	29.04	M4East investigations
BH290	323651.5	6251341.1	Carrington St, North Strathfield		17-20	32.92	21-Mar-16	3.920	29.00	M4East investigations
BH290	323651.5	6251341.1	Carrington St, North Strathfield		17-20	32.92	13-Apr-16	3.960	28.96	M4East investigations
BH290	323651.5	6251341.1	Carrington St, North Strathfield		17-20	32.92	9-May-16	3.980	28.94	M4East investigations
BH301	326830.4	6249992.9	Page Ave, Ashfield	Ashfield Shale	15-18	6.904	25-Jun-15	2.820	4.08	M4East investigations
BH301	326830.4	6249992.9	Page Ave, Ashfield	Ashfield Shale	15-18	6.904	30-Jul-15	2.780	4.12	M4East investigations
BH301	326830.4	6249992.9	Page Ave, Ashfield	Ashfield Shale	15-18	6.904	13-Aug-15	2.830	4.07	M4East investigations
BH301	326830.4	6249992.9	Page Ave, Ashfield	Ashfield Shale	15-18	6.904	25-Sep-15	2.990	3.91	M4East investigations
BH301	326830.4	6249992.9	Page Ave, Ashfield	Ashfield Shale	15-18	6.904	19-Nov-15	2.990	3.91	M4East investigations

swl - standing water level
ND - not done
mbtoc - metres below top of casing
RL toc - relative level top of casing

Summary Table B3
M4M5 Link WestConnex
Historical Groundwater Level Monitoring

Monitoring Well	Co-ordinates		Location	Lithology	screen	RL toc		swl		data source
	Easting	Northing			interval		sample			
				Screened	(m)	mAHD	date	mbtoc	mAHD	
BH301	326830.4	6249992.9	Page Ave, Ashfield	Ashfield Shale	15-18	6.904	17-Dec-15	3.080	3.82	M4East investigations
BH301	326830.4	6249992.9	Page Ave, Ashfield	Ashfield Shale	15-18	6.904	20-Jan-16	3.078	3.83	M4East investigations
BH301	326830.4	6249992.9	Page Ave, Ashfield	Ashfield Shale	15-18	6.904	18-Feb-16	2.880	4.02	M4East investigations
BH301	326830.4	6249992.9	Page Ave, Ashfield	Ashfield Shale	15-18	6.904	23-Mar-16	2.800	4.10	M4East investigations
BH301	326830.4	6249992.9	Page Ave, Ashfield	Ashfield Shale	15-18	6.904	14-Apr-16	2.710	4.19	M4East investigations
BH301	326830.4	6249992.9	Page Ave, Ashfield	Ashfield Shale	15-18	6.904	11-May-16	2.720	4.18	M4East investigations
BH302	327010.4	6249995.7	Northcote St, Haberfield	Hawkesbury Sst	47-50	10.536	25-Jun-15	4.720	5.82	M4East investigations
BH302	327010.4	6249995.7	Northcote St, Haberfield	Hawkesbury Sst	47-50	10.536	30-Jul-15	6.480	4.06	M4East investigations
BH302	327010.4	6249995.7	Northcote St, Haberfield	Hawkesbury Sst	47-50	10.536	13-Aug-15	6.520	4.02	M4East investigations
BH302	327010.4	6249995.7	Northcote St, Haberfield	Hawkesbury Sst	47-50	10.536	25-Sep-15	6.510	4.03	M4East investigations
BH302	327010.4	6249995.7	Northcote St, Haberfield	Hawkesbury Sst	47-50	10.536	14-Oct-15	6.760	3.78	M4East investigations
BH302	327010.4	6249995.7	Northcote St, Haberfield	Hawkesbury Sst	47-50	10.536	19-Nov-15	6.708	3.83	M4East investigations
BH302	327010.4	6249995.7	Northcote St, Haberfield	Hawkesbury Sst	47-50	10.536	17-Dec-15	6.680	3.86	M4East investigations
BH302	327010.4	6249995.7	Northcote St, Haberfield	Hawkesbury Sst	47-50	10.536	20-Jan-16	6.785	3.75	M4East investigations
BH302	327010.4	6249995.7	Northcote St, Haberfield	Hawkesbury Sst	47-50	10.536	18-Feb-16	6.700	3.84	M4East investigations
BH302	327010.4	6249995.7	Northcote St, Haberfield	Hawkesbury Sst	47-50	10.536	23-Mar-16	6.630	3.91	M4East investigations
BH302	327010.4	6249995.7	Northcote St, Haberfield	Hawkesbury Sst	47-50	10.536	12-Apr-16	6.600	3.94	M4East investigations
BH302	327010.4	6249995.7	Northcote St, Haberfield	Hawkesbury Sst	47-50	10.536	11-May-16	6.750	3.79	M4East investigations
BH006	323555.4	6242879.6	Canterbury Golf Course, Beverly Grove, Kingsg	Hawkesbury Sst	22-25	24.71	19-Oct-15	4.56	20.15	AECOM New M5 Investigation
BH18	326717.0	6243421.8	Moore St, on Grass, Bardwell park	Hawkesbury Sst	51-54	34.84	16-Nov-15	38.67	-3.83	AECOM New M5 Investigation
BH024	327221.9	6243305.9	Bardwell Valley Golf Course, Bardwell Valley	Hawkesbury Sst	26-29	8.17	16-Nov-15	9.22	-1.05	AECOM New M5 Investigation
BH025	328636.7	6243271.0	Queen St, Arncliff	Hawkesbury Sst	55-58	23.85	21-Jan-15	29.4	-5.55	AECOM New M5 Investigation
BH029	329349.6	6242708.8	Barton Park Driving Range, near Eve St, Arnclif	Hawkesbury Sst	33-36	4.28	16-Nov-15	5.41	-1.13	AECOM New M5 Investigation
BH036	329402.6	6243808.7	Cahill Park, Princes Highway, Wolli Creek	Hawkesbury Sst	60-63	1.58	16-Nov-15	2.79	-1.20	AECOM New M5 Investigation
BH039	329553.2	6244157.9	Discovery Park, Brodie Sparke Dr, Wolli Creek	Hawkesbury Sst	49-52	3.32	19-Oct-15	4.36	-1.04	AECOM New M5 Investigation
BH040	329679.8	6244313.4	View St, Tempe	Basalt	65-68	1.61	16-Nov-15	2.41	-0.80	AECOM New M5 Investigation
BH042	329718.7	6244348.2	Kendrick Park, View St, Tempe	Hawkesbury Sst	45.5-48.5	1.94	16-Nov-15	0.91	1.03	AECOM New M5 Investigation
BH063s	329208.5	6242450.5	Eve Street Banksia	Hawkesbury Sst	41-44	3.37	16-Nov-15	2.34	1.03	AECOM New M5 Investigation
BH063d	329206.5	6242450.0	Banksia Field Arncliffe	Botany Sands	5.0-8.0	3.31	16-Nov-15	6.52	-3.21	AECOM New M5 Investigation
BH070	329041.8	6242920.4	Off Bellevue St, Arncliffe	Hawkesbury Sst	35-38	17.54	19-Oct-15	10.75	6.79	AECOM New M5 Investigation
BH072	325560.6	6243242.8	Bexley Rd, Gilchrist Park, Kingsgrove	Hawkesbury Sst	28-31	7.47	16-Nov-15	2.43	5.04	AECOM New M5 Investigation
BH074	329227.9	6243670.2	Argyle St, Arncliff	Hawkesbury Sst	39-42	2.58	19-Oct-15	3.45	-0.87	AECOM New M5 Investigation
BH084	325612.9	6243435.4	Johnston St, Earlwood	Hawkesbury Sst	47.5-50.5	30.02	16-Nov-15	34.49	-4.47	AECOM New M5 Investigation
BH088	326181.7	6243434.4	176 Slade Rd, Bardwell Park	Hawkesbury Sst	41-44	16.78	19-Oct-15	16.13	0.65	AECOM New M5 Investigation
BH093	327657.0	6243183.2	Lorraine Ave,, Bardwell Park	Hawkesbury Sst	47-50	36.39	19-Oct-15	12.90	23.49	AECOM New M5 Investigation
BH094	327867.3	6243174.3	7 Athelstane Ave, Arncliffe	Hawkesbury Sst	54-57	31.17	19-Oct-15	3.02	28.15	AECOM New M5 Investigation
BH103	330430.7	6245201.0	Samuel St, Sydnham, near Henry st	Hawkesbury Sst	48-51	11.10	19-Oct-15	6.64	4.46	AECOM New M5 Investigation

swl - standing water level

ND - not done

mbtoc - metres below top of casing

RL toc - relative level top of casing

Summary Table B3
M4M5 Link WestConnex
Historical Groundwater Level Monitoring

Monitoring Well	Co-ordinates		Location	Lithology Screened	screen interval (m)	RL toc	sample date	swl		data source
	Easting	Northing				mAHD		mbtoc	mAHD	
BH109	331220.5	6245632.2	Southern Cross Hotel car park, St Peters	Rouse Hill Siltstone	33-36	6.91	16-Nov-15	7.36	-0.45	AECOM New M5 Investigation
BH115	331875.1	6246376.3	Sydney Park,off Barwon Park Road St Peters	Ashfield Shale	29.5-32.5	20.33	16-Nov-15	14.36	5.97	AECOM New M5 Investigation
BH120	331875.1	6246376.3	Edith St, St Peters	Ashfield Shale	18-21	20.33	21-Jan-15	3.15	17.18	AECOM New M5 Investigation
BH122	332029.6	6245872.9	Sydney Park, Campbell St, St Peters	Ashfield Shale	15-18	5.72	16-Nov-15	3.63	2.09	AECOM New M5 Investigation
BH137	324858.2	6243065.5	2 Bonalbo Street Kingsgrove	Hawkesbury Sst	54-57	15.15	19-Oct-15	0.03	15.12	AECOM New M5 Investigation
BH143	327180.8	6242912.2	Silver Jubilee Park, Bardwell Valley	Hawkesbury Sst	82-85	40.185	16-Nov-15	20.85	19.34	AECOM New M5 Investigation
BH152s	329588.6	6244818.3	Tempe train station (Rail corridor)	alluvium	18-21	2.93	16-Nov-15	2.35	0.58	AECOM New M5 Investigation
BH152d	329588.9	6244819.3	Tempe train station (Rail corridor)	Hawkesbury Sst	48-51	2.87	16-Nov-15	1.61	1.26	AECOM New M5 Investigation
BH153	330468.3	6244765.9	IKEA car park, Tempe	Hawkesbury Sst	46-49	11.24	16-Nov-15	8.13	3.11	AECOM New M5 Investigation
BH157	331518.0	6245765.5	KFC car park 108 Princes Hwy, St Peters	Regentville Siltston	32-35	16.82	19-Oct-15	29.74	-12.92	AECOM New M5 Investigation
BH168	329702.2	6243775.2	next to Rockwell Ave, Cahill Park, Wolli Creek	Hawkesbury Sst	48-51	1.36	16-Nov-15	1.71	-0.35	AECOM New M5 Investigation
BH1309	322060	6251815		Clay	3-6	ND	06-Nov-14	2.74		M4East investigations GHD
BH1309	322060	6251815		Clay	3-6	ND	24-Jun-15	2.090		M4East investigations GHD
BH1309	322060	6251815		Clay	3-6	ND	30-Jul-15	2.481		M4East investigations GHD
BH1310	322024	6251751		Clay	3-6	ND	04-Nov-14	2.572		M4East investigations GHD
BH1310	322024	6251751		Clay	3-6	ND	23-Jun-15	2.080		M4East investigations GHD
BH1310	322024	6251751		Clay	3-6	ND	28-Jul-15	2.261		M4East investigations GHD
BH1314	323330	6251307		Clay	4.5 - 7.5	ND	04-Nov-14	5.55		M4East investigations GHD
BH1314	323330	6251307		Clay	4.5 - 7.5	ND	23-Jun-15	5.290		M4East investigations GHD
BH1314	323330	6251307		Clay	4.5 - 7.5	ND	28-Jul-15	5.375		M4East investigations GHD
BH1314	323330	6251307		Clay	4.5 - 7.5	ND	11-Aug-15	5.380		M4East investigations GHD
BH1314	323330	6251307		Clay	4.5 - 7.5	ND	23-Sep-15	5.400		M4East investigations GHD
BH1314	323330	6251307		Clay	4.5 - 7.5	ND	14-Oct-15	5.410		M4East investigations GHD
BH1314	323330	6251307		Clay	4.5 - 7.5	ND	17-Nov-15	5.360		M4East investigations GHD
BH1314	323330	6251307		Clay	4.5 - 7.5	ND	16-Dec-15	5.380		M4East investigations GHD
BH1314	323330	6251307		Clay	4.5 - 7.5	ND	19-Jan-16	5.290		M4East investigations GHD
BH1314	323330	6251307		Clay	4.5 - 7.5	ND	16-Feb-16	5.260		M4East investigations GHD
BH1314	323330	6251307		Clay	4.5 - 7.5	ND	21-Mar-16	5.230		M4East investigations GHD
BH1314	323330	6251307		Clay	4.5 - 7.5	ND	12-Apr-16	5.240		M4East investigations GHD
BH1314	323330	6251307		Clay	4.5 - 7.5	ND	9-May-16	5.250		M4East investigations GHD
BH1316	323522	6251111		Ashfield Shale	3.5 - 6.5	ND	04-Nov-14	4.306		M4East investigations GHD
BH1316	323522	6251111		Ashfield Shale	3.5 - 6.5	ND	23-Jun-15	3.950		M4East investigations GHD
BH1316	323522	6251111		Ashfield Shale	3.5 - 6.5	ND	28-Jul-15	4.031		M4East investigations GHD
BH1316	323522	6251111		Ashfield Shale	3.5 - 6.5	ND	11-Aug-15	3.960		M4East investigations GHD
BH1316	323522	6251111		Ashfield Shale	3.5 - 6.5	ND	23-Sep-15	5.100		M4East investigations GHD
BH1316	323522	6251111		Ashfield Shale	3.5 - 6.5	ND	14-Oct-15	4.140		M4East investigations GHD
BH1316	323522	6251111		Ashfield Shale	3.5 - 6.5	ND	17-Nov-15	4.030		M4East investigations GHD

swl - standing water level
ND - not done

mbtoc - metres below top of casing

RL toc - relative level top of casing

Summary Table B3
M4M5 Link WestConnex
Historical Groundwater Level Monitoring

Monitoring Well	Co-ordinates		Location	Lithology	screen	RL toc		swl		data source
	Easting	Northing			interval		sample			
				Screened	(m)	mAHD	date	mbtoc	mAHD	
BH1316	323522	6251111		Ashfield Shale	3.5 - 6.5	ND	16-Dec-15	4.040		M4East investigations GHD
BH1316	323522	6251111		Ashfield Shale	3.5 - 6.5	ND	19-Jan-16	3.920		M4East investigations GHD
BH1316	323522	6251111		Ashfield Shale	3.5 - 6.5	ND	16-Feb-16	3.810		M4East investigations GHD
BH1316	323522	6251111		Ashfield Shale	3.5 - 6.5	ND	21-Mar-16	4.025		M4East investigations GHD
BH1316	323522	6251111		Ashfield Shale	3.5 - 6.5	ND	12-Apr-16	4.060		M4East investigations GHD
BH1316	323522	6251111		Ashfield Shale	3.5 - 6.5	ND	9-May-16	4.150		M4East investigations GHD
BH1317	324072	6250981		Ashfield Shale	4-7	ND	06-Nov-14	1.121		M4East investigations GHD
BH1317	324072	6250981		Ashfield Shale	4-7	ND	24-Jun-15	0.550		M4East investigations GHD
BH1317	324072	6250981		Ashfield Shale	4-7	ND	29-Jul-15	0.658		M4East investigations GHD
BH1317	324072	6250981		Ashfield Shale	4-7	ND	12-Aug-15	0.640		M4East investigations GHD
BH1317	324072	6250981		Ashfield Shale	4-7	ND	24-Sep-15	0.910		M4East investigations GHD
BH1317	324072	6250981		Ashfield Shale	4-7	ND	14-Oct-15	0.840		M4East investigations GHD
BH1317	324072	6250981		Ashfield Shale	4-7	ND	18-Nov-15	0.520		M4East investigations GHD
BH1317	324072	6250981		Ashfield Shale	4-7	ND	16-Dec-15	0.510		M4East investigations GHD
BH1317	324072	6250981		Ashfield Shale	4-7	ND	21-Jan-16	0.540		M4East investigations GHD
BH1317	324072	6250981		Ashfield Shale	4-7	ND	17-Feb-16	0.530		M4East investigations GHD
BH1317	324072	6250981		Ashfield Shale	4-7	ND	22-Mar-16	0.720		M4East investigations GHD
BH1317	324072	6250981		Ashfield Shale	4-7	ND	13-Apr-16	0.760		M4East investigations GHD
BH1317	324072	6250981		Ashfield Shale	4-7	ND	10-May-16	0.770		M4East investigations GHD
BH1320	324177	6250888		Ashfield Shale	5.5 - 8.5	ND	04-Nov-14	1.225		M4East investigations GHD
BH1320	324177	6250888		Ashfield Shale	5.5 - 8.5	ND	24-Jun-15	0.850		M4East investigations GHD
BH1320	324177	6250888		Ashfield Shale	5.5 - 8.5	ND	28-Jul-15	0.976		M4East investigations GHD
BH1320	324177	6250888		Ashfield Shale	5.5 - 8.5	ND	12-Aug-15	0.980		M4East investigations GHD
BH1320	324177	6250888		Ashfield Shale	5.5 - 8.5	ND	24-Sep-15	1.370		M4East investigations GHD
BH1320	324177	6250888		Ashfield Shale	5.5 - 8.5	ND	14-Oct-15	1.250		M4East investigations GHD
BH1320	324177	6250888		Ashfield Shale	5.5 - 8.5	ND	18-Nov-15	0.680		M4East investigations GHD
BH1320	324177	6250888		Ashfield Shale	5.5 - 8.5	ND	16-Dec-15	0.680		M4East investigations GHD
BH1320	324177	6250888		Ashfield Shale	5.5 - 8.5	ND	21-Jan-16	1.150		M4East investigations GHD
BH1320	324177	6250888		Ashfield Shale	5.5 - 8.5	ND	17-Feb-16	1.020		M4East investigations GHD
BH1320	324177	6250888		Ashfield Shale	5.5 - 8.5	ND	22-Mar-16	1.045		M4East investigations GHD
BH1320	324177	6250888		Ashfield Shale	5.5 - 8.5	ND	13-Apr-16	1.030		M4East investigations GHD
BH1320	324177	6250888		Ashfield Shale	5.5 - 8.5	ND	10-May-16	1.030		M4East investigations GHD
BH1326	324447	6250779		Ashfield Shale	21.5-24.5	ND	04-Nov-14	8.252		M4East investigations GHD
BH1326	324447	6250779		Ashfield Shale	21.5-24.5	ND	24-Jun-15	7.370		M4East investigations GHD
BH1326	324447	6250779		Ashfield Shale	21.5-24.5	ND	29-Jul-15	7.390		M4East investigations GHD
BH1326	324447	6250779		Ashfield Shale	21.5-24.5	ND	12-Aug-15	7.340		M4East investigations GHD
BH1326	324447	6250779		Ashfield Shale	21.5-24.5	ND	23-Sep-15	7.350		M4East investigations GHD

swl - standing water level
ND - not done
mbtoc - metres below top of casing
RL toc - relative level top of casing

Summary Table B3
M4M5 Link WestConnex
Historical Groundwater Level Monitoring

Monitoring Well	Co-ordinates		Location	Lithology	screen	RL toc		swl		data source
	Easting	Northing		Screened	interval (m)	mAHD	sample date	mbtoc	mAHD	
BH1326	324447	6250779		Ashfield Shale	21.5-24.5	ND	14-Oct-15	7.360		M4East investigations GHD
BH1326	324447	6250779		Ashfield Shale	21.5-24.5	ND	18-Nov-15	7.113		M4East investigations GHD
BH1326	324447	6250779		Ashfield Shale	21.5-24.5	ND	16-Dec-15	7.160		M4East investigations GHD
BH1326	324447	6250779		Ashfield Shale	21.5-24.5	ND	20-Jan-16	6.960		M4East investigations GHD
BH1326	324447	6250779		Ashfield Shale	21.5-24.5	ND	17-Feb-16	6.950		M4East investigations GHD
BH1326	324447	6250779		Ashfield Shale	21.5-24.5	ND	22-Mar-16	6.900		M4East investigations GHD
BH1326	324447	6250779		Ashfield Shale	21.5-24.5	ND	13-Apr-16	6.900		M4East investigations GHD
BH1326	324447	6250779		Ashfield Shale	21.5-24.5	ND	10-May-16	6.830		M4East investigations GHD
BH1331	324785	6250750		Ashfield Shale	4-7	ND	04-Nov-14	3.5		M4East investigations GHD
BH1331	324785	6250750		Ashfield Shale	4-7	ND	24-Jun-15	3.330		M4East investigations GHD
BH1331	324785	6250750		Ashfield Shale	4-7	ND	29-Jul-15	3.386		M4East investigations GHD
BH1331	324785	6250750		Ashfield Shale	4-7	ND	11-Aug-15	3.340		M4East investigations GHD
BH1331	324785	6250750		Ashfield Shale	4-7	ND	24-Sep-15	3.510		M4East investigations GHD
BH1331	324785	6250750		Ashfield Shale	4-7	ND	15-Oct-15	3.470		M4East investigations GHD
BH1331	324785	6250750		Ashfield Shale	4-7	ND	18-Nov-15	3.310		M4East investigations GHD
BH1331	324785	6250750		Ashfield Shale	4-7	ND	17-Dec-15	3.320		M4East investigations GHD
BH1331	324785	6250750		Ashfield Shale	4-7	ND	20-Jan-16	3.210		M4East investigations GHD
BH1331	324785	6250750		Ashfield Shale	4-7	ND	18-Feb-16	3.130		M4East investigations GHD
BH1331	324785	6250750		Ashfield Shale	4-7	ND	22-Mar-16	3.360		M4East investigations GHD
BH1331	324785	6250750		Ashfield Shale	4-7	ND	12-Apr-16	3.480		M4East investigations GHD
BH1331	324785	6250750		Ashfield Shale	4-7	ND	9-May-16	3.590		M4East investigations GHD
BH1333	324876	6250760		Ashfield Shale	5-8	ND	04-Nov-14	4.141		M4East investigations GHD
BH1333	324876	6250760		Ashfield Shale	5-8	ND	25-Jun-15	4.250		M4East investigations GHD
BH1333	324876	6250760		Ashfield Shale	5-8	ND	29-Jul-15	4.531		M4East investigations GHD
BH1333	324876	6250760		Ashfield Shale	5-8	ND	11-Aug-15	4.350		M4East investigations GHD
BH1333	324876	6250760		Ashfield Shale	5-8	ND	23-Sep-15	4.430		M4East investigations GHD
BH1333	324876	6250760		Ashfield Shale	5-8	ND	14-Oct-15	4.390		M4East investigations GHD
BH1333	324876	6250760		Ashfield Shale	5-8	ND	17-Nov-15	4.360		M4East investigations GHD
BH1333	324876	6250760		Ashfield Shale	5-8	ND	17-Dec-15	4.330		M4East investigations GHD
BH1333	324876	6250760		Ashfield Shale	5-8	ND	19-Jan-16	4.300		M4East investigations GHD
BH1333	324876	6250760		Ashfield Shale	5-8	ND	16-Feb-16	4.110		M4East investigations GHD
BH1333	324876	6250760		Ashfield Shale	5-8	ND	22-Mar-16	4.840		M4East investigations GHD
BH1333	324876	6250760		Ashfield Shale	5-8	ND	12-Apr-16	5.070		M4East investigations GHD
BH1333	324876	6250760		Ashfield Shale	5-8	ND	9-May-16	5.020		M4East investigations GHD
BH1336	325021	6250714		Ashfield Shale	5-8	ND	04-Nov-14	2.78		M4East investigations GHD
BH1336	325021	6250714		Ashfield Shale	5-8	ND	24-Jun-15	2.920		M4East investigations GHD
BH1336	325021	6250714		Ashfield Shale	5-8	ND	29-Jul-15	3.007		M4East investigations GHD

swl - standing water level

ND - not done

mbtoc - metres below top of casing

RL toc - relative level top of casing

Summary Table B3
M4M5 Link WestConnex
Historical Groundwater Level Monitoring

Monitoring Well	Co-ordinates		Location	Lithology	screen	RL toc		swl		data source
	Easting	Northing			interval		sample			
				Screened	(m)	mAHD	date	mbtoc	mAHD	
BH1336	325021	6250714		Ashfield Shale	5-8	ND	11-Aug-15	2.700		M4East investigations GHD
BH1336	325021	6250714		Ashfield Shale	5-8	ND	24-Sep-15	2.980		M4East investigations GHD
BH1336	325021	6250714		Ashfield Shale	5-8	ND	15-Oct-15	2.960		M4East investigations GHD
BH1336	325021	6250714		Ashfield Shale	5-8	ND	17-Nov-15	2.800		M4East investigations GHD
BH1336	325021	6250714		Ashfield Shale	5-8	ND	17-Dec-15	2.900		M4East investigations GHD
BH1336	325021	6250714		Ashfield Shale	5-8	ND	20-Jan-16	2.760		M4East investigations GHD
BH1336	325021	6250714		Ashfield Shale	5-8	ND	18-Feb-16	2.770		M4East investigations GHD
BH1336	325021	6250714		Ashfield Shale	5-8	ND	22-Mar-16	2.880		M4East investigations GHD
BH1336	325021	6250714		Ashfield Shale	5-8	ND	12-Apr-16	2.830		M4East investigations GHD
BH1336	325021	6250714		Ashfield Shale	5-8	ND	9-May-16	2.850		M4East investigations GHD
BH1344	325555	6250622		Hawkesbury Sst	22-25	ND	06-Nov-14	5.471		M4East investigations GHD
BH1344	325555	6250622		Hawkesbury Sst	22-25	ND	24-Jun-15	5.470		M4East investigations GHD
BH1344	325555	6250622		Hawkesbury Sst	22-25	ND	29-Jul-15	5.620		M4East investigations GHD
BH1344	325555	6250622		Hawkesbury Sst	22-25	ND	12-Aug-15	5.130		M4East investigations GHD
BH1344	325555	6250622		Hawkesbury Sst	22-25	ND	24-Sep-15	5.060		M4East investigations GHD
BH1344	325555	6250622		Hawkesbury Sst	22-25	ND	14-Oct-15	4.980		M4East investigations GHD
BH1344	325555	6250622		Hawkesbury Sst	22-25	ND	18-Nov-15	4.720		M4East investigations GHD
BH1344	325555	6250622		Hawkesbury Sst	22-25	ND	16-Dec-15	4.720		M4East investigations GHD
BH1344	325555	6250622		Hawkesbury Sst	22-25	ND	21-Jan-16	4.805		M4East investigations GHD
BH1344	325555	6250622		Hawkesbury Sst	22-25	ND	17-Feb-16	5.120		M4East investigations GHD
BH1344	325555	6250622		Hawkesbury Sst	22-25	ND	22-Mar-16	4.840		M4East investigations GHD
BH1344	325555	6250622		Hawkesbury Sst	22-25	ND	13-Apr-16	5.540		M4East investigations GHD
BH1344	325555	6250622		Hawkesbury Sst	22-25	ND	10-May-16	5.460		M4East investigations GHD
BH1365	326948	6250090		Hawkesbury Sst	13.8 - 16.8	ND	05-Nov-14	4.98		M4East investigations GHD
BH1365	326948	6250090		Hawkesbury Sst	13.8 - 16.8	ND	25-Jun-15	5.030		M4East investigations GHD
BH1365	326948	6250090		Hawkesbury Sst	13.8 - 16.8	ND	30-Jul-15	5.180		M4East investigations GHD
BH1365	326948	6250090		Hawkesbury Sst	13.8 - 16.8	ND	12-Aug-15	5.230		M4East investigations GHD
BH1365	326948	6250090		Hawkesbury Sst	13.8 - 16.8	ND	25-Sep-15	5.330		M4East investigations GHD
BH1365	326948	6250090		Hawkesbury Sst	13.8 - 16.8	ND	14-Oct-15	7.360		M4East investigations GHD
BH1365	326948	6250090		Hawkesbury Sst	13.8 - 16.8	ND	19-Nov-15	5.120		M4East investigations GHD
BH1365	326948	6250090		Hawkesbury Sst	13.8 - 16.8	ND	17-Dec-15	5.060		M4East investigations GHD
BH1365	326948	6250090		Hawkesbury Sst	13.8 - 16.8	ND	20-Jan-16	4.930		M4East investigations GHD
BH1365	326948	6250090		Hawkesbury Sst	13.8 - 16.8	ND	18-Feb-16	4.810		M4East investigations GHD
BH1365	326948	6250090		Hawkesbury Sst	13.8 - 16.8	ND	23-Mar-16	4.850		M4East investigations GHD
BH1365	326948	6250090		Hawkesbury Sst	13.8 - 16.8	ND	14-Apr-16	4.890		M4East investigations GHD
BH1365	326948	6250090		Hawkesbury Sst	13.8 - 16.8	ND	11-May-16	4.940		M4East investigations GHD
BH1369	327079	6249791		Ashfield Shale	5.5 - 8.5	ND	05-Nov-14	2.594		M4East investigations GHD

swl - standing water level
ND - not done
mbtoc - metres below top of casing
RL toc - relative level top of casing

Summary Table B3
M4M5 Link WestConnex
Historical Groundwater Level Monitoring

Monitoring Well	Co-ordinates		Location	Lithology	screen	RL toc		swl		data source
	Easting	Northing			interval		sample			
				Screened	(m)	mAHD	date	mbtoc	mAHD	
BH1369	327079	6249791		Ashfield Shale	5.5 - 8.5	ND	25-Jun-15	2.200		M4East investigations GHD
BH1369	327079	6249791		Ashfield Shale	5.5 - 8.5	ND	30-Jul-15	2.064		M4East investigations GHD
BH1369	327079	6249791		Ashfield Shale	5.5 - 8.5	ND	13-Aug-15	2.040		M4East investigations GHD
BH1369	327079	6249791		Ashfield Shale	5.5 - 8.5	ND	25-Sep-15	2.210		M4East investigations GHD
BH1369	327079	6249791		Ashfield Shale	5.5 - 8.5	ND	14-Oct-15	2.210		M4East investigations GHD
BH1369	327079	6249791		Ashfield Shale	5.5 - 8.5	ND	18-Nov-15	2.020		M4East investigations GHD
BH1369	327079	6249791		Ashfield Shale	5.5 - 8.5	ND	17-Dec-15	2.070		M4East investigations GHD
BH1369	327079	6249791		Ashfield Shale	5.5 - 8.5	ND	21-Jan-16	1.920		M4East investigations GHD
BH1369	327079	6249791		Ashfield Shale	5.5 - 8.5	ND	17-Feb-16	1.870		M4East investigations GHD
BH1369	327079	6249791		Ashfield Shale	5.5 - 8.5	ND	21-Mar-16	1.890		M4East investigations GHD
BH1369	327079	6249791		Ashfield Shale	5.5 - 8.5	ND	13-Apr-16	1.970		M4East investigations GHD
BH1369	327079	6249791		Ashfield Shale	5.5 - 8.5	ND	10-May-16	1.900		M4East investigations GHD
BH1373	327204	6249512		Ashfield Shale	5-8	ND	05-Nov-14	1.71		M4East investigations GHD
BH1373	327204	6249512		Ashfield Shale	5-8	ND	25-Jun-15	1.620		M4East investigations GHD
BH1373	327204	6249512		Ashfield Shale	5-8	ND	30-Jul-15	1.394		M4East investigations GHD
BH1373	327204	6249512		Ashfield Shale	5-8	ND	12-Aug-15	1.350		M4East investigations GHD
BH1373	327204	6249512		Ashfield Shale	5-8	ND	25-Sep-15	1.380		M4East investigations GHD
BH1373	327204	6249512		Ashfield Shale	5-8	ND	15-Oct-15	1.340		M4East investigations GHD
BH1373	327204	6249512		Ashfield Shale	5-8	ND	17-Nov-15	1.230		M4East investigations GHD
BH1373	327204	6249512		Ashfield Shale	5-8	ND	16-Dec-15	1.230		M4East investigations GHD
BH1373	327204	6249512		Ashfield Shale	5-8	ND	20-Jan-16	1.200		M4East investigations GHD
BH1373	327204	6249512		Ashfield Shale	5-8	ND	17-Feb-16	1.460		M4East investigations GHD
BH1373	327204	6249512		Ashfield Shale	5-8	ND	21-Mar-16	1.580		M4East investigations GHD
BH1373	327204	6249512		Ashfield Shale	5-8	ND	13-Apr-16	1.570		M4East investigations GHD
BH1373	327204	6249512		Ashfield Shale	5-8	ND	10-May-16	1.700		M4East investigations GHD
BH1379	327491	6249158		Ashfield Shale	6-9	ND	05-Nov-14	1.744		M4East investigations GHD
BH1379	327491	6249158		Ashfield Shale	6-9	ND	25-Jun-15	1.670		M4East investigations GHD
BH1379	327491	6249158		Ashfield Shale	6-9	ND	30-Jul-15	1.710		M4East investigations GHD
BH1379	327491	6249158		Ashfield Shale	6-9	ND	12-Aug-15	1.780		M4East investigations GHD
BH1379	327491	6249158		Ashfield Shale	6-9	ND	25-Sep-15	1.850		M4East investigations GHD
BH1379	327491	6249158		Ashfield Shale	6-9	ND	15-Oct-15	1.860		M4East investigations GHD
BH1379	327491	6249158		Ashfield Shale	6-9	ND	17-Nov-15	1.690		M4East investigations GHD
BH1379	327491	6249158		Ashfield Shale	6-9	ND	16-Dec-15	1.800		M4East investigations GHD
BH1379	327491	6249158		Ashfield Shale	6-9	ND	20-Jan-16	1.530		M4East investigations GHD
BH1379	327491	6249158		Ashfield Shale	6-9	ND	16-Feb-16	1.550		M4East investigations GHD
BH1379	327491	6249158		Ashfield Shale	6-9	ND	21-Mar-16	1.630		M4East investigations GHD
BH1379	327491	6249158		Ashfield Shale	6-9	ND	13-Apr-16	1.660		M4East investigations GHD

swl - standing water level
ND - not done
mbtoc - metres below top of casing
RL toc - relative level top of casing

Summary Table B3
M4M5 Link WestConnex
Historical Groundwater Level Monitoring

Monitoring Well	Co-ordinates		Location	Lithology	screen	RL toc		swl		data source
	Easting	Northing			interval		sample			
				Screened	(m)	mAHD	date	mbtoc	mAHD	
BH1379	327491	6249158		Ashfield Shale	6-9	ND	9-May-16	1.680		M4East investigations GHD
BH1397	326599	6250388		shale/sandstone	3.5 - 8	ND	25-Nov-14	2.594		M4East investigations GHD
BH1397	326599	6250388		shale/sandstone	3.5 - 8	ND	25-Jun-15	2.790		M4East investigations GHD
BH1397	326599	6250388		shale/sandstone	3.5 - 8	ND	29-Jul-15	2.984		M4East investigations GHD
BH1397	326599	6250388		shale/sandstone	3.5 - 8	ND	13-Aug-15	2.800		M4East investigations GHD
BH1397	326599	6250388		shale/sandstone	3.5 - 8	ND	24-Sep-15	2.760		M4East investigations GHD
BH1397	326599	6250388		shale/sandstone	3.5 - 8	ND	15-Oct-15	2.660		M4East investigations GHD
BH1397	326599	6250388		shale/sandstone	3.5 - 8	ND	18-Nov-15	2.520		M4East investigations GHD
BH1397	326599	6250388		shale/sandstone	3.5 - 8	ND	17-Dec-15	2.590		M4East investigations GHD
BH1397	326599	6250388		shale/sandstone	3.5 - 8	ND	21-Jan-16	2.390		M4East investigations GHD
BH1397	326599	6250388		shale/sandstone	3.5 - 8	ND	18-Feb-16	2.530		M4East investigations GHD
BH1397	326599	6250388		shale/sandstone	3.5 - 8	ND	21-Mar-16	2.580		M4East investigations GHD
BH1397	326599	6250388		shale/sandstone	3.5 - 8	ND	12-Apr-16	2.680		M4East investigations GHD
BH1397	326599	6250388		shale/sandstone	3.5 - 8	ND	10-May-16	2.670		M4East investigations GHD
BH54			Rozelle Railyards	alluvium	1.0 - 3.5	ND	Apr-03	1.6	1.2	Parsons Brinckerhoff, 2003
BH57			Rozelle Railyards	alluvium	2.0 - 5.0	ND	May-03	0.9	1.8	Parsons Brinckerhoff, 2003
BH60			Rozelle Railyards	alluvium	1.0 - 4.0	ND	Apr-03	1.8	0.9	Parsons Brinckerhoff, 2003
BH90			Rozelle Railyards	alluvium	2.0 - 5.0	ND	May-03	3.6	-0.2	Parsons Brinckerhoff, 2003

swl - standing water level
ND - not done

mbtoc - metres below top of casing

RL toc - relative level top of casing

Summary Table B4
M4-M5 Link WestConnex
Packer Test Results

Borehole	Coordinates		Date Tested	Lithology	Test Interval (m)	Test Midpoint (m)	Hydraulic Conductivity (interpreted)		Classification
	Easting	Northing					Lugeon	m/day	
CM_BH01	331645.5	6249003.8	25/08/2016	Hawkesbury Sandstone	7 - 14	10.5	<1	<0.0086	Low
			25/08/2016	Hawkesbury Sandstone	14 - 21	17.5	<1	<0.0086	Low
			25/08/2016	Hawkesbury Sandstone	21 - 28	24.5	<1	<0.0086	Low
			25/08/2016	Hawkesbury Sandstone	28 - 35	31.5	<1	<0.0086	Low
			25/08/2016	Hawkesbury Sandstone	35 - 42	38.5	<1	<0.0086	Low
CM_BH03	331871.0	6248978.1	19/07/2016	Ashfield Shale	12 - 15	13.5	14	0.1210	High
			19/07/2016	Hawkesbury Sandstone	14.5 - 21	17.8	5	0.0432	Moderate
			20/07/2016	Hawkesbury Sandstone	21 - 28	24.5	<1	<0.0086	Low
			21/07/2016	Hawkesbury Sandstone	28 - 35	31.5	<1	<0.0086	Low
			21/07/2016	Hawkesbury Sandstone	35 - 42	38.5	<1	<0.0086	Low
			21/07/2016	Hawkesbury Sandstone	42 - 50	46	2	0.0173	Moderate
CM_BH04	332076.5	6249145.8	18/08/2016	Ashfield Shale	9 - 14	11.5	<1	<0.0086	Low
			18/08/2016	Ashfield/Mittagong	14 - 21	17.5	<1	<0.0086	Low
			19/08/2016	Hawkesbury Sandstone	21 - 28	24.5	<1	<0.0086	Low
			22/08/2016	Hawkesbury Sandstone	28 - 35	31.5	<1	<0.0086	Low
			22/08/2016	Hawkesbury Sandstone	35 - 40	37.5	<1	<0.0086	Low
CM_BH06	332317.7	6249160.5	17/05/2016	Ashfield Shale	9 - 15	6	N/A	N/A	N/A
			17/05/2016	Ashfield Shale	14.5 - 21	17.8	<1	<0.0086	Low
			17/05/2016	Ashfield Shale	21 - 28	24.5	<1	<0.0086	Low
			17/05/2016	Mittagong-Hawkesbury	28 - 35	31.5	N/A	N/A	N/A
			17/05/2016	Hawkesbury Sandstone	35 - 40	37.5	<1	<0.0086	Low
CM_BH07	332369.2	6249136.6	31/08/2016	Ashfield Shale	7 - 14	10.5	1.8	0.0156	Moderate
			5/09/2016	Ashfield Shale	14 - 27	20.5	5.7	0.0492	High
			7/09/2016	Ashfield Shale	27 - 40	33.5	<1	<0.0086	Low
CM_BH08	332503.6	6249167.8	27/05/2016	Ashfield Shale/Mittagong	21 - 30	25.5	<1	<0.0086	Low
CM_BH09	332566.5	6249135.7	18/08/2016	Ashfield Shale	7 - 14	10.5	<1	<0.0086	Low
			19/08/2016	Ashfield Shale	14 - 21	17.5	2.7	0.0233	Moderate
			30/08/2016	Hawkesbury Sandstone	21 - 30	25.5	<1	<0.0086	Low
CM_BH10	332612.0	6249165.5	13/05/2016	Ashfield Shale	10.2 - 15	12.6	74	0.639	Extremely High
			13/05/2016	Ashfield Shale	16 - 21	18.5	3	0.026	Moderate
			12/05/2016	Mittagong	21 - 30	25.5	<1	<0.0086	Low
EP_BH01	330756.9	6250880.4	21/06/2016	Hawkesbury Sandstone	7.5 - 14	10.8	15	0.1296	High
			21/06/2016	Hawkesbury Sandstone	14 - 21	17.5	43	0.3715	Very High
			22/06/2016	Hawkesbury Sandstone	21 - 28	24.5	<1	<0.0086	Low
			22/06/2016	Hawkesbury Sandstone	28 - 35	31.5	<1	<0.0086	Low
			22/06/2016	Hawkesbury Sandstone	35.5 - 40	37.8	<1	<0.0086	Low
EP_BH02	330803.2	6250799.8	15/06/2016	Hawkesbury Sandstone	16 - 20	18	40	0.3456	Very High
			15/06/2016	Hawkesbury Sandstone	20 - 26	23	<1	<0.0086	Low
			15/06/2016	Hawkesbury Sandstone	26 - 33	29.5	<1	<0.0086	Low
			16/06/2016	Hawkesbury Sandstone	33 - 40	36.5	<1	<0.0086	Low
EP_BH03	330765.7	6250761.9	7/06/2016	Hawkesbury Sandstone	11 - 20	15.5	5	0.0432	Moderate
			7/06/2016	Hawkesbury Sandstone	19 - 26	22.5	<1	<0.0086	Low
			7/06/2016	Hawkesbury Sandstone	26 - 32	29	<1	<0.0086	Low
			7/06/2016	Hawkesbury Sandstone	32 - 38	35	<1	<0.0086	Low
			7/06/2016	Hawkesbury Sandstone	38 - 44	41	<1	<0.0086	Low
			7/06/2016	Hawkesbury Sandstone	44 - 50	47	<1	<0.0086	Low
EP_BH04	330926.6	6250911.1	11/11/2016	Hawkesbury Sandstone	8 - 14	11	2	0.0173	Moderate
			11/11/2016	Hawkesbury Sandstone	14 - 21	17.5	<1	<0.0086	Low
			14/11/2016	Hawkesbury Sandstone	21 - 28	24.5	1	0.0086	Moderate
			14/11/2016	Hawkesbury Sandstone	28 - 35	31.5	1	0.0086	Moderate
			14/11/2016	Hawkesbury Sandstone	35 - 40	37.5	2	0.0173	Moderate
EP_BH05	330886	6250862	9/02/2017	Hawkesbury Sandstone	7 - 12	9.5	3	0.0259	Moderate
			10/02/2017	Hawkesbury Sandstone	16 - 21	18.5	2	0.0173	Moderate
			10/02/2017	Hawkesbury Sandstone	22 - 27	24.5	<1	<0.0086	Low
			13/02/2017	Hawkesbury Sandstone	31 - 36	33.5	<1	<0.0086	Low
			13/02/2017	Hawkesbury Sandstone	37 - 42	39.5	<1	<0.0086	Low
			14/02/2017	Hawkesbury Sandstone	45 - 50	47.5	<1	<0.0086	Low
HB_BH01	327648.2	6250282.0	27/04/2016	Hawkesbury Sandstone	10 - 16	13	3	0.026	Moderate
			27/04/2016	Hawkesbury Sandstone	15.8 - 22	18.85	43	0.372	Very High

Summary Table B4
M4-M5 Link WestConnex
Packer Test Results

Borehole	Coordinates		Date Tested	Lithology	Test Interval (m)	Test Midpoint (m)	Hydraulic Conductivity (interpreted)		Classification
	Easting	Northing					Lugeon	m/day	
HB_BH02	327574.8	6250197.4	3/05/2016	Hawkesbury Sandstone	8 - 14	11	3	0.026	Moderate
			3/05/2016	Hawkesbury Sandstone	13.7 - 20	16.9	90	0.778	Extremely High
HB_BH03	327764.9	6250217.2	28/06/2016	Hawkesbury Sandstone	10 - 17.1	13.6	58	0.5011	Extremely High
			29/06/2016	Hawkesbury Sandstone	17 - 24	20.5	N/A	N/A	N/A
HB_BH05	327745.10	6249767.10	20/10/2016	Hawkesbury Sandstone	26-32	29	34	0.2938	Very High
			21/10/2016	Hawkesbury Sandstone	32-40	36	2	0.0173	Moderate
HB_BH06	328800.5	6250244.2	18/05/2016	Hawkesbury Sandstone	26 - 33	29.5	35	0.3024	Very High
			18/05/2016	Hawkesbury Sandstone	33 - 40	36.5	<1	<0.0086	Low
HB_BH07	328852.5	6250215.1	16/05/2016	Hawkesbury Sandstone	26 - 33	29.5	46	0.3974	Very High
			16/05/2016	Hawkesbury Sandstone	33 - 40	36.5	66	0.5702	Extremely High
HB_BH08	328752.0	6250138.2	10/05/2016	Hawkesbury Sandstone	27.9 - 33.9	30.9	<1	<0.0086	Low
			10/05/2016	Hawkesbury Sandstone	33.7 - 40	36.9	<1	<0.0086	Low
HB_BH09	328833.9	6250174.3	12/05/2016	Hawkesbury Sandstone	26 - 33	29.5	89	0.769	Extremely High
			12/05/2016	Hawkesbury Sandstone	33 - 40	36.5	<1	<0.0086	Low
HB_BH12	329047.4	6250099.1	27/06/2016	Hawkesbury Sandstone	26 - 33.5	29.8	1	0.0086	Moderate
			27/06/2016	Hawkesbury Sandstone	29.5 - 40	34.8	<1	<0.0086	Low
HB_BH13	329148.0	6250121.5	30/06/2016	Hawkesbury Sandstone	26 - 33.7	29.9	<1	<0.0086	Low
			1/07/2016	Hawkesbury Sandstone	33 - 40.1	36.5	21	0.1814	Very High
HB_BH14	329206.6	6250086.3	24/05/2016	Hawkesbury Sandstone	26 - 33	29.5	1	0.0086	Moderate
			25/05/2016	Hawkesbury Sandstone	33 - 40	36.5	5	0.0432	Moderate
HB_BH15	329396.4	6250142.8	16/05/2016	Hawkesbury Sandstone	28 - 34	31	<1	<0.0086	Low
			16/05/2016	Hawkesbury Sandstone	33.7 - 40	36.9	<1	<0.0086	Low
HB_BH16	328715.3	6250055.5	17/05/2016	Hawkesbury Sandstone	28 - 34	31	<1	<0.0086	Low
			17/05/2016	Hawkesbury Sandstone	33.7 - 40	36.9	<1	<0.0086	Low
IC_BH01	330383.8	6251639	17/10/2016	Hawkesbury Sandstone	14-21	17.5	<1	<0.0086	Low
IC_BH02	330531.4	6251552.7	18/10/2016	Hawkesbury Sandstone	21-30	25.5	2	0.0173	Moderate
MT_BH01	329491.9	6249838.0	25/11/2016	Hawkesbury Sandstone	57 - 63	60	<1	<0.0086	Low
			25/11/2016	Hawkesbury Sandstone	63 - 70	66.5	<1	<0.0086	Low
MT_BH02	329694.0	6249695.0	20/01/2017	Hawkesbury Sandstone	50 - 57	53.5	1	0.0086	Moderate
			23/01/2017	Hawkesbury Sandstone	57 - 63	60	1	0.0086	Moderate
			23/01/2017	Hawkesbury Sandstone	63 - 70	66.5	<1	<0.0086	Low
MT_BH03	330128	6249987	17/10/2016	Hawkesbury Sandstone	30-38.1	34.1	1	0.0086	Moderate
			17/10/2016	Hawkesbury Sandstone	38.1-44.1	41.1	<1	<0.0086	Low
			17/10/2016	Hawkesbury Sandstone	44.1-50.1	47.1	<1	<0.0086	Low
MT_BH04	330279.0	6250087.3	17/02/2017	Hawkesbury Sandstone	30.0 - 36.00	33.0	<1	<0.0086	Low
			20/02/2017	Hawkesbury Sandstone	36.0 - 42.0	39.0	<1	<0.0086	Low
			20/02/2017	Hawkesbury Sandstone	42.0 - 48.0	45.0	<1	<0.0086	Low
MT_BH05	330366	6250173	28/10/2016	Hawkesbury Sandstone	30-38.1	34.0	1	0.0086	Moderate
			31/10/2016	Hawkesbury Sandstone	38 - 44	41.0	1	0.0086	Moderate
			3/11/2016	Hawkesbury Sandstone	44 - 50	47.0	1	0.0086	Moderate
MT_BH06	330448.0	6250213.0	27/02/2017	Hawkesbury Sandstone	31.0 - 36.0	33.5	1	0.0086	Moderate
			27/02/2017	Hawkesbury Sandstone	37.0 - 42.0	39.5	<1	<0.0086	Low
			28/02/2017	Hawkesbury Sandstone	43.0 - 51.0	47.0	<1	<0.0086	Low
MT_BH07	330355.8	6249914.9	17/11/2016	Hawkesbury Sandstone	30 - 37	33.5	1	0.0086	Moderate
MT_BH08	330411.6	6249843.8	1/03/2017	Hawkesbury Sandstone	13 - 19.1	16.0	<1	<0.0086	Low
			1/03/2017	Hawkesbury Sandstone	19.1 - 25.1	22.1	2	0.0173	Moderate
			1/03/2017	Hawkesbury Sandstone	25.1 - 30.3	27.7	1	0.0086	Moderate
MT_BH09	329960.0	6249514.0	24/01/2017	Hawkesbury Sandstone	46 - 52	49	<1	<0.0086	Low
			24/01/2017	Hawkesbury Sandstone	52 - 59	55.5	<1	<0.0086	Low
			24/01/2017	Hawkesbury Sandstone	57 - 65	61	<1	<0.0086	Low
MT_BH10	330362.0	6249279.0	9/01/2017	Hawkesbury Sandstone	35 - 41	38	<1	<0.0086	Low
			9/01/2017	Hawkesbury Sandstone	41 - 48	44.5	<1	<0.0086	Low
			10/01/2017	Hawkesbury Sandstone	48 - 55	51.5	<1	<0.0086	Low
MT_BH11	330670.7	6249095.1	28/11/2016	Hawkesbury Sandstone	45 - 51	48	48	0.4147	Very High
			28/11/2016	Hawkesbury Sandstone	51 - 58	54.5	<1	<0.0086	Low
			28/11/2016	Hawkesbury Sandstone	58 - 65	61.5	<1	<0.0086	Low

Summary Table B4
M4-M5 Link WestConnex
Packer Test Results

Borehole	Coordinates		Date Tested	Lithology	Test Interval (m)	Test Midpoint (m)	Hydraulic Conductivity (interpreted)		Classification
	Easting	Northing					Lugeon	m/day	
MT_BH12	330972.5	6248594.7	13/11/2016	Hawkesbury Sandstone	29 - 36	32.5	1	0.0086	Moderate
			13/11/2016	Hawkesbury Sandstone	36 - 43	39.5	1	0.0086	Moderate
			13/11/2016	Hawkesbury Sandstone	43 - 50	46.5	<1	<0.0086	Low
MT_BH13	331086.8	6248351.6	3/11/2016	Hawkesbury Sandstone	44 - 51.1	47.6	1	0.0086	Moderate
			3/11/2016	Hawkesbury Sandstone	51 - 58.1	54.6	2	0.0173	Moderate
			3/11/2016	Hawkesbury Sandstone	58 - 65	61.5	2	0.0173	Moderate
MT_BH14	331168.4	6248150.0	8/11/2016	Hawkesbury Sandstone	49 - 56	52.5	1	0.0086	Moderate
			9/11/2016	Hawkesbury Sandstone	56 - 63	59.5	1	0.0086	Moderate
			9/11/2016	Hawkesbury Sandstone	63 - 70	66.5	1	0.0086	Moderate
MT_BH15	331312.9	6247802.5	15/11/2016	Hawkesbury Sandstone	75 - 81	78	1	0.0086	Moderate
			16/11/2016	Hawkesbury Sandstone	81 - 88	84.5	<1	<0.0086	Low
			16/11/2016	Hawkesbury Sandstone	88 - 95	91.5	<1	<0.0086	Low
MT_BH16	331353.9	6247679.3	2/12/2016	Hawkesbury Sandstone	43.3 - 52.0	47.6	<1	<0.0086	Low
			2/12/2016	Hawkesbury Sandstone	64.1 - 70.1	67.1	<1	<0.0086	Low
MT_BH17	328264.6	6250035.4	17/01/2017	Hawkesbury Sandstone	40 - 47	43.5	<1	<0.0086	Low
			17/01/2017	Hawkesbury Sandstone	47 - 54	50.5	<1	<0.0086	Low
			17/01/2017	Hawkesbury Sandstone	54 - 61	57.5	<1	<0.0086	Low
MT_BH18	331711.4	6247001.6	24/10/2016	Hawkesbury Sandstone	57 - 63	60	<1	<0.0086	Low
			24/10/2016	Hawkesbury Sandstone	66 - 73	69.5	1	0.0086	Moderate
			24/10/2016	Hawkesbury Sandstone	73 - 80	76.5	<1	<0.0086	Low
MT_BH19	331680.3	6246735.9	13/12/2016	Hawkesbury Sandstone	49 - 56	52.5	<1	<0.0086	Low
			13/12/2016	Hawkesbury Sandstone	57 - 63	60	2	0.0173	Moderate
			13/12/2016	Hawkesbury Sandstone	64 - 70	67	<1	<0.0086	Low
MT_BH20	330379.0	6249504.6	19/12/2016	Hawkesbury Sandstone	35 - 42	38.5	2	0.0173	Moderate
			20/12/2016	Hawkesbury Sandstone	42 - 49	45.5	2	0.0173	Moderate
			20/12/2016	Hawkesbury Sandstone	49 - 55	52	<1	<0.0086	Low
MT_BH21	330066.7	6249770.9	9/12/2016	Hawkesbury Sandstone	44 - 51	47.5	<1	<0.0086	Low
			9/12/2016	Hawkesbury Sandstone	51 - 58	54.5	<1	<0.0086	Low
			9/12/2016	Hawkesbury Sandstone	58 - 65	61.5	<1	<0.0086	Low
MT_BH22	331774.1	6246667.9	6/01/2017	Hawkesbury Sandstone	43.3 - 52.0	47.6	<1	<0.0086	Low
			9/01/2017	Hawkesbury Sandstone	52.0 - 59.8	55.9	<1	<0.0086	Low
			9/01/2017	Hawkesbury Sandstone	59.8 - 67.6	63.7	4	0.0346	Moderate
RZ_BH16	330609.4	6250409.4	15/06/2016	Hawkesbury Sandstone	10 - 19	14.5	45	0.3888	Very High
RZ_BH20	330857.1	6250681.0	1/06/2016	Hawkesbury Sandstone	18 - 27	22.5	<1	<0.0086	Low
RZ_BH21	330884.8	6250693.6	14/06/2016	Hawkesbury Sandstone	18 - 27	22.5	7	0.0605	High
RZ_BH22a	330912.0	6250711.8	6/06/2016	Hawkesbury Sandstone	18 - 27	22.5	<1	<0.0086	Low
RZ_BH23	330959.0	6250741.0	21/06/2016	Hawkesbury Sandstone	19.2 - 27	23.1	106	0.9158	Extremely High
RZ_BH24	331001.8	6250763.0	17/06/2016	Hawkesbury Sandstone	18 - 27	22.5	39	0.3370	Very High
RZ_BH27	331064.1	6250799.3	7/06/2016	Hawkesbury Sandstone	18 - 27	22.5	18	0.1555	High
RZ_BH28	331126.6	6250818.8	28/07/2016	Hawkesbury Sandstone	16 - 22	19	<1	<0.0086	Low
RZ_BH29	331158.5	6250828.5	9/08/2016	Hawkesbury Sandstone	16 - 22	19	57	0.4925	Extremely High
RZ_BH30	331192.9	6250835.9	13/07/2016	Hawkesbury Sandstone	21 - 27	24	N/A	N/A	N/A
RZ_BH31	331230.8	6250855.3	7/07/2016	Hawkesbury Sandstone	19 - 30	23	<1	<0.0086	Low
RZ_BH32	331265.2	6250858.1	8/07/2016	Hawkesbury Sandstone	16 - 24	20	11	0.0950	High
RZ_BH37	330639.6	6250474.2	20/07/2016	Hawkesbury Sandstone	9.5 - 16	12.8	N/A	N/A	N/A
RZ_BH38	330726.6	6250512.1	1/08/2016	Hawkesbury Sandstone	19 - 24	21.5	1	0.0086	Moderate
RZ_BH39	330801.4	6250556.7	5/08/2016	Hawkesbury Sandstone	19 - 25	22	85	0.7344	Extremely High
RZ_BH40	330916.7	6250668.0	27/07/2016	Hawkesbury Sandstone	20.9 - 26.9	23.9	103	0.8899	Extremely High
RZ_BH41	330938.4	6250680.9	27/07/2016	Hawkesbury Sandstone	26 - 33	19	N/A	N/A	N/A
RZ_BH43	331014.0	6250731.0	19/07/2016	Hawkesbury Sandstone	22.5 - 30	26.3	26	0.2246	Very High
RZ_BH44	330885.8	6250614.0	8/08/2016	Hawkesbury Sandstone	24 - 30	27	49	0.4234	Very High
RZ_BH45	330958.8	6250653.9	12/08/2016	Hawkesbury Sandstone	21 - 26	23.5	135	1.1664	Extremely High
RZ_BH47	331025.2	6250701.7	8/08/2016	Hawkesbury Sandstone	26 - 33.2	23.5	N/A	N/A	N/A
			8/08/2016	Hawkesbury Sandstone	29.5 - 35	32.3	N/A	N/A	N/A
RZ_BH48	330676.3	6250417.5	2/06/2016	Hawkesbury Sandstone	22.5 - 33	27.8	43	0.3715	Very High
			2/06/2016	Hawkesbury Sandstone	31.5 - 43	37.3	<1	<0.0086	Low
RZ_BH49	330732.3	6250463.6	24/06/2016	Hawkesbury Sandstone	21 - 30	25.5	59	0.5098	Extremely High
			27/06/2016	Hawkesbury Sandstone	33 - 42	37.5	72	0.6221	Extremely High

Summary Table B4
M4-M5 Link WestConnex
Packer Test Results

Borehole	Coordinates		Date Tested	Lithology	Test Interval (m)	Test Midpoint (m)	Hydraulic Conductivity (interpreted)		Classification
	Easting	Northing					Lugeon	m/day	
RZ_BH60	330317.8	6250589.6	5/12/2016	Hawkesbury Sandstone	51 - 54	52.5	2	0.0173	Moderate
			6/12/2016	Hawkesbury Sandstone	57 - 61	59	2	0.0173	Moderate
RZ_BH61	330408.7	6250840.9	1/02/2017	Hawkesbury Sandstone	40 - 47	43.5	<1	<0.0086	Low
			2/02/2017	Hawkesbury Sandstone	47 - 54	50.5	<1	<0.0086	Low
			2/02/2017	Hawkesbury Sandstone	54 - 61	57.5	<1	<0.0086	Low
RZ_BH62	330470.3	6250696.6	1/02/2017	Hawkesbury Sandstone	48 - 54	51	1	0.0086	Moderate
			2/02/2017	Hawkesbury Sandstone	54 - 61	57.5	5	0.0432	Moderate
			2/02/2017	Hawkesbury Sandstone	61 - 68	64.5	1	0.0086	Moderate
RZ_BH63	330316.5	6250945.3	9/02/2017	Hawkesbury Sandstone	47 - 54	50.5	<1	<0.0086	Low
			9/02/2017	Hawkesbury Sandstone	54 - 61	57.5	<1	<0.0086	Low
			10/02/2017	Hawkesbury Sandstone	61 - 68	64.5	<1	<0.0086	Low
RZ_BH64	330625.4	6250950.8	19/12/2016	Hawkesbury Sandstone	37 - 44	40.5	1	0.0086	Moderate
RZ_BH65	330535.6	6251109.8	22/02/2017	Hawkesbury Sandstone	45 - 51	48.0	<1	<0.0086	Low
			22/02/2017	Hawkesbury Sandstone	52 - 59	55.5	<1	<0.0086	Low
			22/02/2017	Hawkesbury Sandstone	58 - 65	61.5	<1	<0.0086	Low
RZ_BH67	330961.5	6250999.7	12/12/2016	Hawkesbury Sandstone	30 - 37	33.5	1	0.0086	Moderate
			13/12/2016	Hawkesbury Sandstone	37 - 44	40.5	1	0.0086	Moderate
			13/12/2016	Hawkesbury Sandstone	44 - 51	47.5	1	0.0086	Moderate
RZ_BH69	330556.1	6251217.0	19/01/2017	Hawkesbury Sandstone	19 - 24	21.5	9	0.0778	High
			19/01/2017	Hawkesbury Sandstone	29 - 34	31.5	5	0.0432	Moderate
			19/01/2017	Hawkesbury Sandstone	37 - 42	39.5	65	0.5616	Extremely High
RZ_BH70	330682.0	6251323.3	20/02/2017	Hawkesbury Sandstone	20 - 27	23.5	<1	<0.0086	Low
			21/02/2017	Hawkesbury Sandstone	27 - 34	30.5	<1	<0.0086	Low
			22/02/2017	Hawkesbury Sandstone	34 - 41	37.5	1	0.0086	Moderate
SP_BH01	331750.6	6246432.7	7/09/2016	Ashfield Shale	26 - 33	29.5	<1	<0.0086	Low
			7/09/2016	Ashfield Shale	33 - 46.7	36.8	<1	<0.0086	Low
SP_BH02	331844.8	6246375.9	27/05/2016	Ashfield Shale	23 - 30	26.5	1	0.0086	Moderate
			27/05/2016	Ashfield Shale	30.7 - 40.11	35.4	<1	<0.0086	Low
SP_BH03	331722.8	6246228.8	1/08/2016	Ashfield Shale	26 - 33	29.5	<1	<0.0086	Low
SP_BH04	331658.0	6246185.6	25/06/2016	Ashfield Shale	26 - 33	29.5	1.6	0.0138	Moderate
			25/06/2016	Ashfield Shale	33 - 40	36.5	1.2	0.0104	Moderate
SP_BH08	331817.7	6245976.9	19/05/2016	Ashfield Shale	15 - 21	18	<1	<0.0086	Low
SP_BH09	331800.9	6245948.3	20/05/2016	Ashfield Shale	15 - 20.9	18	1	0.0086	Moderate
			20/05/2016	Ashfield Shale	20.8 - 30.2	25.5	<1	<0.0086	Low
TC_BH01	330660.6	6250304.9	27/06/2016	Hawkesbury Sandstone	20 - 30	25	66	0.5702	Extremely High
			27/06/2016	Hawkesbury Sandstone	30 - 40	35	<1	<0.0086	Low
TC_BH04	330947.5	6250563.8	2/05/2016	Hawkesbury Sandstone	19.75 - 29.75	24.8	N/A	N/A	N/A
			2/05/2016	Hawkesbury Sandstone	40 - 50	45	<1	<0.0086	Low
TC_BH05	331000.8	6250586.9	11/05/2016	Hawkesbury Sandstone	40.5 - 50.5	45.5	<1	<0.0086	Low
TC_BH06	330610.2	6250298.1	4/07/2016	Hawkesbury Sandstone	15 - 24	19.5	<1	<0.0086	Low
			5/07/2016	Hawkesbury Sandstone	30 - 40	35	<1	<0.0086	Low
TC_BH07	330746.0	6250373.6	4/07/2016	Hawkesbury Sandstone	15 - 25	20	<1	<0.0086	Low
			4/07/2016	Hawkesbury Sandstone	25 - 35	30	<1	<0.0086	Low
TC_BH08	330818.3	6250435.9	6/07/2016	Hawkesbury Sandstone	15 - 25	20	31	0.2678	Very High
			7/07/2016	Hawkesbury Sandstone	25 - 35	30	<1	<0.0086	Low
TC_BH09	330830.3	6250444.5	1/07/2016	Hawkesbury Sandstone	15 - 25	20	12	0.1037	High
			1/07/2016	Hawkesbury Sandstone	25 - 40	32.5	<1	<0.0086	Low

Notes:
Lugeon - Hydraulic conductivity represented in lugeon units
m/day - Hydraulic conductivity represented as metres per day
N/A no data - equipment failure
Classification:
Low: less than 1 lugeon
Moderate: 1 to 5 Lugeons
High: 6 to 20 Lugeons
Very High: 21 to 50 Lugeons
Extremely High: greater than 50 Lugeons

Summary Table B4a
Hydraulic Conductivity Statistics

Lugeon		Ashfield Shale		Hawkesbury Sandstone	
	Units	m/day			
		Kh	Kv*	Kh	Kv*
n		24	2	196	11
minimum		<0.0086	0.00001	<0.0086	0.00008
maximum		0.12	0.0002	1.166	0.013
standard deviation		0.024		0.21	0.0039
arithmetic mean		0.017		0.093	0.0031
harmonic mean		0.010		0.011	0.00028

Notes:

* Kv measured in laboratory - refer to Summary Table C11

Summary Table B5
M4-M5 Link WestConnex
Water Quality - Field Parameters

Monitoring Well	Date	Temperature (ºC)	Dissolved Oxygen (ppm)	Conductivity (µS/cm)	pH	Redox Potential (mV)
CM_BH04	31/08/2016	20.4	4.52	2876	8.7	15
CM_BH06	27/07/2016	14	1.84	2111	9.37	-216.2
	31/08/2016	19	0.92	2230	9	-180.8
	27/09/2016	18.7	0.83	2878	8.46	-238.6
HB_BH02	8/06/2016	20.1	0.5	5574	6.34	-43.4
	27/07/2016	18	1.9	2604	7.08	-164.6
	30/08/2016	19.7	2.43	1793	7.3	-95.1
	15/02/2017	22.9	0.38	1107	6.04	-180.7
HB_BH03	10/08/2016	21.1	1.17	1176	5.94	35.8
	29/09/2016	19.4	1.5	558	6.53	-33.2
	26/10/2016	21.1	1.64	792	6.7	-101.4
	30/11/2016	22	1.12	934	8	-72.3
	15/03/2017	23.03	3.02	872.4	7.05	-102.9
	28/04/2017	19.2	5.57	955.4	8.52	-125.5
	25/05/2017	17.38	2.68	1199	6.56	23.1
HB_BH08D	8/06/2016	19.9	1.16	2775	8.75	-228.4
	30/08/2016	19.3	1.49	2430	7.28	-206.1
	27/09/2016	19.6	0.16	3154	6.47	-161.8
	26/10/2016	20.9	2.55	3029	6.53	-106.1
	30/11/2016	21.4	1.7	2951	7.28	-97.6
	14/12/2016	22.1	1.92	2660	7.18	-74
	17/01/2017	26.1	2.85	2030	7.07	-68
	15/02/2017	22.1	1.28	2964	5.91	-161.3
	15/03/2017	22.22	3.19	2581.7	7.93	-32
	24/04/2017	19.93	2.41	2800.2	7.57	-70.9
	25/05/2017	19.59	1.48	2492.3	6.81	-30.2
HB_BH08S	8/06/2016	20.2	0.2	9068	6.76	-105.4
	27/07/2016	17.5	1.74	1561	8.06	-105.9
	30/08/2016	14	1.53	2667	7.12	-78.3
	27/09/2016	19.6	0.12	3609	6.97	-125
	26/10/2016	21.4	1.7	5699	6.21	-105.3
	30/11/2016	21.1	1.47	2637	7.57	-57.9
	14/12/2016	21.7	3.61	3680	7.31	-89
	17/01/2017	22.6	2.96	5380	7.02	-71
	15/02/2017	23	1.66	3467	5.96	-100.4
	15/03/2017	22.03	3.23	5658	7.37	53.4
	28/04/2017	19.48	4.05	5065.3	7.51	131
	25/05/2017	19.9	3.8	1857	6.94	181
HB_BH12	14/07/2016	17.6	1.73	1037	11.19	178.6
	30/08/2016	18.8	1.36	7670	12.25	-235.7
	28/09/2016	18.6	0.22	11946	12.33	-216.5
	26/10/2016	20.6	1.08	5223	11.68	-116.8
	14/12/2016	23.5	1.98	6210	12.03	-15
	15/02/2017	22.3	1.94	4520	10.7	-205.4
	15/03/2017	21.77	0.43	6111.5	12.52	-137.9
	28/04/2017	20.39	2.43	7878.9	11.83	-163
	25/05/2017	18.48	1.86	5422	12.24	16.5
HB_BH14	14/07/2016	19.8	1.31	2169	6.91	141.6
	27/07/2016	19.5	3.75	1196	8.82	-155.3
	30/08/2016	18.9	1.83	1264	7.26	-124.7
	14/12/2016	24.6	2.87	2106	8.72	-138
	15/02/2017	21.9	0.39	2166	7.39	-162.5
	15/03/2017	22.09	1.42	1211.2	8.39	-95.2
	26/05/2017	20.51	2.59	568.8	8.26	43.1

Summary Table B5
M4-M5 Link WestConnex
Water Quality - Field Parameters

Monitoring Well	Date	Temperature (ºC)	Dissolved Oxygen (ppm)	Conductivity (µS/cm)	pH	Redox Potential (mV)
HB_BH15	8/06/2016	19.8	1.68	675	8.25	-14.7
	27/07/2016	19.9	2.37	1010	6.79	-103.7
	30/08/2016	18.5	20.9	958	6.29	-73.4
	28/09/2016	20.2	0.65	1556	7.02	-93
	26/10/2016	22.6	1.61	1517	5.77	-76.7
	30/11/2016	21.7	1.92	967	7.21	-131.8
	14/12/2016	22.7	2.96	16300	7.45	-130
	17/01/2017	24.3	2.97	1385	6.31	-45
	15/02/2017	21.3	2.03	1340	7.08	-136
	15/03/2017	22.11	3.55	1108.3	6.79	15.8
	28/04/2017	19.84	4.46	1337.8	11.01	-229.1
	25/05/2017	20.07	1.29	1216	8.64	-82
RZ_BH01D	27/07/2016	19.4	1.17	1373	7.04	-117.3
	30/08/2016	20.4	1.79	1491	6.63	-116.1
	29/09/2016	18.6	1.43	1261	9.88	-167.6
	24/10/2016	20.7	1.21	1979	6.01	-6.1
	25/10/2016	21.1	0.38	2146	6	-14.5
	28/11/2016	22.4	1.25	1987	6.78	-81.9
	12/12/2016	22.7	2.75	1408	6.65	-72
	12/01/2017	23.1	2.85	1817	6.74	-22
	14/02/2017	20.4	0.6	1869	6.43	-68
	13/03/2017	22.1	1.24	1646	6.92	-114.6
	26/04/2017	22.74	2.54	1876	6.79	-69.2
	24/05/2017	20.26	3.35	1489.1	6.37	19.3
RZ_BH01S	27/07/2016	20	1.72	456	6.96	-95.5
	30/08/2016	19.9	1.61	397.4	6.95	-109
	27/09/2016	19.8	0.09	528	7.02	-163.6
	25/10/2016	25	1.44	627	6.69	-65
	28/11/2016	22.6	2.75	426	7.29	-53.9
	12/12/2016	21.3	3.37	540	7.12	-66
	12/01/2017	22.8	3.82	517	7.07	-25
	14/02/2017	21.3	1.78	560	6.66	-90
	13/03/2017	21.9	0.87	527	6.77	-88.9
	26/04/2017	21.71	3.78	522.6	6.85	-109.4
	24/05/2017	21.03	3.25	448.1	6.75	-4.6
RZ_BH15	27/07/2016	18.7	1.56	611	9.35	-132.3
	30/08/2016	20.7	1.47	368.2	7.7	-76
	29/09/2016	19.1	0.58	1248	7.14	-141
	25/10/2016	20.8	0.09	1048	6.55	-58.1
	28/11/2016	22.7	19.4	698	7.48	-93.2
	12/12/2016	22.7	1.87	995	6.65	18
	12/01/2017	23.8	0.66	694	6.86	-55
	14/02/2017	21.2	1.76	984	6.65	-90.1
	13/03/2017	21.9	1.23	880	6.99	-93.4
	26/04/2017	21.64	1.99	1067.4	7.04	-82.8
	24/05/2017	22.35	2.19	890.3	6.2	17.9

Summary Table B5
M4-M5 Link WestConnex
Water Quality - Field Parameters

Monitoring Well	Date	Temperature (ºC)	Dissolved Oxygen (ppm)	Conductivity (µS/cm)	pH	Redox Potential (mV)
RZ_BH16	14/07/2016	20.5	1.17	1310	7.24	27.1
	27/07/2016	19	1.24	690	10.3	-158.8
	30/08/2016	19.4	1.87	672	10.02	-54.1
	29/09/2016	18.9	0.11	782	8.93	-170.4
	24/10/2016	20.2	1.69	1225	6.09	-17.2
	25/10/2016	23.8	1.75	768	7.32	-41.2
	28/11/2016	22.3	1.46	969	7.51	-75.3
	12/12/2016	20.2	1.53	993	8.96	9
	12/01/2017	22.2	2.06	925	8.38	-9
	14/02/2017	19.9	2.26	969	7.35	-45.3
	13/03/2017	21.9	0.31	1065	7.51	-134.3
	26/04/2017	21.33	4.34	945.4	7.11	-118.9
	24/05/2017	19.71	0.55	829.8	9.22	10.5
RZ_BH19	10/08/2016	20	0.36	1112	7.34	155.9
	29/09/2016	18.6	0	1199	8.11	-132.1
	24/10/2016	21	1.44	1245	6.07	-20.4
	27/10/2016	19.8	0.06	1270	7.04	-135.8
	28/11/2016	21.1	1.5	1227	8.34	-158.7
	12/12/2016	21.8	1.15	1245	9.82	-154
	13/01/2017	21.4	0.66	1190	6.7	124
	14/02/2017	20.4	0.1	1240	8.5	-203
	13/03/2017	23	0.14	1340	6.69	-230
	26/04/2017	21.35	4.5	917.5	7.68	-152.9
	24/05/2017	20.1	2.57	1051.9	7.83	13.5
RZ_BH26	14/07/2016	18.7	1.24	445.4	6.65	60
	27/07/2016	17.4	1.82	449	10.29	-107.2
	30/08/2016	19.8	1.6	4547	9.16	54.3
	29/09/2016	18.9	0.3	560	7.35	-149.5
	24/10/2016	20.6	0.64	547	5.73	-7
	25/10/2016	20.3	3.98	487.8	9.29	-112.6
	28/11/2016	21.2	0.8	611	7.02	-115
	12/12/2016	21.3	1.56	469	6.97	-133
	13/01/2017	23.7	1.44	604	6.83	-29
	14/02/2017	19.8	2.51	617	6.79	-126.9
	13/03/2017	21.3	0.55	712	6.4	-113.2
	26/04/2017	22.56	4.03	601.2	7.09	-66.7
	24/05/2017	18.74	0.24	548.9	6.68	-39.7
RZ_BH28	10/08/2016	18.9	1.08	833	6.09	-7.9
	29/09/2016	18.8	0.95	835	6.79	-88.8
	25/10/2016	20.7	0.17	849	5.96	-972
	28/11/2016	21.4	1.57	887	6.64	-35.4
	12/12/2016	21.2	2.85	935	6.8	-72
	13/01/2017	23.3	2.27	868	642	-17
	14/02/2017	19.7	2.43	862	6.4	-61.3
	13/03/2017	21.1	0.85	963	6.19	-51
	26/04/2017	23.55	3.1	813.9	6.89	-43.2
	24/05/2017	19.63	3.03	724.7	6.34	52.9
RZ_BH30	27/07/2016	20	0.6	1452	6.75	-67.5
	31/08/2016	20.3	2.54	1347	6.7	-87.7
	28/09/2016	21.7	1.2	1598	6.84	-109.8
	16/01/2017	21.1	5.26	951	6.13	95
	26/04/2017	20.08	3.69	1421.6	6.75	-39.2
	24/05/2017	19.61	2.91	1093.7	6.74	52.8

Summary Table B5
M4-M5 Link WestConnex
Water Quality - Field Parameters

Monitoring Well	Date	Temperature (ºC)	Dissolved Oxygen (ppm)	Conductivity (µS/cm)	pH	Redox Potential (mV)
RZ_BH38	10/08/2016	20.1	1.18	1136	9.72	-281.1
	29/09/2016	18.4	0.64	1350	8.57	-178.3
	26/10/2016	20.4	0.81	1682	7.86	-94.9
	27/10/2016	21.1	0.89	1276	10.45	-139.2
	28/11/2016	22.1	1.29	1946	8.24	-148.2
	12/12/2016	-	3.02	1971	7.99	-96
	12/01/2017	24.2	2.5	1933	8	-56
	14/02/2017	20.6	1.29	2056	7.3	-164
	13/03/2017	22.1	0.28	2193	7.51	22.1
	26/04/2017	20.55	6.22	1466.6	7.35	-94.6
	24/05/2017	19.98	1.54	1542.5	7.43	28.3
RZ_BH44S	10/08/2016	21.8	0.99	6681	6.49	-62.5
	29/09/2016	18.3	0.26	3713	5.79	-28.9
	27/10/2016	19.1	0.21	2706	6.28	-70.8
	28/11/2016	22.3	1.06	2844	6.67	-18.8
	12/12/2016	21.3	3.57	2610	5.84	-6
	13/01/2017	21.5	4.2	2390	6.78	-38
	14/02/2017	20.4	2.38	2685	6.17	-19.8
	13/03/2017	21.4	1.66	2934	6.7	-91
	26/04/2017	22.45	3.68	2430	7.2	-44.9
	24/05/2017	20.97	3.22	2247.8	6.3	50.2
RZ_BH44D	10/08/2016	20.9	0.53	715	6.95	-84.5
	29/09/2016	18.7	0.94	1168	7.04	-124.3
	27/10/2016	20.6	2.65	1304	7.04	-106.1
	28/11/2016	22	2.56	1401	7.89	-117
	12/12/2016	22.6	0.93	1199	6.77	-117
	13/01/2017	22.3	3.08	1344	7.42	11
	14/02/2017	20.9	0.43	1470	7.01	-133.8
	13/03/2017	21.4	1.82	1332	6.89	-123
	26/04/2017	24.04	2.85	1403.1	7.62	-128.1
	24/05/2017	20.6	2.32	1071.2	7.02	2.4
RZ_BH47S	31/08/2016	23	1.75	1216	6.27	-57.2
	29/09/2016	18.7	0.22	1393	5.56	10.8
	25/10/2016	19.9	5.22	328.3	9.64	-129.4
	28/11/2016	23.1	0.69	1271	6.65	4.2
	12/12/2016	23.4	4.22	932	6.39	-14
	13/01/2017	24.8	2.36	1203	6.41	-24
	14/02/2017	21.1	0.88	1120	6.25	-22.5
	13/03/2017	22.3	0.99	1202	6.14	-27
	26/04/2017	22.58	3.16	1192.6	7.26	-21.8
	24/05/2017	20.52	3.03	1003.3	6.06	64.3
RZ_BH47D	31/08/2016	22.5	2.26	829	6.51	-62.3
	29/09/2016	19.1	0.13	1031	6.34	-63
	25/10/2016	21.7	4.3	337.8	8.72	-132.9
	28/11/2016	21.9	1.2	900	6.7	-60.5
	12/12/2016	23.3	2.08	921	6.58	-73
	13/01/2017	25.4	3.35	931	6.49	-16
	14/02/2017	20.8	1	946	6.58	-104.3
	13/03/2017	21.9	0.6	1007	6.65	-104
	26/04/2017	21.41	4.82	926.4	6.98	-70.8
	24/05/2017	19.9	1.2	844.5	6.4	29.7

Summary Table B5
M4-M5 Link WestConnex
Water Quality - Field Parameters

Monitoring Well	Date	Temperature (ºC)	Dissolved Oxygen (ppm)	Conductivity (µS/cm)	pH	Redox Potential (mV)
RZ_BH49	14/07/2016	19.1	0.67	9258	7.57	33.7
	27/07/2016	18	3.46	3017	9.95	-168.8
	30/08/2016	20	1.96	7900	6.69	-55.6
	29/09/2016	18.1	0.41	10778	6.49	-64.2
	26/10/2016	20.8	2.28	5419	7.56	-87.1
	28/11/2016	22.2	2.82	4416	8.46	-49.7
	12/12/2016	20	4.25	3580	7.82	-3
	12/01/2017	22.6	4.16	646	7.35	38
	14/02/2017	19.9	0.8	9348	6.45	-53.2
	13/03/2017	21.4	1.05	9869	6.82	-75.7
	26/04/2017	21.06	5.36	1995.1	7	-19.4
	24/05/2017	19.7	3.69	6453	7.31	53.5
RZ_BH50	31/08/2016	20.9	1.44	338.4	7.47	-120.3
	28/09/2016	22	0.82	678	6.05	-37.9
	25/10/2016	22.4	0.2	594	5.76	-111.6
	28/11/2016	21.4	0.79	598	6.79	-37.2
	12/12/2016	23	2.41	422	6.2	-33
	16/01/2017	20.9	5.78	423	6.5	-10
	14/02/2017	20.5	6.1	6600	6.74	-54.7
	15/03/2017	22.8	2.58	531.4	6.56	-20.6
	26/04/2017	23.07	4.07	549.8	7.26	-1.4
	24/05/2017	20.1	2.75	550	6.22	34.9
RZ_BH51	10/08/2016	24.9	1.52	4100	11.92	-190.6
	28/09/2016	20	0.23	1770	6.62	-84.8
	25/10/2016	26.5	2.26	1801	6.37	-107.1
	28/11/2016	21.8	0.9	1580	7.16	-123.5
	12/12/2016	22	3.04	1645	6.71	-30
	16/01/2017	21.5	13.01	1440	6.57	63
	14/02/2017	21	1.46	1533	6.74	-77
	26/04/2017	20.86	5.4	1161	6.88	-18.4
	24/05/2017	20.64	3.55	1466.7	6.48	43.9
RZ_BH52	10/08/2016	22	1.23	526	10.15	154.3
	28/09/2016	21	1.08	1256	6.59	-74.1
	25/10/2016	21.3	0.17	1004	5.6	-106.2
	28/11/2016	22.2	2.5	1033	7.44	-48.5
	12/12/2016	22.2	2.42	775	6.44	-77
	14/02/2017	21.2	0.27	1087	6.66	-72.8
	15/03/2017	25.28	0.32	919.8	6.68	16
	26/04/2017	20.51	3.78	818.1	7.05	-64.6
	24/05/2017	20.67	1.38	872.9	6.45	20.6
RZ_BH60	16/01/2017	22.5	9.63	4910	11.76	-95
	17/02/2017	20.9	0.79	4291	11.43	-294.1
	15/03/2017	21.19	0.93	3393	12.37	-93.2
	27/04/2017	18.46	2.76	3764	11.86	-184.9
	26/05/2017	18.98	2.88	3302.7	12.19	64.4
RZ_BH64	26/05/2017	19.32	1.59	572.1	9.16	562
RZ_BH69	16/02/2017	20.4	1.13	424.1	5.79	-168.1
	15/03/2017	20.06	2.98	2468.6	12.28	-80.8
RZ_BH67	17/02/2017	21.4	0.03	773	8.96	-316.8
	15/03/2017	22.17	0.78	601.8	7.06	-61.7
	27/04/2017	17.52	5.2	507.4	6.73	-20.9
	26/05/2017	20.17	3.11	522.6	6.42	19.2

Summary Table B5
M4-M5 Link WestConnex
Water Quality - Field Parameters

Monitoring Well	Date	Temperature (ºC)	Dissolved Oxygen (ppm)	Conductivity (µS/cm)	pH	Redox Potential (mV)
SP_BH01	26/10/2016	23.5	1.91	2088	7.23	-103.3
	30/11/2016	22.2	0.8	901	9.79	-216.1
	13/12/2016	22.4	7.26	1824	7.18	-185
	17/01/2017	22.9	2.07	1544	7.19	-166
	15/02/2017	21.6	2.61	2801	6.86	-255.8
	15/03/2017	22.9	0.31	2165.4	7.36	-203
	27/04/2017	19.8	4.95	2681.6	8.43	-169.2
	26/05/2017	18.7	2.28	1062	8.98	-6.5
SP_BH02	27/07/2016	20	0.88	2988	5.95	-29.7
	31/08/2016	21.4	2.51	2349	5.85	19.9
	27/09/2016	19.1	1.52	3548	5.85	-60.1
	26/10/2016	24.4	1.49	2385	6.2	-86.9
	30/11/2016	23	0.2	1015	10.88	-109.3
	15/02/2017	25.1	0	11986	5.51	-103.7
	15/03/2017	23.92	1.89	2429.3	6.16	-1.3
	26/05/2017	20.44	2.09	2913.8	6.43	36.3
SP_BH04	10/08/2016	21.8	0.56	3665	6.99	-86
	29/09/2016	17.8	8.7	5150	7.11	-182.6
	26/10/2016	23.2	0.54	3301	7.46	-121.3
	30/11/2016	21.3	1.29	3141	8.27	-213.6
	13/12/2016	24.1	2.11	3050	7.11	42
	17/01/2017	21.9	2.7	3270	7.14	-88
	15/02/2017	22.1	0.08	5934	6.68	-196
	15/03/2017	22.38	1.48	5114.7	7.05	-28
	27/04/2017	19.93	4.11	5448.3	8.13	-123.7
	26/04/2017	19.46	0.28	3551.4	8.34	-9.6
SP_BH06	8/06/2016	20.9	0.75	9881	12.13	-1619
	30/11/2016	20.6	0.13	1030	12.03	-200.5
SP_BH09	8/06/2016	25.6	0	242	8.19	-288
	27/07/2016	17	3.51	1748	7.69	-62.3
TC_BH01D	8/07/2016	18.2	1.85	1126	8.66	30.7
	27/07/2016	17.4	2.2	3883	12.06	-183.4
	30/08/2016	18.5	0.84	3267	11.86	-293.2
	27/09/2016	21.9	1.34	3817	11.53	-242.5
	26/10/2016	20.7	0.48	3855	10.3	-118.5
	29/11/2016	21.6	2.61	1696	7.61	-99.6
	13/12/2016	25	2.06	3230	11.59	-289
	16/01/2017	23.6	4.94	2450	10.88	-117
	16/02/2017	23.1	0.04	4004	10.52	-297.1
	14/03/2017	22.04	1.95	2962.3	9.42	-112.7
	27/04/2017	19.66	4.06	3076.5	9.26	-184.7
	25/05/2017	18.9	2.07	2723.6	7.35	20.5
TC_BH01S	8/07/2016	19.5	3.59	11084	6.97	-219.8
	21/07/2016	17.1	3.7	17511	6.87	-64.7
	30/08/2016	17.4	4.25	6899	7.05	-52
	27/09/2016	19.3	0.16	34922	6.63	-81.4
	26/10/2016	21.6	1.77	24313	6.68	-110.6
	29/11/2016	21.7	2.67	9665	7.03	-14.6
	13/12/2016	21.9	3.93	19850	7.37	-109
	16/01/2017	23.2	5.5	14240	8.25	-71
	16/02/2017	23.8	0.89	29747	6.82	-168
	14/03/2017	23.24	2.04	27563.8	7.03	130.6
	27/04/2017	20.64	2.85	29459.9	8.3	-100.4
	25/05/2017	19.24	6.36	11553.9	6.87	46.7

Summary Table B5
M4-M5 Link WestConnex
Water Quality - Field Parameters

Monitoring Well	Date	Temperature (ºC)	Dissolved Oxygen (ppm)	Conductivity (µS/cm)	pH	Redox Potential (mV)
TC_BH06	8/07/2016	17.4	3.55	1966	6.54	-40.7
	27/07/2016	18.9	1.02	1993	7.14	-113
	30/08/2016	17.3	3.06	1424	6.84	-83
	27/09/2016	18.9	0.22	1677	6.33	-55.7
	26/10/2016	19.9	1.01	1672	7.5	-112.7
	29/11/2016	20.2	2.39	3530	7.88	-45.4
	13/12/2016	22.5	7.65	1628	6.84	-65
	16/01/2017	22.8	5.47	1935	7.76	-135
	17/02/2017	21.9	1.98	2236	7.31	-216.1
	14/03/2017	21.91	2.03	1463.5	0.71	3.9
	27/04/2017	20.5	3.41	1504.4	10.25	-188.8
	25/05/2017	19.67	3.15	1499.7	6.57	18.4
TC_BH07D	8/07/2016	18.7	5.41	4202	11.84	-132.7
	27/07/2016	17.3	1.56	1762	7.63	-91.2
	31/08/2016	19.5	1.07	1713	8.55	-18.9
	26/10/2016	24.2	0.66	2640	6.84	-101.7
	16/01/2017	22.8	9.48	1547	7.4	-79
	16/02/2017	23.4	1.9	3123	6.49	-183
	14/03/2017	23.88	3.72	2416.4	7.18	-40.2
	27/04/2017	19.7	3.91	2045.4	9.01	-96.7
TC_BH07S	8/07/2016	18.1	3.33	30018	7.78	-117.9
	27/07/2016	17.6	1.24	23684	6.98	-160.2
	30/08/2016	18.2	1.68	24493	6.81	-71.2
	27/09/2016	18.6	0.06	31947	6.82	-260
	26/10/2016	21.9	1.7	28266	6.71	-107.4
	29/11/2016	-	-	-	-	-
	13/12/2016	22.7	3.51	373	6.93	-62
	16/01/2017	22.6	8.2	16700	6.9	-44
	16/02/2017	23.7	2.04	26816	6.2	-179
	14/03/2017	24.34	2.52	30387.9	6.89	-66.2
	28/04/2017	17.16	4.63	29619.1	6.91	-113.6
	25/05/2017	20.12	2.35	28938.4	6.72	27.5
TC_BH08	27/07/2016	19	1.23	7575	9.71	14.8
	30/08/2016	17.6	5.45	7104	8.1	20.7
	27/09/2016	19.2	0.06	13379	6.85	-121
	26/10/2016	21	2.36	10250	6.97	-88.6
	29/11/2016	20.2	2.01	12491	7.25	-95
	13/12/2016	24	3.24	10940	7.08	-102
	16/01/2017	22.3	6.06	10250	7.23	-46
	16/02/2017	22.5	5.39	11702	7.19	-182.3
	14/03/2017	22.61	2.28	13552.2	7.21	40.3
	27/04/2017	20.47	3.76	7203.3	8.46	-128.6
	25/05/2017	20.4	1.49	9734.6	6.95	10.5
TC_BH09D	27/07/2016	18.8	1	1761	6.25	2.3
	30/08/2016	17.3	1.32	1385	6.62	-41.5
	28/09/2016	17.5	4.94	1917	6.5	-67.5
	26/10/2016	22.5	1.44	2012	6.95	-86.3
	29/11/2016	-	2.84	1794	8.13	84.7
	13/12/2016	24.4	1.01	2020	7.96	-129
	16/01/2017	23.6	8.01	2050	7.92	-110
	16/02/2017	23.6	1.57	1995	7.51	-232
	14/03/2017	23.09	0.37	1870	7.46	-56.2
	27/04/2017	20.24	4.4	1909.7	9.59	-102.2
	25/05/2017	19.68	1.52	1906.6	7.53	-9

Summary Table B5
M4-M5 Link WestConnex
Water Quality - Field Parameters

Monitoring Well	Date	Temperature (ºC)	Dissolved Oxygen (ppm)	Conductivity (µS/cm)	pH	Redox Potential (mV)
TC_BH09S	27/07/2016	18.4	0.35	2601	6.73	17.4
	30/08/2016	16.1	2.05	1255	6.59	143.7
	26/10/2016	21.4	1.95	4699	6.48	-73.8
	29/11/2016	20.4	2.04	5114	7.54	-43.6
	13/12/2016	23	3.83	2830	7.16	-111
	17/01/2017	23	2.38	2780	6.25	21
	17/02/2017	23.4	1.55	3955	6.93	-204.5
	28/04/2017	18.15	3.57	2997.1	8.63	-107.4
	26/05/2017	18.42	0.78	3194.7	7.1	24.8
EP_BH07	27/10/2016	20.4	7.29	429.2	7.97	-81.2
	30/11/2016	19.8	2.96	415.6	7.28	160.3
	13/12/2016	20.9	8.1	245	5.25	169
	12/01/2017	21.5	3.22	261	5.89	136
	16/02/2017	20.5	1.92	329.6	6.54	-137.1
	14/03/2017	21.17	3.51	335.5	4.48	127.5
	27/04/2017	16.81	4.99	313.9	7.64	130.7
	26/05/2017	19.78	5.63	286.6	8.68	77.6
EP_BH06	27/10/2016	21.5	5.08	547	7.59	-102.6
	30/11/2016	20.7	2.41	1274	8.08	-10.4
	13/12/2016	22.2	1.88	851	5.53	129
	12/01/2017	21.2	1.29	659	5.63	72
	16/02/2017	21.1	0.95	509	5.91	-165
	14/03/2017	21.76	1.48	468.7	5.7	85.9
	27/04/2017	18.07	2.72	420.5	6.99	42.3
	26/05/2017	20.89	2.73	397.7	7.21	68.3
IC_BH01	27/10/2016	20.8	0.42	2852	11.65	-98.4
	30/11/2016	21	0.19	1300	8.65	-95.6
	13/12/2016	23.2	4.33	873	6.54	63
	17/01/2017	22.7	10.51	723	6.02	32
	14/03/2017	22	0.75	7980	6.11	81.5
	28/08/2017	20.75	1.12	784.3	11.2	-244
IC_BH02	14/03/2017	22.13	2.72	159.6	5.31	84.3
	28/04/2017	16.72	3.75	191	9.26	34.5
	26/05/2017	18.5	6.06	258.6	7.44	51.2
MT_BH02	15/03/2017	22.02	4.72	8899.9	12.69	-33.5
	28/04/2017	19.57	5.06	8700.5	11.33	-101
	26/05/2017	19.37	4.16	8185.3	12.33	58.1
MT_BH07	17/02/2017	20.4	1.13	2880	10.8	-295.1
	14/03/2017	21.95	1.93	2362	12.13	42.3
	27/04/2017	17	6.12	2139.7	11.73	-40.7
	26/05/2017	20.15	3.48	1737.6	11.22	51.3
MT_BH14	17/01/2017	22.8	2.47	2170	8.18	-51
	17/02/2017	20.8	0.13	2296	7.66	-267.2
	15/03/2017	22.22	1.93	2036.5	8.05	-51
	28/04/2017	17.1	5.27	1961	8.24	-133.2
MT_BH19	16/01/2017	24.2	5.94	16.8	12.2	-60
	17/02/2017	22.4	3.12	6690	11.85	-276.7
	26/05/2017	19.54	3.44	3768.3	12.04	27.4
MT_BH21	17/02/2017	20.6	1.76	2797	11.18	-246.3
	14/03/2017	22.31	3.69	1984.6	8.22	194.9
BH60	29/09/2016	18.1	0.05	3912	7.35	-200.2

Notes:
ºC - Degress Celsius
ppm - Parts Per Million
µS/cm - Microsiemens per centimetre
mV - Millivolts

Summary Table B6
M4-M5 Link WestConnex
Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
CM_BH01	14/09/2016	151	< 1	140	90	60	< 1	263	323	68	335	1.2	474	0.13	< 0.01	0.11	-	-	< 0.05	-	-
CM_BH04	31/08/2016	52	16	605	21	28	17	< 1	46	836	294	0.6	301	0.03	< 0.01	< 0.01	-	-	< 0.01	-	-
CM_BH06	28/06/2016	137	< 1	291	28	50	< 1	296	345	328	216	-	352	0.10	< 0.01	0.08	0.78	5.3	< 0.01	3.14	-
	28/07/2016	16	10	572	13	74	188	< 1	262	568	193	0.7	356	0.02	< 0.01	0.01	-	-	0.06	-	-
	31/08/2016	13	8	569	13	93	146	< 1	239	624	235	0.6	352	< 0.01	< 0.01	< 0.01	-	-	0.08	-	-
CM_BH10	28/06/2016	6	8	79	3	< 1	108	< 1	108	78	60	-	1680	< 0.01	0.03	0.03	0.04	< 0.1	0.67	1.27	-
EP_BH06	27/10/2016	52	8	28	4	< 1	48	< 1	48	33	109	0.4	1970	0.04	0.22	0.26	-	-	< 0.01	-	-
	30/11/2016	97	30	78	5	< 1	36	< 1	36	77	394	0.2	943	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	13/12/2016	58	23	70	3	< 1	29	< 1	29	68	272		1150	< 0.01	0.05	0.05			< 0.01		1400
	12/01/2017	31	13	61	3	< 1	28	< 1	28	74	136		1580	0.03	< 0.01	< 0.01	0.03	< 0.1	< 0.01		
	16/02/2017	21	10	65	2	< 1	22	< 1	22	71	96		1830	< 0.01	0.18	0.18	0.05	0.2	< 0.01		
	14/03/2017	15	8	64	2	< 1	22	< 1	22	96	90		1970	< 0.01	0.04	0.04	0.03	0.2	< 0.01	0.02	
	27/04/2017	11	8	71	1	< 1	12	< 1	12	71	77		2040	< 0.01	0.05	0.05	0.02	0.2	< 0.01		
	26/05/2017	11	7	63	1	< 1	12	< 1	12	72	71		2090	< 0.01	0.07	0.07	< 0.05 J	1.5	< 0.01	0.42	
EP_BH07	27/10/2016	21	6	53	3	< 1	66	< 1	66	53	27	0.6	2410	0.02	0.19	0.21	-	-	< 0.01	-	-
	30/11/2016	8	10	42	7	< 1	9	< 1	9	47	72	< 0.1	2720	0.03	1.15	1.18	-	-	< 0.01	-	-
	13/12/2016	6	10	39	6	< 1	4	< 1	4	42	76		2840	< 0.01	1.39	1.39			< 0.01		
	12/01/2017	8	7	33	9	< 1	16	< 1	16	43	61		2920	0.01	0.50	0.51	0.21	0.7	0.02		
	16/02/2017	9	8	37	9	< 1	15	< 1	15	41	60		3050	0.02	1.22	1.24	0.06	0.3	< 0.01		
	14/03/2017	9	9	38	8	< 1	11	< 1	11	48	62		2810	< 0.01	1.30	1.30	0.10	0.4	< 0.01	0.09	
	27/04/2017	9	10	37	6	< 1	4	< 1	4	40	70		2760	< 0.01	1.40	1.40	0.08	0.3	< 0.01		
	26/05/2017	8	8	35	7	< 1	2	< 1	2	41	64		2910	< 0.01	1.39	1.39		0.4	< 0.01	0.02	

Summary Table B6
M4-M5 Link WestConnex
Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
HB_BH02	8/06/2016	98	112	952	19	< 1	240	< 1	240	1560	200	-	167	< 0.01	0.04	0.04	0.20	0.3	< 0.01	0.10	-
	30/08/2016	32	28	388	7	< 1	234	< 1	234	534	134	1.2	442	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
HB_BH03	10/08/2016	14	25	190	2	< 1	55	< 1	55	345	35	< 0.1	787	< 0.01	0.03	0.03	-	-	< 0.01	-	-
	29/09/2016	34	4	56	2	< 1	37	< 1	37	53	80	< 0.1	2020	0.72	1.31	2.03	-	-	< 0.01	-	-
	26/10/2016	50	11	95	2	< 1	94	< 1	94	130	70	< 0.1	1220	1.18	0.21	1.39	-	-	< 0.01	-	-
	30/11/2016	46	10	91	2	< 1	74	< 1	74	122	86	< 0.1	1340	0.24	< 0.01	0.22	-	-	< 0.01	-	-
	15/02/2017	9	18	132	2	< 1	58	< 1	58	216	14		1200	< 0.01	0.01	0.01	< 0.01	1.0	< 0.01		
	15/03/2017	12	15	116	3	< 1	83	< 1	83	192	11		1280	< 0.01	0.02	0.02	0.42	1.1	< 0.01	1.21	
	28/04/2017	15	18	136	3	< 1	95	< 1	95	226	8		1060	< 0.01	< 0.01	< 0.01	0.03	0.4	< 0.01		
	25/05/2017	18	19	185	3	< 1	119	< 1	119	282	8		943	< 0.01	0.06	0.06		1.2	< 0.01	0.66	
HB_BH08D	8/06/2016	116	25	438	25	8	213	< 1	221	700	160	-	337	< 0.01	0.06	0.06	3.41	7.9	< 0.01	0.07	-
	28/07/2016	130	47	475	16	< 1	499	< 1	499	714	< 1	0.4	312	< 0.01	0.01	0.01	-	-	0.02	-	-
	30/08/2016	66	45	478	17	< 1	481	< 1	481	776	8	0.3	308	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	26/10/2016	122	54	483	17	< 1	462	< 1	462	771	2	0.3	307	< 0.01	0.02	0.02	-	-	0.02	-	-
	30/11/2016	119	50	492	16	< 1	422	< 1	422	775	2	0.2	317	< 0.01	< 0.01	< 0.01	-	-	0.03	-	-
	14/12/2016	119	50	509	15	< 1	417	< 1	417	824	2		316	< 0.01	0.02	0.02			0.04		500000
	17/01/2017	120	52	427	17	< 1	433	< 1	433	793	3		316	< 0.01	< 0.01	< 0.01	1.40	1.4	0.05		
	15/02/2017	121	52	450	16	< 1	417	< 1	417	764	< 1		320	< 0.01	0.03	0.03	1.32	1.4	0.02		
	15/03/2017	122	47	476	17	< 1	446	< 1	446	803	< 1		310	< 0.01	0.03	0.03	1.30	1.5	0.03	0.04	
	28/04/2017	104	52	457	14	< 1	386	< 1	386	772	< 1		310	< 0.01	< 0.01	< 0.01	1.34	1.5	0.03		
	25/05/2017	113	46	487	15	< 1	410	< 1	410	757	< 1		322	< 0.01	0.04	0.04		1.7	0.06	0.14	

Summary Table B6
M4-M5 Link WestConnex
Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
HB_BH08S	8/06/2016	91	129	1770	73	< 1	387	< 1	387	3380	28	-	99	< 0.01	0.03	0.03	5.76	8.8	< 0.01	1.37	-
	28/07/2016	40	30	462	20	< 1	165	< 1	165	672	48	1.0	368	0.08	0.22	0.30	-	-	< 0.01	-	-
	30/08/2016	64	81	1340	53	< 1	332	< 1	332	1980	32	0.9	136	0.03	0.51	0.54	-	-	< 0.01	-	-
	26/10/2016	54	76	1130	52	< 1	302	< 1	302	1830	25	0.8	153	0.02	2.38	2.40	-	-	< 0.01	-	-
	30/11/2016	48	45	735	31	< 1	185	< 1	185	1050	51	0.9	258	0.03	0.21	0.24	-	-	< 0.01	-	-
	14/12/2016	56	58	952	37	< 1	242	< 1	242	1410	41		196	0.02	0.28	0.30			< 0.01		
	17/01/2017	45	35	477	25	< 1	169	< 1	169	847	47		330	< 0.01	1.49	1.49	0.06	0.9	0.01		
	15/02/2017	54	68	978	48	< 1	269	< 1	269	1550	26		177	0.01	0.81	0.82	1.01	1.4	< 0.01		
	15/03/2017	61	56	937	46	< 1	281	< 1	281	1580	46		181	< 0.01	0.31	0.31	1.64	2.8	< 0.01	0.17	
	28/04/2017	53	35	439	35	< 1	227	< 1	227	788	73		315	< 0.01	0.04	0.04	1.89	4.4	< 0.01 J		
	25/05/2017	52	23	362	30	< 1	211	< 1	211	538	51		463	< 0.01	0.03	0.03		4.0	0.01	0.47	
HB_BH12	14/07/2016	40	4	196	33	64	7	< 1	70	306	92	0.7	769	0.14	0.04	0.18	-	-	< 0.01	-	-
	30/08/2016	796	< 1	490	72	51	< 1	2020	2070	780	14	0.1	100	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	26/10/2016	425	< 1	587	17	31	< 1	779	810	943	106	0.1	154	0.02	0.01	0.03	-	-	< 0.01	-	-
	14/12/2016	522	< 1	654	22	54	< 1	1070	1120	926	110		140	0.05	< 0.01	0.04			< 0.01		
	15/02/2017	270	< 1	521	14	28	< 1	315	344	916	146		222	0.02	< 0.01	< 0.01	0.53	0.8	< 0.01		
	15/03/2017	418	< 1	542	15	30	< 1	644	674	1080	110		167	< 0.01	0.02	0.02	0.53	0.7	< 0.01	0.01	
	28/04/2017	473	< 1	593	14	27	< 1	782	809	1000	41		136	< 0.01	< 0.01	< 0.01	0.50	1.0	< 0.01		
	25/05/2017	540	< 1	615	15	36	< 1	1010	1050	1020	36		132	0.02	0.08	0.10		1.8	< 0.05	0.28	
HB_BH14	14/07/2016	100	56	334	10	< 1	332	< 1	332	538	44	0.4	408	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	27/07/2016	96	40	294	14	< 1	339	< 1	339	442	79	0.5	467	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	30/08/2016	95	44	294	13	< 1	336	< 1	336	506	83	0.5	442	< 0.10	< 0.1	< 0.10	-	-	< 0.01	-	-
	14/12/2016	102	54	341	12	< 1	340	< 1	340	591	70		422	0.02	< 0.01	< 0.01			< 0.01		
	15/02/2017	90	51	294	14	< 1	335	< 1	335	511	42		446	0.02	0.14	0.16	0.44	0.9	< 0.01		
	15/03/2017	73	43	277	20	< 1	277	< 1	277	464	69		521	< 0.01	0.10	0.10	0.46	0.4	< 0.01	0.15	
	26/05/2017	25	10	133	20	< 1	101	< 1	101	134	100		1220	< 0.01	0.15	0.15		5.1	< 0.01	2.72	

Summary Table B6
M4-M5 Link WestConnex
Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
HB_BH15	8/06/2016	37	9	95	9	< 1	95	< 1	95	54	148	-	1350	< 0.01	0.05	0.05	0.54	1.6	< 0.01	0.14	-
	27/07/2016	31	21	174	6	< 1	89	< 1	89	271	79	0.2	820	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	30/08/2016	28	23	177	6	< 1	90	< 1	90	310	90	0.2	781	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	26/10/2016	22	27	185	6	< 1	71	< 1	71	347	65	0.2	725	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	30/11/2016	46	14	140	11	< 1	104	< 1	104	159	136	0.2	990	0.82	0.19	1.01	-	-	< 0.01	-	-
	14/12/2016	49	16	121	9	< 1	108	< 1	108	179	155		980	0.87	< 0.01	0.85			< 0.01		
	17/01/2017	28	26	167	6	< 1	59	< 1	59	314	87		787	< 0.01	0.06	0.06	0.11	0.2	< 0.01		
	15/02/2017	21	30	207	5	< 1	58	< 1	58	357	66		735	0.01	0.57	0.58	0.06	0.3	< 0.01		
	15/03/2017	47	18	160	8	< 1	106	< 1	106	240	107		847	< 0.01	0.83	0.83	0.02	0.4	< 0.01	0.02	
	28/04/2017	29	26	194	5	< 1	68	< 1	68	339	76		719	< 0.01	0.39	0.39	0.04	0.4	< 0.01		
	25/05/2017	28	26	208	5	< 1	72	< 1	72	360	63		730	< 0.01	0.76	0.76		0.3	< 0.01	0.03	
IC_BH01	27/10/2016	382	< 1	141	56	57	< 1	148	205	67	660	0.2	405	0.02	0.37	0.39	-	-	< 0.01	-	-
	30/11/2016	158	5	98	27	< 1	26	< 1	26	78	506	0.1	746	0.04	< 0.01	< 0.01	-	-	< 0.01	-	-
	13/12/2016	157	6	100	22	< 1	45	< 1	45	100	506		758	< 0.01	0.07	0.07			0.09		6000
	17/01/2017	89	18	95	7	< 1	111	< 1	111	178	172		909	< 0.01	0.35	0.35	0.39	0.7	< 0.01		
	14/03/2017	74	14	94	3	< 1	127	< 1	127	196	50		1060	< 0.01	0.06	0.06	0.10	2.6	< 0.01	0.48	
	28/04/2017	33	13	95	3	< 1	59	< 1	59	184	36		1240	< 0.01	0.16	0.16	0.02	0.3	< 0.01		
IC_BH02	14/03/2017	4	4	20	1	< 1	10	< 1	10	21	31		5400	0.14	0.33	0.47	0.02	0.1	< 0.01		
	28/04/2017	2	4	23	1	< 1	7	< 1	7	17	34		5750	0.08	0.42	0.50	< 0.01	0.1	< 0.01		
	26/05/2017	12	4	23	2	< 1	35	< 1	35	21	31		4400	0.03	0.49	0.52		0.4	< 0.01		
	15/03/2017	709	< 1	577	96	76	< 1	2020	2090	640	33		96	< 0.01	0.06	0.06	0.90	1.4	< 0.01	0.01	
	28/04/2017	743	< 1	616	54	41	< 1	1660	1710	898	32		92	0.02	< 0.01	< 0.01	0.64	1.2	< 0.01		
	26/05/2017	753	< 1	703	43	67	< 1	1700	1760	929	18		96	< 0.01	0.04	0.04		0.7	< 0.01	0.08	
MT_BH07	17/02/2017	112	< 1	250	79	50	< 1	476	527	177	125		325	< 0.01	< 0.01	< 0.01	1.63	2.3	< 0.01		
	14/03/2017	59	< 1	247	54	59	< 1	380	439	208	135		382	< 0.01	0.04	0.04	1.04	2.0	< 0.01	0.14	
	27/04/2017	118	< 1	229	36	38	< 1	213	251	170	343		446	< 0.01	< 0.01	< 0.01	1.21	3.0	< 0.01		
	26/05/2017	247	< 1	183	19	28	< 1	153	181	103	588		465	< 0.01	0.06	0.06		1.9	< 0.01	0.16	

Summary Table B6
M4-M5 Link WestConnex
Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
MT_BH14	17/01/2017	66	11	555	34	< 1	30	< 1	30	562	689		309	< 0.01	< 0.01	< 0.01	1.09	1.5	< 0.01		
	17/02/2017	74	19	501	23	< 1	87	< 1	87	429	645		347	< 0.01	0.02	0.02	0.80	1.6	< 0.01		
	15/03/2017	78	15	422	16	21	104	< 1	125	333	501		413	0.07	< 0.01	0.07	0.46	1.0	< 0.01	0.15	
	28/04/2017	78	19	378	13	< 1	127	< 1	127	296	462		446	0.06	0.04	0.10	0.47	1.3	< 0.01		
MT_BH18	16/01/2017	277	< 1	559	29	79	< 1	929	1010	526	69		167	0.02	< 0.01	< 0.01	1.26	1.1	< 0.01		
	17/02/2017	217	< 1	486	22	55	< 1	990	1040	378	62		172	0.02	< 0.01	0.01	1.59	2.0	< 0.01		
	26/05/2017	92	< 1	540	13	85	< 1	494	579	382	111		267	0.01	0.03	0.04		3.2	< 0.01	0.47	
MT_BH21	17/02/2017	219	< 1	373	20	33	< 1	472	506	563	153		239	< 0.01	< 0.01	< 0.01	0.14	0.3	< 0.01		
	14/03/2017	131	42	396	4	< 1	395	< 1	395	532	204		382	< 0.01	0.03	0.03	0.05	0.3	< 0.01	0.08	
RZ_BH01D	28/06/2016	30	36	273	4	< 1	103	< 1	103	489	91	-	524	< 0.01	0.04	0.04	0.28	0.3	< 0.01	0.02	-
	27/07/2016	74	26	196	9	< 1	220	< 1	220	314	75	0.4	662	< 0.01	0.03	0.03	-	-	< 0.01	-	-
	30/08/2016	71	36	234	7	< 1	235	< 1	235	394	79	0.5	571	< 0.01	0.03	0.03	-	-	< 0.01	-	-
	29/09/2016	66	39	232	8	< 1	225	< 1	225	371	60	0.4	613	< 0.01	0.01	0.01	-	-	< 0.01	-	-
	25/10/2016	59	48	312	4	< 1	179	< 1	179	636	68	0.2	420	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	115000
	28/11/2016	68	44	286	5	< 1	178	< 1	178	536	95	0.2	493	< 0.01	0.04	0.04	-	-	< 0.01	-	-
	12/12/2016	75	45	310	5	< 1	174	< 1	174	546	87		463	< 0.01	< 0.01	< 0.01			< 0.01		115000
	12/01/2017	69	41	246	6	< 1	180	< 1	180	500	61		518	< 0.01	0.02	0.02	0.75	0.9	< 0.01		
	14/02/2017	64	40	247	6	< 1	180	< 1	180	460	49		535	0.05	< 0.01	0.03	0.94	1.1	< 0.01		
	13/03/2017	38	14	168	6	< 1	68	< 1	68	345	54		855	0.16	< 0.01	0.06	1.34	1.6	< 0.01	0.04	
	26/04/2017	51	< 1 J	101	7	24	< 1	13	36	176	41		1230				1.74	2.1	0.02		
	24/05/2017	42	13	160	6	< 1	81	< 1	81	268	42		926	0.02	0.69	0.71		1.5	< 0.01	0.06	

Summary Table B6
M4-M5 Link WestConnex
Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
	28/06/2016	37	8	22	7	< 1	156	< 1	156	22	14	-	2430	< 0.01	0.03	0.03	3.81	4.9	< 0.01	0.59	-
	27/07/2016	57	11	15	7	< 1	251	< 1	251	16	15	0.2	2130	< 0.01	0.01	0.01	-	-	< 0.01	-	-
	30/08/2016	60	11	16	6	< 1	208	< 1	208	16	19	0.2	2080	< 0.01	0.01	0.01	-	-	< 0.01	-	-
	25/10/2016	67	14	23	8	< 1	253	< 1	253	23	8	0.3	1820	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	28/11/2016	54	14	17	5	< 1	207	< 1	207	17	10	0.2	2190	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
RZ_BH01S	12/12/2016	62	13	17	4	< 1	210	< 1	210	17	11		2160	< 0.01	0.08	0.08			< 0.01		
	12/01/2017	58	14	29	6	< 1	236	< 1	236	16	17		1940	< 0.01	0.04	0.04	1.36	5.6	< 0.01		
	14/02/2017	55	14	23	7	< 1	232	< 1	232	16	6		1980	< 0.01	0.24	0.24	1.98	2.9	< 0.01		
	13/03/2017	61	11	15	7	< 1	216	< 1	216	23	19		2050	< 0.01	0.03	0.03	4.20	4.3	< 0.01	0.44	
	26/04/2017	44	8	20	7	< 1	175	< 1	175	14	19		2170	< 0.01	0.12	0.12	4.03	4.5	< 0.01		
	24/05/2017	53	11	18	7	< 1	221	< 1	221	20	15		1980	< 0.01	0.04	0.04		8.0	< 0.01	1.24	
	28/06/2016	55	22	212	4	< 1	127	< 1	127	396	45	-	654	< 0.01	0.02	0.02	0.20	0.2	< 0.01	0.09	-
	27/07/2016	46	10	151	6	< 1	105	< 1	105	207	72	0.3	952	< 0.01	< 0.01	< 0.01	-	-	0.01	-	-
	30/08/2016	46	12	105	5	< 1	144	< 1	144	163	42	0.3	1180	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	29/09/2016	39	7	51	5	< 1	108	< 1	108	66	30	0.1	1900	< 0.01	0.01	0.01	-	-	0.07	-	-
	25/10/2016	44	18	163	3	< 1	132	< 1	132	300	25	0.3	806	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	325
	28/11/2016	38	8	63	6	< 1	97	< 1	97	93	28	0.1	1780	< 0.01	0.03	0.03	-	-	0.04	-	-
RZ_BH15	12/12/2016	43	6	46	5	< 1	108	< 1	108	73	35		1770	0.05	0.21	0.26			0.04		
	12/01/2017	40	14	109	5	< 1	114	< 1	114	204	31		1080	< 0.01	0.05	0.05	0.09	0.6	< 0.01		
	14/02/2017	42	11	96	6	< 1	96	< 1	96	166	44		1220	< 0.01	0.12	0.12	0.06	0.4	< 0.01		
	13/03/2017	46	11	104	5	< 1	113	< 1	113	177	35		1210	< 0.01	0.07	0.07	0.08	0.3	< 0.01	0.06	
	26/04/2017	41	15	126	5	< 1	102	< 1	102	226	36		980	< 0.01	< 0.01	< 0.01	0.20	0.8	< 0.01		
	24/05/2017	44	10	109	7	< 1	103	< 1	103	173	30		1230	< 0.01	0.25	0.25		0.4	< 0.01	0.05	

Summary Table B6
M4-M5 Link WestConnex
Inorganic Chemistry Analytical Results

			Inorganic Chemistry																		
			Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
		LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
RZ_BH16	14/07/2016		61	20	141	6	< 1	132	< 1	132	230	75	0.3	885	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	27/07/2016		24	4	117	8	8	23	< 1	30	138	106	0.5	1300	< 0.01	0.02	0.02	-	-	< 0.01	-	-
	30/08/2016		26	4	119	7	14	10	< 1	24	158	119	0.6	1240	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	29/09/2016		28	8	123	8	< 1	40	< 1	40	139	115	0.6	1270	< 0.01	0.02	0.02	-	-	< 0.01	-	5
	25/10/2016		36	6	100	10	< 1	58	< 1	58	110	88	0.6	1280	0.92	0.09	1.01	-	-	< 0.01	-	-
	28/11/2016		35	10	140	7	< 1	56	< 1	56	207	93	0.4	1100	< 0.01	0.26	0.26	-	-	< 0.01	-	-
	12/12/2016		41	7	132	7	< 1	58	< 1	58	183	117		1120	0.02	0.90	0.92			< 0.01		
	12/01/2017		41	9	122	7	< 1	64	< 1	64	199	92		1060	0.04	0.63	0.67	0.02	1.1	< 0.01		
	14/02/2017		38	10	136	5	< 1	54	< 1	54	217	65		1050	< 0.01	0.40	0.40	0.06	0.3	< 0.01		
	13/03/2017		41	9	154	4	< 1	61	< 1	61	232	78		1010	< 0.01	0.05	0.05	0.08	0.1	< 0.01	0.01	
	26/04/2017		38	10	144	5	< 1	58	< 1	58	230	70		971	< 0.01	0.09	0.09	0.10	0.3	< 0.01		
	24/05/2017		38	9	157	4	< 1	52	< 1	52	245	64		1000	< 0.01	0.12	0.12		0.6	< 0.01	0.11	
RZ_BH19	11/08/2016		76	23	150	4	< 1	179	< 1	179	254	40	0.4	813	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	29/09/2016		56	34	147	5	< 1	215	< 1	215	238	20	0.4	870	< 0.01	0.02	0.02	-	-	< 0.01	-	27000
	27/10/2016		116	31	159	5	-	-	-	-	316	33	-	-	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	28/11/2016		55	26	155	5	< 1	157	< 1	157	290	27	0.4	833	< 0.01	0.06	0.06	-	-	< 0.01	-	-
	12/12/2016		62	24	166	5	< 1	148	< 1	148	306	33		806	< 0.01	0.08	0.08			< 0.01		
	13/01/2017		52	25	143	6	1	155	< 1	156	301	23		806	< 0.01	< 0.01	< 0.01	0.08	0.3	0.01		
	14/02/2017		44	25	153	11	< 1	154	< 1	154	289	18		826	< 0.01	< 0.01	< 0.01	0.12	0.4	< 0.01		
	13/03/2017		50	24	166	14	< 1	168	< 1	168	298	18		826	0.03	0.02	0.05	0.27	0.5	0.01	0.06	
	26/04/2017		40	23	139	10	< 1	135	< 1	135	273	16		855	0.05	< 0.01	0.03	0.22	1.3	0.02		
	24/05/2017		44	28	161	8	< 1	181	< 1	181	289	5		826	< 0.01	0.74	0.74		1.0	< 0.01	0.18	

Summary Table B6
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Inorganic Chemistry Analytical Results

			Inorganic Chemistry																			
			Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
		LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
RZ_BH26	14/07/2016		23	7	48	4	< 1	68	< 1	68	72	20	0.3	2190	0.03	0.05	0.08	-	-	< 0.01	-	-
	27/07/2016		16	1	60	6	41	20	< 1	61	61	33	0.8	2430	0.56	0.02	0.58	-	-	< 0.01	-	-
	30/08/2016		24	3	71	5	34	50	< 1	84	67	40	0.8	2070	< 0.01	0.08	0.08	-	-	0.03	-	-
	29/09/2016		37	16	78	3	< 1	167	< 1	167	103	12	0.3	1540	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	500000
	25/10/2016		18	4	76	7	< 1	60	< 1	60	74	28	0.8	1970	0.04	0.02	0.06	-	-	< 0.01	-	-
	28/11/2016		24	7	72	5	< 1	87	< 1	87	92	20	0.6	1850	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	12/12/2016		28	9	66	4	< 1	112	< 1	112	105	13		1720	< 0.01	0.03	0.03			< 0.01		
	13/01/2017		28	12	71	4	< 1	127	< 1	127	102	8		1630	< 0.01	< 0.01	< 0.01	0.04	0.3	< 0.01		
	14/02/2017		24	13	78	4	< 1	122	< 1	122	102	7		1730	< 0.01	0.02	0.02	< 0.01	0.2	< 0.01		
	13/03/2017		22	12	75	4	< 1	141	< 1	141	108	9		1640	< 0.01	0.03	0.03	0.06	0.4	< 0.01	0.12	
	26/04/2017		25	7	72	5	< 1	103	< 1	103	79	7		1800	< 0.01	0.01	0.01	0.09	1.4	< 0.01 J		
	24/05/2017		24	11	69	4	< 1	116	< 1	116	113	5		1740	< 0.01	0.03	0.03		0.6	< 0.01	0.36	
RZ_BH28	11/08/2016		33	23	114	4	< 1	96	< 1	96	222	20	0.2	1050	< 0.01	< 0.01	< 0.01	-	-	0.07	-	-
	29/09/2016		66	23	119	5	< 1	185	< 1	185	213	21	0.2	971	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	25/10/2016		33	21	116	5	< 1	102	< 1	102	251	16	0.3	1070	< 0.01	0.02	0.02	-	-	< 0.01	-	115000
	28/11/2016		39	22	111	4	< 1	113	< 1	113	219	65	0.2	1100	< 0.01	< 0.01	< 0.01	-	-	0.02	-	-
	12/12/2016		30	20	104	4	< 1	83	< 1	83	228	24		1120	< 0.01	0.06	0.06			0.05		
	13/01/2017		32	23	100	5	< 1	95	< 1	95	218	20		1100	< 0.01	< 0.01	< 0.01	0.12	0.6	0.06		
	14/02/2017		27	21	106	5	< 1	82	< 1	82	206	17		1180	< 0.01	0.02	0.02	0.12	0.4	< 0.01		
	13/03/2017		31	20	110	4	< 1	99	< 1	99	218	18		1140	< 0.01	0.03	0.03	0.14	0.4	< 0.01	0.29	
	26/04/2017		28	20	117	5	< 1	73	< 1	73	212	21		1140	< 0.01	< 0.01	< 0.01	0.16	1.6	< 0.01		
	24/05/2017		32	20	114	5	< 1	102	< 1	102	211	18		1150	< 0.01	0.02	0.02		0.2	0.03	0.24	

Summary Table B6
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Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
RZ_BH30	27/07/2016	79	38	195	7	< 1	246	< 1	246	354	39	0.3	617	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	31/08/2016	86	32	189	8	< 1	230	< 1	230	368	40	0.4	625	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	28/09/2016	74	27	168	9	< 1	180	< 1	180	302	38	0.4	752	< 0.01	0.06	0.06	-	-	< 0.01	-	-
	16/01/2017	67	26	140	9	< 1	168	< 1	168	300	36		781	< 0.01	0.14	0.14	0.30	0.5	< 0.01		
	26/04/2017	41	10	77	11	< 1	97	< 1	97	128	31		1450	0.25	0.22	0.47	0.79	1.2	< 0.01		
	24/05/2017	56	22	122	9	< 1	162	< 1	162	226	24		971	0.08	0.74	0.82		1.5	< 0.01	0.19	
RZ_BH38	10/08/2016	24	25	177	18	10	72	< 1	82	278	65	0.4	826	< 0.01	0.04	0.04	-	-	< 0.01	-	-
	29/09/2016	57	36	220	14	< 1	184	< 1	184	352	43	0.3	658	< 0.01	0.03	0.03	-	-	< 0.01	-	-
	27/10/2016	99	47	208	9	< 1	330	< 1	330	422	33	0.3	513	< 0.01	0.01	0.01	-	-	< 0.01	-	500000
	28/11/2016	97	50	237	9	< 1	307	< 1	307	432	34	0.3	538	0.02	< 0.01	0.02	-	-	< 0.01	-	-
	12/12/2016	110	50	252	9	< 1	310	< 1	310	449	40		505	< 0.01	0.05	0.05			< 0.01		
	12/01/2017	100	53	213	10	< 1	322	< 1	322	441	35		518	< 0.01	0.02	0.02	0.30	0.5	< 0.01		
	14/02/2017	93	53	238	9	< 1	322	< 1	322	428	33		518	< 0.01	< 0.01	< 0.01	0.43	0.5	< 0.01		
	13/03/2017	98	49	250	9	< 1	331	< 1	331	434	34		524	< 0.01	0.08	0.08	0.35	1.5	< 0.01	0.4	
	26/04/2017	82	46	210	8	< 1	271	< 1	271	403	35		532	< 0.01	< 0.01	< 0.01	0.45	1.6	< 0.01		
	24/05/2017	92	41	227	9	< 1	311	< 1	311	393	33		559	< 0.01	0.09	0.09		0.8	< 0.01	0.16	
RZ_BH44D	10/08/2016	17	13	89	5	< 1	74	< 1	74	127	20	0.6	1570	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	29/09/2016	48	30	168	6	< 1	206	< 1	206	255	32	0.5	833	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	27/10/2016	50	36	194	6	< 1	216	< 1	216	323	28	0.4	690	< 0.01	0.01	0.01	-	-	< 0.01	-	-
	28/11/2016	44	29	166	5	< 1	196	< 1	196	284	24	0.4	820	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	12/12/2016	50	33	199	5	< 1	199	< 1	199	338	30		704	< 0.01	0.13	0.13			< 0.01		115000
	13/01/2017	48	37	184	6	< 1	215	< 1	215	350	24		685	< 0.01	0.02	0.02	0.14	1.0	< 0.01		
	14/02/2017	48	33	172	6	< 1	210	< 1	210	309	20		730	< 0.01	0.02	0.02	0.14	0.5	< 0.01		
	13/03/2017	53	28	174	5	< 1	223	< 1	223	309	24		735	< 0.01	0.04	0.04	0.13	0.7	< 0.01	0.04	
	26/04/2017	55	7	39	6	< 1	90	< 1	90	49	82		1850	< 0.01	< 0.01	< 0.01	0.13	0.5	0.02		
	24/05/2017	51	15	86	6	< 1	137	< 1	137	147	53		1200	< 0.01	0.06	0.06		0.8	< 0.01	0.17	

Summary Table B6
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Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
RZ_BH44S	10/08/2016	66	132	1260	46	< 1	111	< 1	111	2180	197	0.3	134	< 0.01	0.06	0.06	-	-	< 0.01	-	-
	29/09/2016	56	74	581	27	< 1	135	< 1	135	1060	58	0.1	263	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	27/10/2016	44	64	487	22	< 1	102	< 1	102	877	54	0.2	312	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	28/11/2016	37	59	462	21	< 1	101	< 1	101	875	49	0.1	338	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	12/12/2016	40	55	476	20	< 1	76	< 1	76	866	47		326	< 0.01	< 0.01	< 0.01			< 0.01		
	13/01/2017	36	60	416	22	< 1	47	< 1	47	879	42		350	< 0.01	< 0.01	< 0.01	0.20	1.7	< 0.01		
	14/02/2017	36	57	413	21	< 1	69	< 1	69	818	37		356	< 0.01	0.07	0.07	0.19	0.4	< 0.01		
	13/03/2017	38	57	480	20	< 1	91	< 1	91	873	48		345	< 0.01	0.02	0.02	0.44	0.4	< 0.01	0.08	
	26/04/2017	32	53	419	19	< 1	68	< 1	68	809	46		348	< 0.01	0.04	0.04	0.20	0.5			
	24/05/2017	33	47	428	18	< 1	83	< 1	83	766	40		374	< 0.01	0.09	0.09		1.0	< 0.01		
RZ_BH47D	31/08/2016	34	24	118	4	< 1	146	< 1	146	228	23	0.4	1010	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	29/09/2016	41	28	123	5	< 1	162	< 1	162	217	17	0.3	1010	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	115000
	25/10/2016	22	6	40	3	< 1	76	< 1	76	43	10	1.0	2910	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	28/11/2016	33	25	113	5	< 1	136	< 1	136	206	18	0.3	1110	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	12/12/2016	38	24	118	4	< 1	134	< 1	134	212	20		1100	< 0.01	< 0.01	< 0.01			< 0.01		115000
	13/01/2017	34	25	104	5	< 1	132	< 1	132	213	17		1060	< 0.01	0.01	0.01	0.20	0.5	0.01		
	14/02/2017	34	26	118	5	< 1	130	< 1	130	214	17		1070	< 0.01	< 0.01	< 0.01	0.18	0.4	< 0.01		
	13/03/2017	35	22	114	4	< 1	146	< 1	146	208	14		1080	< 0.01	0.04	0.04	0.15	0.2	< 0.01	0.03	
	26/04/2017	32	24	118	5	< 1	144	< 1	144	212	17		1050	< 0.01	0.12	0.12	0.16	1.0	< 0.01		
	24/05/2017	31	22	127	5	< 1	134	< 1	134	222	18		1050	< 0.01	0.03	0.03		0.6	< 0.01	0.17	

Summary Table B6
M4-M5 Link WestConnex
Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
RZ_BH47S	31/08/2016	17	27	191	4	< 1	71	< 1	71	380	45	0.1	725	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	29/09/2016	20	30	207	4	< 1	67	< 1	67	367	41	< 0.1	741	< 0.01	0.01	0.01	-	-	< 0.01	-	-
	25/10/2016	22	1	42	5	45	< 1	< 1	46	52	17	1.0	2870	0.01	0.16	0.17	-	-	< 0.01	-	-
	28/11/2016	20	12	104	5	< 1	53	< 1	53	183	29	0.6	1410	0.06	< 0.01	0.04	-	-	< 0.01	-	-
	12/12/2016	20	26	191	4	< 1	49	< 1	49	350	45		826	0.07	0.39	0.46			< 0.01		
	13/01/2017	31	14	106	5	< 1	70	< 1	70	203	30		1180	0.05	0.07	0.12	0.02	0.3	< 0.01		
	14/02/2017	19	25	166	4	< 1	44	< 1	44	322	34		862	< 0.01	0.12	0.12	0.06	0.3	< 0.01		
	13/03/2017	20	24	163	4	< 1	68	< 1	68	332	38		862	< 0.01	0.05	0.05	0.14	0.2	< 0.01	0.09	
	26/04/2017	18	25	174	4	< 1	56	< 1	56	330	41		806	< 0.01	< 0.01	< 0.01	0.07	0.2	< 0.01		
	24/05/2017	23	22	173	4	< 1	62	< 1	62	313	35		877	< 0.01	0.02	0.02		1.4	< 0.01	0.35	
RZ_BH49	14/07/2016	46	99	2210	77	< 1	601	< 1	601	3220	326	0.4	89	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	27/07/2016	60	43	1330	53	36	723	< 1	760	1380	252	0.6	153	< 0.01	0.05	0.05	-	-	< 0.01	-	-
	30/08/2016	49	59	1670	66	< 1	832	< 1	832	1950	343	0.5	120	0.02	0.02	0.04	-	-	< 0.01	-	-
	29/09/2016	34	94	2390	88	< 1	947	< 1	947	2980	376	0.4	91	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	26/10/2016	32	50	1440	65	< 1	759	< 1	759	1670	239	0.4	135	0.01	0.04	0.05	-	-	0.01	-	-
	28/11/2016	26	59	1750	75	< 1	764	< 1	764	1970	292	0.4	125	0.13	0.12	0.25	-	-	< 0.01	-	-
	12/12/2016	26	61	1950	69	< 1	808	< 1	808	1990	361		108	0.02	0.52	0.54			< 0.01		
	12/01/2017	24	40	1190	64	< 1	633	< 1	633	1530	265		156	0.02	< 0.01	< 0.01	0.41	0.6	0.02		
	14/02/2017	30	53	1460	69	< 1	767	< 1	767	1650	251		137	< 0.01	0.35	0.35	0.32	1.2	0.02		
	13/03/2017	27	51	1660	70	< 1	900	< 1	900	2180	279		121	< 0.01	0.07	0.07	0.43	0.6	0.02	0.16	
	24/05/2017	27	22	704	29	< 1	380	< 1	380	809	113		284	< 0.01	0.42	0.42		1.0	0.01		
	26/04/2017	28	7	103	9	< 1	121	< 1	121	121	22		1420	< 0.01	0.24	0.24	0.02	1.3	0.02	0.25	

Summary Table B6
M4-M5 Link WestConnex
Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
RZ_BH50	31/08/2016	22	4	49	5	< 1	93	< 1	93	48	25	0.9	2510	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	28/09/2016	11	12	77	2	< 1	74	< 1	74	130	12	0.2	1590	< 0.01	0.01	0.01	-	-	< 0.01	-	-
	25/10/2016	13	12	78	6	< 1	86	< 1	86	130	11	0.3	1620	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	500000
	28/11/2016	9	14	76	2	< 1	63	< 1	63	155	20	0.2	1680	< 0.01	0.01	0.01	-	-	< 0.01	-	-
	12/12/2016	10	11	60	3	< 1	65	< 1	65	151	17		1650	0.02	0.06	0.08			< 0.01		
	16/01/2017	15	14	71	3	< 1	54	< 1	54	141	13		1680	< 0.01	0.03	0.03	0.03	0.6	< 0.01		
	14/02/2017	9	14	72	3	< 1	35	< 1	35	136	10		1880	< 0.01	< 0.01	< 0.01	0.14	0.3	< 0.01		
	15/03/2017	9	14	71	2	< 1	78	< 1	78	146	11		1590	< 0.01	0.04	0.04	0.11	0.3	0.01	0.31	
	24/05/2017	12	12	65	3	< 1	64	< 1	64	136	13		1780	< 0.01	0.04	0.04		1.0	< 0.01	0.49	
RZ_BH51	10/08/2016	231	< 1	210	13	36	< 1	420	456	383	20	0.2	299	< 0.01	0.02	0.02	-	-	< 0.01	-	-
	28/09/2016	87	40	228	6	< 1	227	< 1	227	405	35	0.3	592	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	6000
	25/10/2016	81	37	199	8	< 1	218	< 1	218	412	29	0.3	565	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	28/11/2016	86	46	209	7	< 1	234	< 1	234	420	38	0.2	581	< 0.01	0.02	0.02	-	-	< 0.01	-	-
	12/12/2016	91	40	216	7	< 1	222	< 1	222	425	40		565	< 0.01	0.34	0.34			< 0.01		
	16/01/2017	82	40	176	8	< 1	220	< 1	220	394	36		613	< 0.01	0.41	0.41	0.24	0.7	< 0.01		
	14/02/2017	83	42	184	7	< 1	237	< 1	237	368	33		621	< 0.01	< 0.01	< 0.01	0.38	0.4	< 0.01		
	26/04/2017	71	32	157	6	< 1	185	< 1	185	318	39		699	< 0.01	< 0.01	< 0.01	0.32	0.8	< 0.01		
	24/05/2017	82	35	191	7	< 1	214	< 1	214	354	33		654	< 0.01	0.29	0.29		1.4	< 0.01	0.73	
RZ_BH52	10/08/2016	10	8	87	13	28	29	< 1	57	116	24	0.6	1690	0.04	0.09	0.13	-	-	0.04	-	-
	28/09/2016	62	25	153	5	< 1	164	< 1	164	263	33	0.3	840	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	25/10/2016	33	23	133	5	< 1	104	< 1	104	272	19	0.2	917	< 0.01	0.01	0.01	-	-	< 0.01	-	27000
	28/11/2016	31	23	134	5	< 1	98	< 1	98	260	25	0.2	1010	< 0.01	0.02	0.02	-	-	0.16	-	-
	12/12/2016	40	22	139	5	< 1	102	< 1	102	268	29		952	< 0.01	0.06	0.06			0.05		
	14/02/2017	30	23	124	6	< 1	86	< 1	86	239	20		1040	< 0.01	0.34	0.34	0.19	0.7	< 0.01		
	15/03/2017	39	19	116	5	< 1	119	< 1	119	225	22		1050	< 0.01	0.08	0.08	0.19	0.8	< 0.01	0.62	
	26/04/2017	37	19	110	5	< 1	98	< 1	98	220	23		1050	< 0.01	0.02	0.02	0.19	0.7	< 0.01		
	24/05/2017	38	16	95	5	< 1	94	< 1	94	178	29		1260	< 0.01	0.06	0.06		1.3	< 0.01	0.99	

Summary Table B6
M4-M5 Link WestConnex
Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
RZ_BH60	16/01/2017	343	< 1	114	124	50	< 1	740	790	43	287		254	0.06	< 0.01	0.04	0.92	2.0	< 0.01		
	17/02/2017	333	< 1	111	118	45	< 1	879	924	42	260		222	< 0.05	< 0.05	< 0.05	0.99	2.4	< 0.01		
	14/03/2017	322	< 1	114	114	60	< 1	818	877	38	173		241	0.03	< 0.01	0.01	1.21	2.1	< 0.01	0.14	
	27/04/2017	300	< 1	121	98	51	< 1	678	729	41	191		258	0.02	0.01	0.03	1.04	3.1	< 0.01		
	26/05/2017	304	< 1	126	88	63	< 1	698	761	36	141		277	0.02	0.08	0.10		3.7	< 0.01	0.51	
RZ_BH64	26/04/2017	7	13	75	2	< 1	51	< 1	51	143	12		1650	< 0.01	< 0.01	< 0.01	0.44	2.0	0.05		
	26/05/2017	38	7	78	16	< 1	170	< 1	170	109	18		1420	< 0.01	0.04	0.04		2.8	< 0.01	0.07	
RZ_BH67	17/02/2017	28	14	71	10	< 1	97	< 1	97	142	21		1470	< 0.01	< 0.01	< 0.01	0.13	0.9	< 0.05		
	15/03/2017	18	12	71	6	< 1	92	< 1	92	143	18		1550	< 0.01	0.04	0.04	0.14	0.4	< 0.01	0.16	
	27/04/2017	13	12	74	6	< 1	62	< 1	62	134	23		1610	< 0.01	< 0.01	< 0.01		0.4	< 0.01		
	26/05/2017	20	11	68	8	< 1	65	< 1	65	136	21		1670	< 0.01	0.04	0.04		2.0	< 0.01	0.92	
RZ_BH69	16/02/2017	10	9	54	3	< 1	72	< 1	72	60	35		2330	0.02	0.08	0.10	0.03	0.2	< 0.01		
	14/03/2017	10	2	56	12	35	10	< 1	45	60	45		2330	0.23	0.30	0.53	0.43	0.6	< 0.01	0.06	
SP_BH01	28/06/2016	608	56	330	9	< 1	281	< 1	281	136	2200	-	265	< 0.01	0.04	0.04	0.20	17.5	< 0.01	18.0	-
	14/09/2016	14	< 1	96	52	49	< 1	76	124	52	78	0.7	1210	0.05	0.13	0.18	-	-	< 0.01	-	-
	26/10/2016	48	30	404	14	< 1	475	< 1	475	460	119	0.4	431	0.02	< 0.01	< 0.01	-	-	< 0.01	-	-
	30/11/2016	22	13	250	26	19	217	< 1	236	215	108	0.5	752	0.06	< 0.01	< 0.01	-	-	< 0.01	-	-
	13/12/2016	30	18	287	20	< 1	326	< 1	326	329	98		578	< 0.01	< 0.01	< 0.01			< 0.01		500000
	17/01/2017	46	32	425	16	< 1	454	< 1	454	492	123		403	< 0.01	< 0.01	< 0.01	0.38	1.1	< 0.01		
	15/02/2017	44	28	425	16	< 1	411	< 1	411	448	121		429	< 0.01	< 0.01	< 0.01	0.38	2.8	0.01		
	15/03/2017	44	26	434	19	< 1	423	< 1	423	421	110		457	< 0.01	0.02	0.02	0.47	0.6	< 0.01	0.22	
	26/05/2017	25	17	358	22	< 1	289	< 1	289	357	112		543	< 0.01	0.03	0.03		1.6	0.02	1.39	

Summary Table B6
M4-M5 Link WestConnex
Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
SP_BH02	27/07/2016	579	61	363	5	< 1	267	< 1	267	196	1750	0.4	262	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	31/08/2016	208	20	145	2	< 1	111	< 1	111	54	701	0.3	629	0.02	< 0.01	0.02	-	-	< 0.01	-	-
	26/10/2016	96	12	99	2	< 1	52	< 1	52	35	307	0.2	980	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	30/11/2016	164	23	171	2	< 1	116	< 1	116	70	570	0.2	641	< 0.01	0.08	0.08	-	-	< 0.01	-	-
	15/02/2017	55	6	82	1	< 1	37	< 1	37	24	238		1380	0.01	0.15	0.16	0.06	5.3	< 0.01		
	15/03/2017	82	5	77	< 1 J	< 1	37	< 1	37	28	296		1200	< 0.01	0.04	0.04	0.05	0.3	< 0.01		
	26/05/2017	32	4	72	< 1 J	< 1	30	< 1	30	22	188		1740	0.01	0.10	0.11		3.9	< 0.01	1.39	
SP_BH04	10/08/2016	78	65	763	11	< 1	380	< 1	380	994	158	0.4	231	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	29/09/2016	74	64	788	12	< 1	441	< 1	441	1040	235	0.5	234	< 0.01	0.05	0.05	-	-	0.04	-	-
	26/10/2016	78	66	774	13	< 1	404	< 1	404	1050	184	0.5	216	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	30/11/2016	69	61	804	13	< 1	384	< 1	384	1030	205	0.5	228	< 0.01	< 0.01	< 0.01	-	-	0.01	-	-
	13/12/2016	88	81	835	14	< 1	413	< 1	413	1220	256		190	< 0.01	< 0.01	< 0.01			< 0.01		500000
	17/01/2017	50	50	645	14	8	324	< 1	332	938	178		265	< 0.01	< 0.01	< 0.01	0.83	1.0	0.13		
	15/02/2017	57	57	712	14	< 1	349	< 1	349	1000	198		236	< 0.01	0.04	0.04	0.75	1.6	0.03		
	15/03/2017	84	66	887	13	< 1	398	< 1	398	1220	282		200	< 0.01	0.03	0.03	0.95	1.0	< 0.01	0.1	
	27/04/2017	63	54	790	12	< 1	285	< 1	285	946	447		219	< 0.01	0.07	0.07	0.78	1.5	0.03		
	26/05/2017	85	68	997	12	< 1	376	< 1	376	1170	391		194	< 0.01	0.15	0.15		3.1	0.03		
SP_BH06	9/08/2016	908	< 1	231	120	105	< 1	2340	2440	262	304	-	94	0.03	0.11	0.14	1.80	4.8	< 0.10	0.20	-
	30/11/2016	592	< 1	990	110	84	< 1	1680	1770	1100	< 1	< 0.1	89	< 0.01	0.01	0.01	-	-	< 0.01	-	-
SP_BH09	8/06/2016	-	-	-	-	< 1	895	< 1	895	81	215	-	840	< 0.01	0.07	0.07	3.19	158	< 0.01	236	-
	28/07/2016	35	14	391	41	14	358	< 1	372	226	350	1.0	478	< 0.01	1.17	1.17	-	-	0.01	-	-

Summary Table B6
M4-M5 Link WestConnex
Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
TC_BH01D	27/04/2017	5	3	175	28	38	93	< 1	131	169	74		1000	< 0.01	0.04	0.04	1.05	2.9	0.03		
	8/07/2016	95	47	351	12	< 1	213	< 1	213	598	116	0.5	397	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	27/07/2016	327	< 1	265	23	66	< 1	662	727	391	77	0.2	252	0.02	0.02	0.04	-	-	0.05	-	-
	30/08/2016	152	< 1	331	15	30	< 1	363	393	605	98	0.3	289	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	26/10/2016	107	44	473	13	< 1	67	< 1	67	973	82	0.3	294	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	29/11/2016	102	32	454	15	< 1	54	< 1	54	880	120	0.2	333	0.02	0.03	0.05	-	-	< 0.01	-	-
	13/12/2016	111	28	441	13	< 1	24	< 1	24	915	79		313	< 0.01	< 0.01	< 0.01			< 0.01		75
	16/01/2017	139	23	460	13	< 1	17	< 1	17	982	70		307	< 0.01	< 0.01	< 0.01	0.46	0.6	< 0.01		
	16/02/2017	152	22	493	14	8	7	< 1	15	995	51		299	< 0.01	0.05	0.05	0.39	1.7	< 0.01		
	14/03/2017	151	20	553	11	10	6	< 1	17	1060	48		280	< 0.01	0.06	0.06	0.48	0.6	< 0.01	0.08	
	27/04/2017	108	35	482	12	< 1	20	< 1	20	1000	41		286	< 0.01	< 0.01	< 0.01	0.46	1.2	< 0.01		
	25/05/2017	122	33	541	12	< 1	12	< 1	12	1000	41		294	< 0.01	0.06	0.06		0.6	< 0.01	0.03	
TC_BH01S	8/07/2016	260	413	3980	121	< 1	1030	< 1	1030	6480	829	0.6	47	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	27/07/2016	310	506	4610	124	< 1	896	< 1	896	7520	903	0.4	40	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	30/08/2016	301	518	5010	111	< 1	792	< 1	792	7990	1380	0.5	39	0.10	0.15	0.25	-	-	< 0.01	-	-
	26/10/2016	360	700	6220	188	< 1	807	< 1	807	10200	1320	0.5	30	0.01	0.09	0.10	-	-	< 0.01	-	-
	29/11/2016	328	555	4710	167	< 1	611	< 1	611	7860	1230	0.5	42	0.22	0.79	1.01	-	-	< 0.01	-	-
	13/12/2016	335	780	6440	228	< 1	661	< 1	661	9940	1420		32	0.03	0.25	0.28			< 0.01		
	16/01/2017	342	487	4910	146	< 1	605	< 1	605	9400	1400		36	< 0.01	< 0.01	< 0.01	0.48	1.2	< 0.01		
	16/02/2017	410	512	4510	158	< 1	627	< 1	627	9170	1390		31	< 0.01	0.03	0.03	1.62	2.2	< 0.01		
	14/03/2017	330	725	6030	172	< 1	719	< 1	719	10100	1330		31	< 0.01	0.08	0.08	1.74		< 0.01	0.51	
	27/04/2017	342	653	5410	164	< 1	607	< 1	607	9840	1650		30	< 0.01	0.15	0.15	2.05		< 0.01		
	25/05/2017	311	640	5760	174	< 1	633	< 1	633	9140	1380		35	< 0.01	0.15	0.15		2.2	< 0.01	0.45	

Summary Table B6
M4-M5 Link WestConnex
Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
	8/07/2016	59	65	343	51	< 1	538	< 1	538	118	456	0.4	444	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	27/07/2016	79	76	230	54	< 1	545	< 1	545	125	378	0.3	502	< 0.01	0.01	0.01	-	-	0.01	-	-
	30/08/2016	84	81	202	57	< 1	501	< 1	501	131	400	0.3	515	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	26/10/2016	52	76	154	56	< 1	316	< 1	316	123	293	0.2	606	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	29/11/2016	53	80	161	58	< 1	316	< 1	316	159	353	0.1	610	< 0.01	0.10	0.10	-	-	< 0.01	-	-
TC_BH06	13/12/2016	45	80	168	58	< 1	277	< 1	277	178	359		602	< 0.01	0.05	0.05			< 0.01		
	16/01/2017	50	83	152	62	< 1	268	< 1	268	145	338		625	< 0.01	0.01	0.01	2.39	2.7	< 0.01		
	17/02/2017	57	77	154	61	< 1	328	< 1	328	150	324		588	< 0.01	0.02	0.02	2.32	3.4	< 0.01		
	14/03/2017	53	67	143	56	< 1	312	< 1	312	135	318		625	< 0.01	0.10	0.10	1.82		< 0.01	0.4	
	27/04/2017	45	75	131	58	< 1	240	< 1	240	122	345		641	< 0.01	< 0.01	< 0.01	2.73	3.3	< 0.01		
	25/05/2017	58	71	175	56	< 1	322	< 1	322	164	307		592	< 0.01	0.06	0.06		3.0	< 0.01	0.27	
TC_BH07D	27/04/2017	49	27	174	4	< 1	124	< 1	124	333	40		714	< 0.01	0.56	0.56	0.03	1.5	< 0.01		
	8/07/2016	574	< 1	366	32	74	< 1	2190	2260	199	< 1	0.2	111	0.03	0.08	0.11	-	-	< 0.01	-	-
	27/07/2016	86	4	307	9	29	6	< 1	35	513	82	0.2	469	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	31/08/2016	75	34	302	8	< 1	137	< 1	137	573	98	0.2	454	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	26/10/2016	124	52	317	6	< 1	294	< 1	294	611	64	0.2	392	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	16/01/2017	97	56	289	6	< 1	240	< 1	240	604	72		422	< 0.01	< 0.01	< 0.01	0.12	0.2	< 0.01		
	16/02/2017	94	56	295	6	< 1	238	< 1	238	601	64		433	< 0.01	0.17	0.17	0.08	0.3	< 0.01		
	14/03/2017	94	50	313	6	< 1	222	< 1	222	588	65		433	< 0.01	0.16	0.16	0.14	0.2	< 0.01	0.08	
	25/05/2017	71	39	246	5	< 1	205	< 1	205	434	43		562	< 0.01	0.14	0.14		2.0	< 0.01		

Summary Table B6

M4-M5 Link WestConnex

Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
TC_BH07S	8/07/2016	553	587	7150	168	< 1	619	< 1	619	11300	1480	3.0	28	< 0.01	< 0.01	< 0.01	-	-	0.01	-	-
	27/07/2016	409	715	6300	176	< 1	704	< 1	704	10200	1110	2.3	30	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	30/08/2016	396	690	6210	194	< 1	682	< 1	682	10300	1360	2.0	30	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	26/10/2016	381	714	6420	204	< 1	701	< 1	701	10800	993	1.8	28	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	29/11/2016	471	740	6330	249	< 1	628	< 1	628	11100	1370	2.0	29	< 0.01	0.03	0.03	-	-	< 0.01	-	-
	13/12/2016	373	817	7180	264	< 1	622	< 1	622	11000	1190		28	< 0.01	0.03	0.03			< 0.01		
	16/01/2017	381	500	5100	153	< 1	554	< 1	554	9960	1040		34	< 0.01	0.11	0.11	4.00	6.0	< 0.01		
	16/02/2017	367	491	4490	152	< 1	517	< 1	517	8910	895		33	< 0.01	1.38	1.38	0.95	1.8	< 0.01		
	14/03/2017	325	673	5610	161	< 1	623	< 1	623	9960	912		32	< 0.01	0.13	0.13	4.75		< 0.01	3.55	
	28/04/2017	360	619	5680	180	< 1	550	< 1	550	10200	1030		29	< 0.01	0.42	0.42	2.73		< 0.01 J		
	25/05/2017	378	779	7000	207	< 1	669	< 1	669	11200	1070		30	< 0.01	0.46	0.46		8.8	< 0.01		
TC_BH08	27/07/2016	267	33	1680	64	3	39	< 1	42	2980	671	0.8	109	0.01	0.01	0.02	-	-	< 0.01	-	-
	30/08/2016	223	73	1870	78	< 1	166	< 1	166	3340	740	1.0	96	< 0.01	< 0.01	< 0.01	-	-	0.04	-	-
	26/10/2016	207	111	2000	92	< 1	244	< 1	244	3470	575	0.9	85	0.31	< 0.01	0.12	-	-	0.02	-	-
	29/11/2016	225	126	2210	100	< 1	227	< 1	227	3760	673	0.8	85	< 0.01	0.20	0.20	-	-	< 0.01	-	-
	13/12/2016	185	130	2040	97	< 1	241	< 1	241	3770	602		81	< 0.01	0.40	0.40			< 0.01		
	16/01/2017	194	173	2380	114	< 1	323	< 1	323	4440	688		73	0.02	0.12	0.14	0.18	0.6	0.02		
	17/02/2017	192	185	2660	118	< 1	367	< 1	367	4970	660		57	< 0.01	0.22	0.22	0.07	3.5	< 0.01		
	14/03/2017	154	182	2440	110	< 1	353	< 1	353	4020	535		79	< 0.01	0.25	0.25	0.14		0.02	0.45	
	27/04/2017	34	15	192	56	< 1	236	< 1	236	273	46		719	< 0.01	1.46	1.46	0.06	1.7	0.02		
	25/05/2017	101	92	1330	84	< 1	288	< 1	288	2140	283		134	< 0.01	1.47	1.47		1.2	< 0.01	0.35	

Summary Table B6
M4-M5 Link WestConnex
Inorganic Chemistry Analytical Results

		Inorganic Chemistry																			
		Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Hydroxide Alkalinity as CaCO3	Total Alkalinity as CaCO3	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen - Filtere	Reactive Phosphorus as P	Total Phosphorus as P	Sulfate Reducing Bacteria
	LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	0.01	10	0.01	1.0	1
Monitoring Well	Date Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/m
TC_BH09D	27/07/2016	58	40	253	5	< 1	152	< 1	152	466	65	0.2	546	< 0.01	0.01	0.01	-	-	< 0.01	-	-
	30/08/2016	107	36	243	5	< 1	268	< 1	268	468	76	0.3	500	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	26/10/2016	112	46	258	6	< 1	276	< 1	276	500	56	0.2	463	< 0.01	0.02	0.02	-	-	< 0.01	-	-
	29/11/2016	79	39	258	7	< 1	172	< 1	172	509	85	0.3	518	< 0.01	0.32	0.32	-	-	< 0.01	-	-
	13/12/2016	74	42	234	6	< 1	168	< 1	168	516	65		500	< 0.01	0.08	0.08			< 0.01		
	16/01/2017	73	49	247	6	< 1	170	< 1	170	521	82		500	< 0.01	0.02	0.02	0.10	0.4	< 0.01		
	16/02/2017	115	47	252	6	< 1	273	< 1	273	528	61		465	< 0.01	< 0.01	< 0.01	0.16	13.4	< 0.01		
	14/03/2017	82	45	271	6	< 1	200	< 1	200	536	56		485	< 0.01	0.06	0.06	0.13	0.2	< 0.01	0.08	
	27/04/2017	67	46	253	5	< 1	158	< 1	158	517	62		481	< 0.01	0.10	0.10	0.11	1.1	< 0.01		
	25/05/2017	66	43	295	6	< 1	183	< 1	183	544	54		478	< 0.01	0.05	0.05		0.2	< 0.01	0.05	
TC_BH09S	27/07/2016	320	63	356	29	< 1	576	< 1	576	500	466	0.3	309	0.01	0.12	0.13	-	-	< 0.01	-	-
	30/08/2016	260	33	95	14	< 1	677	< 1	677	155	230	0.4	575	0.05	0.36	0.41	-	-	< 0.01	-	-
	26/10/2016	123	82	781	38	< 1	274	< 1	274	1210	209	0.4	200	< 0.01	< 0.01	< 0.01	-	-	< 0.01	-	-
	29/11/2016	104	76	791	40	< 1	198	< 1	198	1240	272	0.3	210	< 0.01	0.02	0.02	-	-	0.02	-	-
	13/12/2016	67	71	738	39	< 1	151	< 1	151	1210	236		206	< 0.01	< 0.01	< 0.01			< 0.01		
	17/01/2017	89	84	730	44	< 1	198	< 1	198	1310	234		204	< 0.01	< 0.01	< 0.01	0.58	1.0	< 0.01		
	17/02/2017	81	88	867	46	< 1	194	< 1	194	1290	218		203	< 0.01	< 0.01	< 0.01	0.77	1.7	< 0.01		
	28/04/2017	252	52	245	25	< 1	334	< 1	334	666	144		334	< 0.01	0.11	0.11	0.91	7.3	< 0.01		
	26/05/2017	140	49	542	31	< 1	276	< 1	276	911	153		272	< 0.01	0.17	0.17		18.5	< 0.01	6.77	

Summary Table B7
M4M5 Link WestConnex
Water Quality - Metals

		Metals Chemistry									
		Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
LOR		0.01	0.001	0.01	0.001	0.5	0.01	0	0.0001	0.01	0.05
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Monitoring Well	Date										
BH57	29/09/2016	-	-	-	-	-	-	-	-	-	-
BH60	29/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	-	< 0.001	-	< 0.0001	< 0.001	< 0.005
CM_BH01	14/09/2016	< 0.001	< 0.0001	0.275	0.005	0.73	< 0.001	0.009	< 0.0001	0.002	< 0.005
CM_BH04	31/08/2016	0.003	< 0.0001	0.061	< 0.001	40.5	< 0.001	0.937	< 0.0001	< 0.001	< 0.005
CM_BH06	28/06/2016	0.002	< 0.0001	0.015	0.004	110	< 0.001	2.11	< 0.0001	< 0.001	< 0.005
	28/07/2016	0.007	< 0.0001	< 0.001	< 0.001	113	< 0.001	1.70	< 0.0001	< 0.001	< 0.005
	31/08/2016	0.008	< 0.0001	< 0.001	< 0.001	136	< 0.001	1.76	< 0.0001	0.001	< 0.005
CM_BH10	28/06/2016	0.001	< 0.0001	< 0.001	< 0.001	14.8	< 0.001	0.452	< 0.0001	< 0.001	< 0.005
EP_BH06	27/10/2016	< 0.001	< 0.0001	< 0.001	0.003	10.5	< 0.001	0.248	< 0.0001	0.004	0.010
	27/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	18	< 0.001	0.78	< 0.0001	0.043	0.104
	13-Dec-16	< 0.001	< 0.0001	< 0.001	< 0.001	12.8	< 0.001	0.68	< 0.0001	0.028	0.088
	12-Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	9.12	< 0.001	0.33	< 0.0001	0.012	0.047
	16-Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	8.02	< 0.001	0.25	< 0.0001	0.01	0.046
	14-Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	9.15	< 0.001	0.22	< 0.0001	0.01	0.03
	27-Apr-17	< 0.001	< 0.0001	< 0.001	< 0.001	10.6	< 0.001	0.19	< 0.0001	0.009	0.039
	15-May-17	< 0.001	< 0.0001	< 0.001	0.004	11.4	< 0.001	0.23	< 0.0001	0.009	0.055
EP_BH07	27/10/2016	< 0.001	< 0.0001	< 0.001	0.002	23.2	< 0.001	0.188	< 0.0001	< 0.001	< 0.005
	30/11/2016	< 0.001	0.0001	< 0.001	0.043	0.96	< 0.001	0.18	< 0.0001	0.014	0.044
	14-Mar-17	< 0.001	< 0.0001	< 0.001	0.003	7.71	< 0.001	0.16	< 0.0001	0.005	0.038
	27-Apr-17	< 0.001	< 0.0001	< 0.001	0.04	1.5	< 0.001	0.13	< 0.0001	0.004	0.077
	13-Dec-16	< 0.001	< 0.0001	0.001	0.016	0.3	< 0.001	0.16	< 0.0001	0.011	0.045
	12-Jan-17	< 0.001	0.0002	< 0.001	0.008	2.1	< 0.001	0.11	< 0.0001	0.007	0.032
	16-Feb-17	< 0.001	< 0.0001	< 0.001	0.004	4.57	< 0.001	0.12	< 0.0001	0.007	0.046
	15-May-17	< 0.001	< 0.0001	< 0.001	0.039	2.24	< 0.001	0.14	< 0.0001	0.004	0.046
IC_BH01	27/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	14.9	< 0.001	0.466	< 0.0001	0.001	< 0.005
	28/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	54.2	< 0.001	1.28	< 0.0001	0.003	< 0.005
	13-Dec-16	< 0.001	< 0.0001	< 0.001	< 0.001	<0.05	< 0.001	0.09	< 0.0001	0.002	< 0.005
	17-Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	34.1	< 0.001	0.86	< 0.0001	0.021	0.008
	14-Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	61.4	< 0.001	1.37	< 0.0001	0.02	< 0.005
	28-Apr-17	< 0.001	< 0.0001	< 0.001	< 0.001	20	< 0.001	0.5	< 0.0001	0.014	0.018
IC_BH02	14-Mar-17	< 0.001	< 0.0001	< 0.001	0.002	1.33	< 0.001	0.09	< 0.0001	0.01	0.074
	28-Apr-17	< 0.001	< 0.0001	< 0.001	0.002	0.48	< 0.001	0.08	< 0.0001	0.004	0.091
	may 17	< 0.001	< 0.0001	< 0.001	< 0.001	22.4	< 0.001	0.19	< 0.0001	0.004	0.046
HB_BH02	8/06/2016	< 0.001	< 0.0001	< 0.001	< 0.001	23.3	< 0.001	0.677	< 0.0001	0.002	< 0.005
	30/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	29.0	< 0.001	0.406	< 0.0001	0.008	< 0.005
HB_BH03	10/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	40.5	< 0.001	1.23	< 0.0001	0.020	0.083
	29/09/2016	< 0.001	< 0.0001	0.003	< 0.001	3.13	< 0.001	0.097	< 0.0001	< 0.001	< 0.005
	26/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	32.4	< 0.001	1.04	< 0.0001	0.004	< 0.005
	30/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	10.5	< 0.001	0.36	< 0.0001	0.005	0.011
	15/02/2017	< 0.001	< 0.0001	< 0.001	< 0.001	27.5	< 0.001	0.75	< 0.0001	0.03	< 0.005
	15-Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	17.6	< 0.001	0.64	< 0.0001	0.017	< 0.005
	28-Apr-17	< 0.001	< 0.0001	< 0.001	< 0.001	15.1	< 0.001	0.72	< 0.0001	0.011	0.009
	may 17	< 0.001	< 0.0001	< 0.001	< 0.001	27	< 0.001	0.83	< 0.0001	0.006	< 0.005

Summary Table B7
M4M5 Link WestConnex
Water Quality - Metals

Monitoring Well	Date	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
		Metals Chemistry									
LOR		0.01	0.001	0.01	0.001	0.5	0.01	0	0.0001	0.01	0.05
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
HB_BH08D	8/06/2016	0.003	< 0.0001	< 0.001	< 0.001	4.28	< 0.001	0.099	< 0.0001	0.003	< 0.005
	28/07/2016	< 0.001	< 0.0001	< 0.001	< 0.001	4.32	< 0.001	0.186	< 0.0001	0.002	< 0.005
	30/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	14.4	< 0.001	0.288	< 0.0001	0.009	< 0.005
	28/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	-	< 0.001	-	< 0.0001	< 0.001	0.013
	26/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	29.7	< 0.001	0.573	< 0.0001	0.004	< 0.005
	30/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	2.8	< 0.001	0.18	< 0.0001	0.004	< 0.005
	Dec-16	< 0.001	< 0.0001	< 0.001	< 0.001	1.88	< 0.001	0.19	< 0.0001	0.002	0.006
	Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	1.61	< 0.001	0.17	< 0.0001	0.001	< 0.005
	Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	3.31	< 0.001	0.19	< 0.0001	0.001	0.005
	Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	2.12	< 0.001	0.18	< 0.0001	< 0.001	< 0.005
	28/04/2017	< 0.001	< 0.0001	< 0.001	< 0.001	2.73	< 0.001	0.2	< 0.0001	< 0.001	< 0.005
	May-17	< 0.001	< 0.0001	< 0.001	< 0.001	4.18	< 0.001	0.19	< 0.0001	< 0.001	< 0.005
HB_BH08S	8/06/2016	< 0.001	< 0.0001	< 0.001	< 0.001	58.6	< 0.001	0.321	< 0.0001	< 0.001	< 0.005
	28/07/2016	< 0.001	< 0.0001	< 0.001	< 0.001	3.99	< 0.001	0.076	< 0.0001	0.002	0.005
	30/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	23.7	< 0.001	0.182	< 0.0001	0.011	< 0.005
	28/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	-	< 0.001	-	< 0.0001	< 0.001	0.013
	26/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	92.7	< 0.001	0.356	< 0.0001	0.006	< 0.005
	30/11/2016	< 0.001	< 0.0001	< 0.001	0.015	2.72	< 0.001	0.09	< 0.0001	0.072	0.023
	Dec-16	< 0.001	< 0.0001	< 0.001	0.01	4.93	< 0.001	0.11	< 0.0001	0.052	0.017
	Jan-17	< 0.001	< 0.0001	< 0.001	0.018	2.13	< 0.001	0.07	< 0.0001	0.074	0.017
	Feb-17	< 0.001	< 0.0001	< 0.001	0.008	3.44	< 0.001	0.12	< 0.0001	0.029	0.007
	Mar-17	< 0.001	< 0.0001	< 0.001	0.018	4.32	< 0.001	0.13	< 0.0001	0.031	0.01
	28/04/2017	0.003	< 0.0001	< 0.001	0.005	14.4	< 0.001	0.19	< 0.0001	0.011	< 0.005
	May-17	0.002	< 0.0001	0.001	0.005	29.5	< 0.001	0.22	< 0.0001	0.022	0.005
HB_BH12	14/07/2016	0.002	0.0002	0.022	0.029	16.3	0.012	0.284	< 0.0001	0.014	6.98
	30/08/2016	< 0.001	< 0.0001	< 0.001	0.002	458	< 0.001	25.1	< 0.0001	0.008	< 0.005
	28/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	-	< 0.001	-	< 0.0001	0.004	0.016
	26/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	22.2	< 0.001	1.30	< 0.0001	0.002	< 0.005
	Dec-16	< 0.001	< 0.0001	< 0.001	0.002	13.6	< 0.001	0.67	< 0.0001	0.003	< 0.005
	Feb-17	< 0.001	< 0.0001	< 0.001	0.002	7.51	< 0.001	0.33	< 0.0001	0.002	< 0.005
	Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	17.2	< 0.001	0.79	< 0.0001	0.003	< 0.005
	28/04/2017	< 0.001	< 0.0001	< 0.001	0.001	7.58	< 0.001	0.3	< 0.0001	0.002	< 0.005
	May-17	< 0.001	0.0002	< 0.001	0.005	259	< 0.001	6.43	< 0.0001	0.006	< 0.005
HB_BH14	14/07/2016	0.006	< 0.0001	0.003	0.003	2.98	0.004	0.128	< 0.0001	0.004	0.022
	27/07/2016	< 0.001	< 0.0001	< 0.001	< 0.001	220	< 0.001	2.73	< 0.0001	0.003	< 0.005
	30/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	36.6	< 0.001	0.436	< 0.0001	0.005	< 0.005
	Dec-16	< 0.001	< 0.0001	< 0.001	< 0.001	3.32	< 0.001	0.19	< 0.0001	0.002	0.006
	Feb-17	0.001	< 0.0001	< 0.001	< 0.001	4.34	< 0.001	0.2	< 0.0001	< 0.001	< 0.005
	Mar-17	0.001	< 0.0001	< 0.001	< 0.001	5.12	< 0.001	0.17	< 0.0001	< 0.001	< 0.005
	May-17	< 0.001	< 0.0001	< 0.001	< 0.001	418	< 0.001	3.41	< 0.0001	0.002	< 0.005

Summary Table B7
M4M5 Link WestConnex
Water Quality - Metals

		Metals Chemistry									
		Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
LOR		0.01	0.001	0.01	0.001	0.5	0.01	0	0.0001	0.01	0.05
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Monitoring Well	Date										
HB_BH15	8/06/2016	0.001	< 0.0001	< 0.001	< 0.001	4.28	< 0.001	0.212	< 0.0001	0.002	< 0.005
	27/07/2016	< 0.001	< 0.0001	< 0.001	< 0.001	30.3	< 0.001	1.37	< 0.0001	0.026	< 0.005
	30/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	29.4	< 0.001	1.17	< 0.0001	0.040	0.017
	28/09/2016	0.001	< 0.0001	< 0.001	< 0.001	-	< 0.001	-	< 0.0001	0.150	0.038
	26/10/2016	0.001	< 0.0001	< 0.001	< 0.001	24.7	< 0.001	1.32	< 0.0001	0.036	0.017
	30/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	5.24	< 0.001	0.49	< 0.0001	0.048	0.014
	Dec-16	< 0.001	< 0.0001	< 0.001	< 0.001	6.32	< 0.001	0.59	< 0.0001	0.043	0.033
	Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	16.9	< 0.001	0.93	< 0.0001	0.031	0.024
	Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	25.4	< 0.001	1.29	< 0.0001	0.028	0.024
	Mar-17	< 0.001	< 0.0001	< 0.001	0.029	5.7	< 0.001	0.68	< 0.0001	0.036	0.041
	28/04/2017	< 0.001	< 0.0001	< 0.001	< 0.001	16.2	< 0.001	1.07	< 0.0001	0.023	0.03
	May-17	< 0.001	< 0.0001	< 0.001	< 0.001	33	< 0.001	1.24	< 0.0001	0.023	0.035
MT_BH02	Mar-17	< 0.001	< 0.0001	0.02	0.004	5.1	< 0.001	0.08	< 0.0001	< 0.001	< 0.005
	28/04/2017	< 0.001	< 0.0001	0.008	0.009	30.5	< 0.001	0.43	< 0.0001	0.001	< 0.005
	May-17	< 0.001	0.0002	0.006	0.009	20.5	< 0.001	0.17	< 0.0001	0.003	< 0.005
MT_BH07	Feb-17	< 0.001	< 0.0001	0.021	0.002	12.2	< 0.001	0.29	< 0.0001	< 0.001	< 0.005
	Mar-17	< 0.001	< 0.0001	0.002	0.001	16.5	< 0.001	0.29	< 0.0001	0.002	< 0.005
	28/04/2017	< 0.001	< 0.0001	< 0.001	0.003	40.2	< 0.001	0.95	< 0.0001	0.001	< 0.005
	May-17	< 0.001	< 0.0001	< 0.001	0.003	151	< 0.001	2.1	< 0.0001	0.002	< 0.005
MT_BH14	Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	7.46	< 0.001	0.25	< 0.0001	0.007	< 0.005
	Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	10.2	< 0.001	0.28	< 0.0001	0.003	< 0.005
	Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	4.68	< 0.001	0.3	< 0.0001	0.003	< 0.005
	28/04/2017	< 0.001	< 0.0001	< 0.001	< 0.001	9.31	< 0.001	0.69	< 0.0001	0.002	< 0.005
MT_BH18	Jan-17	< 0.001	0.0001	0.098	0.007	0.59	< 0.001	0.01	< 0.0001	< 0.001	< 0.005
	Feb-17	< 0.001	< 0.0001	0.088	0.01	3.35	< 0.001	0.07	< 0.0001	0.001	< 0.005
	May-17	< 0.001	< 0.0001	0.059	0.01	2.37	< 0.001	0.02	< 0.0001	0.001	< 0.005
MT_BH21	Feb-17	< 0.001	< 0.0001	0.037	0.002	2.11	< 0.001	0.22	< 0.0001	< 0.001	< 0.005
	Mar-17	< 0.001	< 0.0001	0.002	< 0.001	9.38	< 0.001	2.29	< 0.0001	0.017	0.01
RZ_BH01D	25/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	35.0	< 0.001	1.25	< 0.0001	0.009	0.005
	28/06/2016	< 0.001	< 0.0001	< 0.001	< 0.001	37.6	< 0.001	1.45	< 0.0001	0.007	0.044
	27/07/2016	< 0.001	< 0.0001	< 0.001	< 0.001	31.4	< 0.001	1.12	< 0.0001	0.016	< 0.005
	30/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	48.2	< 0.001	1.28	< 0.0001	0.035	< 0.005
	29/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	20.1	< 0.001	0.801	< 0.0001	0.003	< 0.005
	28/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	29.6	< 0.001	1.13	< 0.0001	0.001	< 0.005
	Dec-16	< 0.001	< 0.0001	0.003	0.006	25.3	0.002	0.97	< 0.0001	0.003	0.015
	Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	26.1	< 0.001	0.78	< 0.0001	< 0.001	< 0.005
	Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	23.5	< 0.001	0.87	< 0.0001	< 0.001	< 0.005
	Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	6.94	< 0.001	0.39	< 0.0001	< 0.001	< 0.005
	28/04/2017	0.001	< 0.0001	< 0.001	< 0.001	1.35	< 0.001	0.04	< 0.0001	0.002	< 0.005
	May-17	< 0.001	< 0.0001	< 0.001	< 0.001	12.9	< 0.001	0.32	< 0.0001	0.001	< 0.005

Summary Table B7
M4M5 Link WestConnex
Water Quality - Metals

		Metals Chemistry									
		Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
LOR		0.01	0.001	0.01	0.001	0.5	0.01	0	0.0001	0.01	0.05
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Monitoring Well	Date										
RZ_BH01S	28/06/2016	0.002	< 0.0001	< 0.001	0.003	23.0	< 0.001	0.705	< 0.0001	0.007	< 0.005
	27/07/2016	< 0.001	< 0.0001	< 0.001	< 0.001	11.8	< 0.001	0.277	< 0.0001	0.012	< 0.005
	30/08/2016	< 0.001	< 0.0001	< 0.001	0.002	133	< 0.001	0.604	< 0.0001	0.009	< 0.005
	28/09/2016	0.002	< 0.0001	< 0.001	< 0.001	-	< 0.001	-	< 0.0001	< 0.001	0.008
	25/10/2016	0.001	< 0.0001	< 0.001	0.002	109	< 0.001	0.679	< 0.0001	0.006	< 0.005
	28/11/2016	0.003	< 0.0001	< 0.001	< 0.001	86.2	< 0.001	0.52	< 0.0001	0.003	< 0.005
	Dec-16	0.011	0.0002	0.01	0.03	11.5	0.005	0.19	< 0.0001	0.008	0.054
	Jan-17	0.001	< 0.0001	< 0.001	< 0.001	26.7	< 0.001	0.3	< 0.0001	0.004	< 0.005
	Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	12.3	< 0.001	0.26	< 0.0001	0.002	< 0.005
	Mar-17	0.001	< 0.0001	< 0.001	< 0.001	29.7	< 0.001	0.29	< 0.0001	0.002	< 0.005
	26/04/2017	0.001	< 0.0001	< 0.001	0.001	38.9	< 0.001	0.25	< 0.0001	0.005	< 0.005
	May-17	0.001	< 0.0001	< 0.001	< 0.001	30.1	< 0.001	0.25	< 0.0001	0.002	< 0.005
RZ_BH15	25/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	21.1	< 0.001	0.848	< 0.0001	0.004	0.005
	28/06/2016	< 0.001	< 0.0001	< 0.001	< 0.001	27.2	< 0.001	1.24	< 0.0001	0.007	< 0.005
	27/07/2016	< 0.001	< 0.0001	< 0.001	< 0.001	74.1	< 0.001	1.72	< 0.0001	0.009	< 0.005
	30/08/2016	0.002	< 0.0001	< 0.001	< 0.001	65.3	< 0.001	1.74	< 0.0001	0.003	< 0.005
	29/09/2016	0.004	< 0.0001	< 0.001	0.003	5.19	< 0.001	0.257	< 0.0001	0.009	0.006
	28/11/2016	0.002	< 0.0001	< 0.001	0.002	16	< 0.001	0.48	< 0.0001	0.01	< 0.005
	Dec-16	0.006	< 0.0001	0.026	0.038	14.1	0.01	0.41	< 0.0001	0.025	0.229
	Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	15.2	< 0.001	0.58	< 0.0001	0.006	< 0.005
	Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	23.6	< 0.001	0.59	< 0.0001	0.01	0.006
	Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	14.1	< 0.001	0.5	< 0.0001	0.008	< 0.005
	28/04/2017	< 0.001	< 0.0001	< 0.001	< 0.001	17.8	< 0.001	0.66	< 0.0001	0.003	< 0.005
	May-17	0.002	< 0.0001	< 0.001	< 0.001	11.4	< 0.001	0.38	< 0.0001	0.005	< 0.005
RZ_BH16	14/07/2016	0.008	< 0.0001	0.010	0.012	24.4	0.010	0.888	< 0.0001	0.052	0.090
	27/07/2016	0.002	< 0.0001	< 0.001	< 0.001	40.2	< 0.001	1.49	< 0.0001	0.001	< 0.005
	30/08/2016	0.001	< 0.0001	< 0.001	< 0.001	24.4	< 0.001	0.932	< 0.0001	0.001	< 0.005
	29/09/2016	0.002	< 0.0001	< 0.001	< 0.001	1.31	<0.001	0.084	<0.0001	<0.001	< 0.005
	25/10/2016	0.002	< 0.0001	< 0.001	< 0.001	4.43	< 0.001	0.105	< 0.0001	0.008	0.012
	28/11/2016	0.001	< 0.0001	< 0.001	< 0.001	19.2	< 0.001	0.72	< 0.0001	0.005	< 0.005
	12-Dec-16	0.002	< 0.0001	0.002	0.007	1.79	0.002	0.16	< 0.0001	0.068	0.02
	12-Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	2.81	< 0.001	0.21	< 0.0001	0.011	< 0.005
	14-Feb-17	0.001	< 0.0001	< 0.001	0.001	3.25	< 0.001	0.32	< 0.0001	0.007	< 0.005
	13-Mar-17	< 0.001	< 0.0001	< 0.001	0.003	4.1	< 0.001	0.29	< 0.0001	0.005	< 0.005
	26-Apr-17	0.002	< 0.0001	< 0.001	0.002	4.52	< 0.001	0.3	< 0.0001	0.003	< 0.005
	15-May-17	0.001	0.0001	< 0.001	0.002	5.96	< 0.001	0.31	< 0.0001	0.001	< 0.005
RZ_BH19	11/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	94.7	< 0.001	2.60	< 0.0001	0.001	< 0.005
	29/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	23.8	< 0.001	1.11	< 0.0001	<0.001	<0.005
	27/10/2016	-	-	-	-	25.2	-	1.05	-	-	-
	28/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	13.7	< 0.001	0.7	< 0.0001	0.001	< 0.005
	12-Dec-16	0.002	0.0002	0.011	0.01	8.06	0.005	0.47	< 0.0001	0.011	0.044
	13-Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	13.4	< 0.001	0.55	< 0.0001	0.001	< 0.005
	14-Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	3.15	< 0.001	0.28	< 0.0001	0.001	< 0.005
	13-Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	7.01	< 0.001	0.39	< 0.0001	0.002	< 0.005
	26-Apr-17	< 0.001	< 0.0001	< 0.001	< 0.001	3.97	< 0.001	0.29	< 0.0001	< 0.001	< 0.005
	15-May-17	< 0.001	< 0.0001	< 0.001	< 0.001	38.9	< 0.001	1.06	< 0.0001	< 0.001	< 0.005

Summary Table B7
M4M5 Link WestConnex
Water Quality - Metals

		Metals Chemistry									
		Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
LOR		0.01	0.001	0.01	0.001	0.5	0.01	0	0.0001	0.01	0.05
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Monitoring Well	Date										
RZ_BH26	14/07/2016	0.004	0.0001	0.026	0.012	26.5	0.010	0.837	< 0.0001	0.024	0.088
	27/07/2016	< 0.001	< 0.0001	< 0.001	0.002	0.53	< 0.001	0.017	< 0.0001	0.002	< 0.005
	30/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	114	< 0.001	2.04	< 0.0001	0.004	< 0.005
	29/09/2016	<0.001	<0.0001	<0.001	<0.001	47.9	< 0.001	1.71	<0.0001	0.008	<0.005
	25/10/2016	0.002	< 0.0001	< 0.001	< 0.001	17.1	< 0.001	0.365	< 0.0001	0.004	< 0.005
	30/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	14.1	< 0.001	0.54	< 0.0001	0.002	< 0.005
	12-Dec-16	0.001	< 0.0001	0.005	0.006	16.2	0.005	0.7	< 0.0001	0.007	0.019
	13-Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	35.3	< 0.001	0.98	< 0.0001	0.008	< 0.005
	14-Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	27.4	< 0.001	0.88	< 0.0001	0.004	< 0.005
	13-Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	19	< 0.001	0.85	< 0.0001	0.002	< 0.005
	26-Apr-17	< 0.001	< 0.0001	< 0.001	< 0.001	6.36	< 0.001	0.47	< 0.0001	0.006	< 0.005
	15-May-17	< 0.001	< 0.0001	< 0.001	< 0.001	43.7	< 0.001	1.05	< 0.0001	0.006	< 0.005
RZ_BH28	25/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	8.94	< 0.001	0.446	< 0.0001	0.054	0.011
	11/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	15.8	< 0.001	0.452	< 0.0001	< 0.001	< 0.005
	29/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	38.6	< 0.001	0.920	< 0.0001	0.004	< 0.005
	28/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	14.7	< 0.001	0.51	< 0.0001	0.008	< 0.005
	12-Dec-16	< 0.001	< 0.0001	0.002	0.002	12.3	< 0.001	0.45	< 0.0001	0.006	0.005
	13-Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	16.1	< 0.001	0.52	< 0.0001	0.006	< 0.005
	14-Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	12.4	< 0.001	0.46	< 0.0001	0.006	0.007
	13-Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	13.1	< 0.001	0.49	< 0.0001	0.004	< 0.005
	26-Apr-17	< 0.001	< 0.0001	< 0.001	< 0.001	16	< 0.001	0.53	< 0.0001	0.005	0.007
	15-May-17	< 0.001	< 0.0001	< 0.001	< 0.001	20	< 0.001	0.52	< 0.0001	0.005	0.008
RZ_BH30	27/07/2016	< 0.001	< 0.0001	< 0.001	< 0.001	12.7	< 0.001	0.392	< 0.0001	0.004	< 0.005
	31/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	14.4	< 0.001	0.369	< 0.0001	0.006	< 0.005
	28/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	4.30	< 0.001	0.206	< 0.0001	0.013	< 0.005
	16-Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	4.14	< 0.001	0.21	< 0.0001	0.006	< 0.005
	26-Apr-17	0.002	< 0.0001	< 0.001	< 0.001	3.44	< 0.001	0.11	< 0.0001	0.025	0.005
	15-May-17	< 0.001	< 0.0001	< 0.001	< 0.001	16.7	< 0.001	0.35	< 0.0001	0.008	< 0.005
RZ_BH38	27/10/2016	< 0.001	< 0.0001	< 0.001	0.004	-	< 0.001	-	< 0.0001	< 0.001	0.006
	10/08/2016	0.008	< 0.0001	< 0.001	< 0.001	46.8	< 0.001	1.17	< 0.0001	< 0.001	< 0.005
	29/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	3.42	< 0.001	0.167	< 0.0001	< 0.001	< 0.005
	27/10/2016	0.004	< 0.0001	< 0.001	< 0.001	17.9	< 0.001	0.601	< 0.0001	0.002	< 0.005
	28/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	18.3	< 0.001	0.72	< 0.0001	0.001	< 0.005
	12-Dec-16	0.002	< 0.0001	0.003	0.003	2.74	0.002	0.15	< 0.0001	0.006	0.016
	12-Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	3.91	< 0.001	0.19	< 0.0001	0.005	< 0.005
	14-Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	4.85	< 0.001	0.23	< 0.0001	0.001	< 0.005
	13-Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	2.84	< 0.001	0.2	< 0.0001	< 0.001	< 0.005
	26-Apr-17	0.002	< 0.0001	< 0.001	< 0.001	2.53	< 0.001	0.18	< 0.0001	< 0.001	< 0.005
	15-May-17	0.001	< 0.0001	< 0.001	< 0.001	9.39	< 0.001	0.29	< 0.0001	0.002	< 0.005
RZ_BH44D	10/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	11.5	< 0.001	0.420	< 0.0001	0.013	< 0.005
	29/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	11.4	< 0.001	0.578	< 0.0001	0.002	< 0.005
	27/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	15.9	< 0.001	0.614	< 0.0001	0.003	0.005
	28/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	8.23	< 0.001	0.55	< 0.0001	0.003	< 0.005
	12-Dec-16	0.002	< 0.0001	0.002	0.004	11.7	0.009	0.58	< 0.0001	0.003	0.019
	13-Jan-17	0.001	< 0.0001	< 0.001	< 0.001	13.4	< 0.001	0.6	< 0.0001	0.004	< 0.005
	14-Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	8.87	< 0.001	0.57	< 0.0001	0.002	< 0.005
	13-Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	8.54	< 0.001	0.57	< 0.0001	0.002	0.006
	26-Apr-17	0.002	< 0.0001	< 0.001	0.001	4.08	< 0.001	0.12	< 0.0001	0.002	0.042
	15-May-17	< 0.001	< 0.0001	< 0.001	< 0.001	9.54	< 0.001	0.25	< 0.0001	0.002	0.007

Summary Table B7
M4M5 Link WestConnex
Water Quality - Metals

		Metals Chemistry									
		Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
LOR		0.01	0.001	0.01	0.001	0.5	0.01	0	0.0001	0.01	0.05
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Monitoring Well	Date										
RZ_BH44S	27/10/2016	0.002	< 0.0001	< 0.001	< 0.001	-	< 0.001	-	< 0.0001	0.003	0.006
	10/08/2016	0.001	< 0.0001	< 0.001	< 0.001	39.2	< 0.001	0.969	< 0.0001	< 0.001	< 0.005
	29/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	43.2	< 0.001	1.24	< 0.0001	< 0.001	< 0.005
	29/09/2016	0.003	< 0.0001	< 0.001	< 0.001	-	< 0.001	-	< 0.0001	0.002	0.009
	28/11/2016	0.001	< 0.0001	< 0.001	< 0.001	32.1	< 0.001	1.15	< 0.0001	0.002	< 0.005
	Dec-16	0.003	< 0.0001	0.004	0.056	28.5	0.005	1.09	< 0.0001	0.009	0.032
	Jan-17	< 0.001	< 0.0001	< 0.001	0.001	31.8	< 0.001	1.07	< 0.0001	0.004	0.011
	Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	35	< 0.001	1.18	< 0.0001	0.006	0.017
	Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	27.1	< 0.001	1.15	< 0.0001	0.006	0.012
	26/04/2017	< 0.001	< 0.0001	< 0.001	< 0.001	31.5	< 0.001	1.16	< 0.0001	0.002	< 0.005
	May-17	< 0.001	< 0.0001	< 0.001	< 0.001	33.4	< 0.001	1.1	< 0.0001	0.004	0.024
RZ_BH47D	31/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	7.24	< 0.001	0.278	< 0.0001	0.007	0.010
	29/09/2016	<0.001	<0.0001	<0.001	<0.001	11.6	<0.001	0.262	<0.0001	0.001	<0.005
	25/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	1.14	< 0.001	0.092	< 0.0001	0.008	0.005
	28/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	16.9	< 0.001	0.39	< 0.0001	0.005	< 0.005
	12-Dec-16	< 0.001	< 0.0001	0.003	0.002	9.74	0.001	0.27	< 0.0001	0.006	0.017
	13-Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	11.1	< 0.001	0.37	< 0.0001	0.005	0.007
	14-Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	29.4	< 0.001	0.72	< 0.0001	0.008	0.03
	13-Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	14.2	< 0.001	0.49	< 0.0001	0.006	< 0.005
	26-Apr-17	< 0.001	< 0.0001	< 0.001	< 0.001	11.9	< 0.001	0.37	< 0.0001	0.003	< 0.005
	15-May-17	< 0.001	< 0.0001	< 0.001	< 0.001	32.3	< 0.001	0.8	< 0.0001	0.005	0.007
RZ_BH47S	31/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	40.0	< 0.001	1.12	< 0.0001	< 0.001	< 0.005
	29/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	47.3	< 0.001	1.18	< 0.0001	< 0.001	< 0.005
	25/10/2016	< 0.001	< 0.0001	0.004	0.002	0.71	< 0.001	0.014	< 0.0001	< 0.001	< 0.005
	28/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	16.9	< 0.001	0.39	< 0.0001	0.005	< 0.005
	Dec-16	< 0.001	< 0.0001	< 0.001	< 0.001	< 0.001	< 0.001	0.07	< 0.0001	< 0.001	< 0.005
	Jan-17	0.002	< 0.0001	< 0.001	0.002	8.11	< 0.001	0.09	< 0.0001	0.003	0.006
	Feb-17	0.002	< 0.0001	< 0.001	< 0.001	67.5	< 0.001	0.15	< 0.0001	0.002	< 0.005
	Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	21.4	< 0.001	0.12	< 0.0001	0.004	< 0.005
	28/04/2017	0.004	< 0.0001	< 0.001	< 0.001	92.7	< 0.001	0.2	< 0.0001	0.002	< 0.005
	May-17	0.001	< 0.0001	< 0.001	0.011	36.3	< 0.001	0.13	< 0.0001	0.002	< 0.005
RZ_BH49	14/07/2016	0.004	< 0.0001	0.032	0.024	19.2	0.028	0.532	< 0.0001	0.008	0.031
	27/07/2016	< 0.001	< 0.0001	< 0.001	< 0.001	4.61	< 0.001	0.132	< 0.0001	< 0.001	< 0.005
	30/08/2016	< 0.001	< 0.0001	< 0.001	0.001	4.72	< 0.001	0.120	< 0.0001	0.002	< 0.005
	29/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	5.49	< 0.001	0.130	< 0.0001	< 0.001	< 0.005
	26/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	12.7	< 0.001	0.120	< 0.0001	0.001	< 0.005
	30/11/2016	< 0.001	< 0.0001	< 0.001	0.003	3.39	< 0.001	0.08	< 0.0001	0.008	< 0.005
	Dec-16	< 0.001	< 0.0001	0.004	0.004	2.76	0.002	0.08	< 0.0001	0.006	0.006
	Jan-17	0.003	0.0002	0.001	0.015	1.8	< 0.001	0.06	< 0.0001	0.008	< 0.005
	Feb-17	< 0.001	< 0.0001	< 0.001	0.039	3.41	< 0.001	0.09	< 0.0001	0.007	< 0.005
	Mar-17	< 0.001	< 0.0001	< 0.001	0.016	4.54	< 0.001	0.09	< 0.0001	0.002	< 0.005
	26-Apr-17	0.016	< 0.0001	< 0.001	0.026	7.33	< 0.001	0.12	< 0.0001	0.001	< 0.005
	May-17	0.005	< 0.0001	< 0.001	0.037	4.17	< 0.001	0.06	< 0.0001	< 0.001	< 0.005

Summary Table B7
M4M5 Link WestConnex
Water Quality - Metals

		Metals Chemistry									
		Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
LOR		0.01	0.001	0.01	0.001	0.5	0.01	0	0.0001	0.01	0.05
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Monitoring Well	Date										
RZ_BH50	25/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	25.4	< 0.001	0.802	< 0.0001	0.031	< 0.005
	31/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	0.99	< 0.001	0.203	< 0.0001	0.001	0.025
	28/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	62.5	< 0.001	1.42	< 0.0001	0.007	0.014
	28/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	39.8	< 0.001	1.19	< 0.0001	0.011	0.006
	12-Dec-16	< 0.001	< 0.0001	0.003	0.01	25.7	0.016	0.91	< 0.0001	0.029	0.036
	16-Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	30.9	< 0.001	1	< 0.0001	0.021	0.01
	14-Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	39.7	< 0.001	1.11	< 0.0001	0.012	0.016
	15-Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	41.2	< 0.001	1.18	< 0.0001	0.008	0.005
	15-May-17	< 0.001	< 0.0001	< 0.001	< 0.001	37.6	< 0.001	1.04	< 0.0001	0.011	0.028
RZ_BH51	10/08/2016	< 0.001	< 0.0001	0.010	< 0.001	63.0	< 0.001	3.34	< 0.0001	0.001	< 0.005
	28/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	5.65	< 0.001	0.181	< 0.0001	< 0.001	< 0.005
	25/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	4.66	< 0.001	0.163	< 0.0001	0.011	0.005
	28/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	28.5	< 0.001	1.25	< 0.0001	< 0.001	< 0.005
	12-Dec-16	< 0.001	0.0003	0.009	0.005	7.19	0.008	0.25	< 0.0001	0.006	0.06
	16-Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	5.3	< 0.001	0.24	< 0.0001	0.007	0.007
	14-Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	6.88	< 0.001	0.26	< 0.0001	0.003	< 0.005
	26-Apr-17	0.001	< 0.0001	< 0.001	< 0.001	4.77	< 0.001	0.22	< 0.0001	0.007	< 0.005
	15-May-17	< 0.001	< 0.0001	< 0.001	< 0.001	10.4	< 0.001	0.32	< 0.0001	0.003	< 0.005
RZ_BH52	25/10/2016	< 0.001	< 0.0001	< 0.001	0.005	14.5	< 0.001	0.492	< 0.0001	0.001	0.201
	10/08/2016	0.001	< 0.0001	0.003	< 0.001	2.14	< 0.001	0.140	< 0.0001	< 0.001	< 0.005
	28/09/2016	< 0.001	0.0001	< 0.001	< 0.001	44.7	< 0.001	1.09	< 0.0001	0.008	0.008
	28/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	13.2	< 0.001	0.5	< 0.0001	0.001	< 0.005
	12-Dec-16	0.001	< 0.0001	0.007	0.02	17.6	0.017	0.58	< 0.0001	0.013	0.069
	14-Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	13	< 0.001	0.52	< 0.0001	0.002	0.007
	15-Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	22.6	< 0.001	0.62	< 0.0001	0.001	< 0.005
	26-Apr-17	< 0.001	< 0.0001	< 0.001	< 0.001	26	< 0.001	0.68	< 0.0001	0.003	0.01
	15-May-17	< 0.001	< 0.0001	< 0.001	< 0.001	27.8	< 0.001	0.69	< 0.0001	0.003	0.015
RZ_BH56	26-Apr-17	< 0.001	< 0.0001	< 0.001	< 0.001	35.8	< 0.001	1.12	< 0.0001	0.007	0.022
RZ_BH60	14-Mar-17	< 0.001	< 0.0001	0.026	0.004	6.08	< 0.001	0.13	< 0.0001	0.002	< 0.005
	27-Apr-17	0.001	< 0.0001	0.001	0.005	71.6	< 0.001	1.7	< 0.0001	0.003	< 0.005
	15-May-17	< 0.001	< 0.0001	< 0.001	0.004	237	< 0.001	3.35	< 0.0001	0.005	< 0.005
RZ_BH64	16-Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	26.6	< 0.001	0.53	< 0.0001	0.004	0.009
	15-May-17	< 0.001	< 0.0001	< 0.001	< 0.001	14.9	< 0.001	0.68	< 0.0001	0.002	< 0.005
RZ_BH67	17-Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	48.6	< 0.001	1.28	< 0.0001	0.002	< 0.005
	15-Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	50.8	< 0.001	1.36	< 0.0001	0.004	< 0.005
	27-Apr-17	< 0.001	< 0.0001	< 0.001	< 0.001	32.9	< 0.001	1.02	< 0.0001	0.005	0.01
	15-May-17	< 0.001	< 0.0001	< 0.001	< 0.001	44.1	< 0.001	1.32	< 0.0001	0.011	0.008
RZ_BH69	14-Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	8.23	< 0.001	0.3	< 0.0001	< 0.001	< 0.005
SP_BH01	14/09/2016	< 0.001	< 0.0001	0.157	0.003	2.29	< 0.001	0.022	< 0.0001	< 0.001	< 0.005
	26/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	34.8	< 0.001	0.569	< 0.0001	0.001	< 0.005
	30/11/2016	< 0.001	< 0.0001	0.001	< 0.001	1.03	< 0.001	0.02	< 0.0001	< 0.001	< 0.005
	Dec-16	0.002	< 0.0001	< 0.001	< 0.001	0.05	< 0.001	0.07	< 0.0001	< 0.001	< 0.005
	Jan-17	0.003	< 0.0001	< 0.001	< 0.001	10.8	< 0.001	0.23	< 0.0001	< 0.001	< 0.005
	Feb-17	0.005	< 0.0001	0.002	< 0.001	4.6	< 0.001	0.14	< 0.0001	< 0.001	< 0.005
	Mar-17	0.002	< 0.0001	0.001	< 0.001	11.9	< 0.001	0.2	< 0.0001	< 0.001	< 0.005
	May-17	0.002	< 0.0001	< 0.001	< 0.001	9.71	< 0.001	0.12	< 0.0001	< 0.001	< 0.005

Summary Table B7
M4M5 Link WestConnex
Water Quality - Metals

		Metals Chemistry									
		Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
LOR		0.01	0.001	0.01	0.001	0.5	0.01	0	0.0001	0.01	0.05
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Monitoring Well	Date										
SP_BH02	28/06/2016	< 0.001	< 0.0001	< 0.001	< 0.001	395	< 0.001	3.30	< 0.0001	0.010	0.028
	27/07/2016	< 0.001	< 0.0001	< 0.001	< 0.001	101	< 0.001	1.83	< 0.0001	0.039	0.042
	31/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	44.8	< 0.001	0.482	< 0.0001	0.012	0.048
	28/09/2016	-	-	-	-	-	-	-	-	-	-
	26/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	18.9	< 0.001	0.222	< 0.0001	0.004	0.054
	30/11/2016	0.001	< 0.0001	< 0.001	< 0.001	35.1	< 0.001	0.54	< 0.0001	0.006	0.016
	Feb-17	0.001	< 0.0001	< 0.001	< 0.001	38.5	< 0.001	0.14	< 0.0001	0.003	0.126
	Mar-17	0.001	< 0.0001	< 0.001	< 0.001	30.5	< 0.001	0.13	< 0.0001	0.002	0.066
	May-17	0.001	< 0.0001	< 0.001	< 0.001	17.4	< 0.001	0.08	< 0.0001	0.002	0.022
SP_BH04	10/08/2016	0.004	< 0.0001	< 0.001	< 0.001	31.9	< 0.001	0.517	< 0.0001	< 0.001	< 0.005
	29/09/2016	0.002	< 0.0001	< 0.001	< 0.001	6.99	< 0.001	0.287	< 0.0001	< 0.001	0.016
	26/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	214	< 0.001	3.34	< 0.0001	0.002	< 0.005
	30/11/2016	0.002	< 0.0001	< 0.001	< 0.001	1.22	< 0.001	0.14	< 0.0001	0.001	< 0.005
	Dec-16	0.001	< 0.0001	< 0.001	< 0.001	0.06	< 0.001	0.13	< 0.0001	0.001	< 0.005
	Jan-17	0.001	< 0.0001	< 0.001	< 0.001	17.7	< 0.001	0.32	< 0.0001	< 0.001	< 0.005
	Feb-17	0.001	< 0.0001	< 0.001	< 0.001	3.06	< 0.001	0.14	< 0.0001	< 0.001	< 0.005
	Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	8.35	< 0.001	0.18	< 0.0001	0.001	< 0.005
	Apr-17	< 0.001	< 0.0001	< 0.001	< 0.001	4.87	< 0.001	0.15	< 0.0001	< 0.001	< 0.005
	May-17	< 0.001	< 0.0001	< 0.001	< 0.001	38.2	< 0.001	0.35	< 0.0001	0.002	< 0.005
SP_BH06	9/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	0.71	< 0.001	0.024	< 0.0001	< 0.001	< 0.005
	28/11/2016	0.001	< 0.0001	< 0.001	< 0.001	-	< 0.001	16.9	< 0.0001	0.004	< 0.005
	Dec-16	0.001	< 0.0001	< 0.001	< 0.001	448	< 0.001	16.9	< 0.0001	0.004	< 0.005
SP_BH09	8/06/2016	-	-	-	-	4900	-	238	-	-	-
	28/07/2016	0.005	< 0.0001	< 0.001	< 0.001	3.62	< 0.001	0.145	< 0.0001	0.006	< 0.005
TC_BH01D	27/07/2016	< 0.001	< 0.0001	< 0.001	0.018	232	< 0.001	5.62	< 0.0001	0.027	< 0.005
	8/07/2016	0.007	< 0.0001	0.010	0.010	5.73	0.006	0.270	< 0.0001	0.008	0.044
	30/08/2016	< 0.001	< 0.0001	0.001	0.008	22.9	< 0.001	0.447	< 0.0001	0.009	< 0.005
	26/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	1.86	< 0.001	0.033	< 0.0001	0.001	< 0.005
	29/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	1.01	< 0.001	0.02	< 0.0001	0.008	< 0.005
	13-Dec-16	< 0.001	< 0.0001	< 0.001	< 0.001	<0.05	< 0.001	0.01	< 0.0001	0.002	< 0.005
	16-Jan-17	< 0.001	< 0.0001	< 0.001	< 0.001	2.44	< 0.001	0.05	< 0.0001	0.001	< 0.005
	16-Feb-17	< 0.001	< 0.0001	< 0.001	< 0.001	0.97	< 0.001	0.02	< 0.0001	< 0.001	< 0.005
	14-Mar-17	< 0.001	< 0.0001	< 0.001	< 0.001	2.94	< 0.001	0.06	< 0.0001	< 0.001	< 0.005
	27-Apr-17	< 0.001	< 0.0001	< 0.001	< 0.001	1.34	< 0.001	0.03	< 0.0001	< 0.001	< 0.005
	15-May-17	0.004	< 0.0001	< 0.001	< 0.001	9.07	< 0.001	0.14	< 0.0001	0.002	< 0.005
TC_BH01S	27/07/2016	0.002	< 0.0001	< 0.001	0.005	131	< 0.001	0.518	< 0.0001	0.018	< 0.005
	8/07/2016	0.063	0.0002	0.154	0.173	67.6	0.416	0.283	0.0005	0.025	0.171
	30/08/2016	0.002	< 0.0001	< 0.001	0.019	15.2	< 0.001	0.236	< 0.0001	0.004	< 0.005
	28/09/2016	< 0.010	< 0.0010	< 0.010	< 0.010	-	< 0.010	-	< 0.0001	< 0.010	< 0.050
	26/10/2016	< 0.001	< 0.0001	< 0.001	0.001	28.3	< 0.001	0.183	< 0.0001	0.003	< 0.005
	29/11/2016	-	-	-	-	-	-	0.02	< 0.0001	0.013	< 0.005
	Dec-16	< 0.001	< 0.0001	< 0.001	< 0.001	<0.1	< 0.0001	0.12	< 0.0001	< 0.001	< 0.005
	Jan-17	0.001	< 0.0001	< 0.001	0.002	24	< 0.0001	0.14	< 0.0001	0.003	< 0.005
	Feb-17	< 0.001	< 0.0001	< 0.001	0.001	44.5	< 0.0001	0.22	< 0.0001	0.004	< 0.005
	Mar-17	< 0.001	< 0.0001	< 0.001	< 0.0001	90.1	< 0.0001	0.39	< 0.0001	0.005	< 0.005
	27/04/2017	0.002	< 0.0001	< 0.001	0.005	16	< 0.0001	0.17	< 0.0001	0.006	0.007
	May-17	0.003	< 0.0001	< 0.001	0.002	92.9	< 0.0001	0.22	< 0.0001	0.001	< 0.005

Summary Table B7
M4M5 Link WestConnex
Water Quality - Metals

		Metals Chemistry									
		Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
LOR		0.01	0.001	0.01	0.001	0.5	0.01	0	0.0001	0.01	0.05
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Monitoring Well	Date										
TC_BH06	27/07/2016	< 0.001	< 0.0001	< 0.001	< 0.001	40.5	< 0.001	0.382	< 0.0001	0.008	< 0.005
	8/07/2016	0.019	< 0.0001	0.043	0.015	45.8	0.035	0.369	< 0.0001	0.007	0.039
	30/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	69.4	< 0.001	0.410	< 0.0001	0.013	< 0.005
	28/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	-	< 0.001	-	< 0.0001	< 0.001	0.010
	26/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	43.3	< 0.001	0.351	< 0.0001	0.002	< 0.005
	29/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	34.2	< 0.001	0.42	< 0.0001	0.001	< 0.005
	Dec-16	< 0.0001	< 0.0001	< 0.0001	< 0.0001	15.3	< 0.0001	0.42	< 0.0001	0.002	< 0.005
	Jan-17	< 0.0001	< 0.0001	< 0.0001	< 0.0001	31.6	< 0.0001	0.43	< 0.0001	0.001	< 0.005
	Feb-17	< 0.0001	< 0.0001	< 0.0001	< 0.0001	51.7	< 0.0001	0.47	< 0.0001	0.001	< 0.005
	Mar-17	< 0.0001	< 0.0001	< 0.0001	< 0.0001	58.3	< 0.0001	0.46	< 0.0001	0.002	< 0.005
	27/04/2017	< 0.0001	< 0.0001	< 0.0001	< 0.0001	75.1	< 0.0001	0.5	< 0.0001	0.001	< 0.005
	May-17	< 0.0001	< 0.0001	< 0.0001	< 0.0001	131	< 0.0001	0.54	< 0.0001	< 0.001	< 0.005
TC_BH07D	27/07/2016	< 0.001	< 0.0001	< 0.001	< 0.001	98.5	< 0.001	2.30	< 0.0001	0.004	< 0.005
	8/07/2016	0.002	0.0001	0.007	0.013	0.99	0.008	0.014	< 0.0001	0.003	0.020
	31/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	83.8	< 0.001	1.56	< 0.0001	0.003	< 0.005
	26/10/2016	0.002	< 0.0001	< 0.001	< 0.001	34.0	< 0.001	0.833	< 0.0001	0.005	< 0.005
	16-Jan-17	< 0.0001	< 0.0001	< 0.0001	< 0.0001	10.2	< 0.0001	0.37	< 0.0001	0.003	< 0.005
	16-Feb-17	< 0.0001	< 0.0001	< 0.0001	< 0.0001	7.86	< 0.0001	0.38	< 0.0001	0.002	< 0.005
	14-Mar-17	< 0.0001	< 0.0001	< 0.0001	< 0.0001	9.48	< 0.0001	0.36	< 0.0001	0.002	< 0.005
	27-Apr-17	< 0.0001	< 0.0001	< 0.0001	< 0.0001	4.53	< 0.0001	0.18	< 0.0001	0.003	0.054
	15-May-17	< 0.0001	< 0.0001	< 0.0001	< 0.0001	30.4	< 0.0001	0.42	< 0.0001	0.002	0.011
TC_BH07S	27/07/2016	0.003	< 0.0001	< 0.001	0.003	76.3	< 0.001	0.190	< 0.0001	0.018	< 0.005
	8/07/2016	0.144	< 0.0010	0.223	0.066	117	0.128	0.324	0.0002	0.025	0.166
	30/08/2016	< 0.010	< 0.0010	< 0.010	< 0.010	168	< 0.010	0.264	< 0.0001	0.014	< 0.050
	28/09/2016	0.020	< 0.0001	< 0.001	< 0.001	-	< 0.001	-	< 0.0001	< 0.001	0.008
	26/10/2016	0.003	< 0.0001	< 0.001	< 0.001	74.9	< 0.001	0.174	< 0.0001	0.005	0.148
	29/11/2016	-	-	-	-	-	-	0.02	< 0.0001	< 0.01	< 0.005
	Dec-16	< 0.0001	< 0.0001	< 0.0001	< 0.0001	<0.1	< 0.001	0.07	< 0.0001	< 0.001	< 0.005
	Jan-17	0.002	< 0.0001	< 0.0001	0.002	8.11	< 0.001	0.09	< 0.0001	0.003	0.006
	Feb-17	0.002	< 0.0001	< 0.0001	< 0.001	67.5	< 0.001	0.15	< 0.0001	0.002	< 0.005
	Mar-17	< 0.0001	< 0.0001	< 0.0001	< 0.001	21.4	< 0.001	0.12	< 0.0001	0.004	< 0.005
	28/04/2017	0.004	< 0.0001	< 0.0001	< 0.001	92.7	< 0.001	0.2	< 0.0001	0.002	< 0.005
	May-17	0.001	< 0.0001	< 0.0001	0.011	36.3	< 0.001	0.13	< 0.0001	0.002	< 0.005
TC_BH08	27/07/2016	0.006	< 0.0001	0.001	0.001	2.40	< 0.001	0.014	< 0.0001	0.008	< 0.005
	30/08/2016	0.005	< 0.0001	< 0.001	0.001	89.7	< 0.001	0.664	< 0.0001	0.021	< 0.005
	28/09/2016	< 0.001	< 0.0001	< 0.001	< 0.001	-	< 0.001	-	< 0.0001	< 0.001	0.008
	26/10/2016	0.004	< 0.0001	< 0.001	0.003	130	< 0.001	1.30	< 0.0001	0.018	< 0.005
	30/11/2016	0.001	< 0.0001	< 0.001	0.047	2.59	< 0.001	0.14	< 0.0001	0.045	< 0.005
	Dec-16	0.001	< 0.0001	< 0.001	0.008	<0.05	< 0.001	0.12	< 0.0001	0.036	< 0.005
	Jan-17	0.003	< 0.0001	< 0.001	0.002	74.2	< 0.001	0.68	< 0.0001	0.012	< 0.005
	Feb-17	< 0.0001	< 0.0001	< 0.001	< 0.001	96.4	< 0.001	0.48	< 0.0001	0.006	< 0.005
	Mar-17	0.003	< 0.0001	< 0.001	0.001	297	< 0.001	2.02	< 0.0001	0.008	< 0.005
	27/04/2017	0.003	< 0.0001	< 0.001	0.006	61	< 0.001	0.41	< 0.0001	0.005	< 0.005
	May-17	0.001	< 0.0001	< 0.001	0.003	174	< 0.001	0.93	< 0.0001	0.004	< 0.005

Summary Table B7
M4M5 Link WestConnex
Water Quality - Metals

		Metals Chemistry									
		Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
LOR		0.01	0.001	0.01	0.001	0.5	0.01	0	0.0001	0.01	0.05
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Monitoring Well	Date										
TC_BH09D	27/07/2016	< 0.001	< 0.0001	< 0.001	< 0.001	42.5	< 0.001	0.830	< 0.0001	0.001	0.005
	30/08/2016	< 0.001	< 0.0001	< 0.001	< 0.001	29.0	< 0.001	0.525	< 0.0001	0.025	< 0.005
	26/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	81.2	< 0.001	1.35	< 0.0001	0.003	< 0.005
	29/11/2016	< 0.001	< 0.0001	< 0.001	0.002	1.88	< 0.001	0.17	< 0.0001	0.003	< 0.005
	Dec-16	< 0.0001	< 0.0001	< 0.001	< 0.001	3.96	< 0.001	0.3	< 0.0001	0.003	0.008
	Jan-17	< 0.0001	< 0.0001	< 0.001	< 0.001	16.8	< 0.001	0.43	< 0.0001	0.002	0.008
	Feb-17	< 0.0001	< 0.0001	< 0.001	< 0.001	58.6	< 0.001	0.89	< 0.0001	0.002	< 0.005
	Mar-17	< 0.0001	< 0.0001	< 0.001	< 0.001	17.1	< 0.001	0.44	< 0.0001	< 0.001	0.006
	Apr-17	< 0.0001	< 0.0001	< 0.001	< 0.001	13.2	< 0.001	0.35	< 0.0001	< 0.001	0.007
	May-17	< 0.0001	< 0.0001	< 0.001	< 0.001	37	< 0.001	0.43	< 0.0001	0.001	< 0.005
TC_BH09S	27/07/2016	< 0.001	< 0.0001	< 0.001	< 0.001	1130	< 0.001	2.19	< 0.0001	0.004	0.258
	30/08/2016	< 0.001	< 0.0001	< 0.001	0.002	128	< 0.001	0.211	< 0.0001	0.004	< 0.005
	26/10/2016	< 0.001	< 0.0001	< 0.001	< 0.001	154	< 0.001	0.608	< 0.0001	0.006	0.005
	29/11/2016	< 0.001	< 0.0001	< 0.001	< 0.001	723	< 0.001	1.14	< 0.0001	0.005	< 0.005
	Dec-16	< 0.0001	< 0.0001	< 0.001	< 0.001	5.54	< 0.001	0.41	< 0.0001	0.01	0.019
	Jan-17	< 0.0001	< 0.0001	< 0.001	< 0.001	42.6	< 0.001	0.44	< 0.0001	0.006	0.006
	Feb-17	< 0.0001	< 0.0001	< 0.001	< 0.001	57.9	< 0.001	0.43	< 0.0001	0.004	< 0.005
	28/04/2017	< 0.0001	< 0.0001	< 0.001	< 0.001	52.8	< 0.001	0.19	< 0.0001	0.003	< 0.005
	May-17	0.002	< 0.0001	< 0.001	< 0.001	219	< 0.001	0.67	< 0.0001	0.002	< 0.005

Notes:
mg/L: Milligrams per litre
- : Not analysed

Summary Table B8
M4M5 Link WestConnex
Water Quality - Hydrocarbons

		Hydrocarbons - Total Recoverable Petroleum Hydrocarbons, BTEXN and PAH																		
		C6 - C9 Fraction	C10 - C14 Fraction	C15 - C28 Fraction	C29 - C36 Fraction	C10 - C36 Fraction	C6 - C10 Fraction	C6 - C10 Fraction minus BTEX (F1)	C10 - C16 Fraction	C16 - C34 Fraction (F3)	C34 - C40 Fraction (F4)	C10 - C40 Fraction (sum)	C10 - C16 minus Napthalene (F2)	Toluene	Total Xylene	m & p-Xylene	Ethylbenzene	Benzene	Sum of BTEX	PAH
	LOR	10	50	100	50	50	20	20	100	100	100	100	100	2	2	2	2	1	1	1
Guidelines	Date	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
ANZECC (2000) Ecosystems Marine Water																		700		
ANZECC (2000) Ecosystems Marine Water Med-														180			5	500		
NEPM 2013 HSL D - Sand 2 to <4m																		5000		
NHMRC ADWG (amended 2015) Aesthetic														25	20		3			
NHMRC ADWG (amended 2015) Human Health														800	600		300	1		
US EPA RSL - May 2016 - Tapwater														1100	190		1.5	0.05		
Monitoring Well																				
BH57	29/09/2016	40	1490000	6400000	1580000	9470000	240	240	2350000	6270000	559000	9180000	2350000	< 2	< 2	< 2	< 2	< 1	< 1	nd
BH60	29/09/2016	< 20	80	< 100	< 50	80	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
HB_BH08D	28/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
HB_BH08S	28/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
HB_BH12	28/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	6	2	2	< 2	< 1	8	nd
HB_BH15	28/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
RZ_BH01D	25/10/2016	< 20	< 50	< 100	< 50	< 50	40	40	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
RZ_BH01S	28/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
RZ_BH15	25/10/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
RZ_BH16	29/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
RZ_BH19	29/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
RZ_BH26	29/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
RZ_BH28	25/10/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
RZ_BH38	27/10/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
RZ_BH44S	27/10/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
RZ_BH44S	29/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
RZ_BH47D	29/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	11	< 2	< 2	< 2	< 1	11	nd
RZ_BH47S	29/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
RZ_BH49	29/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
RZ_BH50	25/10/2016	< 20	< 50	520	< 50	520	< 20	< 20	< 100	490	< 100	490	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
RZ_BH51	28/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
RZ_BH52	25/10/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
SP_BH02	28/09/2016	520	140	540	440	1120	540	530	< 100	770	280	1050	< 100	< 2	< 2	< 2	10	2	12	nd
TC_BH01S	28/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
TC_BH06	28/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd
TC_BH07S	28/09/2016	40	< 50	< 100	< 50	< 50	70	50	< 100	< 100	< 100	< 100	< 100	< 2	18	12	< 2	< 1	18	nd
TC_BH08	28/09/2016	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100	< 2	< 2	< 2	< 2	< 1	< 1	nd

Notes:
LOR: Limit of reporting
mg/L: Milligrams per litre
- : Not analysed

Summary Table B9
M4M5 Link WestConnex
Water Quality - VOCs Summary

						MAH							Chlorinated Hydrocarbons						
			VOCs	Amino Aliphatics	Anilines	All other*	1,2,4-trimethylbenzene	1,3,5-trimethylbenzene	Isopropylbenzene	n-propylbenzene	sec-butylbenzene	Nitroaromatics	Solvents	All other*	1,1,2-trichloroethane	Chloroform	Explosives	Halogenated Benzenes	Halogenated Hydrocarbons	Halogenated Phenols
Guidelines																				
ANZECC (2000) Ecosystems Marine Water (95%)															1900					
ANZECC (2000) Ecosystems Marine Water Med-									30						1900	370				
NEPM 2013 HSL D - Sand 2 to <4m																				
NHMRC ADWG (amended 2015) Aesthetic																				
NHMRC ADWG (amended 2015) Human Health																				
US EPA RSL - May 2016 - Tapwater							15	120	450	660	2000				0.28	0.22				
Detected but below guidelines																				
Monitoring Well	Sample ID	Date/Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
BH57	BH57_2016929	29/09/2016	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
BH60	BH60_2016929	29/09/2016	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
HB_BH08D	HB_BH08D_2016927	27/09/2016	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
HB_BH08S	HB_BH08S_2016927	27/09/2016	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
HB_BH12	HB_BH12_2016928	28/09/2016	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
HB_BH15	HB_BH15_2016928	28/09/2016	nd	nd	nd		nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
RZ_BH01S	RZ_BH01S_2016927	27/09/2016	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
RZ_BH16	RZ_BH16_2016929	29/09/2016	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		<5	13	nd	nd	nd	nd
RZ_BH19	RZ_BH19_2016929	29/09/2016	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
RZ_BH26	RZ_BH26_2016929	29/09/2016	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
RZ_BH44S	RZ_BH44S_2016928	29/09/2016	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
RZ_BH47D	RZ_BH47D_2016929	29/09/2016	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
RZ_BH47S	RZ_BH47S_2016929	29/09/2016	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
RZ_BH49	RZ_BH49_2016929	29/09/2016	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
RZ_BH51	RZ_BH51_2016928	28/09/2016	nd	nd	nd		nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
SP_BH02	SP_BH02_2016927	27/09/2016	nd	nd	nd	nd	nd	nd	11	19	5	nd	nd	nd	5	<5	nd	nd	nd	nd
TC_BH01S	TC_BH01S_2016927	27/09/2016	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
TC_BH06	TC_BH06_2016927	27/09/2016	nd	nd	nd		nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
TC_BH07S	TC_BH07S_2016927	27/09/2016	nd	nd	nd	nd	11	6	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd
TC_BH08	TC_BH08_2016927	27/09/2016	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<5	<5	nd	nd	nd	nd

Notes: nd = below laboratory detection limits * all other = other compounds in the analytical suite

Summary Table B10
M4M5 Link WestConnex
Water Quality - SVOCs Summary

			Herbicides	Organochlorine Pesticides	Organophosphorous Pesticides	Pesticides	Phthalates	Bis(2-ethylhexyl) phthalate	PCBs
Guidelines									
ANZECC (2000) Ecosystems Marine Water (95%)									
ANZECC (2000) Ecosystems Marine Water Med-Low								1	
NEPM 2013 HSL D - Sand 2 to <4m									
NHMRC ADWG (amended 2015) Aesthetic									
NHMRC ADWG (amended 2015) Human Health								10	
US EPA RSL - May 2016 - Tapwater								5.6	
Detected but below guidelines									
Monitoring Wel	Sample ID	Date/Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
BH57	BH57_2016929	29/09/2016	nd	nd	nd	nd	nd	35,100	nd
BH60	BH60_2016929	29/09/2016	nd	nd	nd	nd	nd	nd	nd
HB_BH08D	HB_BH08D_2016927	27/09/2016	nd	nd	nd	nd	nd	nd	nd
HB_BH08S	HB_BH08S_2016927	27/09/2016	nd	nd	nd	nd	nd	nd	nd
HB_BH08S	QC100_2016927	27/09/2016	nd	nd	nd	nd	nd	nd	nd
HB_BH12	HB_BH12_2016928	28/09/2016	nd	nd	nd	nd	nd	nd	nd
HB_BH15	HB_BH15_2016928	28/09/2016	nd	nd	nd	nd	nd	nd	nd
HB_BH15	QC200_2016928	28/09/2016	nd	nd	nd	nd	nd	nd	nd
RZ_BH01S	RZ_BH01S_2016927	27/09/2016	nd	nd	nd	nd	nd	nd	nd
RZ_BH16	RZ_BH16_2016929	29/09/2016	nd	nd	nd	nd	nd	nd	nd
RZ_BH19	RZ_BH19_2016929	29/09/2016	nd	nd	nd	nd	nd	nd	nd
RZ_BH26	RZ_BH26_2016929	29/09/2016	nd	nd	nd	nd	nd	nd	nd
RZ_BH44S	RZ_BH44S_2016928	29/09/2016	nd	nd	nd	nd	nd	nd	nd
RZ_BH47D	RZ_BH47D_2016929	29/09/2016	nd	nd	nd	nd	nd	nd	nd
RZ_BH47S	RZ_BH47S_2016929	29/09/2016	nd	nd	nd	nd	nd	nd	nd
RZ_BH49	RZ_BH49_2016929	29/09/2016	nd	nd	nd	nd	nd	nd	nd
RZ_BH51	RZ_BH51_2016928	28/09/2016	nd	nd	nd	nd	nd	nd	nd
SP_BH02	SP_BH02_2016927	27/09/2016	nd	nd	nd	nd	nd	nd	nd
TC_BH01S	TC_BH01S_2016927	27/09/2016	nd	nd	nd	nd	nd	nd	nd
TC_BH06	TC_BH06_2016927	27/09/2016	nd	nd	nd	nd	nd	nd	nd
TC_BH07S	TC_BH07S_2016927	27/09/2016	nd	nd	nd	nd	nd	nd	nd
TC_BH08	TC_BH08_2016927	27/09/2016	nd	nd	nd	nd	nd	nd	nd

Notes: nd = below laboratory detection limits *all other = other compounds in the analytical suite

Summary Table B11
M4-M5 Link WestConnex
Laboratory Testing
Hydraulic Conductivity and Porosity data from Core

Monitoring Well	Sample Interval (m)	Lithology	Porosity (%)					Hydraulic conductivity	
			Sample 1	Sample 2	Sample 3	Sample 4	Averag	m/sec	m/day
EP_BH04	25.3 - 25.46	Hawkesbury Sandstone	14.8	12.8	12.4	14.3	13.6	3.20E-08	2.76E-03
HB_BH24	18.27 - 18.45	Hawkesbury Sandstone	13.2	14.6	14.6	13.9	14.1	5.30E-08	4.58E-03
MT_BH01	59.43 - 59.61	Hawkesbury Sandstone	13.4	10.8	14.3	13.8	13.1	6.40E-08	5.53E-03
MT_BH07	42.38 - 42.58	Hawkesbury Sandstone	11.6	11.5	10.7	11.3	11.3	4.80E-08	4.15E-03
MT_BH11	53.38 - 53.56	Hawkesbury Sandstone	13.5	16.1	14.7	10.0	13.6	4.40E-09	3.80E-04
MT_BH12	46.11 - 46.25	Hawkesbury Sandstone	19.2	19.1	18.4	18.1	18.7	4.10E-08	3.54E-03
MT_BH16	79.45 - 79.58	Hawkesbury Sandstone	14.5	15	14	14.9	14.6	1.50E-07	1.30E-02
RZ_BH60	49.15 - 49.30	Hawkesbury Sandstone	13.7	14.1	14.5	15.0	14.3	1.40E-09	1.21E-04
MT_BH20	42.70 - 42.85	Hawkesbury Sandstone						8.90E-10	7.69E-05
RZ_BH64	38.43 - 38.61	Hawkesbury Sandstone						2.10E-09	1.81E-04
RZ_BH67	42.00 - 42.20	Hawkesbury Sandstone						1.40E-09	1.21E-04
MT_BH16	39.25 - 39.43	Mudstone (Ashfield Shale)	5.3	5.8	5.6	5.8	5.6	2.30E-09	1.99E-04
MT_BH19	35.16 - 35.41	Mudstone (Ashfield Shale)						1.00E-10	8.64E-06
Statistics - Hawkesbury Sandstone									
Minimum							11.3		0.00008
Maximum							18.7		0.0130
Arithmetic Mean							14.2		0.0031
Geometric Mean									0.0010
Harmonic Mean									0.00028
Statistics - Ashfield Shale									
Minimum									0.00001
Maximum									0.0002
Arithmetic Mean									0.0001
Geometric Mean									0.0000
Harmonic Mean									1.7E-05

Summary Table B ST1
Monthly Statistical Summary - June 2016 to May 2017
Field Parameters - alluvium

Statistical parameter	Temperature	Dissolved Oxygen	Electrical Conductivity	pH	Redox Potential
Unit	(ºC)	ppm	(µS/cm)	(pH unit)	(mv)
Minimum	14.0	0.1	328.3	5.56	-260
Maximum	25.0	8.2	34922	8.63	181
sample set (n)	112	112	112	107	112
standard deviation	2.04	1.7	9052	0.57	77
average	20.7	2.5	7647	6.96	-59
student T (95%)	0.4	0.3	1695	0.11	14
95% confidence limit	0.4	0.3	1677	0.11	14
Student T (95%) LCL	20.3	2.2	5952	6.85	-73
Student T (95%) UCL	21.1	2.8	9342	7.07	-45

Summary Table B ST2
Monthly Statistical Summary - June 2016 to May 2017
Field Parameters - Ashfield Shale

Statistical parameter	Temperature	Dissolved Oxygen	Electrical Conductivity	pH	Redox Potential
Unit	(ºC)	ppm	(µS/cm)	(pH unit)	(mv)
Minimum	14.0	0	242	5.5	-288
Maximum	25.6	8.7	11986	9.0	42
sample set (n)	34	34	34	27	34
standard deviation	2.4	2.0	2363	1.0	92
average	21.2	2.0	3215	7.2	-117
student T (95%)	0.9	0.7	825	0.38	32
95% confidence limit	0.8	0.7	794	0.37	31
Student T (95%) LCL	20.4	1.3	2390	6.8	-149
Student T (95%) UCL	22.1	2.7	4039	7.6	-85

Summary Table B ST3
Monthly Statistical Summary - June 2016 to May 2017
Field Parameters - Hawkesbury Sandstone

Statistical parameter	Temperature	Dissolved Oxygen	Electrical Conductivity	pH	Redox Potential
Unit	(ºC)	ppm	(µS/cm)	(pH unit)	(mv)
Minimum	16.7	0	17	4.5	-316.8
Maximum	26.5	10	16300	9.0	194.9
sample set (n)	267	269	269	206	269
standard deviation	1.8	1.6	2620	0.80	109
average	21.0	2.2	1803	7.0	-68
student T (95%)	0.2	0.2	315	0.110	13
95% confidence limit	0.2	0.2	313	0.110	13
Student T (95%) LCL	20.8	2.0	1490	6.9	-81
Student T (95%) UCL	21.2	2.4	2116	7.1	-55

9.0 elevated pH above 9 removed

Summary Table B ST4
Statistical Summary
Inorganic chemistry and nutrients - alluvium
June 2016 - May 2017

	Inorganic Chemistry															
	Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen	Reactive Phosphorus as P	Total Phosphorus as P
LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	10	0.01	0.01
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Statistical Parameter																
Minimum	17.0	1.0	15.0	4.0	1.0	39.0	14.0	6.0	0.1	28.0	0.0	0.0	0.02	0.2	0.01	0.08
Maximum	553	817	7180	264	45	1030	11300	1650	3.0	2870	0.3	2.4	5.76	18.5	0.04	6.77
sample set (n)	106	106	106	106	106	106	106	106	45	106	106	106	41	45	105	19
standard deviation	135.3	240.7	2166.1	63.7	5.4	258.1	3687.4	462.8	0.6	662.5	0.0	0.4	1.52	3.33	0.00	1.61
average	133.4	175.8	1751.1	68.3	1.8	371.2	2885.7	404.7	0.7	509.0	0.0	0.2	1.43	2.97	0.01	0.95
student T (95%)	26.1	46.4	417.2	12.3	1.0	49.7	710.2	89.1	0.2	127.6	0.0	0.1	0.48	1.00	0.00	0.78
95% confidence limit	25.8	45.8	412.4	12.1	1.0	49.1	702.0	88.1	0.2	126.1	0.0	0.1	0.47	0.97	0.00	0.73
Student T (95%) LCL	107.3	129.4	1333.9	56.0	0.7	321.5	2175.6	315.6	0.5	381.4	0.0	0.1	0.95	1.97	0.01	0.17
Student T (95%) UCL	159.5	222.1	2168.2	80.6	2.8	420.9	3595.9	493.9	0.8	636.6	0.0	0.3	1.91	3.97	0.01	1.72

Summary Table B ST5
Statistical Summary
Inorganic chemistry and nutrients - Ashfield Shale
June 2016 - May 2017

	Inorganic Chemistry															
	Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen	Reactive Phosphorus as P	Total Phosphorus as P
LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	10	0.01	0.01
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Statistical Parameter																
Minimum	6.0	1.0	72.0	1.0	1.0	1.0	22.0	1.0	0.1	89.0	0.0	0.0	0.04	0.01	0.01	0.1
Maximum	908	81	997	120	105	895	1220	2200	1.0	1740	0.1	1.2	3.19	158	0.67	236
sample set (n)	34	34	34	34	35	35	35	35	15	35	35	35	14	17	35	9
standard deviation	208.9	25.5	291.0	26.4	29.7	196.5	423.2	437.6	0.2	436.1	0.0	0.2	0.84	37.76	0.11	77.80
average	134.8	30.7	463.0	20.1	15.7	257.0	515.7	329.2	0.5	533.0	0.0	0.1	0.76	12.32	0.04	29.08
student T (95%)	72.9	8.9	101.5	9.2	10.2	67.5	145.4	150.3	0.1	149.8	0.0	0.1	0.49	19.41	0.04	59.80
95% confidence limit	70.2	8.6	97.8	8.9	9.8	65.1	140.2	145.0	0.1	144.5	0.0	0.1	0.44	17.95	0.04	50.83
Student T (95%) LCL	61.9	21.8	361.4	10.9	5.5	189.5	370.3	178.8	0.4	383.2	0.0	0.0	0.27	0.00	0.00	0.00
Student T (95%) UCL	207.7	39.6	564.5	29.4	25.9	324.5	661.1	479.5	0.6	682.8	0.0	0.1	1.25	31.73	0.08	88.88

Summary Table B ST6
Statistical Summary
Inorganic chemistry and nutrients- Hawkesbury Sandstone
June 2016 - May 2017

	Inorganic Chemistry															
	Calcium	Magnesium	Sodium	Potassium	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO	Chloride	Sulphate as SO4 2-	Fluoride	Resistivity at 80°C	Nitrite as N	Nitrate as N	Ammonia as N	Total Kjeldahl Nitrogen	Reactive Phosphorus as P	Total Phosphorus as P
LOR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	0.01	10	0.01	0.01
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ohms/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Statistical Parameter																
Minimum	2.0	1.0	20.0	1.0	1.0	1.0	17.0	1.0	0.1	92.0	0.0	0.0	0.01	0.1	0.01	0.01
Maximum	796	112	952	124	85	499	1560	689	1.2	5750	1.2	1.4	3.41	13.4	0.16	2.72
sample set (n)	264	264	264	264	263	263	264	264	95	263	263	263	117	147	264	62
standard deviation	121.7	16.7	154.7	18.3	17.3	108.5	259.8	105.2	0.2	779.8	0.1	0.2	0.51	1.43	0.01	0.41
average	87.6	21.6	203.9	12.0	7.8	123.8	329.5	73.5	0.4	989.6	0.0	0.1	0.40	1.10	0.01	0.26
student T (95%)	14.7	2.0	18.7	2.2	2.1	13.2	31.5	12.7	0.0	94.7	0.0	0.0	0.09	0.23	0.00	0.10
95% confidence limit	14.7	2.0	18.7	2.2	2.1	13.1	31.3	12.7	0.0	94.2	0.0	0.0	0.09	0.23	0.00	0.10
Student T (95%) LCL	72.9	19.6	185.1	9.8	5.7	110.6	298.0	60.8	0.3	894.9	0.0	0.1	0.31	0.87	0.01	0.15
Student T (95%) UCL	102.4	23.7	222.6	14.3	9.9	137.0	361.0	86.3	0.4	1084.3	0.1	0.1	0.50	1.33	0.02	0.36

Summary Table B ST7
Statistical Summary
Metals - alluvium
June 2016 - May 2017

	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
LOR	0.01	0.001	0.01	0.001	0.5	0.01	0.001	0.0001	0.01	0.05
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Statistical Parameter										
Minimum	0.001	0.0001	0.001	0.001	0.05	0.001	0.014	0.0001	0.001	0.005
Maximum	0.144	0.0002	0.22	0.17	1130	0.13	2.19	0.0005	0.159	0.26
sample set (n)	108	108	108	107	100	108	102	110	109	110
standard deviation	0.02	0.00002	0.03	0.02	135.91	0.01	0.43	0.0000	0.02	0.04
average	0.004	0.0001	0.01	0.01	62.65	0.00	0.46	0.0001	0.01	0.02
student T (95%)	0.003	0.000003	0.00	0.00	26.97	0.00	0.09	0.0037	0.00	0.01
95% confidence limit	0.003	0.000003	0.00	0.00	26.64	0.00	0.08	0.0037	0.00	0.01
Student T (95%) LCL	0.001	0.0001	0.000	0.003	35.7	0.000	0.377	0.0000	0.007	0.009
Student T (95%) UCL	0.007	0.0001	0.010	0.011	89.6	0.005	0.547	0.0039	0.015	0.022
Guidelines:										
ANZECC (2000)^		0.0055	0.0044	0.0013		0.0044		0.0004	0.07	0.015
NHMRC ADWG ^^	0.01				0.3^^^		0.5^^^^			

^ANZECC (2000) Ecosystems Marine Water (95%) ^^^ aesthetic
^^NHMRC ADWG (amended 2015) Human Health ^^^^ health

Summary Table B ST8
Statistical Summary
Metals - Ashfield Shale
June 2016 - May 2017

	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
LOR	0.01	0.001	0.01	0.001	0.5	0.01	0.001	0.0001	0.01	0.05
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Statistical Parameter										
Minimum	0.001	0.0001	0.001	0.001	0.05	0.001	0.02	0.0001	0.001	0.005
Maximum	0.008	0.0001	0.157	0.004	448	0.001	16.9	0.0001	0.039	0.126
sample set (n)	33	33	33	33	32	33	33	33	33	33
standard deviation	0.0018	0.000	0.029	0.0006	87.71	0.000	4.03	5.51E-20	0.007	0.025
average	0.0020	0.0001	0.008	0.0012	48.11	0.001	1.54	0.0001	0.003	0.016
student T (95%)	0.0006	0.000	0.010	0.0002	31.62	0.000	1.43	1.95E-20	0.002	0.009
95% confidence limit	0.0006	0.000	0.010	0.0002	30.39	0.000	1.38	1.88E-20	0.002	0.009
Student T (95%) LCL	0.001	0.0001	0.000	0.001	16.49	0.001	0.110	0.0001	0.001	0.007
Student T (95%) UCL	0.003	0.0001	0.018	0.001	79.73	0.001	2.970	0.0001	0.006	0.025
Guidelines:										
ANZECC (2000)^		0.0055	0.0044	0.0013		0.0044		0.0004	0.07	0.015
NHMRC ADWG ^^	0.01				0.3^^^		0.5^^^^			

^ANZECC (2000) Ecosystems Marine Water (95%) ^^^ aesthetic
^^NHMRC ADWG (amended 2015) Human Health ^^^^ health

Summary Table B ST9 Statistical Summary
Metals - Hawkesbury Sandstone
June 2016 - May 2017

	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Zinc
LOR	0.01	0.001	0.01	0.001	0.5	0.01	0.001	0.0001	0.01	0.05
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Statistical Parameter										
Minimum	0.001	0.0001	0.001	0.001	0.05	0.001	0.007	0.0001	0.001	0.005
Maximum	0.016	0.0003	0.28	0.043	458	0.017	25.1	0.0001	0.15	6.98
sample set (n)	271	271	271	271	267	271	271	271	271	271
standard deviation	0.0013	0.0000	0.019	0.0060	50.77	0.0020	1.67	0.0000	0.0132	0.42
average	0.0013	0.0001	0.0039	0.0029	26.26	0.0014	0.74	0.0001	0.0078	0.04
student T (95%)	0.00015	0.0000	0.0023	0.0007	6.12	0.0002	0.20	0.0000	0.0016	0.05
95% confidence limit	0.00015	0.0000	0.0023	0.0007	6.09	0.0002	0.20	0.0000	0.0016	0.05
Student T (95%) LCL	0.001	0.0001	0.002	0.002	20.147	0.001	0.543	0.0001	0.006	0.000
Student T (95%) UCL	0.001	0.0001	0.006	0.004	32.381	0.002	0.942	0.0001	0.009	0.091
Guidelines:										
ANZECC (2000)^		0.0055	0.0044	0.0013		0.0044		0.0004	0.07	0.015
NHMRC ADWG ^^	0.01				0.3^^^		0.5^^^^			

^ANZECC (2000) Ecosystems Marine Water (95%) ^^^ aesthetic

^^NHMRC ADWG (amended 2015) Human Health ^^^^ health

Summary Table B ST10
Statistical Summary - aggressivity parameters
Monthly Statistical Summary - June 2016 to May 2017
Ashfield Shale
n=32

Analyte	units	average	minimum	maximum	standard deviation	Aggressivity^^	
						concrete	steel
pH	pH Units	7.2	5.5	9.0	0.97	non-aggressive	non-aggressive
Cl	mg/L	624	22	1220	463	non-aggressive	non-aggressive
SO4	mg/L	360	1	2200	445	non-aggressive	
EC	µS/cm	7647	328	34922	1695		
Resistivity	Ωcm	445	89	1740	399		moderately aggressive

elevated pHs removed
^^ based on average results

Summary Table B ST11
Statistical Summary - aggressivity parameters
Monthly Statistical Summary - June 2016 to May 2017
Hawkesbury Sandstone
n=259

Analyte	units	average	minimum	maximum	standard deviation	Aggressivity^^	
						concrete	steel
pH	pH Units	7.0	4.5	9.0	0.80	mild-aggressive	non-aggressive
Cl	mg/L	334	17	1560	261	mild-aggressive	non-aggressive
SO4	mg/L	74	1	689	105	mild-aggressive	
EC	µS/cm	1800	0	16300	2620		
Resistivity	Ωcm	983	92	5750	787		severely aggressive

elevated pHs removed
^^ based on average results
* based on AS2159-2009

Summary Table B ST12
Statistical Summary - aggressivity parameters
Monthly Statistical Summary - June 2016 to May 2017
Alluvium
n = 112

Analyte	units	average	minimum	maximum	standard deviation	Aggressivity^^	
						concrete	steel
pH	pH Units	7.0	5.6	8.7	0.58	mild-aggressive	non-aggressive
Cl	mg/L	2890	14	11300	3690	moderately aggressive	mild-aggressive
SO4	mg/L	405	6	1650	463	mild-aggressive	
EC	µS/cm	112	328	34900	9053		
Resistivity	Ωcm	509	28	2870	3690		severely aggressive

elevated pHs removed
^^ based on average results
* based on AS2159-2009

Summary Table B ST13
Groundwater aggressivity per monitoring well
Ashfield Shale

						Exposure condition *					
Well	Date	pH	resistivity	chloride	sulphate	concrete			steel		
unit			Ωcm	mg/L	mg/L	pH	Cl	SO4	pH	Cl	resistivity
CM_BH04	31/08/2016	8.7	301	836	294	non agg	non agg	non agg	non agg	non agg	moderate agg
CM_BH06	27/07/2016	9.37	352	328	216	non agg	non agg	non agg	non agg	non agg	moderate agg
CM_BH06	31/08/2016	9	356	568	193	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH01	26/10/2016	7.23	431	460	119	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH01	30/11/2016	9.79	752	215	108	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH01	13/12/2016	7.18	190	1220	256	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH01	17/01/2017	7.19	265	938	178	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH01	15/02/2017	6.86	236	1000	198	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH01	15/03/2017	7.36	200	1220	282	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH01	26/05/2017	8.98	543	357	112	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH02	27/07/2016	5.95	265	136	2200	non agg	non agg	mildly agg	non agg	non agg	moderate agg
SP_BH02	31/08/2016	5.85	262	196	1750	non agg	non agg	mildly agg	non agg	non agg	moderate agg
SP_BH02	27/09/2016	5.85		46	596	non agg	non agg	non agg	non agg	non agg	
SP_BH02	26/10/2016	6.2	980	35	307	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH02	30/11/2016	10.88	641	70	570	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH02	15/02/2017	5.51	1380	24	238	non agg	non agg	non agg	non agg	non agg	mildly agg
SP_BH02	15/03/2017	6.16	1200	28	296	non agg	non agg	non agg	non agg	non agg	mildly agg
SP_BH02	26/05/2017	6.43	1740	22	188	non agg	non agg	non agg	non agg	non agg	mildly agg
SP_BH04	10/08/2016	6.99	231	994	158	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH04	29/09/2016	7.11	234	1040	235	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH04	26/10/2016	7.46	216	1050	184	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH04	30/11/2016	8.27	228	1030	205	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH04	13/12/2016	7.11	190	1220	256	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH04	17/01/2017	7.14	265	938	178	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH04	15/02/2017	6.68	236	1000	198	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH04	15/03/2017	7.05	200	1220	282	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH04	26/04/2017	8.34	219	946	447	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH04	27/05/2017	8.13	194	1170	391	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH06	8/06/2016	12.13	94	262	304	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH06	30/11/2016	12.03	89	1100	1	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH09	8/06/2016	8.19	840	81	215	non agg	non agg	non agg	non agg	non agg	moderate agg
SP_BH09	27/07/2016	7.69	478	226	350	non agg	non agg	non agg	non agg	non agg	moderate agg

* based on AS2159-2009

Summary Table B ST14
Groundwater aggressivity per monitoring well
Hawkesbury Sandstone

						Exposure condition *					
Well	Date	pH^	resistivity	chloride	sulphate	concrete			steel		
unit			Ωcm	mg/L	mg/L	pH	Cl	SO4	pH	Cl	resistivity
EP_BH06	27/10/2016	7.59	1970	33	109	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
EP_BH06	30/11/2016	8.1	943	77	394	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
EP_BH06	13/12/2016	5.53	1150	68	272	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
EP_BH06	12/01/2017	5.63	1580	74	136	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
EP_BH06	16/02/2017	5.91	1830	71	96	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
EP_BH06	14/03/2017	5.7	1970	96	90	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
EP_BH06	27/04/2017	6.99	2040	71	77	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
EP_BH06	26/05/2017	7.21	2090	72	71	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
EP_BH07	27/10/2016	7.97	2410	53	27	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
EP_BH07	30/11/2016	7.28	2720	47	72	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
EP_BH07	13/12/2016	5.25	2840	42	76	moderate agg	mild agg	mild agg	non agg	non agg	mildly agg
EP_BH07	12/01/2017	5.89	2920	43	61	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
EP_BH07	16/02/2017	6.54	3050	41	60	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
EP_BH07	14/03/2017	4.48	2810	48	62	moderate agg	mild agg	mild agg	non agg	non agg	mildly agg
EP_BH07	27/04/2017	7.64	2760	40	70	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
EP_BH07	26/05/2017	8.68	2910	41	64	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
HB_BH02	8/06/2016	6.34	167	1560	200	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
HB_BH02	30/08/2016	7.3	442	534	134	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH03	10/08/2016	5.94	787	345	35	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH03	29/09/2016	6.53	2020	53	80	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
HB_BH03	26/10/2016	6.7	1220	130	70	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
HB_BH03	30/11/2016	7.21	1340	122	86	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
HB_BH03	15/03/2017	7.05	1280	192	11	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
HB_BH03	25/05/2017	6.56	943	282	8	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH08D	8/06/2016	8.75	337	700	160	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH08D	30/08/2016	7.28	308	776	8	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH08D	27/09/2016	6.47	317	665	1	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH08D	26/10/2016	6.53	307	771	2	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH08D	30/11/2016	7.28	317	775	2	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH08D	14/12/2016	7.18	316	824	2	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH08D	17/01/2017	7.07	316	793	3	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH08D	15/02/2017	5.91	320	764	1	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH08D	15/03/2017	7.93	310	803	1	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH08D	24/04/2017	7.57	310	772	1	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH08D	25/05/2017	6.81	322	757	1	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH12	14/07/2016	11.19	769	306	92	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH12	30/08/2016	12.25	100	780	14	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH12	28/09/2016	12.33	93	883	3	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH12	26/10/2016	11.68	154	943	106	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH12	14/12/2016	12.03	140	926	110	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH12	15/02/2017	10.7	222	916	146	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH12	15/03/2017	12.52	167	1080	110	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
HB_BH12	28/04/2017	11.83	136	1000	41	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
HB_BH12	25/05/2017	12.24	132	1020	36	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
HB_BH14	14/07/2016	6.91	408	538	44	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH14	27/07/2016	8.82	467	442	79	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH14	30/08/2016	7.26	442	506	83	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH14	14/12/2016	8.72	422	591	70	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH14	15/02/2017	7.39	446	511	42	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH14	15/03/2017	8.39	521	464	69	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH14	26/05/2017	8.26	1220	134	100	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
HB_BH15	8/06/2016	8.25	1350	54	148	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
HB_BH15	27/07/2016	6.79	820	271	79	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH15	30/08/2016	6.29	781	310	90	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH15	28/09/2016	7.02	671	357	62	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH15	26/10/2016	5.77	725	347	65	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH15	30/11/2016	7.21	990	159	136	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH15	14/12/2016	7.45	980	179	155	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH15	17/01/2017	6.31	787	314	87	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH15	15/02/2017	7.08	735	357	66	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH15	15/03/2017	6.79	847	240	107	mild agg	mild agg	mild agg	non agg	non agg	Severely agg

Summary Table C ST14
Groundwater aggressivity per monitoring well
Hawkesbury Sandstone

						Exposure condition *					
Well	Date	pH^	resistivity	chloride	sulphate	concrete			steel		
unit			Ωcm	mg/L	mg/L	pH	Cl	SO4	pH	Cl	resistivity
HB_BH15	28/04/2017	11.01	719	339	76	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH15	25/05/2017	8.64	730	360	63	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
IC_BH01	27/10/2016	11.65	405	67	660	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
IC_BH01	30/11/2016	8.65	746	78	506	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
IC_BH01	13/12/2016	6.54	758	100	506	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
IC_BH01	17/01/2017	6.02	909	178	172	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
IC_BH01	14/03/2017	6.11	1060	196	50	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
IC_BH02	14/03/2017	5.31	5400	21	31	moderate agg	mild agg	mild agg	non agg	non agg	non agg
IC_BH02	28/04/2017	9.26	5750	17	34	mild agg	mild agg	mild agg	non agg	non agg	non agg
IC_BH02	26/05/2017	7.44	4400	21	31	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
MT_BH02	15/03/2017	12.69	96	640	33	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
MT_BH02	28/04/2017	11.33	92	898	32	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
MT_BH02	26/05/2017	12.33	96	929	18	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
MT_BH07	17/02/2017	10.8	325	177	125	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
MT_BH07	14/03/2017	12.13	382	208	135	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
MT_BH07	27/04/2017	11.73	446	170	343	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
MT_BH07	26/05/2017	11.22	465	103	588	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
MT_BH14	17/01/2017	8.18	309	562	689	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
MT_BH14	17/02/2017	7.66	347	429	645	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
MT_BH14	15/03/2017	8.05	413	333	501	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
MT_BH14	28/04/2017	8.24	446	296	462	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
MT_BH18	16/01/2017	12.2	167	526	69	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
MT_BH18	17/02/2017	11.85	172	378	62	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
MT_BH18	26/05/2017	12.04	267	382	111	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
MT_BH21	17/02/2017	11.18	239	563	153	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
MT_BH21	14/03/2017	8.22	382	532	204	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH01D	27/07/2016	7.04	662	314	75	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH01D	30/08/2016	6.63	571	394	79	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH01D	29/09/2016	9.88	420	636	68	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH01D	24/10/2016	6.01	420	636	68	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH01D	28/11/2016	6.78	493	536	95	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH01D	12/12/2016	6.65	463	546	87	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH01D	12/01/2017	6.74	518	500	61	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH01D	14/02/2017	6.43	535	460	49	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH01D	13/03/2017	6.92	855	345	54	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH01D	26/04/2017	6.79	613	371	60	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH01D	24/05/2017	6.37	926	268	42	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH15	27/07/2016	9.35	952	207	72	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH15	30/08/2016	7.7	1180	163	42	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH15	29/09/2016	7.14	1900	66	30	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH15	25/10/2016	6.55	806	300	25	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH15	28/11/2016	7.48	1780	93	28	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH15	12/12/2016	6.65	1770	73	35	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH15	12/01/2017	6.86	1080	204	31	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH15	14/02/2017	6.65	1220	166	44	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH15	13/03/2017	6.99	1210	177	35	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH15	26/04/2017	7.04	980	226	36	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH15	24/05/2017	6.2	1230	173	30	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH16	14/07/2016	7.24	885	230	75	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH16	27/07/2016	10.3	1300	138	106	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH16	30/08/2016	10.02	1240	158	119	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH16	29/09/2016	8.93	1270	139	115	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH16	24/10/2016	6.09	1280	110	88	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH16	28/11/2016	7.51	1100	207	93	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH16	12/12/2016	8.96	1120	183	117	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH16	12/01/2017	8.38	1060	199	92	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH16	14/02/2017	7.35	1050	217	65	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH16	13/03/2017	7.51	1010	232	78	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH16	26/04/2017	7.11	971	230	70	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH16	24/05/2017	9.22	1000	245	64	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH19	10/08/2016	7.34	813	254	40	mild agg	mild agg	mild agg	non agg	non agg	Severely agg

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						Exposure condition *					
Well	Date	pH^	resistivity	chloride	sulphate	concrete			steel		
unit			Ωcm	mg/L	mg/L	pH	Cl	SO4	pH	Cl	resistivity
RZ_BH19	29/09/2016	8.11	870	238	20	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH19	24/10/2016	6.07	-	316	33	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH19	28/11/2016	8.34	833	290	27	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH19	12/12/2016	9.82	806	306	33	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH19	13/01/2017	6.7	806	301	23	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH19	14/02/2017	8.5	826	289	18	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH19	13/03/2017	6.69	826	298	18	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH19	26/04/2017	7.68	855	273	16	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH19	24/05/2017	7.83	826	289	5	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH26	14/07/2016	6.65	2190	72	20	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
RZ_BH26	27/07/2016	10.29	2430	61	33	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
RZ_BH26	30/08/2016	9.16	2070	67	40	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
RZ_BH26	29/09/2016	7.35	1540	103	12	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH26	24/10/2016	5.73	1970	74	28	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH26	28/11/2016	7.02	1850	92	20	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH26	12/12/2016	6.97	1720	105	13	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH26	13/01/2017	6.83	1630	102	8	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH26	14/02/2017	6.79	1730	102	7	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH26	13/03/2017	6.4	1640	108	9	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH26	26/04/2017	7.09	1800	79	7	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH26	24/05/2017	6.68	1740	113	5	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH28	10/08/2016	6.09	1050	222	20	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH28	29/09/2016	6.79	971	213	21	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH28	25/10/2016	5.96	1070	251	16	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH28	28/11/2016	6.64	1100	219	65	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH28	12/12/2016	6.8	1120	228	24	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH28	13/01/2017	6.42	1100	218	20	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH28	14/02/2017	6.4	1180	206	17	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH28	13/03/2017	6.19	1140	218	18	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH28	26/04/2017	6.89	1140	212	21	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH28	24/05/2017	6.34	1150	211	18	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH30	27/07/2016	6.75	617	354	39	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH30	31/08/2016	6.7	625	368	40	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH30	28/09/2016	6.84	752	302	38	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH30	16/01/2017	6.13	781	300	36	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH30	26/04/2017	6.75	1450	128	31	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH30	24/05/2017	6.74	971	226	24	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH38	10/08/2016	9.72	826	278	65	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH38	29/09/2016	8.57	658	352	43	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH38	26/10/2016	7.86	513	422	33	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH38	28/11/2016	8.24	538	432	34	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH38	12/12/2016	7.99	505	449	40	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH38	12/01/2017	8	518	441	35	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH38	14/02/2017	7.3	518	428	33	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH38	13/03/2017	7.51	524	434	34	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH38	26/04/2017	7.35	532	403	35	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH38	24/05/2017	7.43	559	393	33	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH44D	10/08/2016	6.95	1570	127	20	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH44D	29/09/2016	7.04	833	255	32	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH44D	27/10/2016	7.04	690	323	28	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH44D	28/11/2016	7.89	820	284	24	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH44D	12/12/2016	6.77	704	338	30	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH44D	13/01/2017	7.42	685	350	24	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH44D	14/02/2017	7.01	730	309	20	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH44D	13/03/2017	6.89	735	309	24	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH44D	26/04/2017	7.62	1850	49	82	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH44D	24/05/2017	7.02	1200	147	53	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH47D	31/08/2016	6.51	1010	228	23	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH47D	29/09/2016	6.34	1010	217	17	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH47D	25/10/2016	8.72	2910	43	10	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
RZ_BH47D	28/11/2016	6.7	1110	206	18	mild agg	mild agg	mild agg	non agg	non agg	moderate agg

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						Exposure condition *					
Well	Date	pH^	resistivity	chloride	sulphate	concrete			steel		
unit			Ωcm	mg/L	mg/L	pH	Cl	SO4	pH	Cl	resistivity
RZ_BH47D	12/12/2016	6.58	1100	212	20	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH47D	13/01/2017	6.49	1060	213	17	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH47D	14/02/2017	6.58	1070	214	17	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH47D	13/03/2017	6.65	1080	208	14	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH47D	26/04/2017	6.98	1050	212	17	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH47D	24/05/2017	6.4	1050	222	18	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH50	31/08/2016	7.47	2510	48	25	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
RZ_BH50	28/09/2016	6.05	1590	405	35	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH50	25/10/2016	5.76	1620	130	11	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH50	28/11/2016	6.79	1680	155	20	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH50	12/12/2016	6.2	1650	151	17	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH50	16/01/2017	6.5	1680	141	13	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH50	14/02/2017	6.74	1880	136	10	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH50	15/03/2017	6.56	1590	146	11	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH50	24/05/2017	6.22	1780	136	13	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH51	10/08/2016	11.92	299	383	20	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH51	28/09/2016	6.62	592	130	12	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH51	25/10/2016	6.37	565	412	29	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH51	28/11/2016	7.16	581	420	38	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH51	12/12/2016	6.71	565	425	40	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH51	16/01/2017	6.57	613	394	36	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH51	14/02/2017	6.74	621	368	33	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH51	26/04/2017	6.88	699	318	39	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH51	24/05/2017	6.48	654	354	33	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH52	10/08/2016	10.15	1690	116	24	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH52	28/09/2016	6.59	840	263	33	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH52	25/10/2016	5.6	917	272	19	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH52	28/11/2016	7.44	1010	260	25	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH52	12/12/2016	6.44	952	268	29	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH52	14/02/2017	6.66	1040	239	20	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH52	15/03/2017	6.68	1050	225	22	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH52	26/04/2017	7.05	1050	220	23	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH52	24/05/2017	6.45	1260	178	29	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH60	16/01/2017	11.76	254	43	287	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH60	17/02/2017	11.43	222	42	260	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH60	15/03/2017	12.37	241	38	173	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH60	27/04/2017	11.86	258	41	191	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH60	26/05/2017	12.19	277	36	141	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH64	26/05/2017	9.16	1420	109	18	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH67	17/02/2017	8.96	1470	142	21	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH67	15/03/2017	7.06	1550	143	18	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH67	27/04/2017	6.73	1610	134	23	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH67	26/05/2017	6.42	1670	136	21	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH69	16/02/2017	5.79	2330	60	35	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
RZ_BH69	15/03/2017	12.28	2330	60	45	mild agg	mild agg	mild agg	non agg	non agg	mildly agg
TC_BH01D	8/07/2016	8.66	397	598	116	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH01D	27/07/2016	12.06	252	391	77	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH01D	30/08/2016	11.86	289	605	98	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH01D	27/09/2016	11.53	347	721	127	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH01D	26/10/2016	10.3	294	973	82	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH01D	29/11/2016	7.61	333	880	120	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH01D	13/12/2016	11.59	313	915	79	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH01D	16/01/2017	10.88	307	982	70	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH01D	16/02/2017	10.52	299	995	51	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH01D	14/03/2017	9.42	280	1060	48	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH01D	27/04/2017	9.26	1000	169	74	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
TC_BH01D	25/05/2017	7.35	294	1000	41	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH07D	8/07/2016	11.84	111	199	1	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH07D	27/07/2016	7.63	469	513	82	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH07D	31/08/2016	8.55	454	573	98	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH07D	26/10/2016	6.84	392	611	64	mild agg	mild agg	mild agg	non agg	non agg	Severely agg

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						Exposure condition *					
Well	Date	pH^	resistivity	chloride	sulphate	concrete			steel		
unit			Ωcm	mg/L	mg/L	pH	Cl	SO4	pH	Cl	resistivity
TC_BH07D	16/01/2017	7.4	422	604	72	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH07D	16/02/2017	6.49	433	601	64	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH07D	14/03/2017	7.18	433	588	65	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH07D	27/04/2017	9.01	714	333	40	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH07D	25/05/2017	7.53	562	434	43	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH09D	27/07/2016	6.25	546	466	65	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH09D	30/08/2016	6.62	500	468	76	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH09D	28/09/2016	6.5	495	426	55	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH09D	26/10/2016	6.95	463	500	56	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH09D	29/11/2016	8.13	518	509	85	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH09D	13/12/2016	7.96	500	516	65	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH09D	16/01/2017	7.92	500	521	82	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH09D	16/02/2017	7.51	465	528	61	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH09D	14/03/2017	7.46	485	536	56	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH09D	27/04/2017	9.59	481	517	62	mild agg	mild agg	mild agg	non agg	non agg	Severely agg

* based on AS2159-2009

^ elevated pH above 9.0 removed

Summary Table B ST15
Groundwater aggressivity per monitoring well
Alluvium

						Exposure condition *					
Well	Date	pH	resistivity	chloride	sulphate	concrete			steel		
unit			Ωcm	mg/L	mg/L	pH	Cl	SO4	pH	Cl	resistivity
HB_BH08S	8/06/2016	6.76	99	3380	28	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
HB_BH08S	27/07/2016	8.06	368	672	48	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH08S	30/08/2016	7.12	136	1980	32	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
HB_BH08S	26/10/2016	6.21	153	1830	25	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
HB_BH08S	30/11/2016	7.57	258	1050	51	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
HB_BH08S	14/12/2016	7.31	196	1410	41	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
HB_BH08S	17/01/2017	7.02	330	847	47	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH08S	15/02/2017	5.96	177	1550	26	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
HB_BH08S	15/03/2017	7.37	181	1580	46	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
HB_BH08S	28/04/2017	7.51	315	788	73	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH08S	25/05/2017	6.94	463	538	51	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
HB_BH08S	28/06/2016	6.76	2430	22	14	mild agg	mild agg	mild agg	non agg	non agg	mild agg
RZ_BH01S	27/07/2016	6.96	2130	16	15	mild agg	mild agg	mild agg	non agg	non agg	mild agg
RZ_BH01S	30/08/2016	6.95	2080	16	19	mild agg	mild agg	mild agg	non agg	non agg	mild agg
RZ_BH01S	25/10/2016	6.69	1820	23	8	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH01S	28/11/2016	7.29	2190	17	10	mild agg	mild agg	mild agg	non agg	non agg	mild agg
RZ_BH01S	12/12/2016	7.12	2160	17	11	mild agg	mild agg	mild agg	non agg	non agg	mild agg
RZ_BH01S	12/01/2017	7.07	1940	16	17	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH01S	14/02/2017	6.66	1980	16	6	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH01S	13/03/2017	6.77	2050	23	19	mild agg	mild agg	mild agg	non agg	non agg	mild agg
RZ_BH01S	26/04/2017	6.85	2170	14	19	mild agg	mild agg	mild agg	non agg	non agg	mild agg
RZ_BH01S	24/05/2017	6.75	1980	20	15	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH44S	10/08/2016	6.49	134	2180	197	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
RZ_BH44S	29/09/2016	5.79	263	1060	58	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
RZ_BH44S	27/10/2016	6.28	312	877	54	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH44S	28/11/2016	6.67	338	875	49	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH44S	12/12/2016	5.84	326	866	47	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH44S	13/01/2017	6.78	350	879	42	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH44S	14/02/2017	6.17	356	818	37	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH44S	13/03/2017	6.7	345	873	48	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH44S	26/04/2017	7.2	348	809	46	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH44S	24/05/2017	6.3	374	766	40	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH47S	31/08/2016	6.27	725	380	45	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH47S	29/09/2016	5.56	741	367	41	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH47S	25/10/2016	9.64	2870	52	17	mild agg	mild agg	mild agg	non agg	non agg	mild agg
RZ_BH47S	28/11/2016	6.65	1410	183	29	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH47S	12/12/2016	6.39	826	350	45	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH47S	13/01/2017	6.41	1180	203	30	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH47S	14/02/2017	6.25	862	322	34	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH47S	13/03/2017	6.14	862	332	38	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH47S	26/04/2017	7.26	806	330	41	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH47S	24/05/2017	6.06	877	313	35	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
RZ_BH49	14/07/2016	7.57	89	3220	326	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
RZ_BH49	27/07/2016	9.95	153	1380	252	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
RZ_BH49	30/08/2016	6.69	120	1950	343	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
RZ_BH49	29/09/2016	6.49	91	2980	376	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
RZ_BH49	26/10/2016	7.56	135	1670	239	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
RZ_BH49	28/11/2016	8.46	125	1970	292	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
RZ_BH49	12/12/2016	7.82	108	1990	361	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
RZ_BH49	12/01/2017	7.35	156	1530	265	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
RZ_BH49	14/02/2017	6.45	137	1650	251	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
RZ_BH49	13/03/2017	6.82	121	2180	279	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
RZ_BH49	26/04/2017	7	1420	121	22	mild agg	mild agg	mild agg	non agg	non agg	moderate agg
RZ_BH49	24/05/2017	7.31	284	809	113	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH01S	8/07/2016	6.97	40	7520	903	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH01S	21/07/2016	6.87	47	6480	829	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH01S	30/08/2016	7.05	39	7990	1380	mild agg	moderate agg	moderate agg	non agg	mild agg	Severely agg
TC_BH01S	26/10/2016	6.68	30	10200	1320	mild agg	moderate agg	moderate agg	non agg	moderate agg	Severely agg
TC_BH01S	29/11/2016	7.03	42	7860	1230	mild agg	moderate agg	moderate agg	non agg	mild agg	Severely agg
TC_BH01S	13/12/2016	7.37	32	9940	1420	mild agg	moderate agg	moderate agg	non agg	mild agg	Severely agg

Summary Table C ST15
Groundwater aggressivity per monitoring well
Alluvium

						Exposure condition *					
Well	Date	pH	resistivity	chloride	sulphate	concrete			steel		
unit			Ωcm	mg/L	mg/L	pH	Cl	SO4	pH	Cl	resistivity
TC_BH01S	16/01/2017	8.25	36	9400	1400	mild agg	moderate agg	moderate agg	non agg	mild agg	Severely agg
TC_BH01S	16/02/2017	6.82	31	9170	1390	mild agg	moderate agg	moderate agg	non agg	mild agg	Severely agg
TC_BH01S	14/03/2017	7.03	31	10100	1330	mild agg	moderate agg	moderate agg	non agg	moderate agg	Severely agg
TC_BH01S	27/04/2017	8.3	30	9840	1650	mild agg	moderate agg	moderate agg	non agg	mild agg	Severely agg
TC_BH01S	25/05/2017	6.87	35	9140	1380	mild agg	moderate agg	moderate agg	non agg	non agg	Severely agg
TC_BH06	8/07/2016	6.54	502	125	378	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH06	27/07/2016	7.14	444	118	456	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH06	30/08/2016	6.84	515	131	400	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH06	26/10/2016	7.5	606	123	293	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH06	29/11/2016	7.88	610	159	353	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH06	13/12/2016	6.84	602	178	359	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH06	16/01/2017	7.76	625	145	338	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH06	17/02/2017	7.31	588	150	324	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH06	14/03/2017	7.1	625	135	318	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH06	27/04/2017	10.45	641	122	345	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH06	25/05/2017	6.57	592	164	307	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH07S	8/07/2016	7.78	30	10200	1110	mild agg	moderate agg	moderate agg	non agg	moderate agg	Severely agg
TC_BH07S	27/07/2016	6.98	28	11300	1480	mild agg	moderate agg	moderate agg	non agg	moderate agg	Severely agg
TC_BH07S	30/08/2016	6.81	30	10300	1360	mild agg	moderate agg	moderate agg	non agg	moderate agg	Severely agg
TC_BH07S	26/10/2016	6.71	28	10800	993	mild agg	moderate agg	mild agg	non agg	moderate agg	Severely agg
TC_BH07S	29/11/2016	6.81	29	11100	1370	mild agg	moderate agg	moderate agg	non agg	moderate agg	Severely agg
TC_BH07S	13/12/2016	6.93	28	11000	1190	mild agg	moderate agg	moderate agg	non agg	moderate agg	Severely agg
TC_BH07S	16/01/2017	6.9	34	9960	1040	mild agg	moderate agg	moderate agg	non agg	mild agg	Severely agg
TC_BH07S	16/02/2017	6.2	33	8910	895	mild agg	moderate agg	mild agg	non agg	mild agg	Severely agg
TC_BH07S	14/03/2017	6.89	32	9960	912	mild agg	moderate agg	mild agg	non agg	mild agg	Severely agg
TC_BH07S	28/04/2017	6.91	29	10200	1030	mild agg	moderate agg	moderate agg	non agg	moderate agg	Severely agg
TC_BH07S	25/05/2017	6.72	30	11200	1070	mild agg	moderate agg	moderate agg	non agg	moderate agg	Severely agg
TC_BH08	27/07/2016	9.71	109	2980	671	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH08	30/08/2016	8.1	96	3340	740	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH08	26/10/2016	6.97	85	3470	575	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH08	29/11/2016	7.25	85	3760	673	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH08	13/12/2016	7.08	81	3770	602	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH08	16/01/2017	7.23	73	4440	688	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH08	16/02/2017	7.19	57	4970	660	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH08	14/03/2017	7.21	79	4020	535	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH08	27/04/2017	8.46	719	273	46	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH08	25/05/2017	6.95	134	2140	283	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH09S	27/07/2016	6.73	309	500	466	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH09S	30/08/2016	6.59	575	155	230	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH09S	26/10/2016	6.48	200	1210	209	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH09S	29/11/2016	7.54	210	1240	272	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH09S	13/12/2016	7.16	206	1210	236	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH09S	17/01/2017	6.25	204	1310	234	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH09S	17/02/2017	6.93	203	1290	218	mild agg	mild agg	mild agg	non agg	mild agg	Severely agg
TC_BH09S	28/04/2017	8.63	334	666	144	mild agg	mild agg	mild agg	non agg	non agg	Severely agg
TC_BH09S	26/05/2017	7.1	272	911	153	mild agg	mild agg	mild agg	non agg	non agg	Severely agg

* based on AS2159-2009
^ elevated pH above 9.0 removed

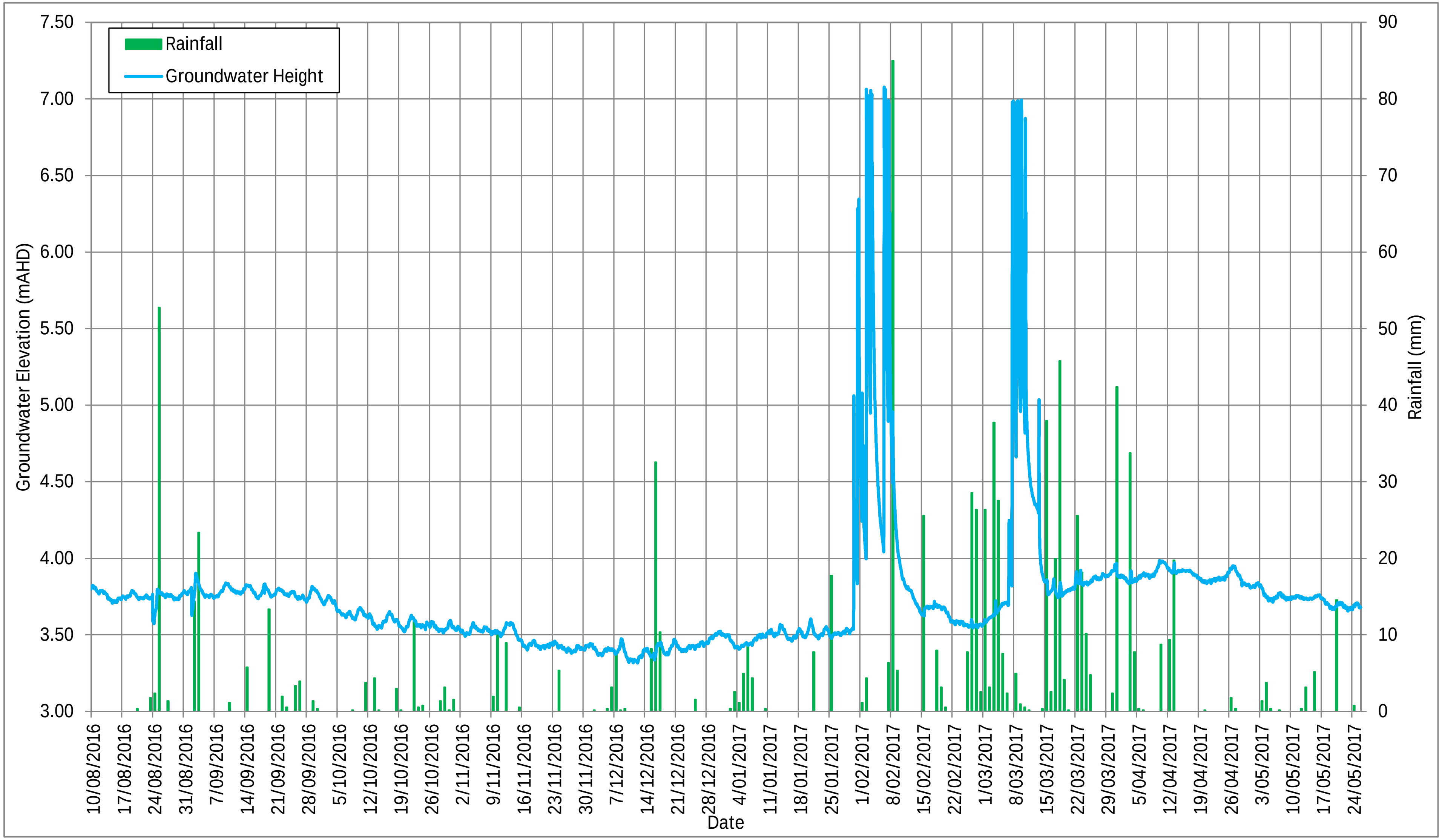
Annexure C – Hydrographs

Annexure C – Hydrographs

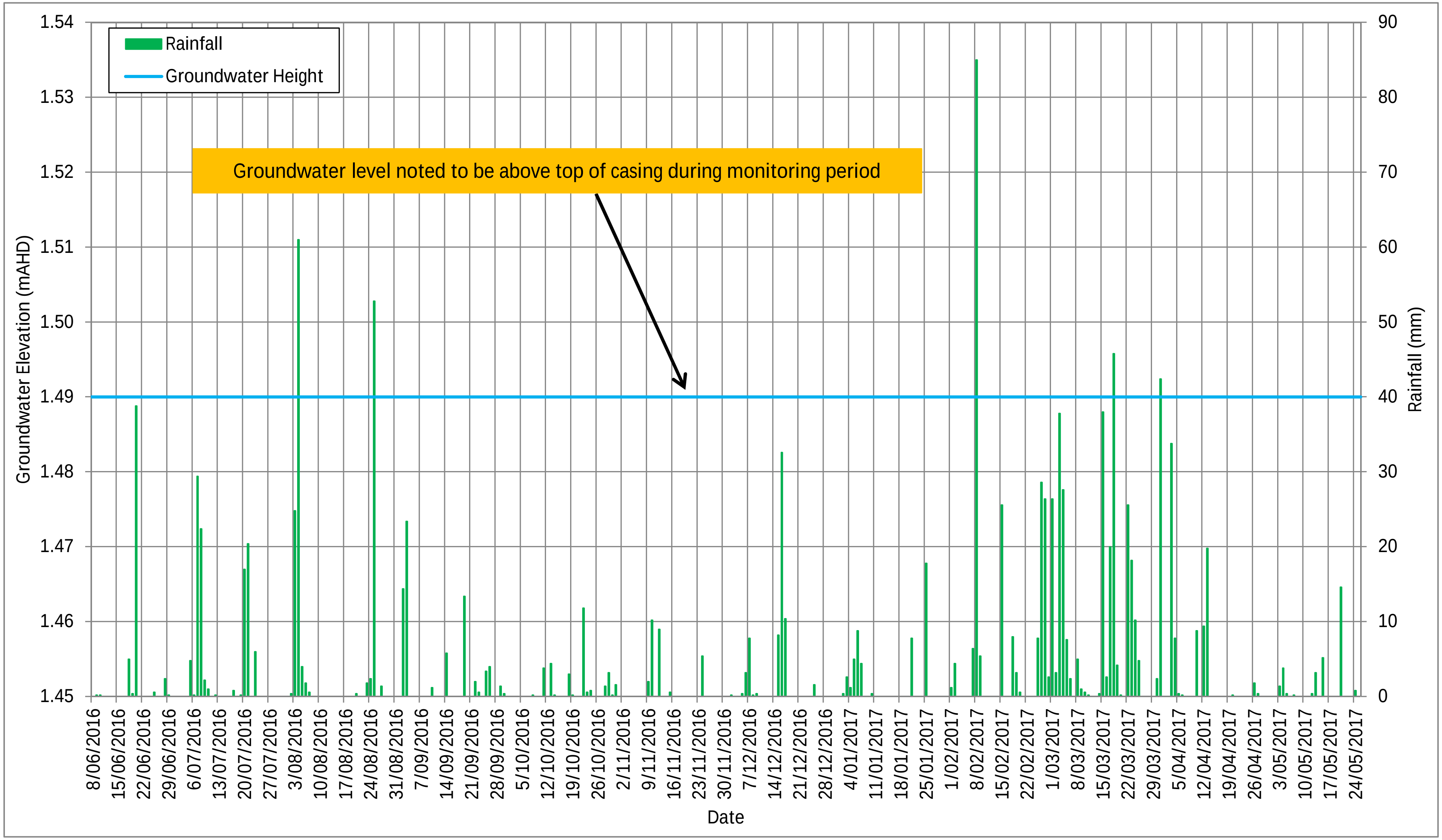
Figure	Well	Lithology Screened
Figure C1	HB_BH03	Hawkesbury Sandstone
Figure C2	HB_BH8D	Hawkesbury Sandstone
Figure C3	HB_BH08S	Alluvium
Figure C4	HB_BH12	Hawkesbury Sandstone
Figure C5	HB_BH14	Hawkesbury Sandstone
Figure C6	HB_BH15	Hawkesbury Sandstone
Figure C7	SP_BH01	Ashfield Shale
Figure C8	SP_BH02	Residual Clay
Figure C9	SP_BH04	Hawkesbury Sandstone
Figure C10	RZ_BH01D	Hawkesbury Sandstone
Figure C11	RZ_BH01S	Alluvium
Figure C12	RZ_BH15	Hawkesbury Sandstone
Figure C13	RZ_BH16	Hawkesbury Sandstone
Figure C14	RZ_BH19	Hawkesbury Sandstone
Figure C15	RZ_BH26	Hawkesbury Sandstone
Figure C16	RZ_BH28	Hawkesbury Sandstone
Figure C17	RZ_BH30	Hawkesbury Sandstone
Figure C18	RZ_BH38	Hawkesbury Sandstone
Figure C19	RZ_BH44d	Hawkesbury Sandstone
Figure C20	RZ_BH44s	Alluvium
Figure C21	RZ_BH47d	Hawkesbury Sandstone
Figure C22	RZ_BH47s	Alluvium
Figure C23	RZ_BH49	Alluvium
Figure C24	RZ_BH50	Hawkesbury Sandstone
Figure C25	RZ_BH51	Hawkesbury Sandstone
Figure C26	RZ_BH52	Hawkesbury Sandstone
Figure C27	RZ_BH60	Hawkesbury Sandstone
Figure C28	RZ_BH67	Hawkesbury Sandstone
Figure C29	TC_BH01D	Hawkesbury Sandstone
Figure C30	TC_BH01S	Alluvium
Figure C31	TC_BH06	Alluvium

Annexure C – Hydrographs

Figure	Well	Lithology Screened
Figure C32	TC_BH07D	Hawkesbury Sandstone
Figure C33	TC_BH07S	Alluvium
Figure C34	TC_BH08	Alluvium
Figure C35	TC_BH09D	Hawkesbury Sandstone
Figure C36	TC_BH09S	Alluvium
Figure C37	EP_BH06	Hawkesbury Sandstone
Figure C38	EP_BH07	Hawkesbury Sandstone
Figure C39	IC_BH02	Hawkesbury Sandstone
Figure C40	MT_BH02	Hawkesbury Sandstone
Figure C41	MT_BH07	Hawkesbury Sandstone
Figure C42	MT_BH14	Laminate
Figure C43	MT_BH19	Hawkesbury Sandstone
Figure C44	MT_BH21	Hawkesbury Sandstone



AECOM	Title: Hydrograph HB_BH03 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Parking lane outside 236 Alternate St, Haberfield	Screen Interval: 14 - 17 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 6.15 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C1** **HB_BH03**



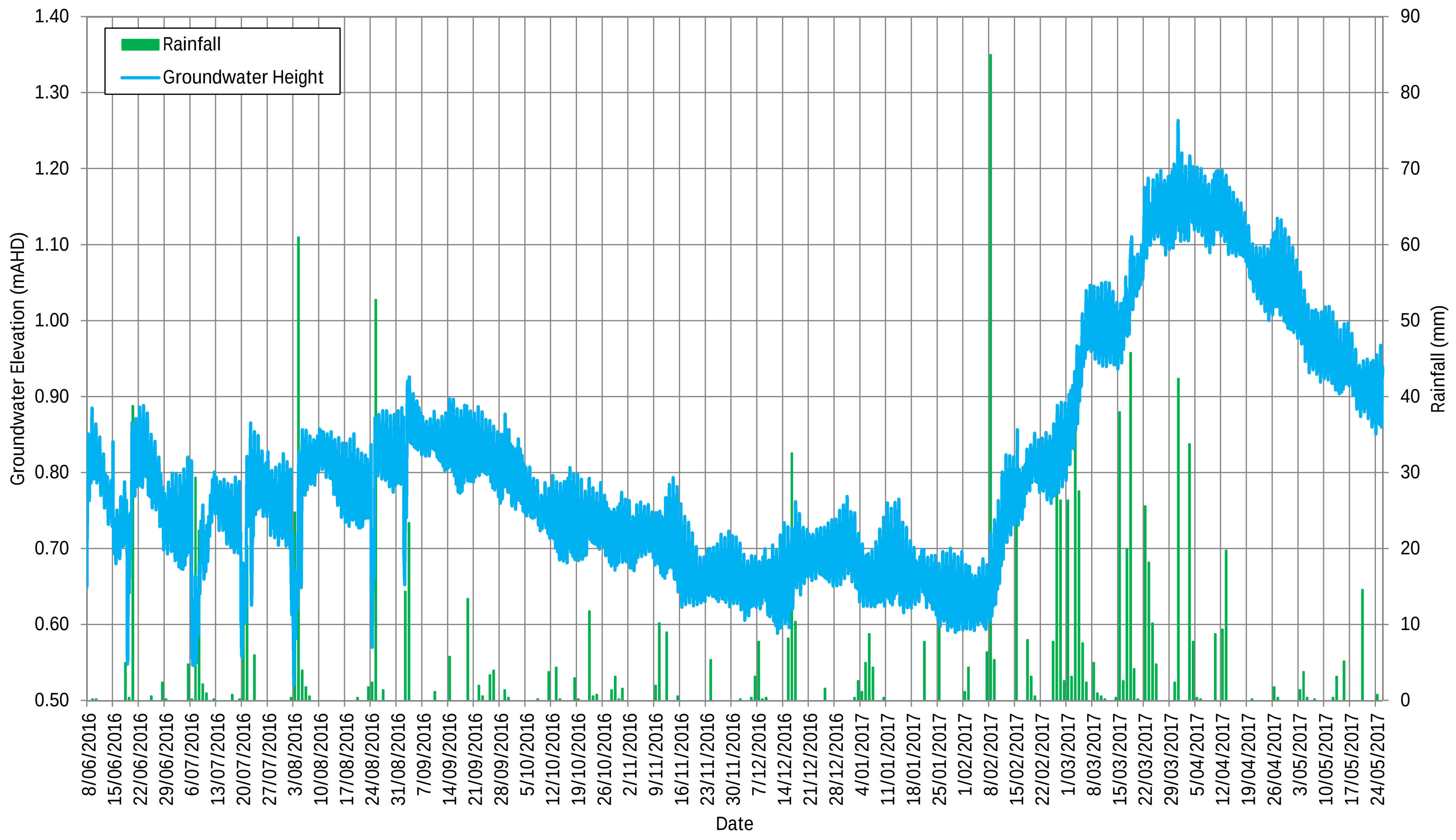
AECOM

Title: Hydrograph HB_BH08D and Rainfall
Project: WestConnex - M4/M5 Link
Client: Sydney Motorway Corporation
Location: Hawthorne Parade, Haberfield

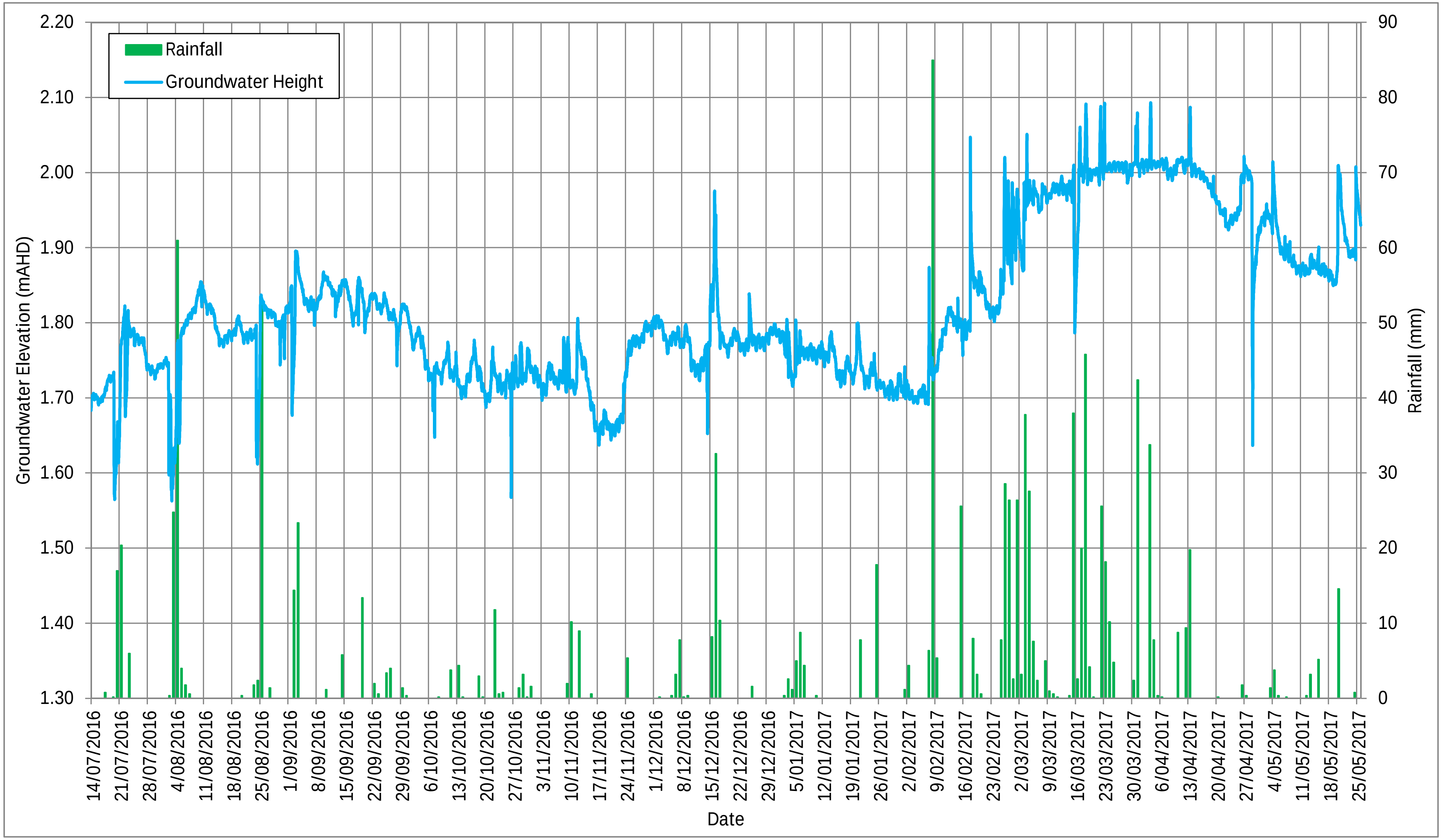
Screen Interval: 22 - 25 m
Lithology Screened: Hawkesbury Sandstone
Monitoring Well Elevation: 1.49 m AHD
Rainfall Measured at Sydney Observatory BoM 066062

Figure C2

HB_BH08D



AECOM	Title: Hydrograph HB_BH08S and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Hawthorne Parade, Haberfield	Screen Interval: 10 - 13 m Lithology Screened: Alluvium Monitoring Well Elevation: 1.43 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C3** **HB_BH08S**

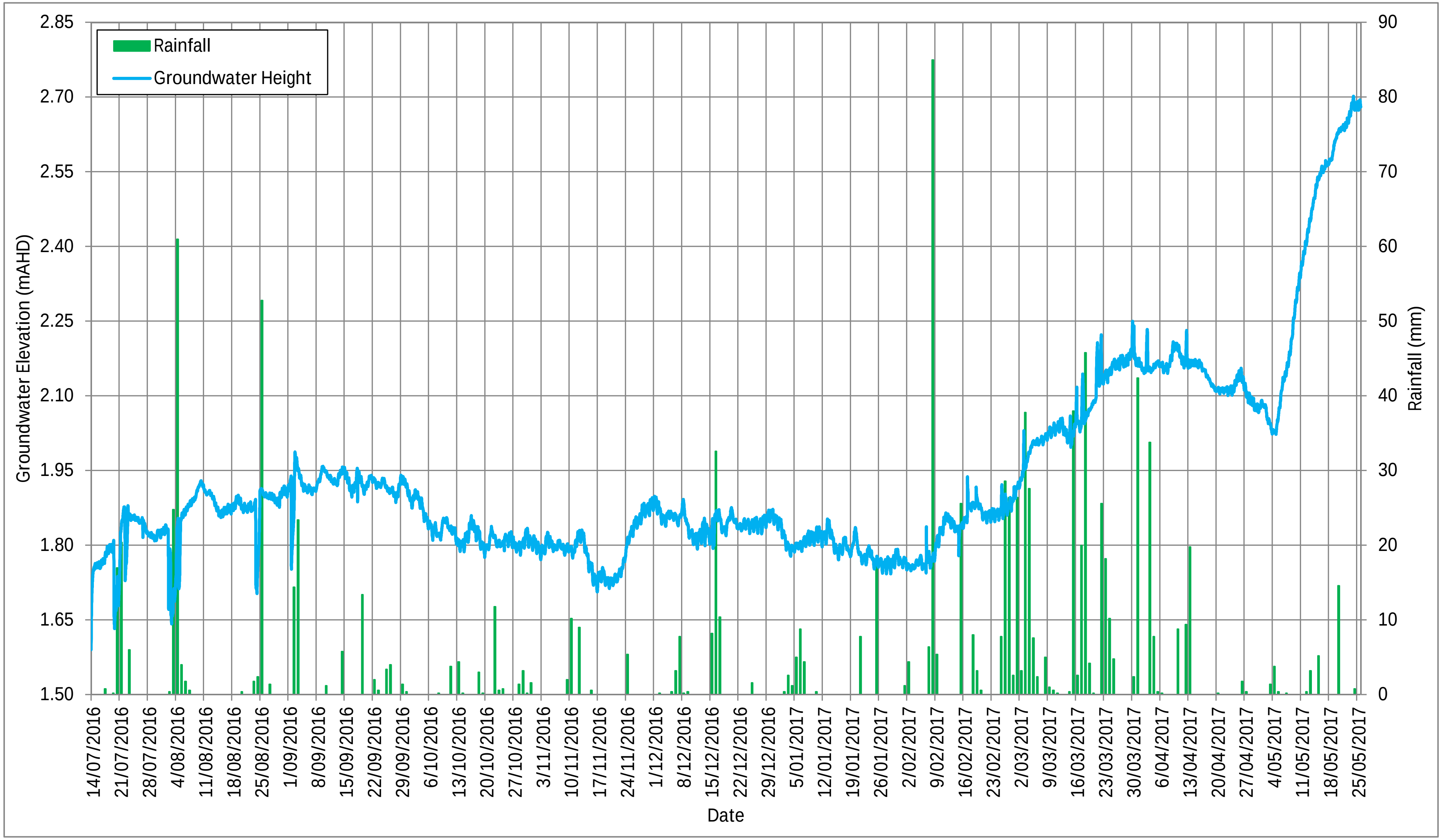


AECOM

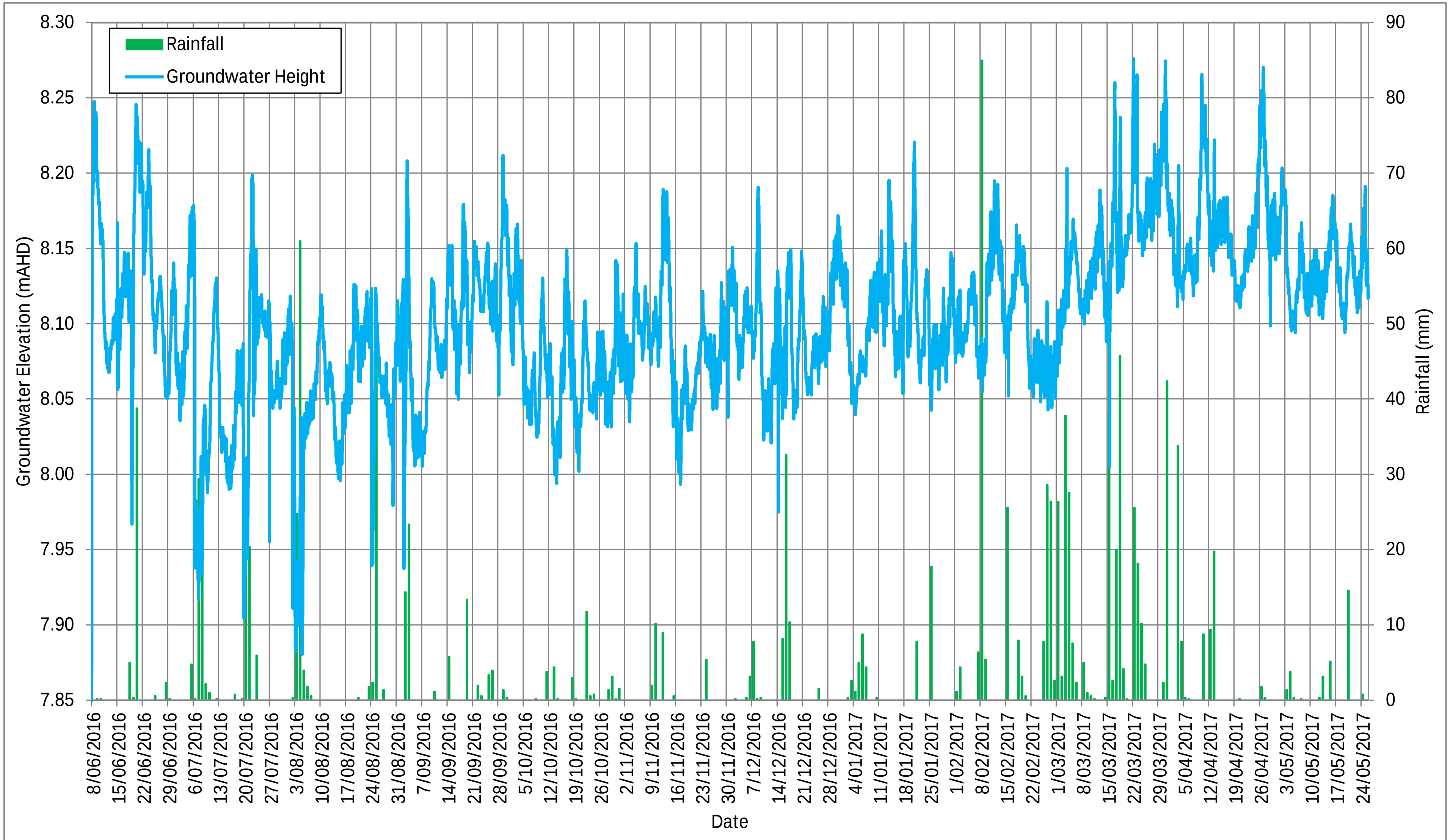
Title:	Hydrograph HB_BH12 and Rainfall
Project:	WestConnex - M4/M5 Link
Client:	Sydney Motorway Corporation
Location:	Darley Road, Leichhardt

Screen Interval: 27 - 30 m
Lithology Screened: Hawkesbury Sandstone
Monitoring Well Elevation: 2.13 mAHD
Rainfall Measured at Sydney Observatory BoM 066062

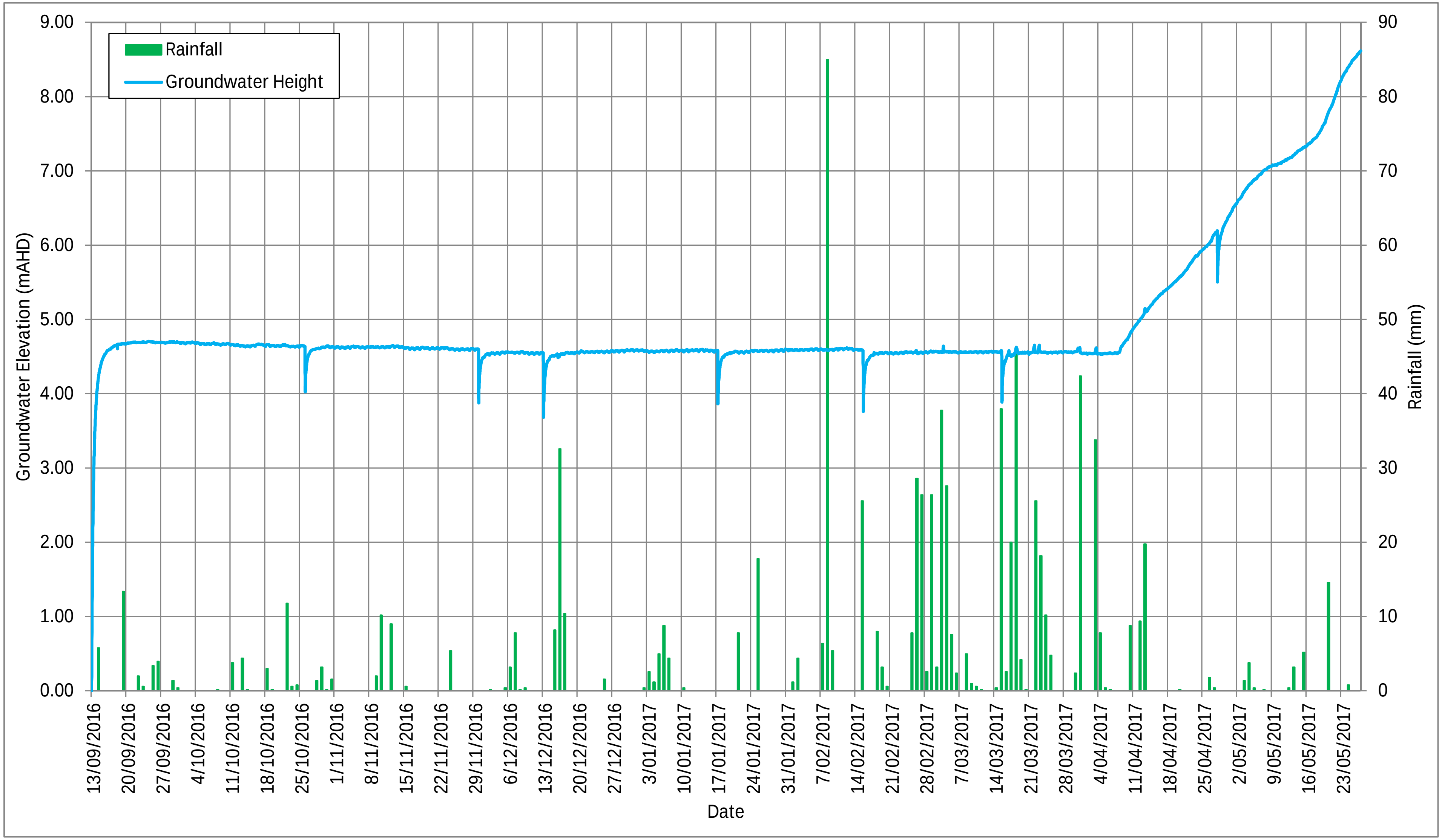
Figure C4
HB_BH12



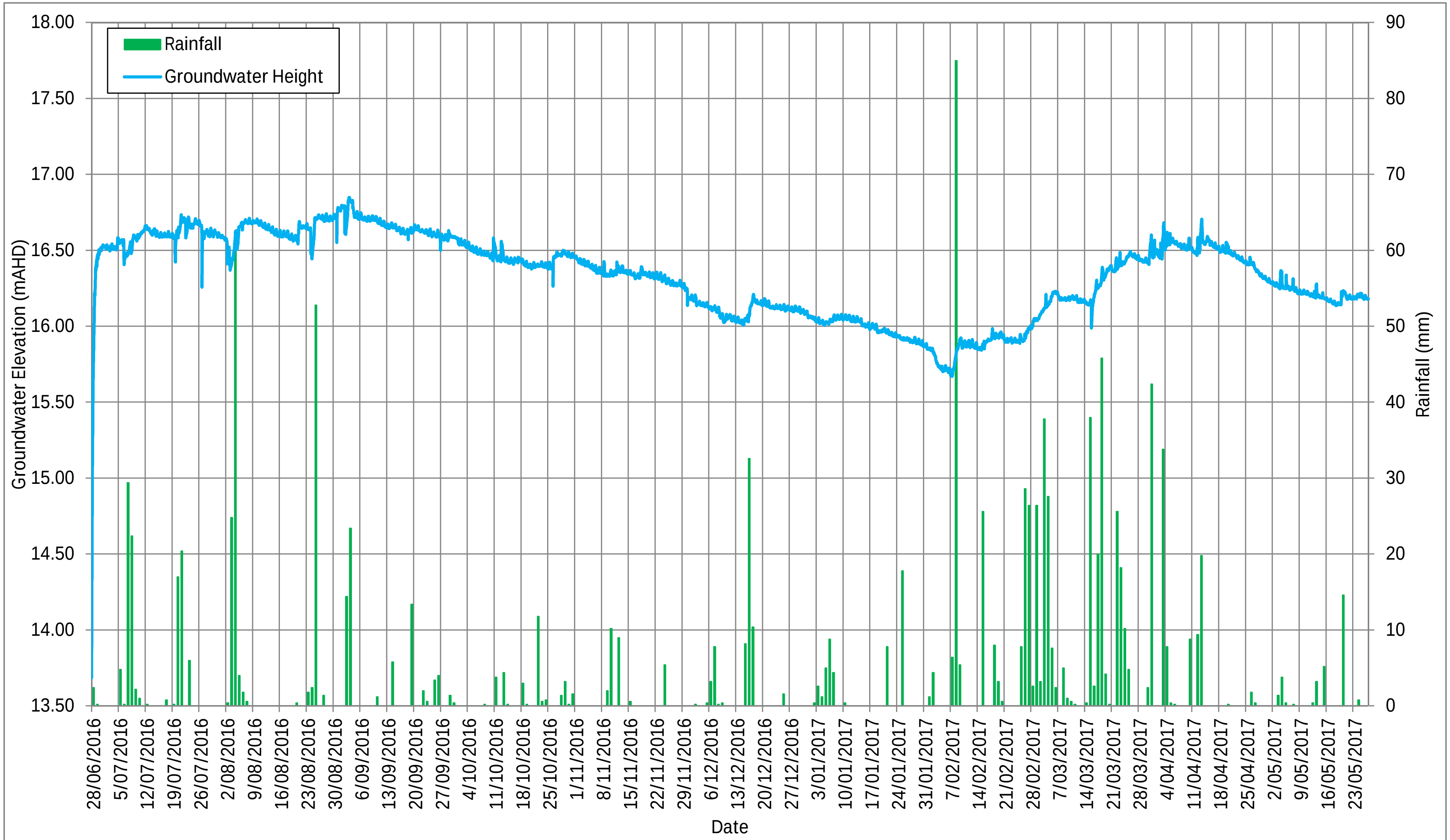
AECOM	Title: Hydrograph HB_BH14 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Hubert Street, Leichhardt	Screen Interval: 37 - 40 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 4.20 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C5** **HB_BH14**



AECOM	Title: Hydrograph HB_BH15 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: James Road, Leichhardt	Screen Interval: 19 - 22 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 17.80 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C6** **HB_BH15**



AECOM	Title: Hydrograph SP_BH01 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Applebee Street, St Peters	Screen Interval: 36 - 39 m Lithology Screened: Ashfield Shale Monitoring Well Elevation: 17.71 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C7** **SP_BH01**

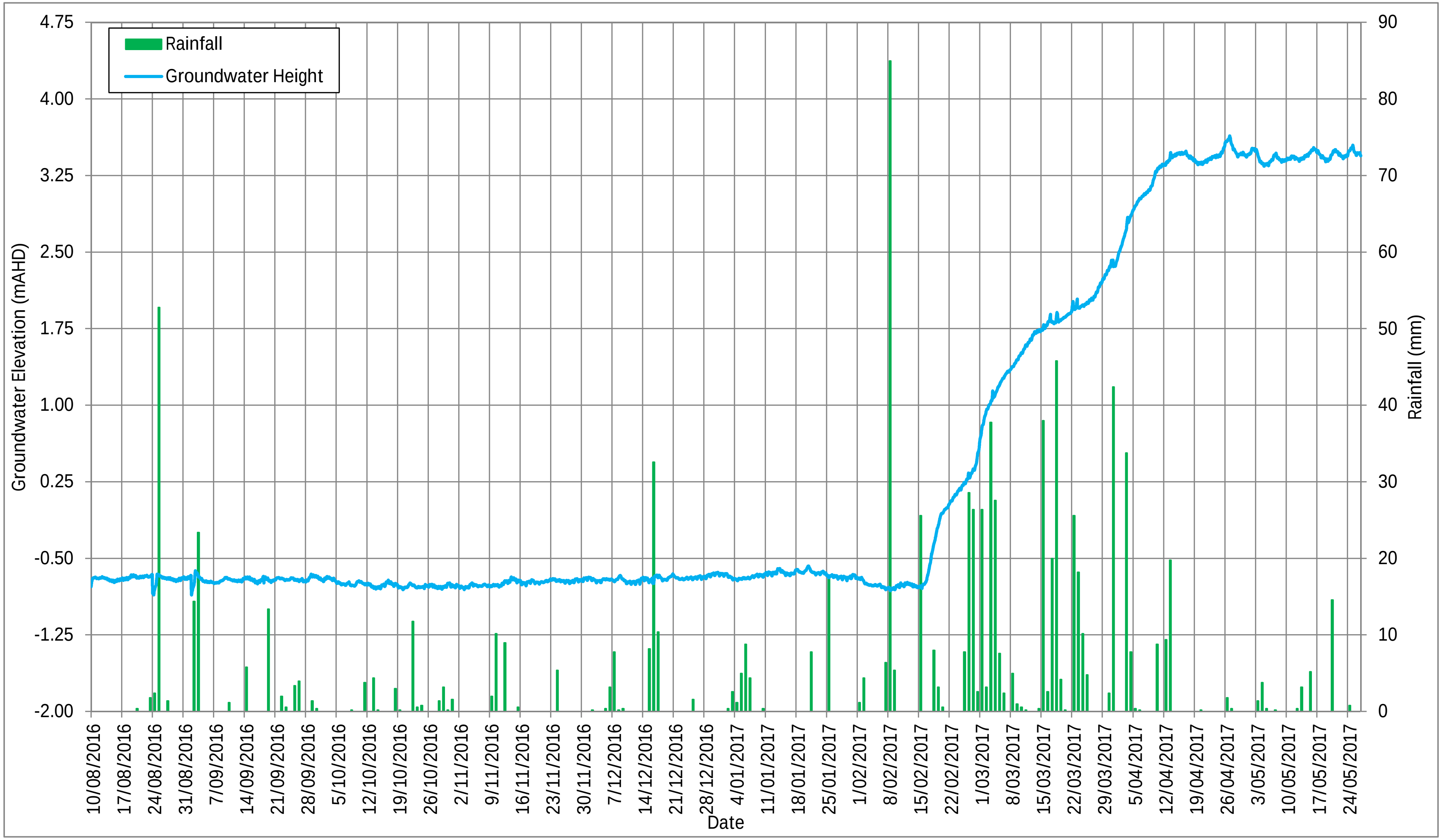


AECOM

Title: Hydrograph SP_BH02 and Rainfall
Project: WestConnex - M4/M5 Link
Client: Sydney Motorway Corporation
Location: Barwon Park Road, St Peters

Screen Interval: 4 - 10 m
Lithology Screened: Residual Clay
Monitoring Well Elevation: 19.42 mAHD
Rainfall Measured at Sydney Observatory BoM 066062

Figure C8
SP_BH02

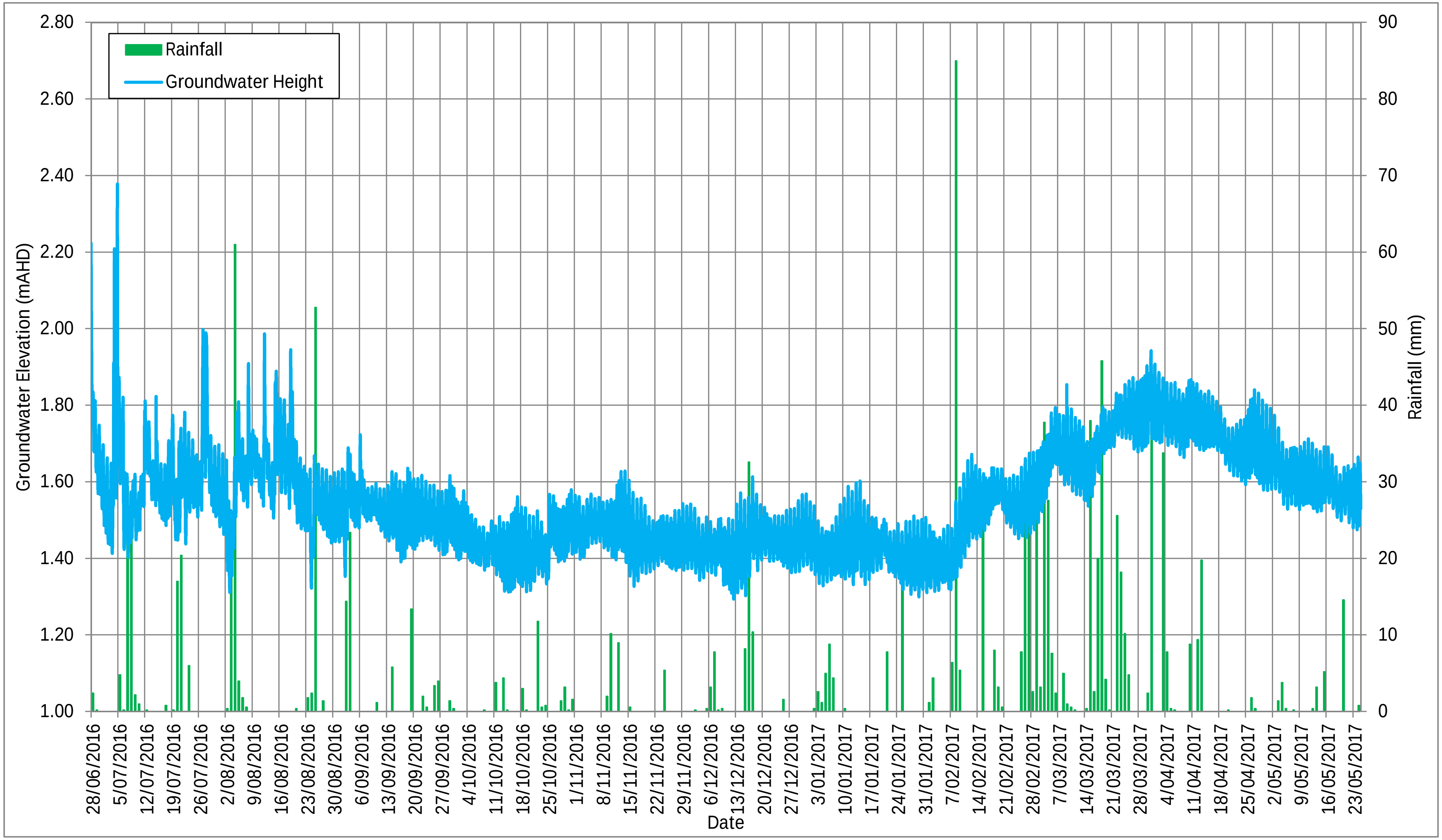


AECOM

Title: Hydrograph SP_BH04 and Rainfall
Project: WestConnex - M4/M5 Link
Client: Sydney Motorway Corporation
Location: Corner Lackey Street, Applebee Street, St Peters

Screen Interval: 32 - 35 m
Lithology Screened: Hawkesbury Sandstone
Monitoring Well Elevation: 12.23 mAHD
Rainfall Measured at Sydney Observatory BoM 066062

Figure C9
SP_BH04

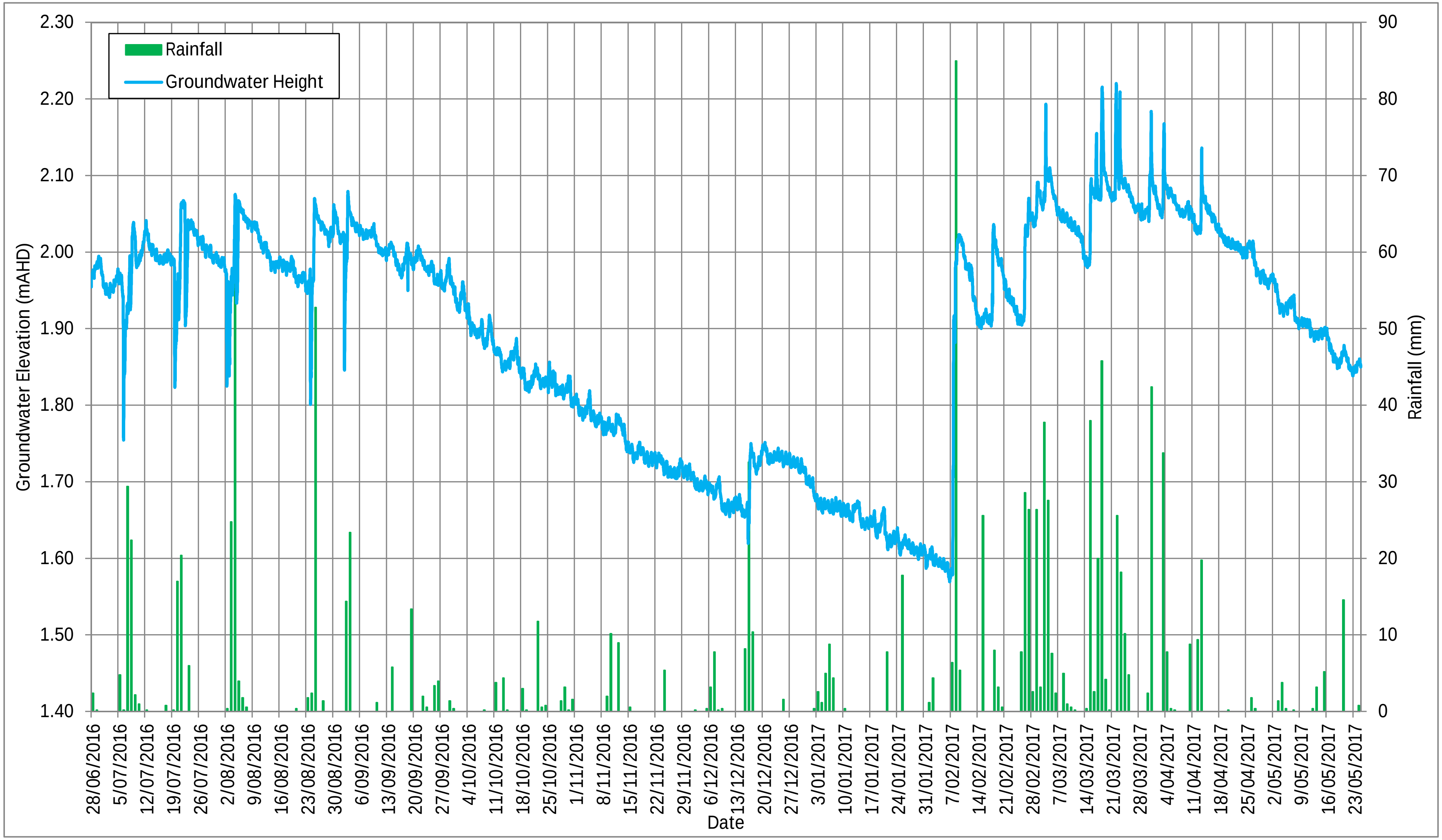


AECOM

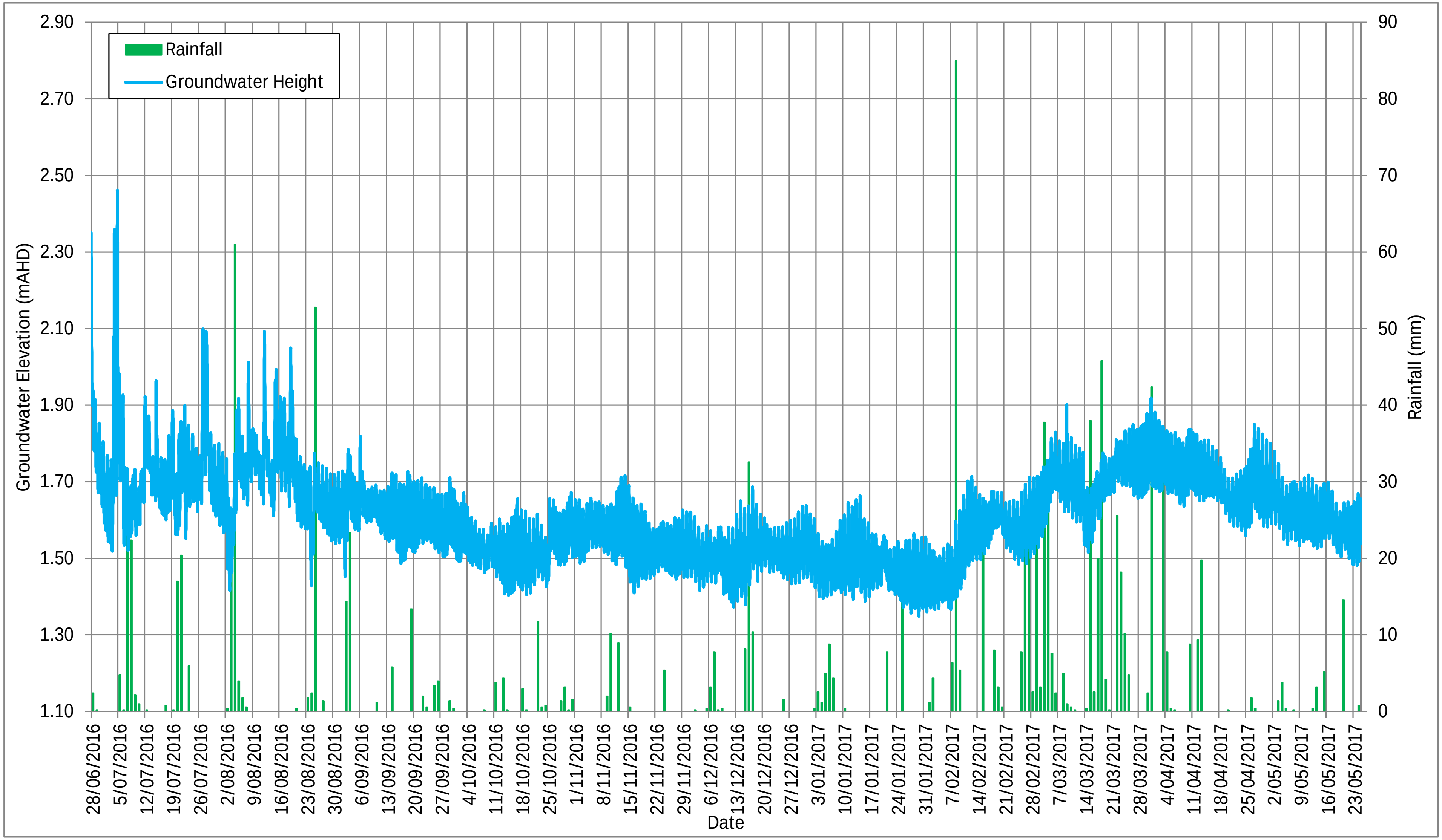
Title: Hydrograph RZ_BH01D and Rainfall
Project: WestConnex - M4/M5 Link
Client: Sydney Motorway Corporation
Location: Rozelle Rail Yards

Screen Interval: 22 - 25 m
Lithology Screened: Hawkesbury Sandstone
Monitoring Well Elevation: 6.30 mAHD
Rainfall Measured at Sydney Observatory BoM 066062

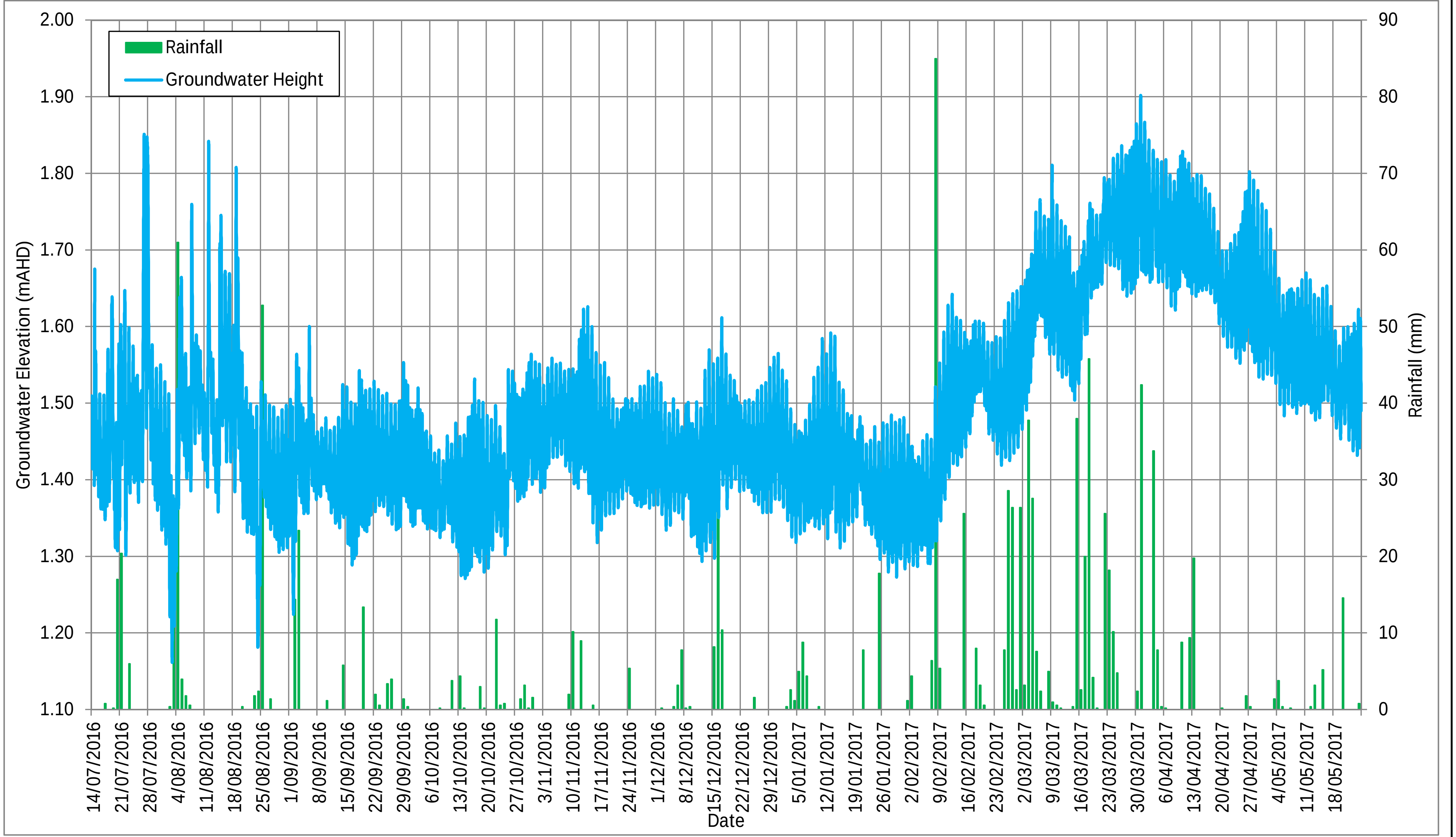
Figure C10
RZ_BH01D



AECOM	Title: Hydrograph RZ_BH01S and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Rozelle Rail Yards	Screen Interval: 7 - 10 m Lithology Screened: Alluvium Monitoring Well Elevation: 6.39 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C11** **RZ_BH01S**



AECOM	Title: Hydrograph RZ_BH15 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Rozelle Rail Yards	Screen Interval: 18 - 21 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 6.02 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C12** **RZ_BH15**

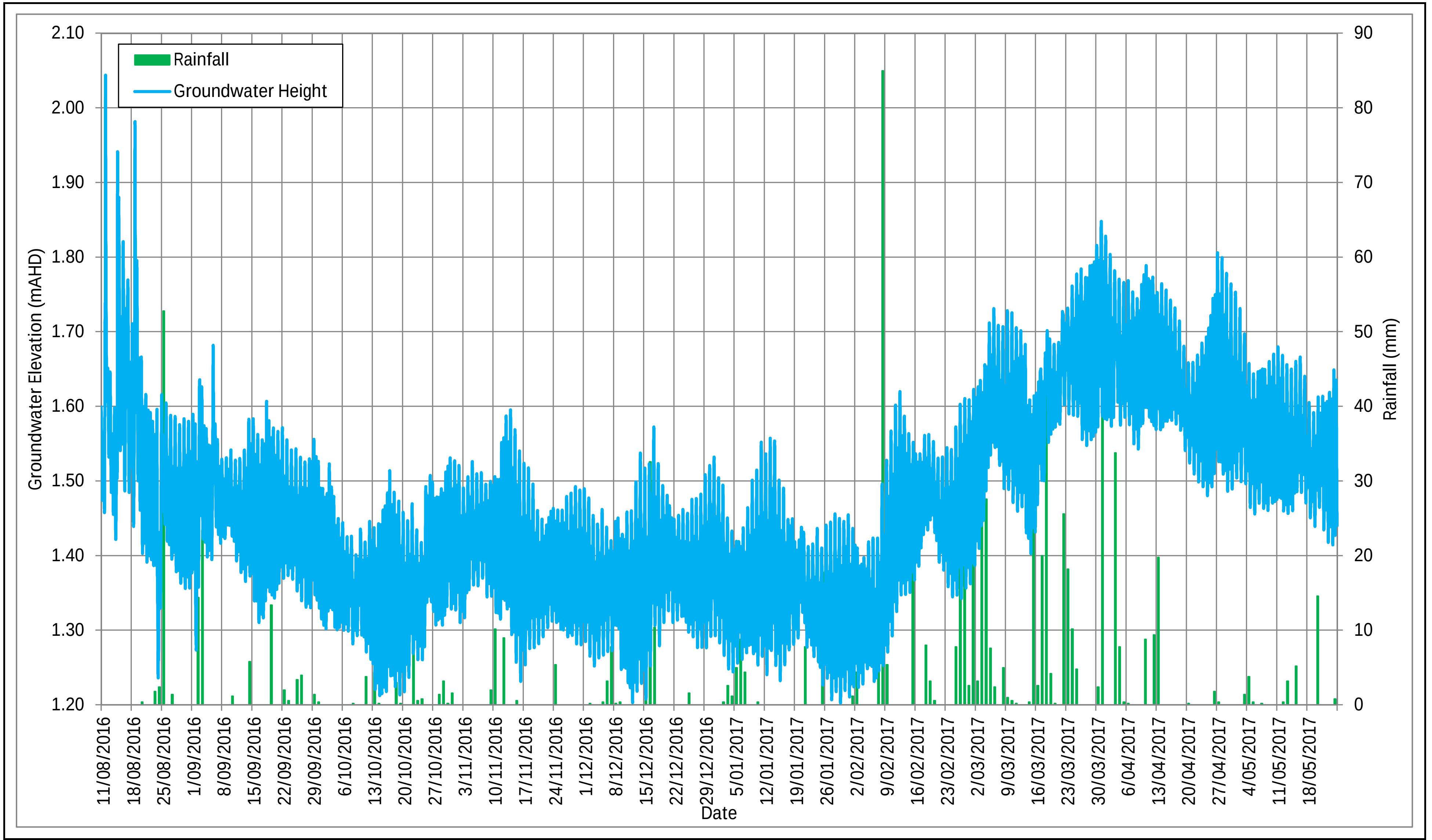


AECOM

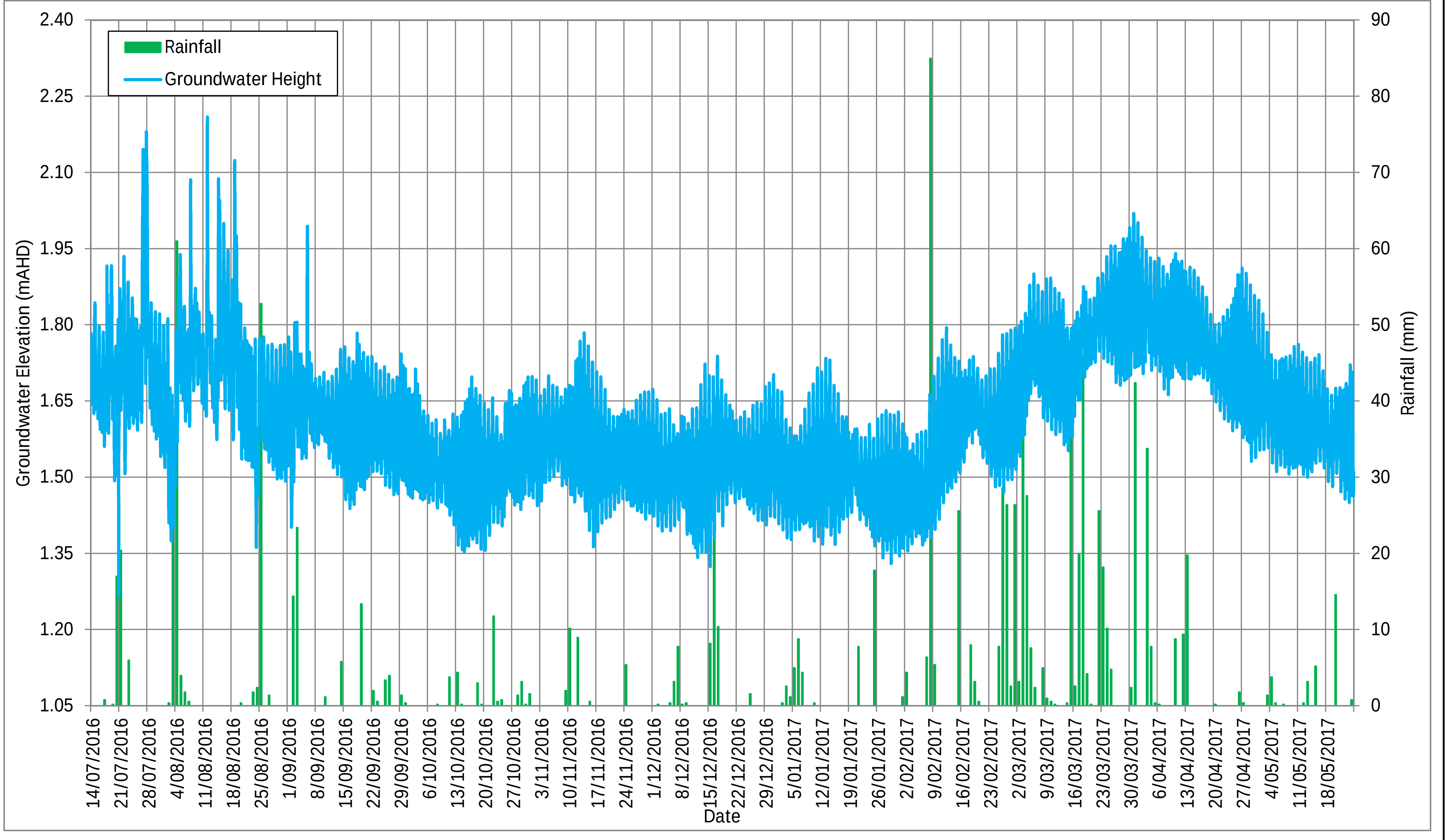
Title: Hydrograph RZ_BH16 and Rainfall
Project: WestConnex - M4/M5 Link
Client: Sydney Motorway Corporation
Location: Rozelle Rail Yards

Screen Interval: 17 - 20 m
Lithology Screened: Hawkesbury Sandstone
Monitoring Well Elevation: 5.82 mAHD
Rainfall Measured at Sydney Observatory BoM 066062

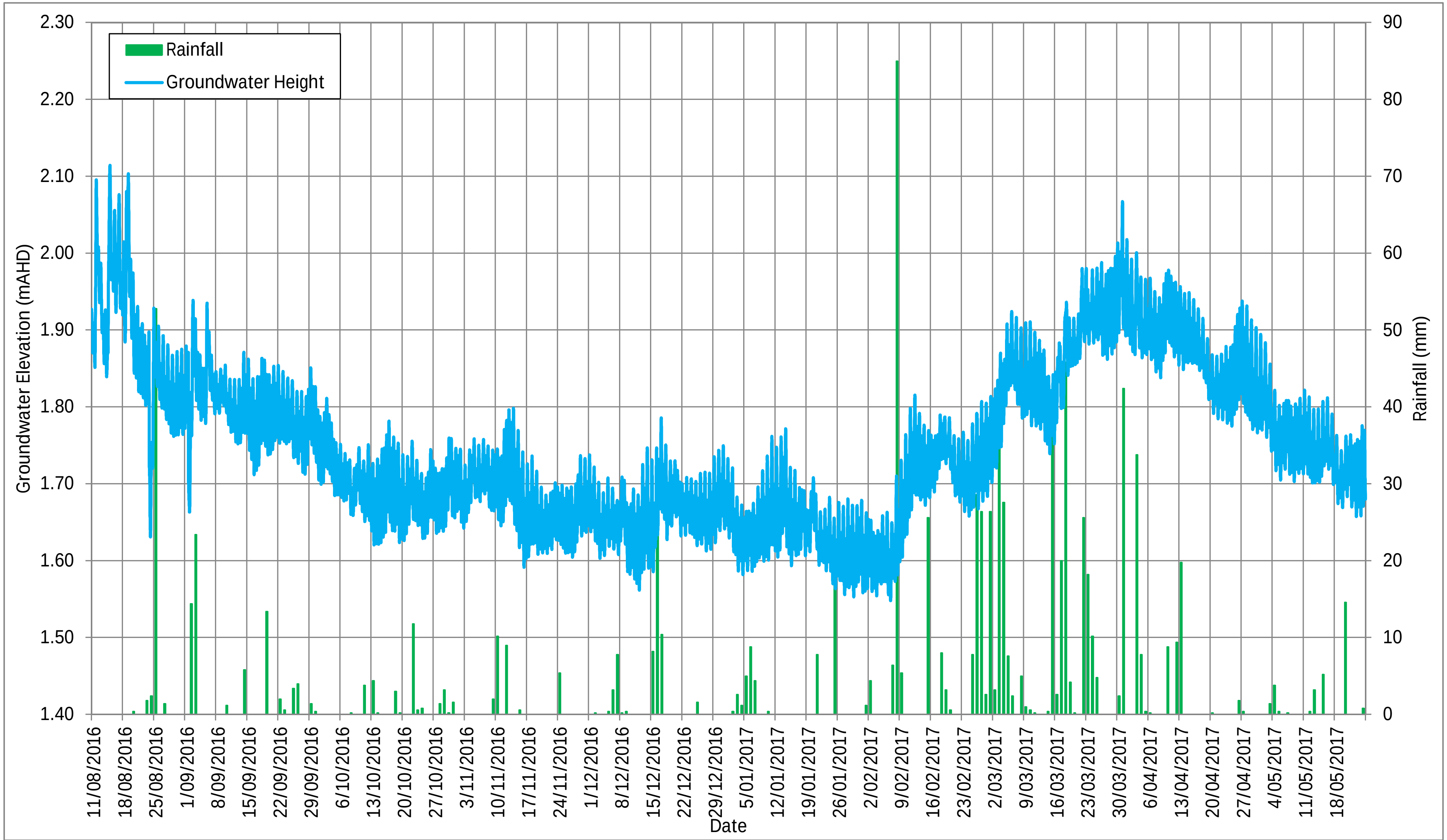
Figure C13
RZ_BH16



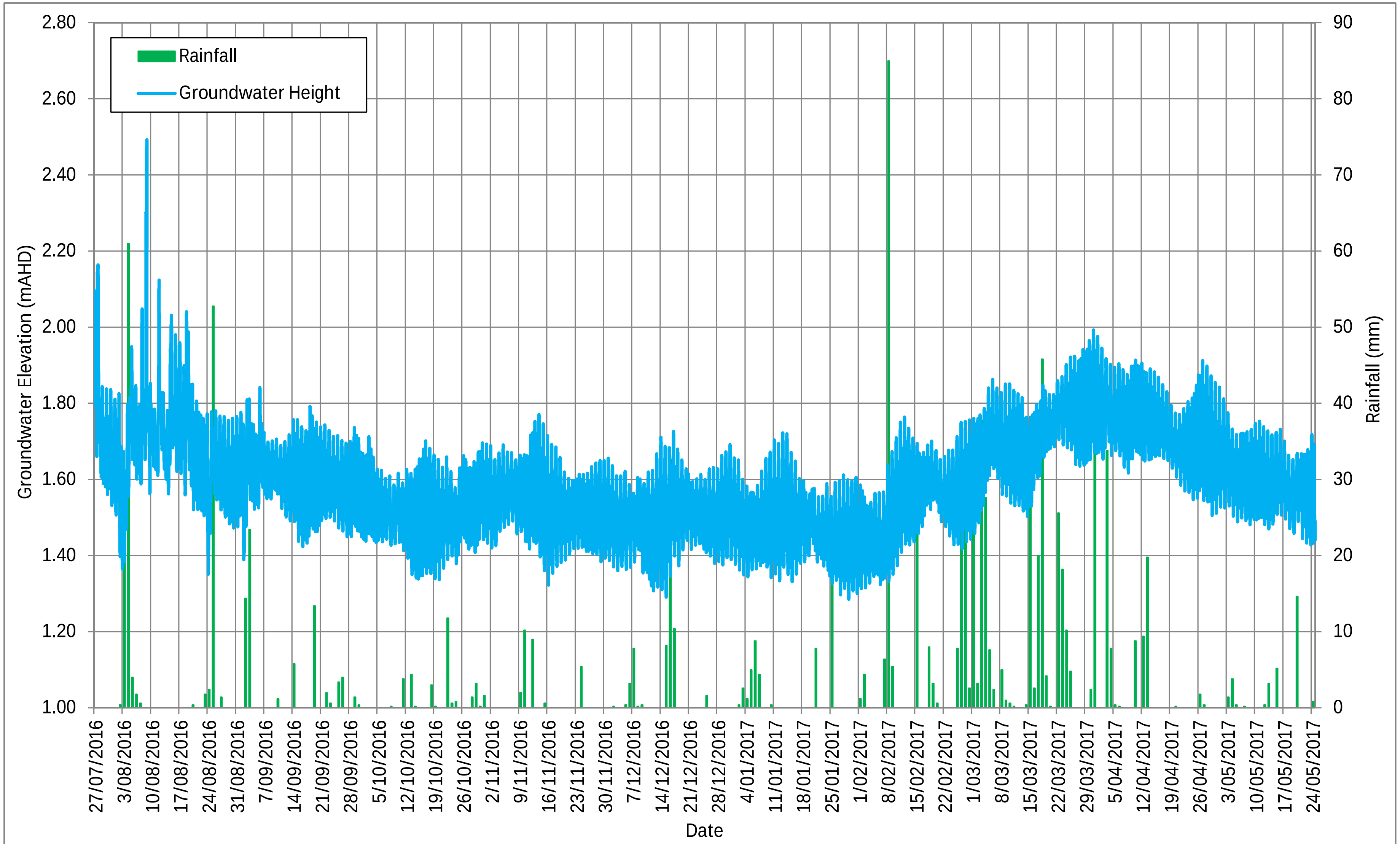
AECOM	Title: Hydrograph RZ_BH19 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Rozelle Rail Yards	Screen Interval: 19 - 22 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 2.46 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C14** **RZ_BH19**



AECOM	Title: Hydrograph RZ_BH26 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Rozelle Rail Yards	Screen Interval: 20 - 23 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 2.84 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C15** **RZ_BH26**

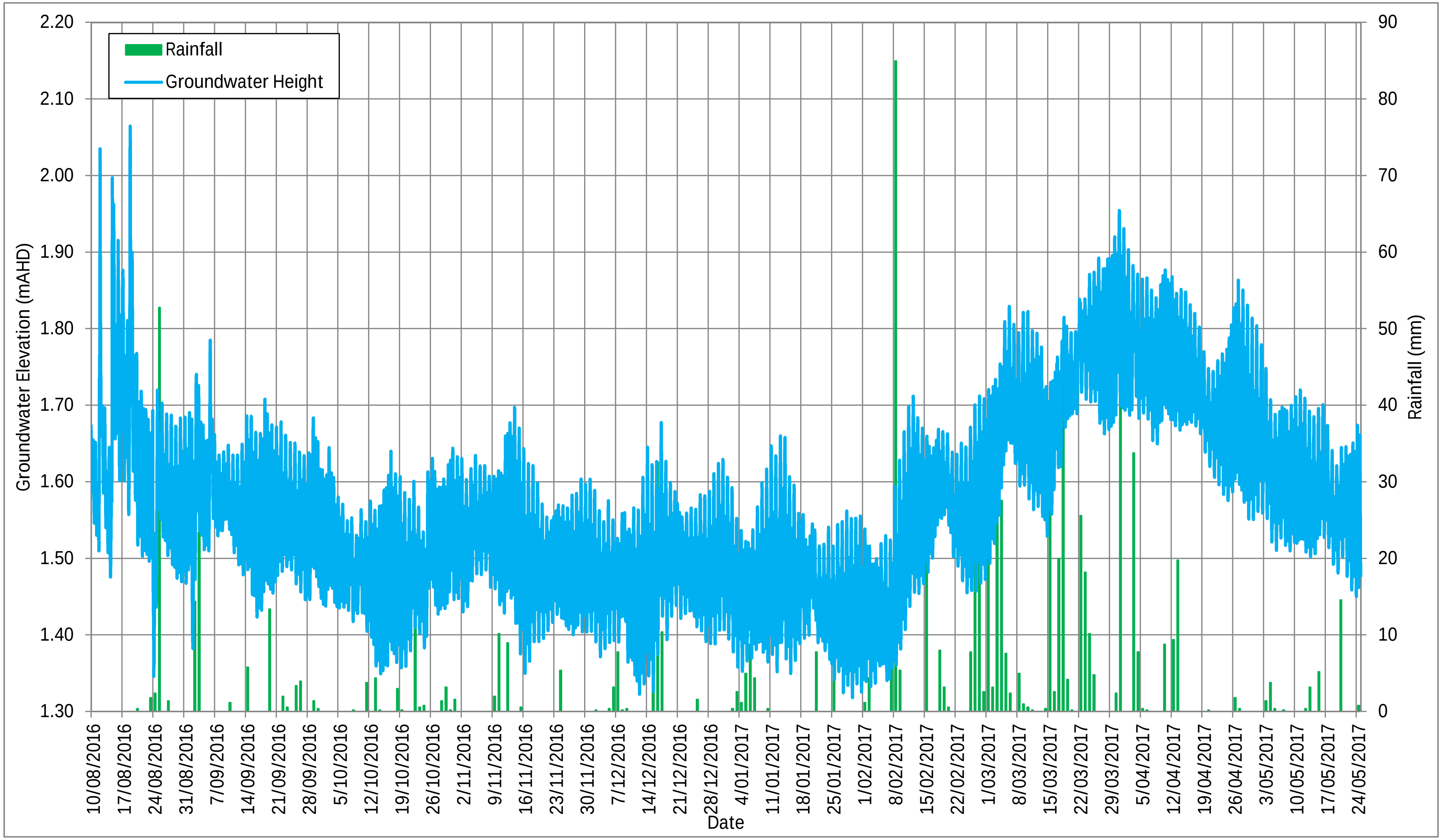


AECOM	Title: Hydrograph RZ_BH28 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Rozelle Rail Yards	Screen Interval: 27 - 30 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 2.83 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C16** **RZ_BH28**



AECOM	Title: Hydrograph RZ_BH30 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Rozelle Rail Yards	Screen Interval: 16 - 19 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 2.04 mAHD Rainfall Measured at Sydney Observatory BoM 066062

Figure C17
RZ_BH30

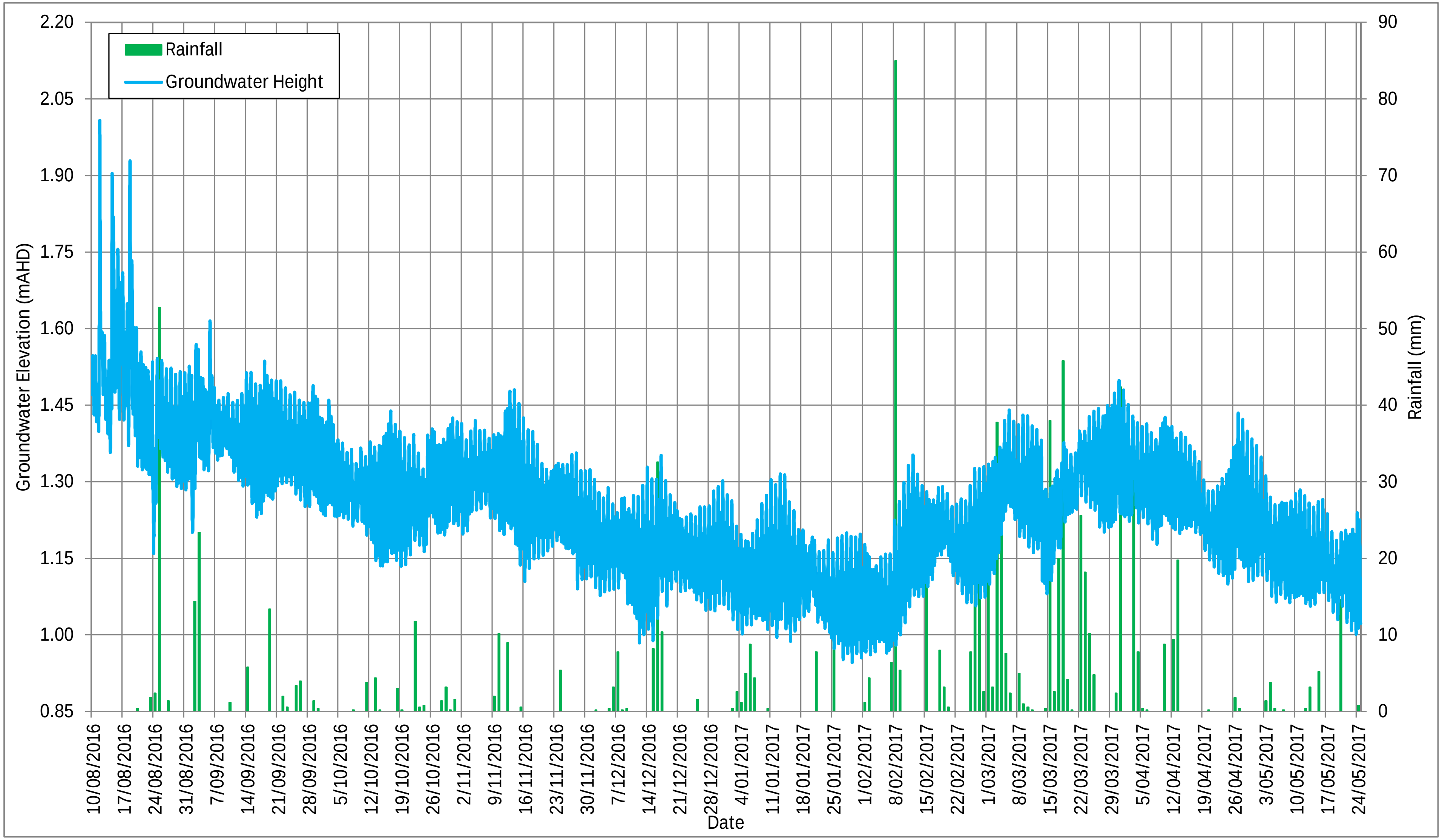


AECOM

Title: Hydrograph RZ_BH38 and Rainfall
Project: WestConnex - M4/M5 Link
Client: Sydney Motorway Corporation
Location: Rozelle Rail Yards

Screen Interval: 28 - 31 m
Lithology Screened: Hawkesbury Sandstone
Monitoring Well Elevation: 2.27 mAHD
Rainfall Measured at Sydney Observatory BoM 066062

Figure C18
RZ_BH38

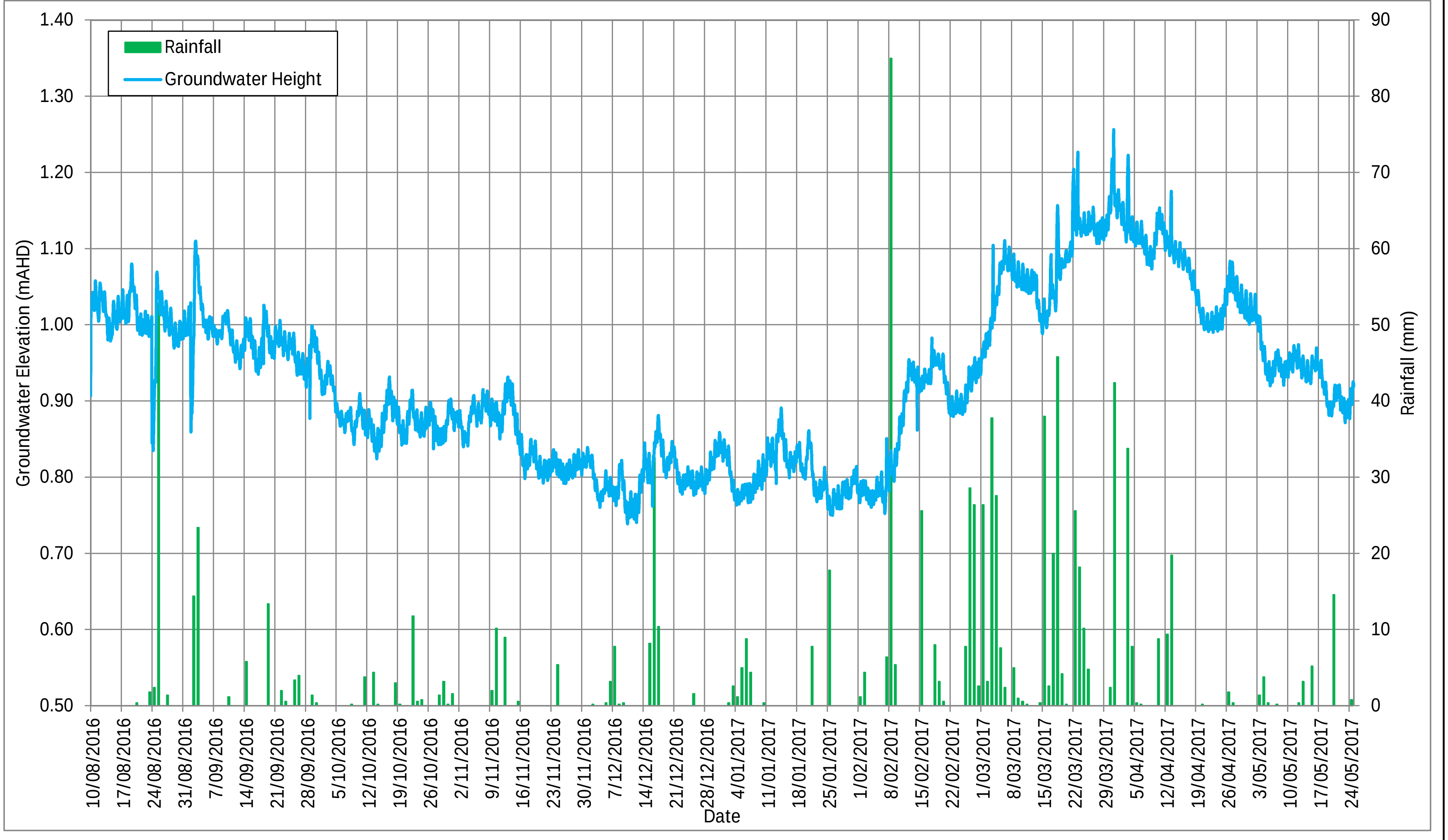


AECOM

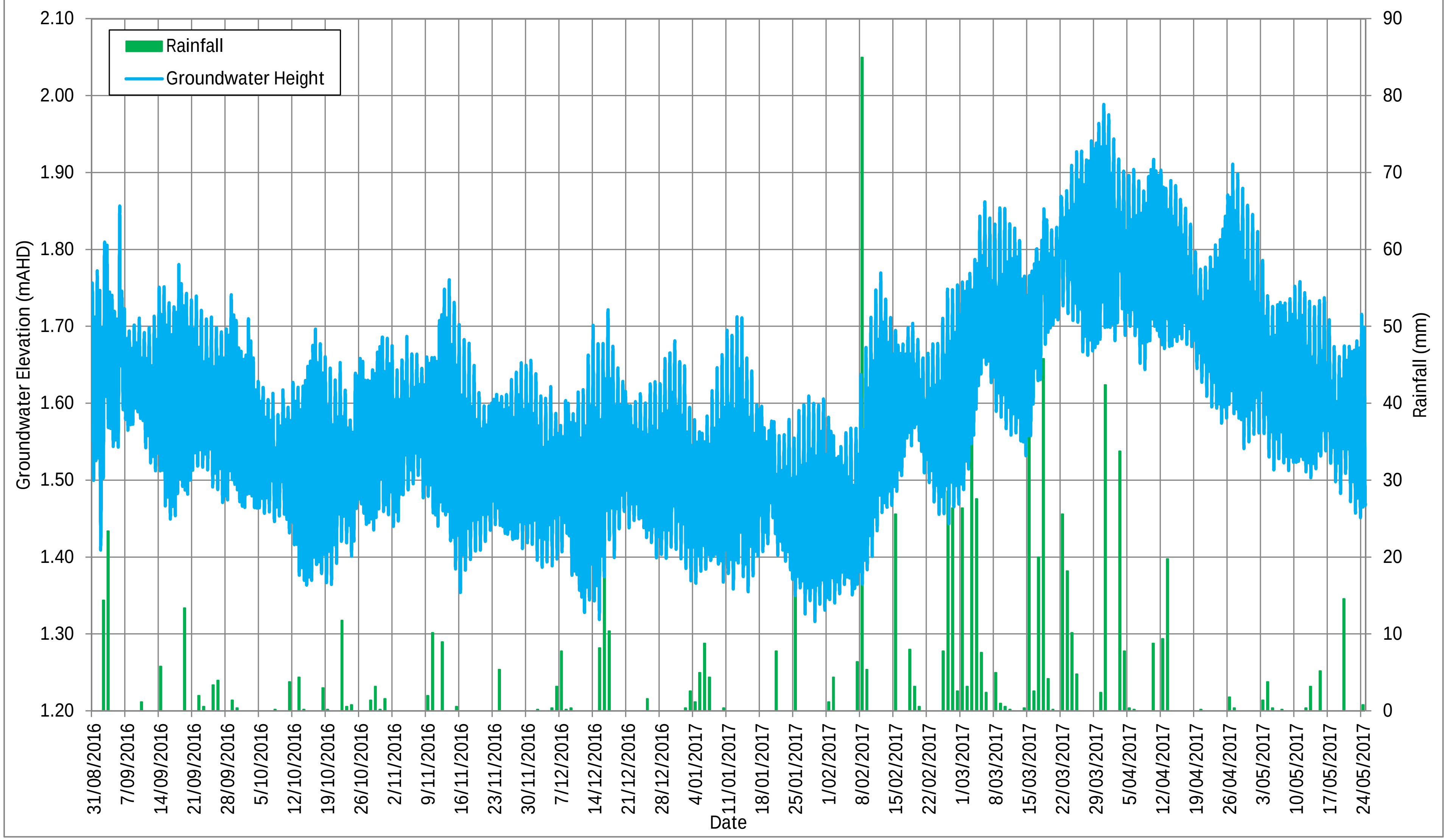
Title: Hydrograph RZ_BH44d and Rainfall
Project: WestConnex - M4/M5 Link
Client: Sydney Motorway Corporation
Location: Rozelle Rail Yards

Screen Interval: 25 - 28 m
Lithology Screened: Hawkesbury Sandstone
Monitoring Well Elevation: 2.29 mAHD
Rainfall Measured at Sydney Observatory BoM 066062

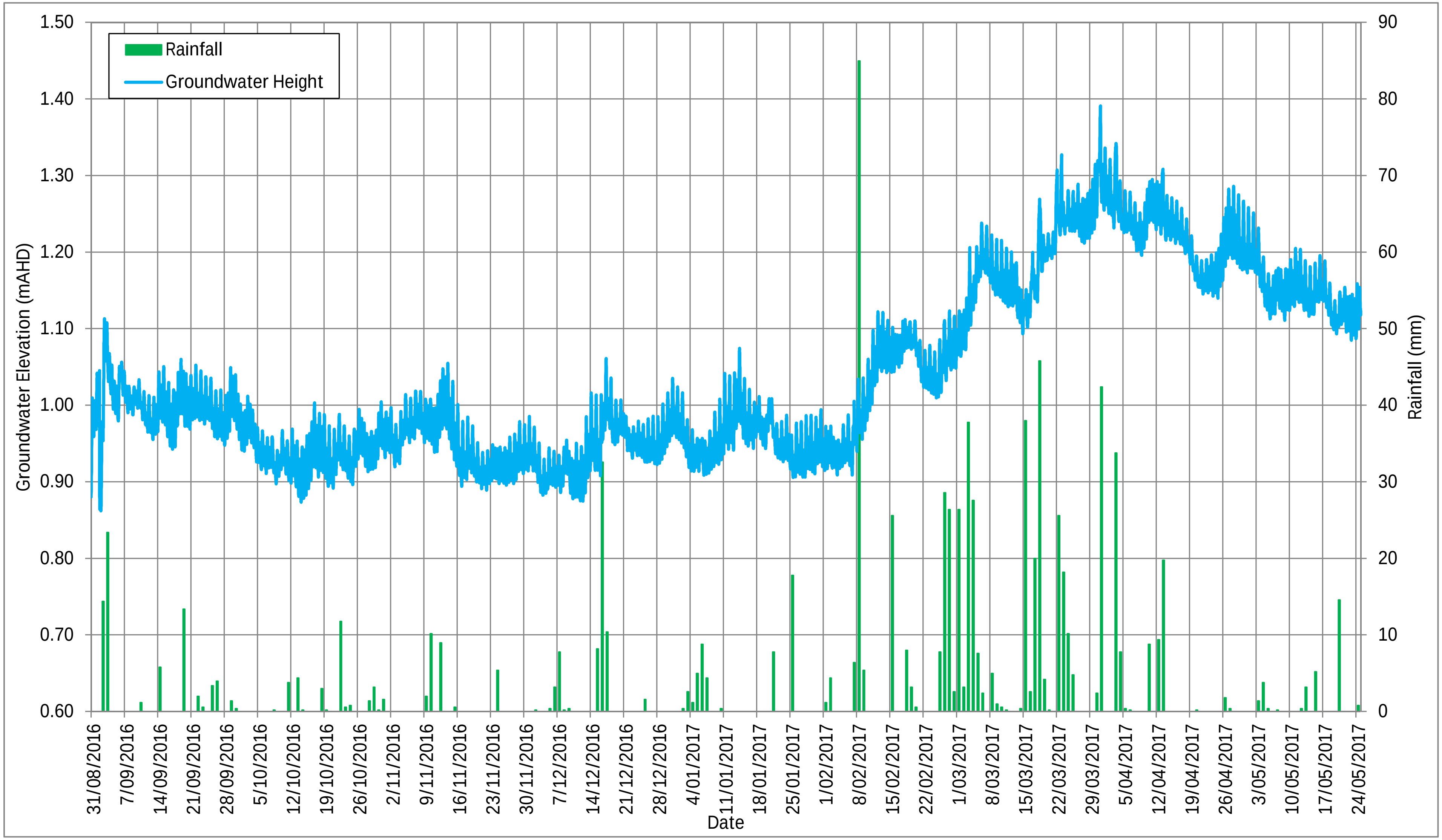
Figure C19
RZ_BH44d



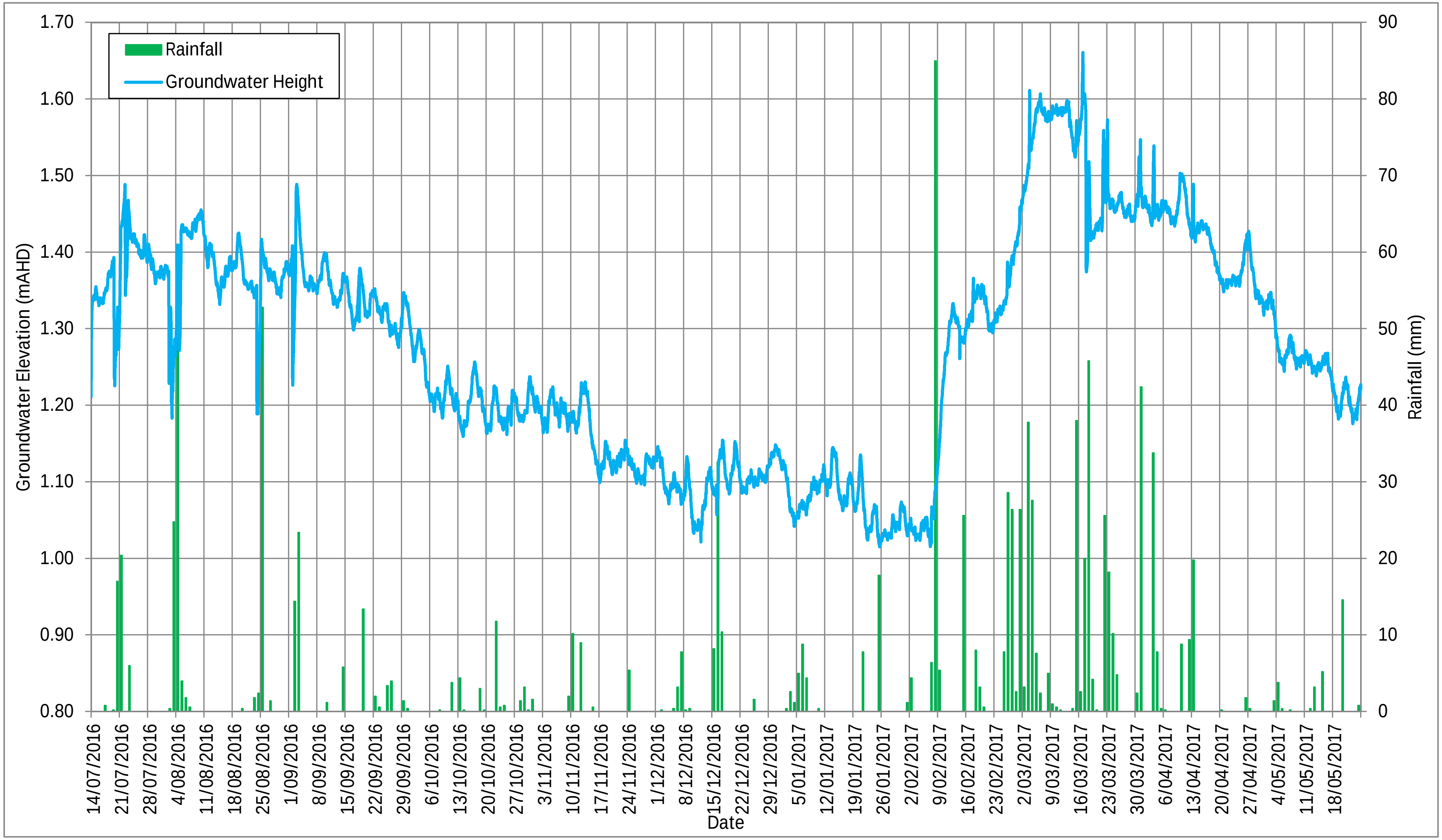
AECOM	Title: Hydrograph RZ_BH44s and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Rozelle Rail Yards	Screen Interval: 12 - 15 m Lithology Screened: Alluvium Monitoring Well Elevation: 2.25 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C20** **RZ_BH44s**



AECOM	Title: Hydrograph RZ_BH47d and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Rozelle Rail Yards	Screen Interval: 27 - 30 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 2.30 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C21** **RZ_BH47d**



AECOM	Title: Hydrograph RZ_BH47s and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Rozelle Rail Yards	Screen Interval: 15 - 18 m Lithology Screened: Alluvium Monitoring Well Elevation: 2.50 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C22** **RZ_BH47s**

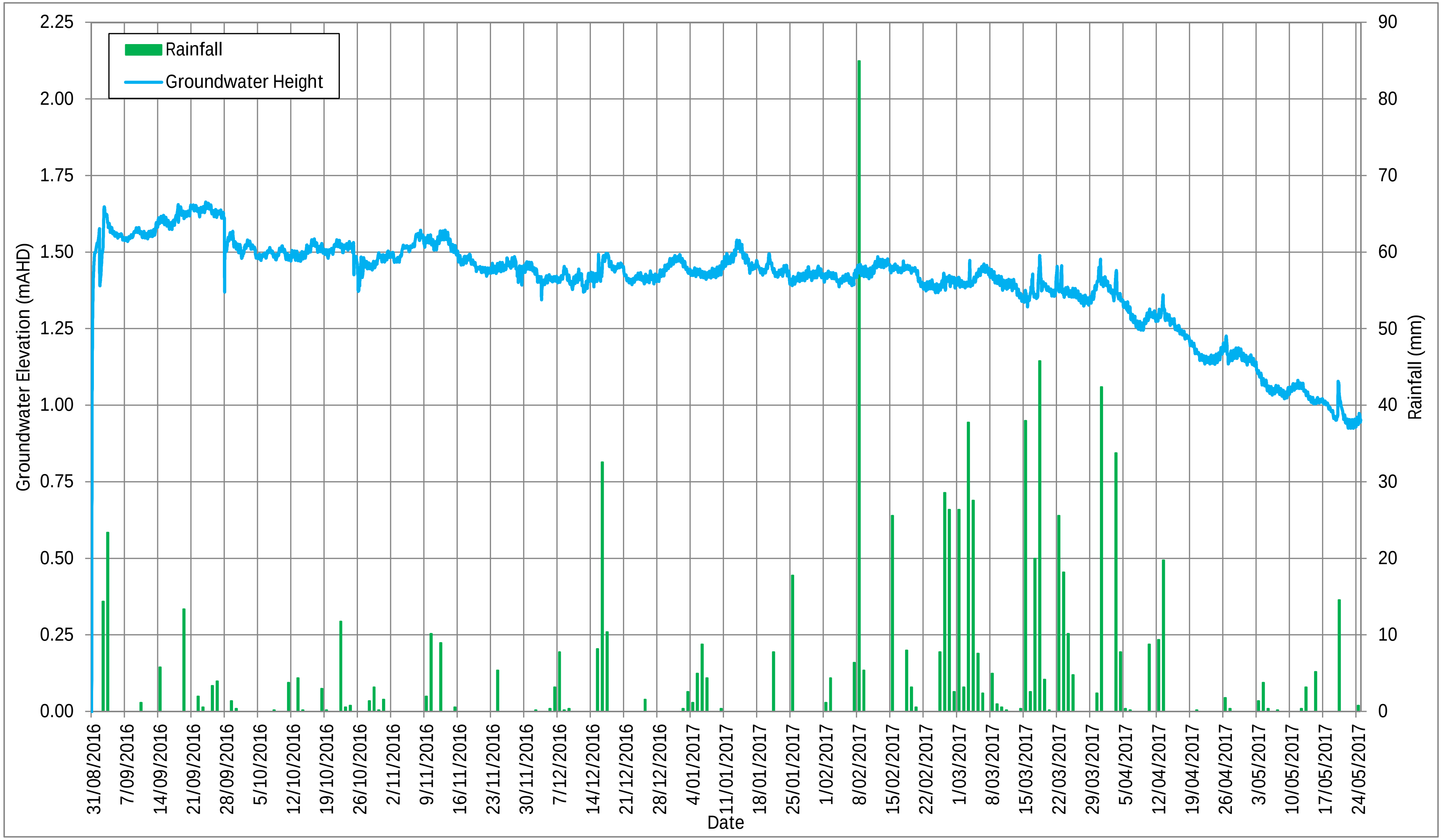


AECOM

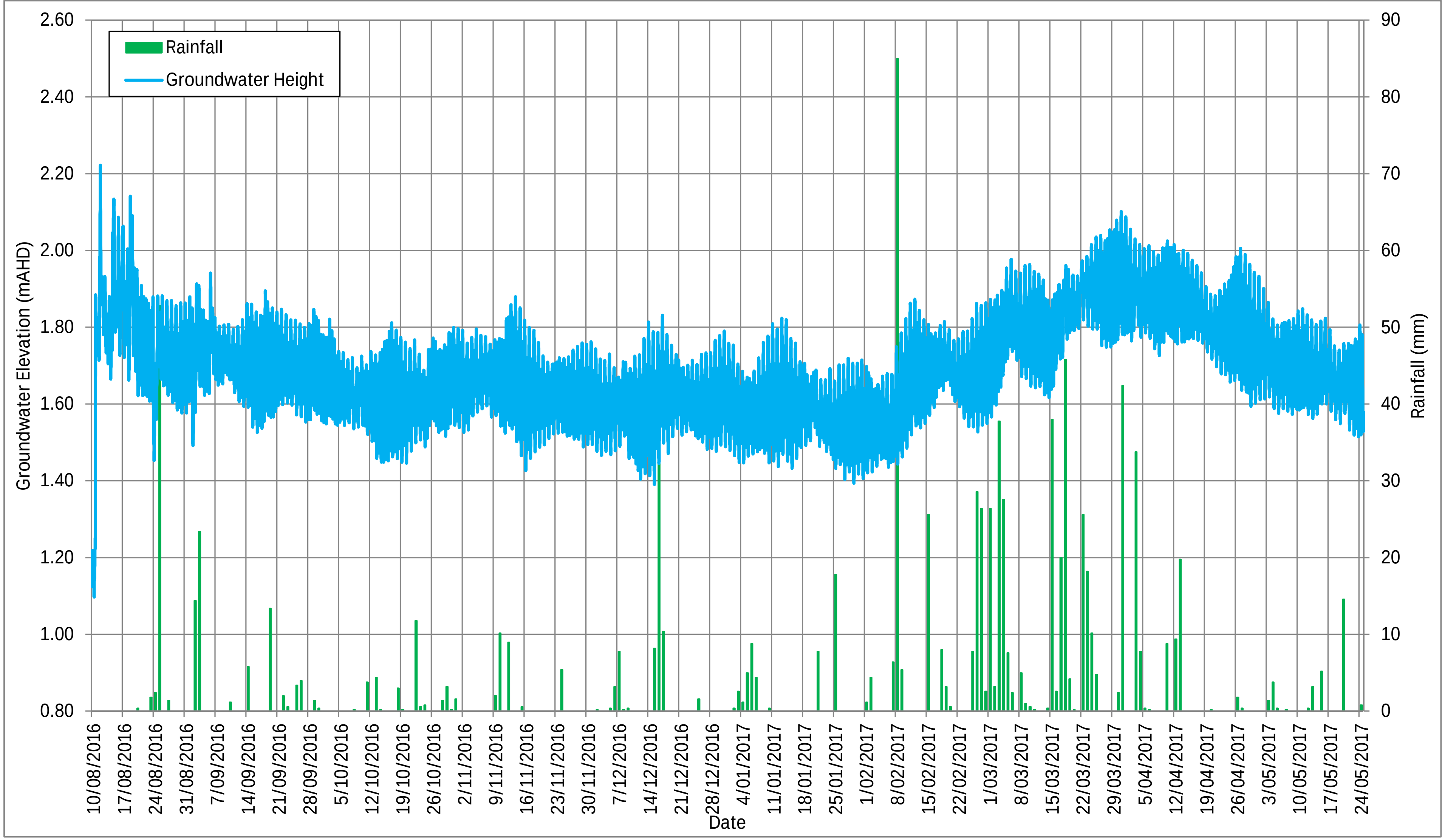
Title: Hydrograph RZ_BH49 and Rainfall
Project: WestConnex - M4/M5 Link
Client: Sydney Motorway Corporation
Location: Rozelle Rail Yards

Screen Interval: 13 - 16 m
Lithology Screened: Alluvium
Monitoring Well Elevation: 5.99 mAHD
Rainfall Measured at Sydney Observatory BoM 066062

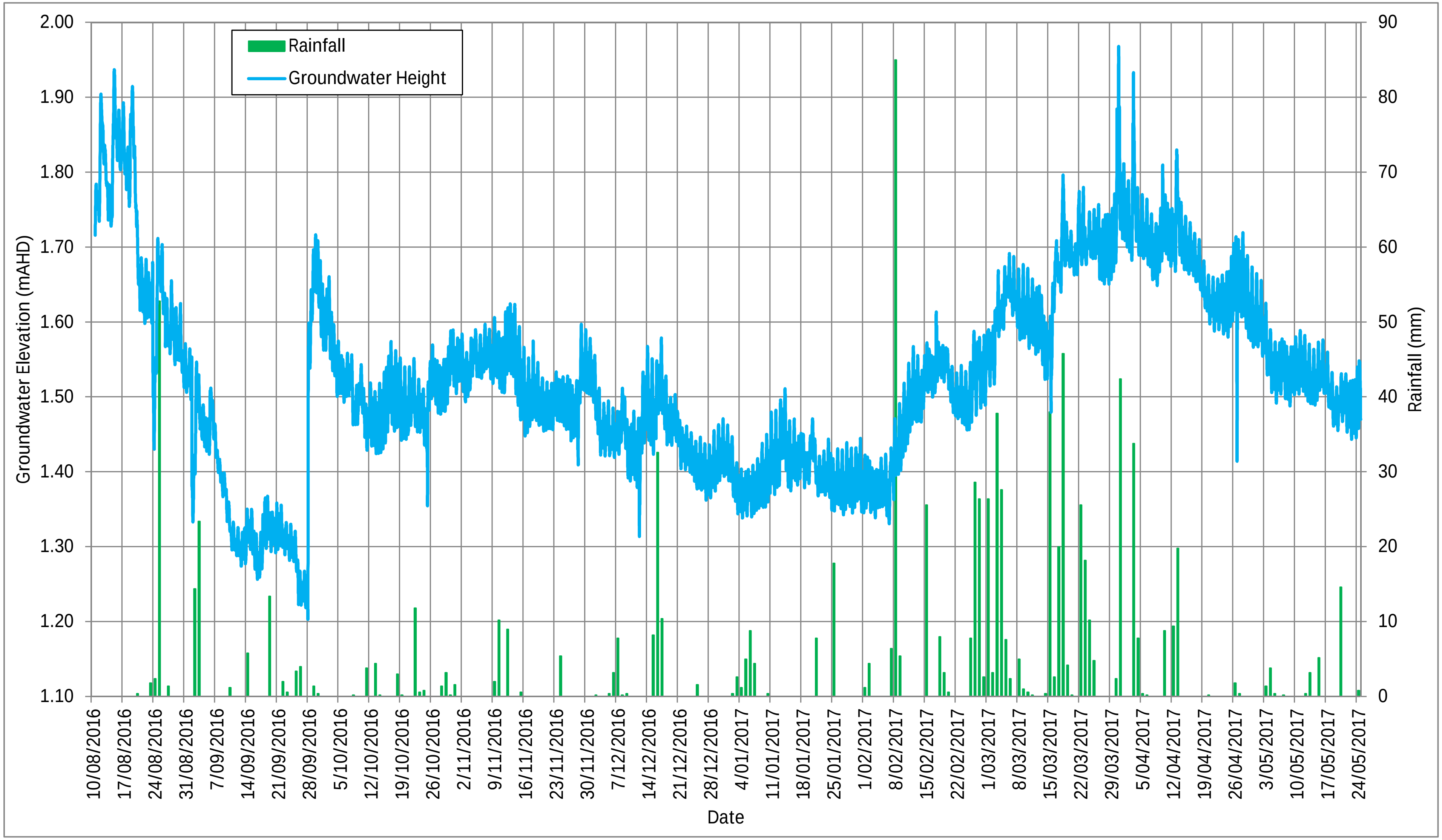
Figure C23
RZ_BH49



AECOM	Title: Hydrograph RZ_BH50 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Rozelle Rail Yards	Screen Interval: 22 - 25 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 1.92 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C24** **RZ_BH50**



AECOM	Client: Hydrograph RZ_BH51 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Rozelle Rail Yards	Screen Interval: 19 - 22 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 2.15 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C25** **RZ_BH51**

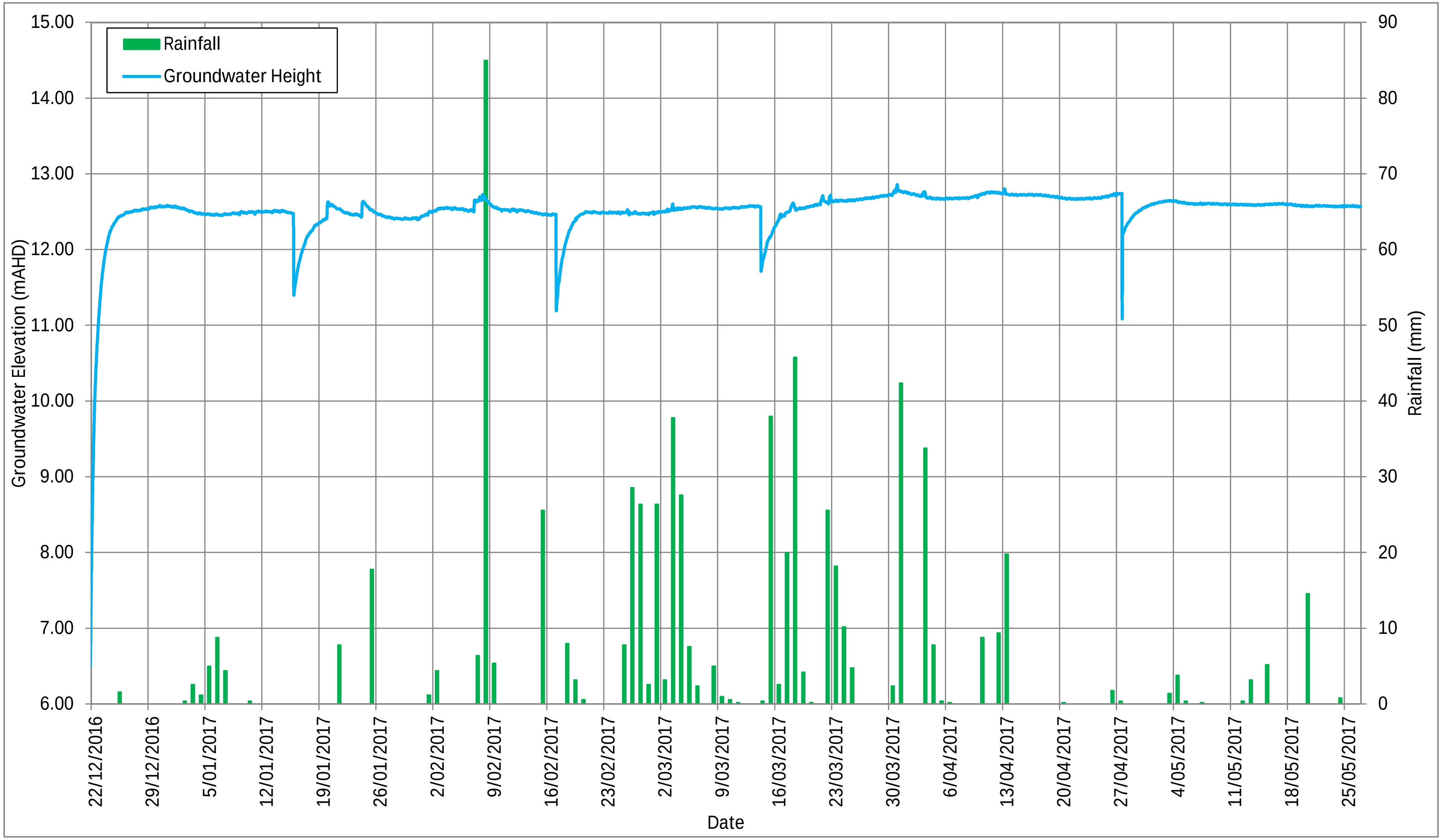


AECOM

Title: Hydrograph RZ_BH52 and Rainfall
Project: WestConnex - M4/M5 Link
Client: Sydney Motorway Corporation
Location: Rozelle Rail Yards

Screen Interval: 32 - 35 m
Lithology Screened: Hawkesbury Sandstone
Monitoring Well Elevation: 2.53 mAHD
Rainfall Measured at Sydney Observatory BoM 066062

Figure C26
RZ_BH52

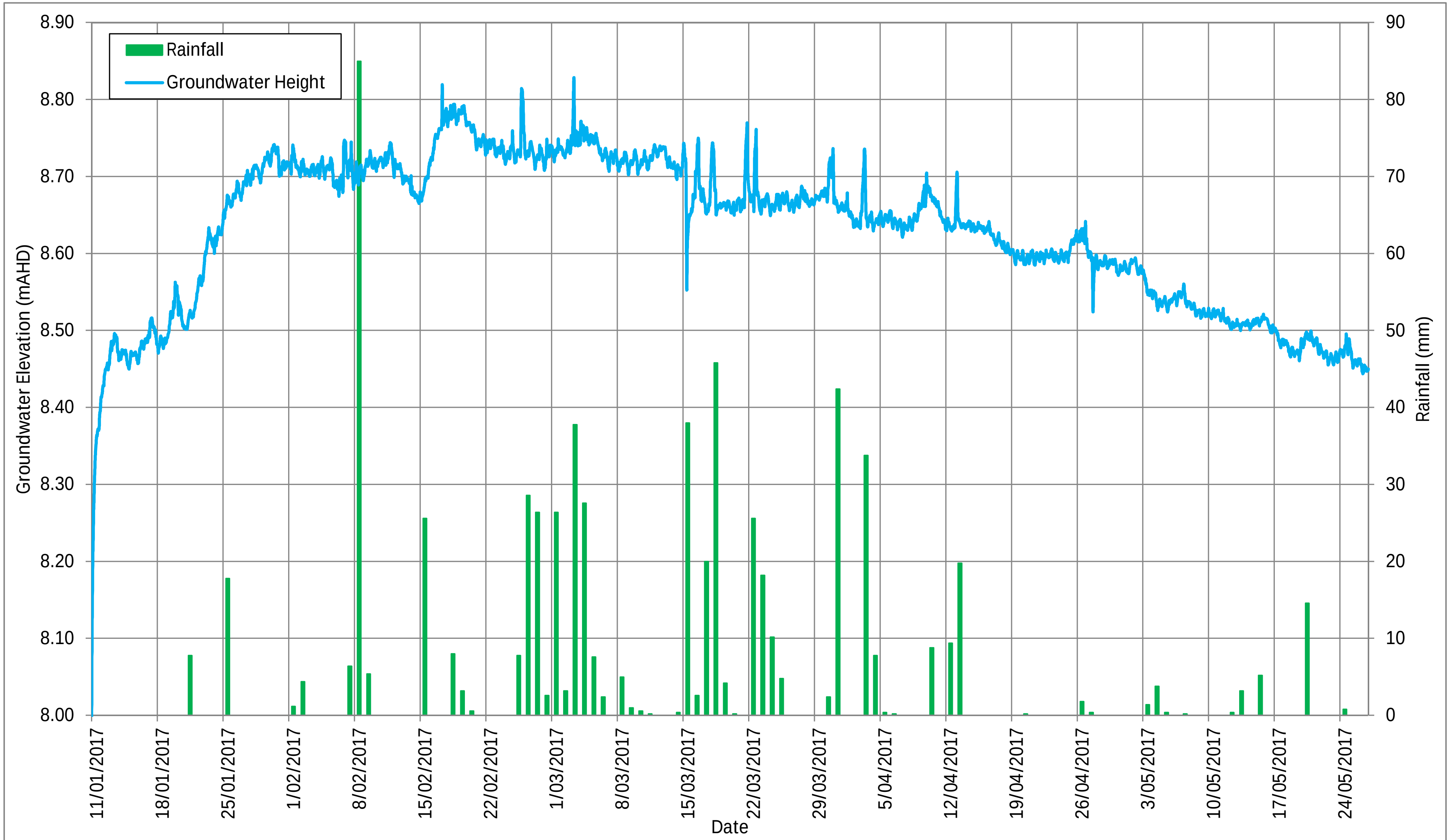


AECOM

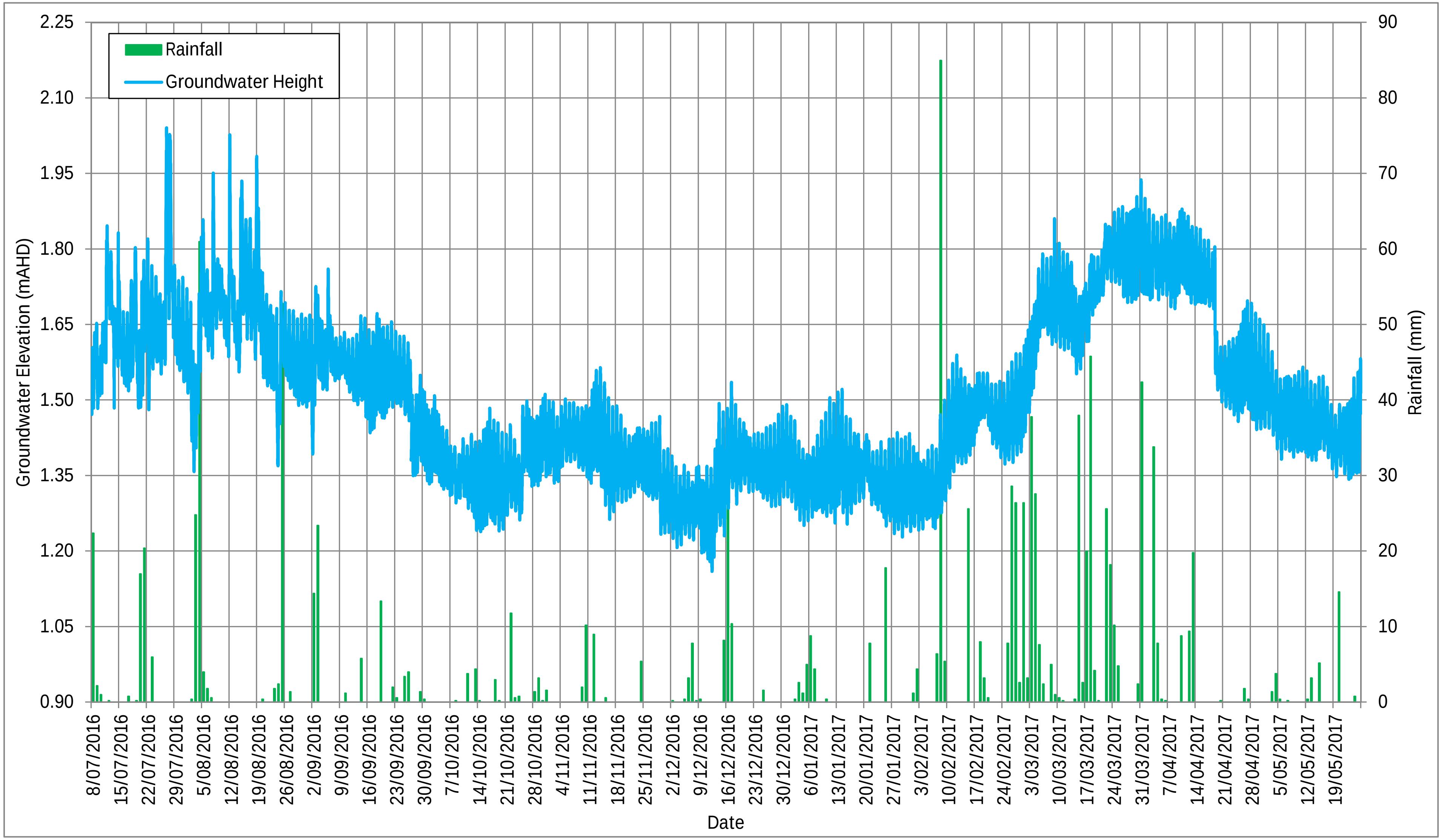
Title: Hydrograph RZ_BH60 and Rainfall
Project: WestConnex - M4/M5 Link
Client: Sydney Motorway Corporation
Location: Rozelle Rail Yards

Screen Interval: 56 - 59 m
Lithology Screened: Hawkesbury Sandstone
Monitoring Well Elevation: 24.96 mAHD
Rainfall Measured at Sydney Observatory BoM 066062

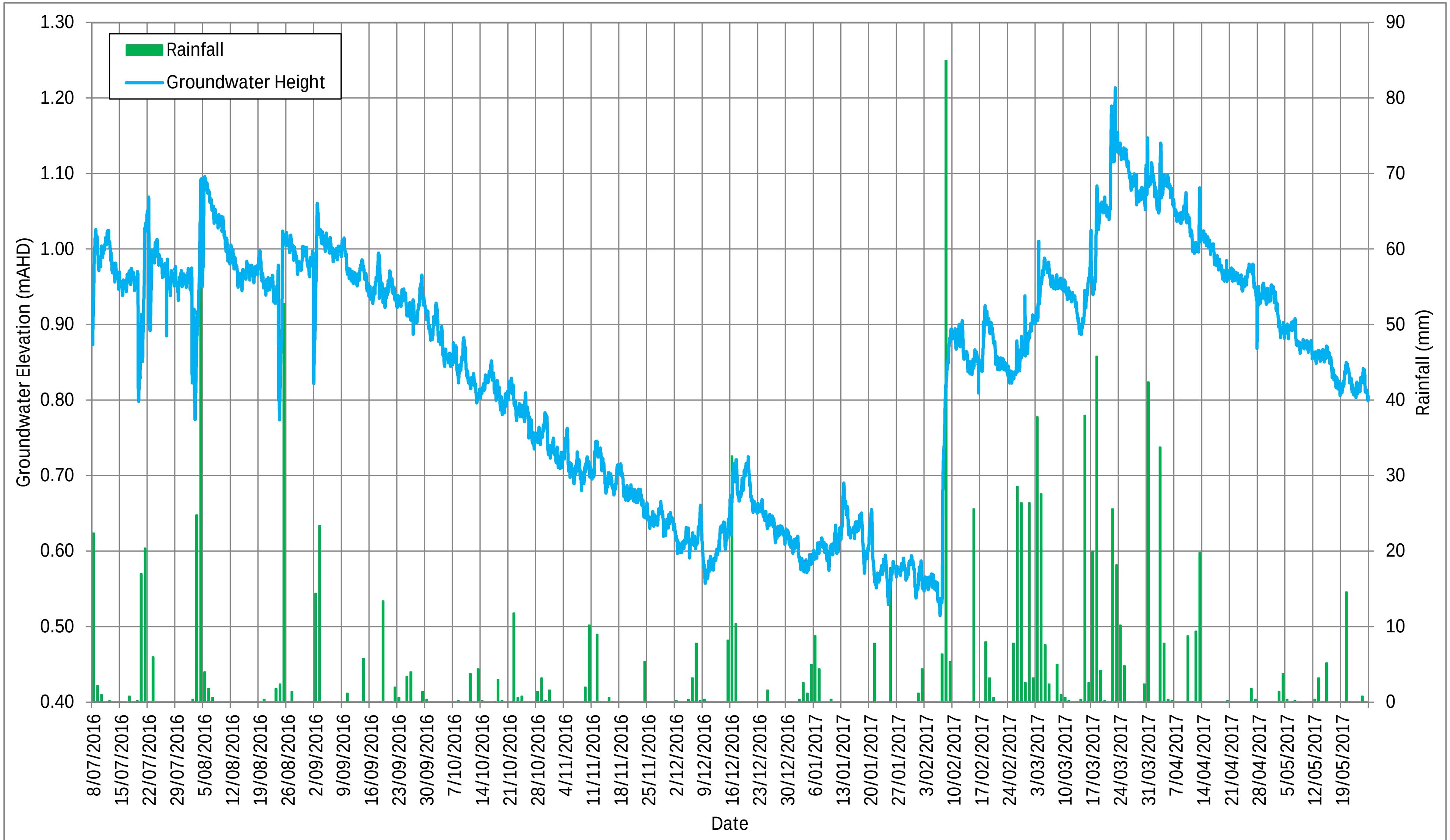
Figure C27
RZ_BH60



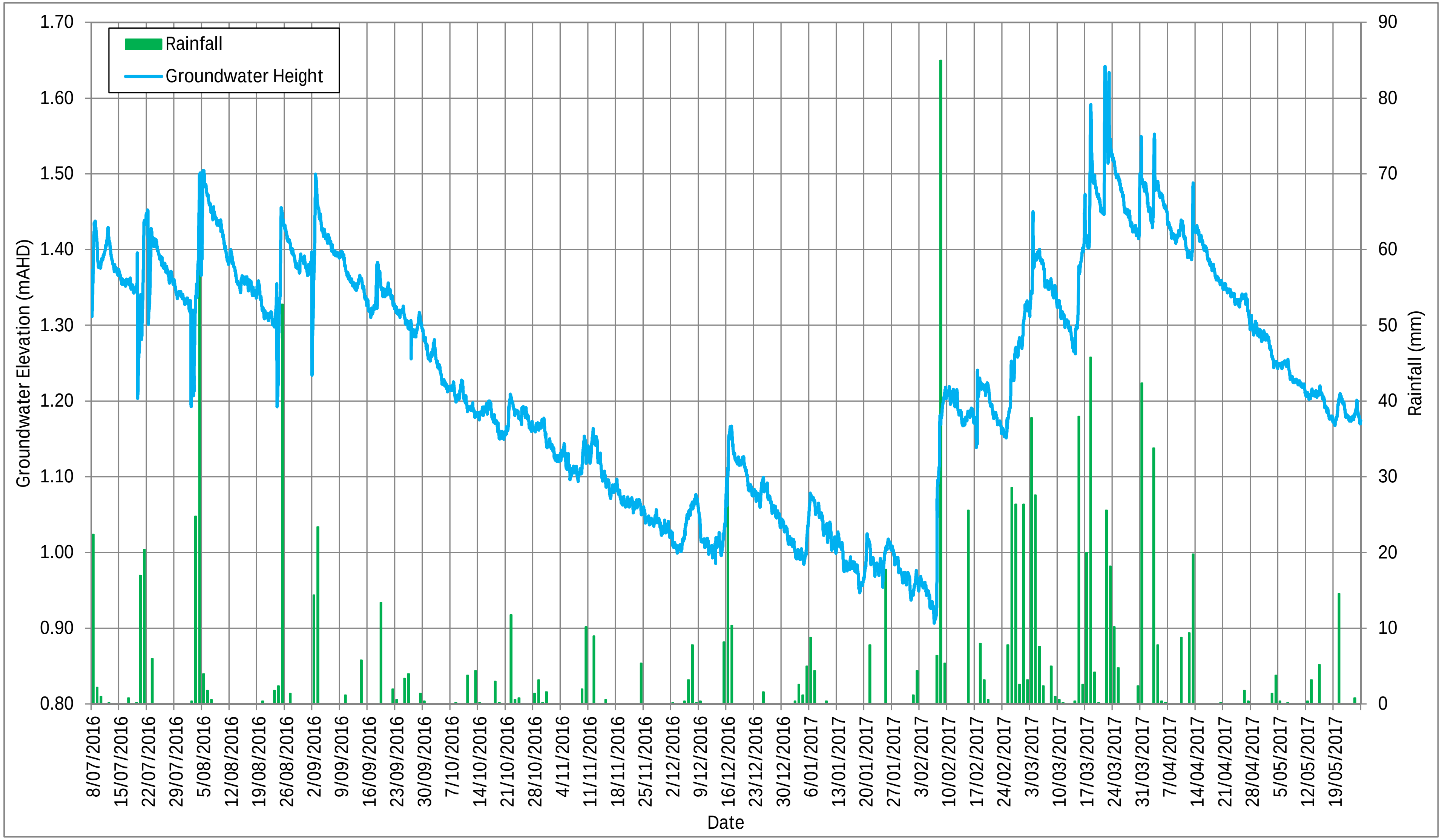
AECOM	Title: Hydrograph RZ_BH67 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Alfred St, Rozelle	Screen Interval: 46 - 49 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 12.84 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C28** **RZ_BH67**



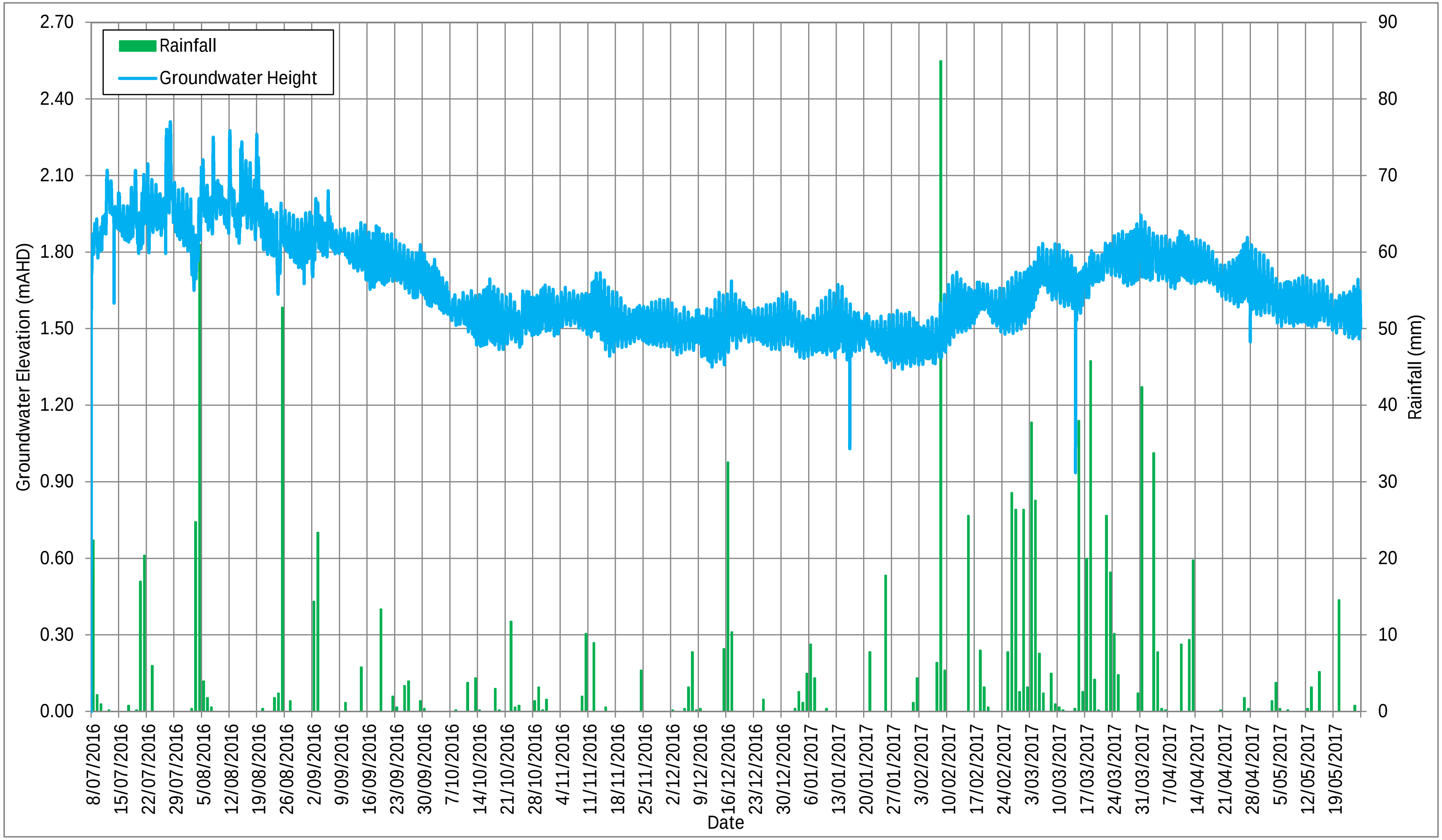
AECOM	Title: Hydrograph TC_BH01D and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Brenan Street, Lilyfield	Screen Interval: 25 - 28 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 2.54 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C29** **TC_BH01D**



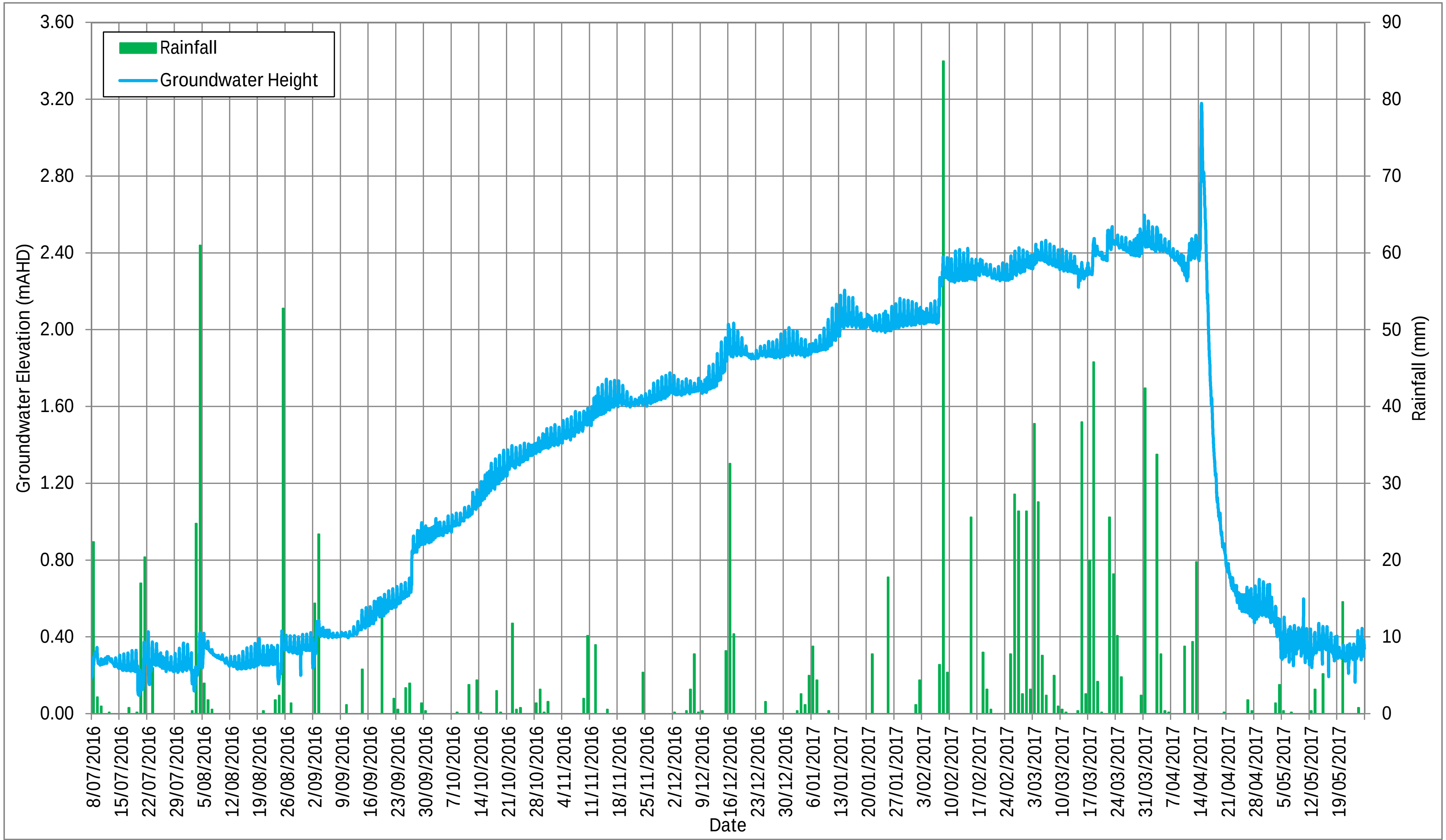
AECOM	Title: Hydrograph TC_BH01S and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Brenan Street, Annandale	Screen Interval: 3 - 6 m Lithology Screened: Alluvium Monitoring Well Elevation: 2.55 m AHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C30** **TC_BH01S**



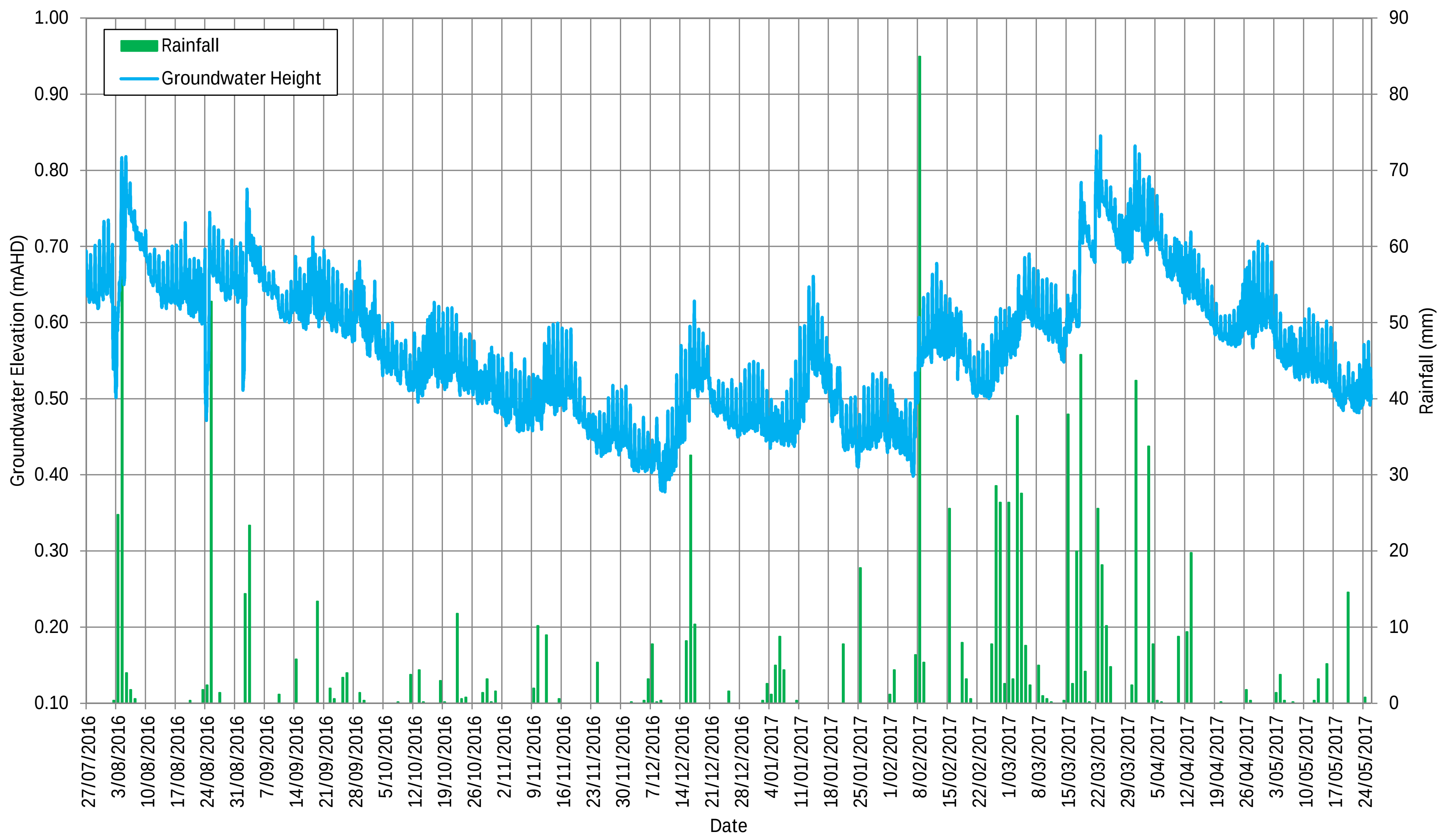
AECOM	Title: Hydrograph TC_BH06 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Brenan Street, Annandale	Screen Interval: 4.5 - 7.5 m Lithology Screened: Alluvium Monitoring Well Elevation: 2.65 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C31** **TC_BH06**



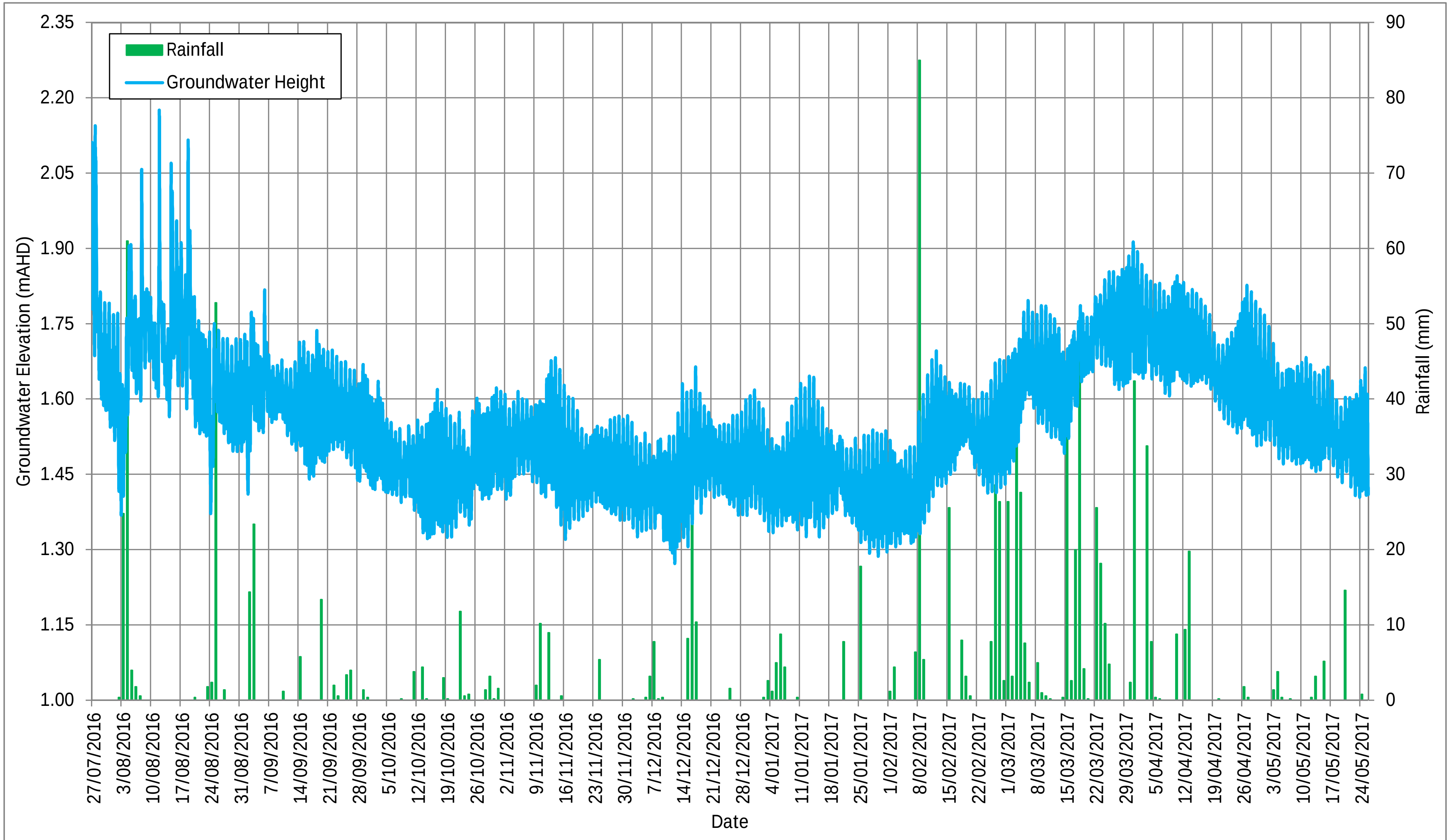
AECOM	Title: Hydrograph TC_BH07D and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Railway Parade, Annandale	Screen Interval: 19 - 22 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 2.03 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C32** **TC_BH07D**



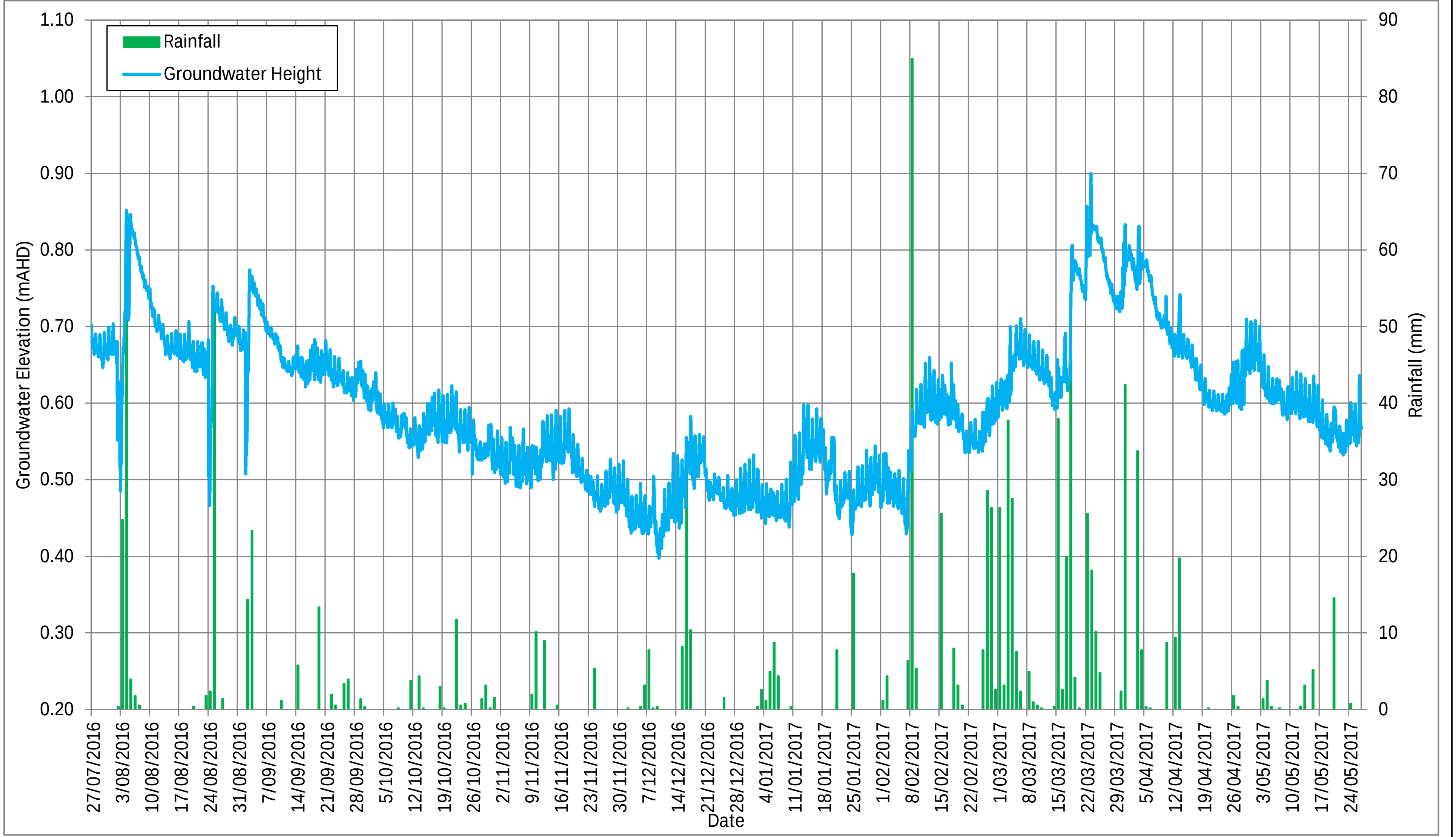
AECOM	Title: Hydrograph TC_BH07S and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Railway Parade, Annandale	Screen Interval: 3 - 6 m Lithology Screened: Alluvium Monitoring Well Elevation: 2.06 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C33** **TC_BH07S**



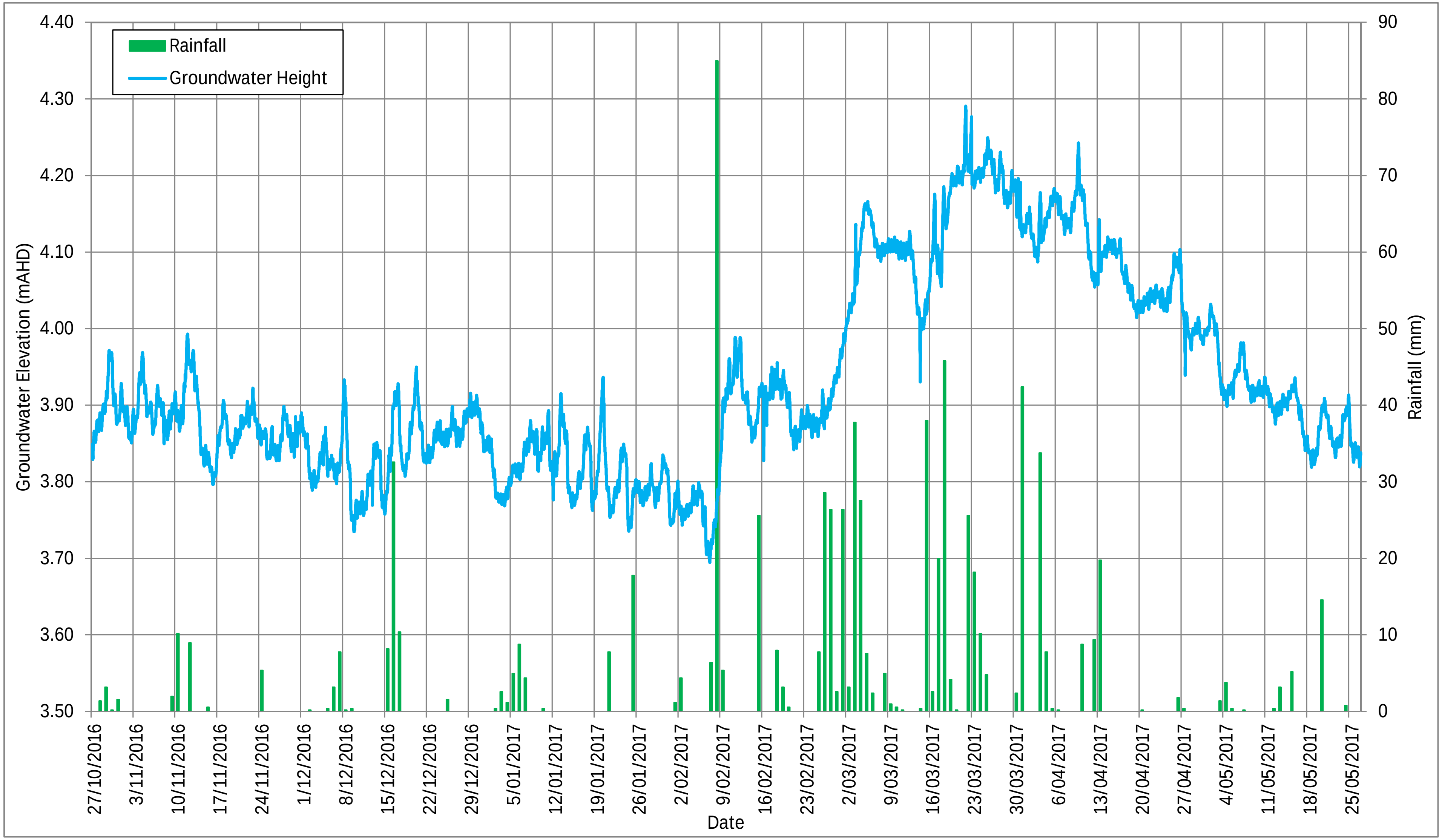
AECOM	Title: Hydrograph TC_BH08 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Railway Parade, Annandale	Screen Interval: 5 - 8 m Lithology Screened: Alluvium Monitoring Well Elevation: 2.24 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C34** **TC_BH08**



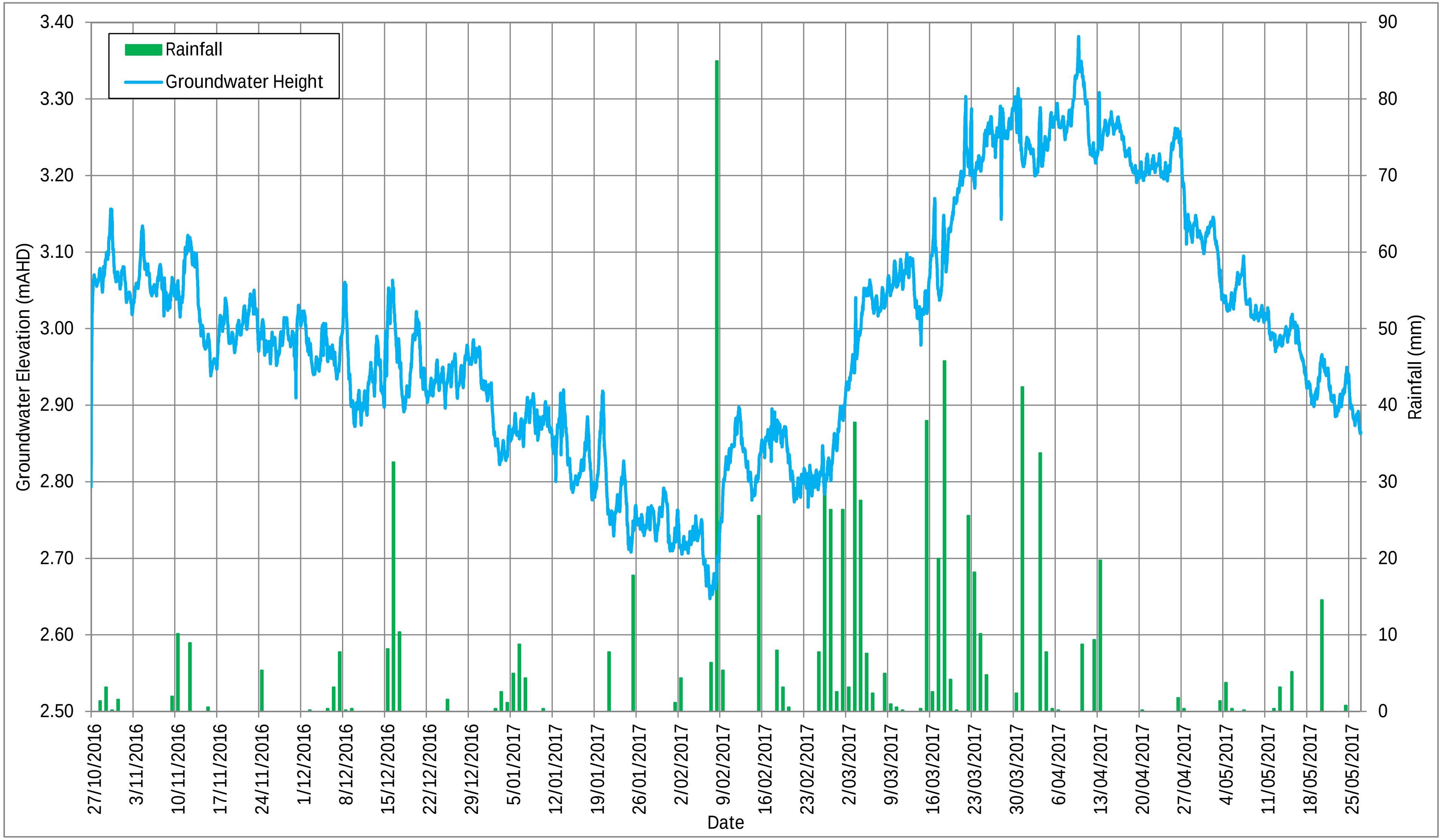
AECOM	Title: Hydrograph TC_BH09D and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Railway Parade, Annandale	Screen Interval: 21 - 24 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 2.25 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C35** **TC_BH09D**



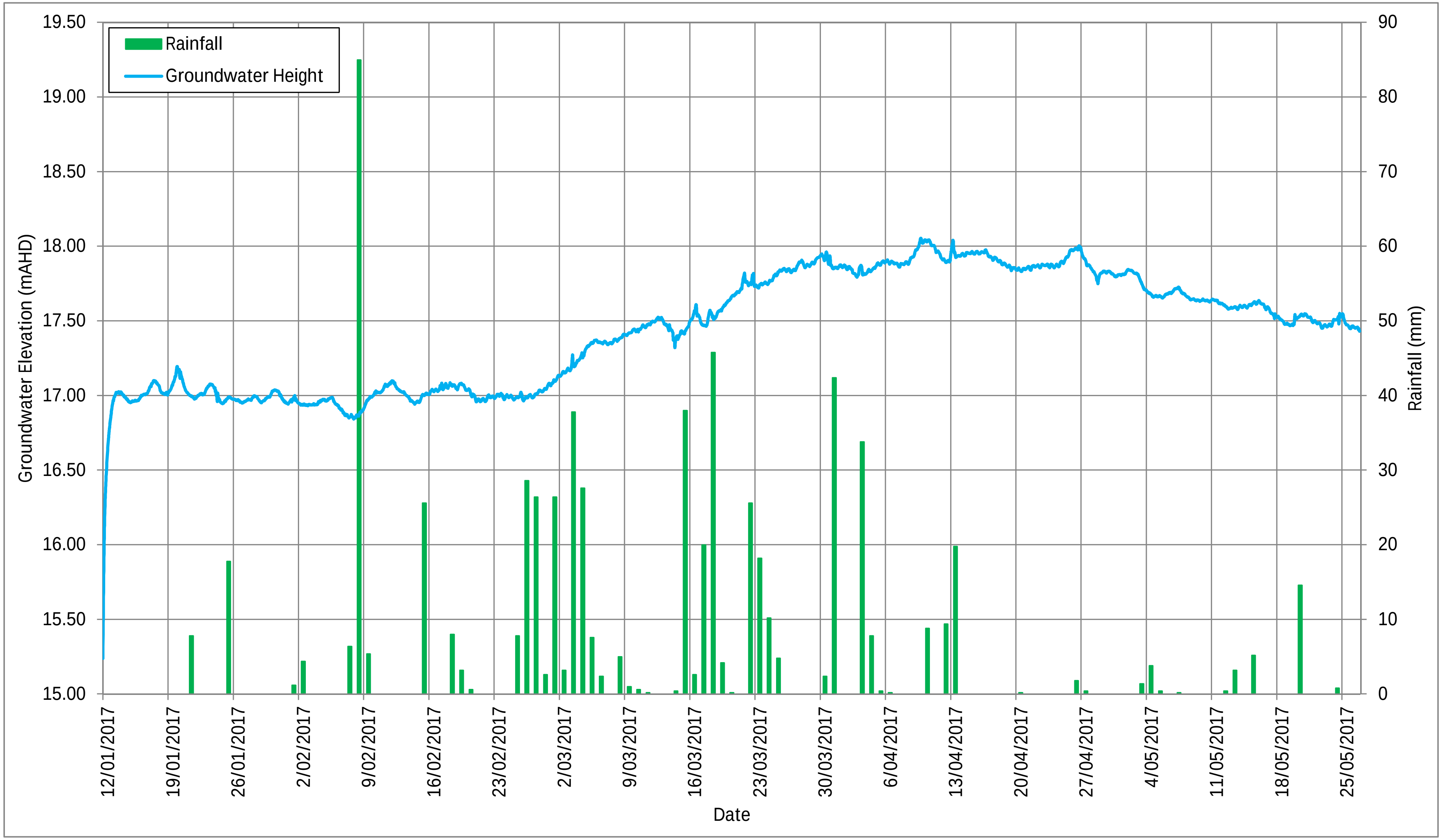
AECOM	Title: Hydrograph TC_BH09S and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Railway Parade, Annandale	Screen Interval: 2 - 5 m Lithology Screened: Alluvium Monitoring Well Elevation: 2.29 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C36** **TC_BH09S**



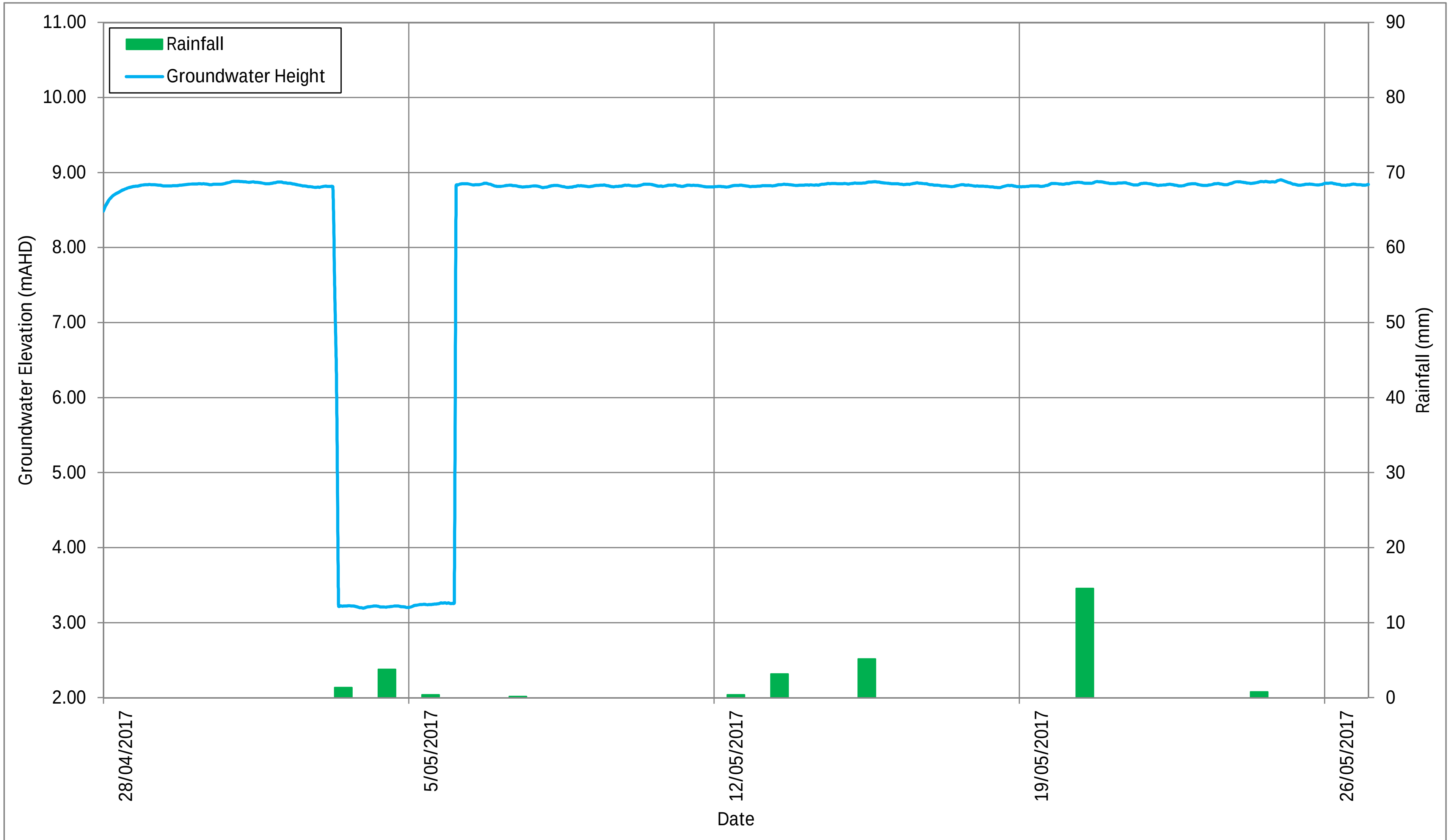
AECOM	Title: Hydrograph EP_BH06 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Opposite 55 Lilyfield Road, Rozelle	Screen Interval: 10 - 13 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 7.601 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C37** **EP_BH06**



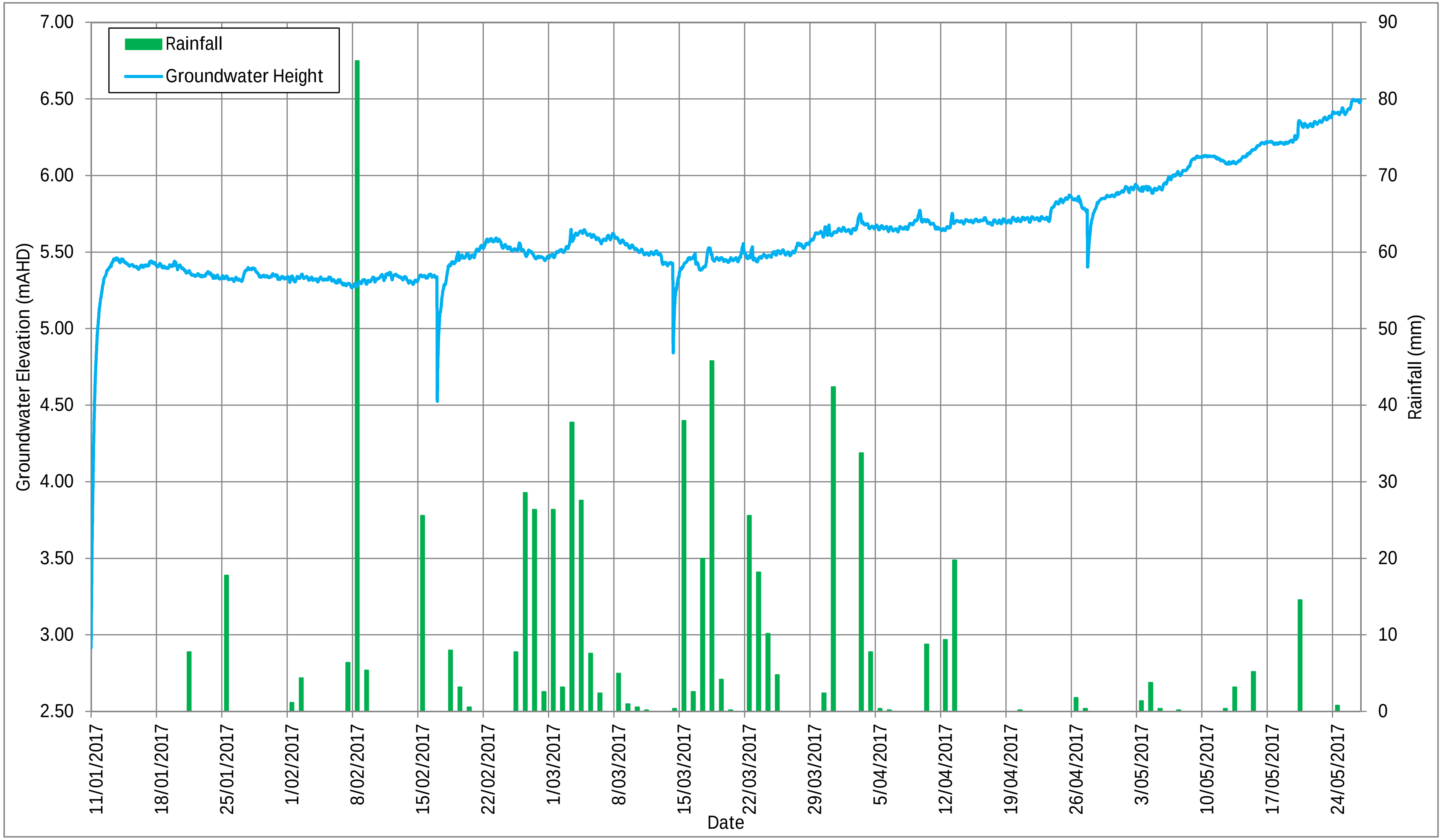
AECOM	Title: Hydrograph EP_BH07 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Opposite 41 Lilyfield Road, Rozelle	Screen Interval: 10 - 13 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 10.478 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C38** **EP_BH07**



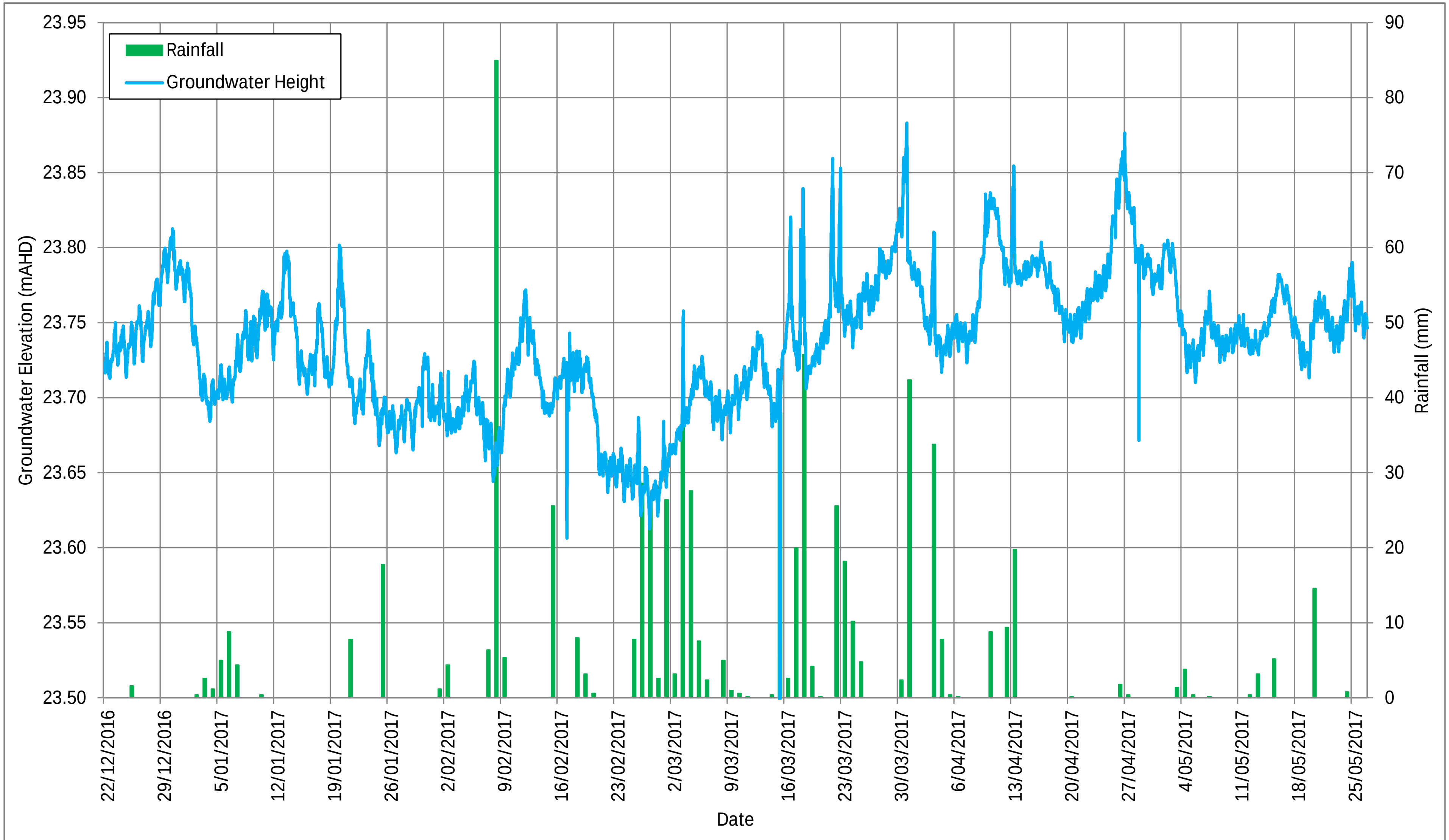
AECOM	Title: Hydrograph IC_BH02 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Toelle Street, Rozelle	Screen Interval: 5 - 11 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 20.77 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C39** **IC_BH02**



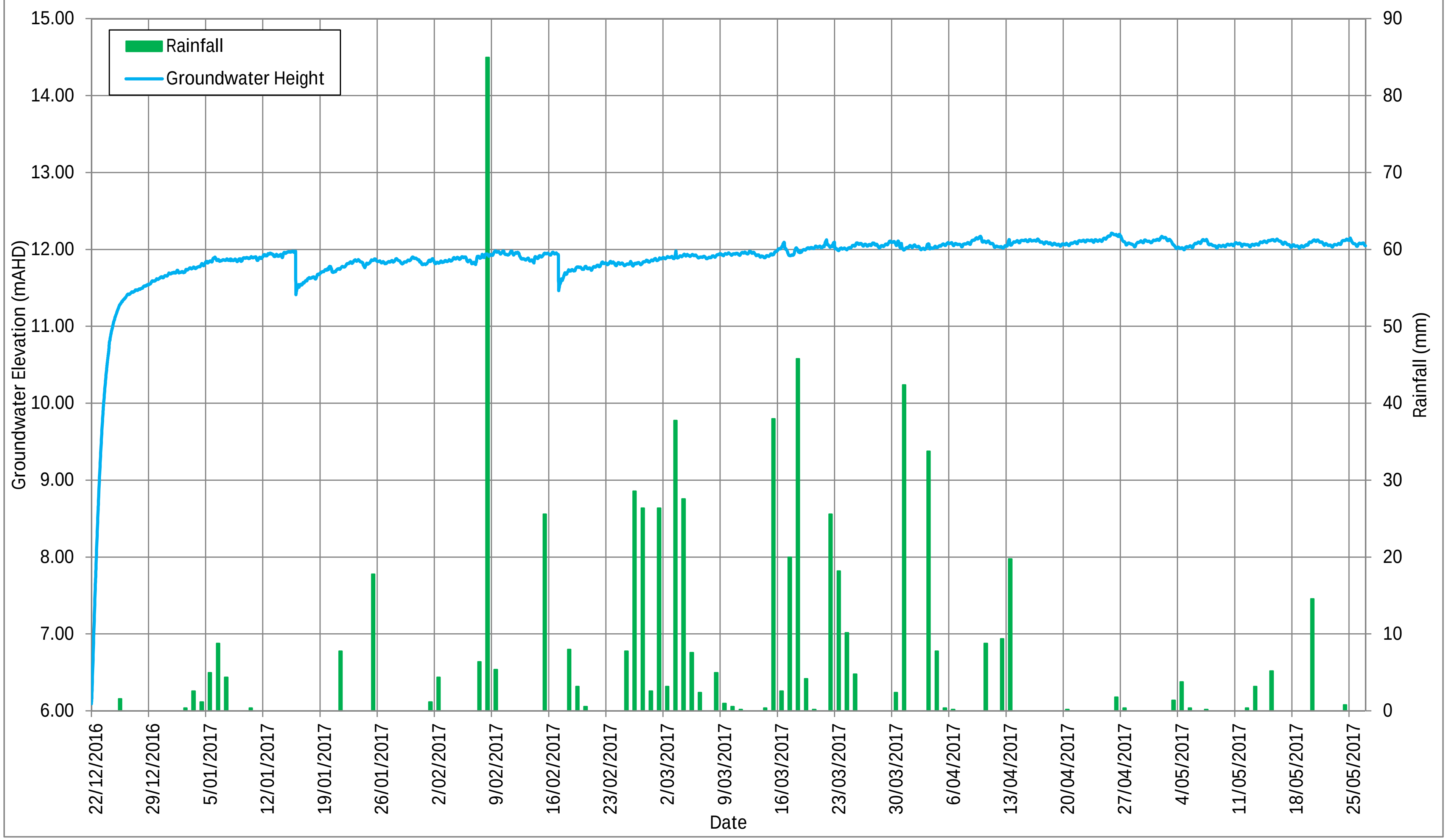
Title: Hydrograph MT_BH02 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Derbyshire Road, Leichhardt	Screen Interval: 42 - 45 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 34.10 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C40** **MT_BH02**



AECOM	Title: Hydrograph MT_BH07 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: 21 Paling Street, Lilyfield	Screen Interval: 43 - 46 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 24.41 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C41** **MT_BH07**



AECOM	Title: Hydrograph MT_BH14 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Rowley Street, Camperdown	Screen Interval: 27 - 30 m Lithology Screened: Laminate Monitoring Well Elevation: 27.314 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C42** **MT_BH14**

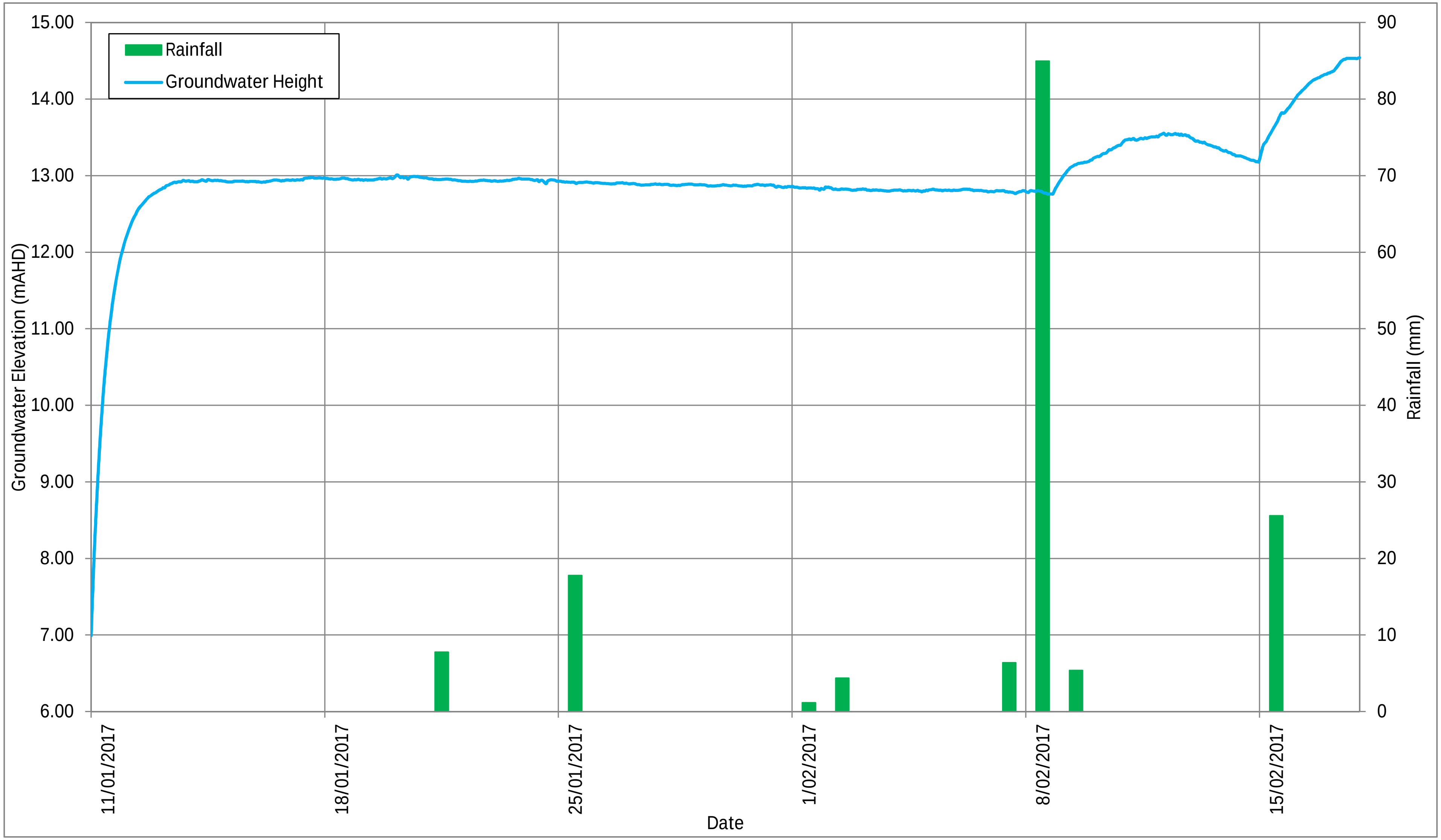


AECOM

Title: Hydrograph MT_BH19 and Rainfall
Project: WestConnex - M4/M5 Link
Client: Sydney Motorway Corporation
Location: Holmwood Street, Newtown

Screen Interval: 55 - 58 m
Lithology Screened: Hawkesbury Sandstone
Monitoring Well Elevation: 16.07 mAHD
Rainfall Measured at Sydney Observatory BoM 066062

Figure C43
MT_BH19



AECOM	Title: Hydrograph MT_BH21 and Rainfall Project: WestConnex - M4/M5 Link Client: Sydney Motorway Corporation Location: Ainsworth Street, Lilyfield	Screen Interval: 47 - 50 m Lithology Screened: Hawkesbury Sandstone Monitoring Well Elevation: 25.05 mAHD Rainfall Measured at Sydney Observatory BoM 066062	**Figure C44** **MT_BH21**

Annexure D – DPI-Water Groundwater database search

Table D1 Summary of Bores registered with DPI (Water)

Bore ID	Depth of Bore (m)	SWL* mbgl	Purpose	Co-ordinates E	Co-ordinates N	Geology Screened
GW071907	180	11.6	Recreation	334034	6247997	Sandstone
GW072018	18	Not Available	Monitoring	327883	6251400	Sandstone
GW102655	25	6.6	Monitoring	330131	6251717	Siltstone
GW102672	9	Not Available	Monitoring	331676	6251590	Sand
GW103258	7	Not Available	Monitoring	331116	6248466	Fill
GW103260	10.7	6.5	Monitoring	331116	6248466	Shale
GW103261	7.4	7.4	Monitoring	331116	6248466	Fill
GW105170	8.2	1.612	Monitoring	324089	6250844	Shale
GW105171	8.2	1.541	Monitoring	324092	6250853	Shale
GW105172	8.2	1.546	Monitoring	324082	6250860	Shale
GW105173	8.2	1.554	Monitoring	324056	6250851	Shale
GW105317	6.5	1.7	Monitoring	331965	6247846	Fill
GW106159	2.5	Not Available	Domestic	326801	6252194	Clay
GW106192	6	4	Domestic	333418	6247611	Sand
GW109646	8.2	5.93	Monitoring	333312	6249293	Sandstone
GW109648	6.2	5.23	Monitoring	333342	6249333	Sandstone
GW109649	7.2	2.95	Monitoring	333320	6249352	Sandstone
GW109651	2.6	0.42	Monitoring	330203	6250093	Sandstone
GW109712	5.8	2.64	Monitoring	332788	6251938	Sandstone
GW109713	6	2.521	Monitoring	332750	6251951	Sandstone
GW109714	5.9	2.55	Monitoring	332745	6252032	Sandstone
GW109715	5.9	4.398	Monitoring	332556	6252060	Sandstone
GW109716	6	1.792	Monitoring	332729	6251981	Sandstone
GW109729	6	1.4	Monitoring	332074	6247641	Clay
GW109730	6.5	1	Monitoring	332089	6247634	Clay
GW109731	6	1.1	Monitoring	332066	6247634	Clay
GW109732	4.3	1.5	Monitoring	332071	6247629	Clay
GW109733	2.4	1.4	Monitoring	332082	6247631	Clay
GW110174	30.1	1.9	Monitoring	328299	6250692	Sandstone
GW110175	3.8	1.9	Monitoring	328303	6250694	Sand
GW110176	37	Not Available	Monitoring	327939	6250491	Sandstone
GW110177	3.7	Not Available	Monitoring	327939	6250492	Sand
GW110178	48	Not Available	Monitoring	327764	6250387	Sandstone
GW110179	5.2	Not Available	Monitoring	327766	6250389	Sandstone
GW110180	34	Not Available	Monitoring	327751	6250334	Sandstone
GW110181	3.1	Not Available	Monitoring	327883	6251400	Sand
GW110182	7.2	Not Available	Monitoring	328036	6250571	Fill
GW110183	30	Not Available	Monitoring	327289	6249422	Shale
GW110184	3	Not Available	Monitoring	327288	6249424	Shale
GW110247	210	31	Domestic	332357	6248363	Sandstone
GW110370	4	0.6	Monitoring	332598	6250123	Sand
GW110371	4	0.7	Monitoring	332598	6250115	Sand
GW110372	4	0.6	Monitoring	332606	6250121	Sandstone
GW110373	4	0.6	Monitoring	332590	6250126	Sandstone

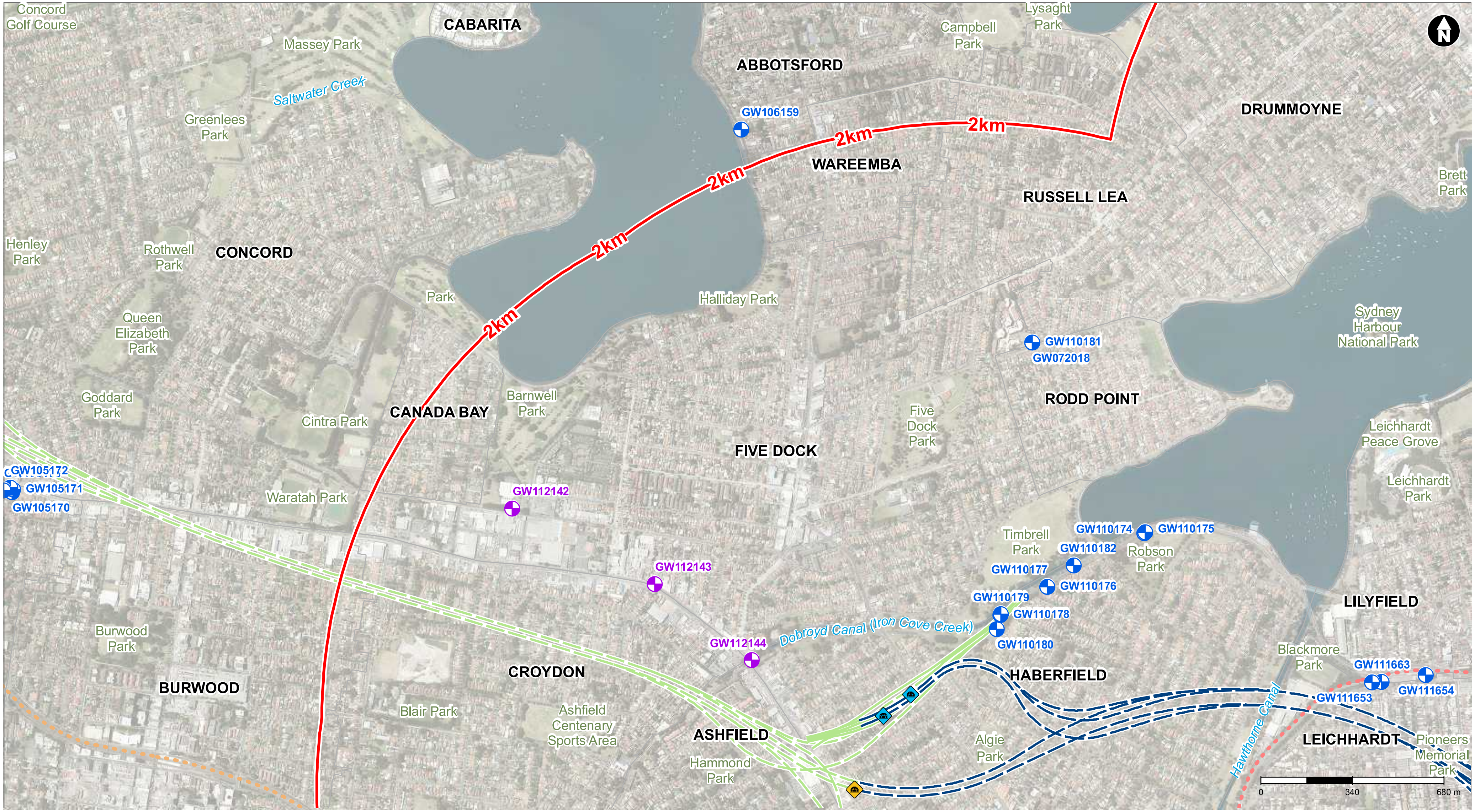
Bore ID	Depth of Bore (m)	SWL* mbgl	Purpose	Co-ordinates E	Co-ordinates N	Geology Screened
GW110374	4	Not Available	Monitoring	332603	6250122	Sand
GW110496	4	1.75	Monitoring	330809	6249527	Sandstone
GW110497	4	2.4	Monitoring	330787	6249544	Sandstone
GW110498	4	2.3	Monitoring	330795	6249554	Sandstone
GW111087	8.7	Not Available	Monitoring	329693	6248632	Clay
GW111088	9	Not Available	Monitoring	329706	6248636	Clay
GW111089	9	Not Available	Monitoring	329715	6248641	Clay
GW111164	8	Not Available	Domestic	332686	6246860	Sand
GW111329	6	Not Available	Monitoring	332704	6250560	Sandstone
GW111330	4	Not Available	Monitoring	332729	6250538	Sandstone
GW111331	6	Not Available	Monitoring	332742	6250509	Sandstone
GW111350	7.5	Not Available	Monitoring	331456	6247614	Shale
GW111352	8	7.7	Monitoring	331445	6247600	Shale
GW111353	7	2.5	Monitoring	331440	6247590	Shale
GW111408	4.4	2.07	Monitoring	332066	6249142	Sand
GW111653	2.5	Not Available	Monitoring	329146	6250135	Sand
GW111654	3	Not Available	Monitoring	329345	6250163	Sandstone
GW111663	4	2.3	Monitoring	329182	6250138	Sandstone
GW111686	3.3	1.55	Monitoring	329728	6246909	Clay
GW111687	4.25	2.5	Monitoring	329742	6246916	Clay
GW111692	1.3	0.5	Monitoring	329704	6246701	Clay
GW111958	6	3.49	Monitoring	333507	6247347	Sand

Table D2 Summary of Bores registered with DPI(Water) - no hydrogeological data

Bore ID	Co-ordinates		Location
	E	N	
GW102356	333120	6246963	Green Square
GW102357	333093	6246993	Green Square
GW102358	333145	6246994	Green Square
GW102359	333146	6246901	Green Square
GW102360	333147	6246871	Green Square
GW102361	333146	6246901	Green Square
GW102362	333171	6246963	Green Square
GW109230	331802	6249055	Parramatta Rd Camperdown
GW109231	331787	6249063	Parramatta Rd Camperdown
GW109500	333698	6248974	Former Brewery Camperdown
GW109501	333441	6249156	Former Brewery Camperdown
GW109502	333442	6249090	Former Brewery Camperdown
GW109503	333460	6249045	Former Brewery Camperdown
GW110351	332651	6247224	Sydney Park
GW112107	327311	6249352	Parramatta Rd Ashfield
GW112108	327319	6249352	Parramatta Rd Ashfield
GW112109	327317	6249364	Parramatta Rd Ashfield
GW112110	327310	6249373	Parramatta Rd Ashfield
GW112142	325949	6250783	Parramatta Rd Croydon
GW112143	326478	6250502	Parramatta Rd Croydon
GW112144	326839	6250218	Parramatta Rd Croydon
GW113092	327981	6249414	Ramsay St Haberfield
GW113093	327981	6249407	Ramsay St Haberfield
GW113094	327988	6249401	Ramsay St Haberfield
GW113095	327997	6249404	Ramsay St Haberfield
GW113096	328012	6249415	Ramsay St Haberfield
GW113097	328008	6249428	Ramsay St Haberfield
GW113098	327992	6249422	Ramsay St Haberfield
GW113099	328013	6249424	Ramsay St Haberfield
GW113557	333535	6252060	Barangaroo
GW113558	333541	6251980	Barangaroo
GW113559	333544	6251910	Barangaroo
GW113560	333548	6251850	Barangaroo
GW113561	333555	6251791	Barangaroo
GW113562	333562	6251731	Barangaroo
GW113563	333577	6251647	Barangaroo
GW113564	333582	6251610	Barangaroo
GW113565	333619	6251603	Barangaroo
GW113566	333667	6251601	Barangaroo
GW113596	333741	6251591	Barangaroo
GW113597	333738	6251600	Barangaroo
GW113598	333745	6251581	Barangaroo
GW113599	333687	6251505	Barangaroo
GW113600	333687	6251505	Barangaroo

Bore ID	Co-ordinates		Location
	E	N	
GW113601	333687	6251505	Barangaroo
GW113602	333727	6251531	Barangaroo
GW113603	333717	6251525	Barangaroo
GW113604	333735	6251538	Barangaroo
GW113605	333744	6251547	Barangaroo
GW113606	333686	6251550	Barangaroo
GW113607	333727	6251558	Barangaroo
GW113608	333754	6251570	Barangaroo
GW113609	333754	6251570	Barangaroo
GW113610	333722	6251579	Barangaroo
GW113611	333687	6251539	Barangaroo
GW113612	333710	6251585	Barangaroo
GW113799	333085	6246786	Green Square
GW113800	333065	6246798	Green Square
GW113801	333046	6246787	Green Square
GW113802	332978	6246947	Green Square
GW113803	333001	6246929	Green Square
GW113804	332988	6246909	Green Square
GW113805	332998	6246723	Green Square
GW113806	332986	6246705	Green Square
GW113807	333116	6246792	Green Square
GW113808	333087	6246770	Green Square
GW113809	333088	6246755	Green Square
GW113810	332969	6246740	Green Square
GW113811	332968	6246812	Green Square
GW113812	332969	6246796	Green Square
GW113813	332982	6246807	Green Square
GW113814	333016	6246665	Green Square
GW113815	332950	6246887	Green Square
GW113816	332861	6246662	Green Square
GW113817	332988	6246671	Green Square
GW113818	332975	6246752	Green Square
GW113819	332948	6246700	Green Square
GW113820	332988	6246690	Green Square
GW113821	333031	6246703	Green Square
GW113822	332995	6246774	Green Square
GW113823	333029	6246835	Green Square
GW113824	333035	6246857	Green Square
GW113855	333710	6248970	Green Square
GW113856	333708	6248970	Green Square
GW113857	333685	6248983	Green Square
GW113858	333682	6248985	Green Square
GW113859	333677	6248973	Green Square
GW113860	333712	6248976	Green Square
GW113861	333537	6249043	Former Brewery Camperdown
GW113862	333564	6248987	Former Brewery Camperdown

Bore ID	Co-ordinates		Location
	E	N	
GW113863	333563	6248991	Former Brewery Camperdown
GW113864	333563	6248995	Former Brewery Camperdown
GW113865	333563	6248998	Former Brewery Camperdown
GW113866	333562	6249008	Former Brewery Camperdown
GW113867	333562	6249004	Former Brewery Camperdown
GW113869	333562	6249011	Former Brewery Camperdown
GW113870	333561	6249016	Former Brewery Camperdown
GW113871	333561	6249019	Former Brewery Camperdown
GW113872	333572	6249020	Former Brewery Camperdown
GW113873	333698	6248979	Former Brewery Camperdown
GW113874	333699	6248977	Former Brewery Camperdown
GW113875	333698	6248974	Former Brewery Camperdown
GW113876	333578	6249020	Former Brewery Camperdown
GW113877	333587	6249019	Former Brewery Camperdown
GW113878	333596	6249017	Former Brewery Camperdown
GW113879	333711	6249000	Former Brewery Camperdown
GW113880	333544	6249014	Former Brewery Camperdown
GW113881	333691	6248963	Former Brewery Camperdown
GW113882	333696	6248961	Former Brewery Camperdown
GW113883	333712	6248959	Former Brewery Camperdown
GW113884	333698	6248974	Former Brewery Camperdown
GW113885	333710	6248956	Former Brewery Camperdown
GW113886	333680	6248970	Former Brewery Camperdown
GW113887	333664	6248987	Former Brewery Camperdown
GW113888	333668	6248990	Former Brewery Camperdown
GW113889	333685	6248979	Former Brewery Camperdown
GW113890	333700	6248961	Former Brewery Camperdown
GW113891	333705	6248960	Former Brewery Camperdown
GW113892	333708	6248960	Former Brewery Camperdown
GW113893	333711	6248960	Former Brewery Camperdown
GW114004	328896	6249585	Darley Rd Leichhardt
GW114182	332763	6250568	Blackwattle Bay northern foreshore
GW114183	332766	6250591	Blackwattle Bay northern foreshore
GW114184	332799	6250576	Blackwattle Bay northern foreshore
GW114185	332727	6250577	Blackwattle Bay northern foreshore
GW114186	332785	6250595	Blackwattle Bay northern foreshore
GW114187	332760	6250542	Blackwattle Bay northern foreshore
GW114211	325854	6248634	Blackwattle Bay northern foreshore
GW114212	325854	6248636	Blackwattle Bay northern foreshore
GW114213	325855	6248640	Blackwattle Bay northern foreshore
GW114214	325856	6248643	Blackwattle Bay northern foreshore



New M5
- Surface road
- Tunnel

M4 East
- Surface road
- Tunnel

M4-M5 Link

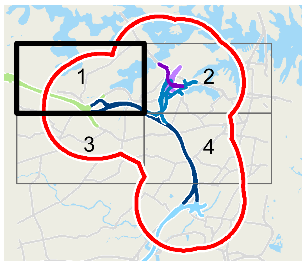
Mainline
- Surface road
- Tunnel

Rozelle interchange
- Surface road
- Tunnel

Iron Cove Link
- Surface road
- Tunnel

Proposed future WHTBL connections (civil construction only)
- Surface road
- Tunnel

Groundwater impact assessment
- Area of interest
- Bore location
- Bore location (no geological information available)



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SHEET Page 1 of 4	COORDINATE SYSTEM GDA 1994 MGA Zone 56

TITLE
M4-M5 LINK - GROUNDWATER IMPACT ASSESSMENT
GROUNDWATER BORE LOCATIONS
AREA OF INTEREST - NORTHWEST

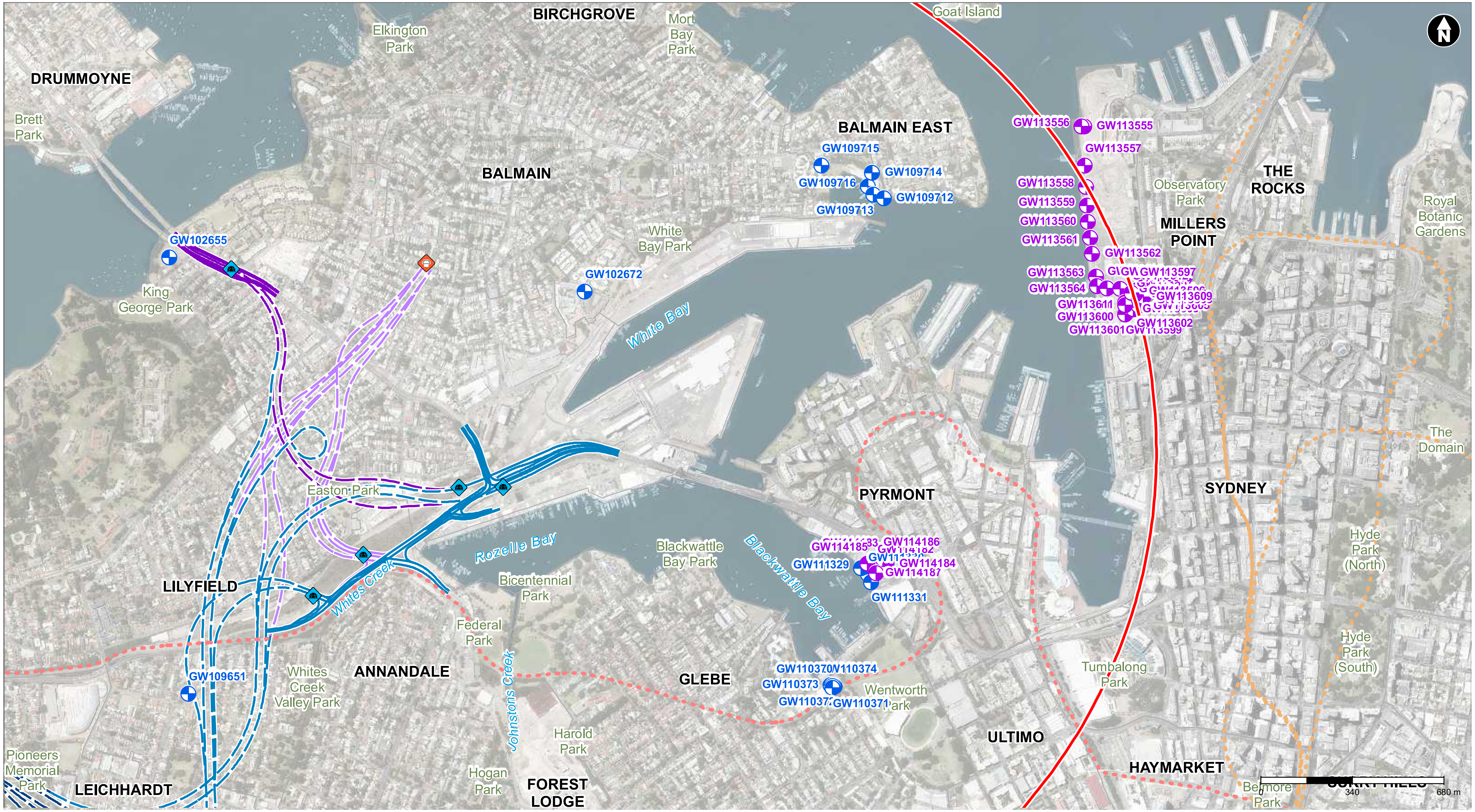
PROJECT
WESTCONNEX M4-M5 LINK

CLIENT
SYDNEY MOTORWAY CORPORATION

DRAWN	CHECK	DATE	PROJECT #	MAP #	REV	Project
SG		10/08/2017	60491677	WCXM4M5474	01	60491677

WestConnex
Building for the future

AECOM



New M5
- Surface road
- Tunnel

M4 East
- Surface road
- Tunnel

M4-M5 Link
Mainline
- Surface road
- Tunnel

Rozelle interchange
- Surface road
- Tunnel

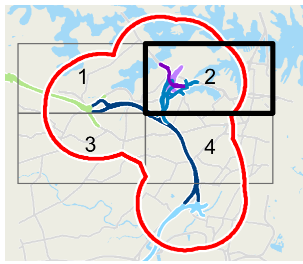
Iron Cove Link
- Surface road
- Tunnel

Proposed future WHTBL connections (civil construction only)
- Surface road
- Tunnel

Groundwater impact assessment
- Area of interest
- Bore location
- Bore location (no geological information available)

WestConnex
Building for the future

AECOM



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COORDINATE SYSTEM GDA 1994 MGA Zone 56

TITLE
M4-M5 LINK - GROUNDWATER IMPACT ASSESSMENT
GROUNDWATER BORE LOCATIONS
AREA OF INTEREST - NORTHEAST

PROJECT
WESTCONNEX M4-M5 LINK

CLIENT
SYDNEY MOTORWAY CORPORATION

DRAWN	CHECK	DATE	PROJECT #	MAP #	REV	Project
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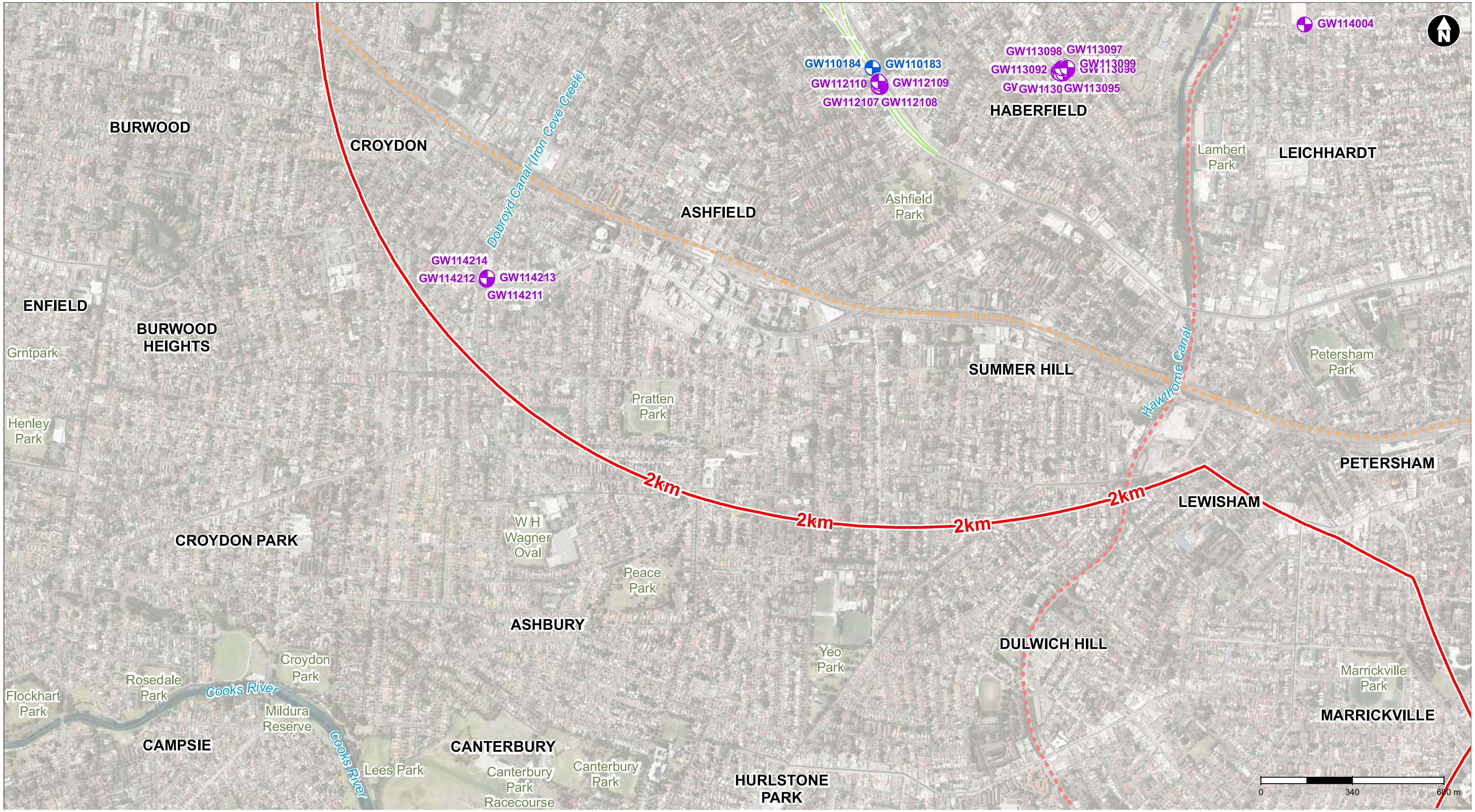
AECOM GIS Printed Date: 10/08/2017



New M5
- Surface road
- Tunnel

M4 East
- Surface road
- Tunnel

M4-M5 Link
Mainline
- Surface road
- Tunnel

Rozelle interchange
- Surface road
- Tunnel

Iron Cove Link
- Surface road
- Tunnel

Proposed future WHTBL connections (civil construction only)
- Surface road
- Tunnel

Groundwater impact assessment
- Area of interest
- Bore location
- Bore location (no geological information available)

WestConnex
Building for the future

AECOM

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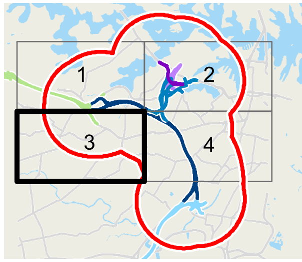

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Page 3 of 4

COORDINATE SYSTEM
GDA 1994 MGA Zone 56

TITLE
M4-M5 LINK - GROUNDWATER IMPACT ASSESSMENT
GROUNDWATER BORE LOCATIONS
AREA OF INTEREST - SOUTHWEST

PROJECT
WESTCONNEX M4-M5 LINK

CLIENT
SYDNEY MOTORWAY CORPORATION

DRAWN	CHECK	DATE	PROJECT #	MAP #	REV	Project
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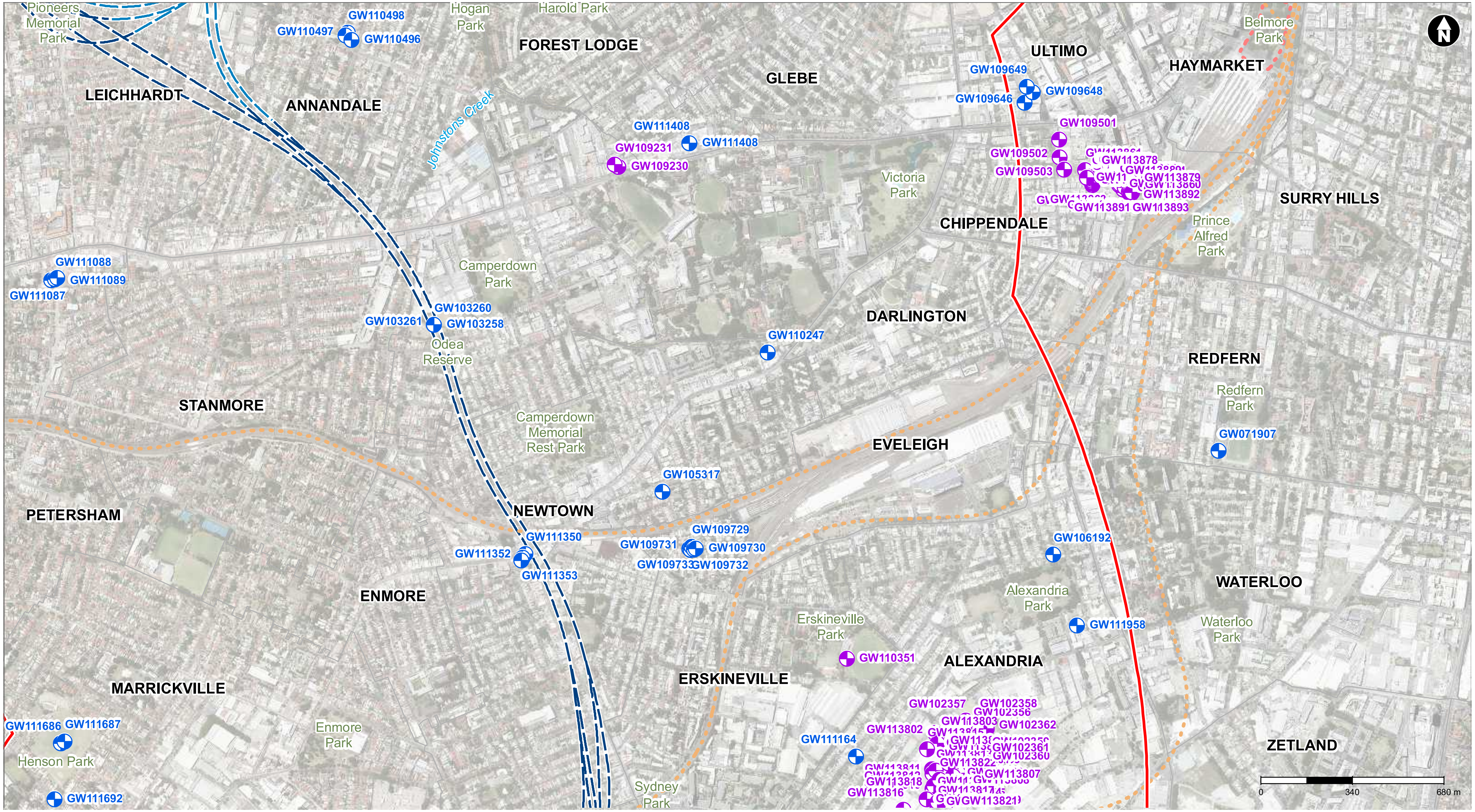


New M5
- Surface road
- Tunnel

M4 East
- Surface road
- Tunnel

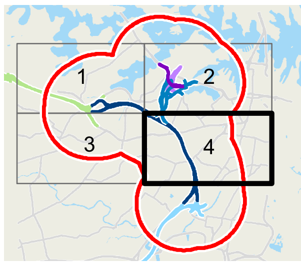
M4-M5 Link Mainline
- Surface road
- Tunnel

Rozelle interchange
- Surface road
- Tunnel

Iron Cove Link
- Surface road
- Tunnel

Proposed future WHTBL connections (civil construction only)
- Surface road
- Tunnel

Groundwater impact assessment
- Area of interest
- Bore location
- Bore location (no geological information available)



WestConnex
Building for the future

AECOM

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SHEET Page 4 of 4	COORDINATE SYSTEM GDA 1994 MGA Zone 56

TITLE
M4-M5 LINK - GROUNDWATER IMPACT ASSESSMENT
GROUNDWATER BORE LOCATIONS
AREA OF INTEREST - SOUTHEAST

PROJECT
WESTCONNEX M4-M5 LINK

CLIENT
SYDNEY MOTORWAY CORPORATION

DRAWN	CHECK	DATE	PROJECT #	MAP #	REV	Project
SG		10/08/2017	60491677	WCXM4M5474	01	60491677

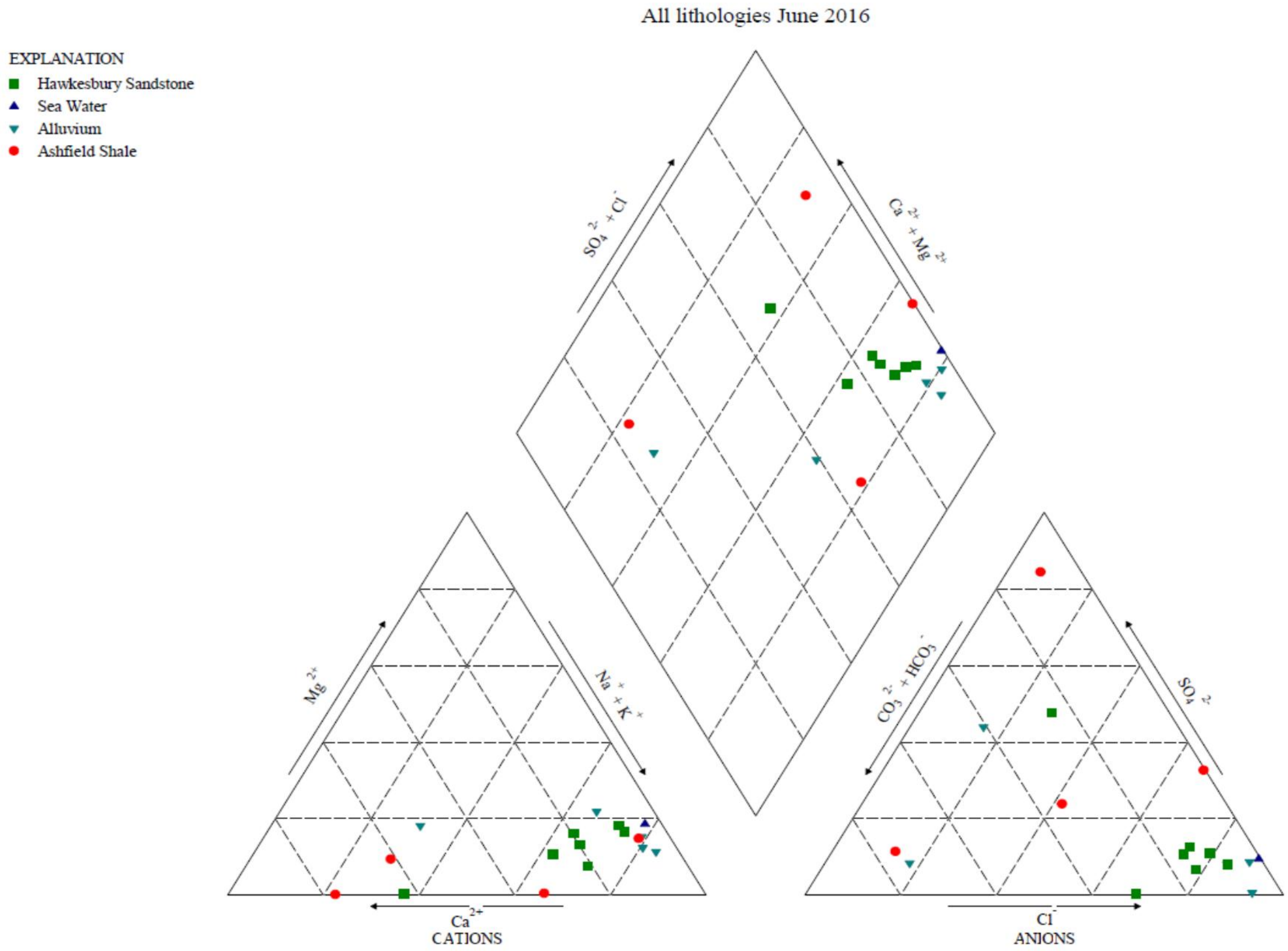
Annexure E – Hydrogeochemical plots

Annexure E – Figures

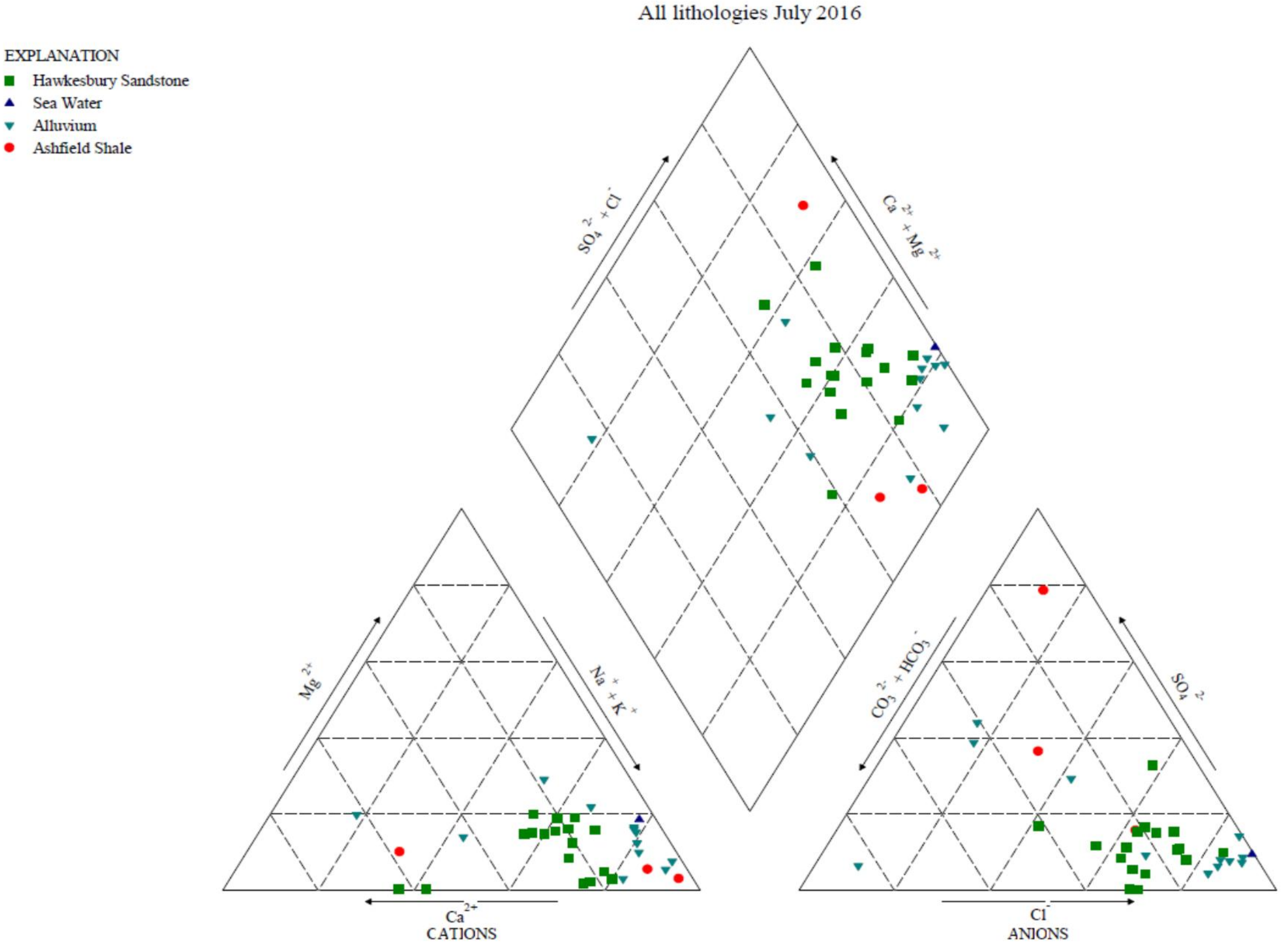
Piper diagrams

Annexure E – Figures

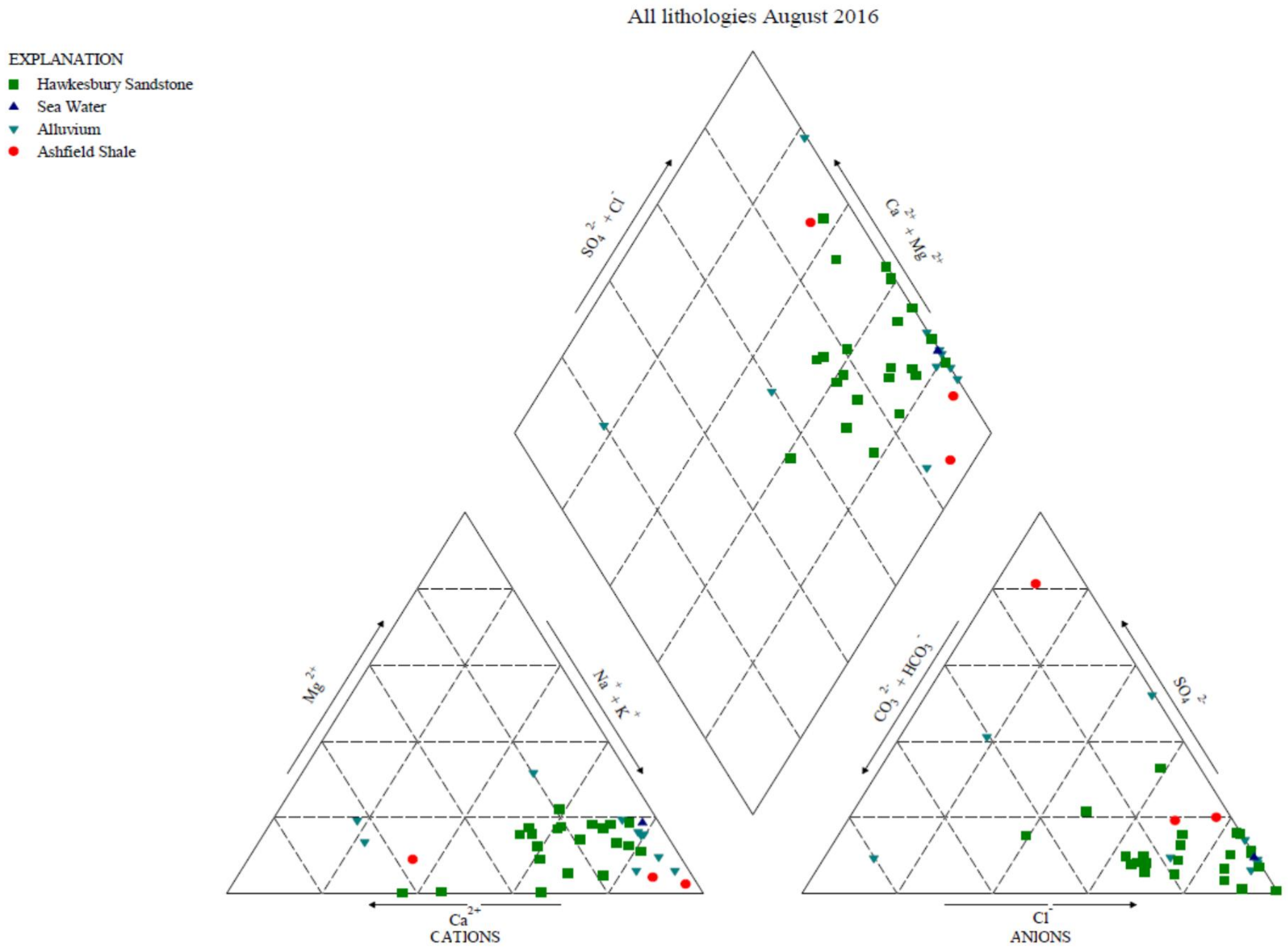
Schoeller Diagrams – Metals



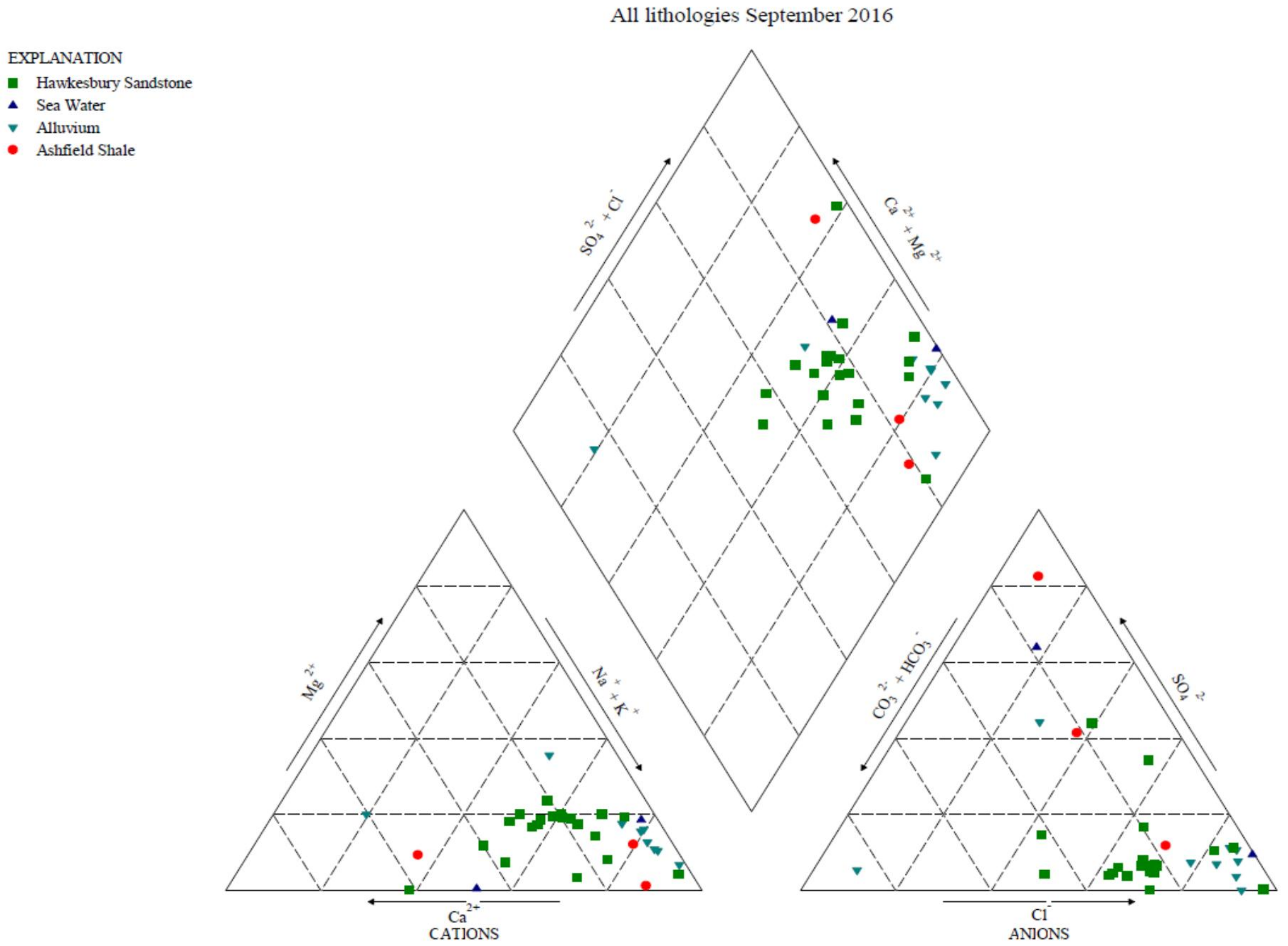
AECOM	Title: Piper Diagram Project: M4-M5 Link WestConnex Client: Sydney Motorway Corporation Location: Inner West Sydney	Aquifer: All lithologies Month: June 2016	Figure: E1.1 Project No: 60493796



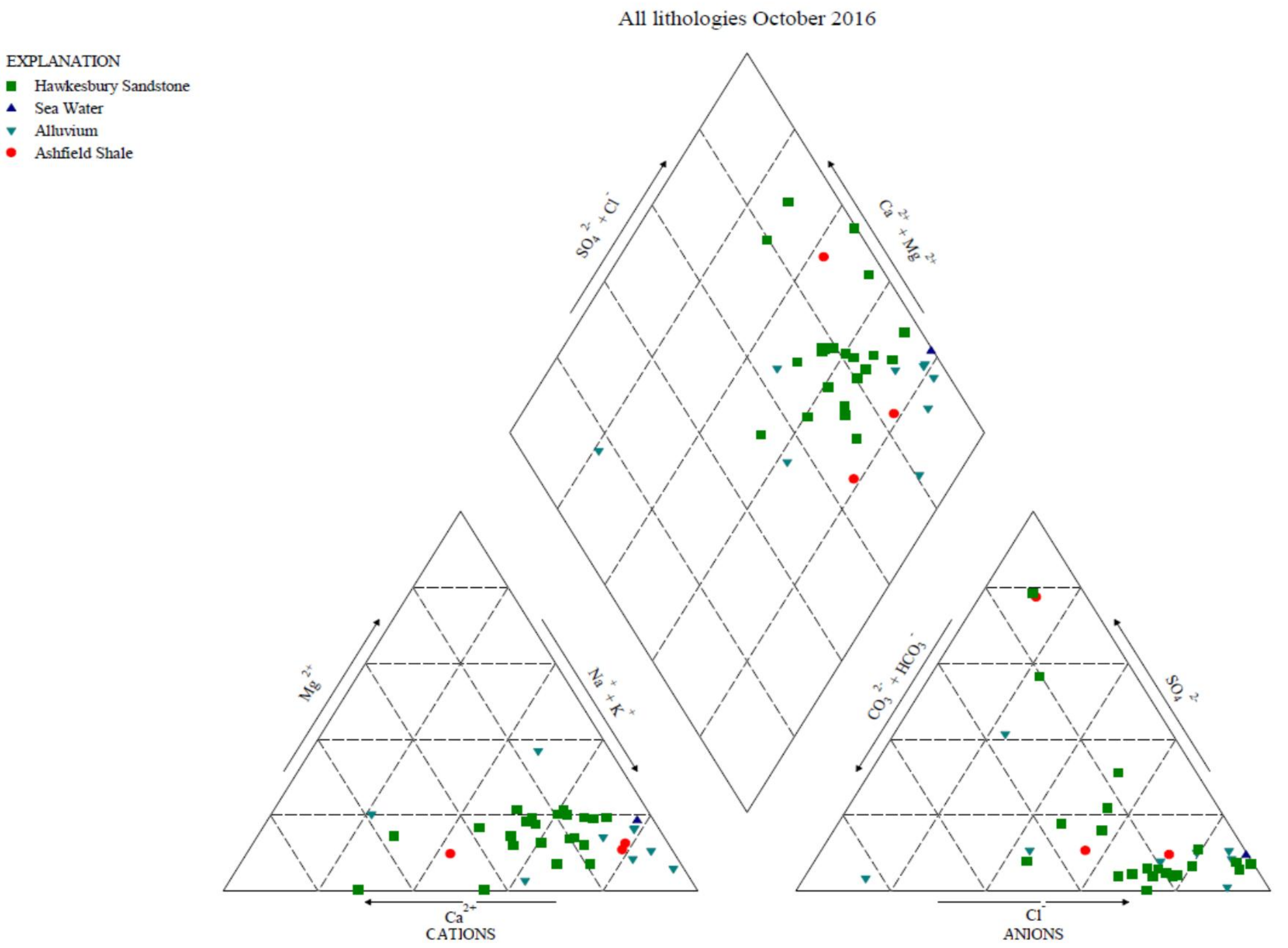
AECOM	Title: Project: Client: Location:	Piper Diagram M4-M5 Link WestConnex Sydney Motorway Corporation Inner West Sydney	Aquifer: All lithologies Month: July 2016	Figure: E1.2 Project No: 60493796



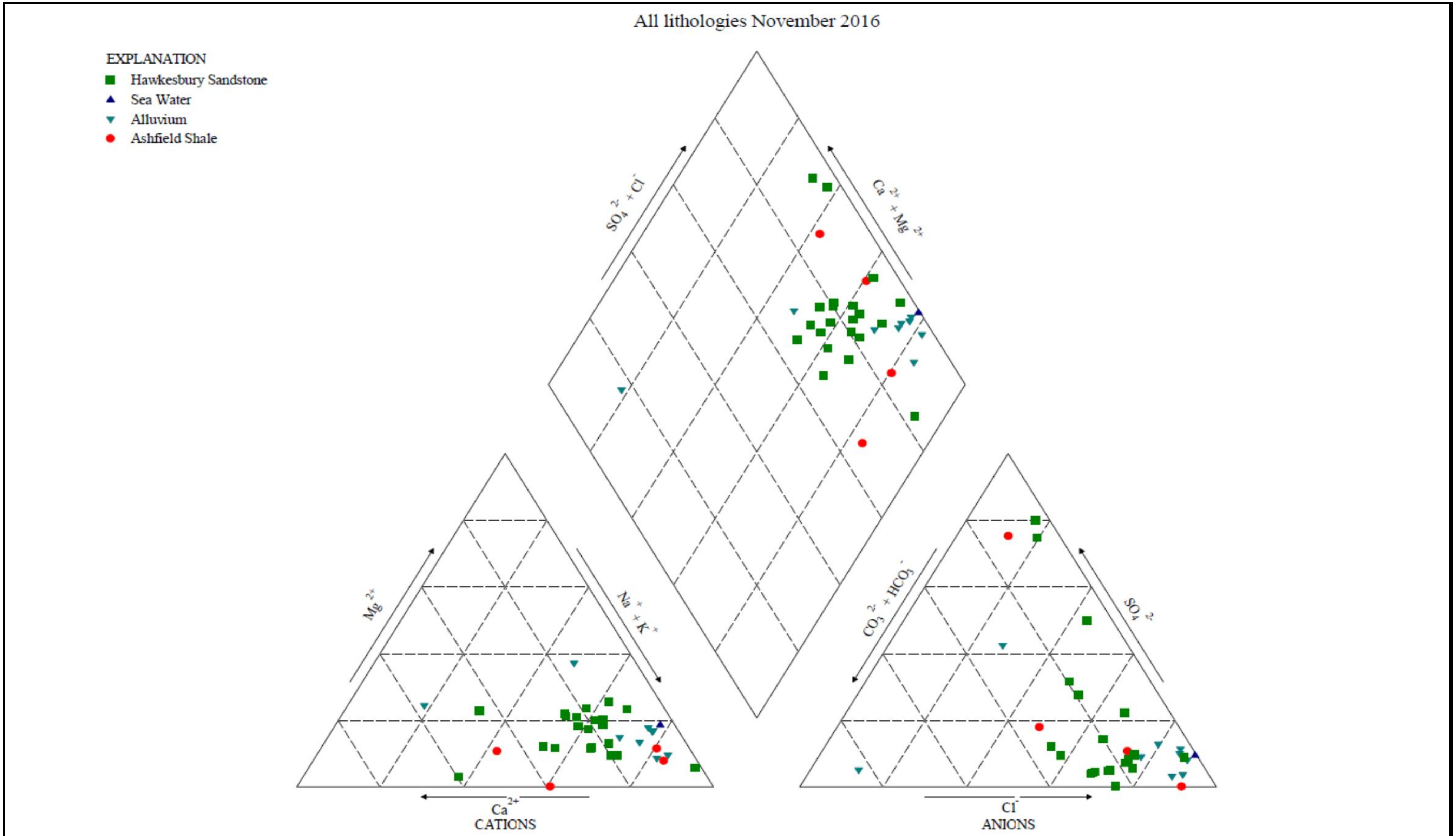
AECOM	Title:	Piper Diagram	Aquifer: All lithologies	Figure: E1.3
	Project:	M4-M5 Link WestConnex	Month: August 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



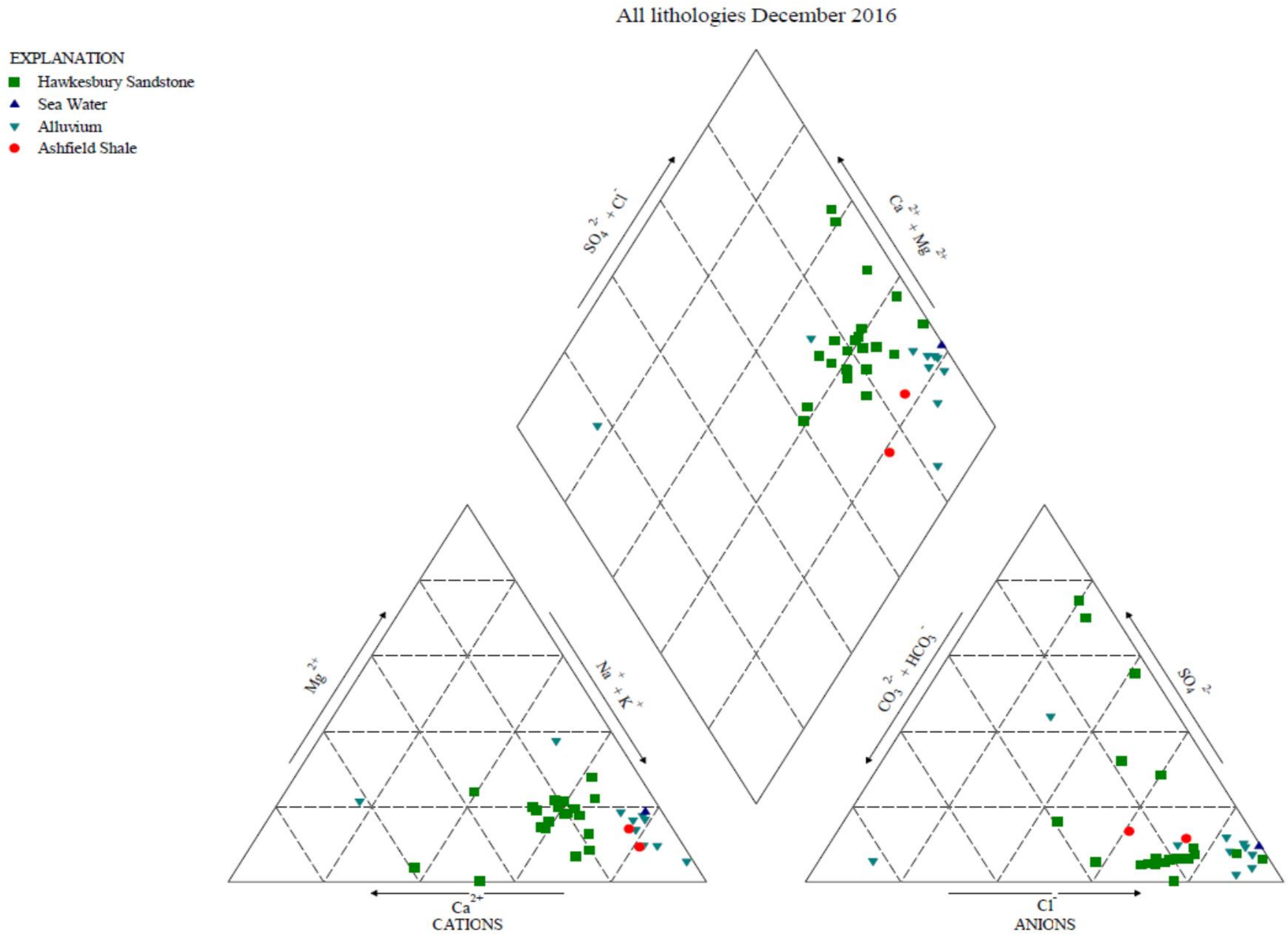
AECOM	Title: Piper Diagram Project: M4-M5 Link WestConnex Client: Sydney Motorway Corporation Location: Inner West Sydney	Aquifer: All lithologies Month: September 2016	Figure: E1.4 Project No: 60493796



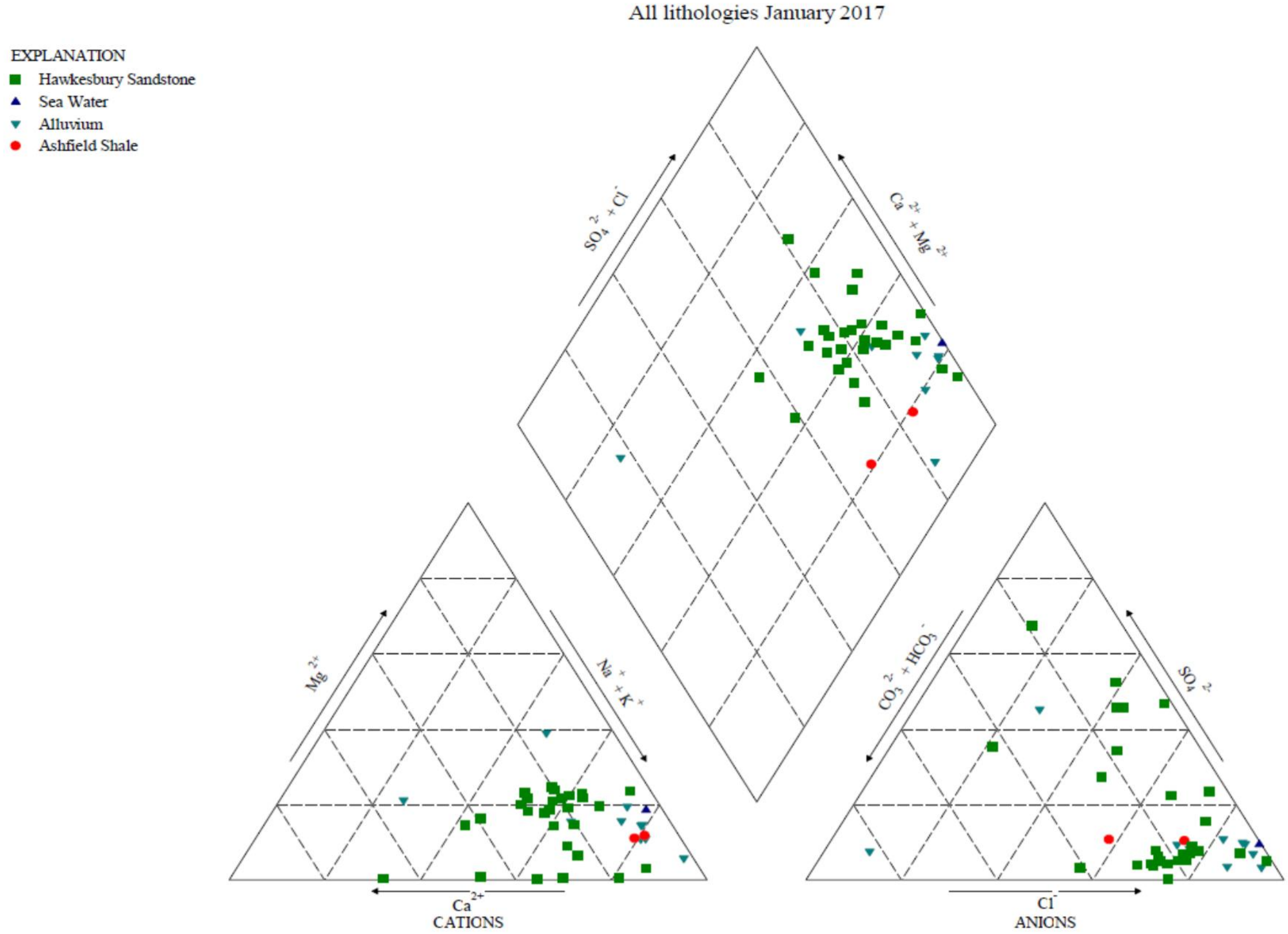
AECOM	Title: Piper Diagram	Aquifer: All lithologies	Figure: E1.5
	Project: M4-M5 Link WestConnex	Month: October 2016	Project No: 60493796
	Client: Sydney Motorway Corporation		
	Location: Inner West Sydney		



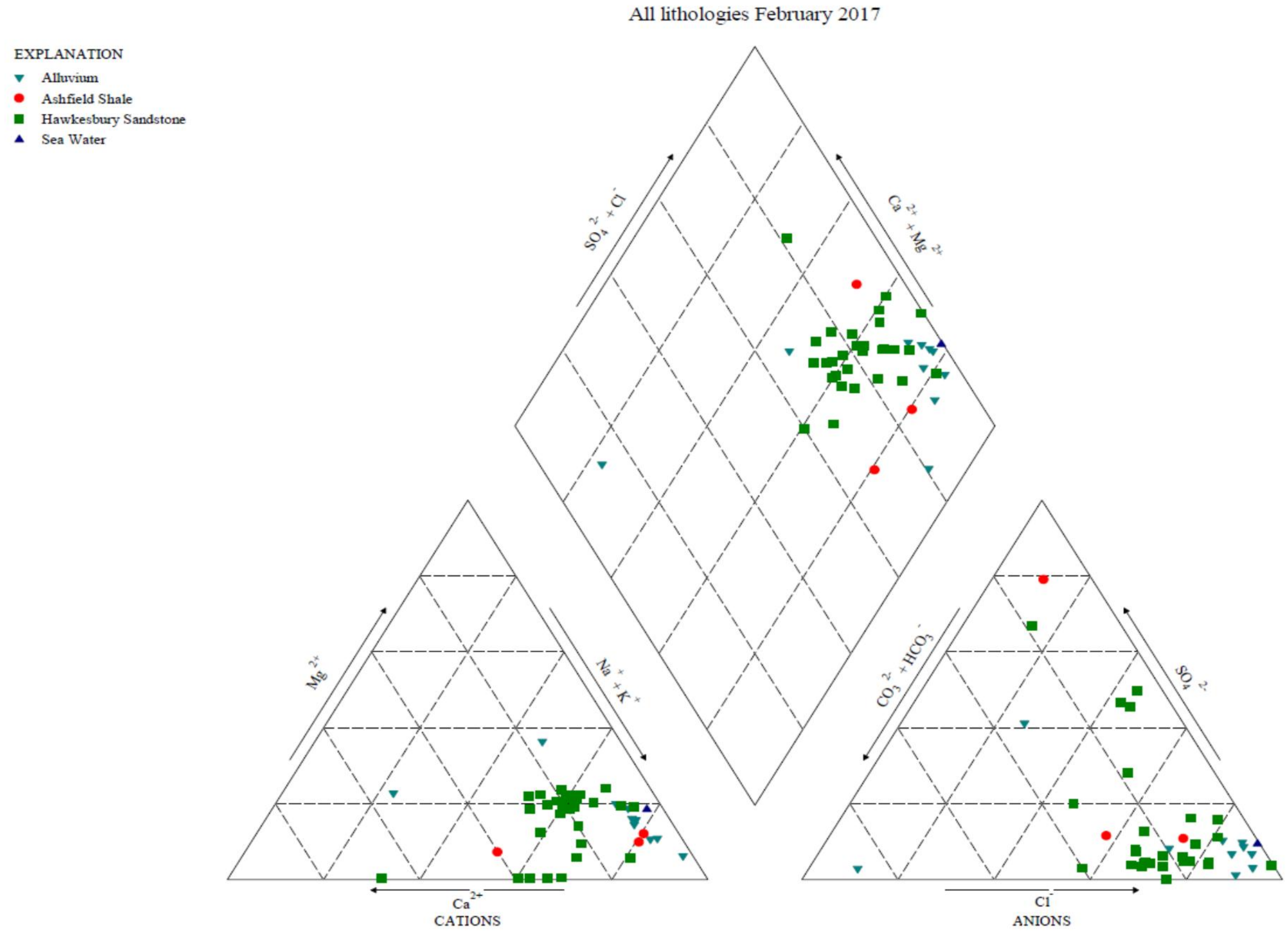
AECOM	Title:	Piper Diagram	Aquifer: All lithologies	Figure: E1.6
	Project:	M4-M5 Link WestConnex	Month: November 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



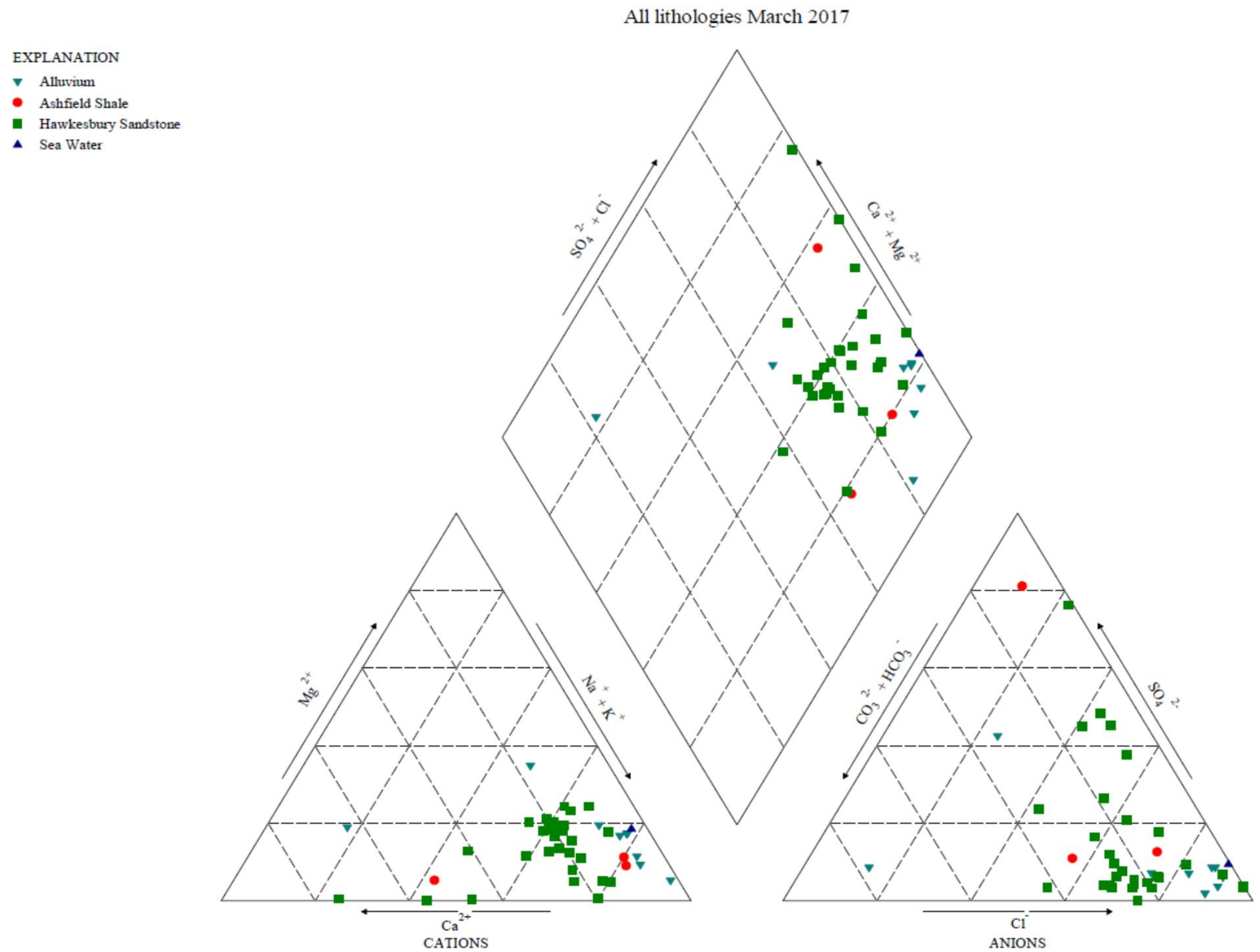
AECOM	Title:	Piper Diagram	Aquifer: All lithologies	Figure: E1.7
	Project:	M4-M5 Link WestConnex	Month: December 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



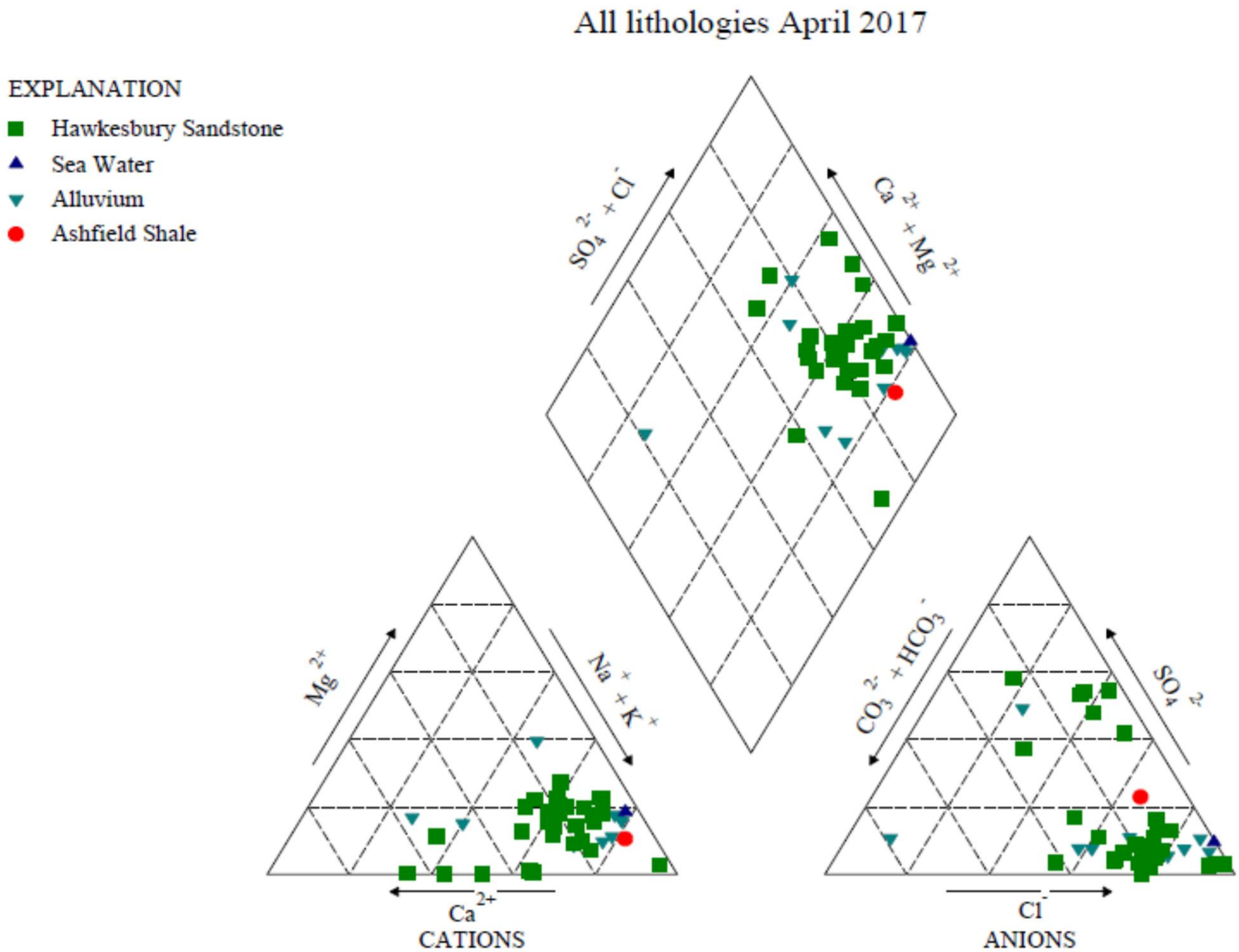
AECOM	Title:	Piper Diagram	Aquifer: All lithologies	Figure: E1.8	
	Project:	M4-M5 Link WestConnex	Month: January 2017	Project No:	60493796
	Client:	Sydney Motorway Corporation			
	Location:	Inner West Sydney			



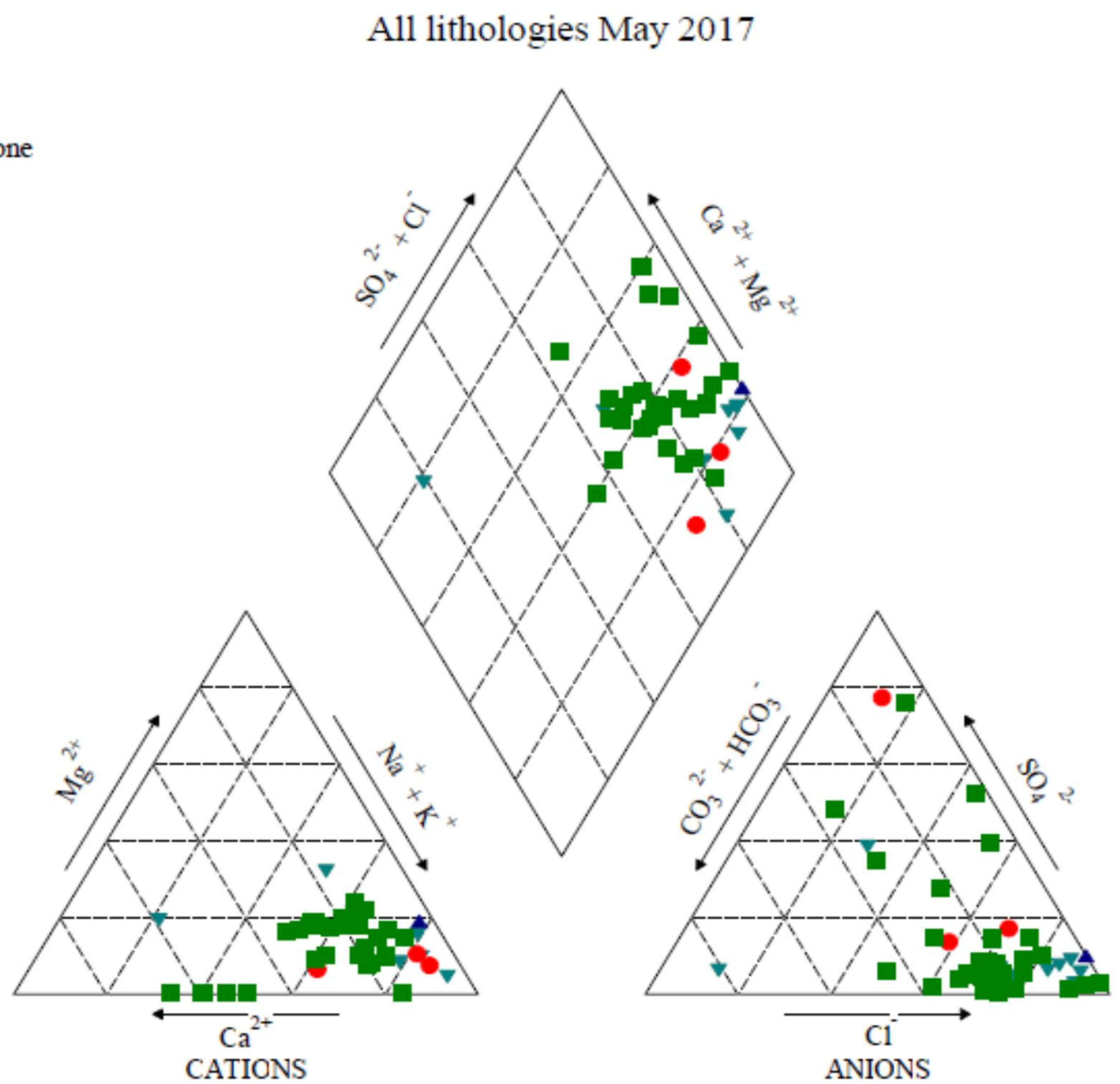
AECOM	Title: Project: Client: Location:	Piper Diagram M4-M5 Link WestConnex Sydney Motorway Corporation Inner West Sydney	Aquifer: All lithologies Month: February 2017	Figure: E1.9 Project No: 60493796



AECOM	Title:	Piper Diagram	Aquifer: All lithologies	Figure: E1.10
	Project:	M4-M5 Link WestConnex	Month: March 2017	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



AECOM	Title:	Piper Diagram	Aquifer: All lithologies	Figure: E1.11
	Project:	M4-M5 Link WestConnex	Month: April 2017	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



AECOM	Title:	Piper Diagram	Aquifer: All lithologies	Figure: E1.12
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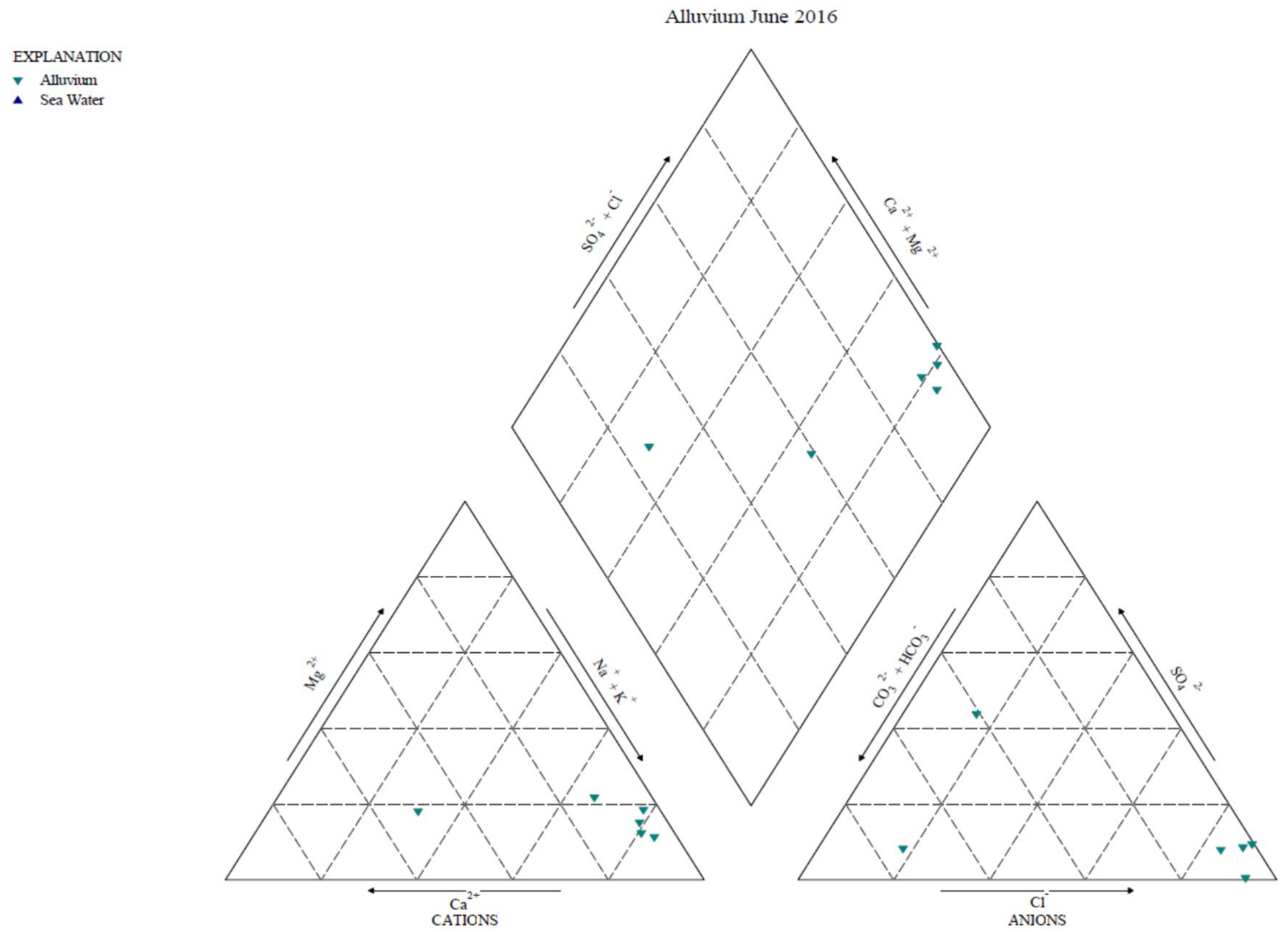
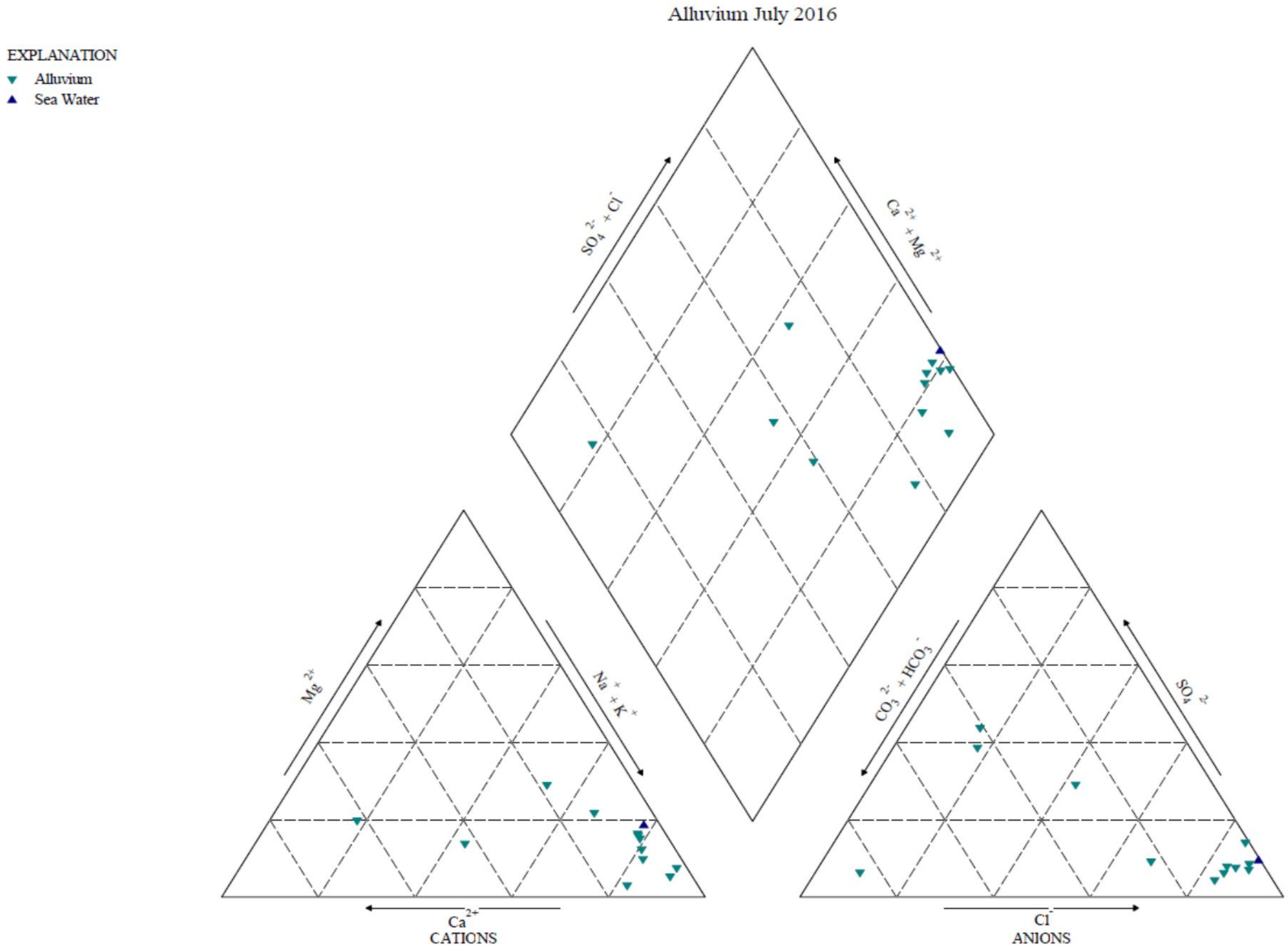
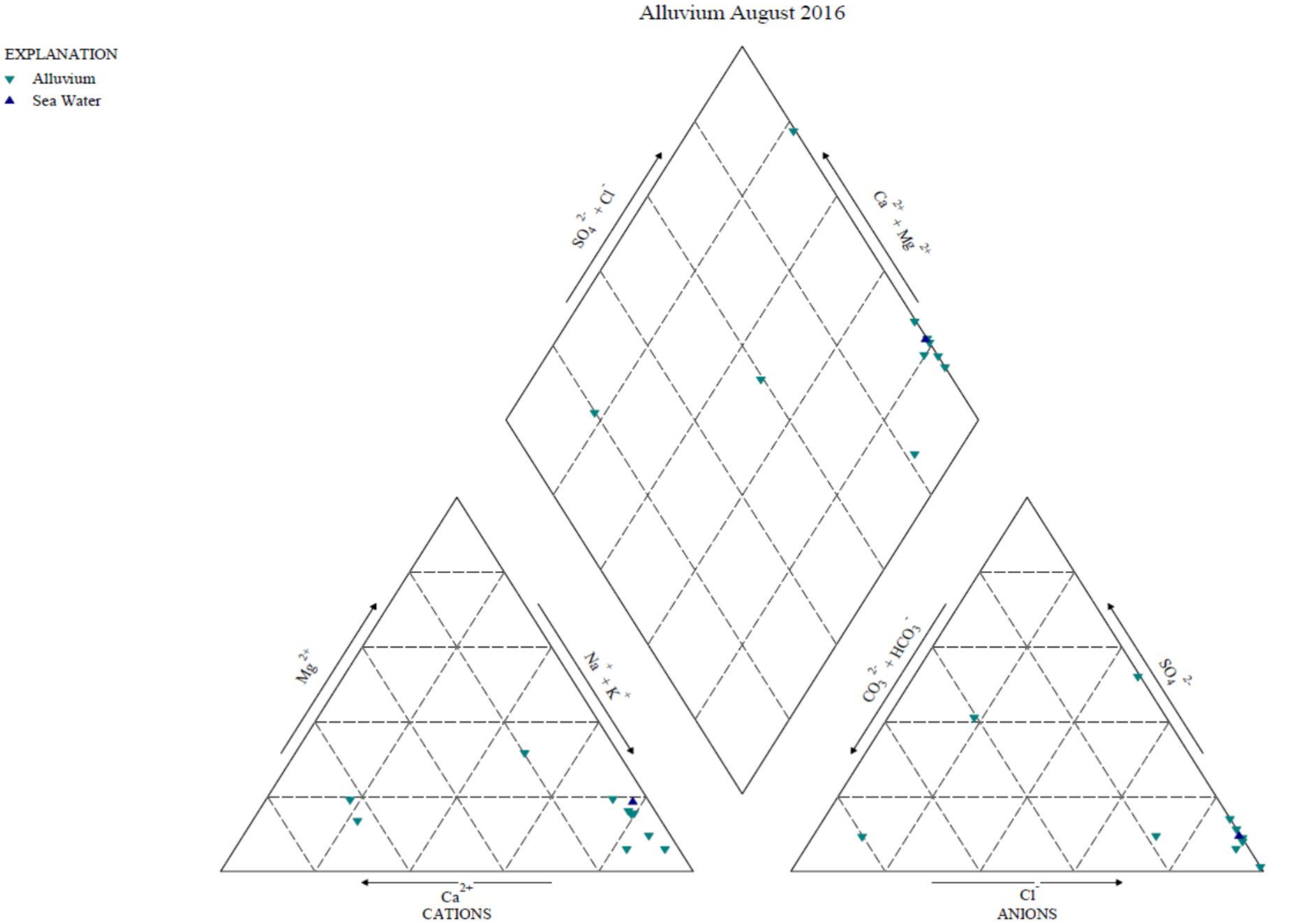
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



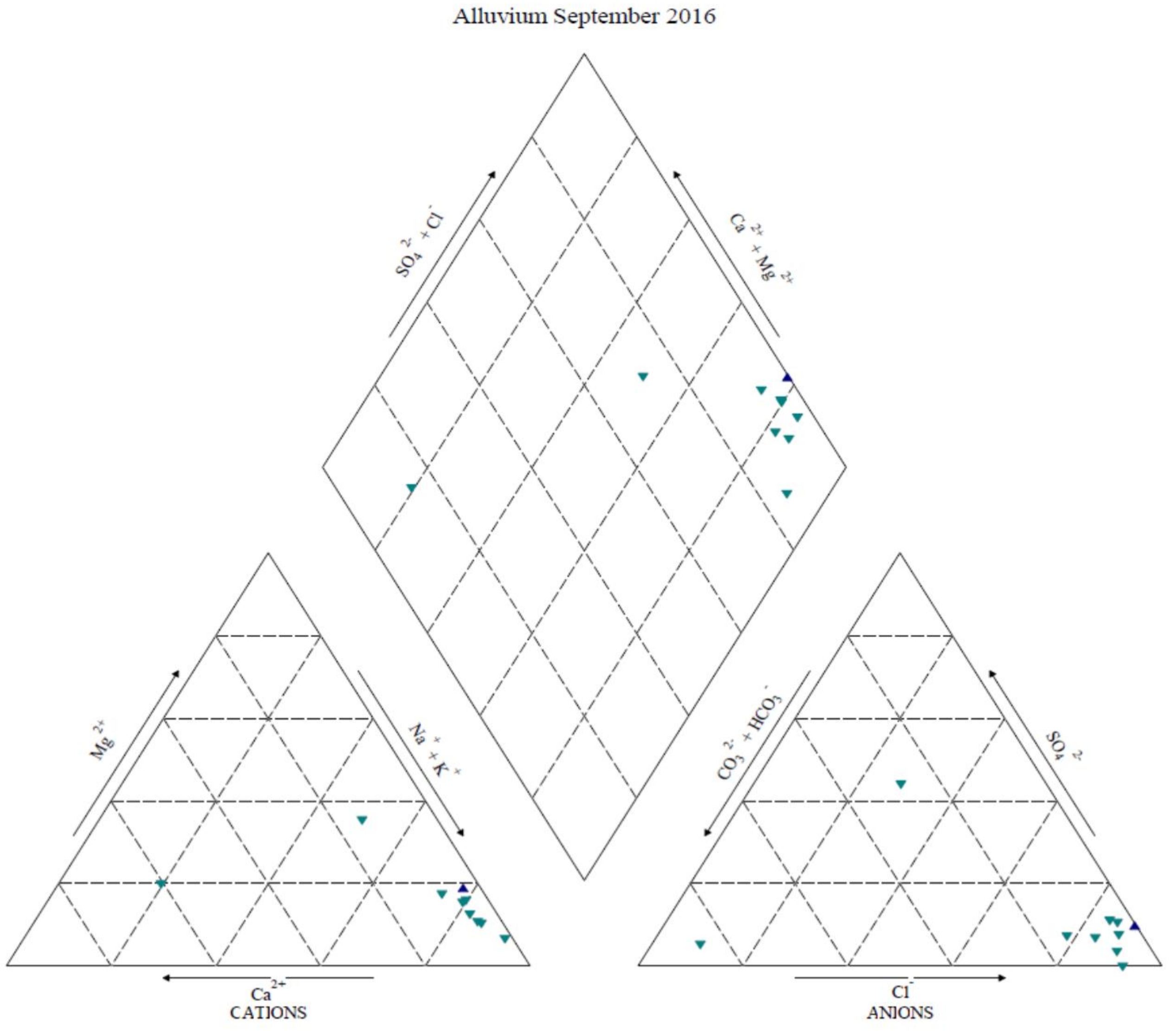
AECOM	Title: Project: Client: Location:	Piper Diagram M4-M5 Link WestConnex Sydney Motorway Corporation Inner West Sydney	Aquifer: Alluvium Month: June 2016	Figure: E2.1 Project No: 60493796



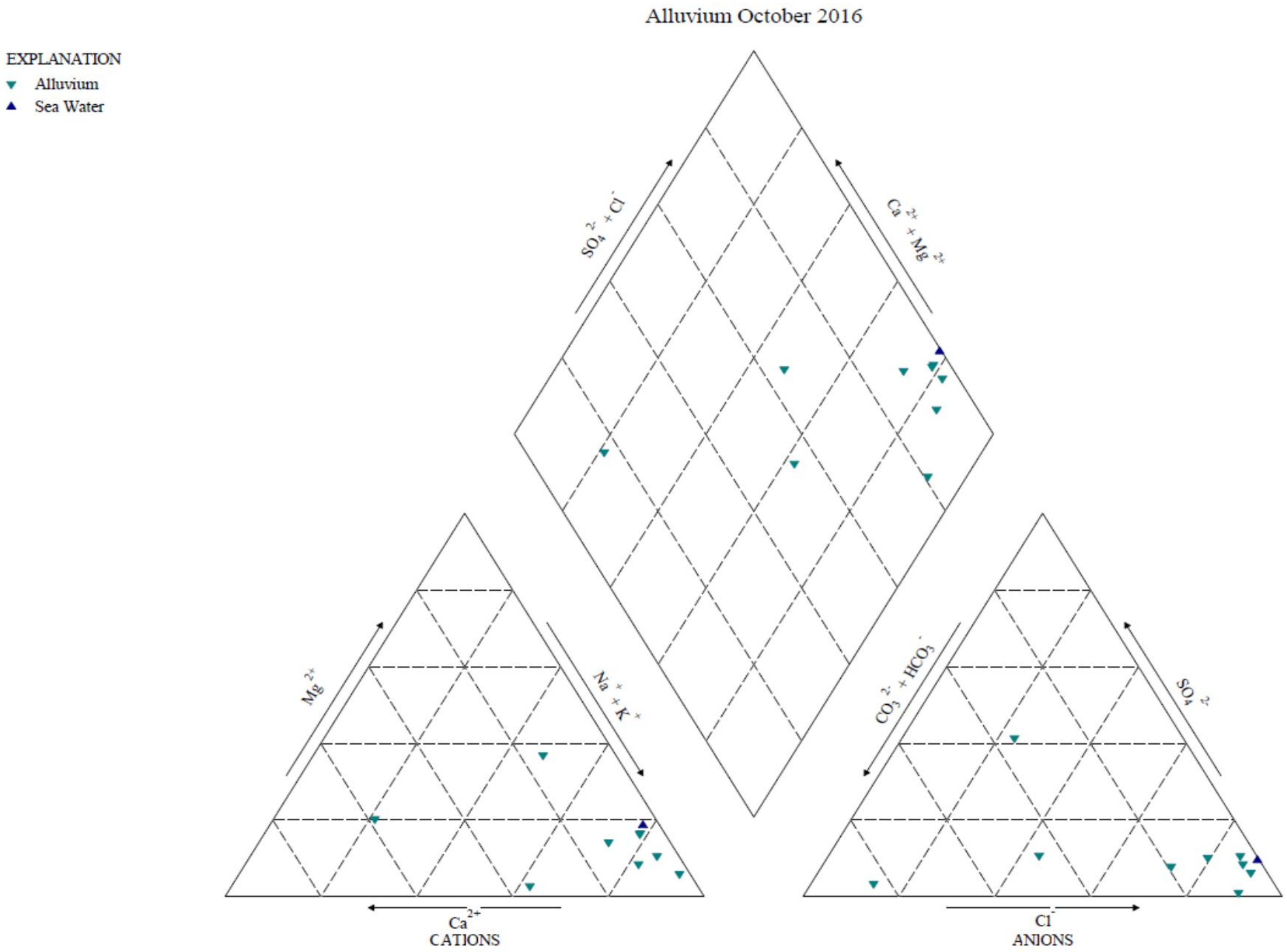
AECOM	Title:	Piper Diagram	Aquifer: Alluvium	Figure: E2.2
	Project:	M4-M5 Link WestConnex	Month: July 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



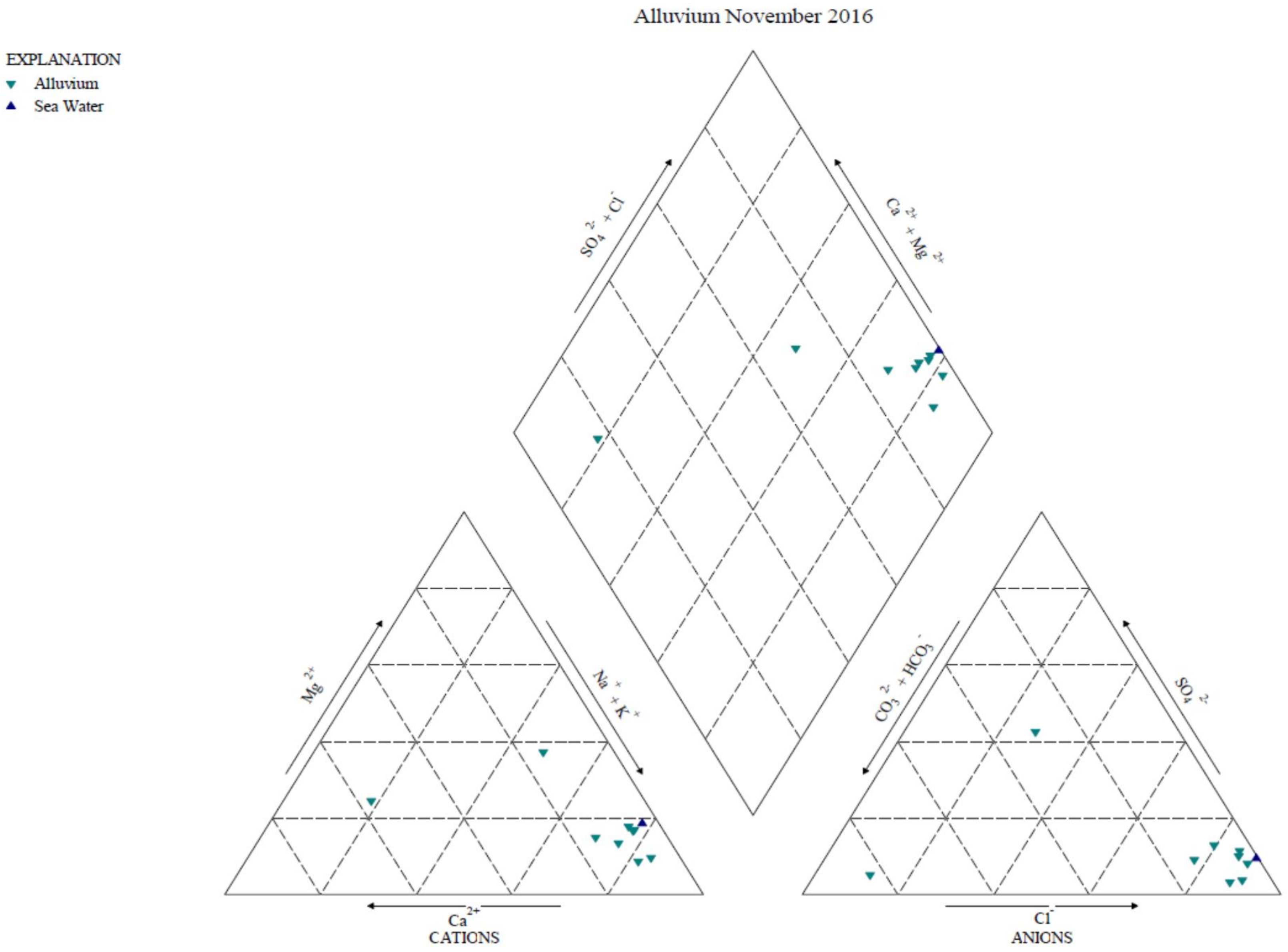
AECOM	Title: Project: Client: Location:	Piper Diagram M4-M5 Link WestConnex Sydney Motorway Corporation Inner West Sydney	Aquifer: Alluvium Month: August 2016	Figure: E2.3 Project No: 60493796



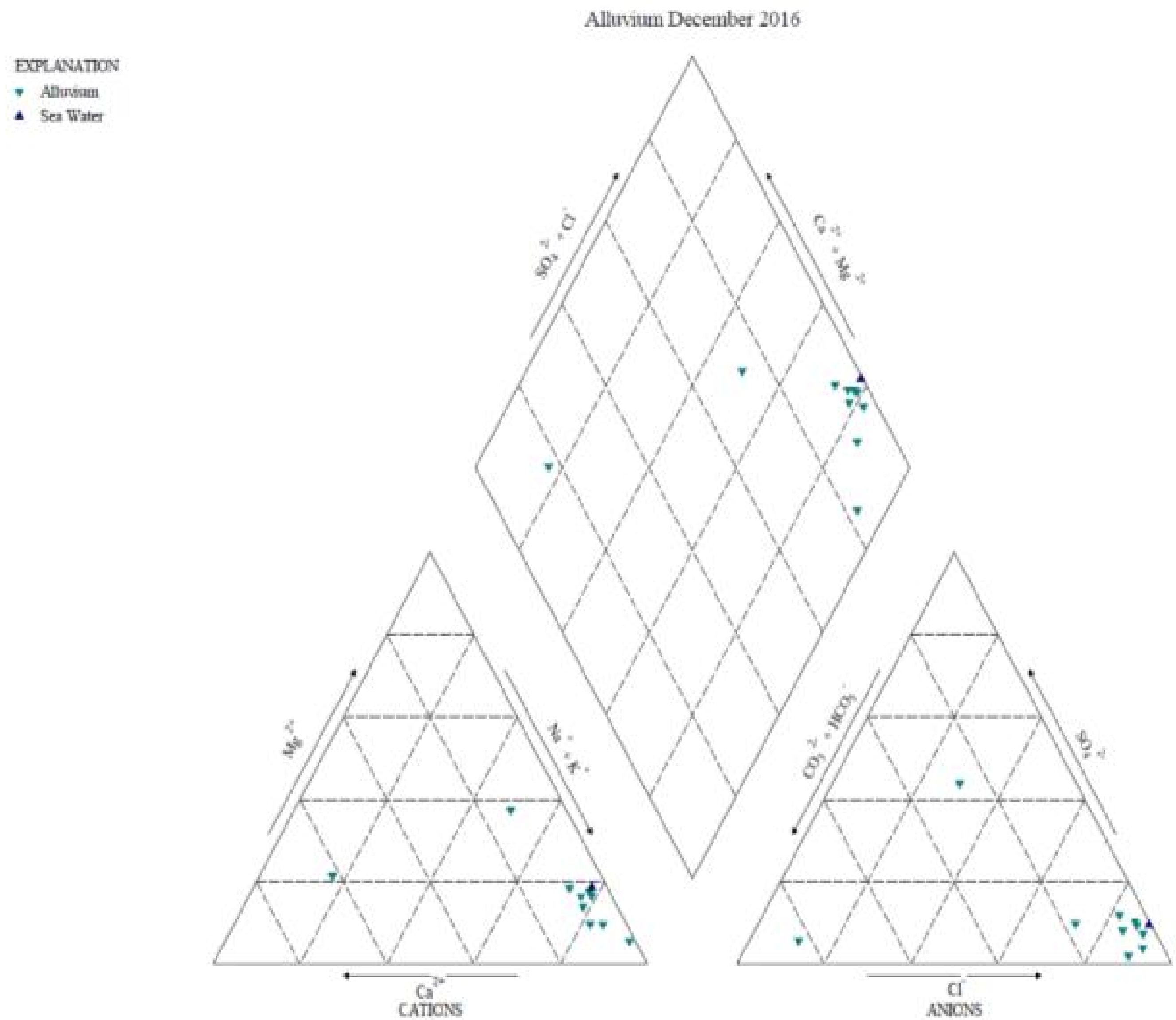
AECOM	Title:	Piper Diagram	Aquifer: Alluvium	Figure: E2.4
	Project:	M4-M5 Link WestConnex	Month: September 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



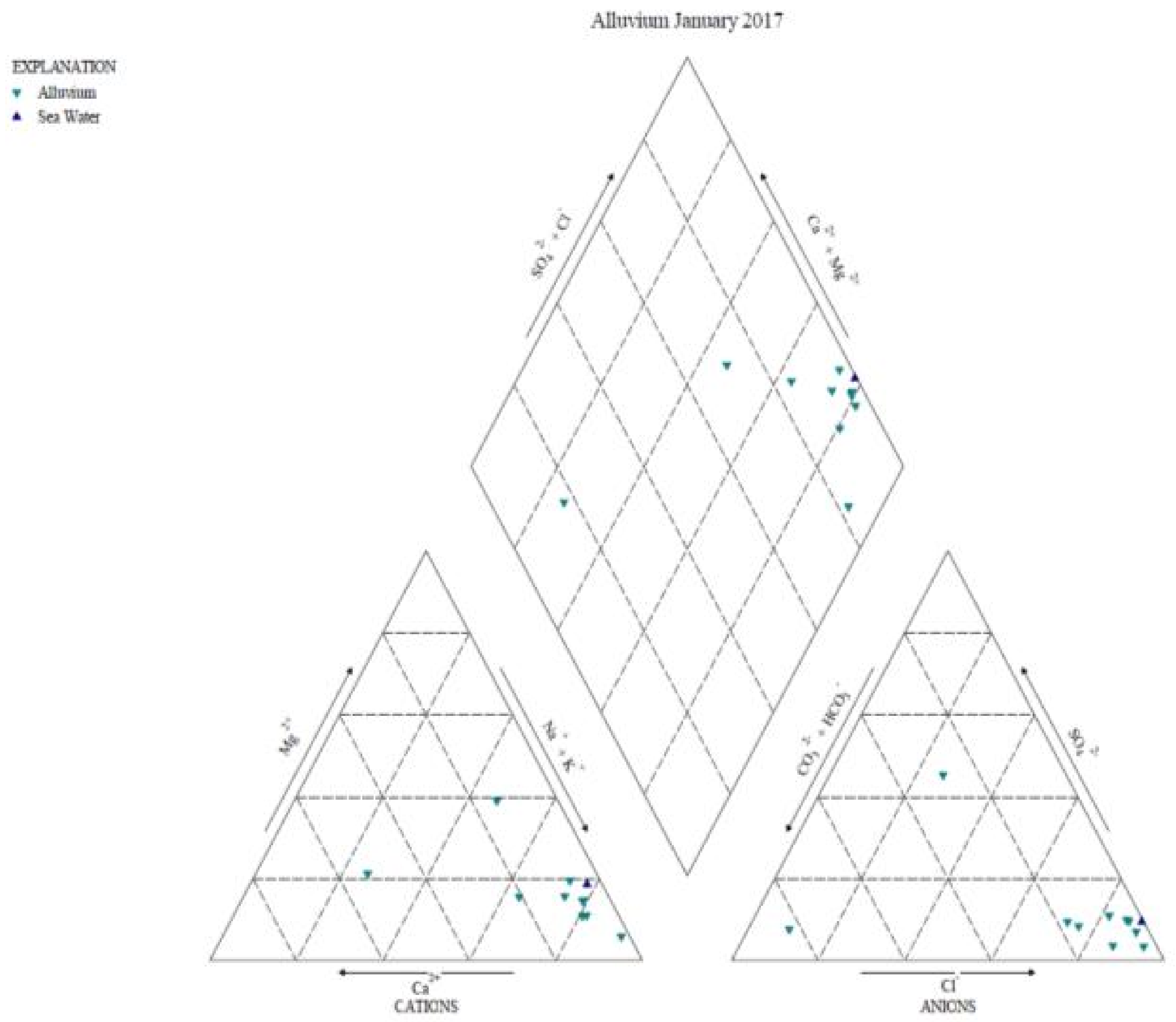
AECOM	Title:	Piper Diagram	Aquifer: Alluvium	Figure: E2.5
	Project:	M4-M5 Link WestConnex	Month: October 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



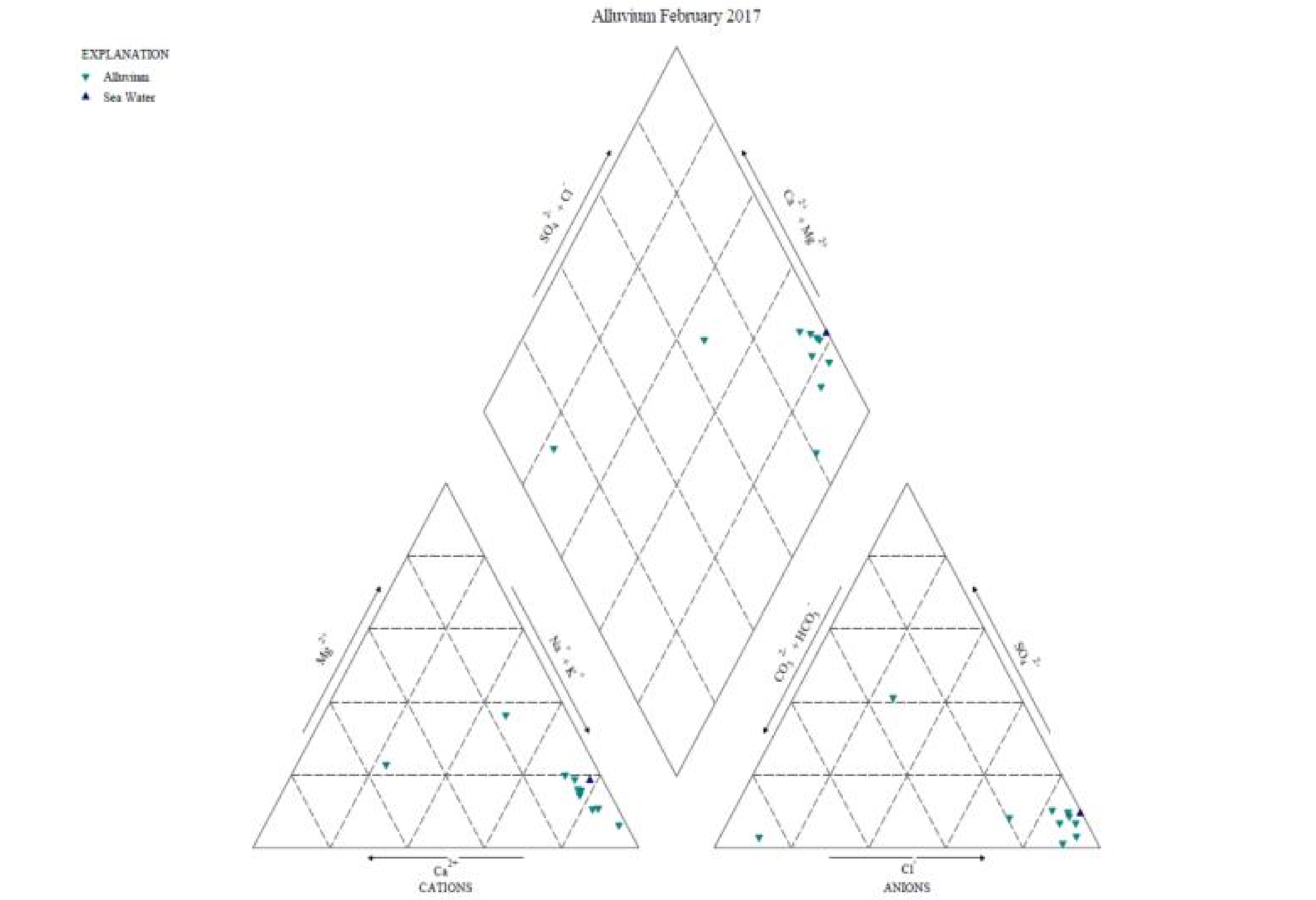
AECOM	Title:	Piper Diagram	Aquifer: Alluvium	Figure: E2.6
	Project:	M4-M5 Link WestConnex	Month: November 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



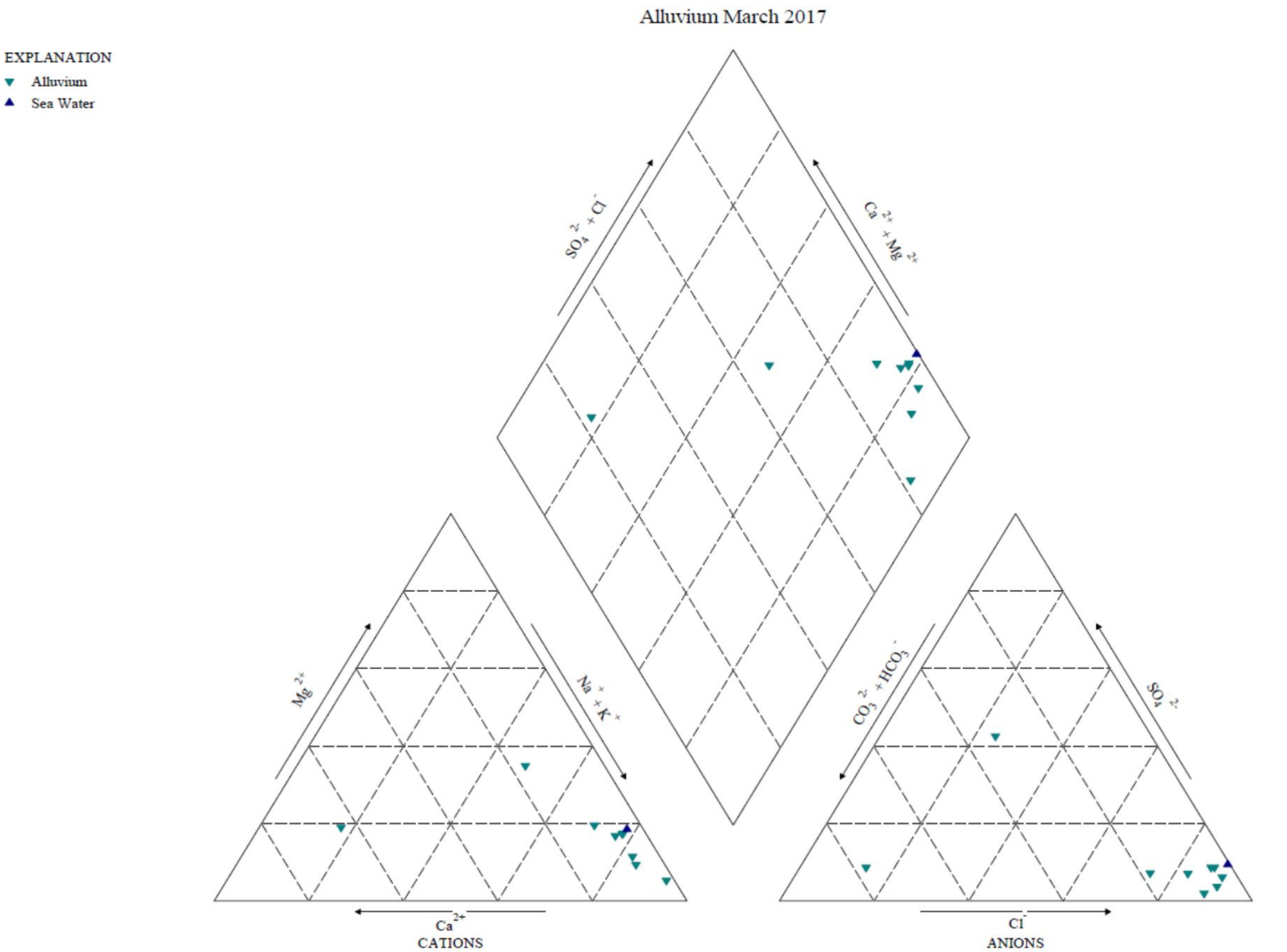
AECOM	Title:	Piper Diagram	Aquifer: Alluvium	Figure: E2.7
	Project:	M4-M5 Link WestConnex	Month: December 2016	Project No: 60493796
	Client:	Sydney Motorw ay Corporation		
	Location:	Inner West Sydney		



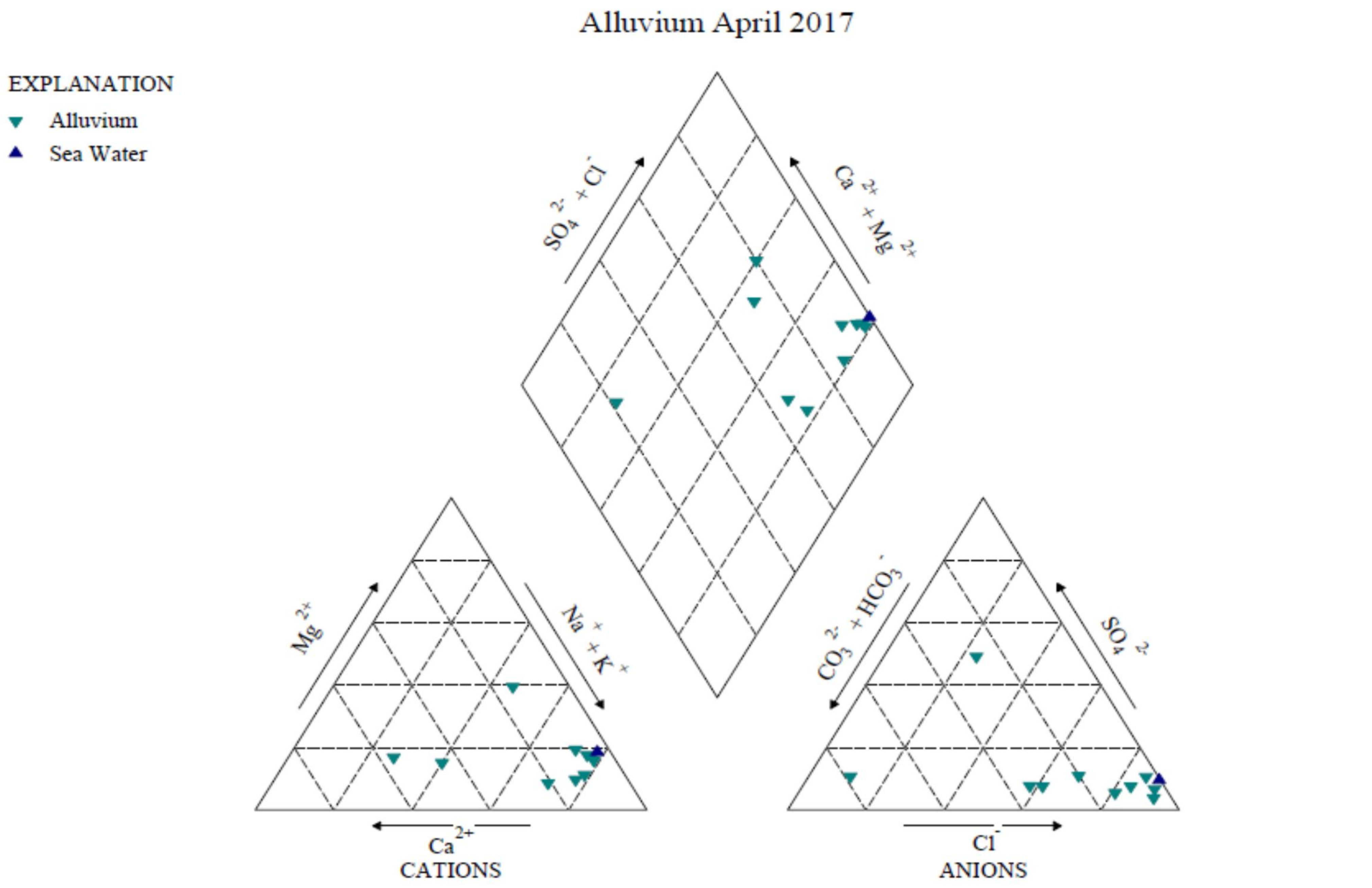
Title:	Piper Diagram	Aquifer: Alluvium	Figure: E2.8
Project:	M4-M5 Link WestConnex	Month: January 2017	Project No: 60493796
Client:	Sydney Motorw ay Corporation		
Location:	Inner West Sydney		



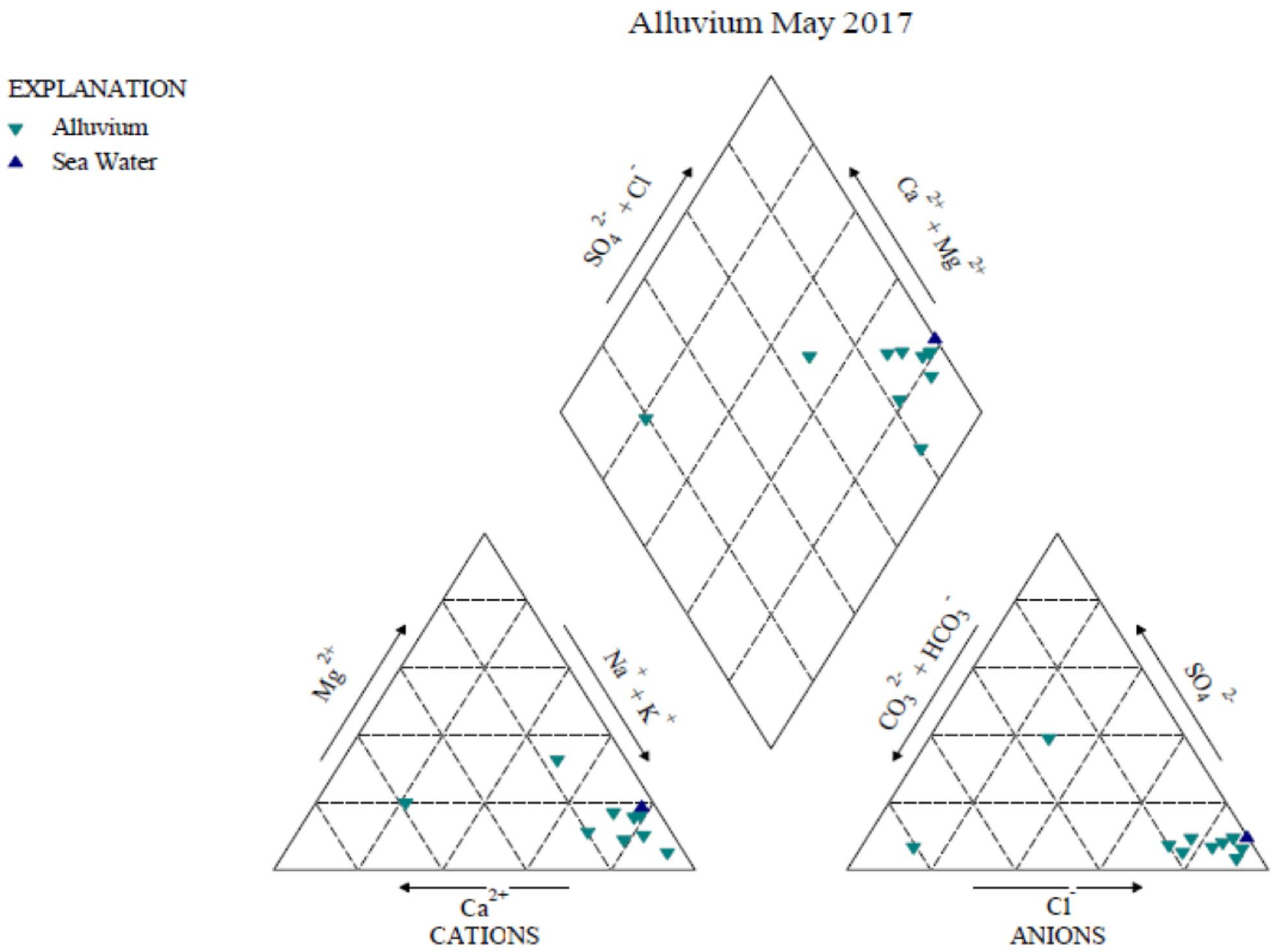
Title:	Piper Diagram	Aquifer: Alluvium	Figure: E2.9
Project:	M4-M5 Link WestConnex	Month: Febuary 2017	Project No: 60493796
Client:	Sydney Motorw ay Corporation		
Location:	Inner West Sydney		



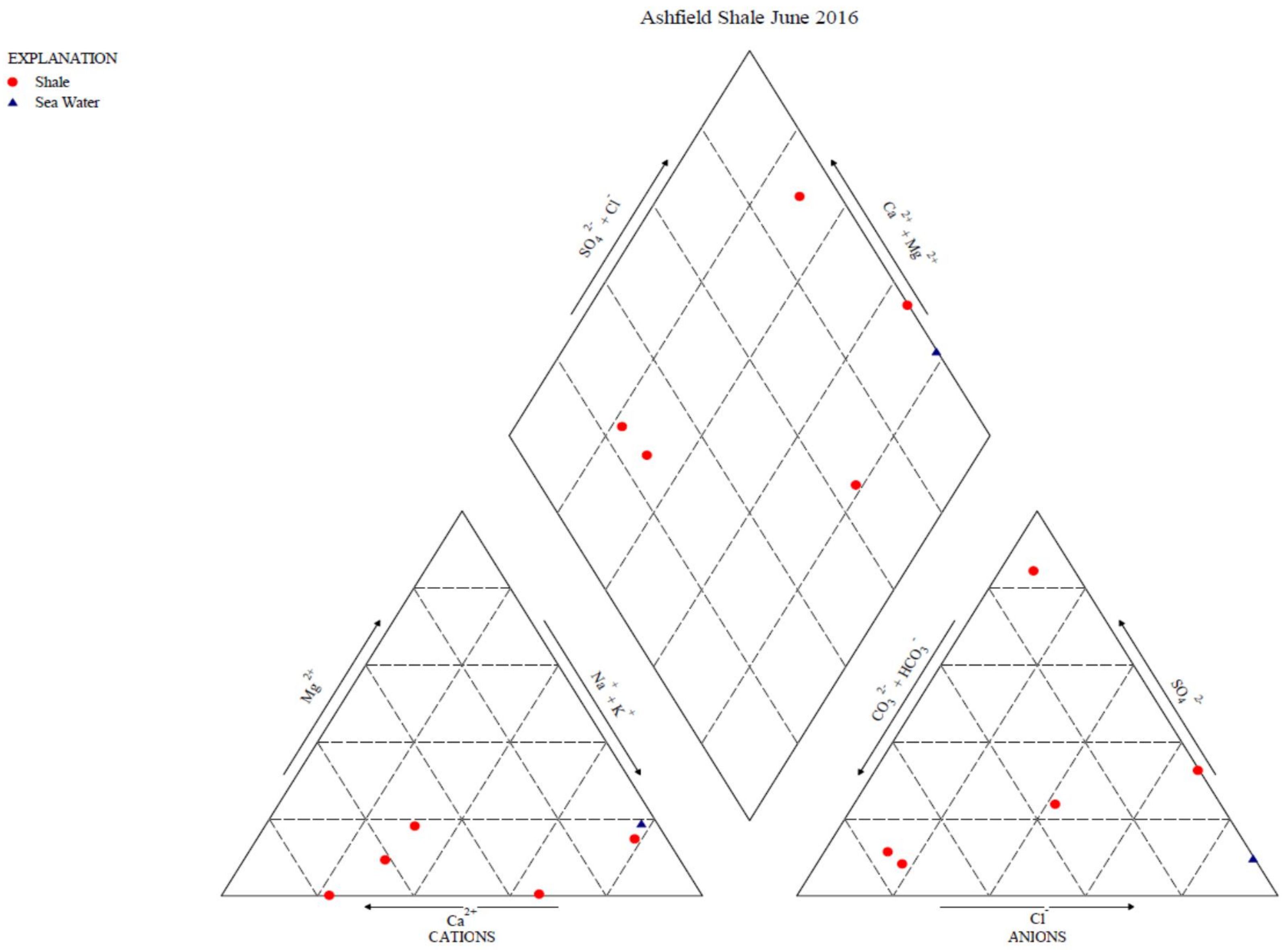
AECOM	Title:	Piper Diagram	Aquifer: Alluvium	Figure: E2.10
	Project:	M4-M5 Link WestConnex	Month: March 2017	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



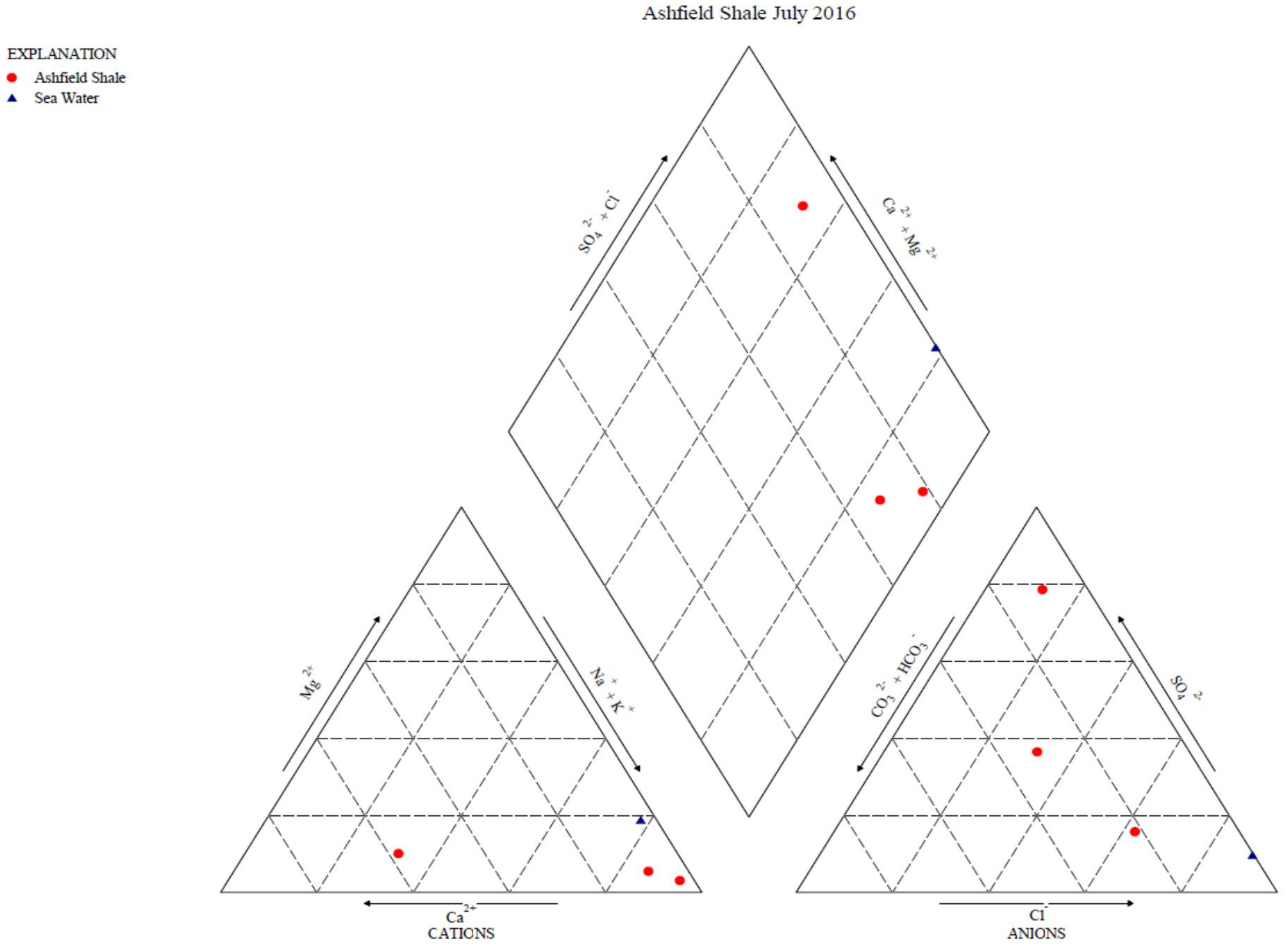
AECOM	Title:	Piper Diagram	Aquifer: Alluvium	Figure: E2.11	
	Project:	M4-M5 Link WestConnex	Month: April 2017	Project No:	60493796
	Client:	Sydney Motorway Corporation			
	Location:	Inner West Sydney			



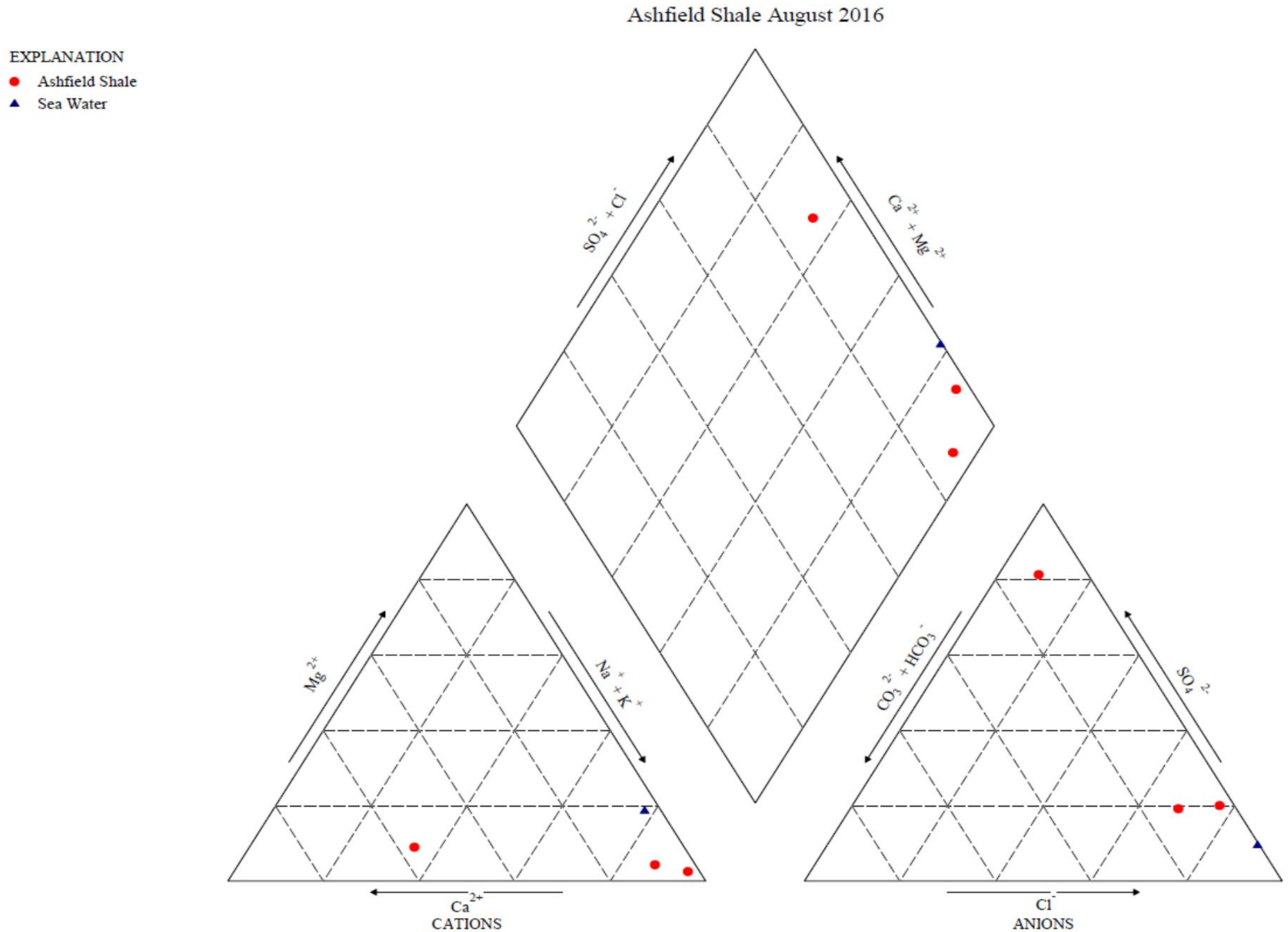
AECOM	Title:	Piper Diagram	Aquifer: Alluvium	Figure: E2.12
	Project:	M4-M5 Link WestConnex	Month: May 2017	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



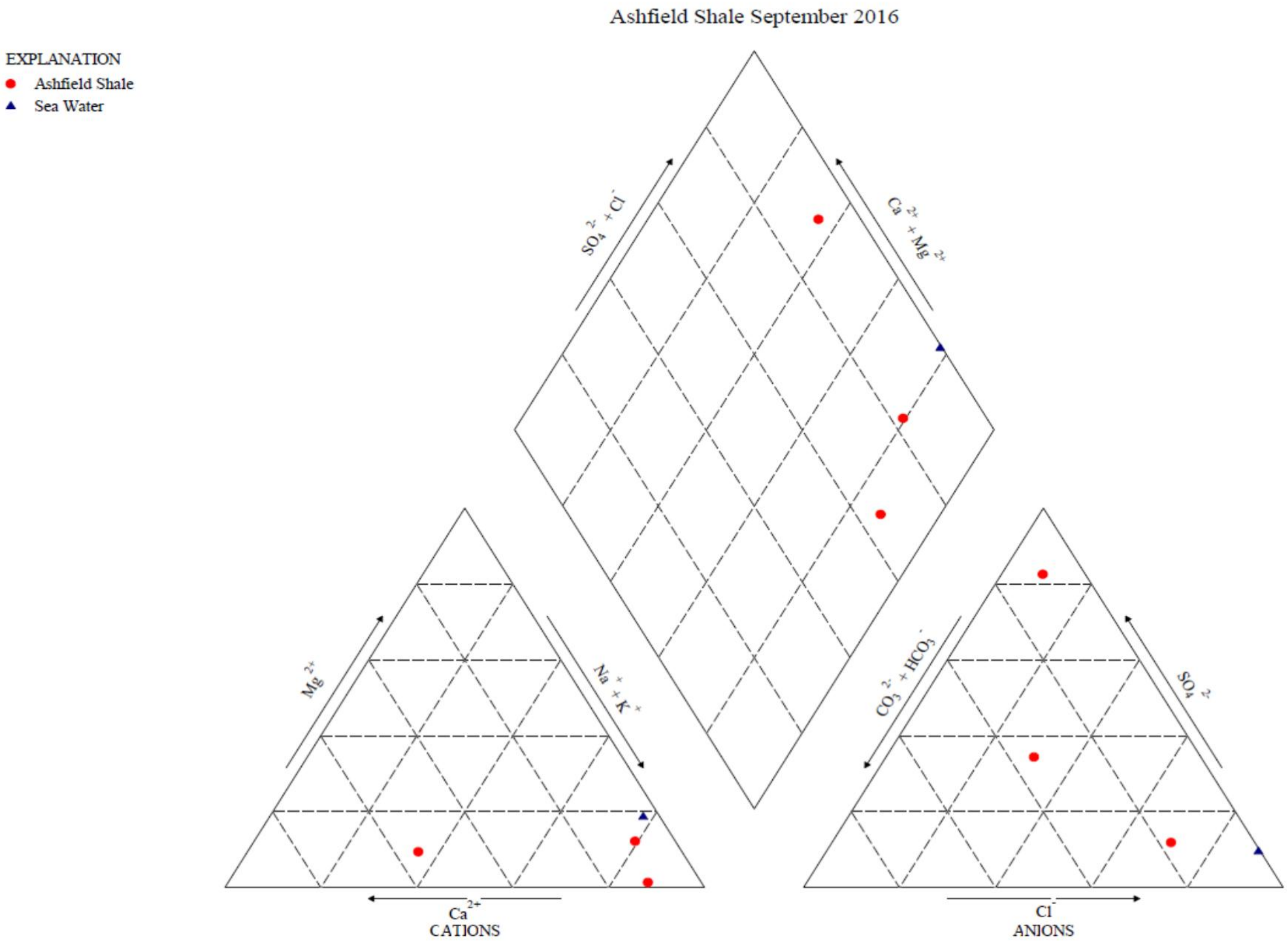
AECOM	Title:	Piper Diagram	Aquifer: Ashfield Shale	Figure: E3.1
	Project:	M4-M5 Link WestConnex	Month: June 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



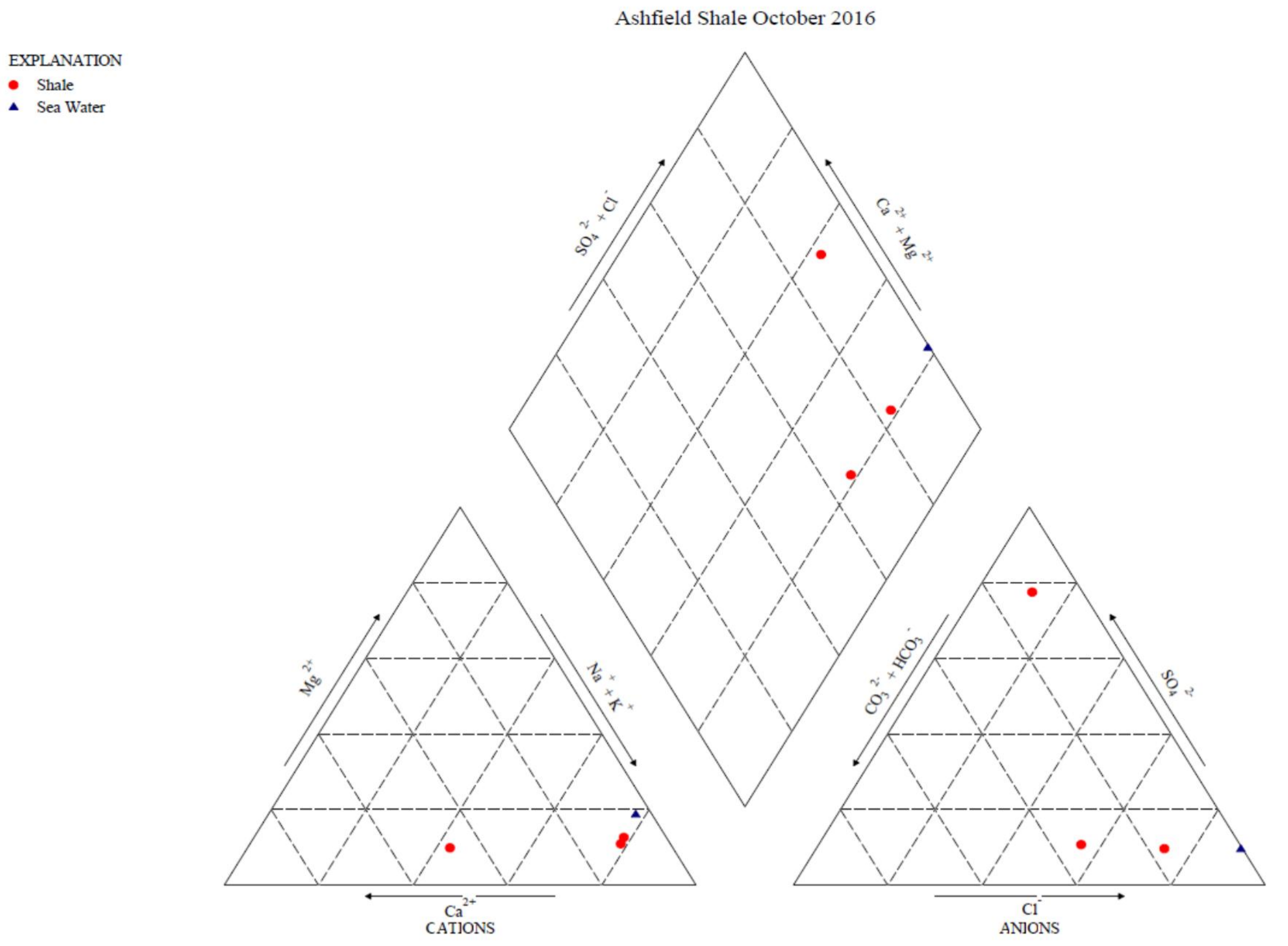
AECOM	Title:	Piper Diagram	Aquifer: Ashfield Shale	Figure: E3.2
	Project:	M4-M5 Link WestConnex	Month: July 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



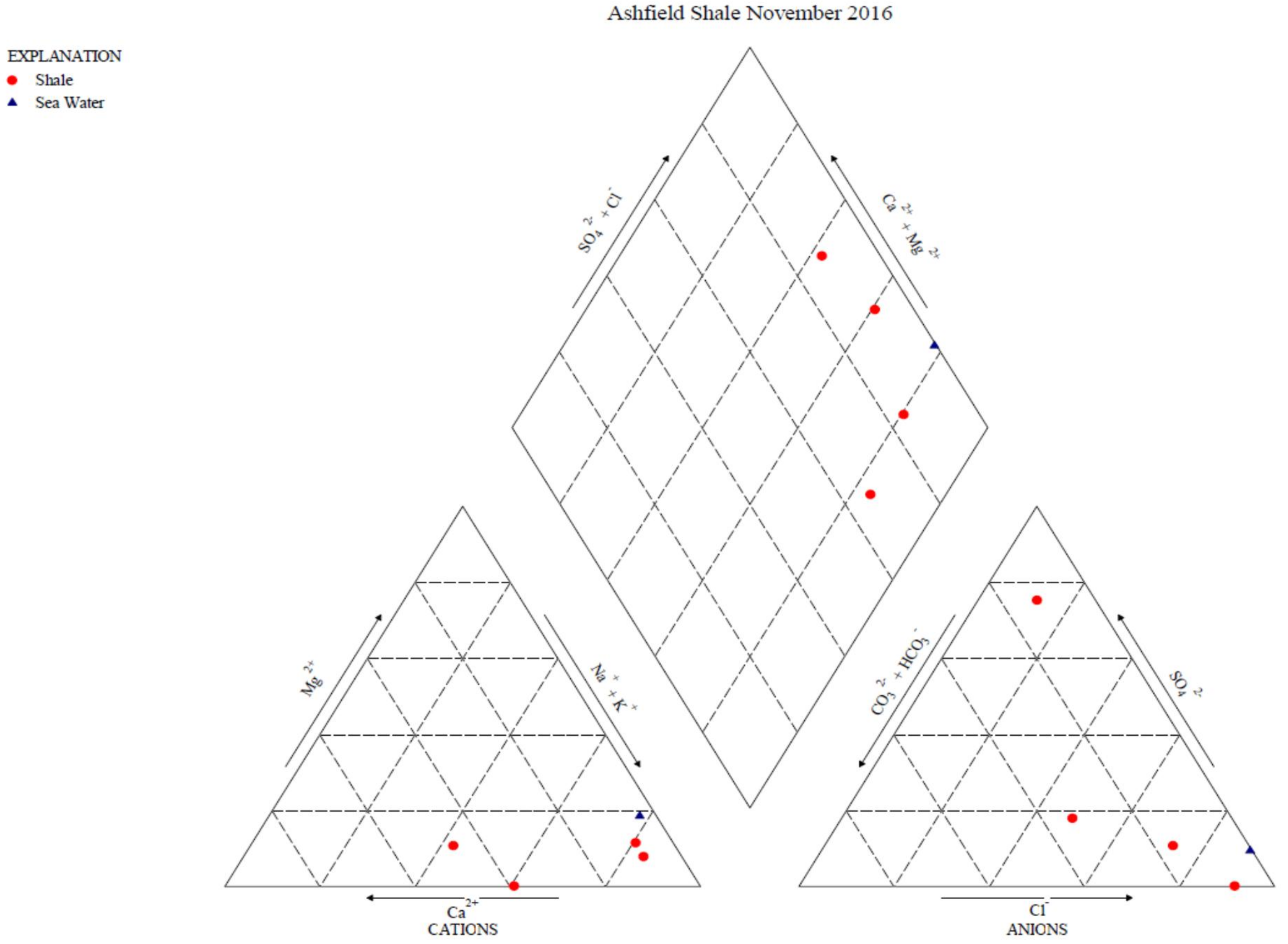
AECOM	Title:	Piper Diagram	Aquifer: Ashfield Shale	Figure: E3.3
	Project:	M4-M5 Link WestConnex	Month: August 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



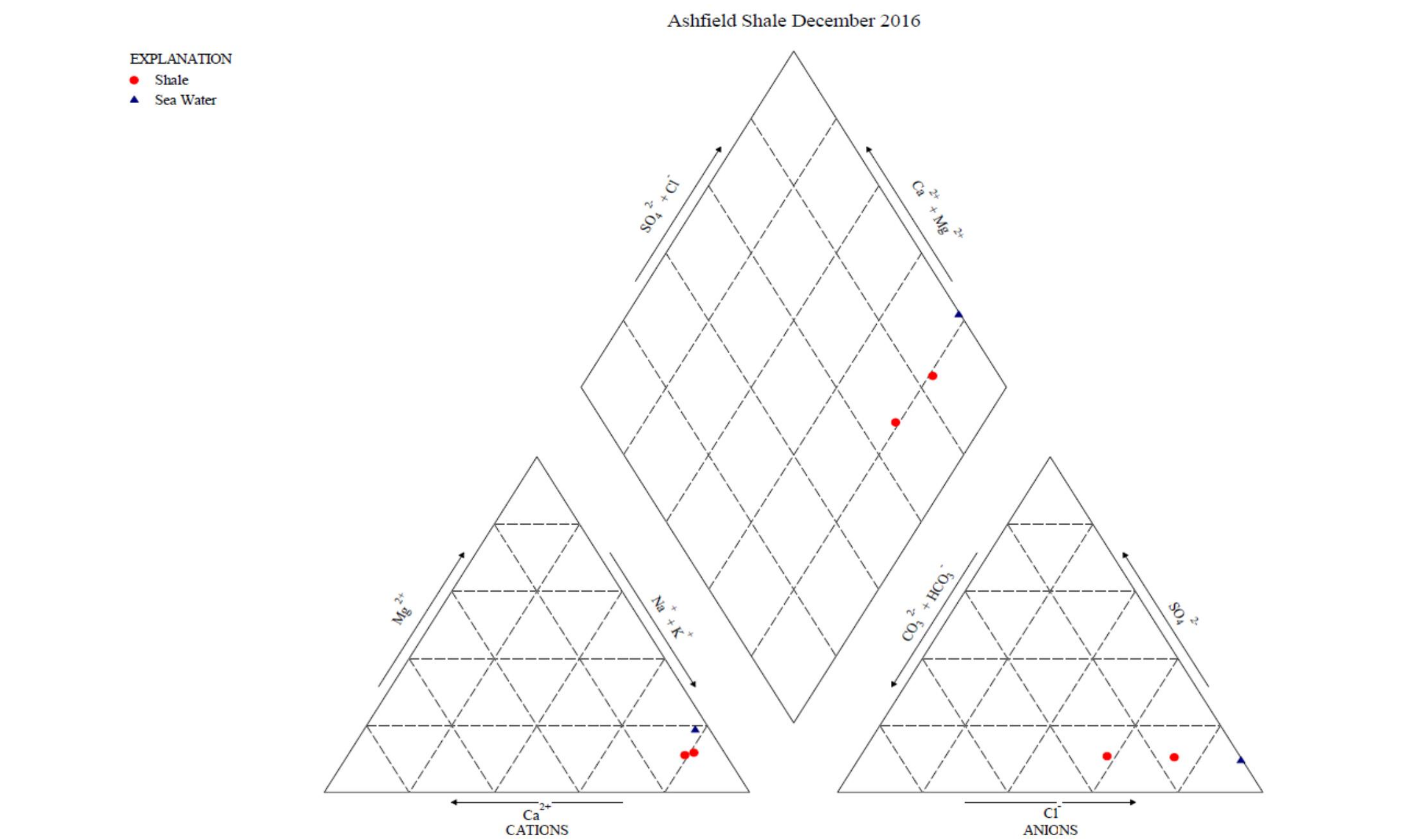
AECOM	Title:	Piper Diagram	Aquifer: Ashfield Shale	Figure: E3.4
	Project:	M4-M5 Link WestConnex	Month: September 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



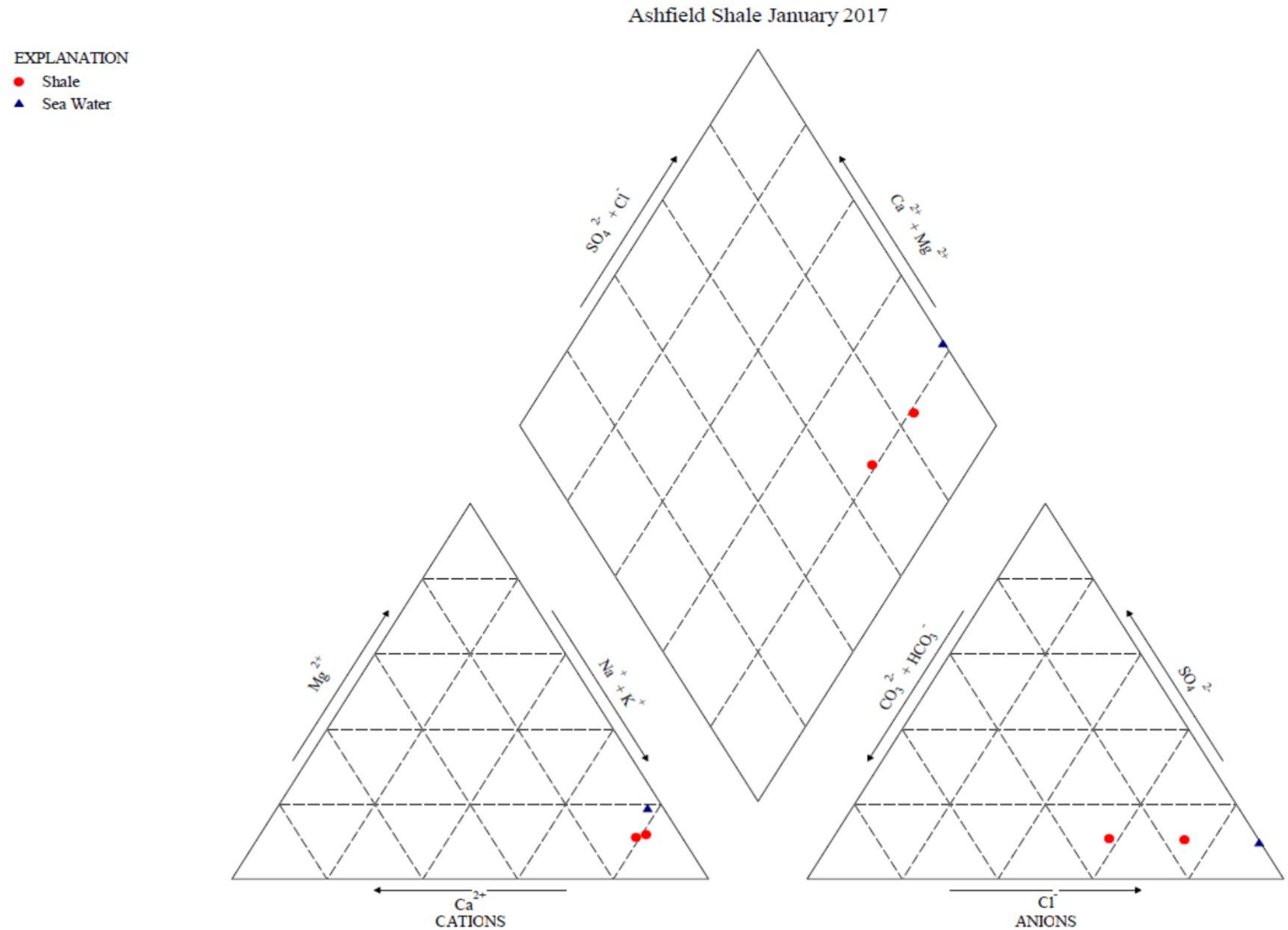
AECOM	Title:	Piper Diagram	Aquifer: Ashfield Shale	Figure: E3.5
	Project:	M4-M5 Link WestConnex	Month: October 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



AECOM	Title:	Piper Diagram	Aquifer: Ashfield Shale	Figure: E3.6
	Project:	M4-M5 Link WestConnex	Month: November 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		

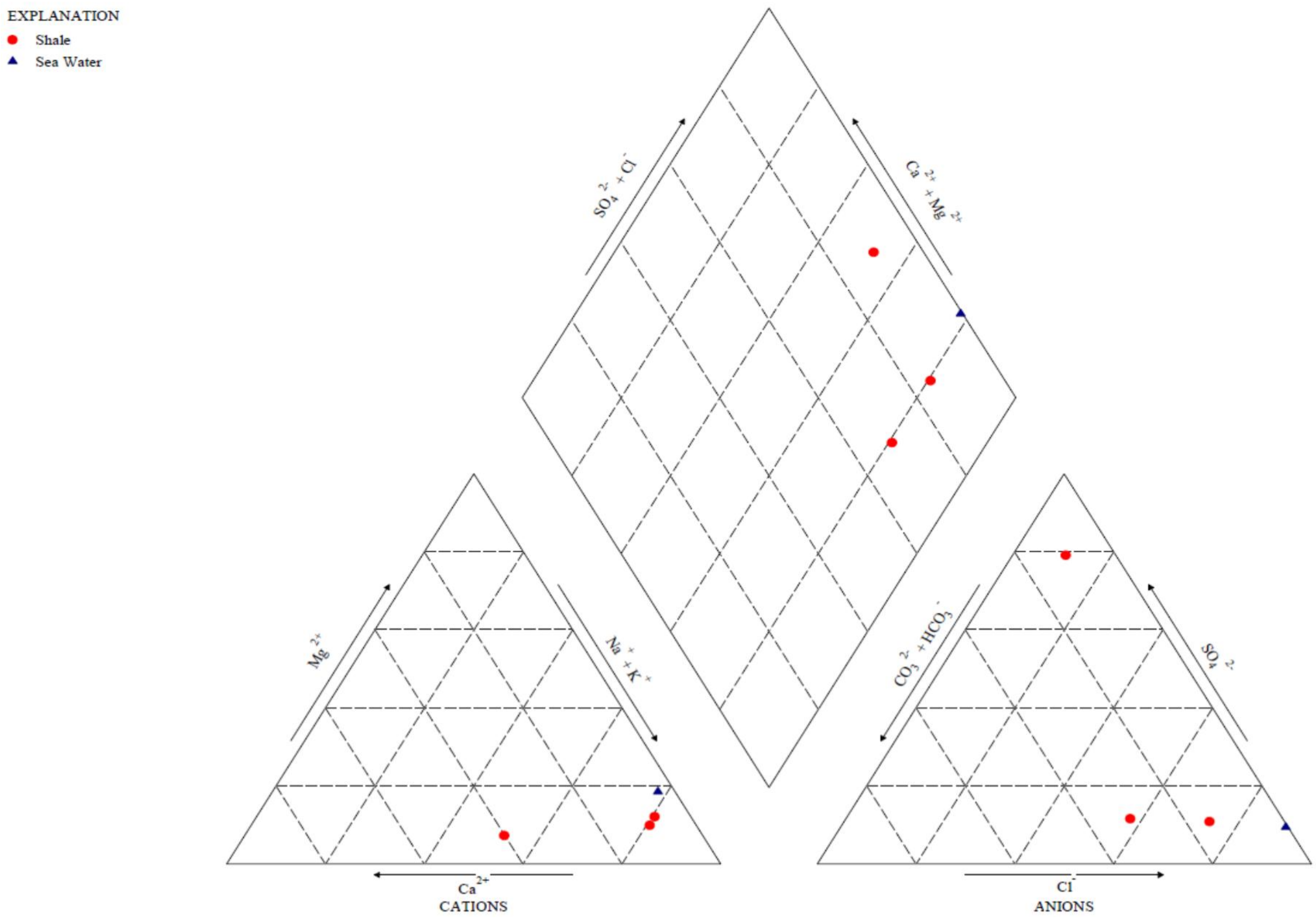


AECOM	Title:	Piper Diagram	Aquifer: Ashfield Shale	Figure: E3.7
	Project:	M4-M5 Link WestConnex	Month: December 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		

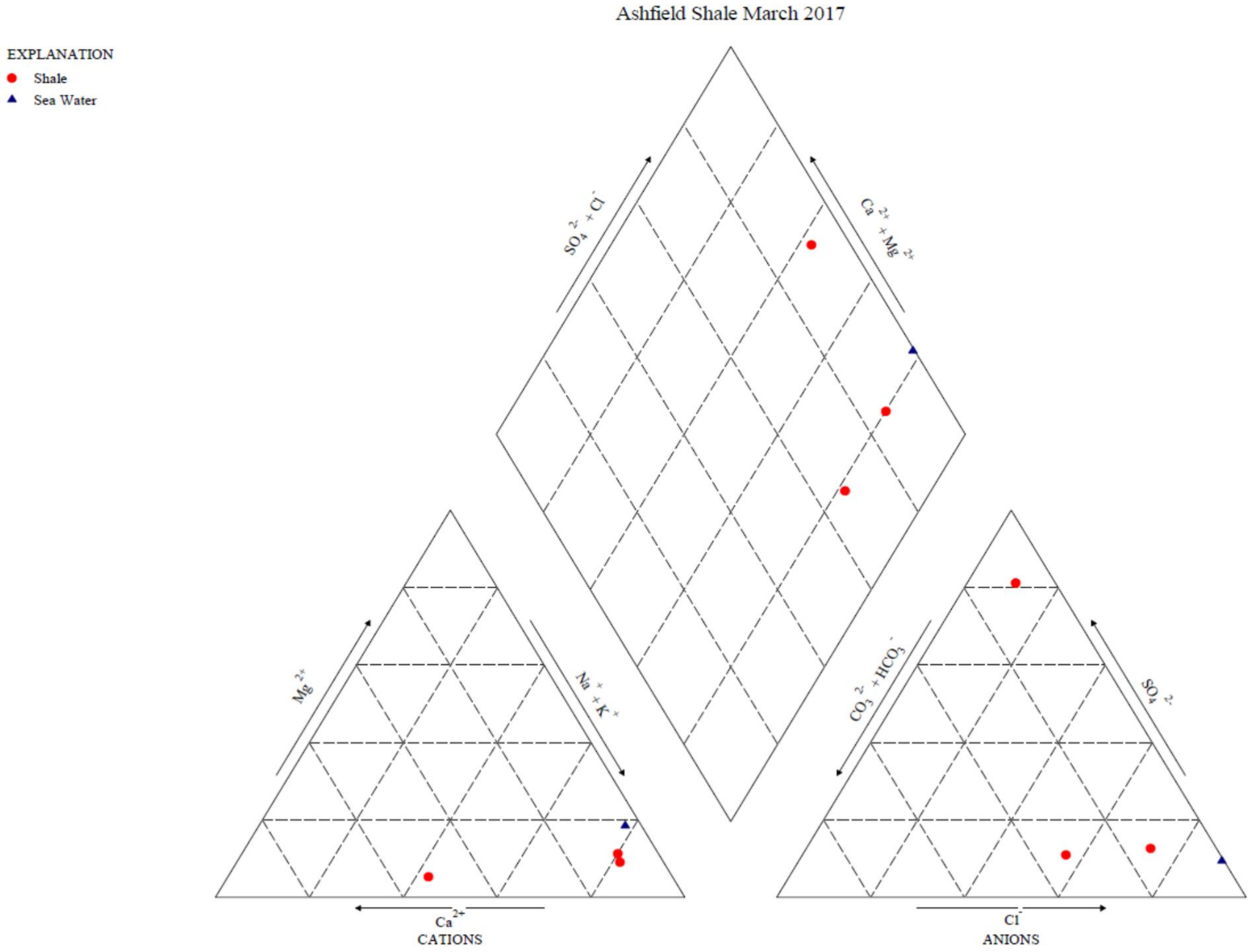


AECOM	Title:	Piper Diagram	Aquifer: Ashfield Shale	Figure: E3.8	
	Project:	M4-M5 Link WestConnex	Month: January 2017	Project No:	60493796
	Client:	Sydney Motorway Corporation			
	Location:	Inner West Sydney			

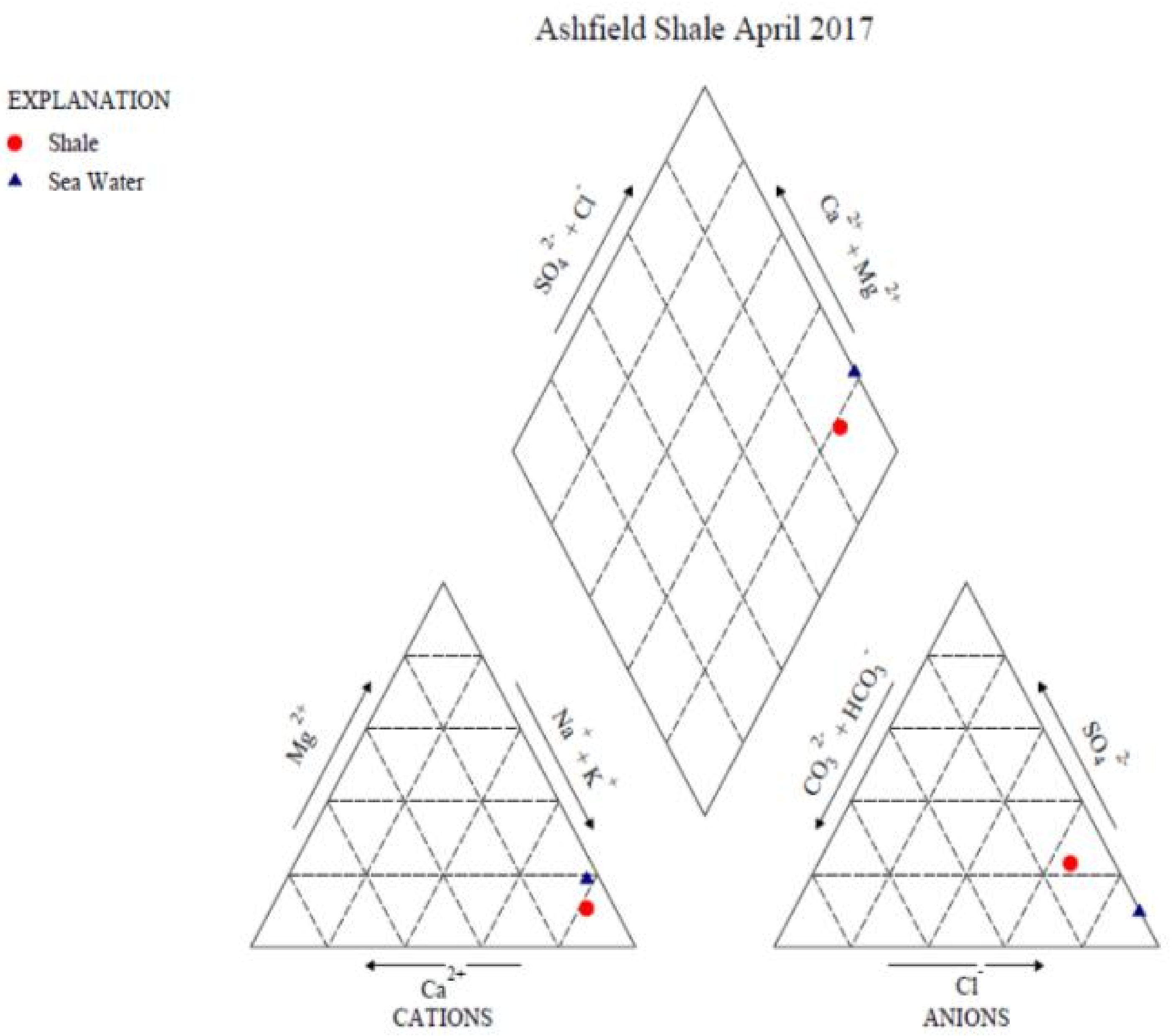
Ashfield Shale February 2017



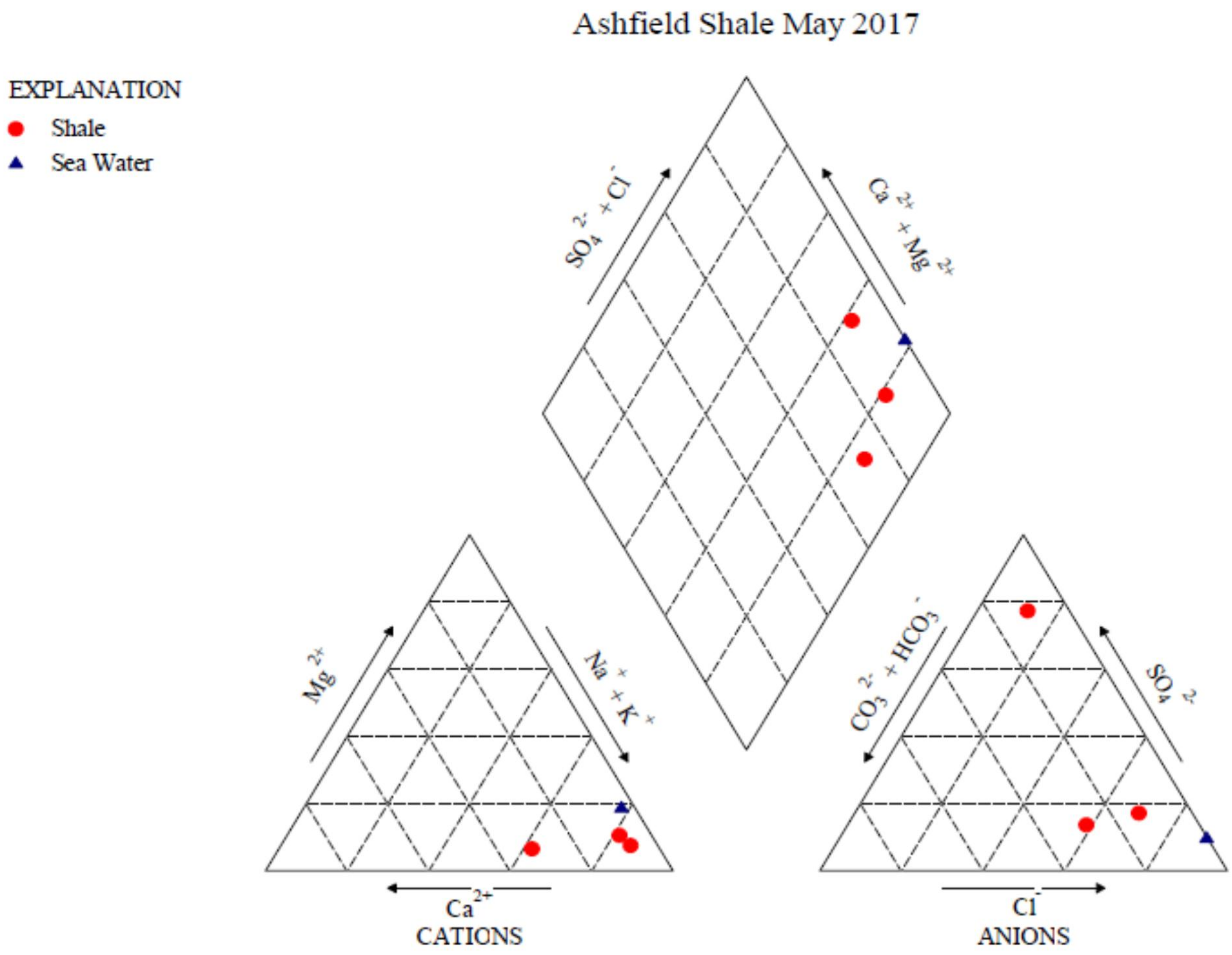
AECOM	Title:	Piper Diagram	Aquifer: Ashfield Shale	Figure: E3.9
	Project:	M4-M5 Link WestConnex	Month: Febuary 2017	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



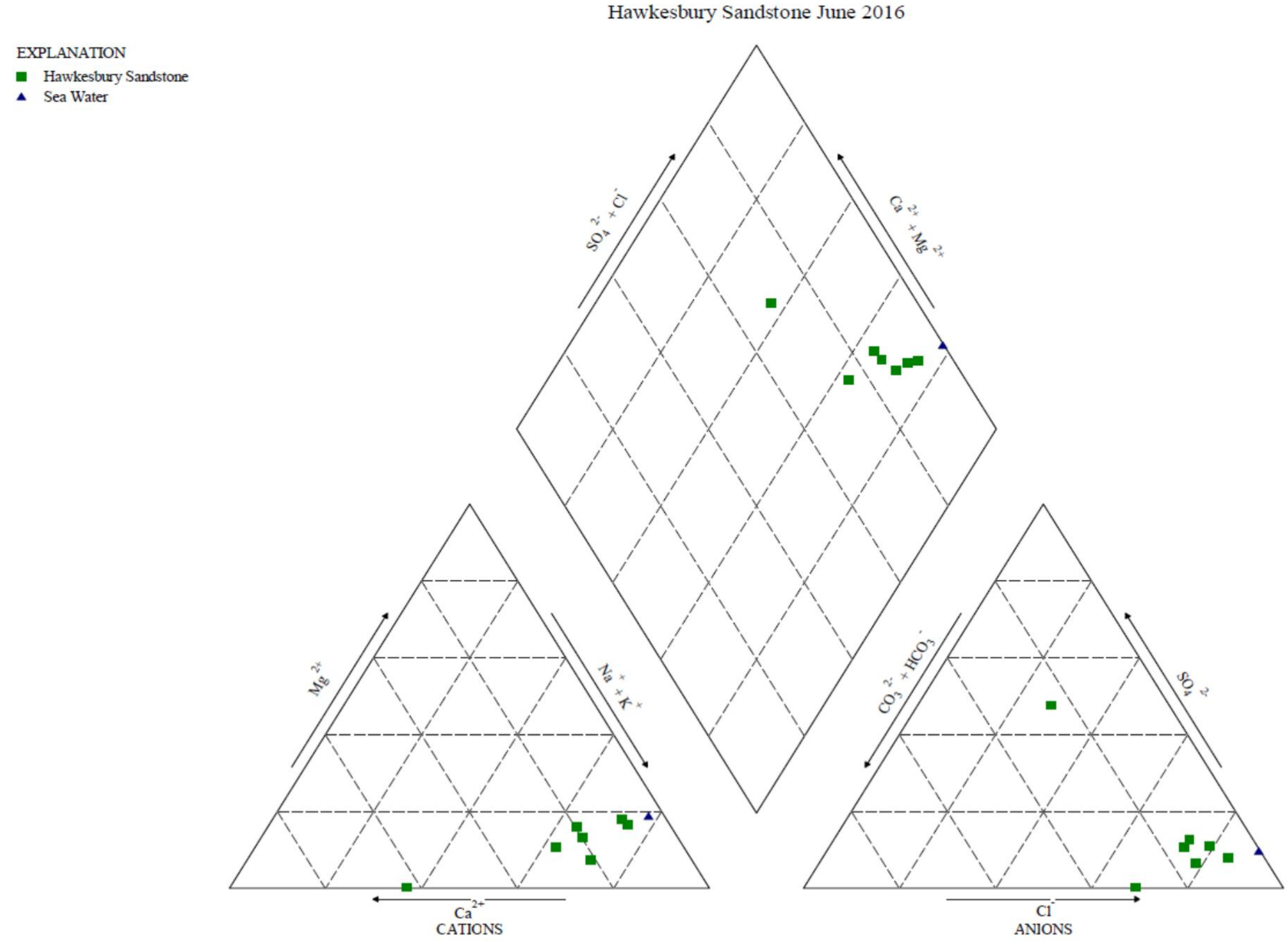
AECOM	Title:	Piper Diagram	Aquifer: Ashfield Shale	Figure: E3.10
	Project:	M4-M5 Link WestConnex	Month: March 2017	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



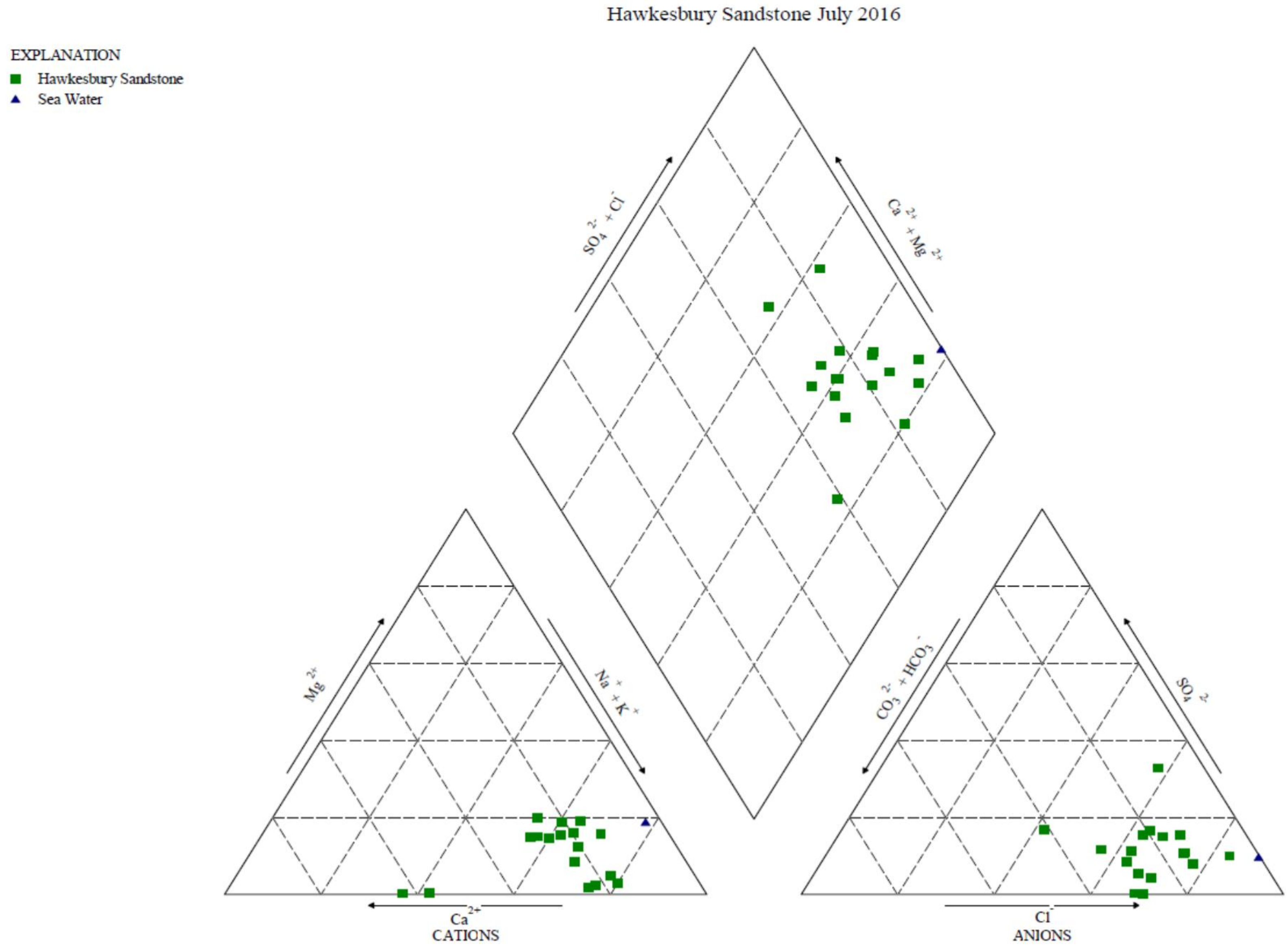
AECOM	Title:	Piper Diagram	Aquifer: Ashfield Shale	Figure: E3.11
	Project:	M4-M5 Link WestConnex	Month: April 2017	Project No: 60493796
	Client:	Sydney Motorw ay Corporation		
	Location:	Inner West Sydney		



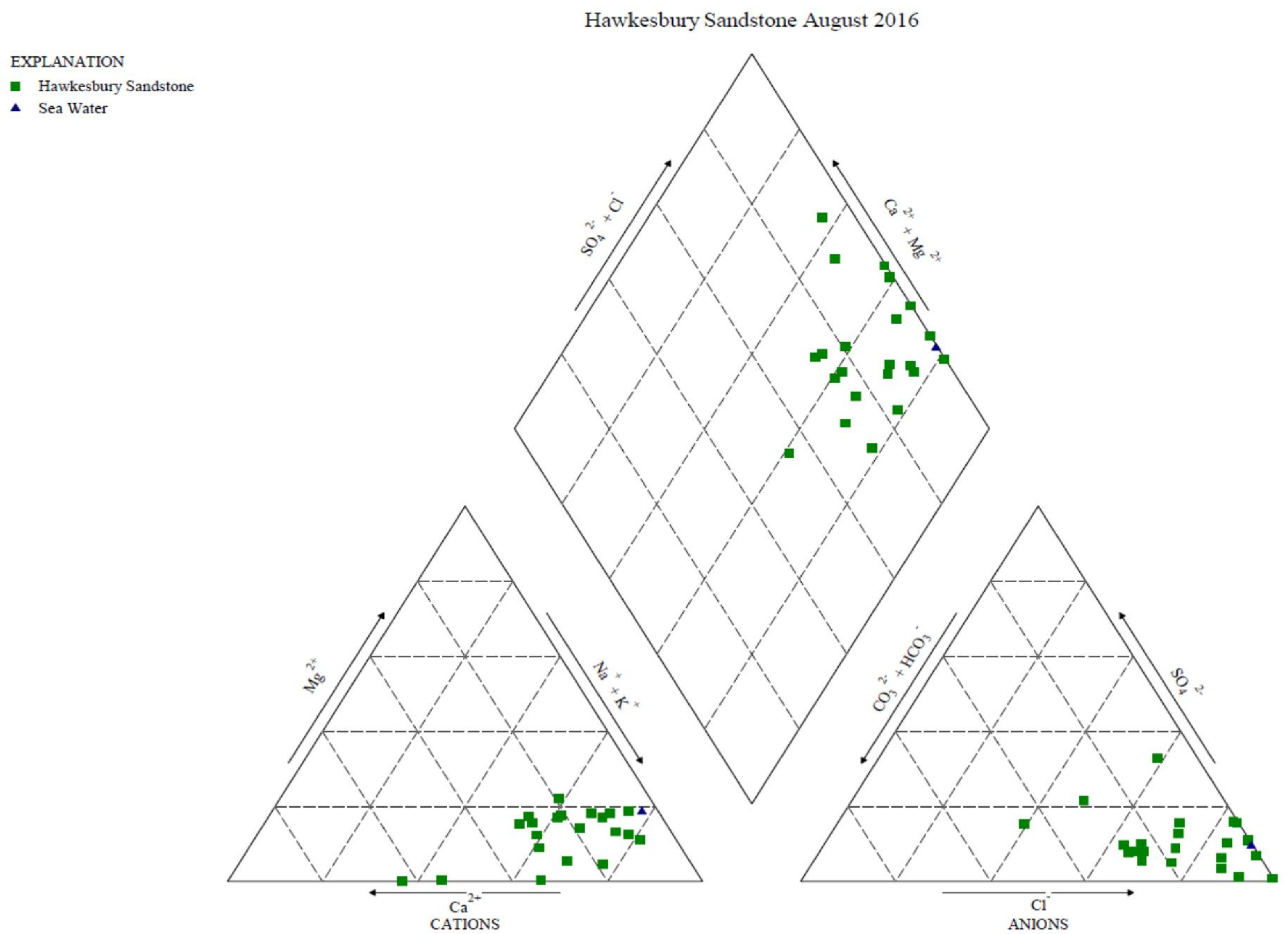
AECOM	Title: Piper Diagram	Aquifer: Ashfield Shale	Figure: E3.12
	Project: M4-M5 Link WestConnex	Month: May 2017	Project No: 60493796
	Client: Sydney Motorway Corporation		
	Location: Inner West Sydney		



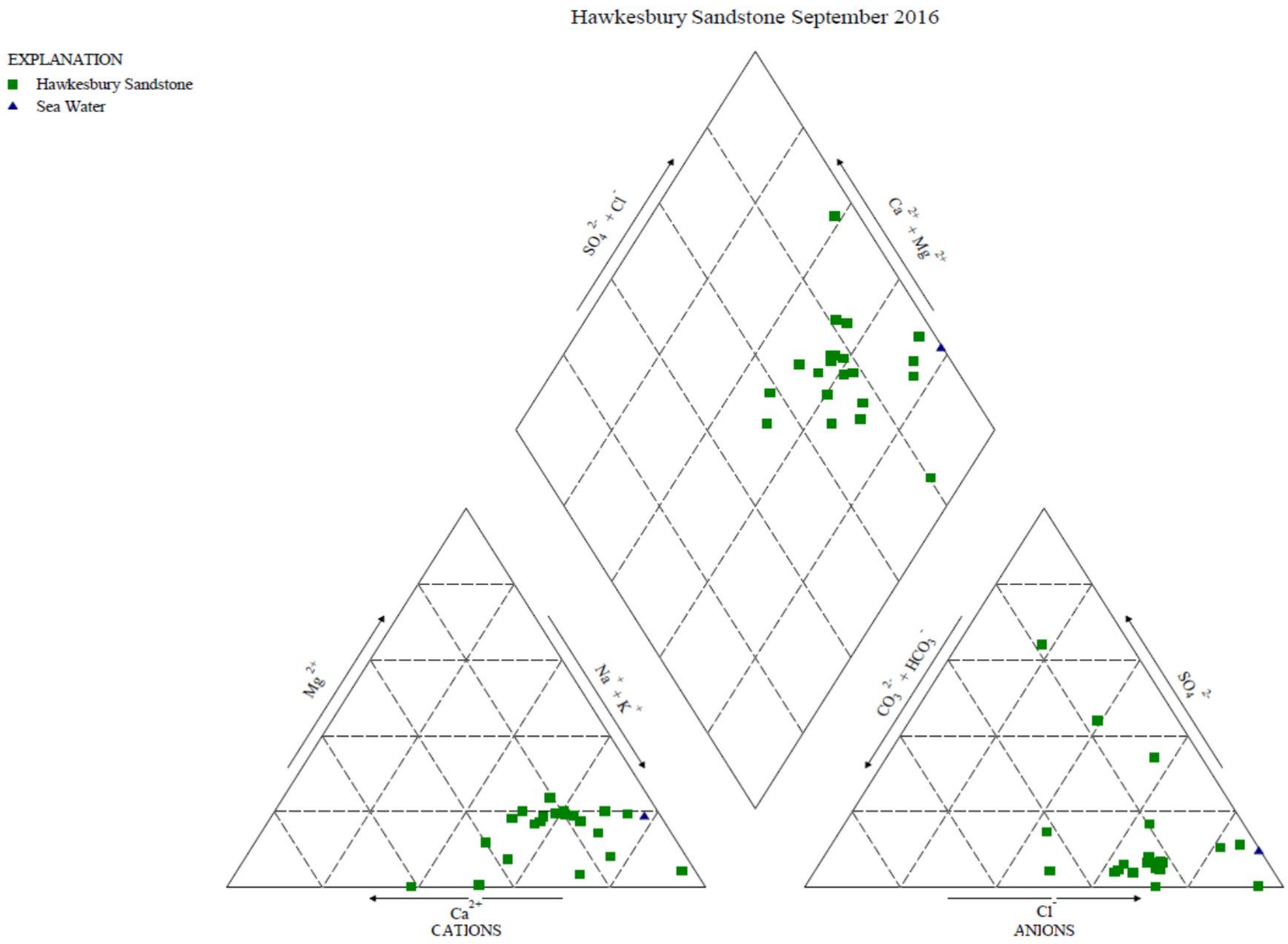
AECOM	Title:	Piper Diagram	Aquifer: Hawkesbury Sandstone	Figure: E4.1	
	Project:	M4-M5 Link WestConnex	Month: June 2016	Project No:	60493796
	Client:	Sydney Motorway Corporation			
	Location:	Inner West Sydney			



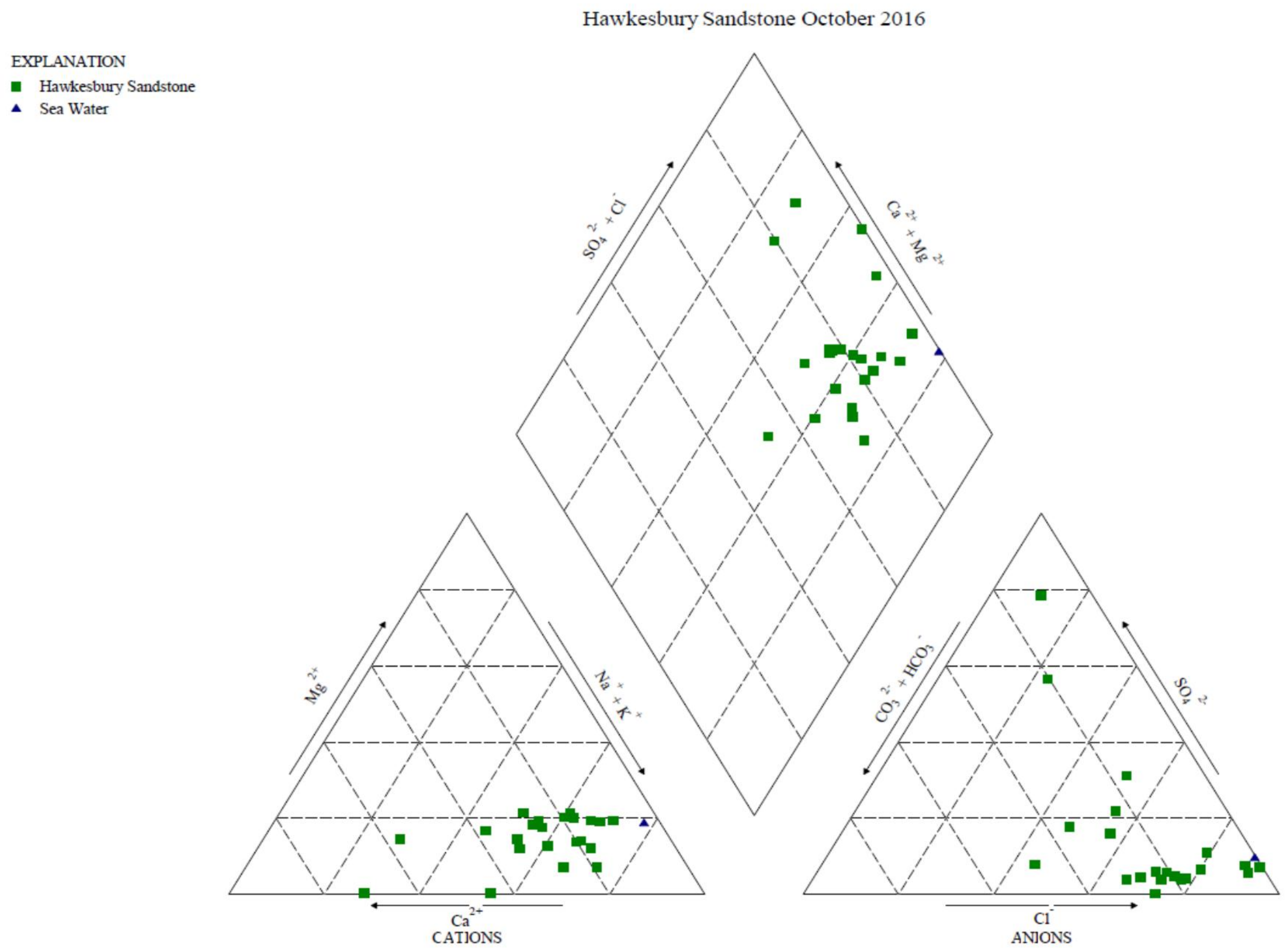
AECOM	Title:	Piper Diagram	Aquifer: Hawkesbury Sandstone	Figure: E4.2
	Project:	M4-M5 Link WestConnex	Month: July 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



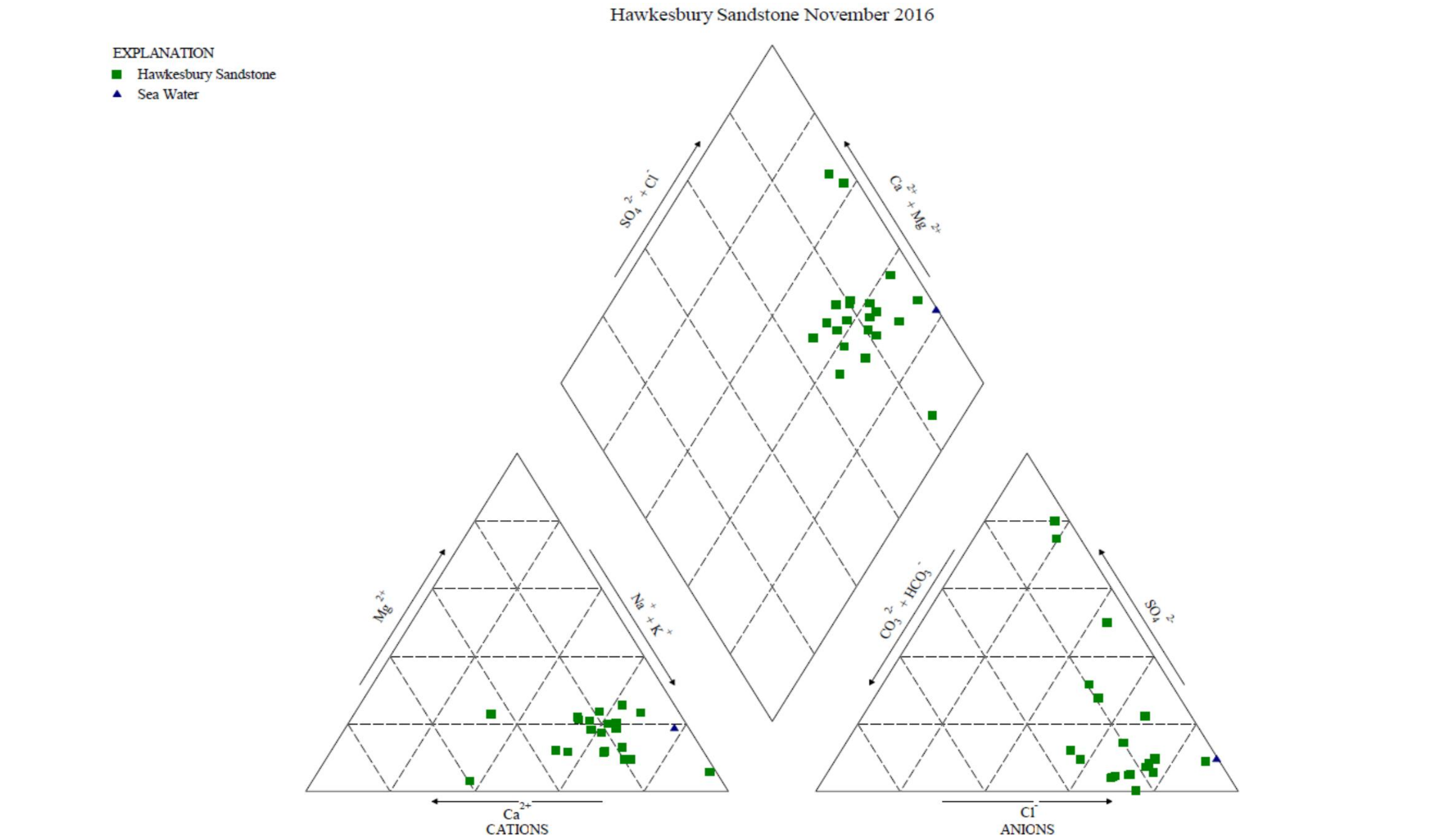
AECOM	Title:	Piper Diagram	Aquifer: Hawkesbury Sandstone	Figure: E4.3
	Project:	M4-M5 Link WestConnex	Month: August 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



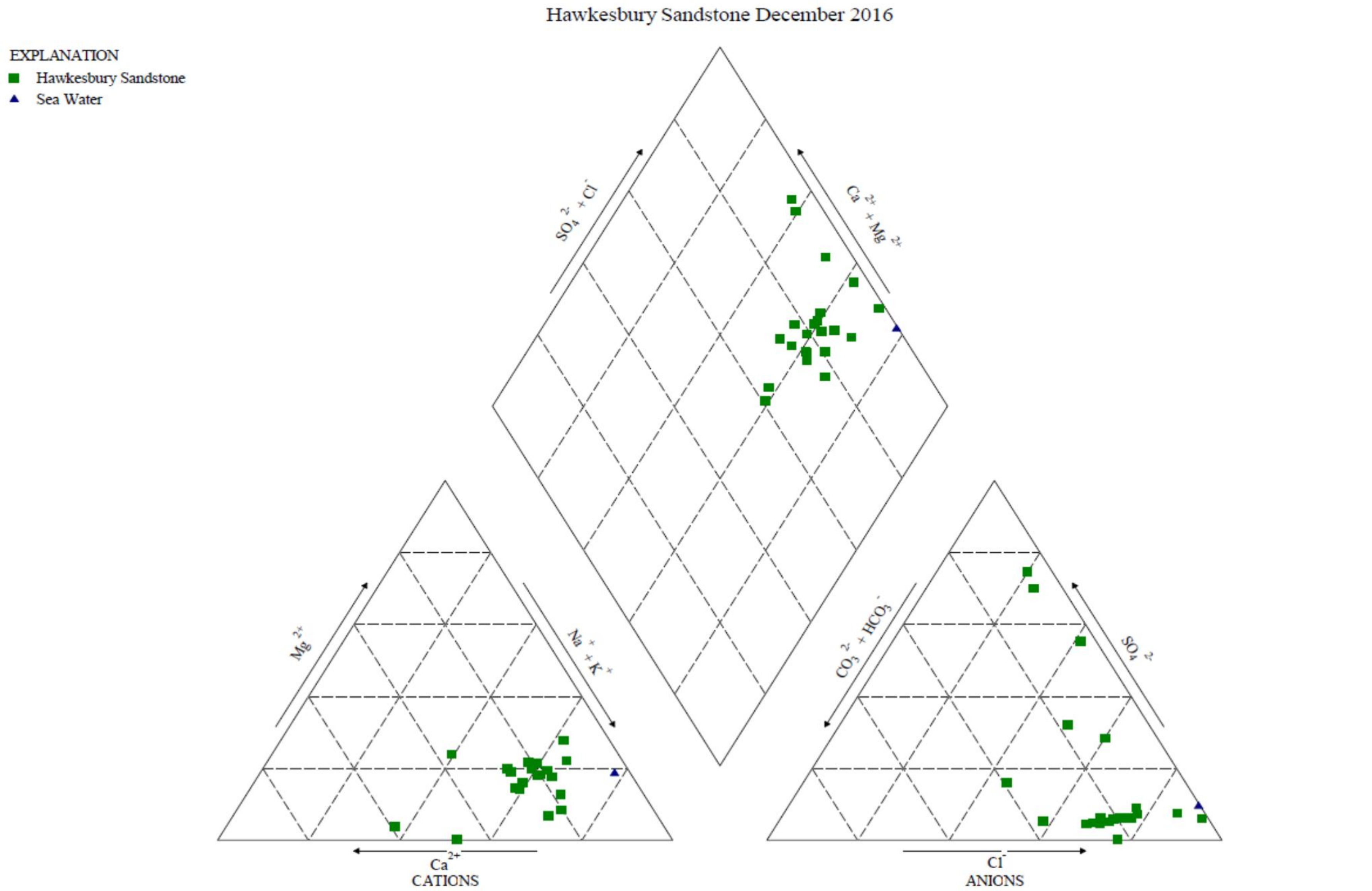
AECOM	Title: Project: Client: Location:	Piper Diagram M4-M5 Link WestConnex Sydney Motorway Corporation Inner West Sydney	Aquifer: Hawkesbury Sandstone Month: September 2016	Figure: E4.4 Project No: 60493796



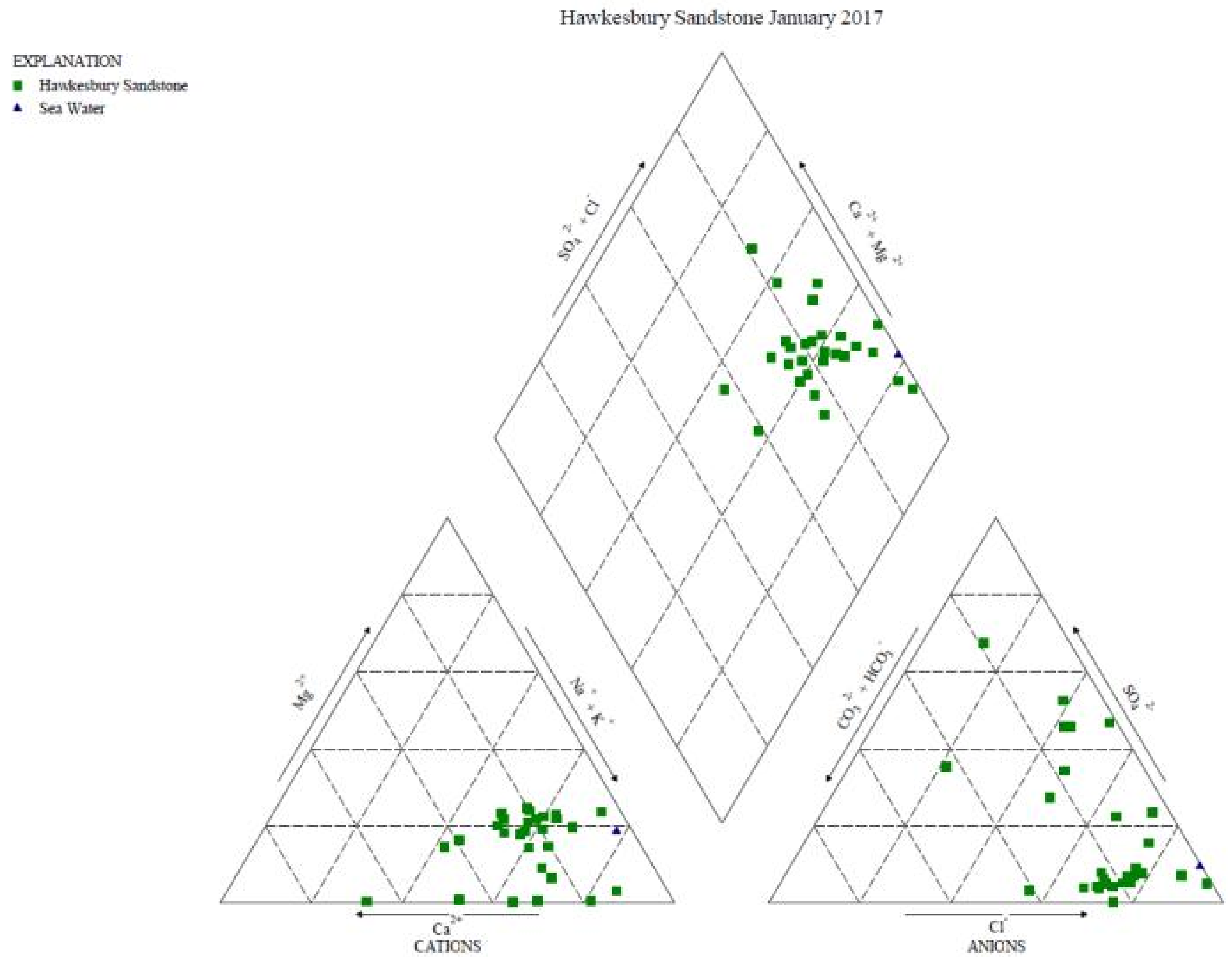
AECOM	Title:	Piper Diagram	Aquifer: Hawkesbury Sandstone	Figure: E4.5
	Project:	M4-M5 Link WestConnex	Month: October 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



AECOM	Title:	Piper Diagram	Aquifer: Hawkesbury Sandstone	Figure: E4.6
	Project:	M4-M5 Link WestConnex	Month: November 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		

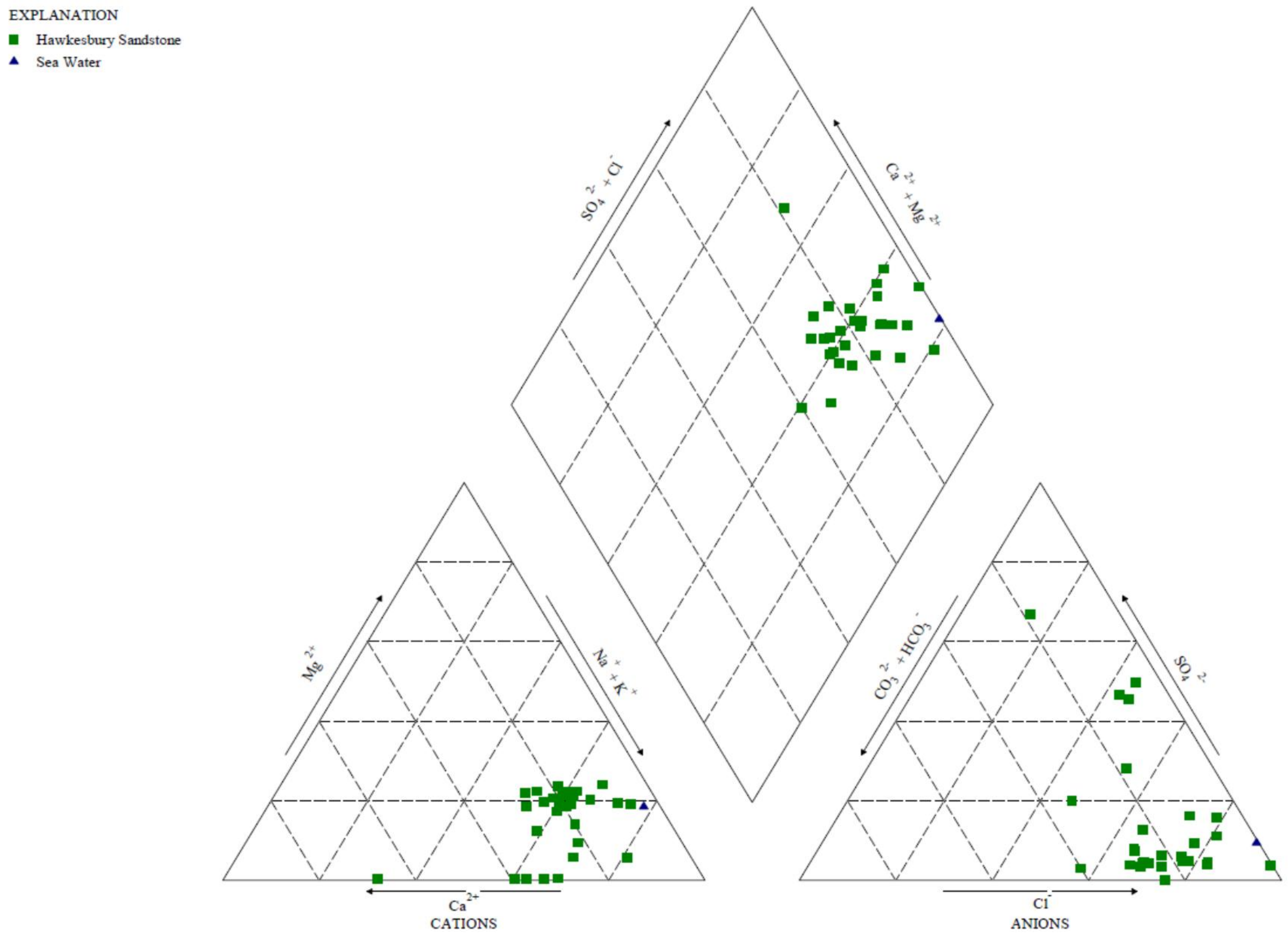


AECOM	Title:	Piper Diagram	Aquifer: Hawkesbury Sandstone	Figure: E4.7
	Project:	M4-M5 Link WestConnex	Month: December 2016	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		

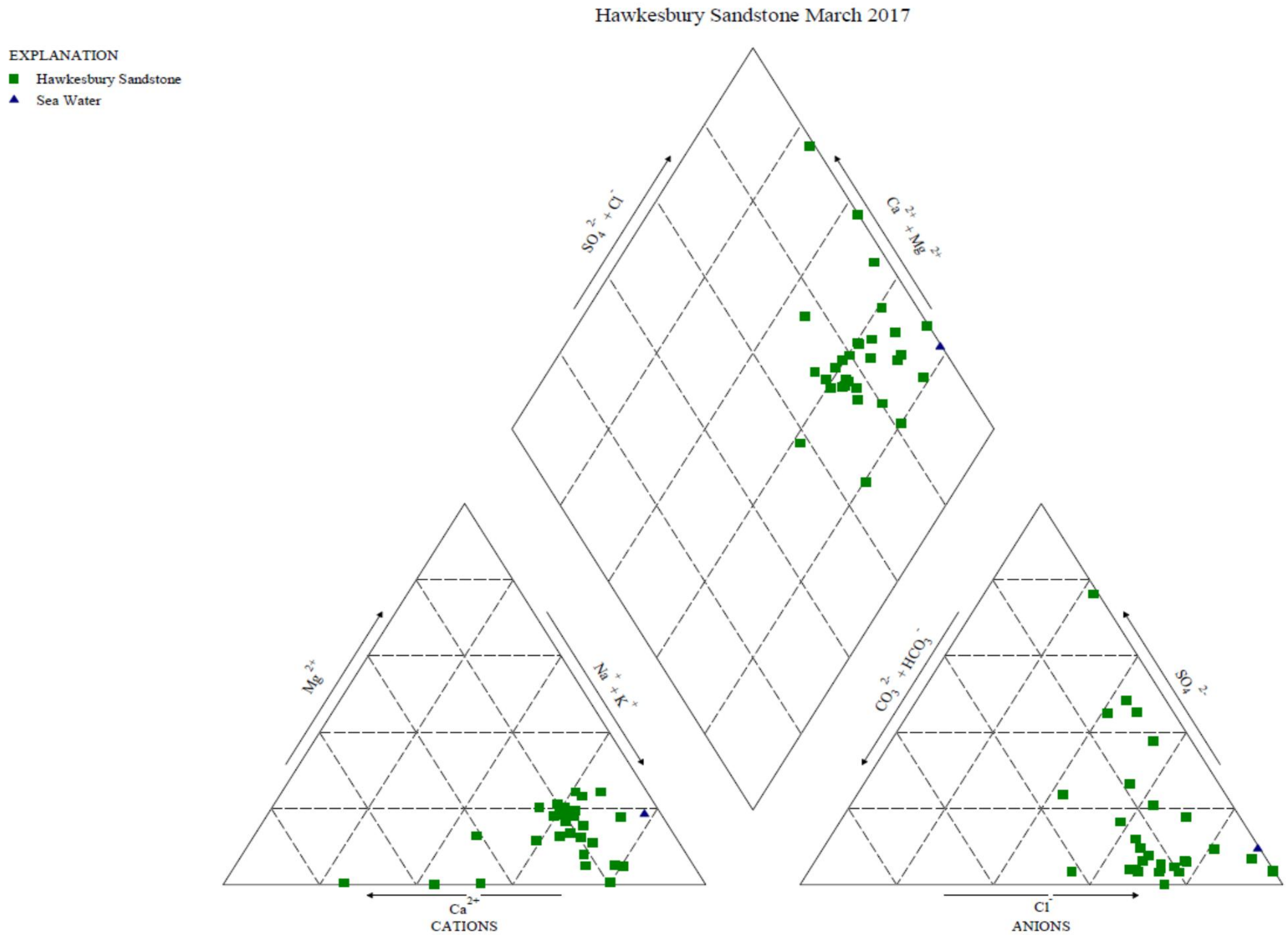


AECOM	Title:	Piper Diagram	Aquifer:	Hawkesbury Sandstone	Figure: E4.8	
	Project:	M4-M5 Link WestConnex	Month:	January 2017	Project No:	60493796
	Client:	Sydney Motorway Corporation				
	Location:	Inner West Sydney				

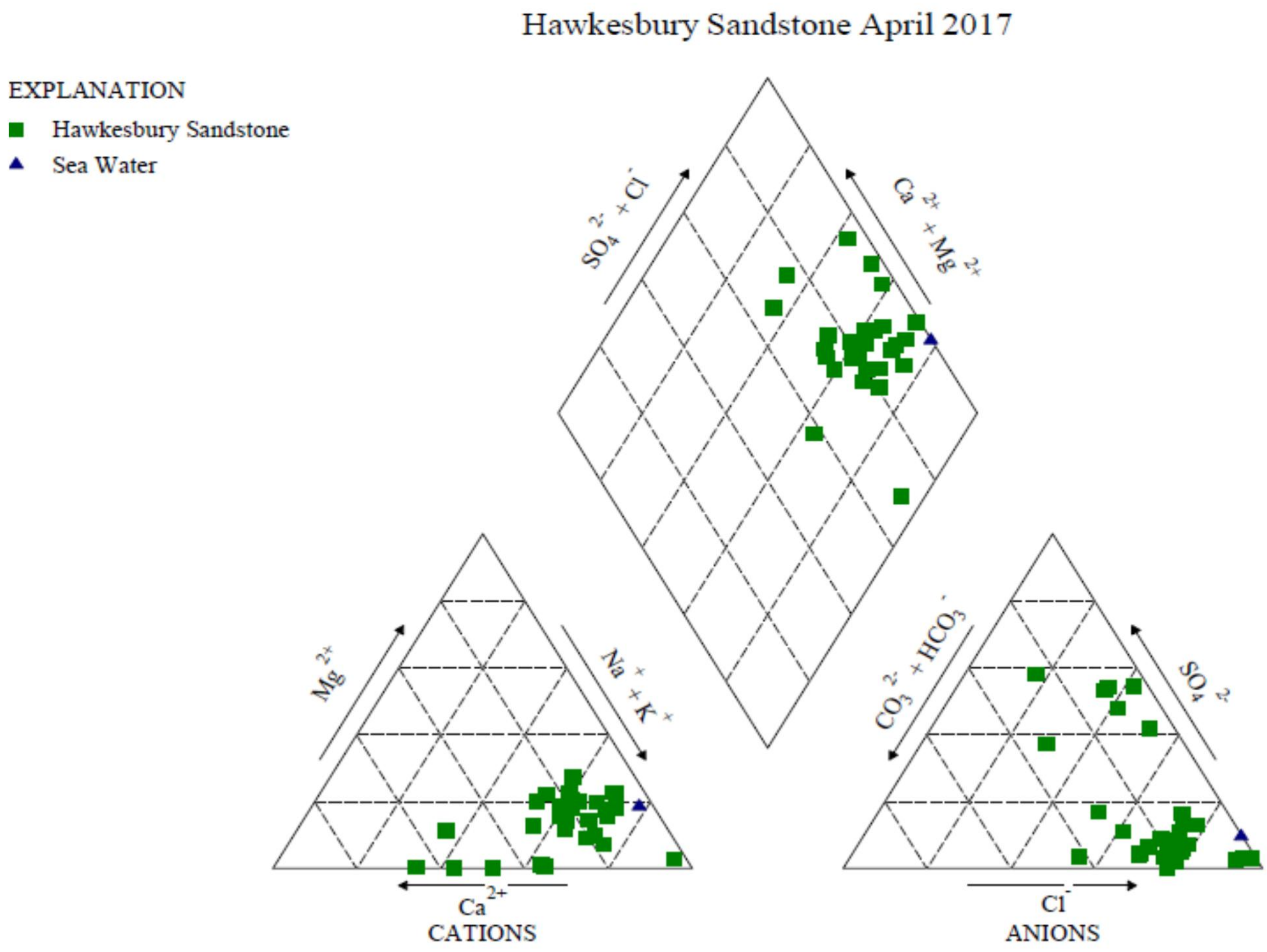
Hawkesbury Sandstone Febuary 2017



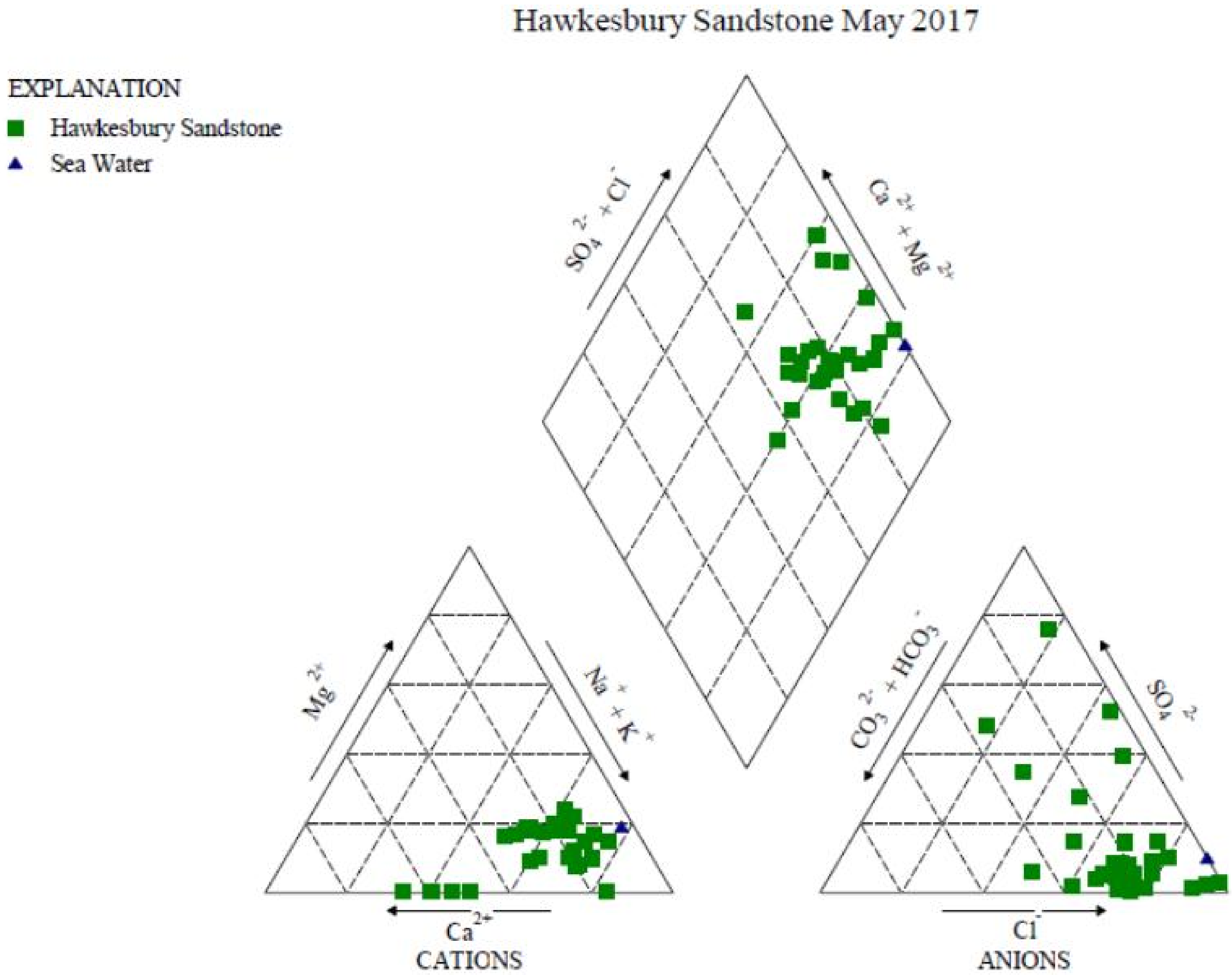
AECOM	Title:	Piper Diagram	Aquifer: Hawkesbury Sandstone	Figure: E4.9
	Project:	M4-M5 Link WestConnex	Month: February 2017	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



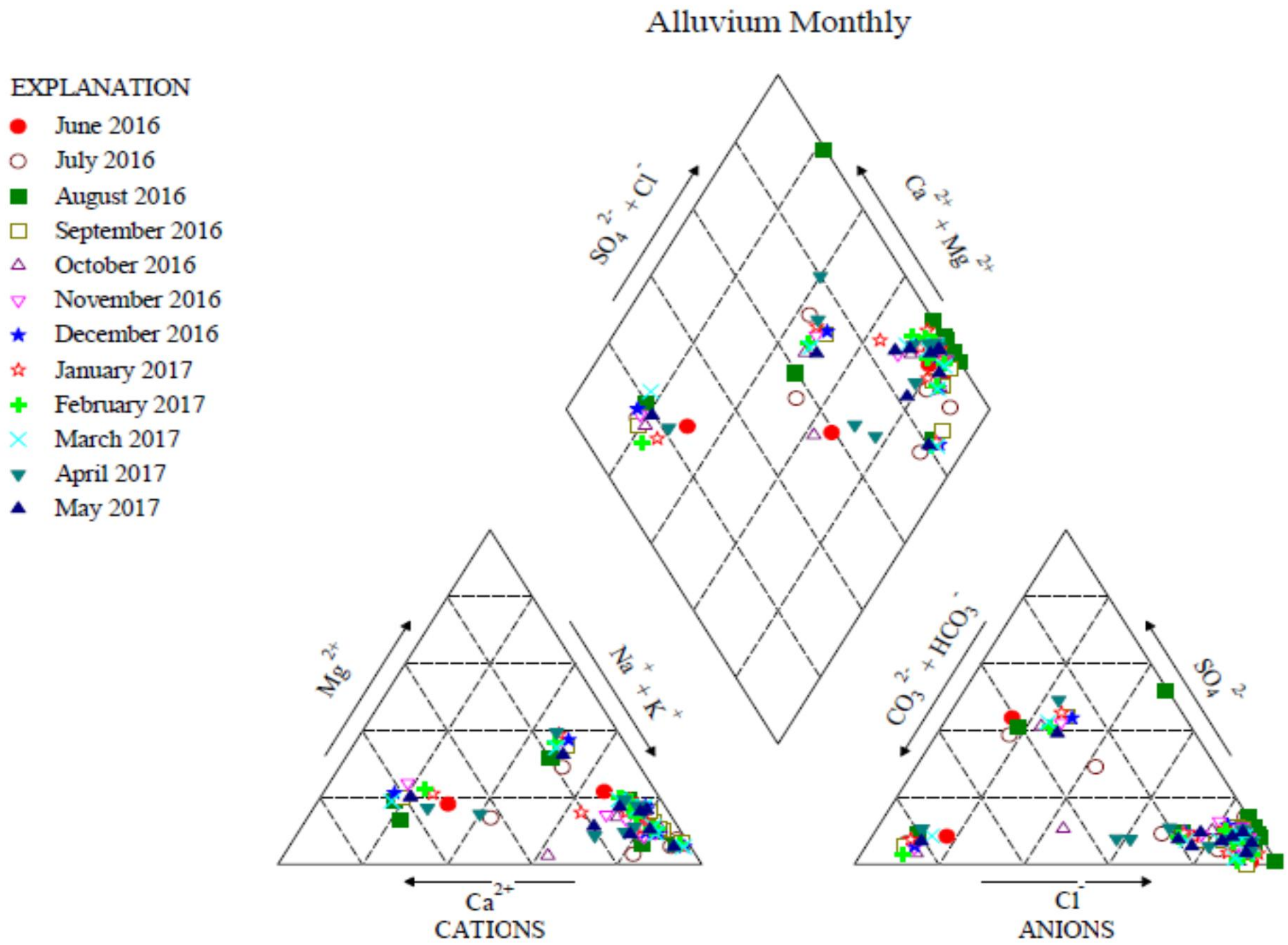
Title:	Piper Diagram	Aquifer: Hawkesbury Sandstone	Figure: E4.10
Project:	M4-M5 Link WestConnex	Month: March 2017	Project No: 60493796
Client:	Sydney Motorway Corporation		
Location:	Inner West Sydney		



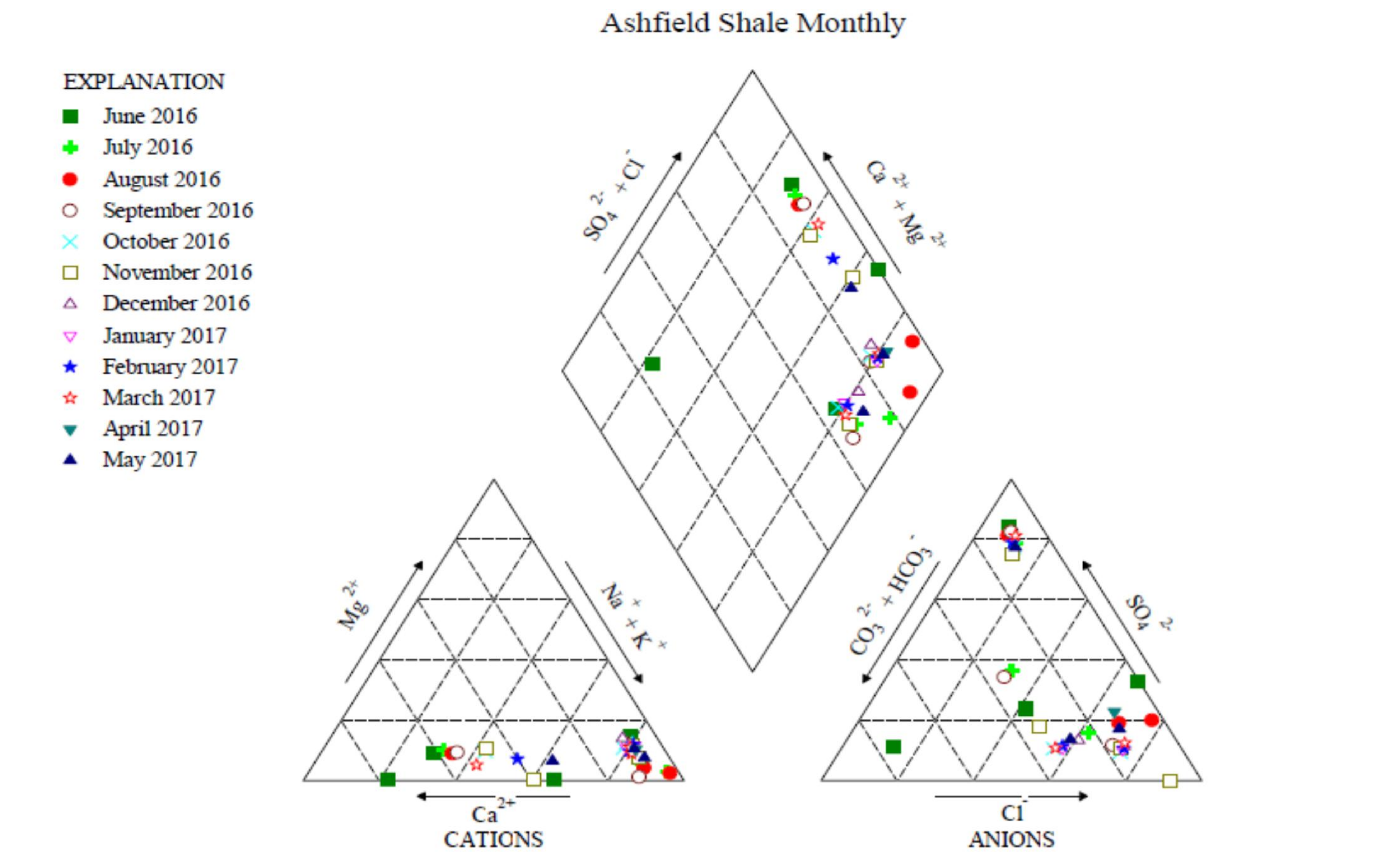
AECOM	Title:	Piper Diagram	Aquifer: Hawkesbury Sandstone	Figure: E4.11
	Project:	M4-M5 Link WestConnex	Month: April 2017	Project No: 60493796
	Client:	Sydney Motorway Corporation		
	Location:	Inner West Sydney		



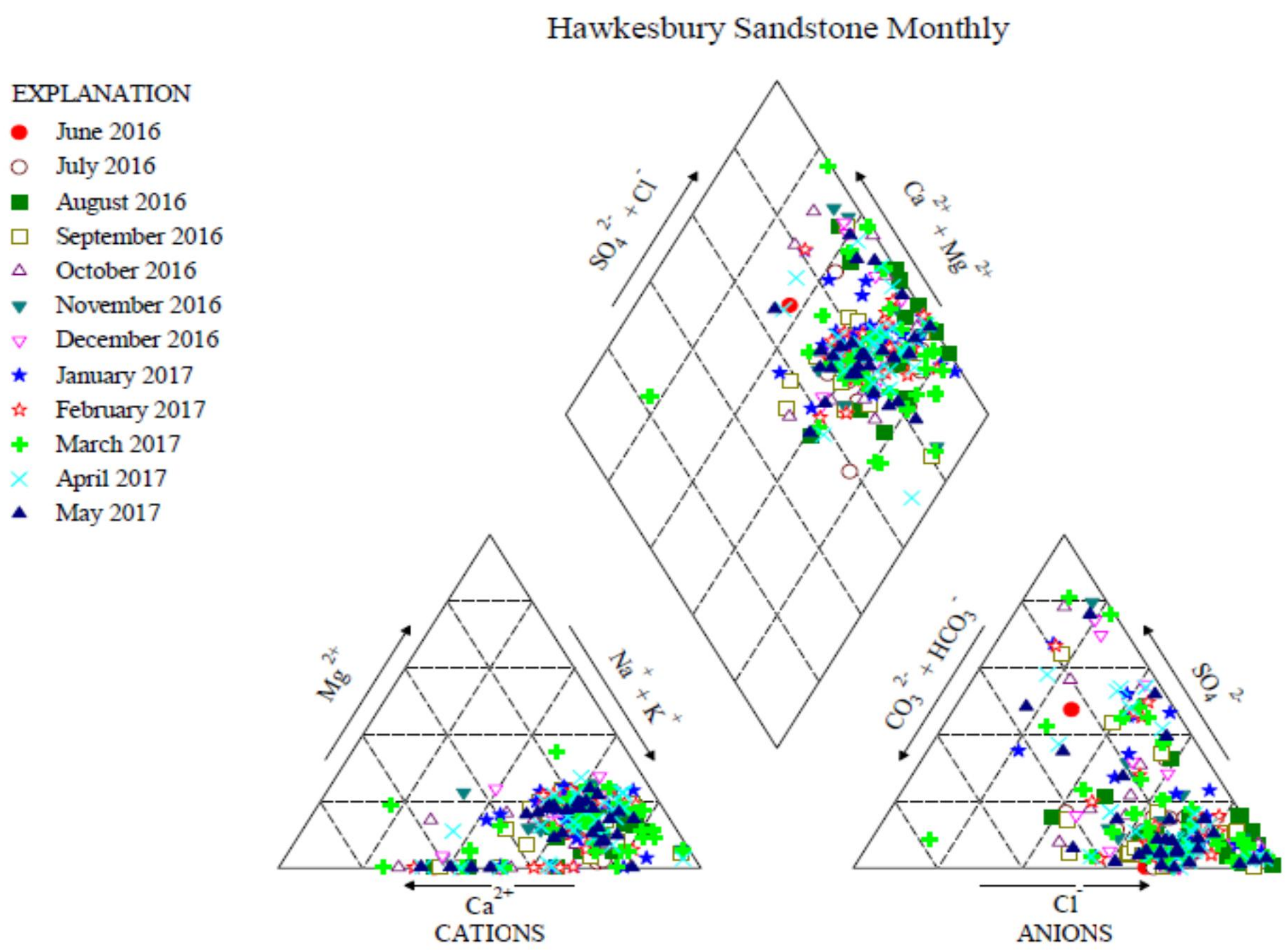
AECOM	Title:	Piper Diagram	Aquifer:	Hawkesbury Sandstone	Figure: E4.12	
	Project:	M4-M5 Link WestConnex	Month:	May 2017	Project No:	60493796
	Client:	Sydney Motorway Corporation				
	Location:	Inner West Sydney				



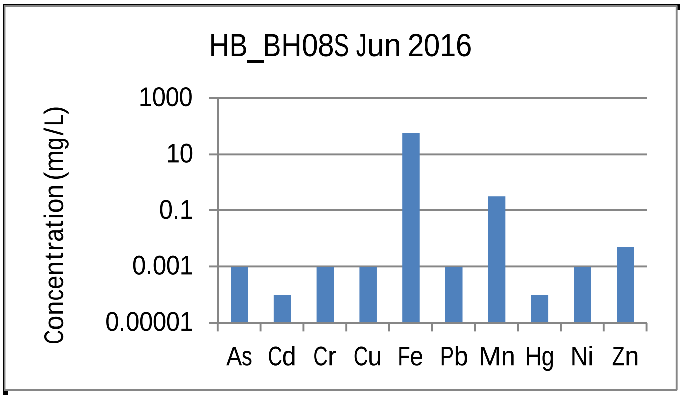
AECOM	Title: Project: Client: Location:	Piper Diagram M4-M5 Link WestConnex Sydney Motorway Corporation Inner West Sydney	Aquifer: Alluvium Month: June 2016 - May 2017	Figure: E5.1 Project No: 60493796

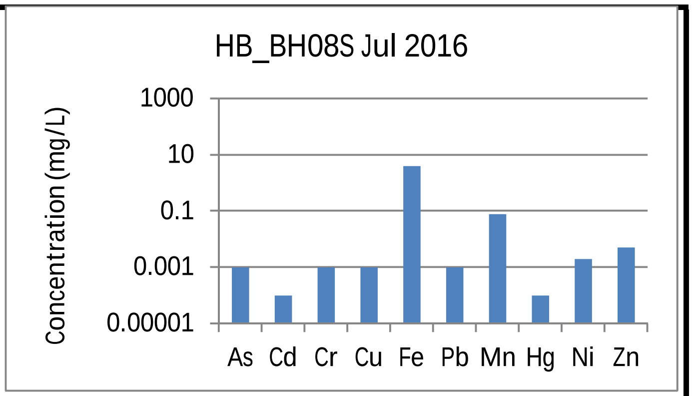


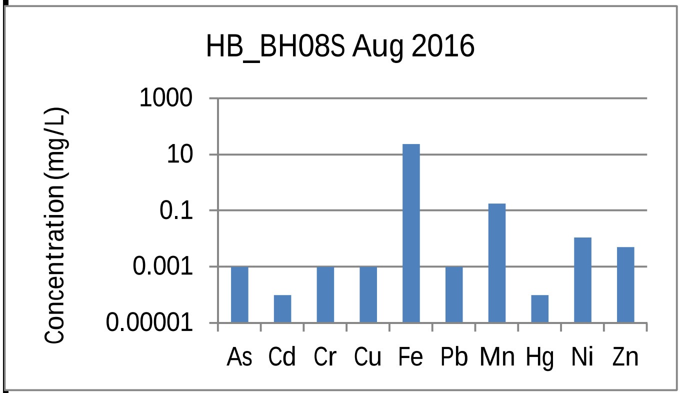
AECOM	Title: Project: Client: Location:	Piper Diagram M4-M5 Link WestConnex Sydney Motorway Corporation Inner West Sydney	Aquifer: Ashfield Shale Month: June 2016 - May 2017	Figure: E5.2 Project No: 60493796

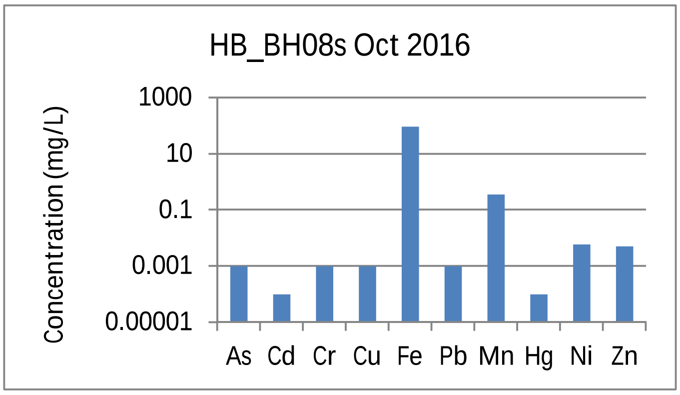


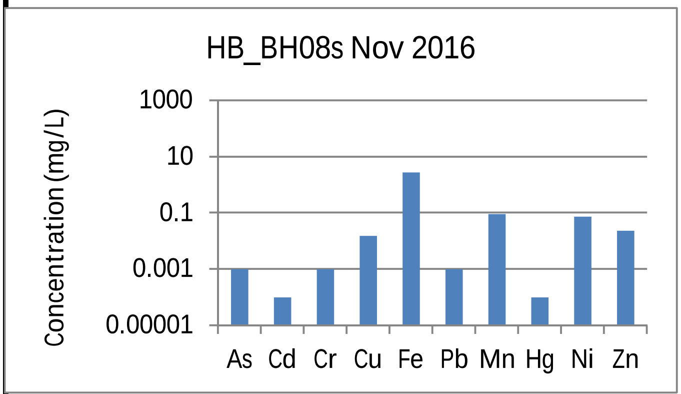
AECOM	Title: Project: Client: Location:	Piper Diagram M4-M5 Link WestConnex Sydney Motorway Corporation Inner West Sydney	Aquifer: Hawkesbury Sandstone Month: June 2016 - May 2017	Figure: E5.3 Project No: 60493796

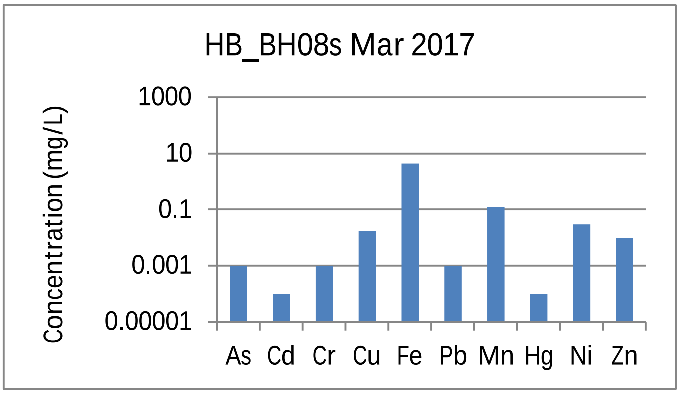


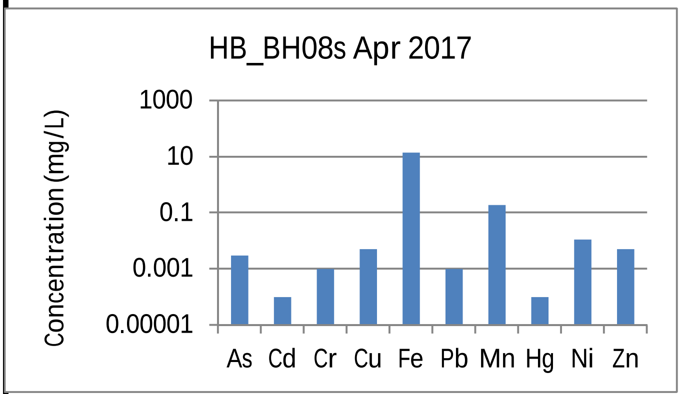


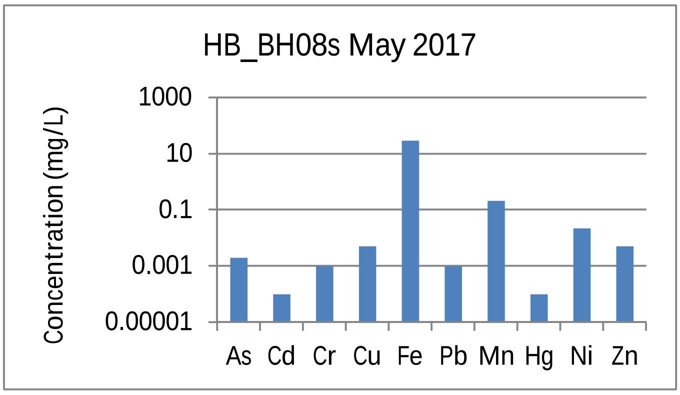




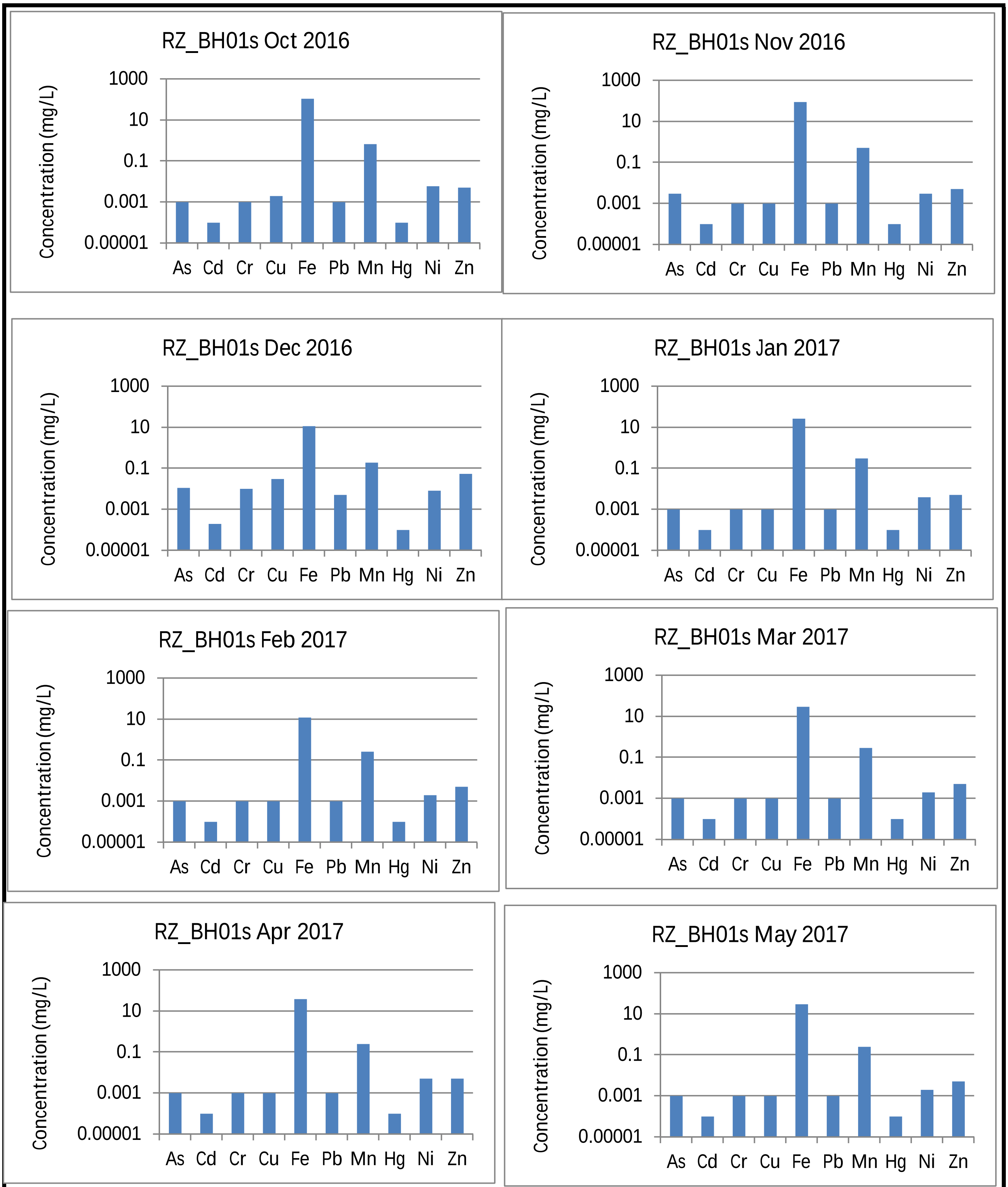






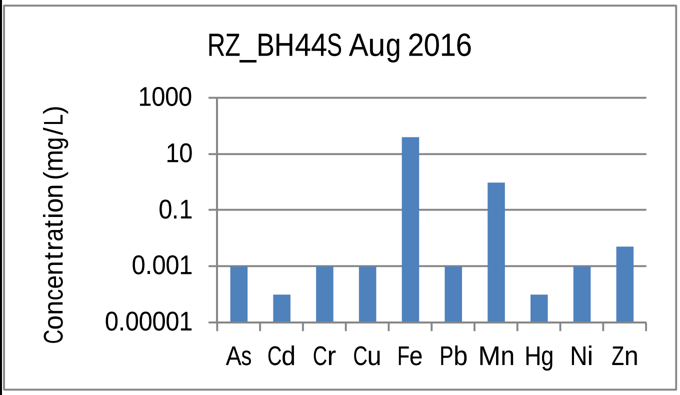


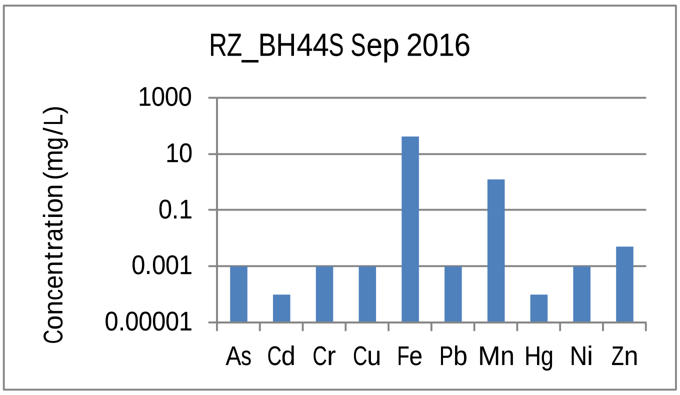
Client:	Sydney Motorway Corporation	Figure E6.1
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - HB_BH8s Alluvium - Haberfield	

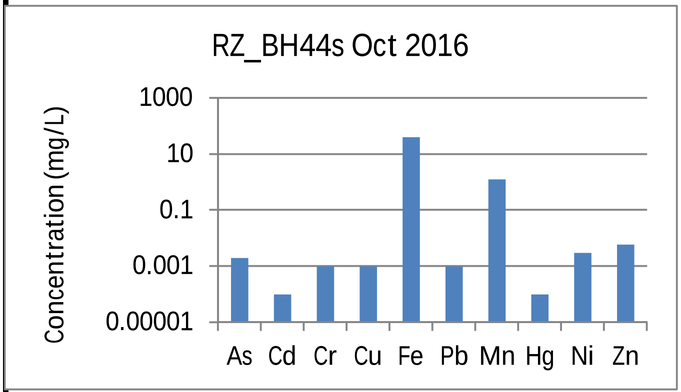


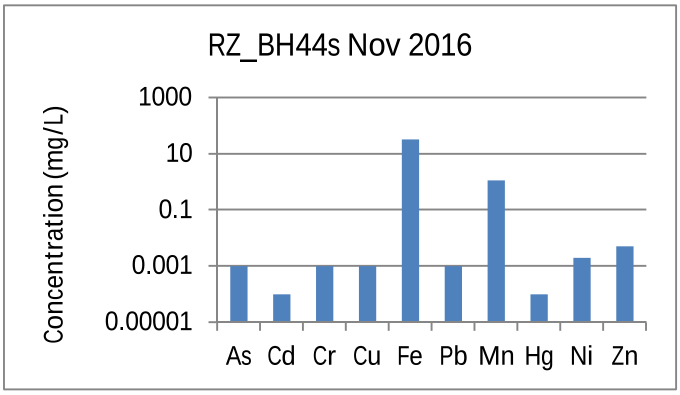
Client: Sydney Motorway Corporation
Project: M4-M5 Link
Title: Schoeller Diagrams - Metals - RZ_BH01s
Alluvium Rozelle

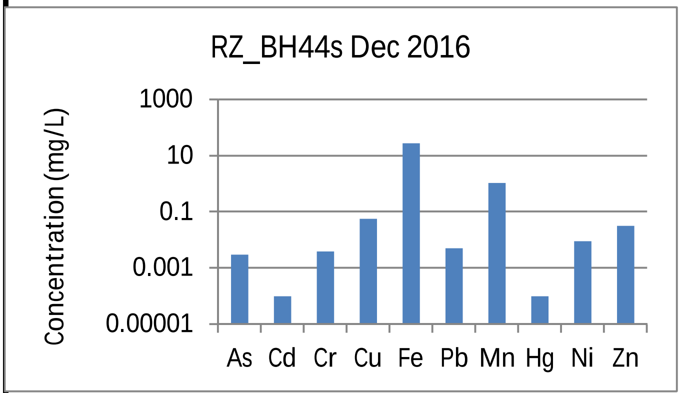
Figure E6.2

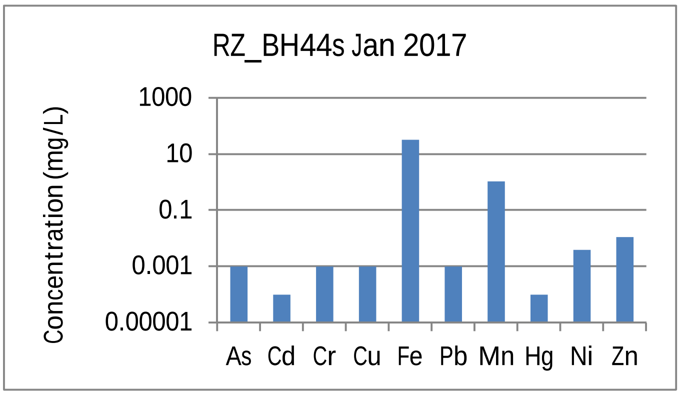


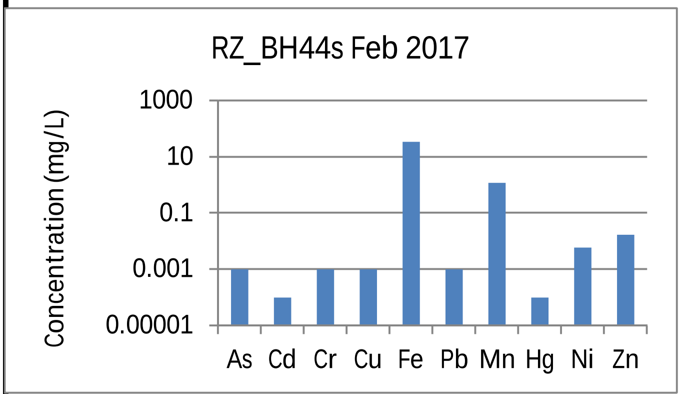


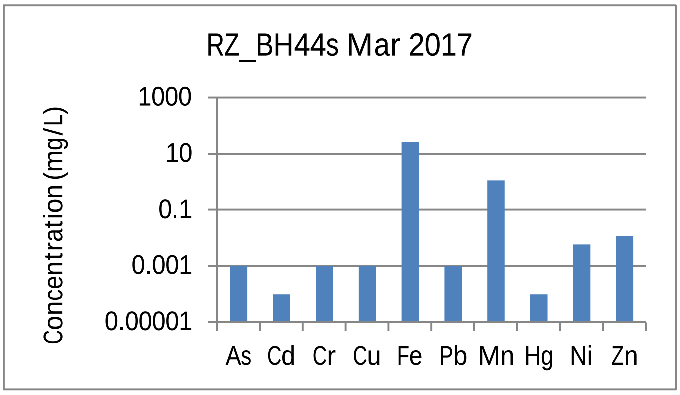


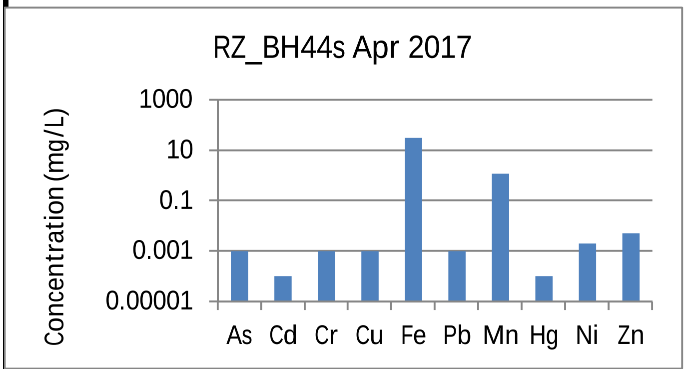


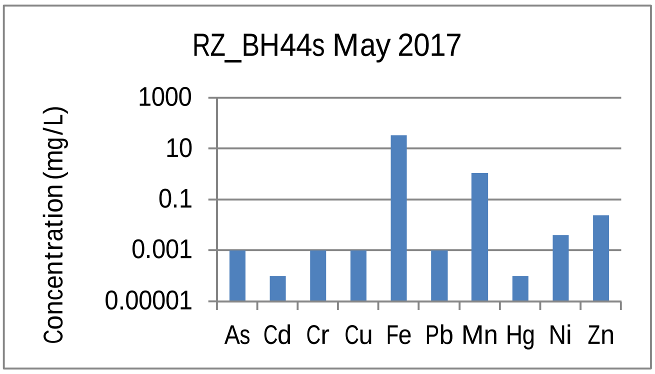




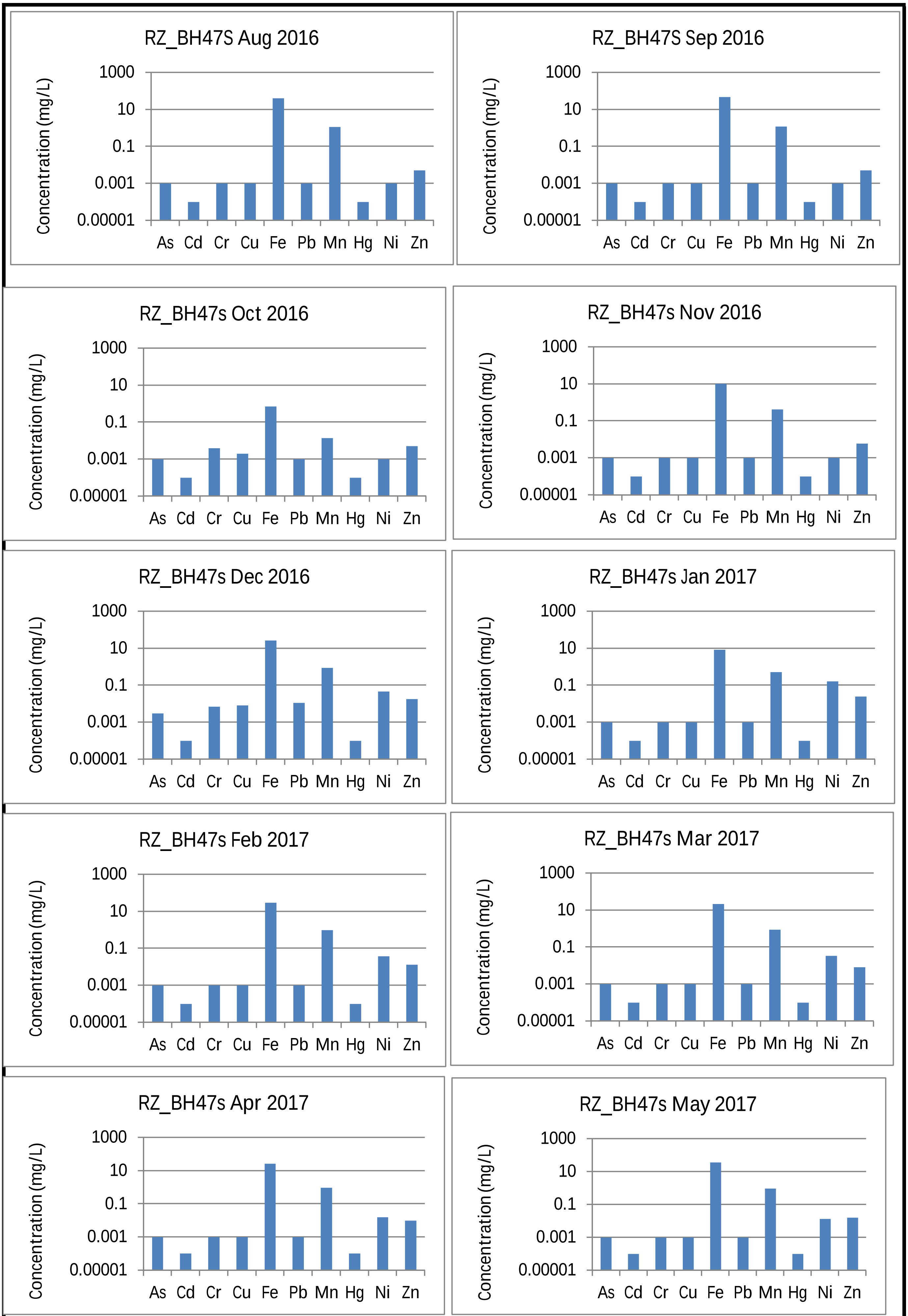




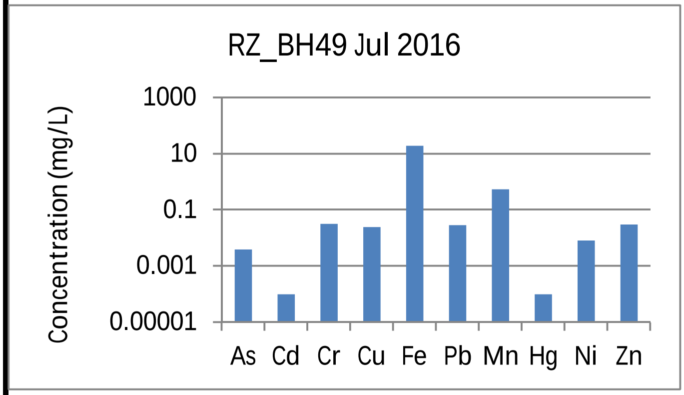


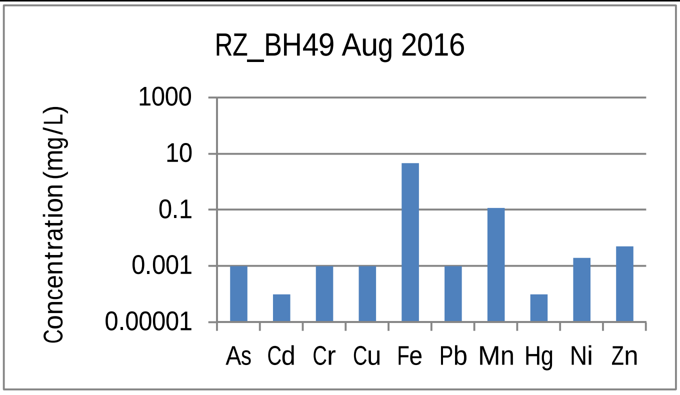


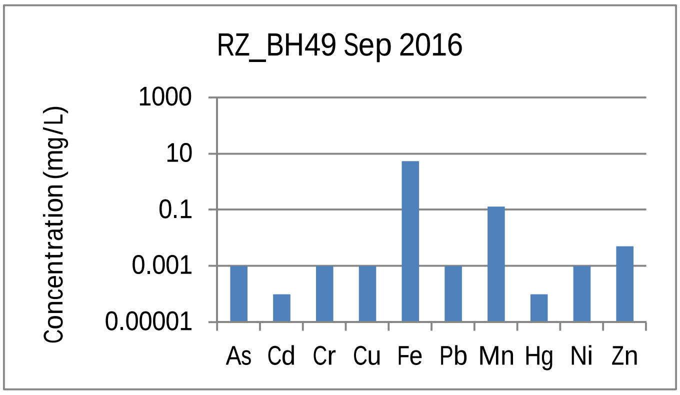
Client:	Sydney Motorway Corporation	Figure E6.3
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - RZ_BH44s Alluvium - Rozelle	

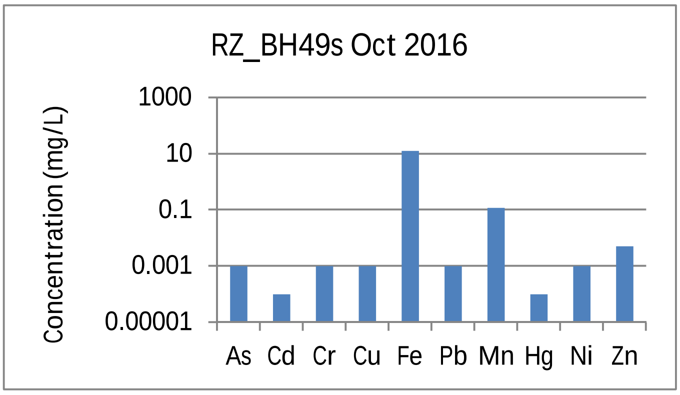


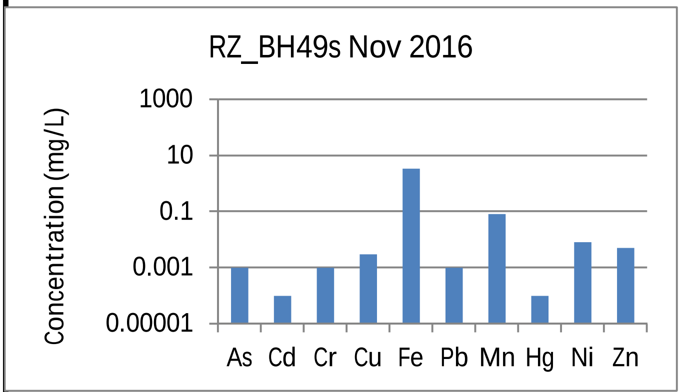
Client:	Sydney Motorway Corporation	Figure E6.4
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - RZ_BH47s Alluvium - Rozelle	

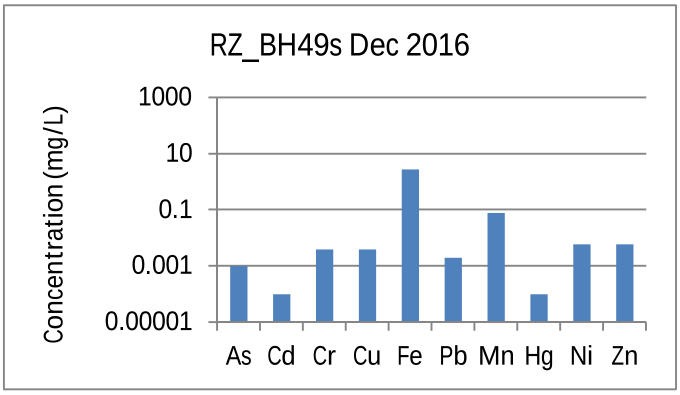


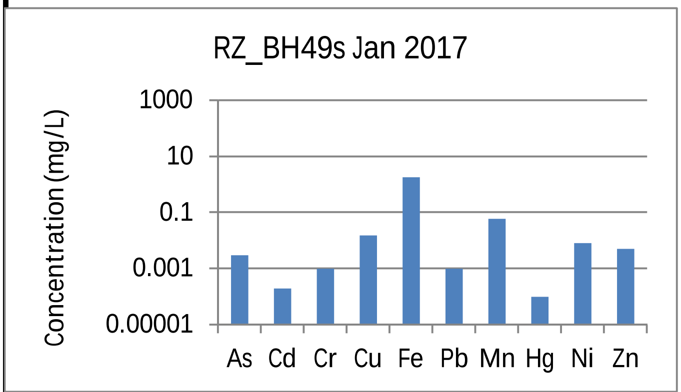


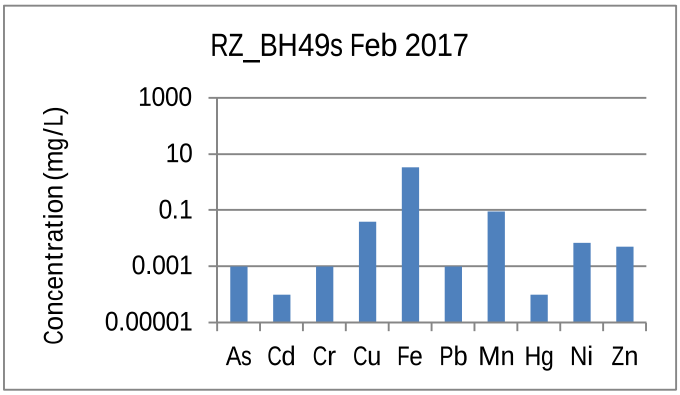


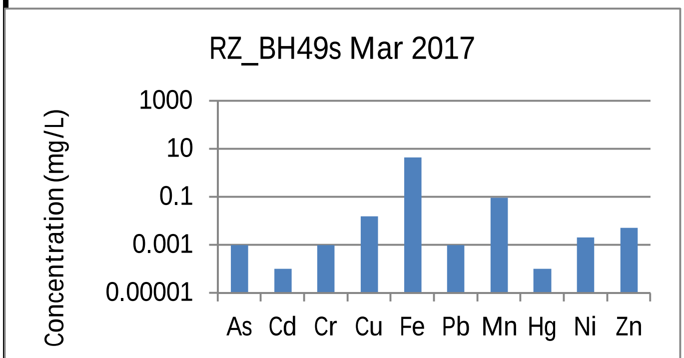


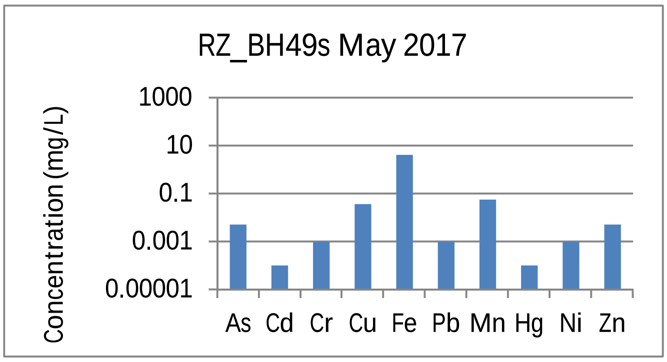




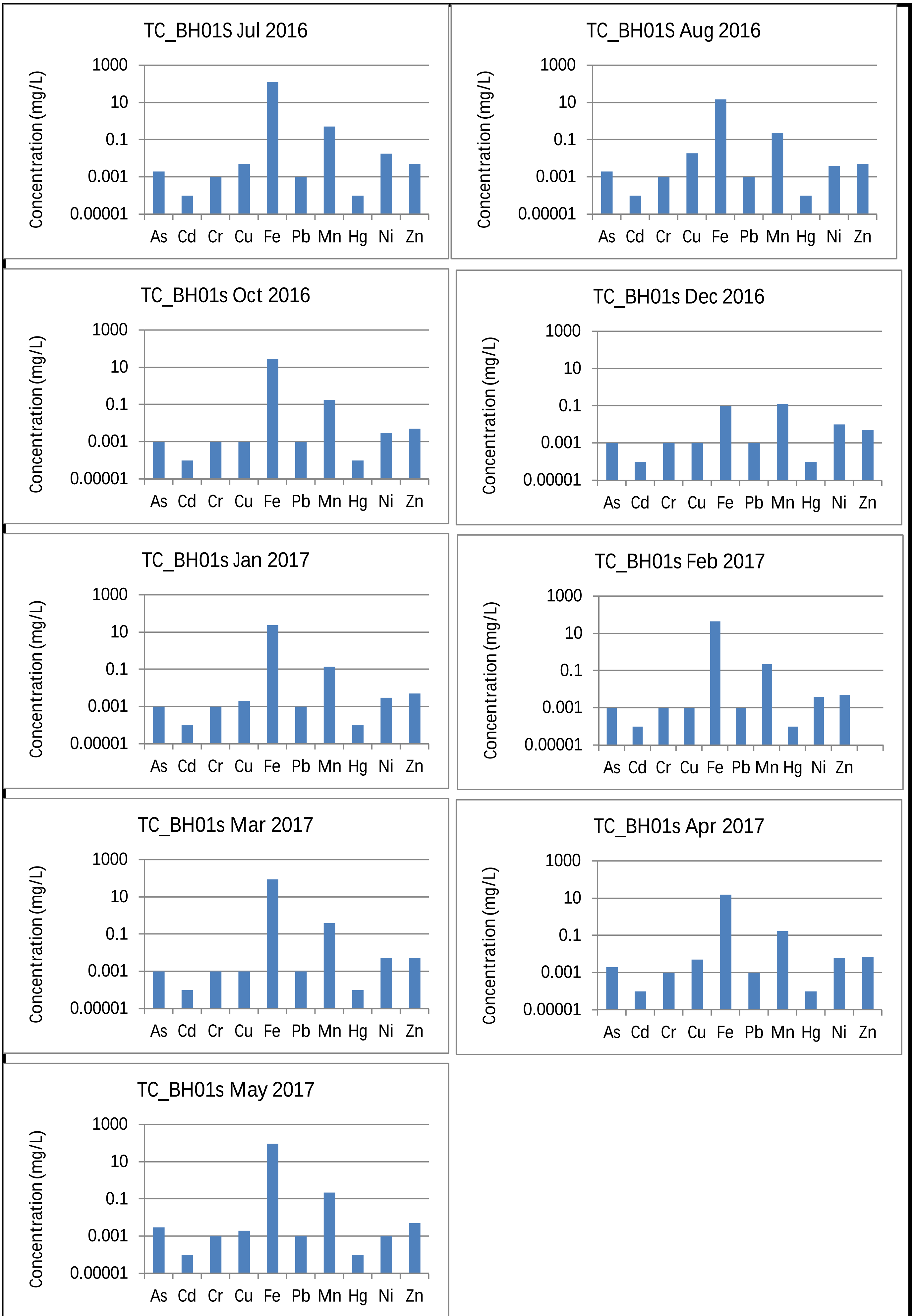




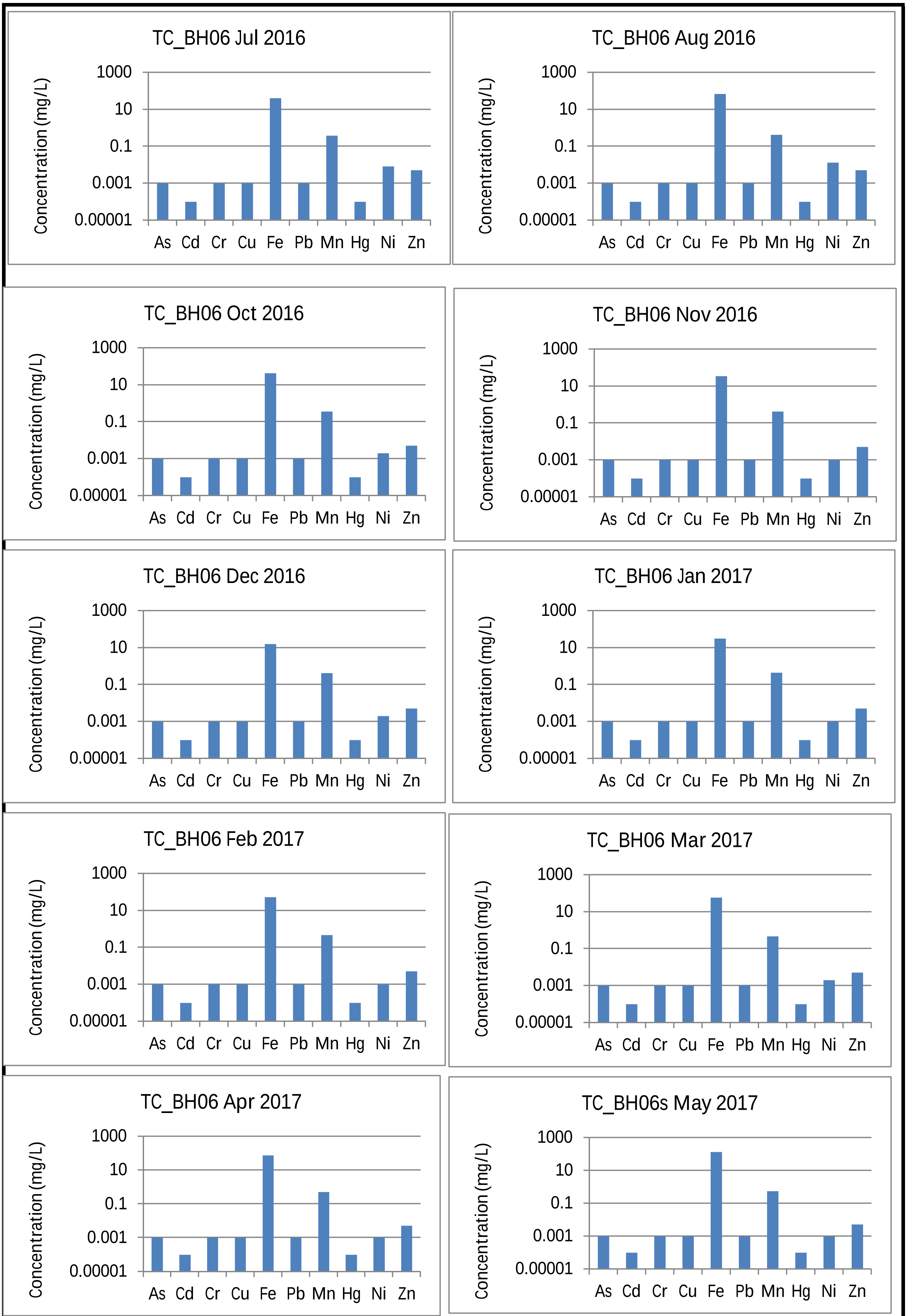




Client:	Sydney Motorway Corporation	Figure E6.5
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - RZ_BH49s Alluvium - Rozelle	

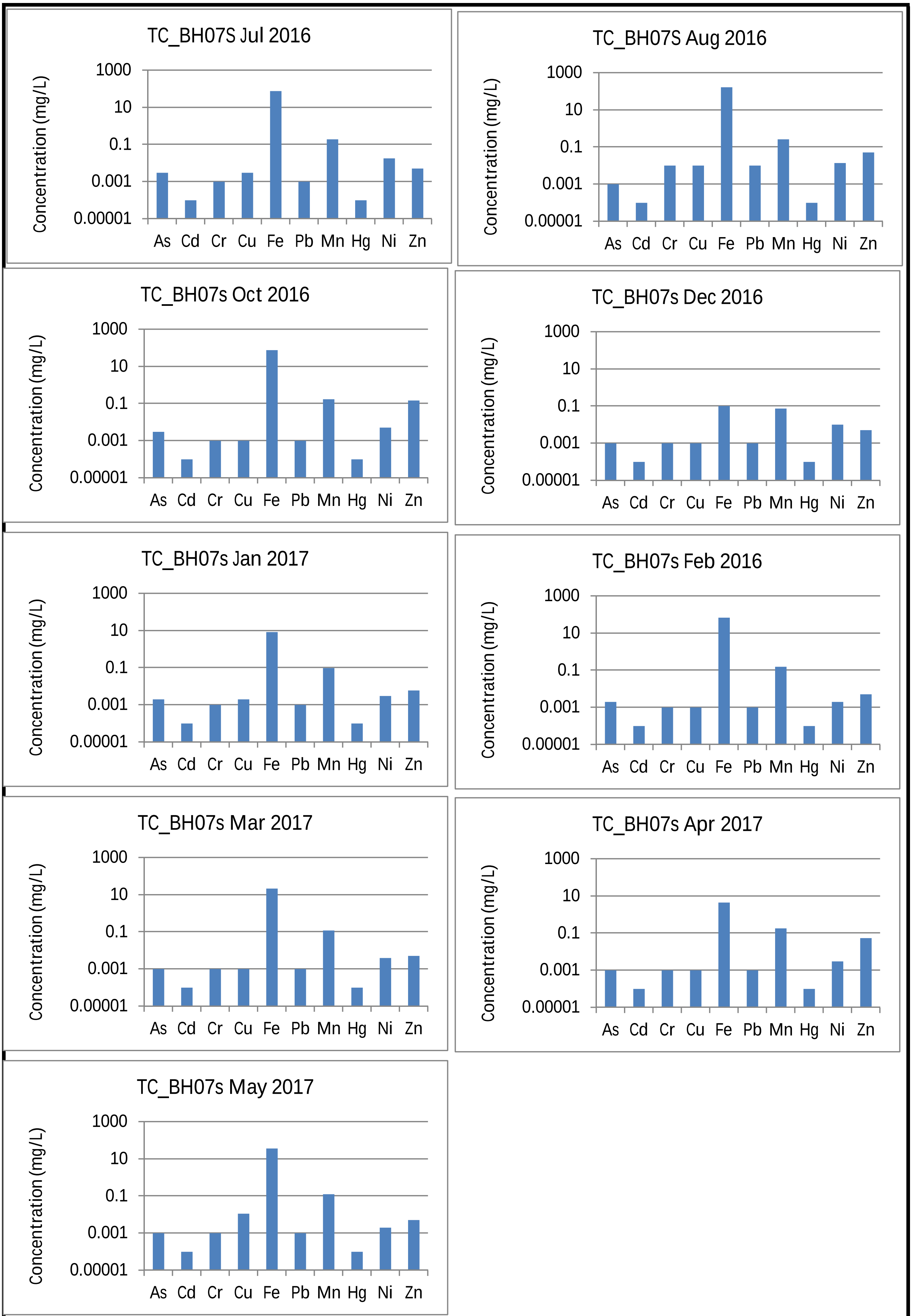


Client:	Sydney Motorway Corporation	Figure E6.6
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - TC_BH01s Alluvium - The Crescent	



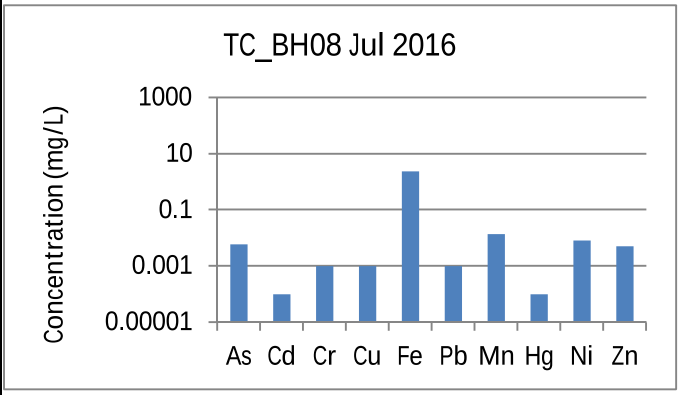
Client:	Sydney Motorway Corporation
Project:	M4-M5 Link
Title:	Schoeller Diagrams - Metals - TC_BH06s Alluvium - The Crescent

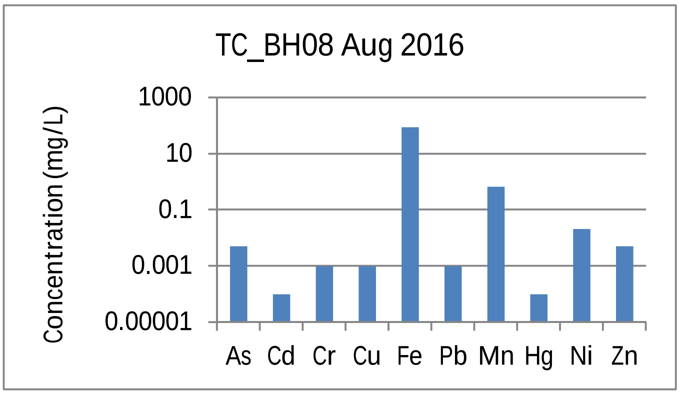
Figure E6.7

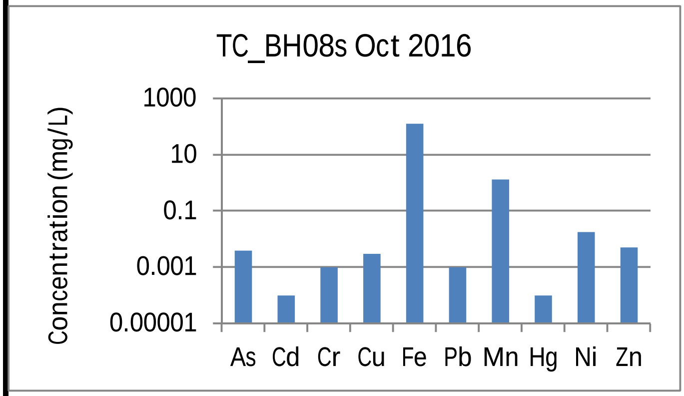


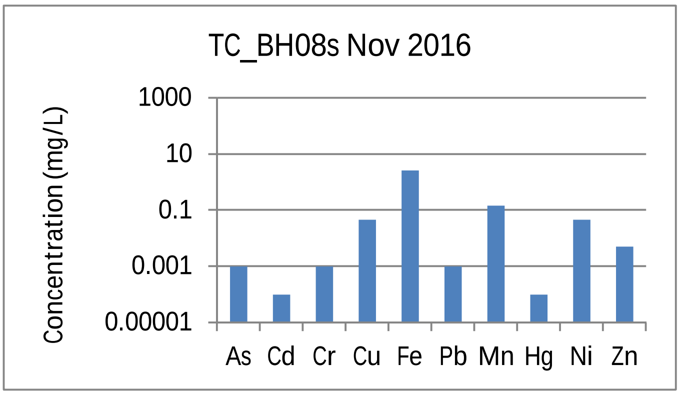
Client:	Sydney Motorway Corporation
Project:	M4-M5 Link
Title:	Schoeller Diagrams - Metals - TC_BH07s Alluvium - The Crescent

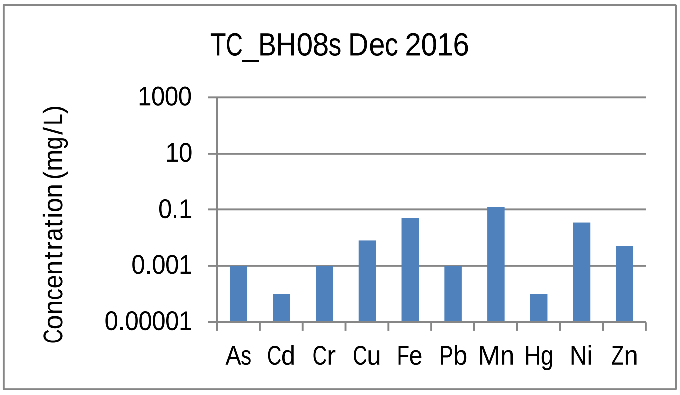
Figure E6.8

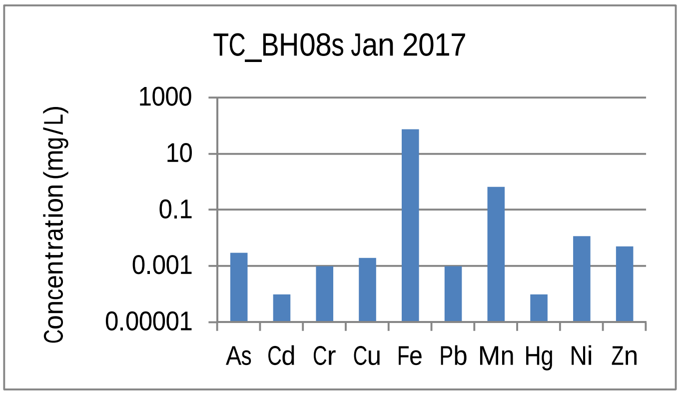


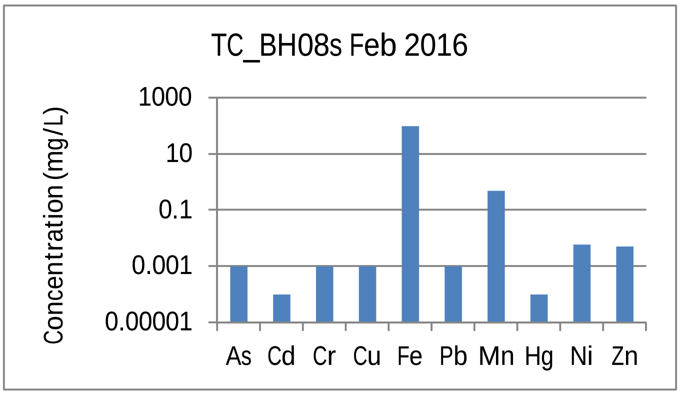


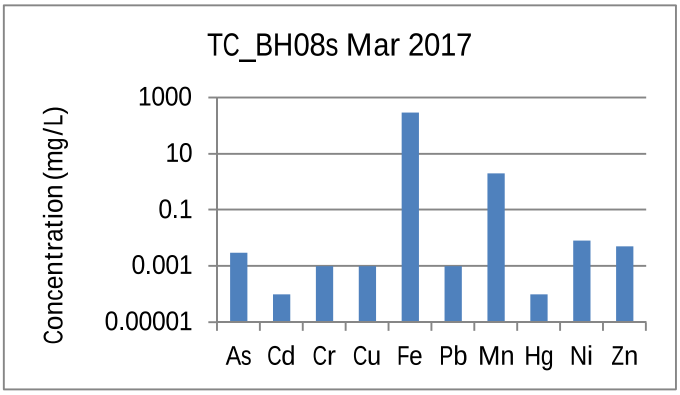


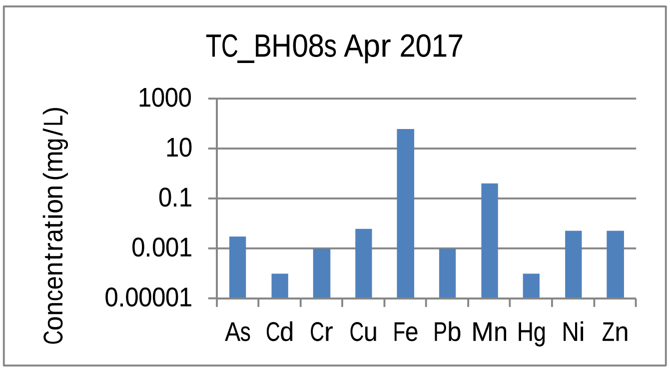


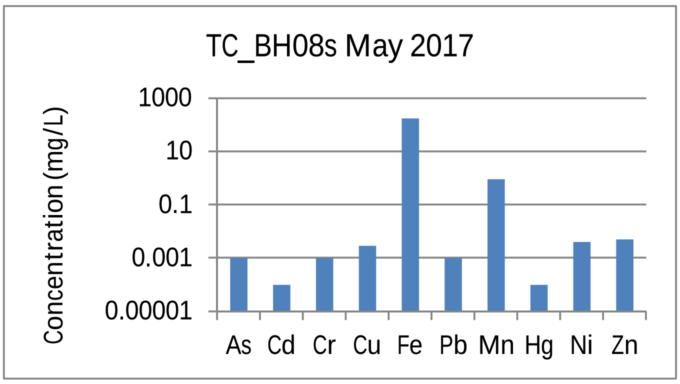




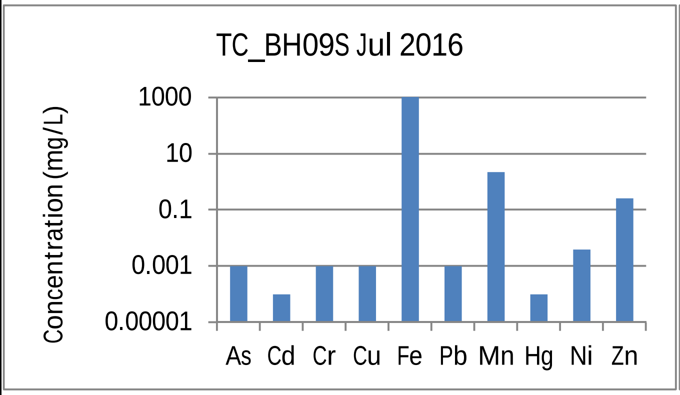


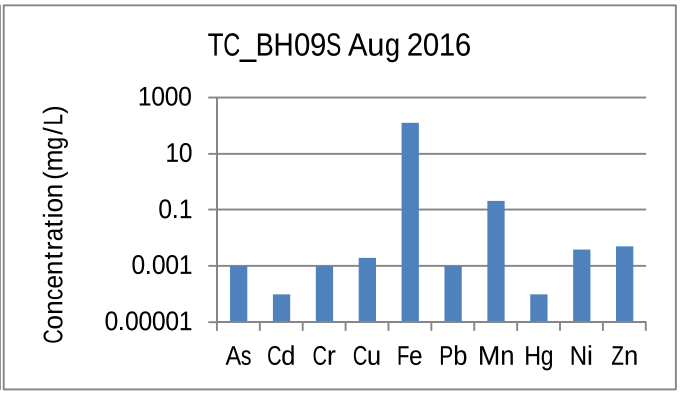


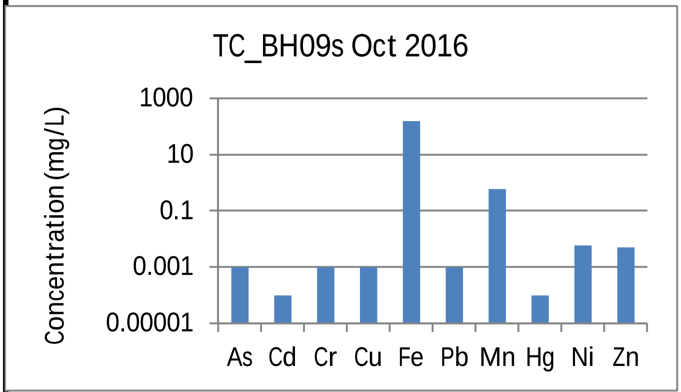


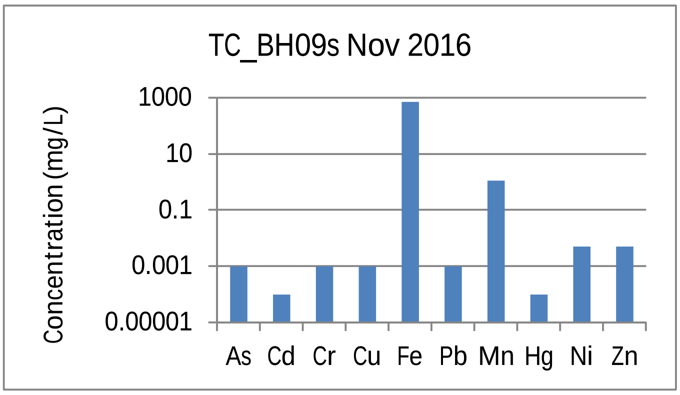


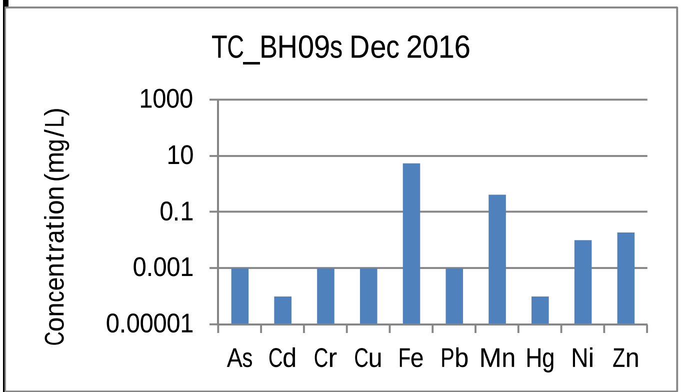
Client:	Sydney Motorway Corporation	Figure E6.9
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - TC_BH08s Alluvium - The Crescent	

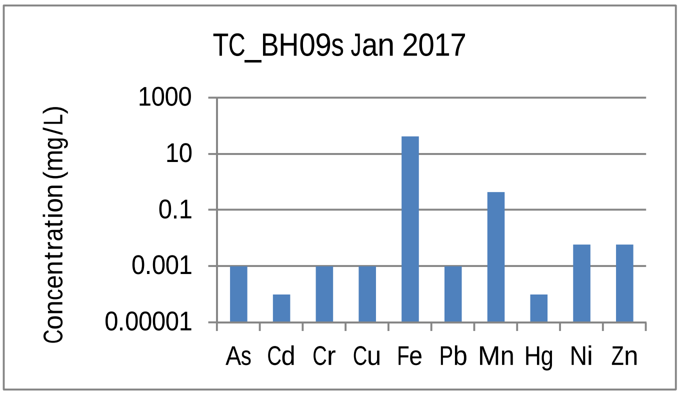


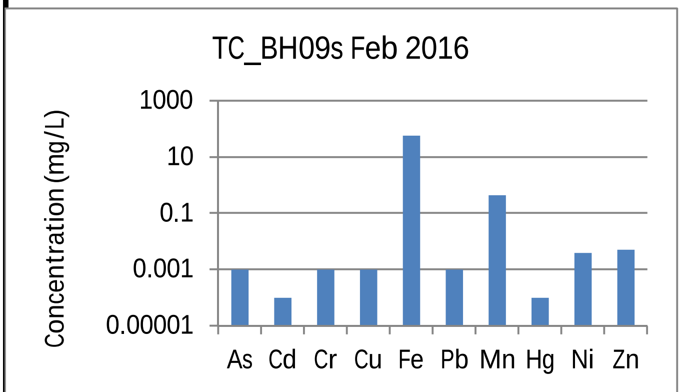


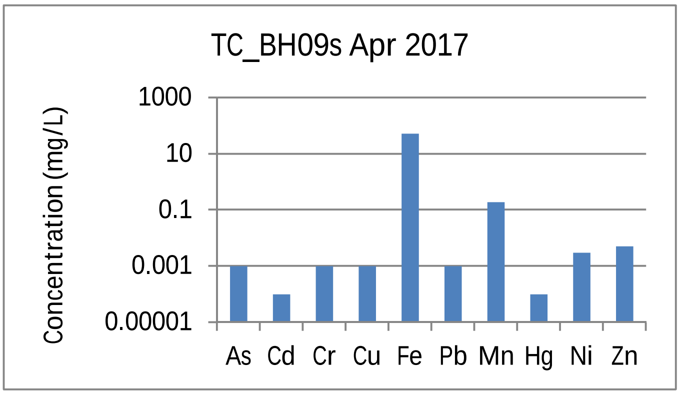


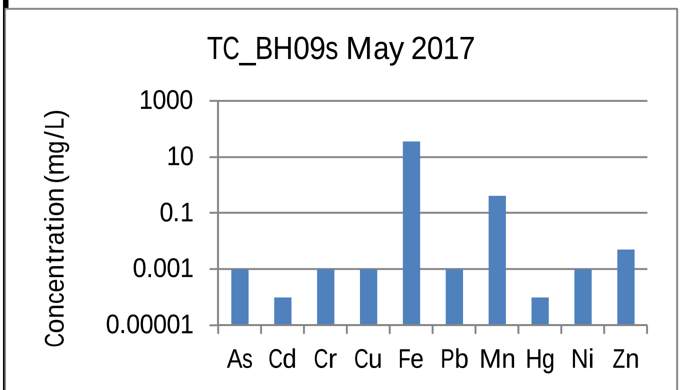




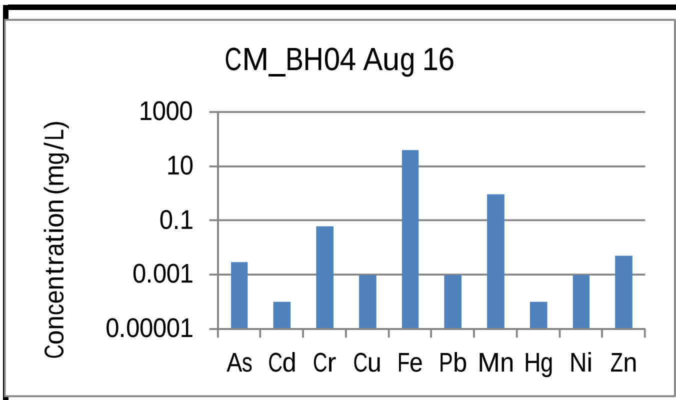


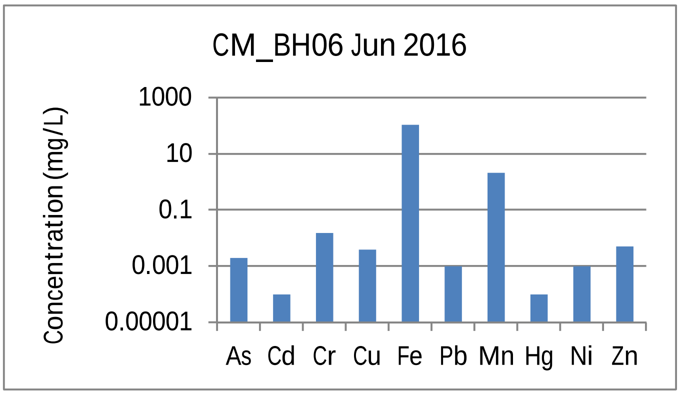


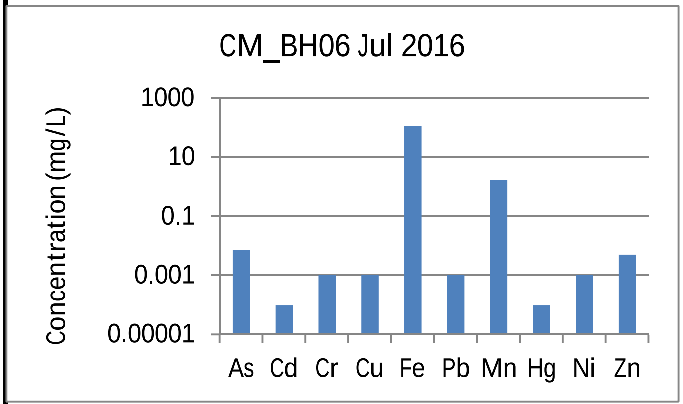


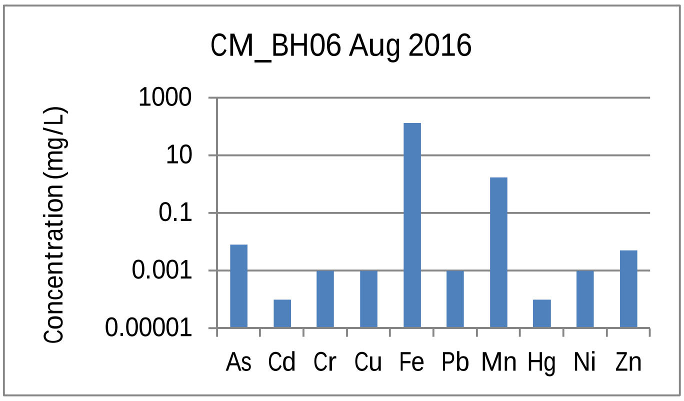


Client:	Sydney Motorway Corporation	Figure E6.10
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - TC_BH09s Alluvium - The Crescent	

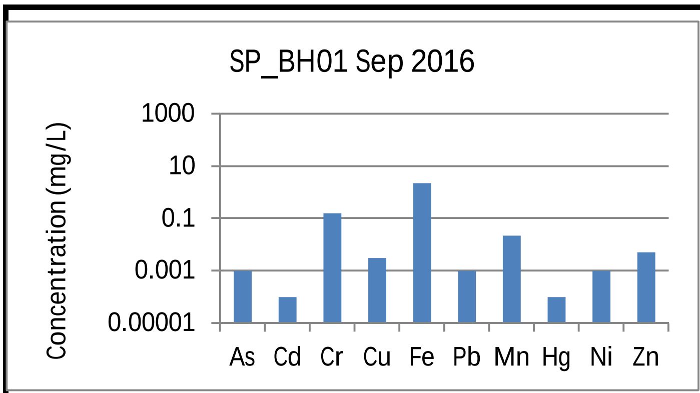


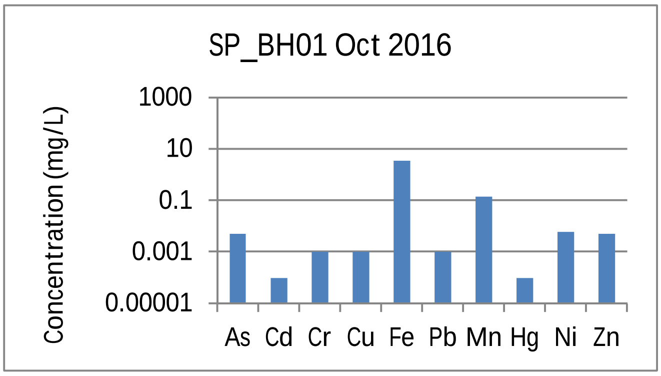


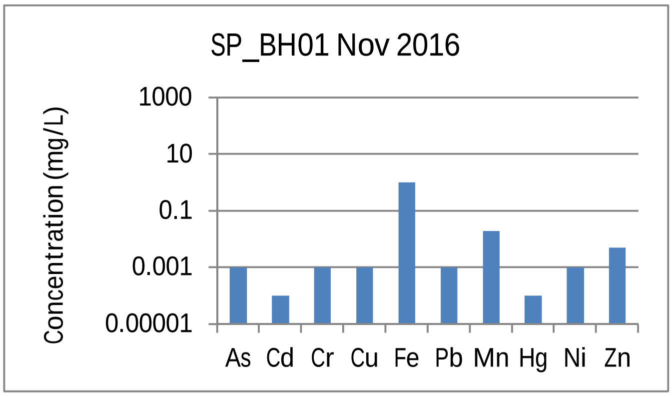


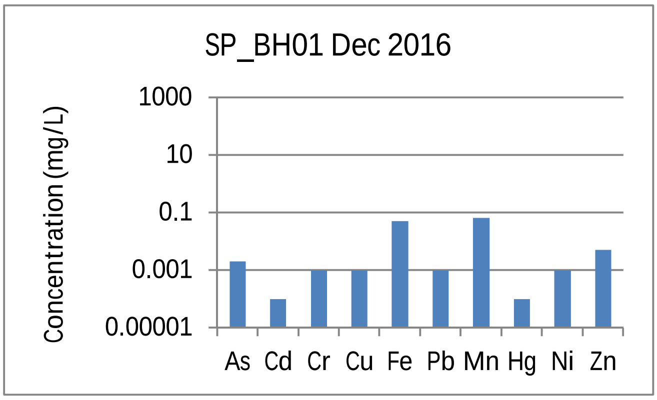


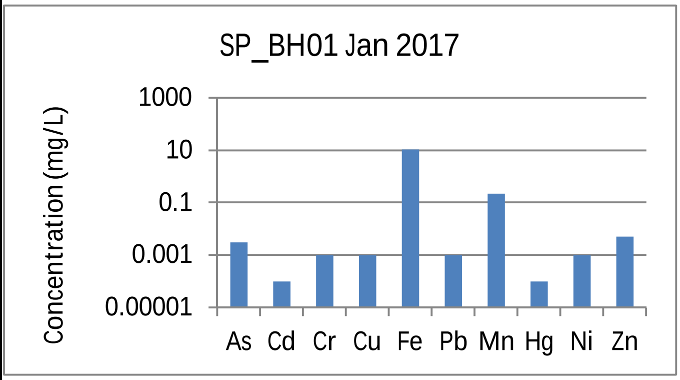
Client:	Sydney Motorway Corporation	Figure E7.1
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - Camperdown Ashfield Shale - Camperdown CM_BH04 and CM_BH06	

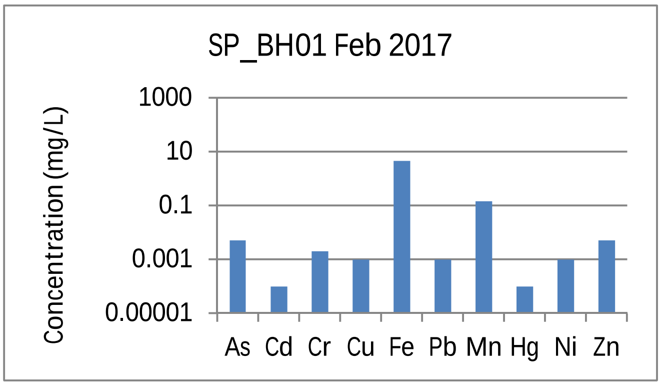


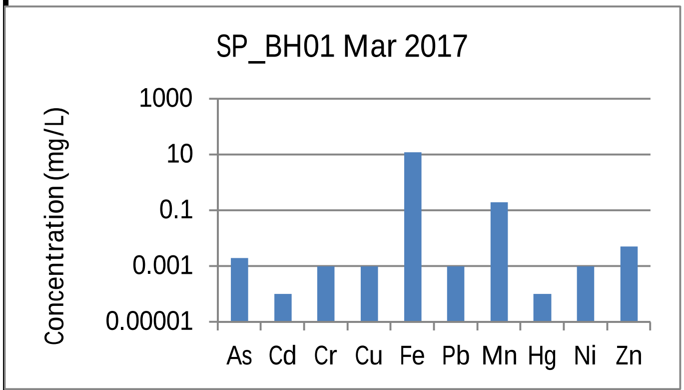


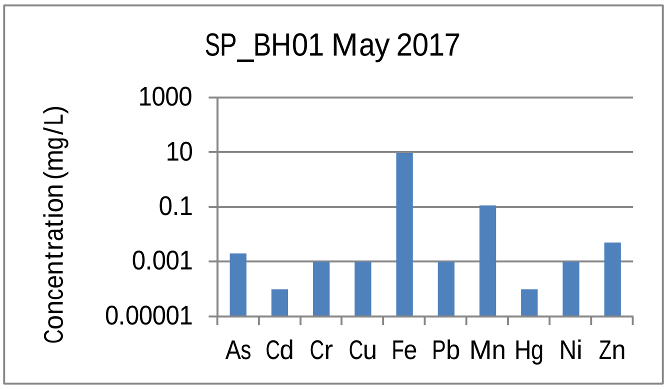




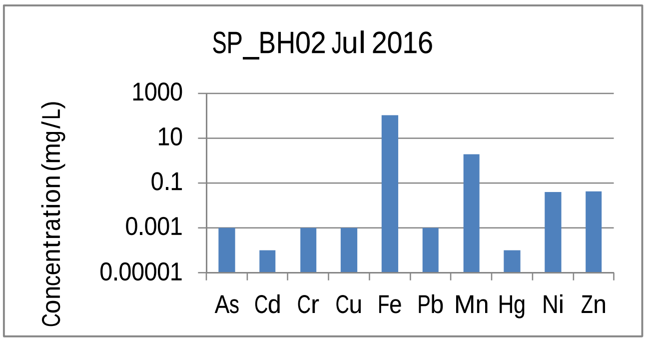


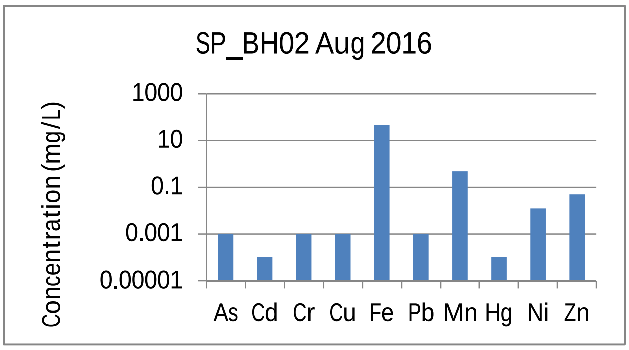


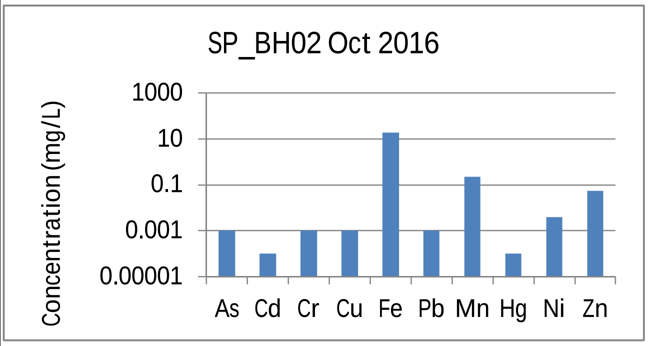


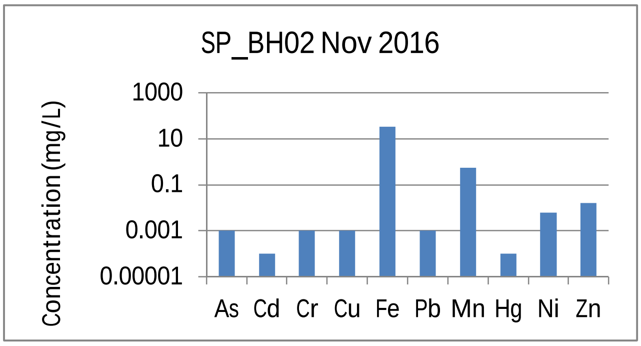


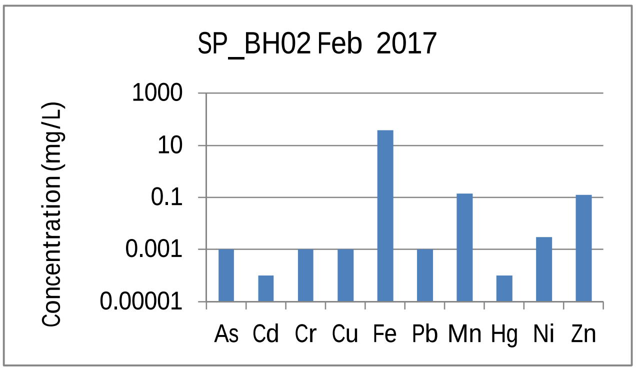
Client:	Sydney Motorway Corporation	Figure E7.2
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - SP_BH01 Ashfield Shale - St Peters	

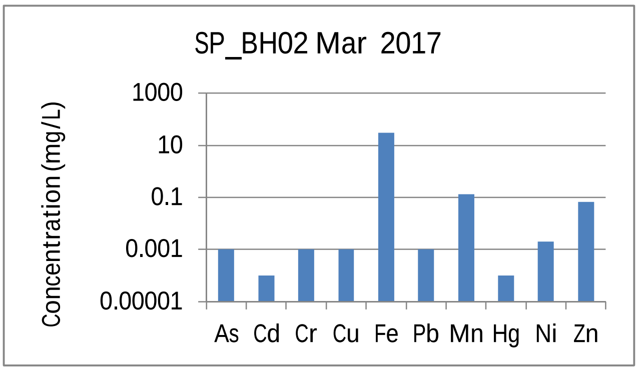


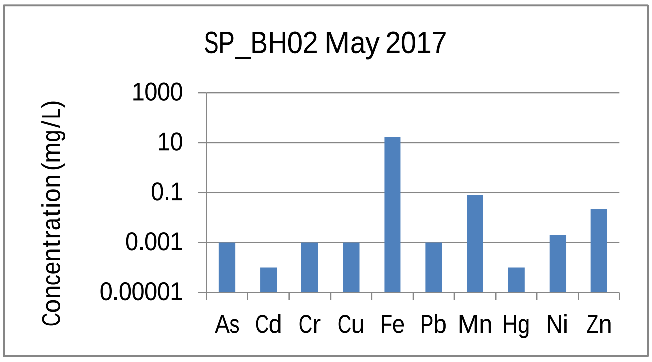




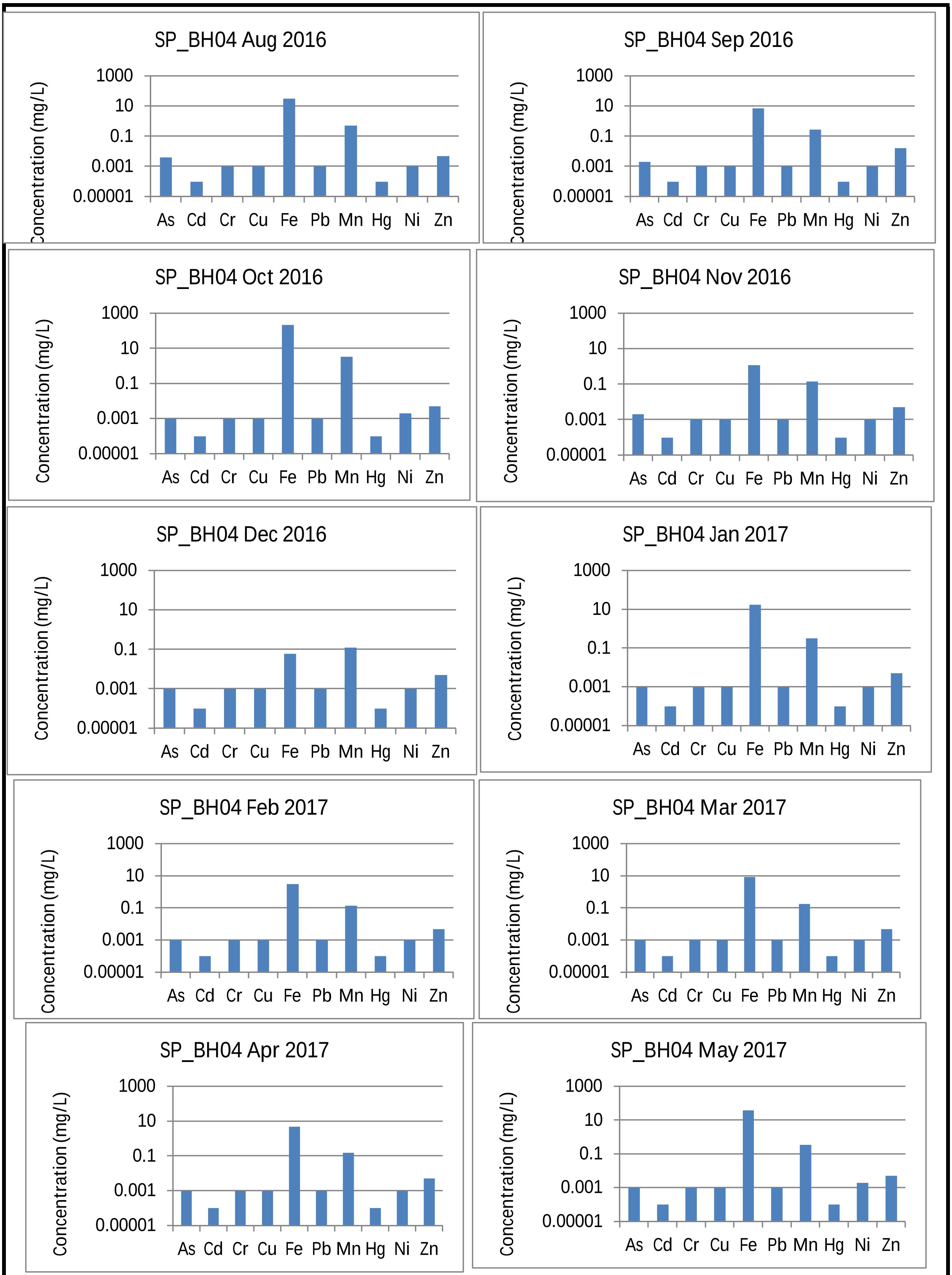






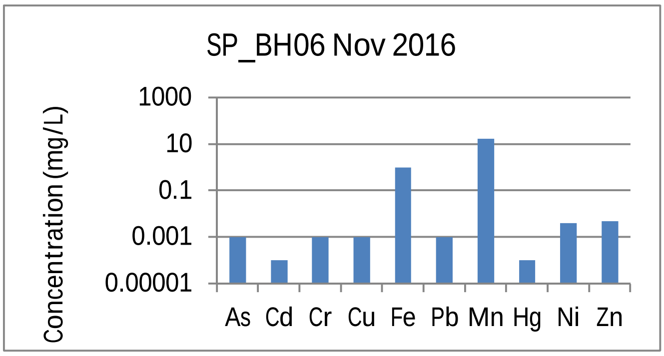


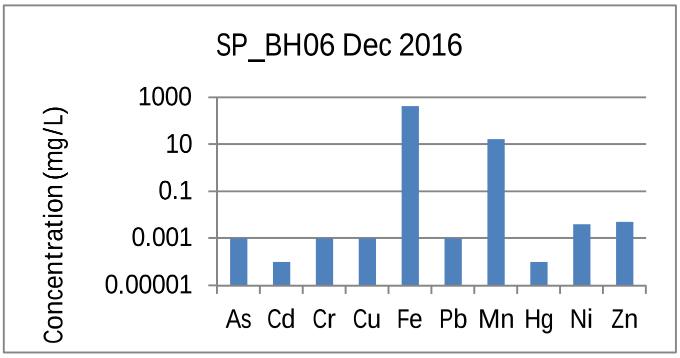
Client:	Sydney Motorway Corporation	Figure E7.3
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - SP_BH02 Ashfield Shale - St Peters	

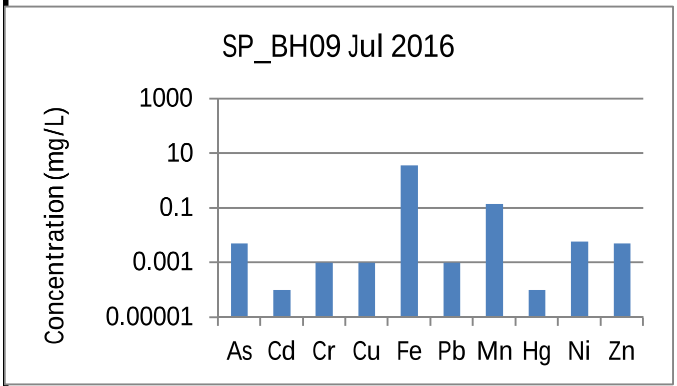


Client:	Sydney Motorway Corporation
Project:	M4-M5 Link
Title:	Schoeller Diagrams - Metals - SP_BH04
	Ashfield Shale - St Peters

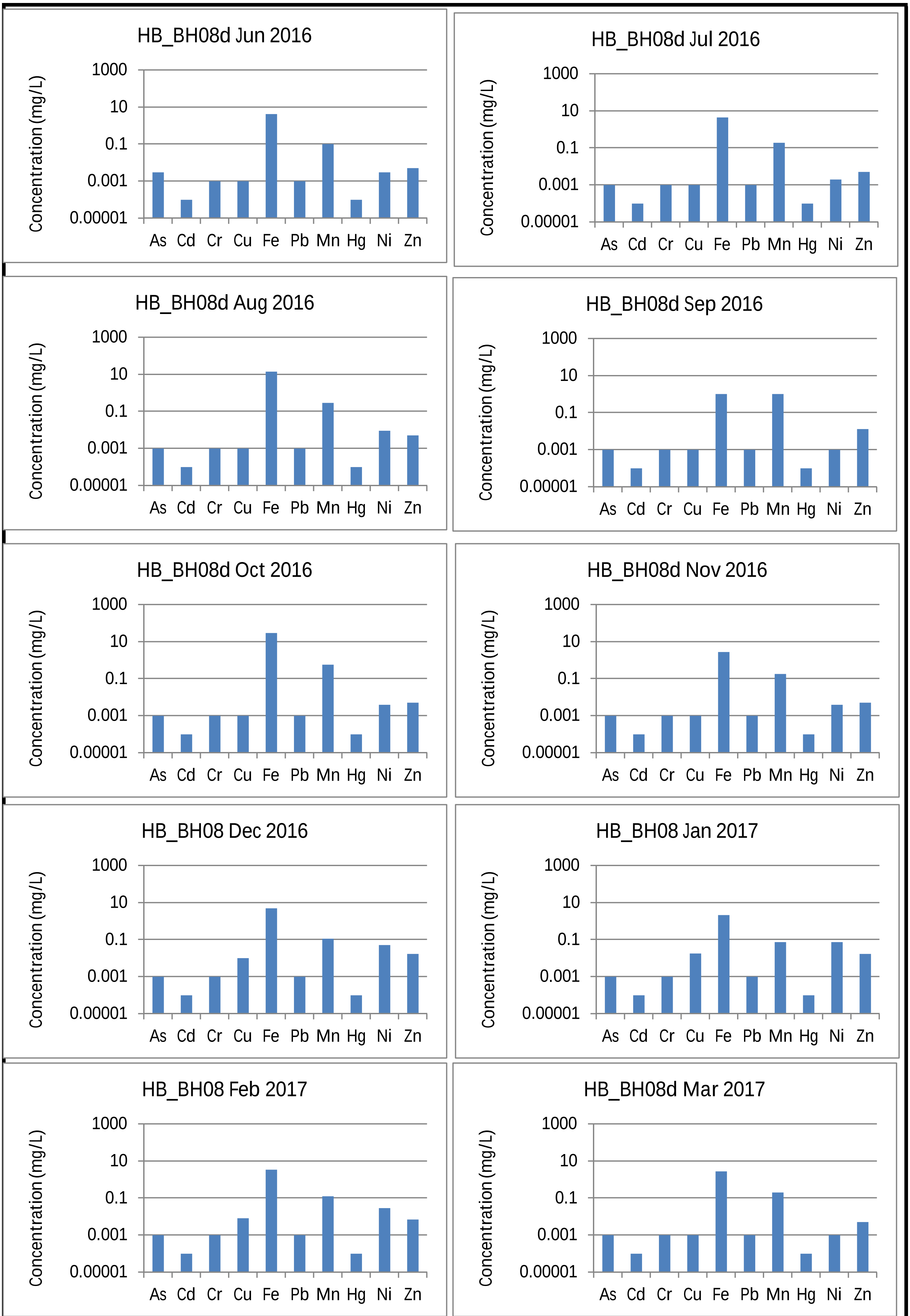
Figure E7.4



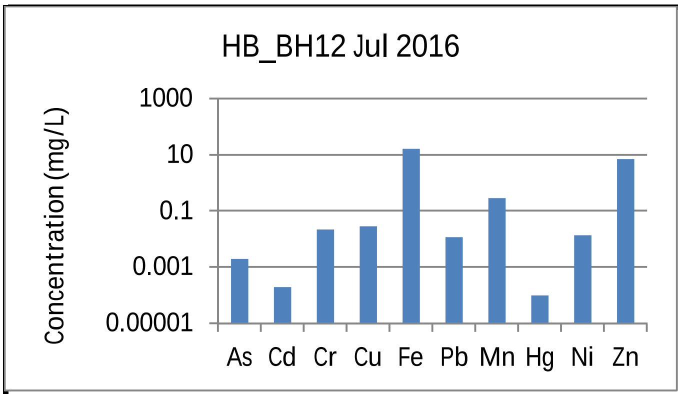


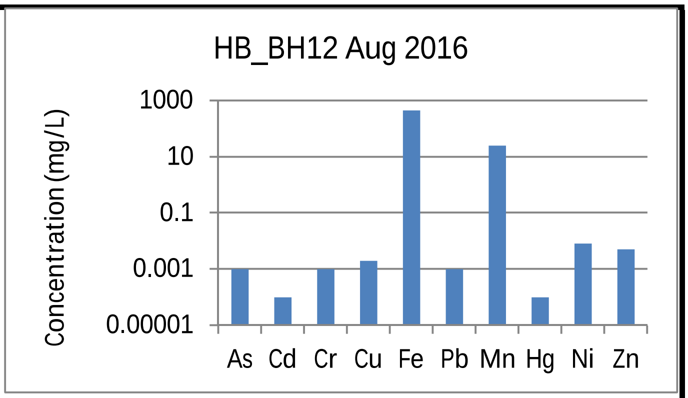


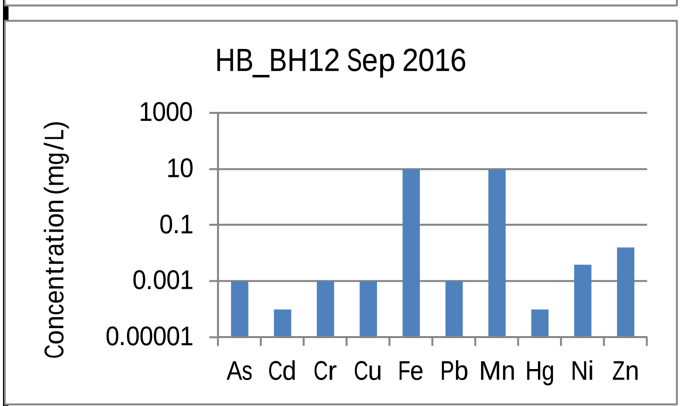
Client:	Sydney Motorway Corporation	Figure E7.5
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - SP_BH06 and SP_BH09 Ashfield Shale - St Peters	

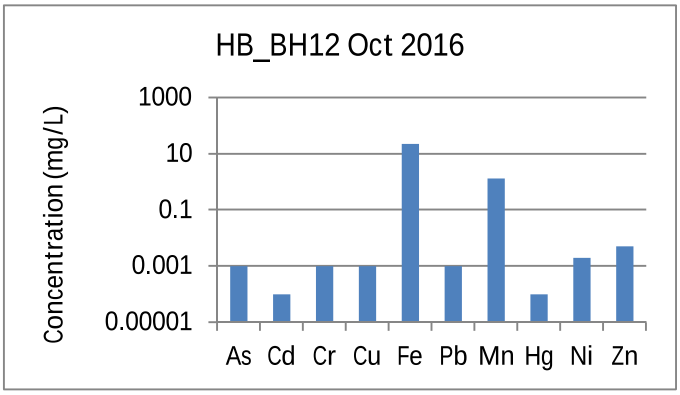


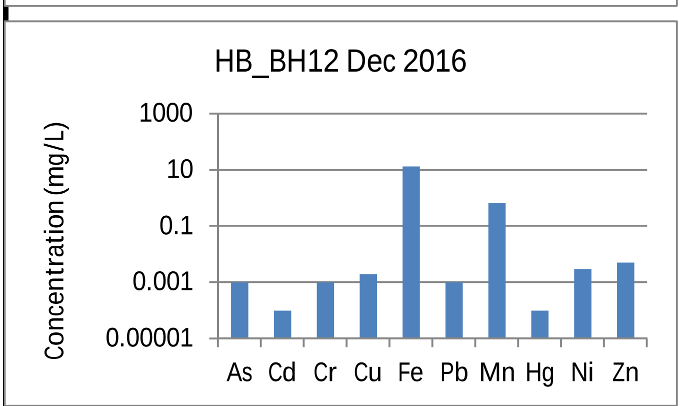
Client:	Sydney Motorway Corporation	Figure E8.1
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - HB_BH08 Hawkesbury Sandstone - Haberfield Precinct	

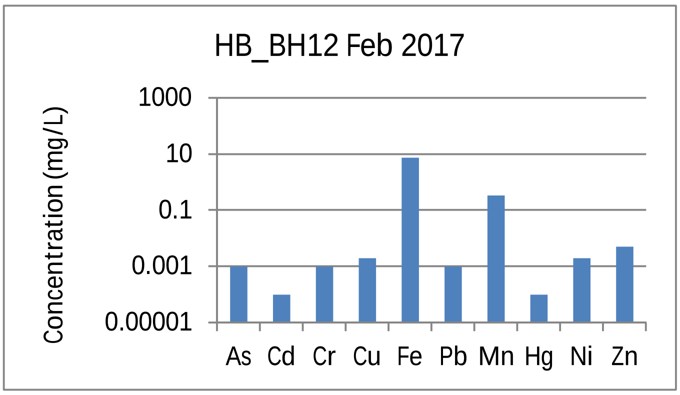


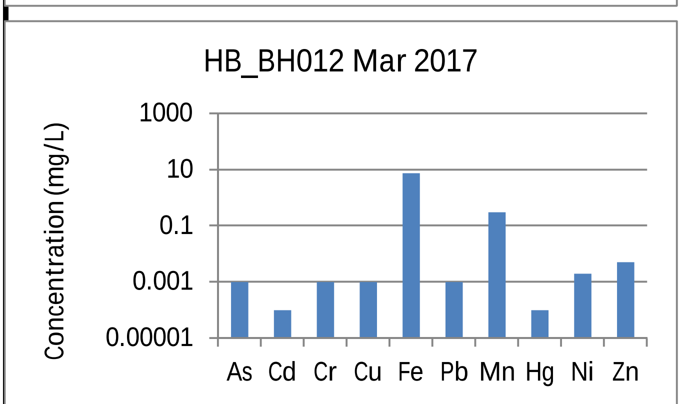




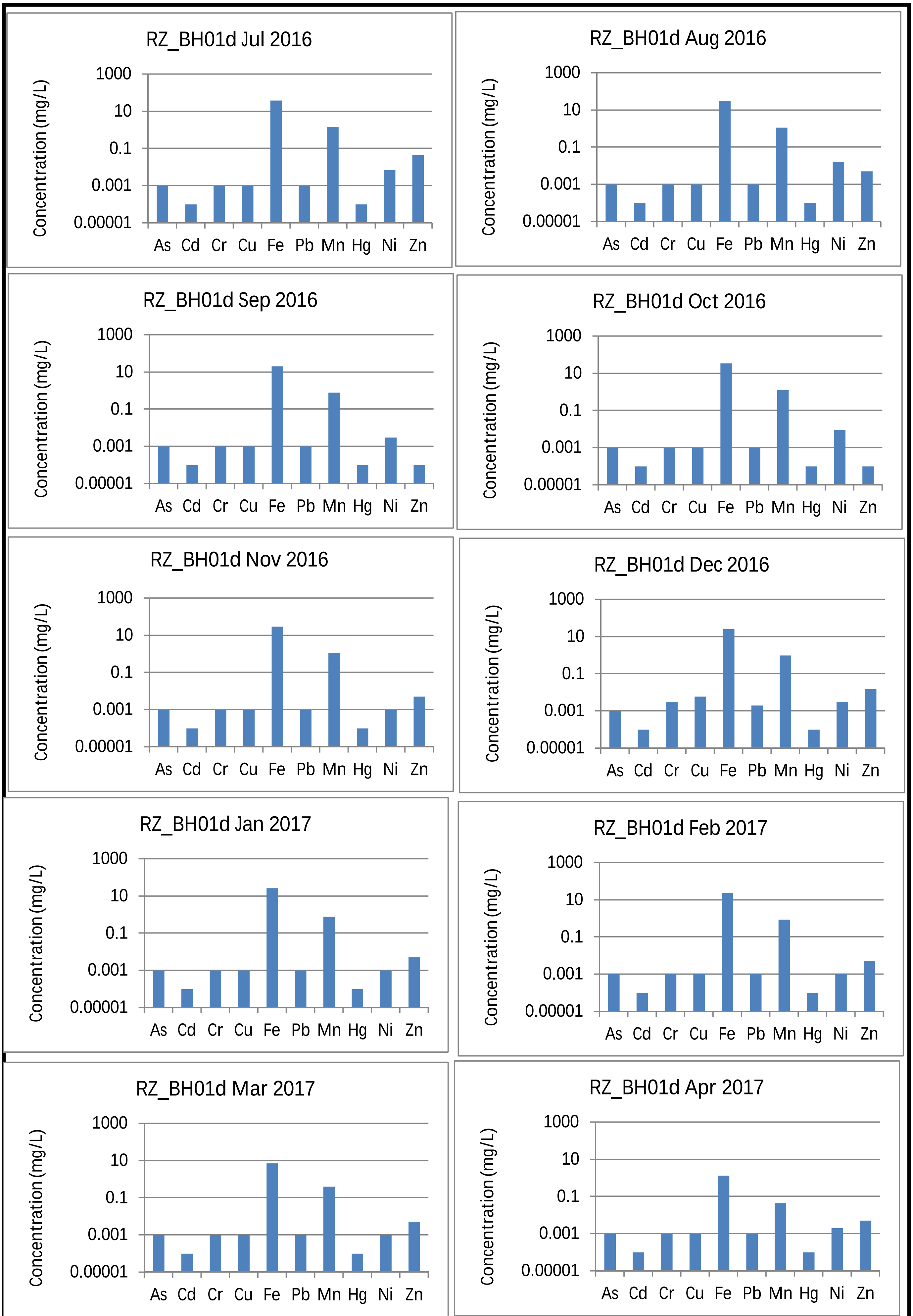




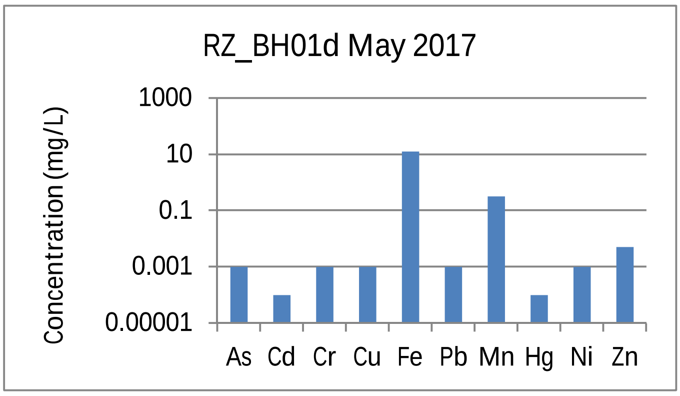




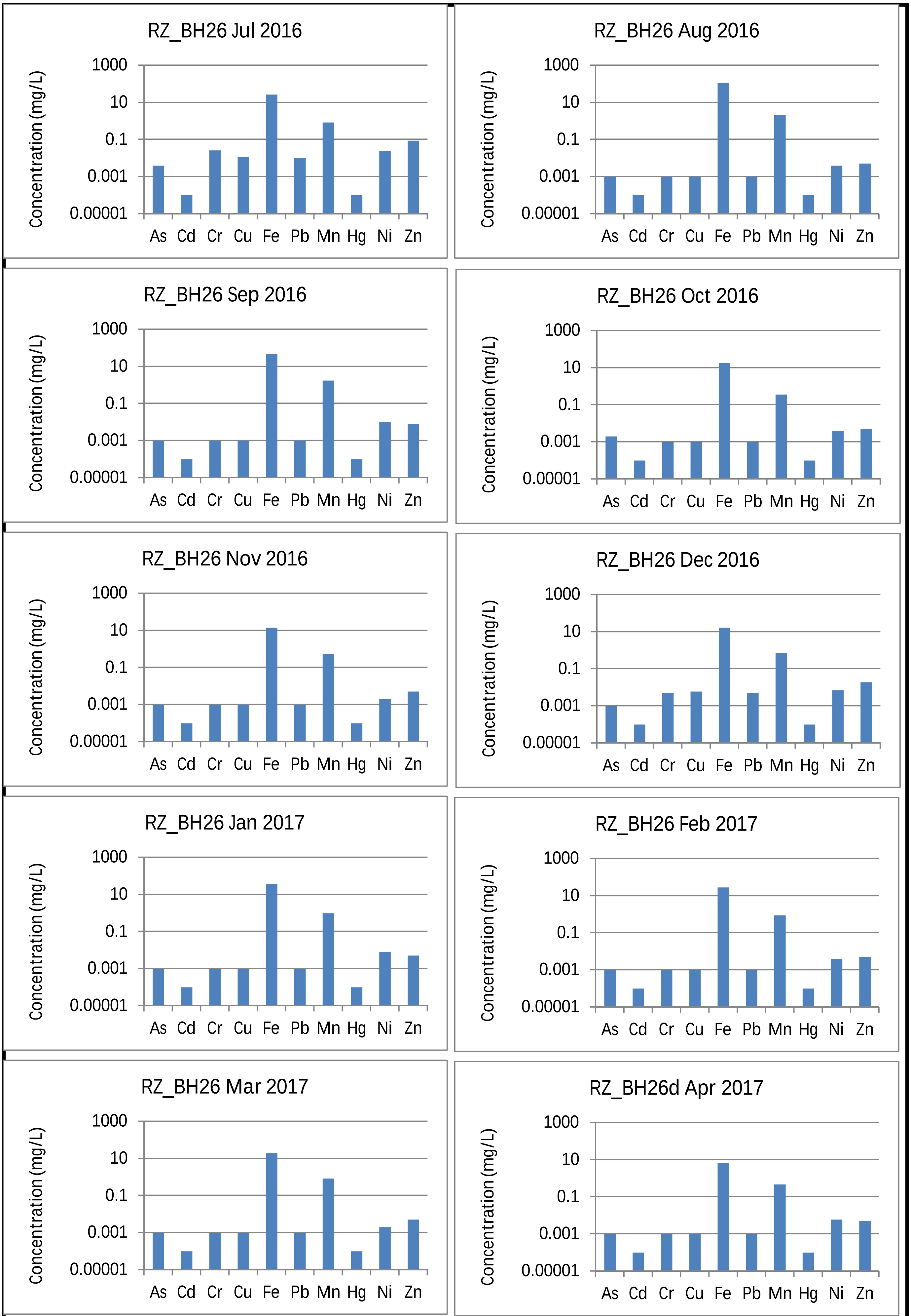
Client:	Sydney Motorway Corporation	Figure E8.2
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - HB_BH12	
	Hawkesbury Sandstone - Haberfield Precinct	



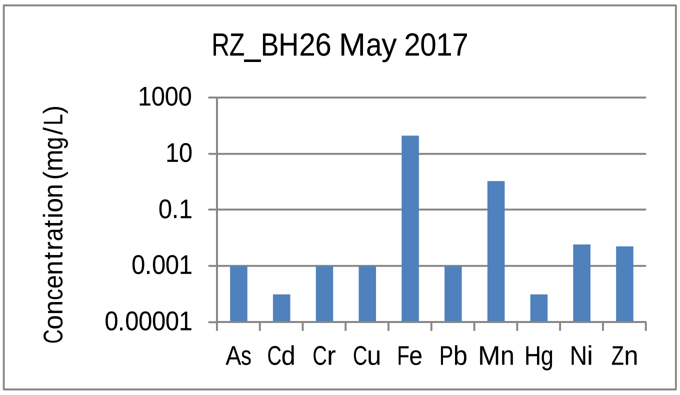
Client:	Sydney Motorway Corporation	Figure E8.3
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - RZ_BH01d Hawkesbury Sandstone - Rozelle Precinct	



Client:	Sydney Motorway Corporation	Figure E8.3a
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - RZ_BH01d	
	Hawkesbury Sandstone - Rozelle Precinct	

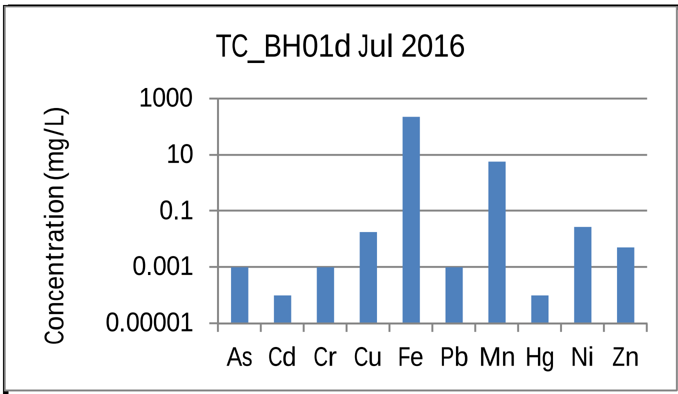


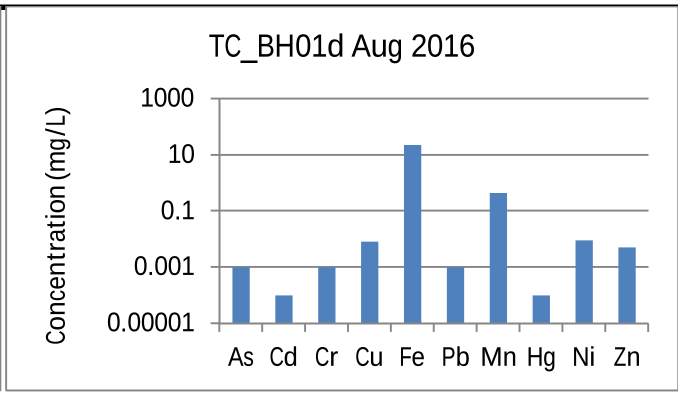
Client:	Sydney Motorway Corporation	Figure E8.4
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - RZ_BH26 Hawkesbury Sandstone - Rozelle Precinct	

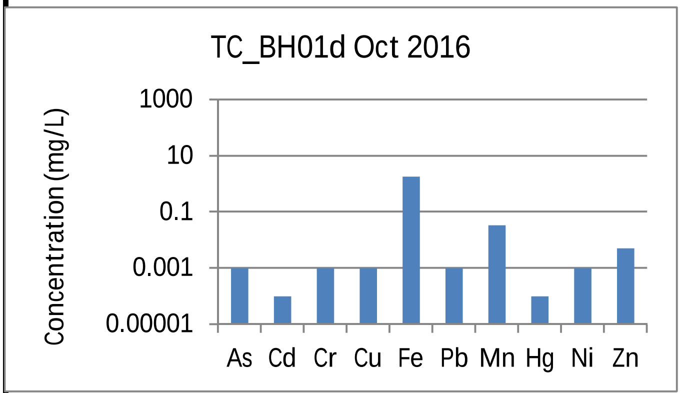


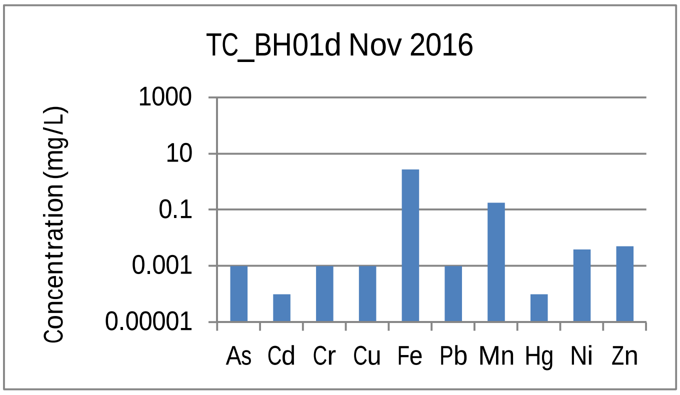
Client:	Sydney Motorway Corporation
Project:	M4-M5 Link
Title:	Schoeller Diagrams - Metals - RZ_BH26
	Hawkesbury Sandstone - Rozelle Precinct

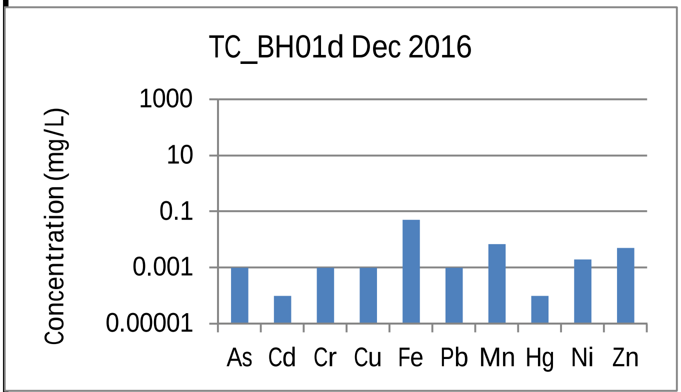
Figure E8.4a

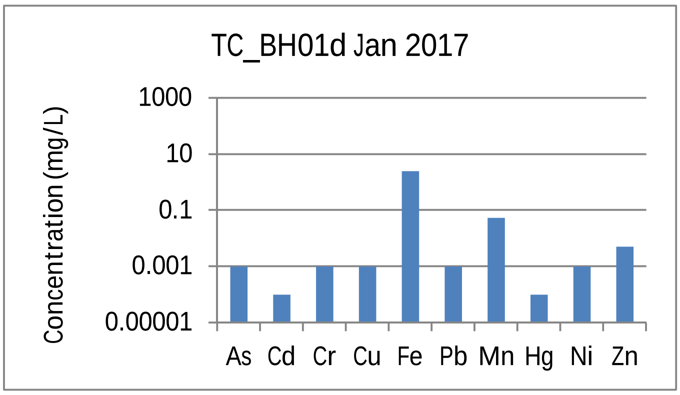


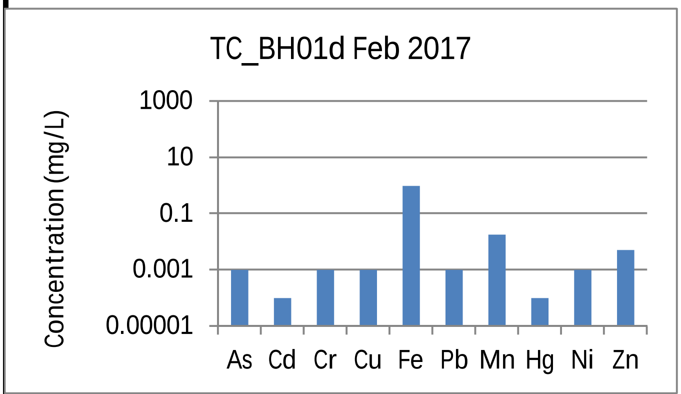


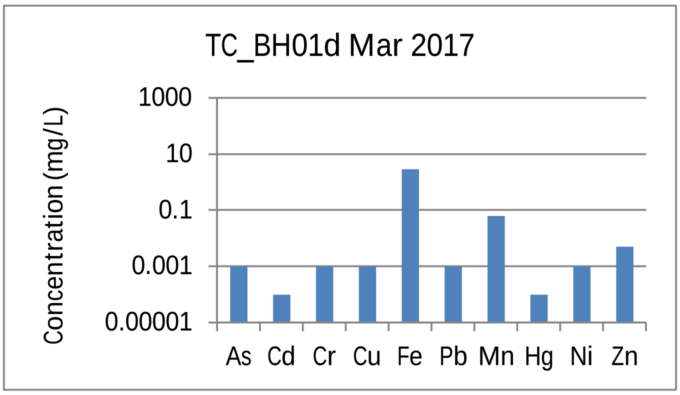


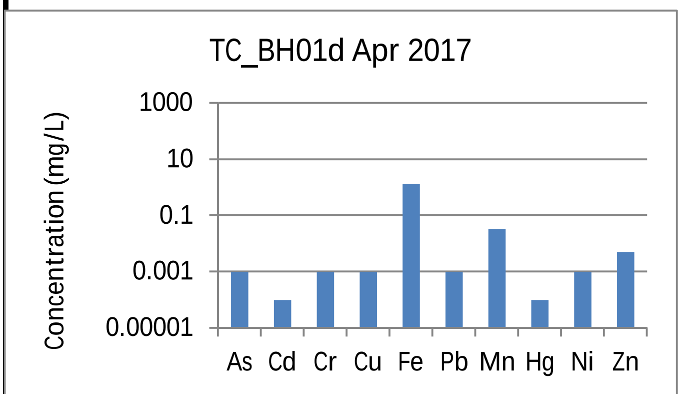


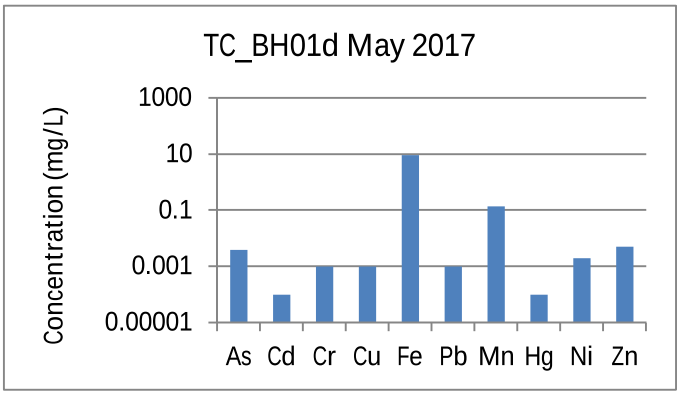




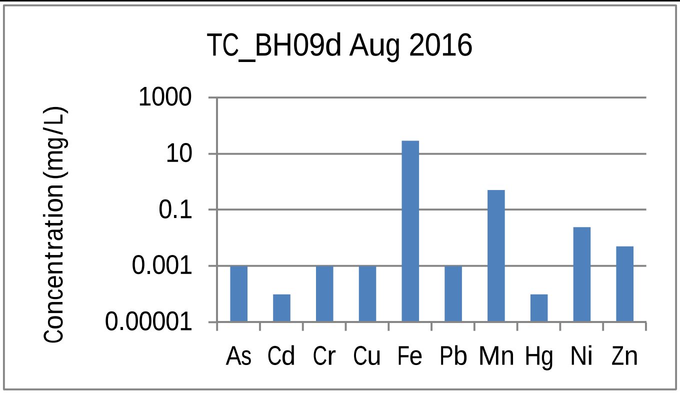


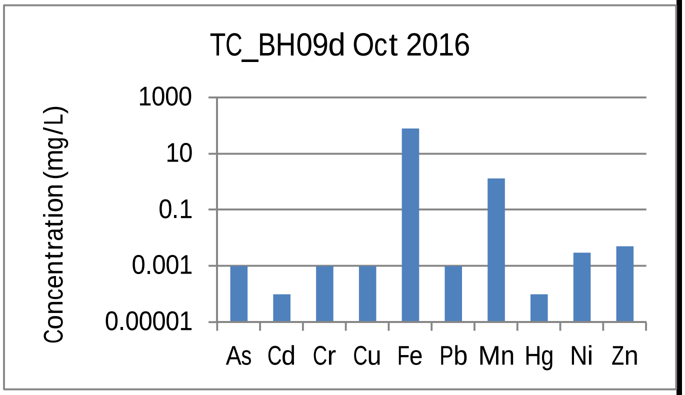


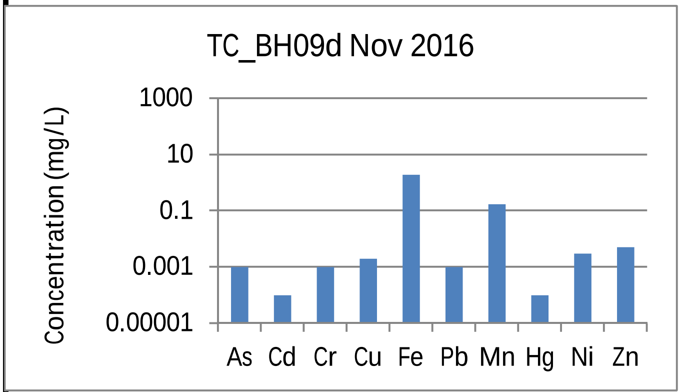


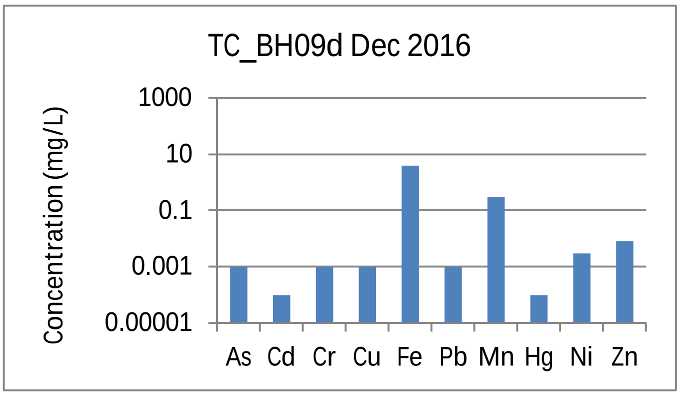


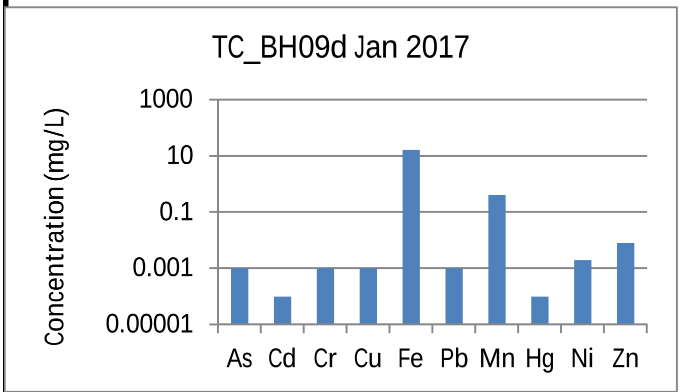
Client:	Sydney Motorway Corporation	Figure E8.5
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals - TC_BH01d Hawkesbury Sandstone - The Crescent Precinct	

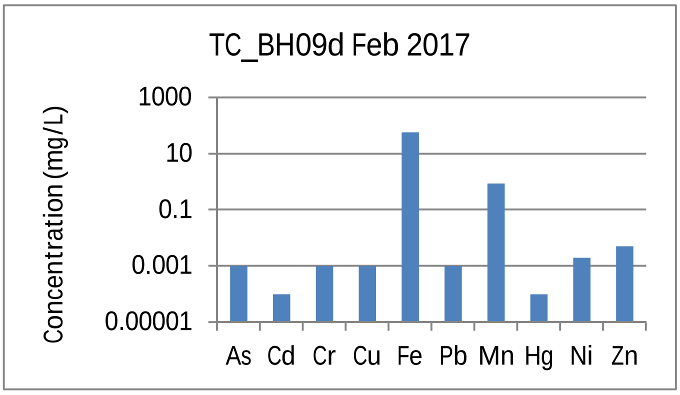


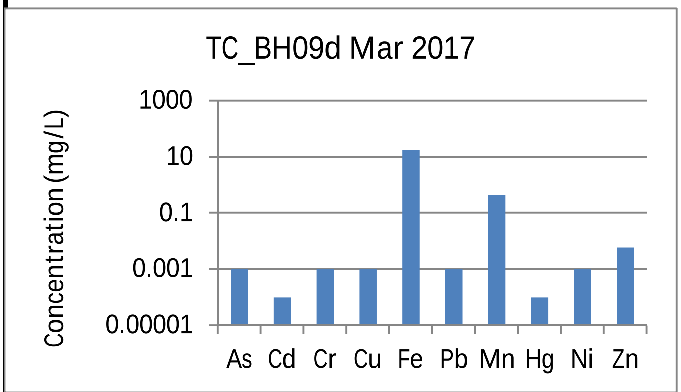


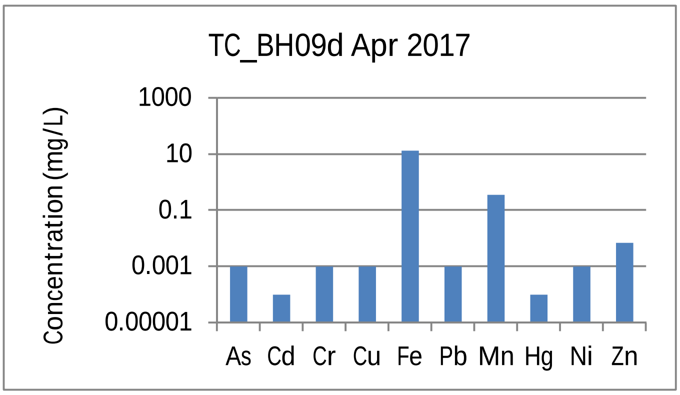












Client:	Sydney Motorway Corporation	Figure E8.6
Project:	M4-M5 Link	
Title:	Schoeller Diagrams - Metals	
	Hawkesbury Sandstone - The Crescent Precinct	

Annexure F – Project borelogs

AECOM Engineering Log

PIEZOMETER No. CM_BH01

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** TC/NB	**Checked by:** BF
Location: Barr St, Camperdown		**Start Date:** 22/08/2016	**End Date:** 31/08/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331645.5 m	**RL:** 22.64 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6249003.8 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data

Method	Core Run	TCR (%)	RQD (%)
HA			
HQ3	Run 1	97	0
HQ3	Run 2	100	54
HQ3	Run 3	100	30
HQ3	Run 4	100	99
HQ3	Run 5	100	100
HQ3	Run 6	100	100
HQ3	Run 7	100	100
HQ3	Run 8	100	100
HQ3	Run 9	100	100
HQ3	Run 10	100	100
HQ3	Run 11	100	100
HQ3	Run 12	100	100
HQ3	Run 13	100	100
HQ3	Run 14	100	100
HQ3	Run 15	100	100
HQ3	Run 16	100	100
HQ3	Run 17	100	99
HQ3	Run 18	100	97
HQ3	Run 19	100	97
HQ3	Run 20	100	100
HQ3	Run 21	100	98

Ground Water | Reduced Level (m): 22.0, 20.0, 18.0, 16.0, 14.0, 12.0, 10.0, 8.0, 6.0, 4.0, 2.0, 0.0, -2.0, -4.0, -6.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Graphic Log

Rock Description

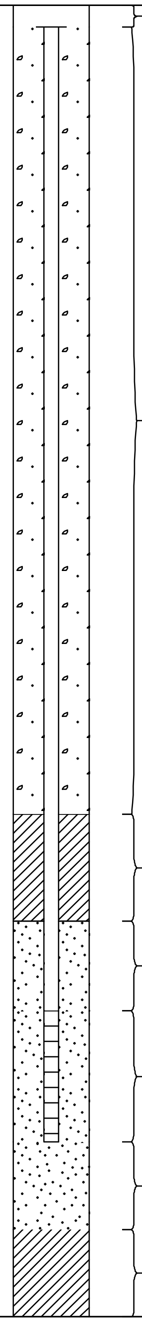
Summary Geology (refer to geological log for full descriptions)

- ASPHALT
- SANDSTONE, medium grained, yellow-brown
- MUDSTONE, red-brown banded light grey and grey
- SANDSTONE, fine to coarse grained, red-brown, light grey and yellow-brown
- MUDSTONE, dark grey
- SANDSTONE, medium to coarse grained, light grey and red-brown
- SANDSTONE, fine to coarse grained, light yellow-brown
- SANDSTONE, fine to coarse grained, light grey
- SANDSTONE, medium to coarse grained, light grey and red-brown
- SANDSTONE, medium grained, grey and brown-grey
- SANDSTONE, medium grained, grey
- SANDSTONE, medium grained, grey

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	26.0 mBGL
Screen Top:	23.0 mBGL
Screen/Sensor Base:	26.0 mBGL
Instrument Details:	-
Installation Date:	1/09/2016
Development Date:	-



Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 18.5 m	GROUT
Depth 18.5 to 21.0 m	BENTONITE
Depth 21.0 to 23.0 m	FILTER SAND
Depth 23.0 to 26.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 26.0 to 28.0 m	FILTER SAND
Depth 28.0 to 35.0 m	BENTONITE

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. CM_BH01

Sheet: 2 of 2

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** TC/NB	**Checked by:** BF
Location: Barr St, Camperdown		**Start Date:** 22/08/2016	**End Date:** 31/08/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331645.5 m	**RL:** 22.64 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6249003.8 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data

Method: HQ3

Core Run	TCR (%)	RQD (%)
Run 22	100	97
Run 23	100	98
Run 24	100	100
Run 25	100	100
Run 26	100	100
Run 27	100	100
Run 28	100	100
Run 29	100	97
Run 30	100	100
Run 31	100	100
Run 32	100	100
Run 33	100	100
Run 34	100	100
Run 35	100	100
Run 36	100	99
Run 37	100	100

Ground Water | Reduced Level (m): -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0, -28.0, -30.0, -32.0, -34.0, -36.0

Depth (m): 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0

Graphic Log

Rock Description

Summary Geology (refer to geological log for full descriptions)

Depth (m)	Summary Geology
to 36.0	SANDSTONE, medium to coarse grained, light grey *continued*
36.0 – 43.0	SANDSTONE, coarse grained, light grey
43.0 – 45.0	LAMINITE
45.0 – 50.0	SANDSTONE, medium to coarse grained, light grey
50.0	*CM_BH01 Terminated at 50.00 m.*

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 26.0 mBGL
Screen Top: 23.0 mBGL
Screen/Sensor Base: 26.0 mBGL
Instrument Details: -
Installation Date: 1/09/2016
Development Date: -

Depth	Backfill
Depth 28.0 to 35.0 m	BENTONITE
Depth 35.0 to 50.0 m	BENTONITE + CEMENT

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. **CM_BH04**

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** LH	**Checked by:** BF
Location: Ross St, Camperdown		**Start Date:** 16/08/2016	**End Date:** 22/08/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 332076.5 m	**RL:** 24.46 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6249145.8 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data

Method	Core Run	TCR (%)	RQD (%)
HA			
AD			
HQ3	Run 1	100	0
HQ3	Run 2	100	60
HQ3	Run 3	100	68
HQ3	Run 4	100	100
HQ3	Run 5	100	90
HQ3	Run 6	100	93
HQ3	Run 7	100	50
HQ3	Run 8	100	97
HQ3	Run 9	100	47
HQ3	Run 10	100	85
HQ3	Run 11	100	100

Ground Water / Reduced Level (m) / Depth (m) / Graphic Log

Reduced Level (m): 24.0, 22.0, 20.0, 18.0, 16.0, 14.0, 12.0, 10.0, 8.0, 6.0, 4.0, 2.0, 0.0, -2.0, -4.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Rock Description

Summary Geology (refer to geological log for full descriptions)

Defect Spacing (mm): 20, 60, 200, 600, 2000

- ASPHALT
- Gravelly SAND
- CONCRETE
- Sandy GRAVEL, coarse grained, brown
- Sandy CLAY, red-brown
- CLAY, black
- CLAY, red
- MUDSTONE, pale grey
- MUDSTONE, dark grey and dark brown
- MUDSTONE, dark grey
- INTERBEDDED MUDSTONE AND SANDSTONE
- SANDSTONE, medium grained, light grey
- NO CORE
- SANDSTONE, medium grained, light grey

Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 19.0 mBGL
Screen Top: 16.0 mBGL
Screen/Sensor Base: 19.0 mBGL
Instrument Details: -
Installation Date: 24/08/2016
Development Date: -

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 11.9 m	GROUT
Depth 11.9 to 14.0 m	BENTONITE
Depth 14.0 to 16.0 m	FILTER SAND
Depth 16.0 to 19.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 19.0 to 21.1 m	FILTER SAND
Depth 21.1 to 26.5 m	BENTONITE
Depth 26.5 to 40.0 m	BENTONITE + CEMENT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log** **PIEZOMETER No.** **CM_BH04**

Client:	Sydney Motorway Corporation		**Project No:**	60493796	
Project:	M4-M5 Link Geotech Investigation		**Logged by:**	LH	**Checked by:** BF
Location:	Ross St, Camperdown		**Start Date:**	16/08/2016	**End Date:** 22/08/2016
Driller:	Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:**	332076.5 m	**RL:** 24.46 m
Drill Rig:	Hydrapower Scout	**Inclination:** -90°	**Northing:**	6249145.8 m	**Ver. Datum:** AHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Asphalt

Field Data | **Rock Description** | **Piezometer Details**

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 19.0 mBGL
Screen Top: 16.0 mBGL
Screen/Sensor Base: 19.0 mBGL
Instrument Details: -
Installation Date: 24/08/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm) 20 60 200 600 2000
HQ3	Run 12	100	90		-6.0, -8.0	32.0	SANDSTONE, medium grained, light grey *continued*	
	Run 13	100	100		-10.0	34.0		
	Run 14	100	100		-12.0	36.0		
	Run 15	100	100		-14.0	38.0	SANDSTONE, fine grained, grey	
						40.0	SANDSTONE, medium grained, grey	
					-16.0		*CM_BH04 Terminated at 40.00 m.*	
					-18.0, -20.0, -22.0, -24.0, -26.0, -28.0, -30.0, -32.0, -34.0	42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0		

Depth 26.5 to 40.0 m — BENTONITE + CEMENT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. CM_BH06

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** LH	**Checked by:** BF
Location: Opp 71 Arundel St, Camperdown		**Start Date:** 11/05/2016	**End Date:** 19/05/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 332317.7 m	**RL:** 37.00 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6249160.5 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data

Method	Core Run	TCR (%)	RQD (%)
HA			
ADT			
HQ3	Run 1	100	0
HQ3	Run 2	100	0
HQ3	Run 3	93	0
HQ3	Run 4	100	57
HQ3	Run 5	100	86
HQ3	Run 6	100	100
HQ3	Run 7	100	23
HQ3	Run 8	100	77
HQ3	Run 9	100	98
HQ3	Run 10	100	100
HQ3	Run 11	100	91
HQ3	Run 12	100	100

Ground Water | Reduced Level (m) | Depth (m) | Graphic Log

Reduced Level (m): 36.0, 34.0, 32.0, 30.0, 28.0, 26.0, 24.0, 22.0, 20.0, 18.0, 16.0, 14.0, 12.0, 10.0, 8.0

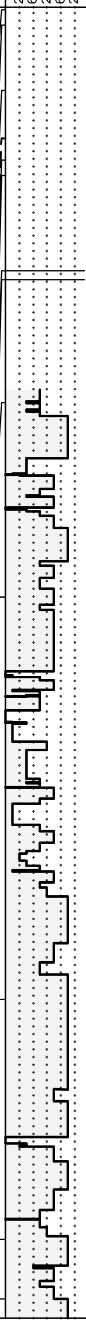
Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Rock Description

Summary Geology (refer to geological log for full descriptions)

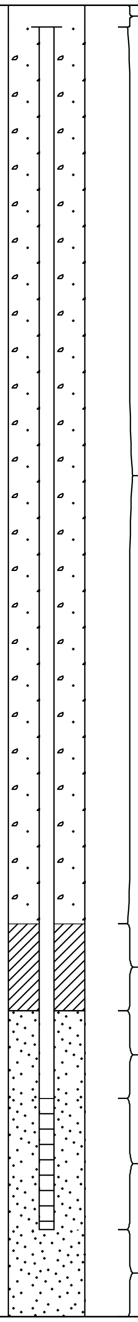
- ASPHALT
- Sandy GRAVEL, fine and coarse grained, grey
- Silty CLAY, red, mottled orange
- Silty CLAY, light grey, mottled pink
- MUDSTONE
- MUDSTONE, light grey, mottled red, brown
- MUDSTONE
- NO CORE
- MUDSTONE
- MUDSTONE
- LAMINITE
- MUDSTONE
- SANDSTONE, fine grained, brown-grey

Defect Spacing (mm): 20, 60, 200, 600, 2000



Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 28.0 mBGL
Screen Top: 28.0 mBGL
Screen/Sensor Base: 25.0 mBGL
Instrument Details: -
Installation Date: 19/05/2016
Development Date: -



Depth	Material
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 21.0 m	GROUT
Depth 21.0 to 23.0 m	BENTONITE
Depth 23.0 to 25.0 m	FILTER SAND
Depth 25.0 to 28.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 28.0 to 30.0 m	FILTER SAND

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. CM_BH06

Client:	Sydney Motorway Corporation		**Project No:**	60493796	
Project:	M4-M5 Link Geotech Investigation		**Logged by:**	LH	**Checked by:** BF
Location:	Opp 71 Arundel St, Camperdown		**Start Date:**	11/05/2016	**End Date:** 19/05/2016
Driller:	Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:**	332317.7 m	**RL:** 37.00 m
Drill Rig:	Hydrapower Scout	**Inclination:** -90°	**Northing:**	6249160.5 m	**Ver. Datum:** AHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Asphalt

Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 28.0 mBGL
Screen Top: 28.0 mBGL
Screen/Sensor Base: 25.0 mBGL
Instrument Details: -
Installation Date: 19/05/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)	Piezometer Details
HQ3	Run 13	100	100		6.0	32.0	SANDSTONE, medium grained, light grey *continued*	Depth 30.0 to 32.0 m — BENTONITE
HQ3							SANDSTONE, medium grained, light grey	
HQ3	Run 14	100	100		4.0	34.0		Depth 32.0 to 50.0 m — BENTONITE + CEMENT
HQ3	Run 15	100	100		2.0	36.0		
HQ3	Run 16	100	100		0.0	38.0		
HQ3					-2.0	40.0		
HQ3	Run 17	100	100		-4.0	42.0		
HQ3	Run 18	100	100		-6.0	44.0		
HQ3	Run 19	100	100		-8.0	46.0		
HQ3					-10.0	48.0		
HQ3	Run 20	100	100		-12.0	50.0		
							CM_BH06 Terminated at 50.00 m.	
					-14.0	52.0		
					-16.0	54.0		
					-18.0	56.0		
					-20.0	58.0		
					-22.0	60.0		

Defect Spacing (mm): 20 60 200 600 2000

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. **CM_BH08**

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	LH	**Checked by:**	BF
Location:	Opp 37A Arundel St, Camperdown	**Start Date:**	27/05/2016	**End Date:**	31/05/2016
Driller:	Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 332503.6 m	**RL:**	34.82 m
Drill Rig:	Hydrapower Scout	**Inclination:** -90°	**Northing:** 6249167.8 m	**Ver. Datum:**	AHD
		Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:**	Asphalt

Field Data

Method	Core Run	TCR (%)	RQD (%)
HA			
AD			
HQ3	Run 1	100	0
HQ3	Run 2	72	0
HQ3	Run 3	100	0
HQ3	Run 4	100	14
HQ3	Run 5	100	38
HQ3	Run 6	100	20
HQ3	Run 7	100	0
HQ3	Run 8	100	0
HQ3	Run 9	100	40
HQ3	Run 10	100	83
HQ3	Run 11	100	98
HQ3	Run 12	100	97
HQ3	Run 13	100	99

Columns: Method, Core Run, TCR (%), RQD (%), Ground Water, Reduced Level (m), Depth (m), Graphic Log

Reduced Level (m): 34.0, 32.0, 30.0, 28.0, 26.0, 24.0, 22.0, 20.0, 18.0, 16.0, 14.0, 12.0, 10.0, 8.0, 6.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Rock Description

Summary Geology (refer to geological log for full descriptions)

- ASPHALT
- Sandy GRAVEL, medium to coarse grained, dark grey
- Silty CLAY, light grey, mottled red
- MUDSTONE, red, mottled light grey
- MUDSTONE, red, mottled light grey and brown
- NO CORE
- MUDSTONE, light grey, mottled red
- MUDSTONE, red-brown
- Silty CLAY, light brown
- MUDSTONE, grey
- LAMINITE
- MUDSTONE
- MUDSTONE
- SANDSTONE, fine grained, brown-grey
- SANDSTONE, fine grained, grey
- SANDSTONE, medium to coarse grained, light grey

Defect Spacing (mm): 20, 60, 200, 600, 2000

CM_BH08 Terminated at 30.00 m.

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	30.0 mBGL
Screen Top:	27.0 mBGL
Screen/Sensor Base:	30.0 mBGL
Instrument Details:	-
Installation Date:	31/05/2016
Development Date:	-

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 23.0 m	GROUT
Depth 23.0 to 25.0 m	BENTONITE
Depth 25.0 to 27.0 m	FILTER SAND
Depth 27.0 to 30.0 m	PVC SLOTTED SECTION WITH FILTER SAND

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. CM_BH10

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** LH	**Checked by:** BF
Location: Opp 21 Arundel St, Camperdown		**Start Date:** 11/05/2016	**End Date:** 12/05/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 332612.0 m	**RL:** 31.36 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6249165.5 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Summary Geology (refer to geological log for full descriptions)
HA				ASPHALT
AD				Sandy GRAVEL, grey
AD				Silty CLAY, light brown
AD				LAMINITE, light brown-grey to dark brown-grey
HQ3	Run 1	100	74	LAMINITE
HQ3	Run 2	100	17	
HQ3	Run 3	100	17	MUDSTONE
HQ3	Run 4	98	34	NO CORE
				MUDSTONE
HQ3	Run 5	100	33	MUDSTONE, dark grey
HQ3	Run 6	100	83	
HQ3	Run 7	100	93	SANDSTONE, medium grained, light grey
				SANDSTONE, medium grained, light grey
HQ3	Run 8	100	100	
HQ3	Run 9	100	100	

Reduced Level (m): 30.0, 28.0, 26.0, 24.0, 22.0, 20.0, 18.0, 16.0, 14.0, 12.0, 10.0, 8.0, 6.0, 4.0, 2.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Defect Spacing (mm): 20, 60, 200, 600, 2000

CM_BH10 Terminated at 30.00 m.

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	20.0 mBGL
Screen Top:	17.0 mBGL
Screen/Sensor Base:	20.0 mBGL
Instrument Details:	-
Installation Date:	13/05/2016
Development Date:	-

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 13.0 m	GROUT
Depth 13.0 to 15.0 m	BENTONITE
Depth 15.0 to 17.0 m	FILTER SAND
Depth 17.0 to 20.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 20.0 to 22.0 m	FILTER SAND
Depth 22.0 to 24.0 m	BENTONITE
Depth 24.0 to 30.0 m	BENTONITE + CEMENT

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. EP_BH06

Sheet: 1 of 1

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	LH	**Checked by:**	
Location:	Lilyfield Road, Rozelle	**Start Date:**	21/10/2016	**End Date:**	25/10/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331025.4 m	**RL:**	7.85 m
Drill Rig:	Hanjin D&B	**Inclination:** -90°	**Northing:** 6250903.9 m	**Ver. Datum:**	AHD
		Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:**	Asphalt

Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Summary Geology (refer to geological log for full descriptions)
ADT NDD				Sandy GRAVEL, coarse grained, dark grey
HQ3	Run 1	26	0	SAND, medium grained, red
HQ3	Run 1			NO CORE
HQ3	Run 2	77	77	SANDSTONE, coarse grained, dark brown-red
HQ3	Run 3	97	73	SANDSTONE, fine to medium grained, light grey-pink
HQ3	Run 4	100	96	NO CORE
HQ3	Run 4			SANDSTONE, fine to medium grained, light grey-pink
HQ3	Run 5	100	96	SANDSTONE, medium grained, light grey-pink
HQ3	Run 6	100	100	
HQ3	Run 7	100	100	SANDSTONE, fine grained, dark grey and light grey
HQ3	Run 7			SANDSTONE, medium grained, light grey

EP_BH06 Terminated at 15.00 m.

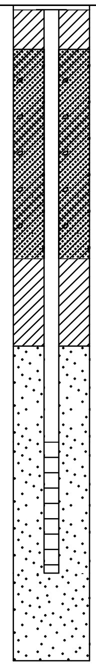
Reduced Level (m): 6.0, 4.0, 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 10.0 mBGL
Screen Top: 10.0 mBGL
Screen/Sensor Base: 13.0 mBGL
Instrument Details: -
Installation Date: 24/10/2016
Development Date: -



Depth	Material
Depth 0.0 to 0.1 m	GATIC COVER
Depth 0.1 to 1.0 m	BENTONITE
Depth 1.0 to 5.8 m	GROUT
Depth 5.8 to 7.8 m	BENTONITE
Depth 7.8 to 10.0 m	FILTER SAND
Depth 10.0 to 13.0 m	PVC SLOTTED SECTION WITH FILTER SOCK with 2 mm FILTER SAND
Depth 13.0 to 15.0 m	FILTER SAND

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. EP_BH07

Client: Sydney Motorway Corporation		**Project No:** 60493796			
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB		**Checked by:**	
Location: Lilyfield Road, Rozelle		**Start Date:** 26/10/2016		**End Date:** 26/10/2016	
Driller: Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331082.3 m		**RL:** 10.54 m	
Drill Rig: Hanjin D&B	**Inclination:** -90°	**Northing:** 6250898.8 m		**Ver. Datum:** AHD	
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H		**Surface:** Road	

Field Data

Method	Core Run	TCR (%)	RQD (%)
ND			
HQ3	Run 1	48	16
HQ3	Run 2	67	14
HQ3	Run 3	48	0
HQ3	Run 4	69	40
HQ3	Run 5	100	85
HQ3	Run 6	79	19
HQ3	Run 7	100	72
HQ3	Run 8	89	25
HQ3	Run 9	53	10
HQ3	Run 10	95	61
HQ3	Run 11	97	65
HQ3	Run 12	100	79

Columns: Ground Water, Reduced Level (m), Depth (m), Graphic Log

Reduced Level (m): 10.0, 8.0, 6.0, 4.0, 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Rock Description

Summary Geology (refer to geological log for full descriptions)

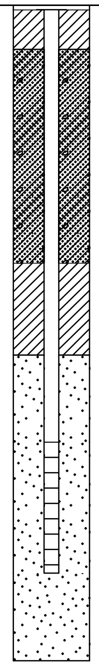
Defect Spacing (mm): 20, 60, 200, 600, 2000

- ASPHALT
- Sandy GRAVEL, coarse grained, dark grey
- Sandy GRAVEL, dark grey
- NO CORE
- SANDSTONE, coarse grained, light grey and yellow-brown
- NO CORE
- SANDSTONE, fine to coarse grained, red-brown
- NO CORE
- SANDSTONE
- NO CORE
- SANDSTONE, coarse grained, light grey and yellow-brown
- NO CORE
- SANDSTONE, coarse grained, light grey and yellow-brown
- NO CORE
- SANDSTONE, fine to medium grained, light grey and yellow-brown
- NO CORE
- SANDSTONE, fine to medium grained, light grey and yellow-brown
- SANDSTONE, medium grained, light to mid grey
- NO CORE
- SANDSTONE, medium grained, light grey

EP_BH07 Terminated at 15.00 m.

Piezometer Details

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 10.0 mBGL
Screen Top: 10.0 mBGL
Screen/Sensor Base: 13.0 mBGL
Instrument Details: -
Installation Date: 26/10/2016
Development Date: 27/10/2016



Depth	Material
Depth 0.0 to 0.1 m	GATIC COVER
Depth 0.1 to 1.0 m	BENTONITE
Depth 1.0 to 5.9 m	GROUT
Depth 5.9 to 8.0 m	BENTONITE
Depth 8.0 to 10.0 m	FILTER SAND
Depth 10.0 to 13.0 m	PVC SLOTTED SECTION WITH FILTER SOCK with 2 mm FILTER SAND
Depth 13.0 to 15.0 m	FILTER SAND

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. HB_BH02

Sheet: 1 of 2

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB	**Checked by:** BF
Location: Cnr Martin St, City West Link		**Start Date:** 3/05/2016	**End Date:** 4/05/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 327574.8 m	**RL:** 2.87 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250197.4 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

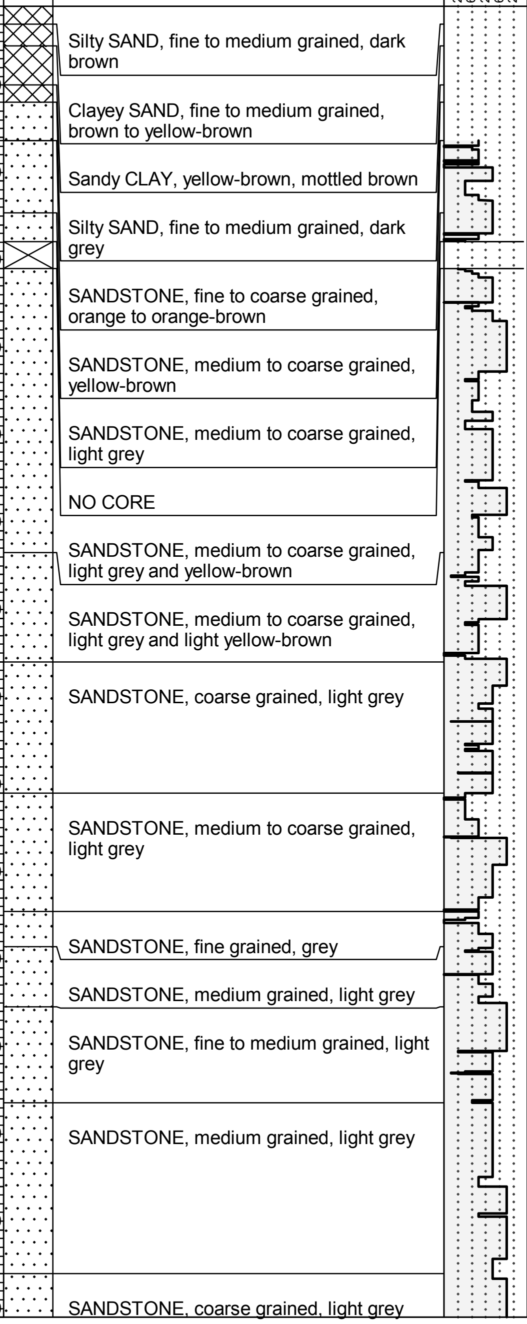
Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HA				0.0–1.0	Silty SAND, fine to medium grained, dark brown
ADT					Clayey SAND, fine to medium grained, brown to yellow-brown
HQ3	Run 1	100	0		Sandy CLAY, yellow-brown, mottled brown
	Run 2	70	50		Silty SAND, fine to medium grained, dark grey
	Run 3	100	83		SANDSTONE, fine to coarse grained, orange to orange-brown
					SANDSTONE, medium to coarse grained, yellow-brown
	Run 4	100	80		SANDSTONE, medium to coarse grained, light grey
					NO CORE
	Run 5	100	89		SANDSTONE, medium to coarse grained, light grey and yellow-brown
	Run 6	100	55		SANDSTONE, medium to coarse grained, light grey and light yellow-brown
	Run 7	100	92		SANDSTONE, coarse grained, light grey
	Run 8	100	42		SANDSTONE, medium to coarse grained, light grey
	Run 9	100	96		
	Run 10	100	78		SANDSTONE, fine grained, grey
	Run 11	100	90		SANDSTONE, medium grained, light grey
					SANDSTONE, fine to medium grained, light grey
	Run 12	100	91		SANDSTONE, medium grained, light grey
	Run 13	100	97	30.0	SANDSTONE, coarse grained, light grey

Reduced Level (m) scale: 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

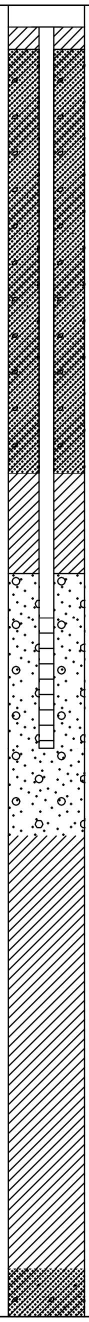
Depth (m) scale: 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Defect Spacing (mm): 20, 60, 200, 600, 2000



Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 14.0 mBGL
Screen Top: 14.0 mBGL
Screen/Sensor Base: 17.0 mBGL
Instrument Details: -
Installation Date: 6/05/2016
Development Date: -



Depth	Material
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 1.0 m	BENTONITE-CEMENT GROUT
Depth 1.0 to 10.7 m	GROUT
Depth 10.7 to 13.0 m	BENTONITE
Depth 13.0 to 14.0 m	FILTER SAND
Depth 14.0 to 17.0 m	PVC SLOTTED SECTION WITH FILTER SOCK with 2mm FILTER SAND
Depth 17.0 to 19.0 m	FILTER SAND
Depth 19.0 to 28.9 m	BENTONITE
Depth 28.9 to 50.0 m	GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. HB_BH02

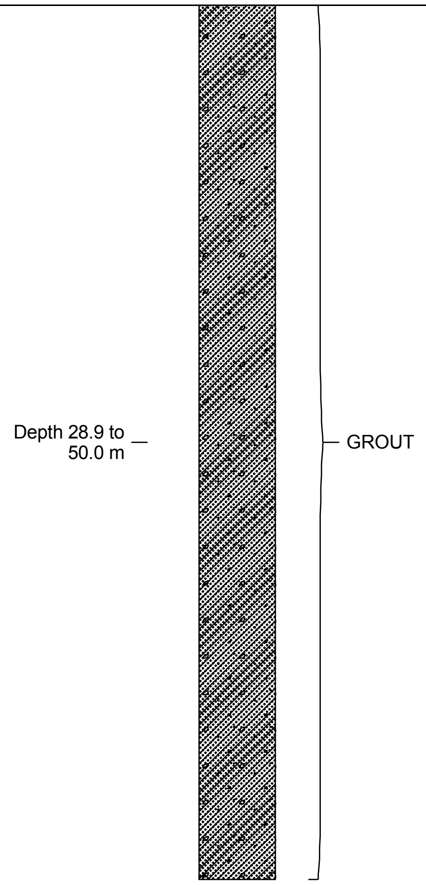
Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	NB	**Checked by:**	BF
Location:	Cnr Martin St, City West Link	**Start Date:**	3/05/2016	**End Date:**	4/05/2016
Driller:	Hagstrom Drilling Pty Ltd; **Hole Diameter:** 96 mm	**Easting:**	327574.8 m	**RL:**	2.87 m
Drill Rig:	Hydrapower Scout; **Inclination:** -90°; **Bearing:** N/A	**Northing:**	6250197.4 m	**Ver. Datum:**	AHD
		Hor. Proj/Dat:	MGA94/GDA94-56H	**Surface:**	Grass

Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Graphic Log	Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm) 20 60 200 600 2000
HQ3	Run 14	100	95		-28.0	32.0		SANDSTONE, coarse grained, light grey *continued*	
	Run 15	100	99		-30.0, -32.0	34.0, 36.0		SANDSTONE, medium to coarse grained, light grey	
	Run 16	100	100		-34.0	38.0		SANDSTONE, medium to coarse grained, light grey	
	Run 17	100	98		-36.0	40.0		SANDSTONE, medium grained, light grey	
					-38.0	42.0		SANDSTONE, medium to coarse grained, light grey	
	Run 18	100	98		-40.0, -42.0	44.0, 46.0		SANDSTONE, medium to coarse grained, light grey	
	Run 19	100	98		-44.0	48.0		SANDSTONE, coarse grained, light grey	
	Run 20	100	98		-46.0	50.0		SANDSTONE, medium to coarse grained, light grey	
					-48.0, -50.0, -52.0, -54.0, -56.0	52.0, 54.0, 56.0, 58.0, 60.0		*HB_BH02 Terminated at 50.00 m.*	

Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 14.0 mBGL
Screen Top: 14.0 mBGL
Screen/Sensor Base: 17.0 mBGL
Instrument Details: -
Installation Date: 6/05/2016
Development Date: -



REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. HB_BH03A

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	NB	**Checked by:**	BF
Location:	Parking Lane, Alternate St, Haberfield	**Start Date:**	27/06/2016	**End Date:**	30/06/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:**	96 mm	**Easting:**	327764.1 m
RL:	6.23 m	**Inclination:**	-90°	**Northing:**	6250215.8 m
Ver. Datum:	AHD	**Drill Rig:**	Ausroc 4000	**Bearing:**	N/A
Hor. Proj/Dat:	MGA94/GDA94-56H	**Surface:**	Asphalt		

Field Data / Rock Description

Columns: Method, Core Run, TCR (%), RQD (%), Ground Water, Reduced Level (m), Depth (m), Graphic Log; Summary Geology (refer to geological log for full descriptions); Defect Spacing (mm) 20 60 200 600 2000

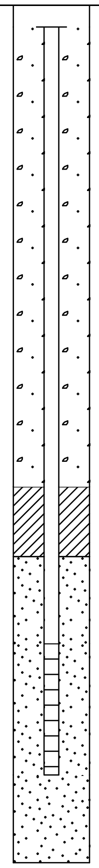
Summary Geology
ASPHALT
Clayey SAND, fine to medium grained, yellow-brown
CLAY, yellow-brown
SANDSTONE, fine to medium grained, light grey
SANDSTONE, fine to medium grained
SANDSTONE, medium to coarse grained, light grey and red-brown
NO CORE
SANDSTONE, medium to coarse grained, light grey
SANDSTONE, fine to coarse grained, light grey, yellow-brown and red-brown
SANDSTONE, fine to medium grained, grey
SANDSTONE, medium to coarse grained, light grey
SANDSTONE, coarse grained, light grey
HB_BH03A Terminated at 20.00 m.

Depth (m) scale: 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Reduced Level (m) scale: 6.0, 4.0, 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	19.6 mBGL
Screen Top:	14.6 mBGL
Screen/Sensor Base:	17.6 mBGL
Instrument Details:	-
Installation Date:	1/07/2016
Development Date:	-



Depth	Material
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 11.0 m	BENTONITE-CEMENT GROUT
Depth 11.0 to 12.6 m	BENTONITE
Depth 12.6 to 14.6 m	FILTER SAND
Depth 14.6 to 17.6 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 17.6 to 19.6 m	FILTER SAND

REMARKS:The material properties are taken from the adjacent borehole HB_BH03
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

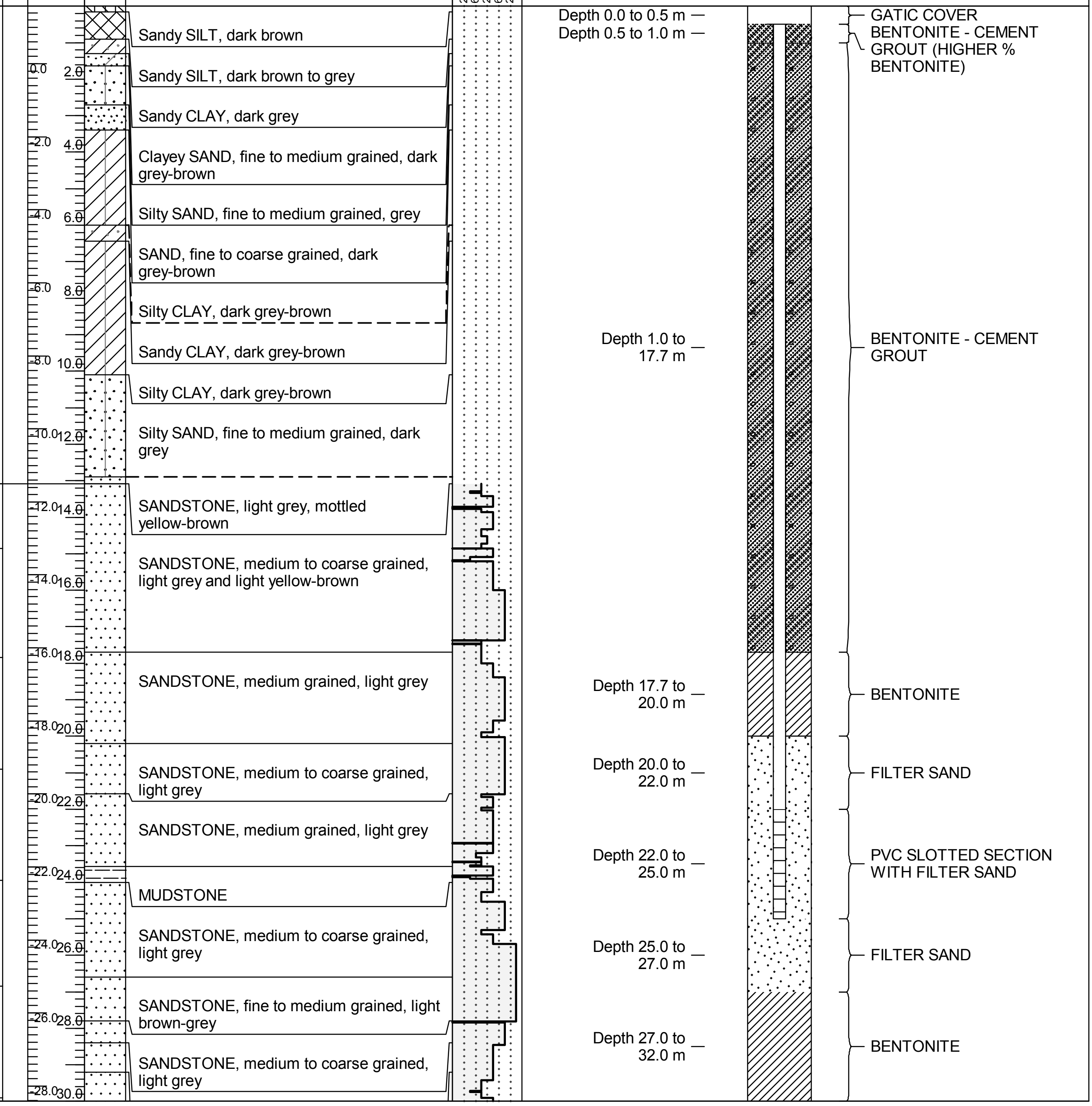
PIEZOMETER No. **HB_BH08**

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB	**Checked by:** BF
Location: Richard Murden Res, Hawthorne Pde, Haberfield		**Start Date:** 6/05/2016	**End Date:** 10/05/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 328752.0 m	**RL:** 1.58 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250138.2 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

Field Data | **Rock Description** | **Piezometer Details**

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 25.0 mBGL
Screen Top: 22.0 mBGL
Screen/Sensor Base: 25.0 mBGL
Instrument Details: -
Installation Date: 11/05/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HA						Sandy SILT, dark brown
ADT				0.0	2.0	Sandy SILT, dark brown to grey
ADT						Sandy CLAY, dark grey
ADT				-2.0	4.0	Clayey SAND, fine to medium grained, dark grey-brown
ADT				-4.0	6.0	Silty SAND, fine to medium grained, grey
ADT						SAND, fine to coarse grained, dark grey-brown
ADT				-6.0	8.0	Silty CLAY, dark grey-brown
ADT						Sandy CLAY, dark grey-brown
CA				-8.0	10.0	Silty CLAY, dark grey-brown
CA				-10.0	12.0	Silty SAND, fine to medium grained, dark grey
HQ3	Run 1	100	80	-12.0	14.0	SANDSTONE, light grey, mottled yellow-brown
HQ3	Run 2	100	91	-14.0	16.0	SANDSTONE, medium to coarse grained, light grey and light yellow-brown
HQ3	Run 3	100	97	-16.0	18.0	SANDSTONE, medium grained, light grey
HQ3	Run 4	100	77	-18.0	20.0	SANDSTONE, medium to coarse grained, light grey
HQ3				-20.0	22.0	SANDSTONE, medium grained, light grey
HQ3	Run 5	100	98	-22.0	24.0	MUDSTONE
HQ3				-24.0	26.0	SANDSTONE, medium to coarse grained, light grey
HQ3	Run 6	100	97	-26.0	28.0	SANDSTONE, fine to medium grained, light brown-grey
HQ3				-28.0	30.0	SANDSTONE, medium to coarse grained, light grey



Depth	Installation
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 1.0 m	BENTONITE - CEMENT GROUT (HIGHER % BENTONITE)
Depth 1.0 to 17.7 m	BENTONITE - CEMENT GROUT
Depth 17.7 to 20.0 m	BENTONITE
Depth 20.0 to 22.0 m	FILTER SAND
Depth 22.0 to 25.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 25.0 to 27.0 m	FILTER SAND
Depth 27.0 to 32.0 m	BENTONITE

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

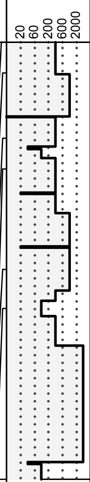
PIEZOMETER No. HB_BH08

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB	**Checked by:** BF
Location: Richard Murden Res, Hawthorne Pde, Haberfield		**Start Date:** 6/05/2016	**End Date:** 10/05/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 328752.0 m	**RL:** 1.58 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250138.2 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

Field Data / Rock Description

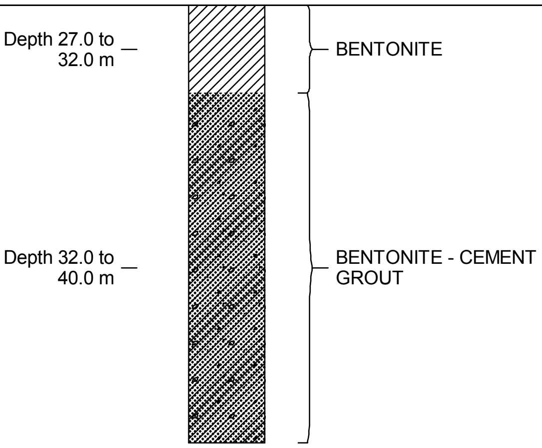
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 7	100	95		-30.0	32.0	SANDSTONE, medium grained, light grey
							SANDSTONE, medium grained, light grey *continued*
	Run 8	100	96		-32.0	34.0	SANDSTONE, fine to medium grained, light grey
	Run 9	100	98				SANDSTONE, medium to coarse grained, light grey
					-34.0	36.0	SANDSTONE, medium grained, light grey
	Run 10	100	100		-36.0	38.0	SANDSTONE, fine to medium grained, light grey
	Run 11	100	88		-38.0	40.0	SANDSTONE, medium to coarse grained, light grey
							HB_BH08 Terminated at 40.00 m.
					-40.0	42.0	
					-42.0	44.0	
					-44.0	46.0	
					-46.0	48.0	
					-48.0	50.0	
					-50.0	52.0	
					-52.0	54.0	
					-54.0	56.0	
					-56.0	58.0	
					-58.0	60.0	

Defect Spacing (mm)



Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 25.0 mBGL
Screen Top: 22.0 mBGL
Screen/Sensor Base: 25.0 mBGL
Instrument Details: -
Installation Date: 11/05/2016
Development Date: -



REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. **HB_BH08A**

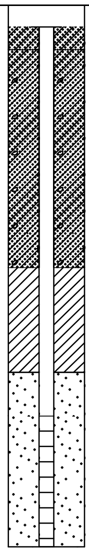
Sheet: 1 of 1

Client: Sydney Motorway Corporation		**Project No:** 60493796			
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB		**Checked by:** BF	
Location: Richard Murden Res, Hawthorne Pde, Haberfield		**Start Date:** 11/05/2016		**End Date:** 11/05/2016	
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 328750.6 m		**RL:** 1.51 m	
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250135.5 m		**Ver. Datum:** AHD	
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H		**Surface:** Grass	

Field Data / Rock Description / Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 12.4 mBGL
Screen Top: 9.4 mBGL
Screen/Sensor Base: 12.4 mBGL
Instrument Details: -
Installation Date: 11/05/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Graphic Log	Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm) 20 60 200 600 2000
HA								Sandy SILT, dark brown	
ADT					0.0	2.0		Sandy SILT, dark brown to grey	
ADT								Sandy CLAY, dark grey	
ADT					-2.0	4.0		Clayey SAND, fine to medium grained, dark grey-brown	
ADT					-4.0	6.0		Silty SAND, fine to medium grained, grey	
ADT								SAND, fine to coarse grained, dark grey-brown	
ADT					-6.0	8.0		Silty CLAY, dark grey-brown	
ADT					-8.0	10.0		Sandy CLAY, dark grey-brown	
CA								Silty CLAY, dark grey-brown	
CA					-10.0	12.0		Silty SAND, fine to medium grained, dark grey	
								HB_BH08A Terminated at 12.40 m.	
					-12.0	14.0			
					-14.0	16.0			
					-16.0	18.0			
					-18.0	20.0			
					-20.0	22.0			
					-22.0	24.0			
					-24.0	26.0			
					-26.0	28.0			
					-28.0	30.0			



Depth	Details
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 1.0 m	BENTONITE - CEMENT GROUT (HIGHER % BENTONITE)
Depth 1.0 to 6.0 m	BENTONITE - CEMENT GROUT
Depth 6.0 to 8.4 m	BENTONITE
Depth 8.4 to 9.4 m	FILTER SAND
Depth 9.4 to 12.4 m	PVC SLOTTED SECTION WITH FILTER SAND

REMARKS:The material properties are taken from the adjacent borehole HB_BH08
GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log**

PIEZOMETER No. HB_BH12

Sheet: 1 of 2

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** FR/JY	**Checked by:** BF
Location: Darley Rd, Leichhardt		**Start Date:** 15/06/2016	**End Date:** 23/06/2016
Driller: Numac Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 329047.4 m	**RL:** 2.36 m
Drill Rig: Comacchio Geo-205	**Inclination:** -90°	**Northing:** 6250099.1 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data

Method	Core Run	TCR (%)	RQD (%)
HA			
RT			
HQ3	Run 1	100	0
HQ3	Run 2	93	88
HQ3	Run 3	100	100
HQ3	Run 4	100	100
HQ3	Run 5	100	100
HQ3	Run 6	94	91
HQ3	Run 7	100	100
HQ3	Run 8	100	100
HQ3	Run 9	100	100
HQ3	Run 10	87	95
HQ3	Run 11	100	98
HQ3	Run 12	100	99
HQ3	Run 13	100	99
HQ3	Run 14	100	100
HQ3	Run 15	100	100
HQ3	Run 16	100	99
HQ3	Run 17	100	79
HQ3	Run 18	100	100

Columns: Method, Core Run, TCR (%), RQD (%), Ground Water, Reduced Level (m), Depth (m), Graphic Log

Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Rock Description

Summary Geology (refer to geological log for full descriptions)

Defect Spacing (mm): 20, 60, 200, 600, 2000

- ASPHALT
- Clayey Gravelly SAND, fine to coarse grained
- SAND, fine to medium grained, yellow
- Silty CLAY, dark grey
- SAND, fine to medium grained, light grey
- Silty CLAY, orange-brown mottled light grey
- SANDSTONE, yellow-brown to orange-brown, and light grey
- SANDSTONE, fine to coarse grained, light red-brown and yellow-brown
- SANDSTONE, fine to coarse grained, yellow-brown, with light grey, mottled red-brown
- NO CORE
- SANDSTONE, fine to coarse grained, light grey, mottled light red-brown
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, fine to coarse grained, light red-brown and yellow-brown
- NO CORE
- SANDSTONE, fine to coarse grained, brown-grey
- SANDSTONE, fine to medium grained, brown-grey
- SANDSTONE, fine to medium grained, brown-grey
- SANDSTONE, medium to coarse grained, brown-grey
- SANDSTONE, fine to coarse grained, brown-grey
- SANDSTONE, fine grained, grey

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	30.0 mBGL
Screen Top:	27.0 mBGL
Screen/Sensor Base:	30.0 mBGL
Instrument Details:	-
Installation Date:	23/06/2016
Development Date:	-

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 23.0 m	BENTONITE + CEMENT GROUT
Depth 23.0 to 24.9 m	BENTONITE
Depth 24.9 to 27.0 m	FILTER SAND
Depth 27.0 to 30.0 m	PVC SLOTTED SECTION WITH FILTER SAND

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. HB_BH12

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** FR/JY	**Checked by:** BF
Location: Darley Rd, Leichhardt		**Start Date:** 15/06/2016	**End Date:** 23/06/2016
Driller: Numac Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 329047.4 m	**RL:** 2.36 m
Drill Rig: Comacchio Geo-205	**Inclination:** -90°	**Northing:** 6250099.1 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data

Method	Core Run	TCR (%)	RQD (%)
HQ3	Run 19	100	100
	Run 20	100	100
	Run 21	100	100
	Run 22	100	92
	Run 23	100	99
	Run 24	77	77
	Run 25	100	100

Ground Water | Reduced Level (m): -28.0, -30.0, -32.0, -34.0, -36.0, -38.0, -40.0, -42.0, -44.0, -46.0, -48.0, -50.0, -52.0, -54.0, -56.0 | Depth (m): 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0 | Graphic Log

Rock Description

Summary Geology (refer to geological log for full descriptions) | Defect Spacing (mm): 20, 60, 200, 600, 2000

- SANDSTONE, medium to coarse grained, brown-grey
- SANDSTONE, fine to medium grained, brown-grey
- INTERBEDDED SHALE/SANDSTONE
- SANDSTONE, fine to medium grained, light grey *continued*
- SANDSTONE, fine to medium grained, brown-grey
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, fine to medium grained, grey
- SANDSTONE, fine to medium grained, brown-grey
- NO CORE
- SANDSTONE, fine to medium grained, brown-grey

HB_BH12 Terminated at 40.00 m.

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	30.0 mBGL
Screen Top:	27.0 mBGL
Screen/Sensor Base:	30.0 mBGL
Instrument Details:	-
Installation Date:	23/06/2016
Development Date:	-

Depth	Backfill
Depth 30.0 to 31.8 m	FILTER SAND
Depth 31.8 to 36.0 m	BENTONITE
Depth 36.0 to 40.0 m	BENTONITE + CEMENT GROUT

REMARKS:

GROUNDWATER MONITORING NOTES:

Engineering Log

PIEZOMETER No. HB_BH14

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** JR	**Checked by:** BF
Location: Hubert St, Leichhardt		**Start Date:** 23/05/2016	**End Date:** 26/05/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 329206.6 m	**RL:** 4.27 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250086.3 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data / Rock Description / Piezometer Details

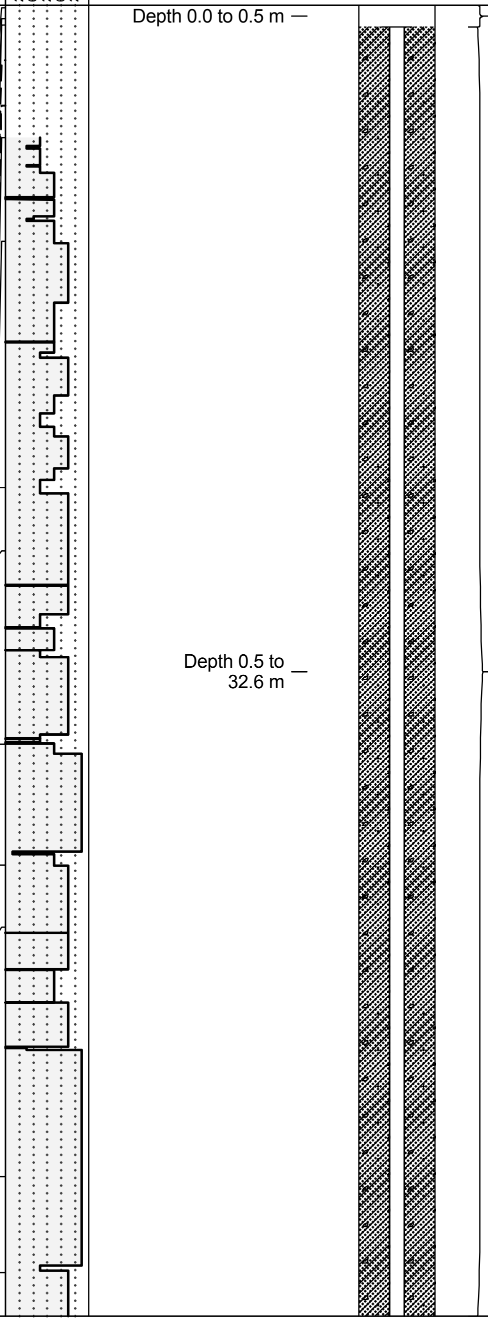
Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 36.6 mBGL
Screen Top: 36.6 mBGL
Screen/Sensor Base: 39.6 mBGL
Instrument Details: -
Installation Date: 26/05/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Summary Geology (refer to geological log for full descriptions)
HA					ASPHALT
AD					Sandy GRAVEL, medium to coarse grained, grey
HQ3	Run 1	100	95		Silty CLAY, brown, mottled yellow
					Silty CLAY, yellow-brown, mottled red
					Silty CLAY, grey, mottled orange-yellow
	Run 2	100	100		SANDSTONE, fine to coarse grained, orange to yellow-brown
					SANDSTONE, medium to coarse grained, light grey
	Run 3	100	81		SANDSTONE, medium to coarse grained, light grey
					SANDSTONE, medium to coarse grained, light grey
	Run 4	100	96		SANDSTONE, medium grained, light grey
	Run 5	100	98	50%	
	Run 6	100	98		SANDSTONE, medium to coarse grained, light grey
					SANDSTONE, medium to coarse grained, light grey
	Run 7	100	97		SANDSTONE, medium to coarse grained, light grey
	Run 8	100	100		
	Run 9	100	100		SANDSTONE, coarse grained, light grey
					SANDSTONE, medium grained, light grey

Reduced Level (m): 4.0, 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Defect Spacing (mm): 20, 60, 200, 600, 2000



Depth 0.0 to 0.5 m — GATIC COVER

Depth 0.5 to 32.6 m — BENTONITE + CEMENT GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. **HB_BH14**

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** JR	**Checked by:** BF
Location: Hubert St, Leichhardt		**Start Date:** 23/05/2016	**End Date:** 26/05/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 329206.6 m	**RL:** 4.27 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250086.3 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data / Rock Description / Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 36.6 mBGL
Screen Top: 36.6 mBGL
Screen/Sensor Base: 39.6 mBGL
Instrument Details: -
Installation Date: 26/05/2016
Development Date: -

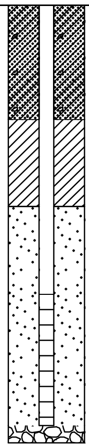
Method	Core Run	TCR (%)	RQD (%)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 10	100	95	MUDSTONE, dark grey
				SANDSTONE, medium to coarse grained, light grey
	Run 11	100	98	SANDSTONE, medium grained
	Run 12	100	97	SANDSTONE, medium to coarse grained, light grey
				SANDSTONE, medium to coarse grained, light grey
	Run 13	100	96	SANDSTONE, medium grained, light grey

HB_BH14 Terminated at 40.08 m.

Reduced Level (m): 26.0, 28.0, 30.0, 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0

Depth (m): 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0

Defect Spacing (mm): 20, 60, 200, 600, 2000



Depth	Backfill
Depth 0.5 to 32.6 m	BENTONITE + CEMENT GROUT
Depth 32.6 to 34.6 m	BENTONITE
Depth 34.6 to 36.6 m	FILTER SAND
Depth 36.6 to 39.6 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 39.6 to 40.0 m	CAVE-IN BACKFILL

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. HB_BH15

Sheet: 1 of 2

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB	**Checked by:** BF
Location: Cnr James St, City West Link, Leichhardt		**Start Date:** 12/05/2016	**End Date:** 16/05/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 329396.4 m	**RL:** 17.87 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250142.8 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

Field Data

Method	Core Run	TCR (%)	RQD (%)
HA			
ADT			
HQ3	Run 1	100	63
HQ3	Run 2	100	93
HQ3	Run 3	100	97
HQ3	Run 4	100	98
HQ3	Run 5	100	96
HQ3	Run 6	100	91
HQ3	Run 7	100	97
HQ3	Run 8	100	99
HQ3	Run 9	100	98
HQ3	Run 10	100	100

Columns: Method, Core Run, TCR (%), RQD (%), Ground Water, Reduced Level (m), Depth (m), Graphic Log

Reduced Level (m): 16.0, 14.0, 12.0, 10.0, 8.0, 6.0, 4.0, 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Rock Description

Summary Geology (refer to geological log for full descriptions)

Defect Spacing (mm): 20, 60, 200, 600, 2000

- Silty SAND, fine to coarse grained, brown
- SAND, medium to coarse grained, brown to orange-brown
- Clayey SAND, coarse grained, dark brown to orange-brown
- SANDSTONE, fine to medium grained, yellow-brown to brown
- SANDSTONE, medium to coarse grained, red-brown, mottled light yellow-brown
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, medium to coarse grained, light yellow-brown

Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 22.0 mBGL
Screen Top: 19.0 mBGL
Screen/Sensor Base: 22.0 mBGL
Instrument Details: -
Installation Date: 16/05/2016
Development Date: -

Depth	Detail
Depth 0.0 to 0.5 m	ROAD BOX
Depth 0.5 to 1.0 m	GROUT BENTONITE (HIGHER % BENTONITE)
Depth 1.0 to 14.8 m	BENTONITE/GROUT MIX
Depth 14.8 to 17.0 m	BENTONITE
Depth 17.0 to 19.0 m	FILTER SAND
Depth 19.0 to 22.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 22.0 to 24.0 m	FILTER SAND
Depth 24.0 to 28.6 m	BENTONITE
Depth 28.6 to 40.1 m	BENTONITE/GROUT MIX

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. HB_BH15

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB	**Checked by:** BF
Location: Cnr James St, City West Link, Leichhardt		**Start Date:** 12/05/2016	**End Date:** 16/05/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 329396.4 m	**RL:** 17.87 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250142.8 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

Field Data / Rock Description / Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 22.0 mBGL
Screen Top: 19.0 mBGL
Screen/Sensor Base: 22.0 mBGL
Instrument Details: -
Installation Date: 16/05/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 11	100	100				
		100	100		-14.0	32.0	SANDSTONE, coarse grained, light grey
	Run 12	100	100		-16.0	34.0	
	Run 13	100	98		-18.0	36.0	SANDSTONE, medium to coarse grained, light grey
	Run 14	100	98		-20.0	38.0	SANDSTONE, fine to medium grained, light grey
	Run 15	100	100		-22.0	40.0	SANDSTONE, medium to coarse grained, light grey
							HB_BH15 Terminated at 40.08 m.
					-24.0	42.0	
					-26.0	44.0	
					-28.0	46.0	
					-30.0	48.0	
					-32.0	50.0	
					-34.0	52.0	
					-36.0	54.0	
					-38.0	56.0	
					-40.0	58.0	
						60.0	

Defect Spacing (mm): 20 60 200 600 2000

Depth 28.6 to 40.1 m — BENTONITE/GROUT MIX

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. IC_BH01

Sheet: 1 of 1

Client: Sydney Motorway Corporation	**Project No:** 60493796		
Project: M4-M5 Link Geotech Investigation	**Logged by:** EC	**Checked by:**	
Location: 46 Waterloo Street, Rozelle	**Start Date:** 12/10/2016	**End Date:** 18/10/2016	
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330514.2 m	**RL:** 26.87 m
Drill Rig: Delta Base 520	**Inclination:** -90°	**Northing:** 6251504.5 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data / Rock Description / Piezometer Details

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 26.0 mBGL
Screen Top: 23.0 mBGL
Screen/Sensor Base: 26.0 mBGL
Instrument Details: -
Installation Date: 17/10/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Summary Geology (refer to geological log for full descriptions)
NDD				ASPHALTIC CONCRETE
AD				Sandy GRAVEL, fine grained, brown and dark brown
HQ3	Run 1	100	54	SANDSTONE, orange brown and red brown
HQ3	Run 2	97	72	SANDSTONE, light grey, with red brown iron staining
HQ3	Run 3	98	88	SANDSTONE, medium to coarse grained, light grey; NO CORE
HQ3	Run 4	96	91	SANDSTONE, medium grained, orange-brown to light grey; NO CORE; SANDSTONE, medium grained, red
HQ3	Run 5	100	96	NO CORE; SANDSTONE, coarse grained, light grey
HQ3	Run 6	100	96	SANDSTONE, fine grained, mid grey; SANDSTONE, coarse grained, mid grey
HQ3	Run 7	100	94	
HQ3	Run 8	100	97	SANDSTONE, coarse grained, mid grey; SANDSTONE, medium to coarse grained, mid grey
HQ3	Run 9	100	93	SANDSTONE, coarse grained, mid grey
HQ3	Run 10	100	93	SANDSTONE, medium grained, mid grey; SANDSTONE, medium grained, mid grey; SANDSTONE, fine to medium grained,

Reduced Level (m): 26.0, 24.0, 22.0, 20.0, 18.0, 16.0, 14.0, 12.0, 10.0, 8.0, 6.0, 4.0, 2.0, 0.0, -2.0
Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0
Defect Spacing (mm): 20, 60, 200, 600, 2000

Depth	Piezometer Detail
Depth 0.0 to 0.1 m	GATIC COVER
Depth 0.1 to 18.5 m	GROUT
Depth 18.5 to 21.0 m	BENTONITE
Depth 21.0 to 23.0 m	FILTER SAND
Depth 23.0 to 26.0 m	PVC SLOTTED SECTION WITH 2 mm FILTER SAND
Depth 26.0 to 30.0 m	FILTER SAND

REMARKS:
GROUNDWATER MONITORING NOTES:

Client:	Sydney Motorway Corporation		**Project No:**	60493796	
Project:	M4-M5 Link Geotech Investigation		**Logged by:**	EC	**Checked by:**
Location:	46 Waterloo Street, Rozelle		**Start Date:**	12/10/2016	**End Date:** 18/10/2016
Driller:	Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:**	330514.2 m	**RL:** 26.87 m
Drill Rig:	Delta Base 520	**Inclination:** -90°	**Northing:**	6251504.5 m	**Ver. Datum:** AHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Asphalt

Field Data								Rock Description		Piezometer Details
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Graphic Log	Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm) 20 60 200 600 2000	**Construction Details:** - **Pipe Diameter:** 50 mm **Pipe Top:** 0.0 mBGL **Pipe Base:** 26.0 mBGL **Screen Top:** 23.0 mBGL **Screen/Sensor Base:** 26.0 mBGL **Instrument Details:** - **Installation Date:** 17/10/2016 **Development Date:** -
					-4.0	32.0		grey-brown		
								SANDSTONE, mid grey		
								IC_BH01 Terminated at 30.00 m.		
					-6.0	34.0				
					-8.0	36.0				
					-10.0	38.0				
					-12.0	40.0				
					-14.0	42.0				
					-16.0	44.0				
					-18.0	46.0				
					-20.0	48.0				
					-22.0	50.0				
					-24.0	52.0				
					-26.0	54.0				
					-28.0	56.0				
					-30.0	58.0				
					-32.0	60.0				

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. IC_BH02

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** EC	**Checked by:**
Location: Toelle street, Rozelle		**Start Date:** 12/10/2016	**End Date:** 19/10/2016
Driller: Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330335.0 m	**RL:** 20.87 m
Drill Rig: Hanjin DB	**Inclination:** -90°	**Northing:** 6251646.4 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data

Method	Core Run	TCR (%)	RQD (%)
NDD			
HQ3	Run 1	96	88
HQ3	Run 2	100	79
HQ3	Run 3	100	100
HQ3	Run 4	100	100
HQ3	Run 5	100	100
HQ3	Run 6	100	100
HQ3	Run 7	100	100
HQ3	Run 8	100	100
HQ3	Run 9	100	100
HQ3	Run 10	100	100
HQ3	Run 11	100	97
HQ3	Run 12	100	100
HQ3	Run 13	100	97

Columns: Ground Water, Reduced Level (m), Depth (m), Graphic Log

Rock Description

Summary Geology (refer to geological log for full descriptions)

- ASPHALTIC CONCRETE
- Sandy GRAVEL, coarse grained, dark grey
- SAND, medium grained, red-orange
- SANDSTONE, medium grained, light grey
- NO CORE
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium grained, light grey and red-brown
- DOLERITE, medium grained, mid grey to grey, brown
- SANDSTONE, coarse grained, light grey
- MUDSTONE, dark grey
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, medium grained, light grey

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details:	-
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	8.0 mBGL
Screen Top:	8.0 mBGL
Screen/Sensor Base:	11.0 mBGL
Instrument Details:	-
Installation Date:	20/10/2016
Development Date:	-

Depth	Material
Depth 0.0 to 0.1 m	GATIC COVER
Depth 0.1 to 1.0 m	BENTONITE
Depth 1.0 to 3.8 m	GROUT
Depth 3.8 to 6.0 m	BENTONITE
Depth 6.0 to 8.0 m	FILTER SAND
Depth 8.0 to 11.0 m	PVC SLOTTED SECTION WITH FILTER SOCK with 2 mm FILTER SAND
Depth 11.0 to 13.1 m	FILTER SAND
Depth 13.1 to 22.2 m	BENTONITE
Depth 22.2 to 35.0 m	GROUT

REMARKS:

GROUNDWATER MONITORING NOTES:

Client:	Sydney Motorway Corporation		**Project No:**	60493796	
Project:	M4-M5 Link Geotech Investigation		**Logged by:**	EC	**Checked by:**
Location:	Toelle street, Rozelle		**Start Date:**	12/10/2016	**End Date:** 19/10/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:**	330335.0 m	**RL:** 20.87 m
Drill Rig:	Hanjin DB	**Inclination:** -90°	**Northing:**	6251646.4 m	**Ver. Datum:** AHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Asphalt

Field Data / Rock Description / Piezometer Details

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 8.0 mBGL
Screen Top: 8.0 mBGL
Screen/Sensor Base: 11.0 mBGL
Instrument Details: -
Installation Date: 20/10/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Graphic Log	Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm) 20 60 200 600 2000
HQ3	Run 14	100	97		-10.0	32.0		SANDSTONE, medium grained, light grey *continued*	
HQ3								SANDSTONE, medium grained, light grey	
HQ3	Run 15	100	99		-12.0	34.0			
					-14.0	36.0		SANDSTONE, fine to medium grained, light grey	
								IC_BH02 Terminated at 35.00 m.	
					-16.0	38.0			
					-18.0	40.0			
					-20.0	42.0			
					-22.0	44.0			
					-24.0	46.0			
					-26.0	48.0			
					-28.0	50.0			
					-30.0	52.0			
					-32.0	54.0			
					-34.0	56.0			
					-36.0	58.0			
					-38.0	60.0			

Depth 22.2 to 35.0 m — GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

Engineering Log

PIEZOMETER No. **MT_BH02**

Sheet: 1 of 3

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	AS	**Checked by:**	
Location:	Derby Shire Road, Leichhardt	**Start Date:**	17/01/2017	**End Date:**	24/01/2017
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:**	329694.0 m	**RL:**	
Drill Rig: DR21 WT002	**Inclination:** -90°	**Northing:**	6249695.0 m	**Ver. Datum:**	mAHD
	Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Grass

Field Data | **Rock Description** | **Piezometer Details**

Construction Details: -
Pipe Diameter: 96 mm
Pipe Top: 0.0 mBGL
Pipe Base: 45.0 mBGL
Screen Top: 42.0 mBGL
Screen/Sensor Base: 45.0 mBGL
Instrument Details: -
Installation Date: 24/01/2017
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Depth (m)	Summary Geology (refer to geological log for full descriptions)
NDD						Silty CLAY, yellow-brown
HQ3	Run 1	66	0		2.0	Silty CLAY, orange-brown
						SHALE, grey and orange-brown
	Run 2	41	0		4.0	NO CORE
						SHALE, grey and dark grey
	Run 3	63	0		6.0	NO CORE
						SHALE, grey and dark grey
	Run 4	100	45		8.0	NO CORE
	Run 5	97	87		10.0	SHALE, dark grey
						SHALE, dark grey
					12.0	SANDSTONE, fine grained, grey
	Run 6	100	100	24/01/2017		SHALE, dark grey
					14.0	SANDSTONE, medium grained, light grey to grey
	Run 7	100	93		16.0	SANDSTONE, medium grained, light grey
						SANDSTONE, medium grained, light grey
					18.0	SANDSTONE, medium grained, light grey
	Run 8	100	95			SANDSTONE, coarse grained, light grey
					20.0	SANDSTONE, coarse grained, light grey
						SANDSTONE, medium grained, light grey
	Run 9	100	93		22.0	SANDSTONE, fine grained, mid grey to dark grey
					24.0	SANDSTONE, fine to medium grained, light grey
	Run 10	100	97		26.0	SANDSTONE, coarse grained, light grey
	Run 11	100	100		28.0	SANDSTONE, fine to medium grained, mid grey
					30.0	SANDSTONE, coarse grained, mid grey

Depth 0.0 to 0.1 m — GATIC COVER

Depth 0.1 to 37.0 m — GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. **MT_BH02**

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** AS	**Checked by:**
Location: Derby Shire Road, Leichhardt		**Start Date:** 17/01/2017	**End Date:** 24/01/2017
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 329694.0 m	**RL:**
Drill Rig: DR21 WT002	**Inclination:** -90°	**Northing:** 6249695.0 m	**Ver. Datum:** mAHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

Field Data

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Graphic Log
HQ3	Run 12	100	100			32.0	
	Run 13	100	100			34.0	
	Run 14	100	98			36.0	
	Run 15	100	100			38.0	
	Run 16	100	100			40.0	
	Run 17	100	100			42.0	
	Run 18	100	100			44.0	
	Run 19	100	100			46.0	
	Run 20	100	100			48.0	
	Run 21	100	98			50.0	
						52.0	
						54.0	
						56.0	
						58.0	
						60.0	

Rock Description

Summary Geology (refer to geological log for full descriptions) — Defect Spacing (mm): 20, 60, 200, 600, 2000

- SANDSTONE, medium to coarse grained, light grey to mid grey *continued*
- SANDSTONE, coarse grained, mid grey
- SANDSTONE, coarse grained, light grey
- SANDSTONE, coarse grained, light grey to brown-grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, coarse grained, light grey
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, fine to medium grained, grey
- SANDSTONE, fine to medium grained, mid grey
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, fine grained, mid grey
- SANDSTONE, medium grained, light grey
- SHALE BRECCIA

Piezometer Details

Construction Details:	-
Pipe Diameter:	96 mm
Pipe Top:	0.0 mBGL
Pipe Base:	45.0 mBGL
Screen Top:	42.0 mBGL
Screen/Sensor Base:	45.0 mBGL
Instrument Details:	-
Installation Date:	24/01/2017
Development Date:	-

Depth	Material
Depth 0.1 to 37.0 m	GROUT
Depth 37.0 to 40.0 m	BENTONITE
Depth 40.0 to 42.0 m	FILTER SAND
Depth 42.0 to 45.0 m	PVC SLOTTED SECTION with FILTER SOCK and FILTER SAND
Depth 45.0 to 47.0 m	FILTER SAND
Depth 47.0 to 49.0 m	BENTONITE
Depth 49.0 to 70.0 m	SAND

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. **MT_BH02**

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** AS	**Checked by:**
Location: Derby Shire Road, Leichhardt		**Start Date:** 17/01/2017	**End Date:** 24/01/2017
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 329694.0 m	**RL:**
Drill Rig: DR21 WT002	**Inclination:** -90°	**Northing:** 6249695.0 m	**Ver. Datum:** mAHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

Piezometer Details

Construction Details: -
Pipe Diameter: 96 mm
Pipe Top: 0.0 mBGL
Pipe Base: 45.0 mBGL
Screen Top: 42.0 mBGL
Screen/Sensor Base: 45.0 mBGL
Instrument Details: -
Installation Date: 24/01/2017
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 22	100	97			62.0	SANDSTONE, medium grained, light grey
	Run 23	100	100			64.0	SANDSTONE, fine grained, mid grey
						66.0	SANDSTONE, medium grained, light grey and mid grey
	Run 24	100	100			68.0	SANDSTONE, medium grained, light grey to mid grey
	Run 25	100	100			70.0	SANDSTONE, medium grained, mid grey
							MT_BH02 Terminated at 70.00 m.

Defect Spacing (mm): 20, 60, 200, 600, 2000

Depth 49.0 to 70.0 m — SAND

Depth scale: 72.0, 74.0, 76.0, 78.0, 80.0, 82.0, 84.0, 86.0, 88.0, 90.0

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log** **PIEZOMETER No. MT_BH07**

Sheet: 1 of 2

Client: Sydney Motorway Corporation		**Project No:** 60493796			
Project: M4-M5 Link Geotech Investigation		**Logged by:** EC		**Checked by:**	
Location: 21 Paling Street, Lilyfield - parking lane		**Start Date:** 15/11/2016		**End Date:** 22/11/2016	
Driller: Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330360.0 m		**RL:**	
Drill Rig: Hanjin DB8	**Inclination:** -60°	**Northing:** 6249919.0 m		**Ver. Datum:** AHD	
	Bearing:	**Hor. Proj/Dat:** MGA94/GDA94-56H		**Surface:** Asphalt	

Field Data | **Rock Description** | **Piezometer Details**

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
NDD							ASPHALT
CA						2.0	COBBLES
							CLAY
HQ3	Run 1	100	78			4.0	COBBLES
							CLAY
						6.0	SAND, medium grained, red
	Run 2	100	98			8.0	SANDSTONE, medium to coarse grained, dark red
							SANDSTONE, medium grained, brown
	Run 3	100	100			10.0	SANDSTONE, medium grained, pale grey
							SANDSTONE, medium grained, pale grey
						12.0	SANDSTONE, medium grained, pale grey
	Run 4	100	100			14.0	SANDSTONE, medium grained, pale grey
	Run 5	100	100			16.0	SANDSTONE, fine grained, pale grey
						18.0	SANDSTONE, medium grained, pale grey
	Run 6	100	100			20.0	
	Run 7	100	100			22.0	SANDSTONE, medium to coarse grained, pale grey
						24.0	INTERBEDDED SHALE/SANDSTONE
	Run 8	100	100			26.0	SANDSTONE, medium grained, pale grey
	Run 9	100	100			28.0	SANDSTONE, medium grained, pale grey
						30.0	SANDSTONE, medium grained, pale grey

Defect Spacing (mm): 20 60 200 600 2000

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 45.0 mBGL
Screen Top: 43.0 mBGL
Screen/Sensor Base: 46.0 mBGL
Instrument Details: -
Installation Date: 22/11/2016
Development Date: -

Depth 0.0 to 0.1 m — GATIC COVER
Depth 0.1 to 1.0 m — BENTONITE
Depth 1.0 to 39.0 m — GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. MT_BH07

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** EC	**Checked by:**
Location: 21 Paling Street, Lilyfield - parking lane		**Start Date:** 15/11/2016	**End Date:** 22/11/2016
Driller: Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330360.0 m	**RL:**
Drill Rig: Hanjin DB8	**Inclination:** -60°	**Northing:** 6249919.0 m	**Ver. Datum:** AHD
	Bearing:	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data

Method: HQ3

Core Run	TCR (%)	RQD (%)
Run 10	100	100
Run 11	100	100
Run 12	100	100
Run 13	100	100
Run 14	100	100
Run 15	100	100
Run 16	100	100
Run 17	100	100
Run 18	100	100
Run 19	100	100
Run 20	100	100
Run 21	100	100

Depth (m): 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0

Rock Description

Summary Geology (refer to geological log for full descriptions)

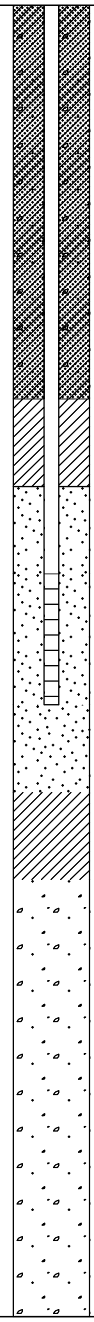
Defect Spacing (mm): 20, 60, 200, 600, 2000

- SANDSTONE, medium to coarse grained, pale grey *continued*
- SANDSTONE, medium grained, pale grey
- SANDSTONE, medium to coarse grained, pale grey
- SANDSTONE, medium grained, pale grey
- SANDSTONE, medium grained, pale grey
- SANDSTONE, medium to coarse grained, pale grey
- SANDSTONE, fine to medium grained, pale grey to medium grey
- SANDSTONE, medium grained, pale grey
- SHALE, dark grey
- SANDSTONE, medium grained, pale grey
- SHALE, dark grey
- SANDSTONE, medium grained
- SANDSTONE, medium grained, pale grey
- SANDSTONE, fine to medium grained, medium grey
- SANDSTONE, medium grained, pale grey

MT_BH07 Terminated at 60.00 m.

Piezometer Details

Construction Details:	-
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	45.0 mBGL
Screen Top:	43.0 mBGL
Screen/Sensor Base:	46.0 mBGL
Instrument Details:	-
Installation Date:	22/11/2016
Development Date:	-



Depth	Material
Depth 1.0 to 39.0 m	GROUT
Depth 39.0 to 41.0 m	BENTONITE
Depth 41.0 to 43.0 m	FILTER SAND
Depth 43.0 to 46.0 m	PVC SLOTTED SECTION WITH FILTER SOCK with 2 mm FILTER SAND
Depth 46.0 to 48.0 m	FILTER SAND
Depth 48.0 to 50.0 m	BENTONITE
Depth 50.0 to 60.0 m	GROUT

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. MT_BH11

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** LH	**Checked by:**
Location: 68 Johnston St, Annandale		**Start Date:** 23/11/2016	**End Date:** 30/11/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96.5 mm	**Easting:** 330670.0 m	**RL:**
Drill Rig: Delta	**Inclination:** -90°	**Northing:** 6249095.0 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

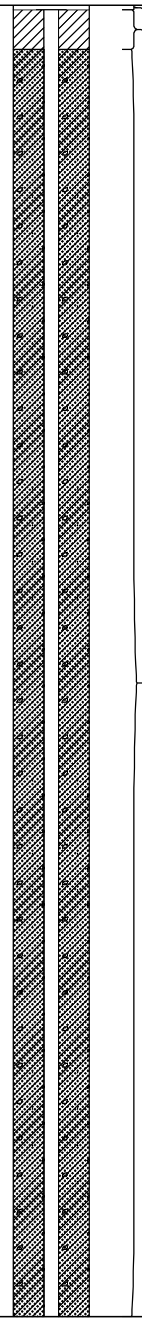
Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
AD						0.0	ASPHALT
AD						2.0	GRAVEL, black
CA							Cobbly SANDSTONE, pale brown
HQ3	Run 1	87	0			4.0	MUDSTONE
HQ3	Run 2	100	100				NO CORE
HQ3	Run 3	100	15			6.0	MUDSTONE, dark brown
HQ3	Run 4	98	90				SANDSTONE, medium grained
HQ3						8.0	SANDSTONE, fine grained, dark grey
HQ3	Run 5	100	93			10.0	SANDSTONE, fine grained, light grey
HQ3							SANDSTONE, fine grained, grey
HQ3	Run 6	100	97			12.0	SANDSTONE, medium grained, light grey
HQ3	Run 7	100	100			14.0–16.0	SANDSTONE, medium grained, light grey
HQ3	Run 8	100	100			18.0–20.0	
HQ3	Run 9	100	100			22.0	SANDSTONE, medium grained, light grey
HQ3	Run 10	100	100			24.0–26.0	SANDSTONE, medium grained, light grey
HQ3	Run 11	100	100			28.0–30.0	SANDSTONE, medium to coarse grained, light grey

Defect Spacing (mm): 20 60 200 600 2000

Piezometer Details

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 58.0 mBGL
Screen Top: 48.0 mBGL
Screen/Sensor Base: 51.0 mBGL
Instrument Details: -
Installation Date: 30/11/2016
Development Date: -



Depth 0.0 to 0.1 m — GATIC COVER
Depth 0.1 to 1.0 m — BENTONITE
Depth 1.0 to 44.0 m — GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. MT_BH11

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** LH	**Checked by:**
Location: 68 Johnston St, Annandale		**Start Date:** 23/11/2016	**End Date:** 30/11/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96.5 mm	**Easting:** 330670.0 m	**RL:**
Drill Rig: Delta	**Inclination:** -90°	**Northing:** 6249095.0 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data / Rock Description

Method: HQ3

Core Run	TCR (%)	RQD (%)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
Run 12	100	100		SANDSTONE, fine grained, grey
				SANDSTONE, medium to coarse grained *continued*
Run 13	100	100	32.0	SANDSTONE, medium grained, light grey
Run 14	100	100	34.0	
Run 15	100	100	36.0	SANDSTONE, medium to coarse grained, light grey
			38.0	SANDSTONE, medium grained, light grey
Run 16	100	100	40.0	SANDSTONE, medium grained, light grey
Run 17	100	100	42.0–44.0	
Run 18	100	100	46.0	
Run 19	100	100	48.0–50.0	SANDSTONE, medium grained, light grey
Run 20	100	100	52.0	SANDSTONE, medium grained, light grey
Run 21	100	100	54.0	SANDSTONE, fine grained, grey
			56.0	SANDSTONE, medium grained, light grey
Run 22	100	100	58.0	SANDSTONE, medium grained, grey
Run 23	100	100	60.0	SANDSTONE, medium grained, light grey

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 58.0 mBGL
Screen Top: 48.0 mBGL
Screen/Sensor Base: 51.0 mBGL
Instrument Details: -
Installation Date: 30/11/2016
Development Date: -

Depth	Material
Depth 1.0 to 44.0 m	GROUT
Depth 44.0 to 45.8 m	BENTONITE
Depth 45.8 to 48.0 m	FILTER SAND
Depth 48.0 to 51.0 m	PVC SLOTTED SECTION WITH FILTER SOCK with 2 mm FILTER SAND
Depth 51.0 to 53.0 m	FILTER SAND
Depth 53.0 to 54.6 m	BENTONITE
Depth 54.6 to 69.9 m	GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	LH	**Checked by:**	
Location:	68 Johnston St, Annandale	**Start Date:**	23/11/2016	**End Date:**	30/11/2016
Driller:	Hagstrom Drilling Pty Ltd	**Easting:**	330670.0 m	**RL:**	
Drill Rig:	Delta	**Northing:**	6249095.0 m	**Ver. Datum:**	AHD
Hole Diameter:	96.5 mm	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Asphalt
Inclination:	-90°				
Bearing:	N/A				

Field Data / Rock Description / Piezometer Details

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 24	100	100			62.0	SANDSTONE, medium grained, light grey *continued*
	Run 25	100	100			64.0	
	Run 26	100	100			66.0	SANDSTONE, fine to medium grained
	Run 27	100	100			68.0	
						70.0	NO CORE *MT_BH11 Terminated at 70.00 m.*

Defect Spacing (mm): 20, 60, 200, 600, 2000

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 58.0 mBGL
Screen Top: 48.0 mBGL
Screen/Sensor Base: 51.0 mBGL
Instrument Details: -
Installation Date: 30/11/2016
Development Date: -

Depth 54.6 to 69.9 m — GROUT

Depth scale: 72.0, 74.0, 76.0, 78.0, 80.0, 82.0, 84.0, 86.0, 88.0, 90.0

REMARKS:
GROUNDWATER MONITORING NOTES:

2015_ANZ_PIEZO 20161216_AECOM_T1_T2_T3_DUMMY FOR PIEZO_2-07.GPJ AECOM_2-01-AA.GDT 60493796AECOM_2-07_LIBRARY.GLB 16.12.2016

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	KDL	**Checked by:**	
Location:	Rowley Street, Camperdown	**Start Date:**	4/11/2016	**End Date:**	9/11/2016
Driller:	Hagstrom Drilling Pty Ltd	**Easting:**	331168.4 m	**RL:**	27.39 m
Drill Rig:	Hydrapower Scout	**Northing:**	6248150.0 m	**Ver. Datum:**	AHD
Hole Diameter:	96 mm	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Asphalt
Inclination:	-90°				
Bearing:	N/A				

Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)
HA			
AD			
HQ3	Run 1	83	0
HQ3	Run 2	67	15
HQ3	Run 3	94	22
HQ3	Run 4	93	85
HQ3	Run 5	93	35
HQ3	Run 6	100	81
HQ3	Run 7	97	82
HQ3	Run 8	100	93
HQ3	Run 9	98	95

Reduced Level (m): 26.0, 24.0, 22.0, 20.0, 18.0, 16.0, 14.0, 12.0, 10.0, 8.0, 6.0, 4.0, 2.0, 0.0, -2.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Summary Geology (refer to geological log for full descriptions):

- ASPHALT
- FILL
- Silty CLAY
- CLAY
- CLAY
- CLAY
- Gravelly CLAY, brown-grey and mottled red
- SHALE
- SHALE, dark grey and brown
- NO CORE
- SHALE, dark grey and brown
- SHALE, dark grey
- NO CORE
- SHALE, dark grey
- NO CORE
- SHALE, dark grey and brown
- NO CORE
- SHALE, dark grey
- NO CORE
- LAMINITE, dark grey
- LAMINITE
- SANDSTONE, fine grained, pale grey
- LAMINITE
- NO CORE
- LAMINITE
- LAMINITE, fine grained, pale grey
- LAMINITE

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details:	-
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	30.0 mBGL
Screen Top:	27.0 mBGL
Screen/Sensor Base:	30.0 mBGL
Instrument Details:	-
Installation Date:	11/11/2016
Development Date:	-

Depth	Detail
Depth 0.0 to 0.1 m	GATIC COVER
Depth 0.1 to 1.0 m	BENTONITE
Depth 1.0 to 22.8 m	GROUT
Depth 22.8 to 25.0 m	BENTONITE
Depth 25.0 to 27.0 m	FILTER SAND
Depth 27.0 to 30.0 m	PVC SLOTTED SECTION WITH FILTER SOCK with 2 mm FILTER SAND

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log**

PIEZOMETER No. MT_BH14

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	KDL	**Checked by:**	
Location:	Rowley Street, Camperdown	**Start Date:**	4/11/2016	**End Date:**	9/11/2016
Driller:	Hagstrom Drilling Pty Ltd	**Easting:**	331168.4 m	**RL:**	27.39 m
Drill Rig:	Hydrapower Scout	**Northing:**	6248150.0 m	**Ver. Datum:**	AHD
		Hor. Proj/Dat:	MGA94/GDA94-56H	**Surface:**	Asphalt

Hole Diameter: 96 mm
Inclination: -90°
Bearing: N/A

Field Data / Rock Description

Method: HQ3

Core Run	TCR (%)	RQD (%)
Run 10	100	100
Run 11	100	100
Run 12	100	100
Run 13	100	100
Run 14	100	95
Run 15	100	95
Run 16	100	100
Run 17	100	98
Run 18	100	100
Run 19	100	98
Run 20	100	100

Reduced Level (m)	Depth (m)
-4.0	32.0
-6.0	34.0
-8.0	36.0
-10.0	38.0
-12.0	40.0
-14.0	42.0
-16.0	44.0
-18.0	46.0
-20.0	48.0
-22.0	50.0
-24.0	52.0
-26.0	54.0
-28.0	56.0
-30.0	58.0
-32.0	60.0

Summary Geology (refer to geological log for full descriptions):

- SANDSTONE, medium to coarse grained, pale grey
- NO CORE
- SANDSTONE, medium to coarse grained, pale grey
- SANDSTONE, coarse grained, pale grey
- SANDSTONE, medium to coarse grained, pale grey
- SANDSTONE, coarse grained, pale grey
- SANDSTONE, medium grained, mid grey
- SANDSTONE, medium to coarse grained, pale grey
- SANDSTONE, coarse grained, pale grey
- SANDSTONE, medium to coarse grained, mid grey
- SANDSTONE, coarse grained, light brown-grey
- SANDSTONE, medium to coarse grained, pale grey
- SANDSTONE, medium grained, pale grey
- SANDSTONE, coarse grained, pale grey
- SANDSTONE, fine grained, pale grey
- SANDSTONE, medium to coarse grained, pale grey
- SANDSTONE, fine grained, mid grey

Defect Spacing (mm): 20 60 200 600 2000

Piezometer Details

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 30.0 mBGL
Screen Top: 27.0 mBGL
Screen/Sensor Base: 30.0 mBGL
Instrument Details: -
Installation Date: 11/11/2016
Development Date: -

Depth	Material
Depth 30.0 to 32.0 m	FILTER SAND
Depth 32.0 to 45.3 m	BENTONITE
Depth 45.3 to 73.0 m	GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. MT_BH14

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** KDL	**Checked by:**
Location: Rowley Street, Camperdown		**Start Date:** 4/11/2016	**End Date:** 9/11/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331168.4 m	**RL:** 27.39 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6248150.0 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data

Method	Core Run	TCR (%)	RQD (%)
HQ3	Run 21	100	100
HQ3	Run 22	100	100
HQ3	Run 23	100	99
HQ3	Run 24	100	100
HQ3	Run 25	100	100
HQ3	Run 26	100	97

Reduced Level (m): -34.0, -36.0, -38.0, -40.0, -42.0, -44.0, -46.0, -48.0, -50.0, -52.0, -54.0, -56.0, -58.0, -60.0, -62.0

Depth (m): 62.0, 64.0, 66.0, 68.0, 70.0, 72.0, 74.0, 76.0, 78.0, 80.0, 82.0, 84.0, 86.0, 88.0, 90.0

Rock Description

Summary Geology (refer to geological log for full descriptions)

- SHALE BRECCIA
- SANDSTONE, coarse grained, pale grey
- SANDSTONE, medium to coarse grained, pale grey *continued*
- SANDSTONE, coarse grained, pale grey
- SANDSTONE, medium grained, pale grey
- SANDSTONE, medium grained, pale grey
- SANDSTONE, medium to coarse grained, pale grey
- SANDSTONE, coarse grained, pale grey
- SHALE BRECCIA, medium grained, pale grey to brown-grey
- SANDSTONE, medium grained, pale grey
- SANDSTONE, medium grained, pale grey
- SANDSTONE, medium grained, pale grey

MT_BH14 Terminated at 75.00 m.

Defect Spacing (mm): 20 60 200 600 2000

Piezometer Details

Construction Details:	-
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	30.0 mBGL
Screen Top:	27.0 mBGL
Screen/Sensor Base:	30.0 mBGL
Instrument Details:	-
Installation Date:	11/11/2016
Development Date:	-

Depth 45.3 to 73.0 m — GROUT

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. **MT_BH18**

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	BF	**Checked by:**	
Location:	Holmwood St, Newtown	**Start Date:**	24/10/2016	**End Date:**	3/11/2016
Driller:	Hagstrom Drilling Pty Ltd	**Hole Diameter:**	96 mm	**Easting:**	331711.4 m
RL:	24.76 m	**Inclination:**	-90°	**Northing:**	6247001.6 m
Ver. Datum:	AHD	**Drill Rig:**	Hydrapower Scout	**Bearing:**	N/A
Hor. Proj/Dat:	MGA94/GDA94-56H	**Surface:**	Asphalt		

Field Data

Method: NDD, AD, HQ3

Core Run	TCR (%)	RQD (%)
Run 1	100	0
Run 2	89	0
Run 3	100	96
Run 4	100	100
Run 5	99	94
Run 6	100	100
Run 7	100	87
Run 8	100	85
Run 9	98	80
Run 10	97	74
Run 11	100	100

Ground Water: 28/10/2016; 31/10/2016; 2/11/2016

Reduced Level (m): 24.0, 22.0, 20.0, 18.0, 16.0, 14.0, 12.0, 10.0, 8.0, 6.0, 4.0, 2.0, 0.0, -2.0, -4.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Rock Description

Summary Geology (refer to geological log for full descriptions)

- ASPHALT
- COBBLES, red-brown, grey and brown
- GRAVEL AND COBBLES, dark grey and red-brown
- SHALE, light grey, mottled yellow-brown
- SHALE
- NO CORE
- SHALE
- SHALE, dark grey
- NO CORE
- LAMINITE
- SHALE
- NO CORE
- SHALE
- NO CORE
- SHALE
- NO CORE
- LAMINITE
- LAMINITE

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details:	-
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	10.0 mBGL
Screen Top:	10.0 mBGL
Screen/Sensor Base:	13.0 mBGL
Instrument Details:	-
Installation Date:	3/11/2016
Development Date:	-

Depth	Detail
Depth 0.0 to 0.1 m	GATIC COVER
Depth 0.1 to 1.0 m	BENTONITE
Depth 1.0 to 6.0 m	GROUT
Depth 6.0 to 8.0 m	BENTONITE
Depth 8.0 to 10.0 m	FILTER SAND
Depth 10.0 to 13.0 m	PVC SLOTTED SECTION WITH FILTER SOCK with 2 mm FILTER SAND
Depth 13.0 to 13.6 m	FILTER SAND
Depth 13.6 to 85.0 m	GROUT

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. **MT_BH18**

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** BF	**Checked by:**
Location: Holmwood St, Newtown		**Start Date:** 24/10/2016	**End Date:** 3/11/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331711.4 m	**RL:** 24.76 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6247001.6 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data / Rock Description / Piezometer Details

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 10.0 mBGL
Screen Top: 10.0 mBGL
Screen/Sensor Base: 13.0 mBGL
Instrument Details: -
Installation Date: 3/11/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 12	100	100		-6.0 / -8.0	32.0 / 34.0	LAMINITE
	Run 13	100	100		-10.0	36.0	SILTSTONE, dark grey
	Run 14	96	87		-12.0	38.0	
					-14.0		NO CORE
	Run 15	100	99		-16.0	40.0 / 42.0	SILTSTONE, dark grey; LAMINITE
	Run 16	100	96		-18.0	44.0	
	Run 17	100	98		-20.0 / -22.0	46.0 / 48.0	SANDSTONE, medium to coarse grained, light grey
	Run 18	100	98		-24.0	50.0	
	Run 19	100	95		-26.0		
	Run 20	100	97		-28.0	52.0 / 54.0	
	Run 21	100	100		-30.0 / -32.0	56.0	SANDSTONE, medium to coarse grained, light grey
	Run 22	100	98		-34.0	58.0 / 60.0	SANDSTONE, fine grained, mid grey; SANDSTONE, medium to coarse grained, light grey

Defect Spacing (mm): 20 60 200 600 2000

Depth 13.6 to 85.0 m — GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. **MT_BH18**

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** BF	**Checked by:**
Location: Holmwood St, Newtown		**Start Date:** 24/10/2016	**End Date:** 3/11/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331711.4 m	**RL:** 24.76 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6247001.6 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data

Method	Core Run	TCR (%)	RQD (%)
HQ3	Run 23	100	99
	Run 24	100	100
	Run 25	100	100
	Run 26	100	92
	Run 27	100	100
	Run 28	100	99
	Run 29	100	100
	Run 30	100	100
	Run 31	100	96
	Run 32	100	95
	Run 33	100	100
	Run 34	100	100
	Run 35	100	90

Ground Water

Reduced Level (m): -36.0, -38.0, -40.0, -42.0, -44.0, -46.0, -48.0, -50.0, -52.0, -54.0, -56.0, -58.0, -60.0, -62.0, -64.0

Depth (m): 62.0, 64.0, 66.0, 68.0, 70.0, 72.0, 74.0, 76.0, 78.0, 80.0, 82.0, 84.0, 86.0, 88.0, 90.0

Graphic Log

Rock Description

Summary Geology (refer to geological log for full descriptions)

Defect Spacing (mm): 20, 60, 200, 600, 2000

- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, medium grained, light grey
- SHALE BRECCIA
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, coarse grained, light grey
- SANDSTONE, medium to coarse grained, pale grey
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium grained, light grey

MT_BH18 Terminated at 85.18 m.

Piezometer Details

Construction Details:	-
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	10.0 mBGL
Screen Top:	10.0 mBGL
Screen/Sensor Base:	13.0 mBGL
Instrument Details:	-
Installation Date:	3/11/2016
Development Date:	-

Depth 13.6 to 85.0 m — GROUT

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. MT_BH19

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB/RKG	**Checked by:**
Location: Darley Street, Newtown		**Start Date:** 2/12/2016	**End Date:** 15/12/2016
Driller: Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331680.3 m	**RL:** 16.18 m
Drill Rig: Hanjin DB8	**Inclination:** -90°	**Northing:** 6246735.9 m	**Ver. Datum:** mAHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Road Surface

Field Data

Method	Core Run	TCR (%)	RQD (%)
NDD			
HQ3	Run 1	75	0
HQ3	Run 2	100	0
HQ3	Run 3	78	10
HQ3	Run 4	93	50
HQ3	Run 5	75	62
HQ3	Run 6	100	95
HQ3	Run 7	100	70
HQ3	Run 8	100	91
HQ3	Run 9	100	97
HQ3	Run 10	100	100
HQ3	Run 11	100	98
HQ3	Run 12	99	99
HQ3	Run 13	98	77
HQ3	Run 14	100	98
HQ3	Run 15	99	82

Ground Water | Reduced Level (m): 16.0, 14.0, 12.0, 10.0, 8.0, 6.0, 4.0, 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0 | Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0 | Graphic Log

Rock Description

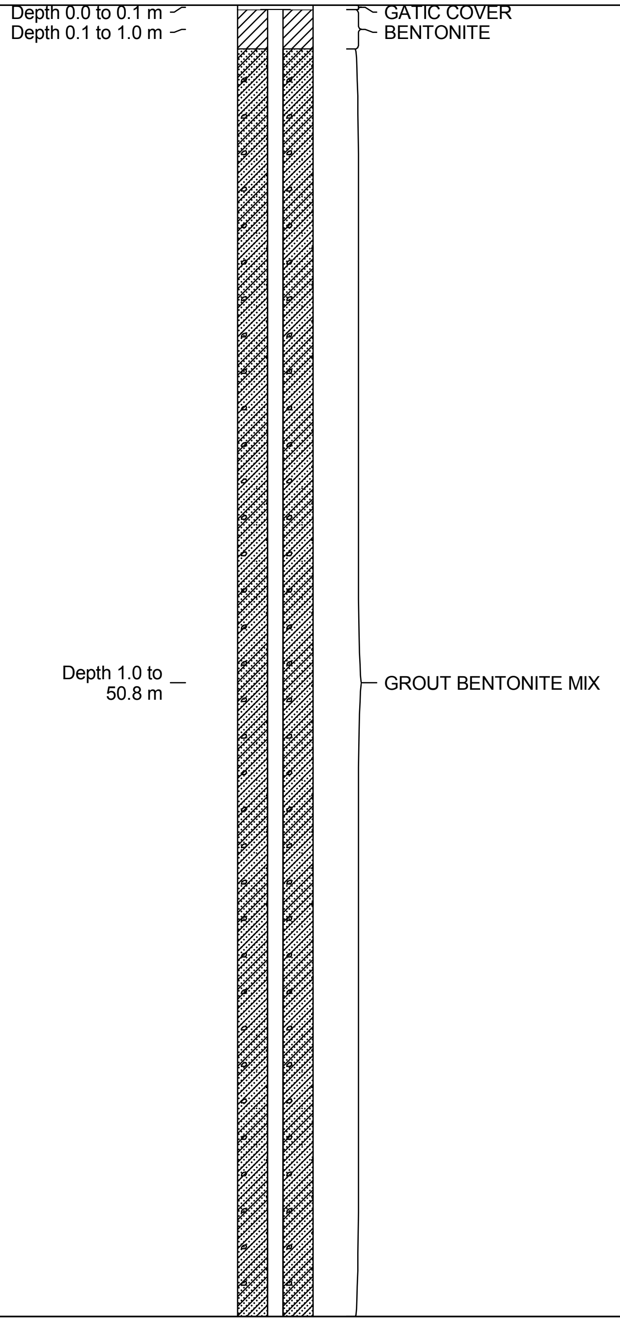
Summary Geology (refer to geological log for full descriptions)

- ASPHALT
- Sandy GRAVEL, fine to medium grained, dark grey
- Clayey GRAVEL, medium to coarse grained, light brown
- Silty CLAY, orange-brown
- CLAY, light grey
- NO CORE
- CLAY, light grey
- NO CORE
- CLAY, light grey
- MUDSTONE, light-mid grey
- NO CORE
- MUDSTONE, light-mid grey
- NO CORE
- MUDSTONE (90%), dark grey and mid grey
- LAMINITE
- NO CORE
- LAMINITE
- MUDSTONE (90%), dark grey
- MUDSTONE (90%), dark grey

Defect Spacing (mm): 20 60 200 600 2000

Piezometer Details

Construction Details:	-
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	53.0 mBGL
Screen Top:	53.0 mBGL
Screen/Sensor Base:	58.0 mBGL
Instrument Details:	-
Installation Date:	14/12/2016
Development Date:	-



REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. MT_BH19

Sheet: 2 of 3

Client: Sydney Motorway Corporation	**Project No:** 60493796		
Project: M4-M5 Link Geotech Investigation	**Logged by:** NB/RKG	**Checked by:**	
Location: Darley Street, Newtown	**Start Date:** 2/12/2016	**End Date:** 15/12/2016	
Driller: Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331680.3 m	**RL:** 16.18 m
Drill Rig: Hanjin DB8	**Inclination:** -90°	**Northing:** 6246735.9 m	**Ver. Datum:** mAHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Road Surface

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 53.0 mBGL
Screen Top: 53.0 mBGL
Screen/Sensor Base: 58.0 mBGL
Instrument Details: -
Installation Date: 14/12/2016
Development Date: -

Field Data / Rock Description

Method: HQ3

Core Run	TCR (%)	RQD (%)	Depth (m)	Reduced Level (m)	Summary Geology (refer to geological log for full descriptions)
			30.0–30.5	-14.0	MUDSTONE (90%), dark grey *continued*
Run 16	100	90	32.0	-16.0	MUDSTONE, dark grey
Run 17	100	84	34.0–36.0	-18.0	
Run 18	100	100	36.0–38.0	-20.0	SILTSTONE, mid grey to light grey
			38.0–40.0	-22.0	SANDSTONE, fine grained, light grey
Run 19	100	99	40.0–41.5	-24.0	LAMINITE
Run 20	100	100	41.5–44.0	-26.0	SANDSTONE, medium to coarse grained, light grey
Run 21	100	100	46.0–48.0	-28.0 / -30.0	
			48.0–50.0	-32.0	SANDSTONE, medium grained, light grey
Run 22	100	98	50.0–54.0	-34.0	SANDSTONE, medium grained, light grey
Run 23	100	100	52.0–54.0	-36.0	
Run 24	100	100	54.0–56.0	-38.0	SANDSTONE, medium grained, light grey
Run 25	100	94	56.0–58.0	-40.0	SANDSTONE, fine to medium grained, light grey
Run 26	100	100	58.0–60.0	-42.0	

Piezometer Details

Depth	Material
Depth 1.0 to 50.8 m	GROUT BENTONITE MIX
Depth 50.8 to 53.0 m	BENTONITE
Depth 53.0 to 55.0 m	FILTER SAND
Depth 55.0 to 58.6 m	PVC SLOTTED SECTION WITH FILTER SOCK with 2 mm FILTER SAND
Depth 58.6 to 60.0 m	FILTER SAND

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log**

PIEZOMETER No. **MT_BH19**

Client: Sydney Motorway Corporation		**Project No:**	60493796		
Project: M4-M5 Link Geotech Investigation		**Logged by:**	NB/RKG	**Checked by:**	
Location: Darley Street, Newtown		**Start Date:**	2/12/2016	**End Date:**	15/12/2016
Driller: Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:**	331680.3 m	**RL:**	16.18 m
Drill Rig: Hanjin DB8	**Inclination:** -90°	**Northing:**	6246735.9 m	**Ver. Datum:**	mAHD
	Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Road Surface

Field Data | **Rock Description** | **Piezometer Details**

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 53.0 mBGL
Screen Top: 53.0 mBGL
Screen/Sensor Base: 58.0 mBGL
Instrument Details: -
Installation Date: 14/12/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3		100	100	60.0	
	Run 27	100	100	62.0	SANDSTONE, medium grained, light grey
	Run 28	100	100		SANDSTONE, medium grained, light grey
	Run 29	100	92	64.0–66.0	LAMINITE
	Run 30	100	97		SANDSTONE, fine grained, mid grey
				68.0	LAMINITE
					SANDSTONE, fine grained, mid grey
	Run 31	100	97	70.0	MUDSTONE, dark grey
					SANDSTONE, fine grained, mid grey
				72.0	SANDSTONE, fine to medium grained, light grey
	Run 32	100	100	74.0	SANDSTONE, medium grained, light grey
					SANDSTONE, medium grained, light grey
					MT_BH19 Terminated at 75.00 m.

Reduced Level (m): 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0, 62.0, 64.0, 66.0, 68.0, 70.0, 72.0

Depth (m): 62.0, 64.0, 66.0, 68.0, 70.0, 72.0, 74.0, 76.0, 78.0, 80.0, 82.0, 84.0, 86.0, 88.0, 90.0

Defect Spacing (mm): 20, 60, 200, 600, 2000

Depth	Material
Depth 60.0 to 65.0 m	BENTONITE
Depth 65.0 to 69.0 m	GROUT SAND MIX
Depth 69.0 to 75.0 m	GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. MT_BH20

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB	**Checked by:**
Location: Beside 19 Hill St, Parking Lane John St, Leichardt		**Start Date:** 15/12/2016	**End Date:** 20/12/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330379.0 m	**RL:**
Drill Rig: Delta Base 525	**Inclination:** -90°	**Northing:** 6249504.6 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Road Surface

Field Data

Method	Core Run	TCR (%)	RQD (%)
NDD			
CA			
HQ3	Run 1	82	50
HQ3	Run 2	94	81
HQ3	Run 3	99	90
HQ3	Run 4	97	95
HQ3	Run 5	100	92
HQ3	Run 6	100	94
HQ3	Run 7	100	95
HQ3	Run 8	100	100
HQ3	Run 9	100	98
HQ3	Run 10	98	98

Columns: Method, Core Run, TCR (%), RQD (%), Ground Water, Reduced Level (m), Depth (m), Graphic Log

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Rock Description

Summary Geology (refer to geological log for full descriptions)

Defect Spacing (mm): 20, 60, 200, 600, 2000

- ASPHALT
- COBBLES
- Clayey SAND, fine to coarse grained, mid grey
- SANDSTONE, fine to coarse grained, yellow-brown
- NO CORE
- SANDSTONE, coarse grained, yellow-brown and light-grey
- NO CORE
- SANDSTONE, coarse grained, yellow-brown and light-grey
- SANDSTONE, medium to coarse grained, light grey
- NO CORE
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, medium to coarse grained, brown grey
- SANDSTONE, coarse grained, light grey
- SHALE BRECCIA
- NO CORE
- SHALE BRECCIA
- SANDSTONE, fine to coarse grained, light grey
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, fine to coarse grained, light brown grey
- SANDSTONE, coarse grained, light grey
- SANDSTONE, medium to coarse grained, light grey

Piezometer Details

Construction Details: -
Pipe Diameter: 60 mm
Pipe Top: 0.0 mBGL
Pipe Base: 41.0 mBGL
Screen Top: 41.1 mBGL
Screen/Sensor Base: 44.0 mBGL
Instrument Details: -
Installation Date: 21/12/2016
Development Date: -

Depth	Detail
Depth 0.0 to 0.1 m	GATIC COVER
Depth 0.1 to 1.0 m	GROUT BENTONITE MIX (HIGHER % BENTONITE)
Depth 1.0 to 37.0 m	GROUT BENTONITE MIX

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. MT_BH20

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	NB	**Checked by:**	
Location:	Beside 19 Hill St, Parking Lane John St, Leichardt	**Start Date:**	15/12/2016	**End Date:**	20/12/2016
Driller:	Hagstrom Drilling Pty Ltd	**Hole Diameter:**	96 mm	**Easting:**	330379.0 m
RL:		**Drill Rig:**	Delta Base 525	**Inclination:**	-90°
Northing:	6249504.6 m	**Ver. Datum:**	AHD	**Bearing:**	N/A
Hor. Proj/Dat:	MGA94/GDA94-56H	**Surface:**	Road Surface		

Field Data

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)
HQ3	Run 11	100	98			32.0
HQ3	Run 12	100	97			34.0
HQ3	Run 13	100	97			36.0–38.0
HQ3	Run 14	99	99			40.0
HQ3	Run 15	100	98			42.0–44.0
HQ3	Run 16	100	100			46.0
HQ3	Run 17	100	100			48.0
HQ3	Run 18	100	100			50.0
HQ3	Run 19	100	100			52.0–54.0

Rock Description

Summary Geology (refer to geological log for full descriptions)

Defect Spacing (mm): 20, 60, 200, 600, 2000

- SANDSTONE, fine to medium grained, light-mid grey
- NO CORE
- SANDSTONE, fine to medium grained, light-mid grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, fine to medium grained, light-mid grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium to coarse grained, light grey
- NO CORE
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, medium to coarse grained, light-mid grey
- SANDSTONE, fine grained, mid grey to dark grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, fine grained, mid grey
- SANDSTONE, medium grained, light grey

MT_BH20 Terminated at 55.00 m.

Depth scale: 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0

Piezometer Details

Construction Details:	-
Pipe Diameter:	60 mm
Pipe Top:	0.0 mBGL
Pipe Base:	41.0 mBGL
Screen Top:	41.1 mBGL
Screen/Sensor Base:	44.0 mBGL
Instrument Details:	-
Installation Date:	21/12/2016
Development Date:	-

Depth	Material
Depth 1.0 to 37.0 m	GROUT BENTONITE MIX
Depth 37.0 to 39.0 m	BENTONITE
Depth 39.0 to 41.1 m	FILTER SAND
Depth 41.1 to 44.0 m	PVC SLOTTED SECTION WITH FILTER SOCK with 2 mm FILTER SAND
Depth 44.0 to 46.0 m	FILTER SAND
Depth 46.0 to 48.2 m	BENTONITE
Depth 48.2 to 55.0 m	GRAVEL

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log**

PIEZOMETER No. **MT_BH21**

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** LH/MC	**Checked by:**
Location: Corner Ainsworth and Moore Street, Lilyfield		**Start Date:** 6/12/2016	**End Date:** 9/12/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330066.7 m	**RL:** 25.14 m
Drill Rig: DR009	**Inclination:** -90°	**Northing:** 6249770.9 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Concrete

Field Data | **Rock Description** | **Piezometer Details**

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 52.0 mBGL
Screen Top: 47.0 mBGL
Screen/Sensor Base: 50.0 mBGL
Instrument Details: -
Installation Date: 9/12/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Summary Geology (refer to geological log for full descriptions)
CA				ASPHALTIC CONCRETE
CA				SANDSTONE
HQ3	Run 1	100	0	CLAY, mottled orange-red
HQ3	Run 2	92	66	SANDSTONE, fine to medium grained, grey and red-brown
HQ3				NO CORE
HQ3	Run 3	100	97	SANDSTONE, fine to medium grained, dark brown
HQ3				SANDSTONE, medium grained, light grey
HQ3	Run 4	100	90	SANDSTONE, medium grained, light grey
HQ3				SANDSTONE, fine to medium grained, light grey and dark grey
HQ3	Run 5	100	98	SANDSTONE, medium grained, light grey
HQ3	Run 6	100	93	SANDSTONE, medium to coarse grained, light grey
HQ3	Run 7	100	100	SANDSTONE, medium grained, light grey
HQ3	Run 8	100	100	
HQ3	Run 9	100	98	SANDSTONE, medium grained, light grey
HQ3	Run 10	100	100	SANDSTONE, medium grained, light grey
HQ3				SANDSTONE, medium grained, light grey

Reduced Level (m): 24.0, 22.0, 20.0, 18.0, 16.0, 14.0, 12.0, 10.0, 8.0, 6.0, 4.0, 2.0, 0.0, -2.0, -4.0
Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Defect Spacing (mm): 20 60 200 600 2000

Depth 0.0 to 0.1 m — GATIC COVER
Depth 0.1 to 1.0 m — BENTONITE
Depth 1.0 to 43.0 m — GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

2015_ANZ_PIEZO 20160120 AECOM_T3_THU_2-07.GPJ AECOM_2-01-AA.GDT 60493796AECOM_2-07_LIBRARY.GLB 25.1.2017

AECOM Engineering Log

PIEZOMETER No. MT_BH21

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** LH/MC	**Checked by:**
Location: Corner Ainsworth and Moore Street, Lilyfield		**Start Date:** 6/12/2016	**End Date:** 9/12/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330066.7 m	**RL:** 25.14 m
Drill Rig: DR009	**Inclination:** -90°	**Northing:** 6249770.9 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Concrete

Field Data / Rock Description / Piezometer Details

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 52.0 mBGL
Screen Top: 47.0 mBGL
Screen/Sensor Base: 50.0 mBGL
Instrument Details: -
Installation Date: 9/12/2016
Development Date: -

Method: HQ3

Core Run	TCR (%)	RQD (%)	Reduced Level (m)	Depth (m)
Run 11	100	100	-6.0	32.0
Run 12	100	100	-8.0	34.0
Run 13	100	100	-10.0 / -12.0	36.0 / 38.0
Run 14	100	100	-14.0	40.0
Run 15	100	100	-16.0 / -18.0	42.0 / 44.0
Run 16	100	100	-20.0 / -22.0	46.0 / 48.0
Run 17	100	100	-24.0	50.0
Run 18	100	100	-26.0 / -28.0	52.0 / 54.0
Run 19	100	100	-30.0	56.0
Run 20	100	100	-32.0	58.0
Run 21	100	100	-34.0	60.0

Summary Geology (refer to geological log for full descriptions):

- SANDSTONE, medium grained, light grey *continued*
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium grained, grey and light grey
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, medium grained, brown-grey
- SILTSTONE (95%)
- SHALE BRECCIA : SANDSTONE (60%),

Defect Spacing (mm): 20 60 200 600 2000

Depth	Piezometer Details
Depth 1.0 to 43.0 m	GROUT
Depth 43.0 to 45.0 m	BENTONITE
Depth 45.0 to 47.0 m	FILTER SAND
Depth 47.0 to 50.0 m	PVC SLOTTED SECTION with FILTER SOCK with 2mm FILTER SAND
Depth 50.0 to 52.0 m	FILTER SAND
Depth 52.0 to 54.5 m	BENTONITE
Depth 54.5 to 70.0 m	GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	LH/MC	**Checked by:**	
Location:	Corner Ainsworth and Moore Street, Lilyfield	**Start Date:**	6/12/2016	**End Date:**	9/12/2016
Driller:	Hagstrom Drilling Pty Ltd **Hole Diameter:** 96 mm	**Easting:**	330066.7 m	**RL:**	25.14 m
Drill Rig:	DR009 **Inclination:** -90°	**Northing:**	6249770.9 m	**Ver. Datum:**	AHD
	Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Concrete

Piezometer Details

Construction Details:	-
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	52.0 mBGL
Screen Top:	47.0 mBGL
Screen/Sensor Base:	50.0 mBGL
Instrument Details:	-
Installation Date:	9/12/2016
Development Date:	-

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)	Piezometer
HQ3		100	100				fine to medium grained, light grey	Depth 54.5 to 70.0 m — GROUT
	Run 22	100	100		-36.0	62.0	SANDSTONE, fine to medium grained, light grey *continued*	
					-38.0	64.0	SANDSTONE, fine grained, grey to dark grey	
	Run 23	100	100				SHALE BRECCIA: SANDSTONE (75%), medium to coarse grained, light yellow-brown	
	Run 24	100	100		-40.0	66.0	SANDSTONE, medium grained, brown-grey	
					-42.0	68.0	SANDSTONE, fine to medium grained	
	Run 25	100	100		-44.0	70.0		
							MT_BH21 Terminated at 70.00 m.	

Reduced Level / Depth scale continues: -46.0 / 72.0; -48.0 / 74.0; -50.0 / 76.0; -52.0 / 78.0; -54.0 / 80.0; -56.0 / 82.0; -58.0 / 84.0; -60.0 / 86.0; -62.0 / 88.0; -64.0 / 90.0

Defect Spacing (mm): 20 60 200 600 2000

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log** **PIEZOMETER No.** **RZ_BH01**

Sheet: 1 of 2

Client:	Sydney Motorway Corporation		**Project No:**	60493796	
Project:	M4-M5 Link Geotech Investigation		**Logged by:**	JR/SJ	**Checked by:** BF
Location:	Rozelle Rail Yards, Lilyfield		**Start Date:**	15/06/2016	**End Date:** 24/06/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:**	330608.9 m	**RL:** 6.42 m
Drill Rig:	Ausroc 4000	**Inclination:** -90°	**Northing:**	6250381.3 m	**Ver. Datum:** AHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Gravel

Field Data

Method	Core Run	TCR (%)	RQD (%)
NDD			
HA			
HWT			
HQ3	Run 1	90	61
HQ3	Run 2	82	57
HQ3	Run 3	100	92
HQ3	Run 4	100	85
HQ3	Run 5	97	85
HQ3	Run 6	100	100
HQ3	Run 7	98	91
HQ3	Run 8	99	98
HQ3	Run 9	100	97
HQ3	Run 10	100	86
HQ3	Run 11	99	94
HQ3	Run 12	100	98

Ground Water, Reduced Level (m), Depth (m), Graphic Log

Reduced Level (m): 6.0, 4.0, 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Rock Description

Summary Geology (refer to geological log for full descriptions)

- Sandy GRAVEL
- Sandy GRAVEL, dark brown to dark grey
- GRAVEL+COBBLES, light grey to dark grey
- COBBLES, light grey to light yellow-brown
- SAND, fine to medium grained, light yellow to light grey
- SAND, medium grained
- BOULDERS
- Clayey SAND, fine to coarse grained
- SAND, fine to coarse grained, yellow-brown
- SILT, dark brown and yellow-brown
- GRAVEL, dark brown
- Clayey SAND, fine to medium grained
- SANDSTONE BOULDER
- Clayey SAND, fine to medium grained
- NO CORE
- SANDSTONE, medium grained, light yellow-brown
- NO CORE
- SANDSTONE, medium grained, light yellow-brown
- NO CORE
- SANDSTONE, medium grained, light yellow-brown
- CLAY
- SANDSTONE
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium grained
- SANDSTONE, medium grained

Defect Spacing (mm): 20 60 200 600 2000

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	25.0 mBGL
Screen Top:	22.0 mBGL
Screen/Sensor Base:	25.0 mBGL
Instrument Details:	-
Installation Date:	23/06/2016
Development Date:	-

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 16.0 m	GROUT
Depth 16.0 to 22.0 m	BENTONITE
Depth 22.0 to 25.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 25.0 to 27.0 m	FILTER SAND
Depth 27.0 to 29.0 m	BENTONITE
Depth 29.0 to 30.0 m	BENTONITE + CEMENT

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH01

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** JR/SJ	**Checked by:** BF
Location: Rozelle Rail Yards, Lilyfield		**Start Date:** 15/06/2016	**End Date:** 24/06/2016
Driller: Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330608.9 m	**RL:** 6.42 m
Drill Rig: Ausroc 4000	**Inclination:** -90°	**Northing:** 6250381.3 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Gravel

Field Data | Rock Description | Piezometer Details

Method | Core Run | TCR (%) | RQD (%) | Ground Water | Reduced Level (m) | Depth (m) | Graphic Log

Summary Geology (refer to geological log for full descriptions)

Defect Spacing (mm): 20 60 200 600 2000

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 25.0 mBGL
Screen Top: 22.0 mBGL
Screen/Sensor Base: 25.0 mBGL
Instrument Details: -
Installation Date: 23/06/2016
Development Date: -

Reduced Level (m): -24.0, -26.0, -28.0, -30.0, -32.0, -34.0, -36.0, -38.0, -40.0, -42.0, -44.0, -46.0, -48.0, -50.0, -52.0

Depth (m): 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0

Summary Geology
CLAY, orange-brown
NO CORE
SANDSTONE, medium grained
SANDSTONE, medium grained
NO CORE
SANDSTONE, medium grained
SANDSTONE, medium to coarse grained, light grey
SANDSTONE, medium grained, light grey
SANDSTONE, medium grained, light grey
SANDSTONE, medium grained, light grey
CLAY
SANDSTONE, medium grained, light grey *continued*

RZ_BH01 Terminated at 30.02 m.

REMARKS:
GROUNDWATER MONITORING NOTES:

Engineering Log

PIEZOMETER No. **RZ_BH01A**

Sheet: 1 of 1

Client: Sydney Motorway Corporation		**Project No:**	60493796		
Project: M4-M5 Link Geotech Investigation		**Logged by:**	TC	**Checked by:**	BF
Location: Rozelle Rail Yards, Lilyfield		**Start Date:**	24/06/2016	**End Date:**	24/06/2016
Driller: Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:**	330611.5 m	**RL:**	6.46 m
Drill Rig: Ausroc 4000	**Inclination:** -90°	**Northing:**	6250381.6 m	**Ver. Datum:**	AHD
	Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Gravel

Field Data | **Rock Description** | **Piezometer Details**

Method | Core Run | TCR (%) | RQD (%) | Ground Water | Reduced Level (m) | Depth (m) | Graphic Log | Summary Geology (refer to geological log for full descriptions) | Defect Spacing (mm) 20 60 200 600 2000

Summary Geology (refer to geological log for full descriptions)
Sandy GRAVEL
Sandy GRAVEL, dark brown to dark grey
GRAVEL+COBBLES, light grey to dark grey
COBBLES, light grey to light yellow-brown
SAND, fine to medium grained, light yellow to light grey
SAND, medium grained
BOULDERS
Clayey SAND, fine to coarse grained
SAND, fine to coarse grained, yellow-brown
SILT, dark brown and yellow-brown
GRAVEL, dark brown
Clayey SAND, fine to medium grained
SANDSTONE BOULDER
Clayey SAND, fine to medium grained

RZ_BH01A Terminated at 9.96 m.

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Reduced Level (m): 6.0, 4.0, 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	9.5 mBGL
Screen Top:	6.5 mBGL
Screen/Sensor Base:	9.5 mBGL
Instrument Details:	-
Installation Date:	24/06/2016
Development Date:	-

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 4.0 m	GROUT
Depth 4.0 to 6.0 m	BENTONITE
Depth 6.0 to 6.5 m	FILTER SAND
Depth 6.5 to 9.5 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 9.5 to 9.7 m	BENTONITE

REMARKS:The material properties are taken from the adjacent borehole RZ_BH01A
GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log** **PIEZOMETER No. RZ_BH15**

Client:	Sydney Motorway Corporation			**Project No:**	60493796
Project:	M4-M5 Link Geotech Investigation			**Logged by:**	LH/FR	**Checked by:**	BF
Location:	Rozelle Rail Yards, Lilyfield			**Start Date:**	7/06/2016	**End Date:**	9/06/2016
Driller:	Hagstrom Drilling Pty Ltd	**Hole Diameter:**	96 mm	**Easting:**	330522.6 m	**RL:**	6.09 m
Drill Rig:	DR04-Hydrapower Scout	**Inclination:**	-90°	**Northing:**	6250349.9 m	**Ver. Datum:**	AHD
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Grass

Field Data

Method	Core Run	TCR (%)	RQD (%)
NDD			
AD			
CA			
HQ3	Run 1	100	100
HQ3	Run 2	95	94
HQ3	Run 3	100	99
HQ3	Run 4	100	99
HQ3	Run 5	100	100
HQ3	Run 6	100	100
HQ3	Run 7	93	79
HQ3	Run 8	97	97
HQ3	Run 9	100	99
HQ3	Run 10	97	97
HQ3	Run 11	100	99
HQ3	Run 12	100	100
HQ3	Run 13	100	100
HQ3	Run 14	100	100

Ground Water; Reduced Level (m): 6.0, 4.0, 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Graphic Log

Rock Description

Summary Geology (refer to geological log for full descriptions)

- GRAVEL, medium to coarse grained, yellow-brown
- Sandy COBBLES
- Sandy GRAVEL, fine to coarse grained, yellow-brown
- Sandy CLAY
- Gravelly Clayey SAND, fine to coarse grained
- Sandy CLAY
- SAND, medium grained, brown
- SANDSTONE, medium to coarse grained, grey, mottled light brown
- NO CORE
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, medium grained, light grey
- NO CORE
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, medium grained, light grey
- NO CORE
- SANDSTONE, medium grained, light grey
- NO CORE
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium grained, light grey

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details:	machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	21.0 mBGL
Screen Top:	18.0 mBGL
Screen/Sensor Base:	21.0 mBGL
Instrument Details:	-
Installation Date:	10/06/2016
Development Date:	-

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 14.0 m	BENTONITE - CEMENT GROUT
Depth 14.0 to 16.0 m	BENTONITE
Depth 16.0 to 18.0 m	FILTER SAND
Depth 18.0 to 21.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 21.0 to 22.0 m	FILTER SAND
Depth 22.0 to 31.8 m	BENTONITE

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log**

PIEZOMETER No. **RZ_BH15**

Client:	Sydney Motorway Corporation		**Project No:**	60493796	
Project:	M4-M5 Link Geotech Investigation		**Logged by:**	LH/FR	**Checked by:** BF
Location:	Rozelle Rail Yards, Lilyfield		**Start Date:**	7/06/2016	**End Date:** 9/06/2016
Driller:	Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:**	330522.6 m	**RL:** 6.09 m
Drill Rig:	DR04-Hydrapower Scout	**Inclination:** -90°	**Northing:**	6250349.9 m	**Ver. Datum:** AHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data | **Rock Description** | **Piezometer Details**

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 15	100	100		-24.0		SANDSTONE, medium to coarse grained, light grey
	Run 16	100	100		-26.0	32.0	SANDSTONE, fine to medium grained, light grey
	Run 17	100	100				SANDSTONE, medium to coarse grained, light grey *continued*
	Run 18	100	100		-28.0	34.0	SANDSTONE, medium to coarse grained, light grey
	Run 19	100	100				SANDSTONE, medium grained, light grey
							RZ_BH15 Terminated at 35.00 m.

Defect Spacing (mm): 20, 60, 200, 600, 2000

Reduced Level (m): -24.0, -26.0, -28.0, -30.0, -32.0, -34.0, -36.0, -38.0, -40.0, -42.0, -44.0, -46.0, -48.0, -50.0, -52.0

Depth (m): 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0

Construction Details:	machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	21.0 mBGL
Screen Top:	18.0 mBGL
Screen/Sensor Base:	21.0 mBGL
Instrument Details:	-
Installation Date:	10/06/2016
Development Date:	-

Depth 22.0 to 31.8 m — BENTONITE

Depth 31.8 to 35.0 m — BENTONITE - CEMENT GROUT

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH16

Sheet: 1 of 2

Client: Sydney Motorway Corporation	**Project No:** 60493796		
Project: M4-M5 Link Geotech Investigation	**Logged by:** HW/LH	**Checked by:** BF	
Location: Rozelle Rail Yards, Lilyfield	**Start Date:** 14/06/2016	**End Date:** 16/06/2016	
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330609.4 m	**RL:** 5.88 m
Drill Rig: Delta 550	**Inclination:** -90°	**Northing:** 6250409.4 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

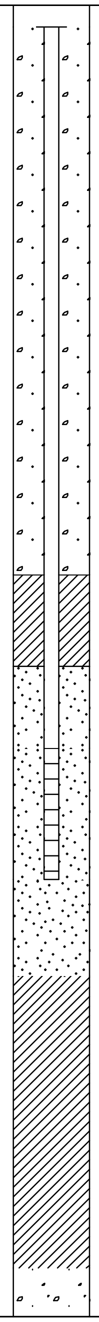
Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Depth (m)	Reduced Level (m)	Summary Geology (refer to geological log for full descriptions)
NDD						Sandy GRAVEL, fine to coarse grained
CA				2.0	4.0	GRAVEL, fine to coarse grained, dark grey
CA						GRAVEL, medium to coarse grained, yellow-brown
CA				4.0	2.0	Gravelly SAND, medium grained
CA				6.0	0.0	CLAY, dark brown-grey
HQ3	Run 1	95	94			SAND, medium grained, light grey, mottled red
HQ3	Run 2	100	93	8.0	-2.0	SANDSTONE, medium to coarse grained, light grey, mottled red
HQ3	Run 3	100	100			
HQ3	Run 4	100	100	10.0	-4.0	SANDSTONE, medium to coarse grained, light grey with orange staining
HQ3	Run 5	100	80			NO CORE
HQ3	Run 6	100	100	12.0	-6.0	SANDSTONE, medium to coarse grained, light grey with orange staining
HQ3	Run 7	100	97	14.0	-8.0	SANDSTONE, medium grained, light grey
HQ3						SANDSTONE, medium grained, light grey
HQ3	Run 8	100	99	16.0	-10.0	SANDSTONE, coarse grained, light grey
HQ3	Run 9	100	100			SANDSTONE, medium grained, light grey
HQ3	Run 10	100	100	18.0	-12.0	SANDSTONE, medium grained, light grey
HQ3	Run 11	100	80			
HQ3	Run 12	97	90	20.0	-14.0	SANDSTONE, medium to coarse grained, light grey
HQ3						NO CORE
HQ3	Run 13	100	99	22.0	-16.0	SANDSTONE, medium to coarse grained, light grey
HQ3	Run 14	100	100	24.0	-18.0	SANDSTONE, medium grained, light grey
HQ3	Run 15	100	95			SANDSTONE, medium to coarse grained, light grey
HQ3	Run 16	100	100	26.0	-20.0	SANDSTONE, medium grained, light grey
HQ3	Run 17	100	100			MUDSTONE, dark grey
HQ3	Run 18	100	100	28.0	-22.0	
HQ3	Run 20	96	96			SANDSTONE, medium grained, light grey
HQ3	Run 21	95	95	30.0		

Defect Spacing (mm): 20 60 200 600 2000

Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 20.0 mBGL
Screen Top: 17.0 mBGL
Screen/Sensor Base: 20.0 mBGL
Instrument Details: -
Installation Date: 16/06/2016
Development Date: -



Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 13.0 m	BENTONITE + CEMENT GROUT
Depth 13.0 to 15.1 m	BENTONITE
Depth 15.1 to 17.0 m	FILTER SAND
Depth 17.0 to 20.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 20.0 to 22.2 m	FILTER SAND
Depth 22.2 to 28.9 m	BENTONITE
Depth 28.9 to 35.0 m	BENTONITE + CEMENT GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH16

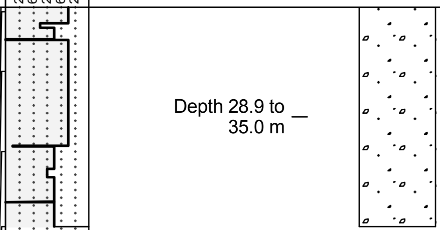
Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	HW/LH	**Checked by:**	BF
Location:	Rozelle Rail Yards, Lilyfield	**Start Date:**	14/06/2016	**End Date:**	16/06/2016
Driller:	Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330609.4 m	**RL:**	5.88 m
Drill Rig:	Delta 550	**Inclination:** -90°	**Northing:** 6250409.4 m	**Ver. Datum:**	AHD
		Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:**	Grass

Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 21	100	100			MUDSTONE
	Run 22	100	100	-26.0	32.0	SANDSTONE, medium to coarse grained, light grey
	Run 23	100	100			NO CORE
	Run 24	100	100	-28.0	34.0	MUDSTONE, dark grey *continued*
	Run 25	100	99			INTERBEDDED MUDSTONE/SANDSTONE
				-30.0	36.0	SANDSTONE, medium grained, light grey
				-32.0	38.0	SANDSTONE, medium grained, light grey
						RZ_BH16 Terminated at 35.00 m.

Depth scale continues: -34.0 / 40.0; -36.0 / 42.0; -38.0 / 44.0; -40.0 / 46.0; -42.0 / 48.0; -44.0 / 50.0; -46.0 / 52.0; -48.0 / 54.0; -50.0 / 56.0; -52.0 / 58.0; 60.0

Defect Spacing (mm): 20, 60, 200, 600, 2000



Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 20.0 mBGL
Screen Top: 17.0 mBGL
Screen/Sensor Base: 20.0 mBGL
Instrument Details: -
Installation Date: 16/06/2016
Development Date: -

Depth 28.9 to 35.0 m — BENTONITE + CEMENT GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. **RZ_BH19**

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	NB/TC	**Checked by:**	BF
Location:	Rozelle Rail Yards, Lilyfield	**Start Date:**	12/07/2016	**End Date:**	22/07/2016
Driller:	Hagstrom Drilling Pty Ltd	**Easting:**	330822.5 m	**RL:**	2.53 m
Drill Rig:	Hydrapower Scout	**Northing:**	6250627.0 m	**Ver. Datum:**	AHD
Hole Diameter:	96 mm	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Grass
Inclination:	-90°				
Bearing:	N/A				

Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
NDD				0.0	GRAVEL, medium to coarse grained
CA				2.0	SAND, medium to coarse grained, light brown
HQ3	Run 1	100	87		Clayey SAND, medium to coarse grained, light red-brown
HQ3	Run 1			4.0	Sandy CLAY
HQ3	Run 2	100	94	6.0	CLAY, yellow-brown
HQ3	Run 2				SAND, light brown
HQ3	Run 2			8.0	CLAY, dark grey
HQ3	Run 3	100	99		SANDSTONE, medium grained, light brown mottled pink
HQ3	Run 3			10.0	SANDSTONE, medium grained, light brown mottled red-brown
HQ3	Run 4	100	100	12.0	SANDSTONE, medium grained, light grey
HQ3	Run 4			14.0	SANDSTONE, medium grained, light grey and grey
HQ3	Run 5	100	97	16.0	SANDSTONE, medium grained, light grey and grey
HQ3	Run 5				SANDSTONE, medium grained, light grey
HQ3	Run 6	100	96	18.0	SANDSTONE, medium grained, light grey
HQ3	Run 6			20.0	SANDSTONE, medium grained, light grey
HQ3	Run 7	100	91	22.0	SANDSTONE, medium grained, light grey and grey
HQ3	Run 7				SANDSTONE, medium grained, light grey
HQ3	Run 8	100	93	24.0–26.0	
HQ3	Run 9	100	100	28.0–30.0	

Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	22.0 mBGL
Screen Top:	19.0 mBGL
Screen/Sensor Base:	22.0 mBGL
Instrument Details:	-
Installation Date:	22/07/2016
Development Date:	-

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 15.0 m	GROUT
Depth 15.0 to 17.0 m	BENTONITE
Depth 17.0 to 19.0 m	FILTER SAND
Depth 19.0 to 22.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 22.0 to 25.0 m	FILTER SAND
Depth 25.0 to 27.0 m	BENTONITE
Depth 27.0 to 35.0 m	BENTONITE + CEMENT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH19

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB/TC	**Checked by:** BF
Location: Rozelle Rail Yards, Lilyfield		**Start Date:** 12/07/2016	**End Date:** 22/07/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330822.5 m	**RL:** 2.53 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250627.0 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

Piezometer Details

- **Construction Details:** Machine slotted PVC pipe
- **Pipe Diameter:** 50 mm
- **Pipe Top:** 0.0 mBGL
- **Pipe Base:** 22.0 mBGL
- **Screen Top:** 19.0 mBGL
- **Screen/Sensor Base:** 22.0 mBGL
- **Instrument Details:** -
- **Installation Date:** 22/07/2016
- **Development Date:** -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)	Piezometer Details
HQ3	Run 10	100	96		-28.0 to -30.0	32.0	SANDSTONE, medium grained, grey *continued*	Depth 27.0 to 35.0 m — BENTONITE + CEMENT
HQ3	Run 11	100	90		-30.0 to -32.0	34.0	SANDSTONE, medium grained, light grey and grey	
						35.0	*RZ_BH19 Terminated at 35.00 m.*	

Defect Spacing (mm): 20, 60, 200, 600, 2000

Depth scale (m): 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0
Reduced Level (m): -34.0, -36.0, -38.0, -40.0, -42.0, -44.0, -46.0, -48.0, -50.0, -52.0, -54.0, -56.0

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH26

Client: Sydney Motorway Corporation	**Project No:** 60493796		
Project: M4-M5 Link Geotech Investigation	**Logged by:** FR/NB	**Checked by:** BF	
Location: Rozelle Rail Yards, Lilyfield	**Start Date:** 4/07/2016	**End Date:** 11/07/2016	
Driller: Numac Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331066.3 m	**RL:** 2.93 m
Drill Rig: Delta Base 520	**Inclination:** -90°	**Northing:** 6250835.1 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Railway track/Fill

Field Data

Method	Core Run	TCR (%)	RQD (%)
NDD			
AD			
HQ3	Run 1	86	57
HQ3	Run 2	97	87
HQ3	Run 3	86	62
HQ3	Run 4	95	90
HQ3	Run 5	100	94
HQ3	Run 6	65	82
HQ3	Run 7	100	75
HQ3	Run 8	100	100
HQ3	Run 9	100	73
HQ3	Run 10	100	91
HQ3	Run 11	100	85

Ground Water: 0%

Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Rock Description

Summary Geology (refer to geological log for full descriptions)

- Sandy GRAVEL, fine to medium grained
- SANDSTONE, orange-brown and light grey
- NO CORE
- SANDSTONE, fine to coarse grained, yellow-brown to red-brown iron-stained
- SANDSTONE, medium to coarse grained, light grey
- NO CORE
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, coarse grained, light grey
- NO CORE
- SANDSTONE, fine to coarse grained, light grey stained orange-brown
- SANDSTONE, fine to coarse grained, light grey stained orange-brown
- MUDSTONE, dark grey
- NO CORE
- MUDSTONE, dark grey
- SANDSTONE
- MUDSTONE, dark grey
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, coarse grained, light grey
- SHALE BRECCIA
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, coarse grained, light grey
- SANDSTONE, fine to medium grained, light grey to light yellow-grey

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	20.0 mBGL
Screen Top:	20.0 mBGL
Screen/Sensor Base:	23.0 mBGL
Instrument Details:	-
Installation Date:	13/07/2016
Development Date:	-

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 2.5 m	GROUT
Depth 2.5 to 14.9 m	COLLAPSED SOIL
Depth 14.9 to 17.6 m	BENTONITE
Depth 17.6 to 20.0 m	FILTER SAND
Depth 20.0 to 23.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 23.0 to 25.0 m	FILTER SAND
Depth 25.0 to 33.0 m	BENTONITE

REMARKS:

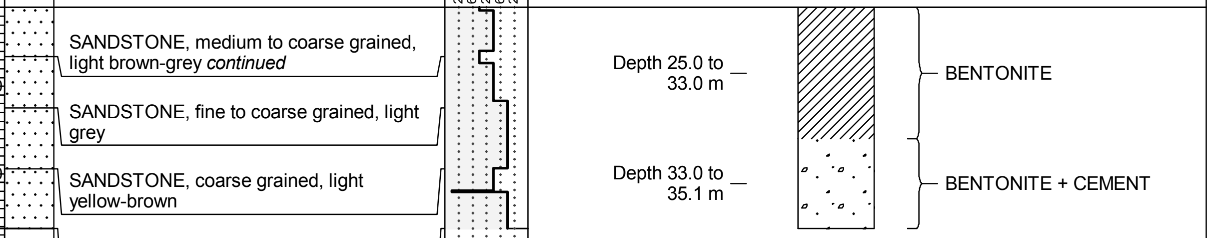
GROUNDWATER MONITORING NOTES:

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	FR/NB	**Checked by:**	BF
Location:	Rozelle Rail Yards, Lilyfield	**Start Date:**	4/07/2016	**End Date:**	11/07/2016
Driller:	Numac Drilling Pty Ltd **Hole Diameter:** 96 mm	**Easting:**	331066.3 m	**RL:**	2.93 m
Drill Rig:	Delta Base 520 **Inclination:** -90° **Bearing:** N/A	**Northing:**	6250835.1 m	**Ver. Datum:**	AHD
		Hor. Proj/Dat:	MGA94/GDA94-56H	**Surface:**	Railway track/Fill

Field Data | Rock Description | Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 20.0 mBGL
Screen Top: 20.0 mBGL
Screen/Sensor Base: 23.0 mBGL
Instrument Details: -
Installation Date: 13/07/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 12	100	100		-28.0	32.0	SANDSTONE, medium to coarse grained, light brown-grey *continued*
							SANDSTONE, fine to coarse grained, light grey
	Run 13	100	99		-30.0	34.0	SANDSTONE, coarse grained, light yellow-brown
					-32.0	36.0	SANDSTONE, medium to coarse grained, light grey to light yellow-grey
							RZ_BH26 Terminated at 35.05 m.



REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH28

Sheet: 1 of 2

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB	**Checked by:** BF
Location: Rozelle Rail Yards, Rozelle		**Start Date:** 27/07/2016	**End Date:** 28/07/2016
Driller: Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331126.6 m	**RL:** 2.91 m
Drill Rig: Ausroc 4000	**Inclination:** -90°	**Northing:** 6250818.8 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

Field Data

Method	Core Run	TCR (%)	RQD (%)
NDD			
ADT			
HQ3	Run 1	100	100
HQ3	Run 2	100	96
HQ3	Run 3	100	77
HQ3	Run 4	100	97
HQ3	Run 5	98	72
HQ3	Run 6	100	72
HQ3	Run 7	100	100
HQ3	Run 8	100	93
HQ3	Run 9	100	85
HQ3	Run 10	100	92
HQ3	Run 11	100	90
HQ3	Run 12	100	96

Ground Water: 90%, 85%, 0%

Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

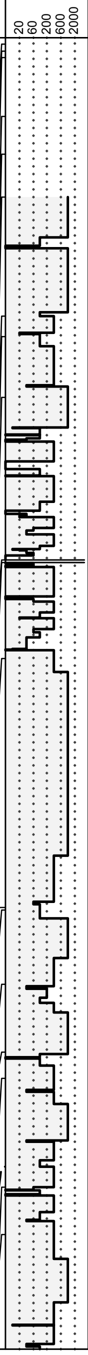
Graphic Log

Rock Description

Summary Geology (refer to geological log for full descriptions)

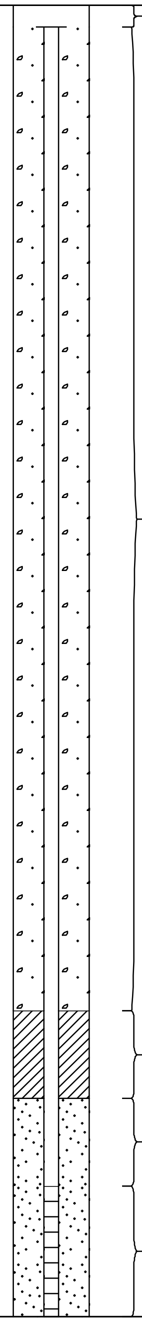
- Clayey SAND, fine to medium grained, dark grey
- SAND, fine to coarse grained, yellow-brown
- Gravelly COBBLES
- GRAVEL, medium to coarse grained
- Clayey GRAVEL, fine to medium grained
- SANDSTONE, medium to coarse grained, yellow-brown
- SANDSTONE, fine to coarse grained, light grey and yellow-brown
- SANDSTONE, fine grained, light grey
- SANDSTONE, yellow-brown
- SANDSTONE, fine to coarse grained, light grey to yellow-brown
- NO CORE
- SANDSTONE, fine to coarse grained, light grey
- SANDSTONE, medium to coarse grained, light grey-grey
- SHALE BRECCIA, fine to coarse grained
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, coarse grained, light grey
- SHALE BRECCIA, medium to coarse grained
- SANDSTONE, medium to coarse grained, brown-grey to light grey
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, medium to coarse grained, light grey and light yellow-brown

Defect Spacing (mm)



Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	30.0 mBGL
Screen Top:	27.0 mBGL
Screen/Sensor Base:	30.0 mBGL
Instrument Details:	-
Installation Date:	29/07/2016
Development Date:	-



Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 23.0 m	GROUT
Depth 23.0 to 25.0 m	BENTONITE
Depth 25.0 to 27.0 m	FILTER SAND
Depth 27.0 to 30.0 m	PVC SLOTTED SECTION WITH FILTER SAND

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH28

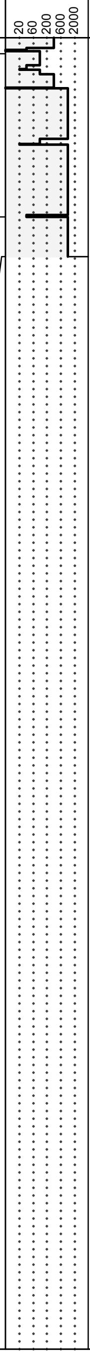
Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	NB	**Checked by:**	BF
Location:	Rozelle Rail Yards, Rozelle	**Start Date:**	27/07/2016	**End Date:**	28/07/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:**	96 mm	**Easting:**	331126.6 m
RL:	2.91 m	**Drill Rig:**	Ausroc 4000	**Inclination:**	-90°
Northing:	6250818.8 m	**Ver. Datum:**	AHD	**Bearing:**	N/A
Hor. Proj/Dat:	MGA94/GDA94-56H	**Surface:**	Grass		

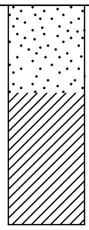
Field Data / Rock Description / Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 30.0 mBGL
Screen Top: 27.0 mBGL
Screen/Sensor Base: 30.0 mBGL
Instrument Details: -
Installation Date: 29/07/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 13	100	94		-28.0	32.0	SANDSTONE, coarse grained, light grey
	Run 14	100	97		-30.0	34.0	SANDSTONE, fine to medium grained, grey
					-32.0	36.0	*RZ_BH28 Terminated at 35.00 m.*
					-34.0	38.0	
					-36.0	40.0	
					-38.0	42.0	
					-40.0	44.0	
					-42.0	46.0	
					-44.0	48.0	
					-46.0	50.0	
					-48.0	52.0	
					-50.0	54.0	
					-52.0	56.0	
					-54.0	58.0	
					-56.0	60.0	

Defect Spacing (mm)





REMARKS:
GROUNDWATER MONITORING NOTES:

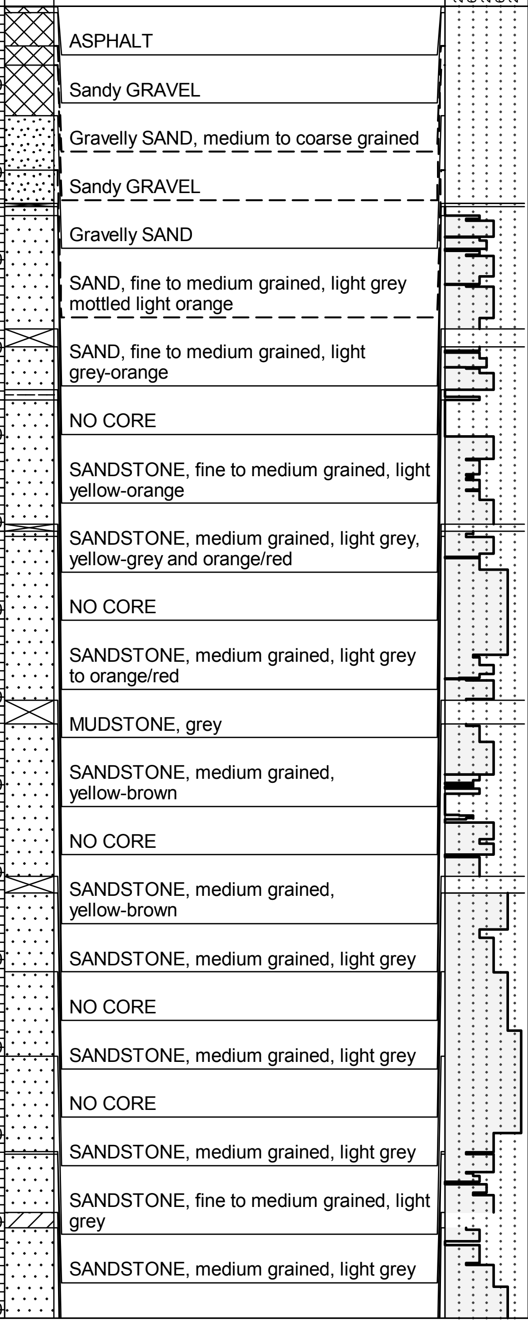
Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** JR/BH	**Checked by:** BF
Location: Rozelle Rail Yards, Rozelle		**Start Date:** 6/07/2016	**End Date:** 13/07/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331192.9 m	**RL:** 2.10 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250835.0 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
NDD				0.0	ASPHALT
AD				2.0	Sandy GRAVEL
AD					Gravelly SAND, medium to coarse grained
AD				4.0	Sandy GRAVEL
HQ3		95	70		Gravelly SAND
HQ3	Run 2	87	73	6.0	SAND, fine to medium grained, light grey mottled light orange
HQ3				8.0	SAND, fine to medium grained, light grey-orange
HQ3					NO CORE
HQ3	Run 3	95	50	10.0	SANDSTONE, fine to medium grained, light yellow-orange
HQ3				12.0	SANDSTONE, medium grained, light grey, yellow-grey and orange/red
HQ3	Run 4	100	95	14.0	NO CORE
HQ3					SANDSTONE, medium grained, light grey to orange/red
HQ3	Run 5	82	75	16.0	MUDSTONE, grey
HQ3				18.0	SANDSTONE, medium grained, yellow-brown
HQ3	Run 6	87	55		NO CORE
HQ3				20.0	SANDSTONE, medium grained, yellow-brown
HQ3	Run 7	100	96	22.0	SANDSTONE, medium grained, light grey
HQ3					NO CORE
HQ3				24.0	SANDSTONE, medium grained, light grey
HQ3	Run 8	100	91		NO CORE
HQ3				26.0	SANDSTONE, medium grained, light grey
HQ3				28.0	SANDSTONE, fine to medium grained, light grey
HQ3	Run 9	100	85	30.0	SANDSTONE, medium grained, light grey

Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

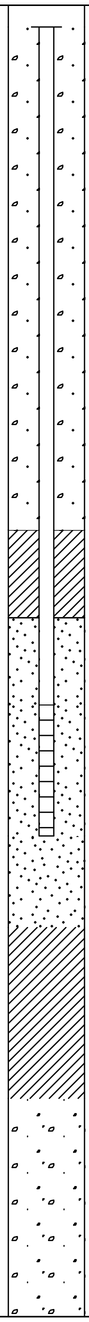
Defect Spacing (mm): 20, 60, 200, 600, 2000



Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 19.0 mBGL
Screen Top: 16.0 mBGL
Screen/Sensor Base: 19.0 mBGL
Instrument Details: -
Installation Date: 14/07/2016
Development Date: -

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 12.0 m	GROUT
Depth 12.0 to 14.0 m	BENTONITE
Depth 14.0 to 16.0 m	FILTER SAND
Depth 16.0 to 19.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 19.0 to 21.1 m	FILTER SAND
Depth 21.1 to 25.0 m	BENTONITE
Depth 25.0 to 35.0 m	BENTONITE + CEMENT



REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH30

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** JR/BH	**Checked by:** BF
Location: Rozelle Rail Yards, Rozelle		**Start Date:** 6/07/2016	**End Date:** 13/07/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331192.9 m	**RL:** 2.10 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250835.0 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 19.0 mBGL
Screen Top: 16.0 mBGL
Screen/Sensor Base: 19.0 mBGL
Instrument Details: -
Installation Date: 14/07/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)	Piezometer Details
HQ3	Run 10	100	100		-28.0		MUDSTONE, fine grained, dark grey-grey	Depth 25.0 to 35.0 m — BENTONITE + CEMENT
					-30.0	32.0	SANDSTONE, fine to medium grained, light grey	
							CLAY, grey	
	Run 11	100	100		-32.0	34.0	SANDSTONE, fine to medium grained, light grey *continued*	
							RZ_BH30 Terminated at 35.00 m.	

Defect Spacing (mm): 20, 60, 200, 600, 2000

Reduced Level (m): -34.0, -36.0, -38.0, -40.0, -42.0, -44.0, -46.0, -48.0, -50.0, -52.0, -54.0, -56.0
Depth (m): 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH38

Sheet: 1 of 2

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** JR	**Checked by:** BF
Location: Rozelle Rail Yards, Rozelle		**Start Date:** 28/07/2016	**End Date:** 2/08/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330726.6 m	**RL:** 2.35 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250512.1 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass/Gravel

Field Data | **Rock Description** | **Piezometer Details**

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 31.3 mBGL
Screen Top: 28.3 mBGL
Screen/Sensor Base: 31.3 mBGL
Instrument Details: -
Installation Date: 1/08/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Summary Geology (refer to geological log for full descriptions)
NDD				Gravelly SAND, dark grey-black
CA				Gravelly SAND
HQ3	Run 1	62	0	SAND, medium grained, light brown-yellow
HQ3	Run 2	100	92	Clayey SAND, fine to medium grained, grey to dark grey; SAND, fine to medium grained, light grey to light yellow
HQ3	Run 3	100	71	SANDSTONE, medium grained, light grey to orange; NO CORE
HQ3	Run 4	100	91	SANDSTONE, medium grained, light grey to light yellow; SANDSTONE, medium to coarse grained, light orange to red-brown
HQ3	Run 5	100	94	SANDSTONE, medium grained, orange-red to brown; SANDSTONE, coarse grained, mainly red to light orange
HQ3	Run 6	100	100	SANDSTONE, medium grained, light grey; SANDSTONE, fine grained, light grey
HQ3	Run 7	100	99	SANDSTONE, medium grained, light grey; SANDSTONE, medium to coarse grained, light grey
HQ3	Run 8	100	98	SANDSTONE, medium grained, light grey
HQ3	Run 9	100	100	SANDSTONE, medium grained, light grey
HQ3	Run 10	100	85	SANDSTONE, fine grained, grey; SANDSTONE, medium grained, light grey

Depth	Installation
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 0.8 m	BENTONITE
Depth 0.8 to 24.1 m	BENTONITE + CEMENT GROUT
Depth 24.1 to 26.0 m	BENTONITE
Depth 26.0 to 28.3 m	FILTER SAND
Depth 28.3 to 31.3 m	PVC SLOTTED SECTION WITH FILTER SAND

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH38

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** JR	**Checked by:** BF
Location: Rozelle Rail Yards, Rozelle		**Start Date:** 28/07/2016	**End Date:** 2/08/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330726.6 m	**RL:** 2.35 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250512.1 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass/Gravel

Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 11	100	90		-28.0		SHALE BRECCIA *continued*
						32.0	SANDSTONE, fine to medium grained, light grey
					-30.0		
	Run 12	100	100				SANDSTONE, medium grained, grey to dark brown
						34.0	
					-32.0		SANDSTONE, medium grained, light grey
							RZ_BH38 Terminated at 35.08 m.

Defect Spacing (mm): 20, 60, 200, 600, 2000

Depth scale: 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0 (RL -34.0 to -56.0)

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	31.3 mBGL
Screen Top:	28.3 mBGL
Screen/Sensor Base:	31.3 mBGL
Instrument Details:	-
Installation Date:	1/08/2016
Development Date:	-

Depth	Detail
Depth 28.3 to 31.3 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 31.3 to 33.1 m	FILTER SAND
Depth 33.1 to 35.0 m	BENTONITE

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH44

Sheet: 1 of 2

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** FR/LH	**Checked by:** BF
Location: Rozelle Rail Yards, Lilyfield		**Start Date:** 2/08/2016	**End Date:** 8/08/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330885.8 m	**RL:** 2.36 m
Drill Rig: Delta 550	**Inclination:** -90°	**Northing:** 6250614.0 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

Field Data

Method	Core Run	TCR (%)	RQD (%)	Ground Water
NDD				
CA				
HQ3	Run 1	100	86	
HQ3	Run 2	100	84	
HQ3	Run 3	93	90	
HQ3	Run 4	100	97	
HQ3	Run 5	100	100	
HQ3	Run 6	100	100	
HQ3	Run 7	100	100	0%
HQ3	Run 8	100	75	
HQ3	Run 9	100	100	
HQ3	Run 10	100	87	
HQ3	Run 11	100	100	

Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Rock Description

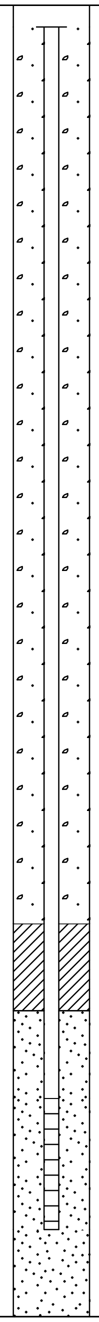
Summary Geology (refer to geological log for full descriptions)

Defect Spacing (mm): 20, 60, 200, 600, 2000

- Clayey SAND, fine to coarse grained, dark grey
- COBBLES
- Clayey SAND, fine to coarse grained, dark brown to dark grey
- SAND, fine to coarse grained, yellow-brown
- CLAY, black
- Sandy CLAY, black
- CLAY, black
- Sandy CLAY, black
- CLAY, black
- Clayey SAND, fine to medium grained, pale brown and dark brown
- CLAY, black
- Clayey SAND, fine to medium grained, pale brown and dark brown
- SANDSTONE, medium grained, pale brown
- NO CORE
- SANDSTONE, medium grained, pale grey
- SHALE BRECCIA
- SANDSTONE, medium grained, pale grey

Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 28.0 mBGL
Screen Top: 25.0 mBGL
Screen/Sensor Base: 28.0 mBGL
Instrument Details: -
Installation Date: 9/08/2016
Development Date: -



Depth	Material
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 21.0 m	GROUT
Depth 21.0 to 23.0 m	BENTONITE
Depth 23.0 to 25.0 m	FILTER SAND
Depth 25.0 to 28.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 28.0 to 30.0 m	FILTER SAND

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH44

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** FR/LH	**Checked by:** BF
Location: Rozelle Rail Yards, Lilyfield		**Start Date:** 2/08/2016	**End Date:** 8/08/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330885.8 m	**RL:** 2.36 m
Drill Rig: Delta 550	**Inclination:** -90°	**Northing:** 6250614.0 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

Field Data | **Rock Description** | **Piezometer Details**

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 28.0 mBGL
Screen Top: 25.0 mBGL
Screen/Sensor Base: 28.0 mBGL
Instrument Details: -
Installation Date: 9/08/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm) 20 60 200 600 2000
HQ3	Run 12	100	97		-28.0			
						32.0	SANDSTONE, medium grained, pale grey	
	Run 13	100	100		-30.0		SANDSTONE, medium to coarse grained, pale grey and dark grey	
	Run 14	100	100			34.0		
	Run 15	100	100		-32.0		SANDSTONE, medium grained, pale grey	
							RZ_BH44 Terminated at 35.00 m.	

Depth 30.0 to 35.0 m — BENTONITE

Depth (m): 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0
Reduced Level (m): -34.0, -36.0, -38.0, -40.0, -42.0, -44.0, -46.0, -48.0, -50.0, -52.0, -54.0, -56.0

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH44A

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	LH	**Checked by:**	BF
Location:	Rozelle Rail Yards, Lilyfield	**Start Date:**	10/08/2016	**End Date:**	10/08/2016
Driller:	Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330884.4 m	**RL:**	2.31 m
Drill Rig:	Delta 550	**Inclination:** -90°	**Northing:** 6250613.3 m	**Ver. Datum:**	AHD
		Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:**	Grass

Field Data / Rock Description / Piezometer Details

Columns: Method, Core Run, TCR (%), RQD (%), Ground Water, Reduced Level (m), Depth (m), Graphic Log; Summary Geology (refer to geological log for full descriptions); Defect Spacing (mm) 20 60 200 600 2000

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 15.0 mBGL
Screen Top: 12.0 mBGL
Screen/Sensor Base: 15.0 mBGL
Instrument Details: -
Installation Date: 10/08/2016
Development Date: -

Summary Geology
Clayey SAND, fine to coarse grained, dark grey
COBBLES
Clayey SAND, fine to coarse grained, dark brown to dark grey
SAND, fine to coarse grained, yellow-brown
CLAY, black
Sandy CLAY, black
CLAY, black
Sandy CLAY, black
CLAY, black
Clayey SAND, fine to medium grained, pale brown and dark brown
CLAY, black
Clayey SAND, fine to medium grained, pale brown and dark brown
RZ_BH44A Terminated at 16.55 m.

Depth scale (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0
Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Depth	Piezometer Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 10.0 m	GROUT
Depth 10.0 to 12.0 m	BENTONITE
Depth 12.0 to 15.0 m	FILTER SAND
Depth 15.0 to 15.9 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 15.9 to 16.6 m	FILTER SAND

REMARKS:The material properties are taken from the adjacent borehole RZ_BH44
GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log**

PIEZOMETER No. **RZ_BH47**

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	HW/TC	**Checked by:**	BF
Location:	Rozelle Rail Yards, Lilyfield	**Start Date:**	2/08/2016	**End Date:**	8/08/2016
Driller:	Numac Drilling Pty Ltd	**Easting:**	331025.2 m	**RL:**	2.40 m
Drill Rig:	Delta Base 520	**Northing:**	6250701.7 m	**Ver. Datum:**	AHD
Hole Diameter:	96 mm	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Grass/Ballast
Inclination:	-90°				
Bearing:	N/A				

Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
NDD					Gravelly SAND, fine to coarse grained, dark brown
ADV					GRAVEL, fine to coarse grained, yellow-brown
CA					COBBLES
					Gravelly SAND, fine to coarse grained sand
					Clayey GRAVEL
					Clayey SAND, fine to medium grained, yellow-brown and brown-grey
					CLAY, yellow-brown and light orange-brown
					Sandy CLAY, dark grey
					Clayey SAND, fine to coarse grained, dark grey
					CLAY, dark grey
					SAND, fine to coarse grained, light grey
					Clayey SAND, fine to coarse grained, dark grey
					CLAY, dark grey
					Clayey SAND, fine to coarse grained, grey
HQ3	Run 1	75	13		SANDSTONE, medium grained, light yellow-brown to light grey
	Run 2	100	86		NO CORE
	Run 3	96	78		SANDSTONE, medium grained, light yellow-brown to light grey
					SANDSTONE, medium grained, light grey and grey
	Run 4	96	81		SANDSTONE, medium to coarse grained, light grey to light yellow-brown
					NO CORE
	Run 5	100	95	30.0	SANDSTONE, medium to coarse grained,

Depth scale (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0
Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 29.2 mBGL
Screen Top: 26.2 mBGL
Screen/Sensor Base: 29.2 mBGL
Instrument Details: -
Installation Date: 9/08/2016
Development Date: -

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 22.2 m	GROUT
Depth 22.2 to 24.2 m	BENTONITE
Depth 24.2 to 26.2 m	FILTER SAND
Depth 26.2 to 29.2 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 29.2 to 31.2 m	FILTER SAND

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log** **PIEZOMETER No. RZ_BH47**

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	HW/TC	**Checked by:**	BF
Location:	Rozelle Rail Yards, Lilyfield	**Start Date:**	2/08/2016	**End Date:**	8/08/2016
Driller:	Numac Drilling Pty Ltd	**Easting:**	331025.2 m	**RL:**	2.40 m
Drill Rig:	Delta Base 520	**Northing:**	6250701.7 m	**Ver. Datum:**	AHD
Hole Diameter:	96 mm	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Grass/Ballast
Inclination:	-90°				
Bearing:	N/A				

Field Data | **Rock Description** | **Piezometer Details**

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 5	100	95		-28.0		light grey to light yellow-brown
						32.0	SANDSTONE, medium grained, light grey
	Run 6	100	93		-30.0		SANDSTONE, medium grained, light grey
						34.0	SANDSTONE, medium grained, light grey
	Run 7	100	93		-32.0		NO CORE
						36.0	SANDSTONE, medium grained, light grey
					-34.0		SANDSTONE, medium grained, light grey
						38.0	SANDSTONE, medium grained, light grey
					-36.0		SANDSTONE, medium grained, light grey
						40.0	SANDSTONE, medium grained, light grey
					-38.0		SANDSTONE, medium grained, light grey to light yellow-brown
						42.0	SANDSTONE, medium grained, light grey
					-40.0		*RZ_BH47 Terminated at 35.00 m.*
						44.0	
					-42.0		
						46.0	
					-44.0		
						48.0	
					-46.0		
						50.0	
					-48.0		
						52.0	
					-50.0		
						54.0	
					-52.0		
						56.0	
					-54.0		
						58.0	
					-56.0		
						60.0	

Graphic Log

Defect Spacing (mm): 20 60 200 600 2000

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 29.2 mBGL
Screen Top: 26.2 mBGL
Screen/Sensor Base: 29.2 mBGL
Instrument Details: -
Installation Date: 9/08/2016
Development Date: -

Depth 29.2 to 31.2 m — FILTER SAND

Depth 31.2 to 35.0 m — BENTONITE

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH47A

Sheet: 1 of 1

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	TC	**Checked by:**	BF
Location:	Rozelle Rail Yards, Lilyfield	**Start Date:**	10/08/2016	**End Date:**	10/08/2016
Driller:	Numac Drilling Pty Ltd	**Easting:**	331027.9 m	**RL:**	2.59 m
Drill Rig:	Delta Base 520	**Northing:**	6250704.0 m	**Ver. Datum:**	AHD
		Hor. Proj/Dat:	MGA94/GDA94-56H	**Surface:**	Grass/Ballast

Hole Diameter: 96 mm
Inclination: -90°
Bearing: N/A

Field Data | Rock Description | Piezometer Details

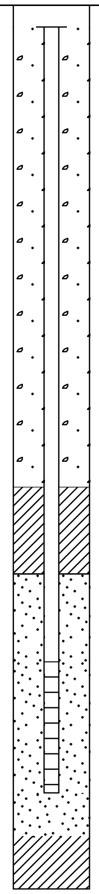
Method | Core Run | TCR (%) | RQD (%) | Ground Water | Reduced Level (m) | Depth (m) | Graphic Log

Summary Geology (refer to geological log for full descriptions)

Defect Spacing (mm): 20 60 200 600 2000

Reduced Level (m)	Depth (m)	Summary Geology
2.0		Gravelly SAND, fine to coarse grained, dark brown
	2.0	GRAVEL, fine to coarse grained, yellow-brown
0.0		
	4.0	COBBLES
-2.0		Gravelly SAND, fine to coarse grained sand
	6.0	Clayey GRAVEL
-4.0		Clayey SAND, fine to medium grained, yellow-brown and brown-grey
	8.0	
-6.0		CLAY, yellow-brown and light orange-brown
	10.0	Sandy CLAY, dark grey
-8.0		Clayey SAND, fine to coarse grained, dark grey
	12.0	
-10.0		CLAY, dark grey
	14.0	
-12.0		SAND, fine to coarse grained, light grey
	16.0	
-14.0		Clayey SAND, fine to coarse grained, dark grey
	18.0	CLAY, dark grey
-16.0		
	20.0	Clayey SAND, fine to coarse grained, grey
-18.0		*RZ_BH47A Terminated at 21.00 m.*
	22.0	
-20.0		
	24.0	
-22.0		
	26.0	
-24.0		
	28.0	
-26.0		
	30.0	

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	18.0 mBGL
Screen Top:	15.0 mBGL
Screen/Sensor Base:	18.0 mBGL
Instrument Details:	-
Installation Date:	10/08/2016
Development Date:	-



Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 11.0 m	GROUT
Depth 11.0 to 13.0 m	BENTONITE
Depth 13.0 to 15.0 m	FILTER SAND
Depth 15.0 to 18.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 18.0 to 19.0 m	FILTER SAND
Depth 19.0 to 20.2 m	BENTONITE

REMARKS:The material properties are taken from the adjacent borehole RZ_BH47
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH49A

Sheet: 1 of 1

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** JR	**Checked by:** BF
Location: Rozelle Rail Yards, Lilyfield		**Start Date:** 30/06/2016	**End Date:** 30/06/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330730.4 m	**RL:** 6.06 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250461.6 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Basalt

Field Data

Method | Core Run | TCR (%) | RQD (%) | Ground Water | Reduced Level (m) | Depth (m) | Graphic Log

Reduced Level (m): 6.0, 4.0, 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Rock Description

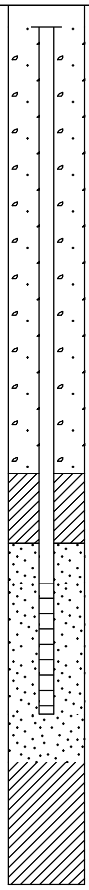
Summary Geology (refer to geological log for full descriptions) | Defect Spacing (mm): 20, 60, 200, 600, 2000

- GRAVEL, fine to coarse grained
- COBBLES
- SAND, medium to coarse grained
- Gravelly CLAY
- COBBLES
- SAND, fine to medium grained, orange-brown
- SAND, medium grained, light grey
- Sandy CLAY
- SAND, medium grained
- SAND, medium grained, dark grey
- CLAY, dark grey
- NO CORE
- SANDSTONE, fine to medium grained, yellow-brown
- SANDSTONE, fine to medium grained, grey
- SANDSTONE, fine to medium grained, light grey

RZ_BH49A Terminated at 24.50 m.

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	16.2 mBGL
Screen Top:	13.2 mBGL
Screen/Sensor Base:	16.2 mBGL
Instrument Details:	-
Installation Date:	30/06/2016
Development Date:	-



Depth	Material
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 10.7 m	GROUT
Depth 10.7 to 12.3 m	BENTONITE
Depth 12.3 to 13.2 m	FILTER SAND
Depth 13.2 to 16.2 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 16.2 to 17.3 m	FILTER SAND
Depth 17.3 to 20.1 m	BENTONITE

REMARKS:The material properties are taken from the adjacent borehole RZ_BH49
GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log**

PIEZOMETER No. **RZ_BH50**

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB	**Checked by:** BF
Location: Rozelle Rail Yards, Rozelle		**Start Date:** 9/08/2016	**End Date:** 10/08/2016
Driller: Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331255.6 m	**RL:** 2.01 m
Drill Rig: Ausroc 4000	**Inclination:** -90°	**Northing:** 6250841.1 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Gravel

Field Data | **Rock Description** | **Piezometer Details**

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 22.0 mBGL
Screen Top: 22.0 mBGL
Screen/Sensor Base: 25.0 mBGL
Instrument Details: -
Installation Date: 11/08/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
NDD					GRAVEL, fine to medium grained
ADV				2.0	Gravelly SAND
ADV					Gravelly SAND
ADV				4.0	SAND, coarse grained, black
ADV					GRAVEL, fine to medium grained
RT				6.0	Clayey SAND, fine to coarse grained, dark grey
HQ3	Run 1	30	0	8.0	Clayey SAND, fine to coarse grained, yellow-brown
HQ3	Run 2	62	0		Clayey SAND, fine to coarse grained, yellow-brown, orange-brown and light grey
HQ3	Run 3	100	97	10.0	
HQ3	Run 4	86	48		SANDSTONE, coarse grained, light grey
HQ3				12.0	NO CORE
HQ3	Run 5	92	69		SANDSTONE, fine to coarse grained, brown and orange-brown
HQ3	Run 6	97	69	14.0	NO CORE
HQ3	Run 7	100	95	16.0	SANDSTONE, fine to coarse grained, orange-brown and light grey
HQ3					NO CORE
HQ3	Run 8	97	90	18.0	SANDSTONE, medium to coarse grained, light grey
HQ3				20.0	NO CORE
HQ3	Run 9	100	87		SANDSTONE, medium to coarse grained, light grey
HQ3				22.0	SANDSTONE, coarse grained, light grey
HQ3	Run 10	100	94	24.0	SANDSTONE, medium to coarse grained, light grey
HQ3				26.0	SANDSTONE, medium to coarse grained, light grey
HQ3	Run 11	100	96		NO CORE
HQ3	Run 12	65	28	28.0	SANDSTONE, medium to coarse grained, light grey
HQ3	Run 13	100	48	30.0	SANDSTONE, fine to coarse grained, light

Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Depth	Piezometer Details
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 1.0 m	BENTONITE - CEMENT GROUT (HIGHER % BENTONITE)
Depth 1.0 to 18.0 m	GROUT
Depth 18.0 to 20.0 m	BENTONITE
Depth 20.0 to 22.0 m	FILTER SAND
Depth 22.0 to 25.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 25.0 to 27.0 m	FILTER SAND
Depth 27.0 to 33.0 m	BENTONITE

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH50

Client: Sydney Motorway Corporation		**Project No:** 60493796			
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB		**Checked by:** BF	
Location: Rozelle Rail Yards, Rozelle		**Start Date:** 9/08/2016		**End Date:** 10/08/2016	
Driller: Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331255.6 m		**RL:** 2.01 m	
Drill Rig: Ausroc 4000	**Inclination:** -90°	**Northing:** 6250841.1 m		**Ver. Datum:** AHD	
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H		**Surface:** Gravel	

Field Data / Rock Description / Piezometer Details

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 14	100	52		-28.0		grey
							NO CORE
	Run 15	87	80		-30.0	32.0	SANDSTONE, medium to coarse grained, grey *continued*
					-32.0	34.0	SANDSTONE, fine to coarse grained, light grey to grey
					-34.0	36.0	NO CORE
							RZ_BH50 Terminated at 33.00 m.
					-36.0	38.0	
					-38.0	40.0	
					-40.0	42.0	
					-42.0	44.0	
					-44.0	46.0	
					-46.0	48.0	
					-48.0	50.0	
					-50.0	52.0	
					-52.0	54.0	
					-54.0	56.0	
					-56.0	58.0	
						60.0	

Defect Spacing (mm): 20, 60, 200, 600, 2000

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 22.0 mBGL
Screen Top: 22.0 mBGL
Screen/Sensor Base: 25.0 mBGL
Instrument Details: -
Installation Date: 11/08/2016
Development Date: -

Depth 27.0 to 33.0 m — BENTONITE

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log**

PIEZOMETER No. **RZ_BH51**

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** SM/FR/NB	**Checked by:** BF
Location: Rozelle Rail Yards, Rozelle		**Start Date:** 1/08/2016	**End Date:** 8/08/2016
Driller: Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331206.6 m	**RL:** 2.22 m
Drill Rig: Ausroc 4000	**Inclination:** -90°	**Northing:** 6250813.3 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Gravel

Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
NDD				0.0	GRAVEL, fine to medium grained
ADV				2.0	Sandy GRAVEL, fine to medium grained, brown-grey and dark grey
ADV					Sandy GRAVEL, fine to medium grained
ADV				4.0	Sandy CLAY
HQ3	Run 1	100	30	6.0	BOULDERS
HQ3	Run 2	96	83		Silty CLAY, brown
HQ3				8.0	Sandy GRAVEL, fine grained
HQ3	Run 3	92	53		Clayey SAND, fine to medium grained sand
HQ3				10.0	SAND, fine to coarse grained, orange-brown mottled yellow-brown and light grey
HQ3	Run 4	100	60	12.0	SANDSTONE, fine to medium grained, light grey mottled yellow-brown
HQ3	Run 5	91	83	14.0	SANDSTONE, medium to coarse grained, light grey
HQ3	Run 6	96	87	16.0	SANDSTONE, fine to coarse grained, orange-brown and red-brown
HQ3					NO CORE
HQ3	Run 7	100	0	18.0	SANDSTONE, fine to coarse grained, orange-brown and red-brown
HQ3	Run 8	95	0		
HQ3	Run 9	97	88		NO CORE
HQ3				20.0	SANDSTONE, fine to coarse grained, light grey
HQ3	Run 10	100	98	22.0	NO CORE
HQ3				24.0	SANDSTONE, fine to coarse grained, light grey
HQ3	Run 11	100	100		NO CORE
HQ3				26.0	SANDSTONE, fine to coarse grained, dark red-brown, red and orange-brown
HQ3	Run 12	100	100	28.0	SANDSTONE, medium to coarse grained, light grey
HQ3				30.0	NO CORE

Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 19.0 mBGL
Screen Top: 19.0 mBGL
Screen/Sensor Base: 22.0 mBGL
Instrument Details: -
Installation Date: 9/08/2016
Development Date: -

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 15.0 m	GROUT
Depth 15.0 to 17.0 m	BENTONITE
Depth 17.0 to 19.0 m	FILTER SAND
Depth 19.0 to 22.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 22.0 to 24.0 m	FILTER SAND
Depth 24.0 to 26.7 m	BENTONITE
Depth 26.7 to 30.0 m	BENTONITE + CEMENT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. **RZ_BH51**

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** SM/FR/NB	**Checked by:** BF
Location: Rozelle Rail Yards, Rozelle		**Start Date:** 1/08/2016	**End Date:** 8/08/2016
Driller: Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331206.6 m	**RL:** 2.22 m
Drill Rig: Ausroc 4000	**Inclination:** -90°	**Northing:** 6250813.3 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Gravel

Field Data | **Rock Description** | **Piezometer Details**

Method | Core Run | TCR (%) | RQD (%) | Ground Water | Reduced Level (m) | Depth (m) | Graphic Log

Summary Geology (refer to geological log for full descriptions)

Defect Spacing (mm): 20, 60, 200, 600, 2000

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 19.0 mBGL
Screen Top: 19.0 mBGL
Screen/Sensor Base: 22.0 mBGL
Instrument Details: -
Installation Date: 9/08/2016
Development Date: -

Reduced Level (m): -28.0, -30.0, -32.0, -34.0, -36.0, -38.0, -40.0, -42.0, -44.0, -46.0, -48.0, -50.0, -52.0, -54.0, -56.0

Depth (m): 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0

SANDSTONE, medium to coarse grained, light grey

SANDSTONE, coarse grained, light grey

SANDSTONE, medium to coarse grained, brown-grey and grey

SANDSTONE, fine to coarse grained, light grey

RZ_BH51 Terminated at 30.00 m.

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log** **PIEZOMETER No.** **RZ_BH52**

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	NB	**Checked by:**	BF
Location:	Rozelle Rail Yards, Rozelle	**Start Date:**	1/08/2016	**End Date:**	2/08/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331163.8 m	**RL:**	2.59 m
Drill Rig:	Ausroc 4000	**Inclination:** -90°	**Northing:** 6250784.6 m	**Ver. Datum:**	AHD
		Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:**	Gravel

Field Data | **Rock Description** | **Piezometer Details**

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 32.0 mBGL
Screen Top: 32.0 mBGL
Screen/Sensor Base: 35.0 mBGL
Instrument Details: -
Installation Date: 3/08/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Summary Geology (refer to geological log for full descriptions)
NDD				Sandy GRAVEL, fine to medium grained
CA				Gravelly SAND, fine to coarse grained, dark brown
CA				GRAVEL, fine to medium grained, dark grey-black
CA				Clayey SAND, fine to coarse grained, brown to brown-grey
CA				SAND, medium to coarse grained, brown mottled yellow-brown
HQ3	Run 1	100	59	Clayey SAND, fine to medium grained, yellow-brown mottled orange-brown
HQ3	Run 2	100	78	SAND, fine to medium grained, brown-grey to grey
HQ3	Run 3	100	95	CLAY, black
HQ3				CLAY, yellow-brown mottled orange-brown
HQ3	Run 4	98	93	Sandy CLAY, light grey
HQ3				SANDSTONE, fine to medium grained, light grey mottled yellow-brown and red-brown
HQ3	Run 5	100	90	SANDSTONE, medium to coarse grained, light yellow-brown streaked and mottled red-brown
HQ3	Run 6	100	93	SANDSTONE, fine to coarse grained, yellow-brown and light grey streaked red-brown
HQ3				SANDSTONE, medium to coarse grained, light grey and light brown
HQ3	Run 7	100	100	NO CORE
HQ3				SANDSTONE, medium to coarse grained, light grey and light brown
HQ3	Run 8	100	100	SANDSTONE, medium to coarse grained, light grey
HQ3				SANDSTONE, coarse grained, light grey
HQ3	Run 9	100	100	SANDSTONE, fine to medium grained, grey

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Defect Spacing (mm): 20 60 200 600 2000

Depth	Piezometer
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 28.0 m	GROUT
Depth 28.0 to 30.0 m	BENTONITE

REMARKS:
GROUNDWATER MONITORING NOTES:

Client:	Sydney Motorway Corporation			**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation			**Logged by:**	NB	**Checked by:**	BF
Location:	Rozelle Rail Yards, Rozelle			**Start Date:**	1/08/2016	**End Date:**	2/08/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:**	96 mm	**Easting:**	331163.8 m	**RL:**	2.59 m
Drill Rig:	Ausroc 4000	**Inclination:**	-90°	**Northing:**	6250784.6 m	**Ver. Datum:**	AHD
		Bearing:	N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Gravel

Field Data / Rock Description / Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 32.0 mBGL
Screen Top: 32.0 mBGL
Screen/Sensor Base: 35.0 mBGL
Instrument Details: -
Installation Date: 3/08/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm) 20 60 200 600 2000
HQ3	Run 10	100	100		-28.0, -30.0	32.0	SANDSTONE, fine to coarse grained, light grey	
	Run 11	100	99		-32.0	34.0		
	Run 12	100	100	20%	-34.0	36.0, 38.0	SANDSTONE, fine to medium grained, brown-grey to light grey	
	Run 13	100	100		-36.0	40.0		
					-38.0 … -56.0	42.0 … 60.0	*RZ_BH52 Terminated at 39.95 m.*	

Depth	Detail
Depth 30.0 to 31.7 m	FILTER SAND
Depth 31.7 to 34.7 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 34.7 to 37.9 m	FILTER SAND
Depth 37.9 to 40.0 m	BENTONITE

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH53

Sheet: 1 of 2

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** LH	**Checked by:** BF
Location: Rozelle Rail Yards, Rozelle		**Start Date:** 2/09/2016	**End Date:** 7/09/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331100.9 m	**RL:** 2.75 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250738.1 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data / Rock Description / Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 21.0 mBGL
Screen Top: 18.0 mBGL
Screen/Sensor Base: 21.0 mBGL
Instrument Details: -
Installation Date: 7/09/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Summary Geology (refer to geological log for full descriptions)
NDD				ASPHALT
NDD				Gravelly SAND, medium grained, black
AD				COBBLES, pale grey
AD				COBBLES
AD				Clayey SAND, medium grained, yellow and dark brown
AD				SAND, medium grained
AD				Sandy CLAY, dark grey
AD				SAND, medium grained, yellow-grey and pale grey
HQ3	Run 1	23	0	NO CORE
HQ3	Run 2	100	88	SANDSTONE, medium grained, orange-brown to light brown
HQ3	Run 3	100	78	SANDSTONE, fine to medium grained, light grey
HQ3				SANDSTONE, medium grained, light grey
HQ3	Run 4	100	96	SANDSTONE, medium grained, light grey
HQ3	Run 5	100	100	SANDSTONE, medium grained, light grey
HQ3	Run 6	100	93	SANDSTONE, medium grained, light grey

Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Defect Spacing (mm): 20, 60, 200, 600, 2000

Depth	Piezometer Details
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 14.0 m	GROUT
Depth 14.0 to 16.2 m	BENTONITE
Depth 16.2 to 18.0 m	FILTER SAND
Depth 18.0 to 21.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 21.0 to 23.0 m	FILTER SAND
Depth 23.0 to 25.3 m	BENTONITE
Depth 25.3 to 40.0 m	BENTONITE + CEMENT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH53

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** LH	**Checked by:** BF
Location: Rozelle Rail Yards, Rozelle		**Start Date:** 2/09/2016	**End Date:** 7/09/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331100.9 m	**RL:** 2.75 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250738.1 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data | **Rock Description** | **Piezometer Details**

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 21.0 mBGL
Screen Top: 18.0 mBGL
Screen/Sensor Base: 21.0 mBGL
Instrument Details: -
Installation Date: 7/09/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm) 20 60 200 600 2000
HQ3	Run 7	100	87		-28.0		SANDSTONE, medium to coarse grained, pale grey *continued*	
						32.0	SANDSTONE, medium grained, pale grey	
	Run 8	100	100		-30.0	34.0	SANDSTONE, medium grained, pale grey	
					-32.0	36.0	SHALE BRECCIA	
	Run 9	100	90		-34.0	38.0		
	Run 10	100	100		-36.0	40.0	SANDSTONE, medium grained, pale grey	
							RZ_BH53 Terminated at 40.00 m.	
					-38.0	42.0		
					-40.0	44.0		
					-42.0	46.0		
					-44.0	48.0		
					-46.0	50.0		
					-48.0	52.0		
					-50.0	54.0		
					-52.0	56.0		
					-54.0	58.0		
					-56.0	60.0		

Depth 25.3 to 40.0 m — BENTONITE + CEMENT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH60

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	RKG	**Checked by:**	
Location:	Opposite 48 Justin Street, Lilyfield	**Start Date:**	29/11/2016	**End Date:**	8/12/2016
Driller:	**Hole Diameter:** -	**Easting:**	330317.8 m	**RL:**	25.04 m
Drill Rig:	**Inclination:** -90°	**Northing:**	6250589.6 m	**Ver. Datum:**	AHD
	Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Asphalt

Field Data

Method	Core Run	TCR (%)	RQD (%)
HQ3	Run 1	100	93
	Run 2	100	94
	Run 3	100	90
	Run 4	100	98
	Run 5	94	57
	Run 6	97	97
	Run 7	100	85
	Run 8	98	96
	Run 9	94	70
	Run 10	100	60

Ground Water | Reduced Level (m): 24.0, 22.0, 20.0, 18.0, 16.0, 14.0, 12.0, 10.0, 8.0, 6.0, 4.0, 2.0, 0.0, -2.0, -4.0 | Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0 | Graphic Log

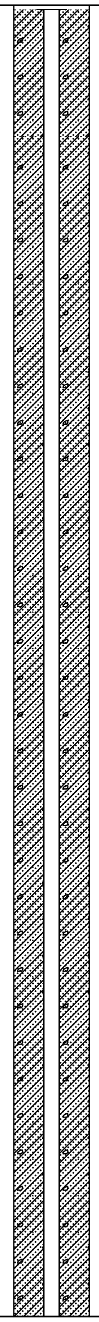
Rock Description

Summary Geology (refer to geological log for full descriptions) | Defect Spacing (mm): 20, 60, 200, 600, 2000

- ASPHALT CONCRETE
- Sandy GRAVEL, fine to medium grained, dark grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, medium to coarse grained, pink-grey
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, fine grained, pink-brown
- SANDSTONE, fine to medium grained, grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium to coarse grained, red brown to grey
- SANDSTONE, fine to medium grained, light grey
- NO CORE
- SANDSTONE, fine to medium grained, brown grey
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, medium grained, light grey
- NO CORE
- SANDSTONE, medium grained, light grey
- SANDSTONE, fine grained, grey
- SANDSTONE, medium grained, light grey
- NO CORE

Piezometer Details

Construction details:	-
Pipe diameter:	60 mm
Pipe Top:	0.0 mBGL
Pipe Base:	56.0 mBGL
Screen Top:	56.0 mBGL
Screen/Sensor Base:	59.0 mBGL
Instrument Details:	-
Installation Date:	7/12/2016
Development Date:	-



Depth	Material
Depth 0.0 to 0.1 m	GATIC COVER
Depth 0.1 to 3.0 m	GROUT BENTONITE - HIGHER % BENTONITE
Depth 3.0 to 51.0 m	GROUT BENTONITE

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH60

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** RKG	**Checked by:**
Location: Opposite 48 Justin Street, Lilyfield		**Start Date:** 29/11/2016	**End Date:** 8/12/2016
Driller:	**Hole Diameter:** -	**Easting:** 330317.8 m	**RL:** 25.04 m
Drill Rig:	**Inclination:** -90°	**Northing:** 6250589.6 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 11	100	79	-6.0	32.0	SANDSTONE, medium grained, light grey *continued*
	Run 12	100	97	-8.0 / -10.0	34.0 / 36.0	SANDSTONE, medium grained, light grey
	Run 13	100	92	-12.0	38.0	
	Run 14	100	100	-14.0	40.0	SANDSTONE, fine to medium grained, grey
	Run 15	100	100			MUDSTONE, dark grey
	Run 16	100	100	-16.0	42.0	SANDSTONE, fine to medium grained, light grey
	Run 17	100	100	-18.0	44.0	INTERBEDDED SILTSTONE/SANDSTONE
	Run 18	100	100	-20.0	46.0	SANDSTONE, medium to coarse grained, light grey
	Run 19	100	100	-22.0	48.0	
	Run 20	100	100	-24.0	50.0	
	Run 21	100	100	-26.0		
	Run 22	100	100	-28.0	52.0 / 54.0	SANDSTONE, medium grained, light grey
	Run 23	100	100	-30.0	56.0	SANDSTONE, fine grained, light grey
	Run 24	100	100	-32.0	58.0	SANDSTONE, fine to medium grained, light grey
	Run 25	100	100	-34.0	60.0	SANDSTONE, fine grained, mid grey

Other column headings: Ground Water, Graphic Log, Defect Spacing (mm) (20, 60, 200, 600, 2000)

Piezometer Details

- **Construction details:** -
- **Pipe diameter:** 60 mm
- **Pipe Top:** 0.0 mBGL
- **Pipe Base:** 56.0 mBGL
- **Screen Top:** 56.0 mBGL
- **Screen/Sensor Base:** 59.0 mBGL
- **Instrument Details:** -
- **Installation Date:** 7/12/2016
- **Development Date:** -

Depth	Material
Depth 3.0 to 51.0 m	GROUT BENTONITE
Depth 51.0 to 53.6 m	BENTONITE
Depth 53.6 to 56.0 m	FILTER SAND
Depth 56.0 to 59.0 m	PVC SLOTTED SECTION
Depth 59.0 to 61.4 m	FILTER SAND

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH60

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** RKG	**Checked by:**
Location: Opposite 48 Justin Street, Lilyfield		**Start Date:** 29/11/2016	**End Date:** 8/12/2016
Driller:	**Hole Diameter:** -	**Easting:** 330317.8 m	**RL:** 25.04 m
Drill Rig:	**Inclination:** -90°	**Northing:** 6250589.6 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data

Method	Core Run	TCR (%)	RQD (%)	Ground Water
HQ3	Run 26	100	100	
HQ3	Run 27	100	100	
HQ3	Run 28	100	97	
HQ3	Run 29	100	91	
HQ3	Run 30	100	100	
HQ3	Run 31	100	100	
HQ3	Run 32	100	97	

Reduced Level (m)	Depth (m)
-36.0	62.0
-38.0	64.0
-40.0	66.0
-42.0	68.0
-44.0	70.0
-46.0	72.0
-48.0	74.0
-50.0	76.0
-52.0	78.0
-54.0	80.0
-56.0	82.0
-58.0	84.0
-60.0	86.0
-62.0	88.0
-64.0	90.0

Graphic Log

Rock Description

Summary Geology (refer to geological log for full descriptions)

SANDSTONE, fine grained, mid grey *continued*

SANDSTONE, medium to coarse grained, light grey

SANDSTONE, fine to medium grained, light grey

SANDSTONE, fine to medium grained, light grey

SANDSTONE, fine to medium grained, light grey

SANDSTONE, fine to medium grained, light grey

SANDSTONE, fine to medium grained, light grey

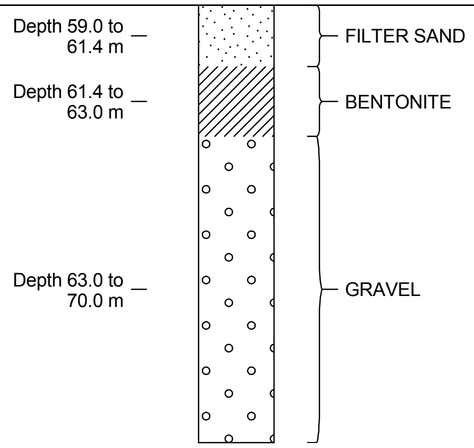
RZ_BH60 Terminated at 70.14 m.

Defect Spacing (mm)

20 60 200 600 2000

Piezometer Details

Construction details: -
Pipe diameter: 60 mm
Pipe Top: 0.0 mBGL
Pipe Base: 56.0 mBGL
Screen Top: 56.0 mBGL
Screen/Sensor Base: 59.0 mBGL
Instrument Details: -
Installation Date: 7/12/2016
Development Date: -



REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH64

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** MC	**Checked by:**
Location: Brockley Street, Rozelle		**Start Date:** 13/12/2016	**End Date:** 21/12/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330625.4 m	**RL:**
Drill Rig: DR009	**Inclination:** -90°	**Northing:** 6250950.8 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Piezometer Details

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 46.0 m above ground level
Pipe Base: 49.0 mBGL
Screen Top: 46.0 mBGL
Screen/Sensor Base: 49.0 mBGL
Instrument Details: -
Installation Date: 21/12/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
NDD							ASPHALT
AD						2.0	GRAVEL, medium to coarse grained, dark grey
HQ3	Run 1	90	82			4.0	GRAVEL and COBBLES, grey-brown
							SAND, medium grained, orange-brown to red-brown
	Run 2	100	98			6.0	SANDSTONE, medium to coarse grained, red-brown
						8.0	NO CORE
							SANDSTONE, medium to coarse grained, red-brown
	Run 3	100	100			10.0	SANDSTONE, medium to coarse grained, light grey
	Run 4	100	100			12.0	
						14.0	SANDSTONE, medium to coarse grained
	Run 5	100	100			16.0	SANDSTONE, fine to medium grained, light grey
	Run 6	100	100			18.0	SANDSTONE, fine to medium grained, light grey
	Run 7	100	100			20.0 / 22.0	
	Run 8	100	100			24.0 / 26.0	
							SANDSTONE, fine to medium grained, light grey and mid grey
	Run 9	100	100			28.0	SANDSTONE, fine to medium grained, light grey
						30.0	

Defect Spacing (mm): 20, 60, 200, 600, 2000

Depth	Construction
Depth 0.0 to 0.1 m	GATIC COVER
Depth 0.1 to 1.0 m	BENTONITE
Depth 1.0 to 42.0 m	GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH64

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	MC	**Checked by:**	
Location:	Brockley Street, Rozelle	**Start Date:**	13/12/2016	**End Date:**	21/12/2016
Driller:	Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330625.4 m	**RL:**	
Drill Rig:	DR009	**Inclination:** -90°	**Northing:** 6250950.8 m	**Ver. Datum:**	AHD
		Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:**	Asphalt

Field Data / Rock Description

Method: HQ3

Core Run	TCR (%)	RQD (%)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
Run 10	100	100		
Run 11	100	100	32.0	SANDSTONE, medium to coarse grained, light grey
Run 12	100	100	34.0–36.0	SANDSTONE, fine to medium grained, brown-grey
Run 13	100	98	38.0	SANDSTONE, fine to medium grained, light grey
Run 14	100	85	40.0	SANDSTONE, brown-grey
Run 15	100	80	42.0	SANDSTONE, fine to medium grained, light grey
Run 16	100	95	44.0	SANDSTONE, medium to coarse grained, pinkish brown
Run 17	95	79	46.0	SANDSTONE, fine to medium grained, dark grey
				NO CORE
Run 18	100	90	48.0	SANDSTONE, fine to medium grained, light grey
Run 19	100	100	50.0	SANDSTONE, fine to medium grained, light grey
Run 20	100	65	52.0	SANDSTONE, fine to medium grained, light grey
				SANDSTONE, fine grained, light grey
			54.0	MUDSTONE, dark brown
Run 21	100	100	56.0	SANDSTONE, fine to medium grained, light grey
Run 22	100	100	58.0–60.0	SANDSTONE, fine to medium grained, light grey

RZ_BH64 Terminated at 60.00 m.

Piezometer Details

Construction Details: -
Pipe Diameter: 50 mm
Pipe Top: 46.0 m above ground level
Pipe Base: 49.0 mBGL
Screen Top: 46.0 mBGL
Screen/Sensor Base: 49.0 mBGL
Instrument Details: -
Installation Date: 21/12/2016
Development Date: -

Depth	Material
Depth 1.0 to 42.0 m	GROUT
Depth 42.0 to 44.0 m	BENTONITE
Depth 44.0 to 46.0 m	FILTER SAND
Depth 46.0 to 49.0 m	PVC SLOTTED SECTION with FILTER SOCK with 2mm FILTER SAND
Depth 49.0 to 51.0 m	BENTONITE
Depth 51.0 to 53.0 m	GROUT (used GRAVEL)
Depth 53.0 to 60.0 m	GROUT (if reaming required)

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. RZ_BH67

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** HW/NB	**Checked by:**
Location: Opposite 53 Alfred Street, Lilyfield		**Start Date:** 8/12/2016	**End Date:** 15/12/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330961.5 m	**RL:** 12.91 m
Drill Rig: Delta Base 525	**Inclination:** -90°	**Northing:** 6250999.7 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data / Rock Description / Piezometer Details

Construction Details: -
Pipe Diameter: 60 mm
Pipe Top: 0.0 mBGL
Pipe Base: 51.0 mBGL
Screen Top: 46.0 mBGL
Screen/Sensor Base: 49.0 mBGL
Instrument Details: -
Installation Date: 14/12/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Summary Geology (refer to geological log for full descriptions)
CADD				ASPHALTIC CONCRETE
HQ3	Run 1	88	40	Sandy GRAVEL, fine to medium grained, light grey, brown
	Run 2	98	88	SANDSTONE, fine to coarse grained, light grey
				SANDSTONE, medium to coarse grained, red-brown
	Run 3	95	93	SANDSTONE, fine to coarse grained, light brown, red-brown
				NO CORE
	Run 4	98	98	SANDSTONE, fine to coarse grained, light brown, red-brown
				SANDSTONE, medium to coarse grained, light grey
	Run 5	89	62	NO CORE
				SANDSTONE, medium to coarse grained, light grey
				SANDSTONE, coarse grained, light grey
	Run 6	70	56	NO CORE
				SANDSTONE, coarse grained, light grey
	Run 7	97	85	SANDSTONE, medium to coarse grained, light grey
				NO CORE
	Run 8	100	92	SANDSTONE, fine to coarse grained, light - mid grey
				NO CORE
	Run 9	100	96	SANDSTONE, fine to coarse grained, light - mid grey
				SANDSTONE, coarse grained, light grey
				NO CORE
	Run 10	100	88	SANDSTONE, coarse grained, light grey
				SANDSTONE, medium to coarse grained, light grey

Piezometer details:

Depth	Material
Depth 0.0 to 0.1 m	GATIC
Depth 0.1 to 1.0 m	BENTONITE
Depth 1.0 to 40.5 m	GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log**

PIEZOMETER No. **RZ_BH67**

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** HW/NB	**Checked by:**
Location: Opposite 53 Alfred Street, Lilyfield		**Start Date:** 8/12/2016	**End Date:** 15/12/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330961.5 m	**RL:** 12.91 m
Drill Rig: Delta Base 525	**Inclination:** -90°	**Northing:** 6250999.7 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data / Rock Description / Piezometer Details

Construction Details: -
Pipe Diameter: 60 mm
Pipe Top: 0.0 mBGL
Pipe Base: 51.0 mBGL
Screen Top: 46.0 mBGL
Screen/Sensor Base: 49.0 mBGL
Instrument Details: -
Installation Date: 14/12/2016
Development Date: -

Method: HQ3

Core Run	TCR (%)	RQD (%)
Run 11	100	90
Run 12	100	95
Run 13	98	98
Run 14	100	98
Run 15	100	99
Run 16	100	100
Run 17	100	97
Run 18	99	99
Run 19	97	93
Run 20	97	94
Run 21	100	88
Run 22	88	77

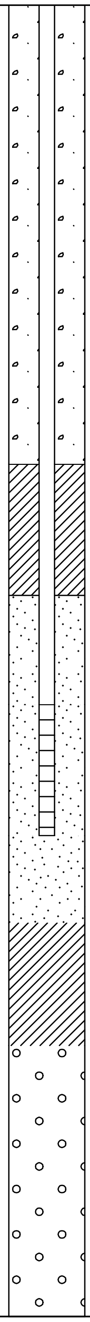
Reduced Level (m): 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0, 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0

Depth (m): 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0

Summary Geology (refer to geological log for full descriptions):

- NO CORE
- SANDSTONE, medium grained
- SANDSTONE, coarse grained, light grey
- SANDSTONE, fine to medium grained
- SANDSTONE, medium to coarse grained, light grey *continued*
- SANDSTONE, fine to coarse grained, light grey
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, coarse grained, brown, light brown
- SANDSTONE, fine to coarse grained, light grey
- SANDSTONE, fine to coarse grained, light brown grey
- SHALE BRECCIA
- SANDSTONE, fine to medium grained, brown grey
- SANDSTONE, coarse grained, light grey
- SANDSTONE, fine to medium grained, mid grey
- SANDSTONE, fine to coarse grained, light-mid brown grey
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, fine to medium grained, mid-grey
- NO CORE
- SANDSTONE, medium to coarse grained, light grey
- SANDSTONE, medium to coarse grained, light grey

Defect Spacing (mm): 20 60 200 600 2000



Depth	Piezometer
Depth 1.0 to 40.5 m	GROUT
Depth 40.5 to 43.5 m	BENTONITE
Depth 43.5 to 46.0 m	FILTER SAND
Depth 46.0 to 49.0 m	PVC SLOTTED SECTION with FILTER SOCK and FILTER SAND
Depth 49.0 to 51.0 m	FILTER SAND
Depth 51.0 to 53.8 m	BENTONITE
Depth 53.8 to 60.0 m	GRAVEL

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log**

PIEZOMETER No. RZ_BH67

Client: Sydney Motorway Corporation	**Project No:** 60493796		
Project: M4-M5 Link Geotech Investigation	**Logged by:** HW/NB	**Checked by:**	
Location: Opposite 53 Alfred Street, Lilyfield	**Start Date:** 8/12/2016	**End Date:** 15/12/2016	
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330961.5 m	**RL:** 12.91 m
Drill Rig: Delta Base 525	**Inclination:** -90°	**Northing:** 6250999.7 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data (Method, Core Run, TCR (%), RQD (%), Ground Water, Reduced Level (m), Depth (m), Graphic Log)

Rock Description — Summary Geology (refer to geological log for full descriptions); Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details:	-
Pipe Diameter:	60 mm
Pipe Top:	0.0 mBGL
Pipe Base:	51.0 mBGL
Screen Top:	46.0 mBGL
Screen/Sensor Base:	49.0 mBGL
Instrument Details:	-
Installation Date:	14/12/2016
Development Date:	-

Reduced Level (m): -48.0, -50.0, -52.0, -54.0, -56.0, -58.0, -60.0, -62.0, -64.0, -66.0, -68.0, -70.0, -72.0, -74.0, -76.0

Depth (m): 62.0, 64.0, 66.0, 68.0, 70.0, 72.0, 74.0, 76.0, 78.0, 80.0, 82.0, 84.0, 86.0, 88.0, 90.0

Summary Geology
NO CORE
SANDSTONE, coarse grained, light grey
NO CORE
SANDSTONE, coarse grained, light grey
SANDSTONE, fine to medium grained, light grey
SANDSTONE, coarse grained, light grey
SANDSTONE, medium to coarse grained, light grey
NO CORE

RZ_BH67 Terminated at 60.00 m.

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log** **PIEZOMETER No.** **RZ_BH69**

Client:	Sydney Motorway Corporation		**Project No:**	60493796	
Project:	M4-M5 Link Geotech Investigation		**Logged by:**	RKG	**Checked by:**
Location:	Albion Street, Rozelle		**Start Date:**	17/01/2017	**End Date:** 25/01/2017
Driller:		**Hole Diameter:** -	**Easting:**	330556.1 m	**RL:**
Drill Rig:		**Inclination:** -90°	**Northing:**	6251217.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Road Surface

Field Data

Method	Core Run	TCR (%)	RQD (%)
HQ3	Run 1	0	0
HQ3	Run 2	81	50
HQ3	Run 3	91	42
HQ3	Run 4	100	82
HQ3	Run 5	100	60
HQ3	Run 6	100	78
HQ3	Run 7	130	58
HQ3	Run 8	40	40
HQ3	Run 9	98	93
HQ3	Run 10	100	93
HQ3	Run 11	100	100
HQ3	Run 12	100	63
HQ3	Run 13	67	100

Ground Water: 23/01/2017; 20/01/2017; 17/01/2017

Reduced Level (m)

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Graphic Log

Rock Description

Summary Geology (refer to geological log for full descriptions)

- ASPHALTIC CONCRETE
- SAND, fine to medium grained, orange-brown to brown
- SAND (60%), fine to medium grained
- SANDSTONE, fine to medium grained, yellow-brown to light orange-brown
- NO CORE
- SANDSTONE, fine to medium grained, orange-brown to yellow-brown
- NO CORE
- SANDSTONE, fine to medium grained, light brown to light grey, speckled yellow-brown
- SANDSTONE, fine to medium grained, orange-brown
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, fine to medium grained, light grey
- NO CORE
- SANDSTONE, fine to medium grained, light grey
- SANDSTONE, medium grained, light grey
- SILTSTONE, dark grey
- BRECCIA, light grey to mid grey
- SILTSTONE, dark grey

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction details:	-
Pipe diameter:	96 mm
Pipe Top:	0.0 mBGL
Pipe Base:	41.0 mBGL
Screen Top:	38.0 mBGL
Screen/Sensor Base:	41.8 mBGL
Instrument Details:	-
Installation Date:	24/01/2017
Development Date:	-

Depth 0.0 to 1.0 m — GATIC COVER

Depth 1.0 to 34.0 m — GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log** **PIEZOMETER No.** **RZ_BH69**

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** RKG	**Checked by:**
Location: Albion Street, Rozelle		**Start Date:** 17/01/2017	**End Date:** 25/01/2017
Driller:	**Hole Diameter:** -	**Easting:** 330556.1 m	**RL:**
Drill Rig:	**Inclination:** -90°	**Northing:** 6251217.0 m	**Ver. Datum:** mAHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Road Surface

Field Data / Rock Description / Piezometer Details

Construction details: -
Pipe diameter: 96 mm
Pipe Top: 0.0 mBGL
Pipe Base: 41.0 mBGL
Screen Top: 38.0 mBGL
Screen/Sensor Base: 41.8 mBGL
Instrument Details: -
Installation Date: 24/01/2017
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 14	100	100			32.0	SANDSTONE, fine to medium grained, light grey to mid grey SANDSTONE, medium grained, light grey *continued*
	Run 15	100	90			34.0	
	Run 16	100	68			36.0	SANDSTONE, fine grained, mid grey
	Run 17	100	83			38.0	SANDSTONE, medium grained, light grey
	Run 18	100	75			40.0 / 42.0	
	Run 19	100	82			44.0	SANDSTONE, fine to medium grained, light grey
	Run 20	100	82			46.0	
	Run 21	100	92			48.0 / 50.0	BRECCIA SANDSTONE, fine grained, light grey
						52.0 / 54.0 / 56.0 / 58.0 / 60.0	*RZ_BH69 Terminated at 50.00 m.*

Defect Spacing (mm): 20, 60, 200, 600, 2000

Depth	Piezometer Details
Depth 1.0 to 34.0 m	GROUT
Depth 34.0 to 36.0 m	BENTONITE
Depth 36.0 to 38.0 m	FILTER SAND
Depth 38.0 to 41.0 m	PVC SLOTTED SECTION with FILTER SOCK and FILTER SAND
Depth 41.0 to 42.8 m	FILTER SAND
Depth 42.8 to 50.0 m	GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. SP_BH01

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** HW/NB	**Checked by:** BF
Location: May Street, Playground, cnr Applebee St, St Peters		**Start Date:** 30/08/2016	**End Date:** 7/09/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331750.6 m	**RL:** 17.80 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6246432.7 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Concrete

Field Data

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)
NDD						
CA					16.0	2.0
HQ3	Run 1	100	0			
HQ3	Run 2	100	0		14.0	4.0
HQ3	Run 3	100	0		12.0	6.0
HQ3	Run 4	100	7			
HQ3	Run 5	100	0		10.0	8.0
HQ3	Run 6	100	16		8.0	10.0
HQ3	Run 7	100	100		6.0	12.0
HQ3	Run 8	100	85			
HQ3	Run 9	100	85		4.0	14.0
HQ3	Run 10	100	90		2.0	16.0
HQ3	Run 11	100	100		0.0	18.0
HQ3	Run 12	100	91			
HQ3	Run 13	100	97		-2.0	20.0
HQ3	Run 14	100	78		-4.0	22.0
HQ3	Run 15	100	0	90%		
HQ3	Run 16	100	90		-6.0	24.0
HQ3	Run 17	100	90			
HQ3	Run 18	100	66		-8.0	26.0
HQ3	Run 19	100	94		-10.0	28.0
HQ3	Run 20	100	99			30.0

Rock Description

Summary Geology (refer to geological log for full descriptions) — Defect Spacing (mm): 20, 60, 200, 600, 2000

- CONCRETE
- Silty CLAY, orange-brown
- Silty CLAY, orange-brown and red-brown
- Silty CLAY, light grey and red-brown
- Silty CLAY, light grey mottled red-brown
- MUDSTONE, light grey mottled red-brown
- MUDSTONE, grey and light grey
- LAMINITE
- MUDSTONE, dark grey
- LAMINITE

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	39.0 mBGL
Screen Top:	39.0 mBGL
Screen/Sensor Base:	36.0 mBGL
Instrument Details:	-
Installation Date:	8/09/2016
Development Date:	-

Depth 0.0 to 0.5 m — GATIC COVER

Depth 0.5 to 31.9 m — GROUT

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

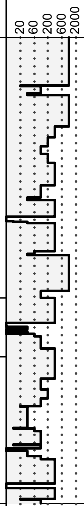
PIEZOMETER No. SP_BH01

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** HW/NB	**Checked by:** BF
Location: May Street, Playground, cnr Applebee St, St Peters		**Start Date:** 30/08/2016	**End Date:** 7/09/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331750.6 m	**RL:** 17.80 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6246432.7 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Concrete

Field Data / Rock Description

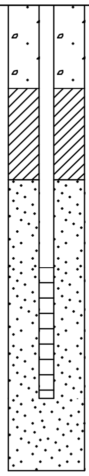
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 21	100	85				MUDSTONE, dark grey *continued*
	Run 22	100	100		-14.0	32.0	
	Run 23	100	79		-16.0	34.0	
	Run 24	100	90		-18.0	36.0	
	Run 25	100	73				LAMINITE
	Run 26	100	58		-20.0	38.0	MUDSTONE, dark grey
	Run 27	100	51		-22.0	40.0	
	Run 28	100	95				
							SP_BH01 Terminated at 40.66 m.
					-24.0	42.0	
					-26.0	44.0	
					-28.0	46.0	
					-30.0	48.0	
					-32.0	50.0	
					-34.0	52.0	
					-36.0	54.0	
					-38.0	56.0	
					-40.0	58.0	
						60.0	

Defect Spacing (mm)



Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 39.0 mBGL
Screen Top: 39.0 mBGL
Screen/Sensor Base: 36.0 mBGL
Instrument Details: -
Installation Date: 8/09/2016
Development Date: -



Depth	Detail
Depth 0.5 to 31.9 m	GROUT
Depth 31.9 to 34.0 m	BENTONITE
Depth 34.0 to 36.0 m	FILTER SAND
Depth 36.0 to 39.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 39.0 to 40.7 m	FILTER SAND

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. SP_BH02

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB	**Checked by:** BF
Location: Barwon Park Road, St Peters		**Start Date:** 25/05/2016	**End Date:** 30/05/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331844.8 m	**RL:** 19.49 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6246375.9 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Concrete

Field Data

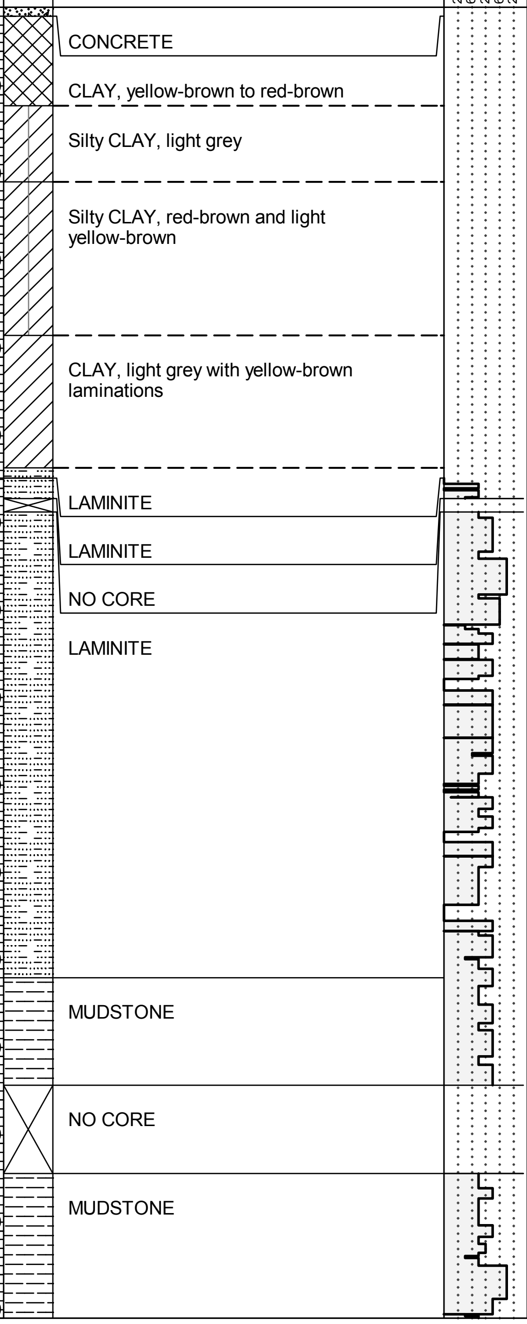
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)
NDD					18.0	2.0
ADT					16.0	4.0
					14.0	6.0
					12.0	8.0
					10.0	10.0
HQ3	Run 1	100	0	NOT OBSERVED	8.0	12.0
	Run 2	79	52		6.0	14.0
	Run 3	100	88		4.0	16.0
	Run 4	100	70		2.0	18.0
	Run 5	100	68		0.0	20.0
	Run 6	100	83		-2.0	22.0
	Run 7	33	24		-4.0	24.0
	Run 8	100	100		-6.0	26.0
	Run 9	100	62		-8.0	28.0
	Run 10	100	32		-10.0	30.0
	Run 11	100	100			

Rock Description

Summary Geology (refer to geological log for full descriptions)

- CONCRETE
- CLAY, yellow-brown to red-brown
- Silty CLAY, light grey
- Silty CLAY, red-brown and light yellow-brown
- CLAY, light grey with yellow-brown laminations
- LAMINITE
- LAMINITE
- NO CORE
- LAMINITE
- MUDSTONE
- NO CORE
- MUDSTONE

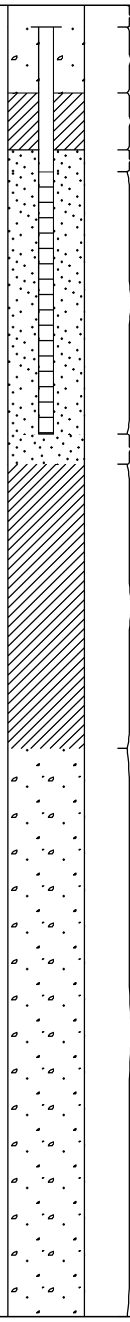
Defect Spacing (mm): 20, 60, 200, 600, 2000



Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 9.8 mBGL
Screen Top: 3.8 mBGL
Screen/Sensor Base: 9.8 mBGL
Instrument Details: -
Installation Date: 30/05/2016
Development Date: -

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 2.0 m	GROUT
Depth 2.0 to 3.3 m	BENTONITE
Depth 3.3 to 3.8 m	FILTER SAND
Depth 3.8 to 9.8 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 9.8 to 10.5 m	FILTER SAND
Depth 10.5 to 17.0 m	BENTONITE
Depth 17.0 to 46.0 m	BENTONITE + CEMENT



REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. SP_BH02

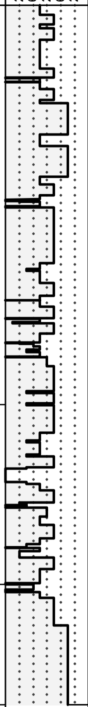
Client:	Sydney Motorway Corporation		**Project No:**	60493796	
Project:	M4-M5 Link Geotech Investigation		**Logged by:**	NB	**Checked by:** BF
Location:	Barwon Park Road, St Peters		**Start Date:**	25/05/2016	**End Date:** 30/05/2016
Driller:	Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:**	331844.8 m	**RL:** 19.49 m
Drill Rig:	Hydrapower Scout	**Inclination:** -90°	**Northing:**	6246375.9 m	**Ver. Datum:** AHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Concrete

Field Data / Rock Description / Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 9.8 mBGL
Screen Top: 3.8 mBGL
Screen/Sensor Base: 9.8 mBGL
Instrument Details: -
Installation Date: 30/05/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3		100	85	NOT OBSERVED			MUDSTONE *continued*
	Run 13	100	97		-12.0	32.0	
	Run 14	100	80		-14.0	34.0	
					-16.0	36.0	
	Run 15	100	74		-18.0	38.0	
	Run 16	100	88		-20.0	40.0	LAMINITE
	Run 17	100	73		-22.0	42.0	
	Run 18	100	38				
	Run 19	100	81		-24.0	44.0	MUDSTONE, dark grey
					-26.0	46.0	*SP_BH02 Terminated at 46.00 m.*
					-28.0	48.0	
					-30.0	50.0	
					-32.0	52.0	
					-34.0	54.0	
					-36.0	56.0	
					-38.0	58.0	
					-40.0	60.0	

Defect Spacing (mm): 20 60 200 600 2000



Depth 17.0 to 46.0 m — BENTONITE + CEMENT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM **Engineering Log**

PIEZOMETER No. SP_BH04

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** LH	**Checked by:** BF
Location: Applebee St, St Peters		**Start Date:** 17/07/2016	**End Date:** 26/07/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331658.0 m	**RL:** 12.31 m
Drill Rig: Delta 550	**Inclination:** -90°	**Northing:** 6246185.6 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Concrete

Field Data

Method	Core Run	TCR (%)	RQD (%)
NDD			
CA			
HQ3	Run 1	100	0
HQ3	Run 2	100	0
HQ3	Run 3	100	87
HQ3	Run 4	100	100
HQ3	Run 5	100	93
HQ3	Run 6	100	100
HQ3	Run 7	100	100
HQ3	Run 8	100	96
HQ3	Run 9	100	93
HQ3	Run 10	100	100
HQ3	Run 11	100	97
HQ3	Run 12	100	100
HQ3	Run 13	100	83
HQ3	Run 14	100	100
HQ3	Run 15	100	100
HQ3	Run 16	100	100
HQ3	Run 17	100	100
HQ3	Run 18	100	100
HQ3	Run 19	100	93
HQ3	Run 20	100	93

Ground Water | Reduced Level (m): 12.0, 10.0, 8.0, 6.0, 4.0, 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0 | Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0 | Graphic Log

Rock Description

Summary Geology (refer to geological log for full descriptions)

- CONCRETE
- Sandy GRAVEL, coarse grained, dark grey
- CLAY, mottled brown-white
- MUDSTONE, light grey
- MUDSTONE, light grey
- LAMINITE
- MUDSTONE, dark grey
- MUDSTONE, dark grey
- MUDSTONE, dark grey

Defect Spacing (mm): 20 60 200 600 2000

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	9.8 mBGL
Screen Top:	3.8 mBGL
Screen/Sensor Base:	9.8 mBGL
Instrument Details:	-
Installation Date:	30/05/2016
Development Date:	-

Depth	Material
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 26.6 m	GROUT
Depth 26.6 to 28.6 m	BENTONITE
Depth 28.6 to 30.6 m	FILTER SAND

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. SP_BH04

Sheet: 2 of 2

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	LH	**Checked by:**	BF
Location:	Applebee St, St Peters	**Start Date:**	17/07/2016	**End Date:**	26/07/2016
Driller:	Hagstrom Drilling Pty Ltd	**Easting:**	331658.0 m	**RL:**	12.31 m
Drill Rig:	Delta 550	**Northing:**	6246185.6 m	**Ver. Datum:**	AHD
		Hor. Proj/Dat:	MGA94/GDA94-56H	**Surface:**	Concrete

Hole Diameter: 96 mm
Inclination: -90°
Bearing: N/A

Field Data / Rock Description / Piezometer Details

Method	Core Run	TCR (%)	RQD (%)	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 21	100	100	18.0		MUDSTONE, dark grey *continued*
	Run 22	100	90	20.0	32.0	LAMINITE
	Run 23	100	30			
	Run 24	100	93	22.0	34.0	
	Run 25	100	100		36.0	
	Run 26	100	100	24.0		
	Run 27	100	100	26.0	38.0	MUDSTONE, dark grey
	Run 28	100	100		40.0	
				28.0		*SP_BH04 Terminated at 40.00 m.*
				30.0	42.0	
				32.0	44.0	
				34.0	46.0	
				36.0	48.0	
				38.0	50.0	
				40.0	52.0	
				42.0	54.0	
				44.0	56.0	
				46.0	58.0	
					60.0	

Columns also include: Ground Water, Graphic Log, Defect Spacing (mm) (20, 60, 200, 600, 2000).

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 9.8 mBGL
Screen Top: 3.8 mBGL
Screen/Sensor Base: 9.8 mBGL
Instrument Details: -
Installation Date: 30/05/2016
Development Date: -

Depth	Piezometer
	FILTER SAND
Depth 30.6 to 33.6 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 33.6 to 37.0 m	FILTER SAND
Depth 37.0 to 40.0 m	BENTONITE

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. **SP_BH06**

Sheet: 1 of 2

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	BH/DC	**Checked by:**	BF
Location:	Crown Street, St Peters	**Start Date:**	26/05/2016	**End Date:**	6/06/2016
Driller:	Numac Drilling Pty Ltd	**Easting:**	331800.1 m	**RL:**	13.28 m
Drill Rig:	Geoprobe 205	**Northing:**	6246136.1 m	**Ver. Datum:**	AHD
Hole Diameter:	96 mm	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Asphalt
Inclination:	-90°				
Bearing:	N/A				

Field Data / Rock Description / Piezometer Details

Construction Details: Machine slotted PVC
Pipe Diameter: 50 mm
Pipe Top: 20.0 mBGL
Pipe Base: 23.0 mBGL
Screen Top: 18.0 mBGL
Screen/Sensor Base: 25.0 mBGL
Instrument Details: -
Installation Date: 6/06/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Graphic Log	Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm) 20 60 200 600 2000
NDD								ASPHALT	
					12.0	2.0		Gravelly SAND	
ADT					10.0	4.0		Silty CLAY, dark grey	
								MUDSTONE	
HQ3	Run 1	100	100						
	Run 2	97	87		8.0	6.0		INTERBEDDED MUDSTONE/SANDSTONE	
	Run 3	100	100		6.0			NO CORE	
	Run 4	100	99			8.0		INTERBEDDED MUDSTONE/SANDSTONE	
	Run 5	100	100		4.0	10.0		LAMINITE	
	Run 6	100	100		2.0	12.0			
	Run 7	100	100		0.0			MUDSTONE	
	Run 8	100	100			14.0		LAMINITE	
	Run 9	100	100		-2.0	16.0		MUDSTONE	
	Run 10	100	100		-4.0	18.0			
	Run 11	100	99		-6.0				
	Run 12	100	77			20.0			
	Run 13	100	44		-8.0	22.0			
	Run 14	100	97		-10.0	24.0		MUDSTONE	
	Run 15	100	40		-12.0				
	Run 16	100	91			26.0			
	Run 17	100	96		-14.0	28.0			
	Run 18	100	83		-16.0	30.0			

Depth	Piezometer Details
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 16.0 m	BENTONITE-CEMENT GROUT
Depth 16.0 to 18.0 m	BENTONITE
Depth 18.0 to 20.0 m	FILTER SAND
Depth 20.0 to 23.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 23.0 to 25.0 m	FILTER SAND
Depth 25.0 to 27.0 m	BENTONITE
Depth 27.0 to 40.0 m	BENTONITE + CEMENT GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. SP_BH06

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	BH/DC	**Checked by:**	BF
Location:	Crown Street, St Peters	**Start Date:**	26/05/2016	**End Date:**	6/06/2016
Driller:	Numac Drilling Pty Ltd	**Hole Diameter:**	96 mm	**Easting:**	331800.1 m
RL:	13.28 m	**Inclination:**	-90°	**Northing:**	6246136.1 m
Drill Rig:	Geoprobe 205	**Ver. Datum:**	AHD	**Bearing:**	N/A
Hor. Proj/Dat:	MGA94/GDA94-56H	**Surface:**	Asphalt		

Piezometer Details

Construction Details:	Machine slotted PVC
Pipe Diameter:	50 mm
Pipe Top:	20.0 mBGL
Pipe Base:	23.0 mBGL
Screen Top:	18.0 mBGL
Screen/Sensor Base:	25.0 mBGL
Instrument Details:	-
Installation Date:	6/06/2016
Development Date:	-

Field Data / **Rock Description**

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 19	100	75		-18.0	32.0	MUDSTONE *continued*
	Run 20	100	96				
	Run 21	100	100		-20.0	34.0	LAMINITE
	Run 22	100	100		-22.0	36.0	MUDSTONE
	Run 23	100	100				LAMINITE
	Run 24	100	100		-24.0	38.0	
	Run 25	100	100		-26.0	40.0	
							SP_BH06 Terminated at 40.00 m.

Reduced Level / Depth scale continues: -28.0 / 42.0; -30.0 / 44.0; -32.0 / 46.0; -34.0 / 48.0; -36.0 / 50.0; -38.0 / 52.0; -40.0 / 54.0; -42.0 / 56.0; -44.0 / 58.0; -46.0 / 60.0

Defect Spacing (mm): 20 60 200 600 2000

Depth 27.0 to 40.0 m — BENTONITE + CEMENT GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

Client: Sydney Motorway Corporation		**Project No:**	60493796		
Project: M4-M5 Link Geotech Investigation		**Logged by:**	NB	**Checked by:**	BF
Location: WCX2 Yard, SW Corner, 4-16 Campbell St, St Peters		**Start Date:**	20/05/2016	**End Date:**	25/05/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:**	331800.9 m	**RL:**	12.90 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:**	6245948.3 m	**Ver. Datum:**	AHD
	Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Concrete

Field Data

Method	Core Run	TCR (%)	RQD (%)
HA			
ADV			
HQ3	Run 1	100	0
HQ3	Run 2	100	11
HQ3	Run 3	97	89
HQ3	Run 4	100	90
HQ3	Run 5	100	98
HQ3	Run 6	100	93
HQ3	Run 7	100	88
HQ3	Run 8	100	89
HQ3	Run 9	100	99
HQ3	Run 10	100	100
HQ3	Run 11	100	77

Ground Water; Reduced Level (m): 12.0, 10.0, 8.0, 6.0, 4.0, 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Graphic Log

Rock Description

Summary Geology (refer to geological log for full descriptions)

- SAND, fine to coarse grained, dark brown to brown
- SAND, fine grained, dark brown
- Silty CLAY, light yellow-brown
- Silty CLAY, light grey to grey-brown
- LAMINITE
- INTERBEDDED MUDSTONE/SANDSTONE
- LAMINITE
- MUDSTONE
- LAMINITE
- MUDSTONE

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	26.0 mBGL
Screen Top:	23.0 mBGL
Screen/Sensor Base:	26.0 mBGL
Instrument Details:	-
Installation Date:	23/05/2016
Development Date:	-

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 1.0 m	BENTONITE - CEMENT GROUT (HIGHER % OF BENTONITE)
Depth 1.0 to 18.5 m	BENTONITE - CEMENT GROUT
Depth 18.5 to 21.0 m	BENTONITE
Depth 21.0 to 23.0 m	FILTER SAND
Depth 23.0 to 26.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 26.0 to 28.0 m	FILTER SAND
Depth 28.0 to 30.2 m	BENTONITE

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. SP_BH09

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB	**Checked by:** BF
Location: WCX2 Yard, SW Corner, 4-16 Campbell St, St Peters		**Start Date:** 20/05/2016	**End Date:** 25/05/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 331800.9 m	**RL:** 12.90 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6245948.3 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Concrete

Field Data								Rock Description		Piezometer Details
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Graphic Log	Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm) 20 60 200 600 2000	**Construction Details:** Machine slotted PVC pipe **Pipe Diameter:** 50 mm **Pipe Top:** 0.0 mBGL **Pipe Base:** 26.0 mBGL **Screen Top:** 23.0 mBGL **Screen/Sensor Base:** 26.0 mBGL **Instrument Details:** - **Installation Date:** 23/05/2016 **Development Date:** -
								SP_BH09 Terminated at 30.20 m.		
					-18.0	32.0				
					-20.0	34.0				
					-22.0	36.0				
					-24.0	38.0				
					-26.0	40.0				
					-28.0	42.0				
					-30.0	44.0				
					-32.0	46.0				
					-34.0	48.0				
					-36.0	50.0				
					-38.0	52.0				
					-40.0	54.0				
					-42.0	56.0				
					-44.0	58.0				
					-46.0	60.0				

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. TC_BH01

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB/TC	**Checked by:** BF
Location: Brenan Street, Lilyfield		**Start Date:** 24/06/2016	**End Date:** 28/06/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330662.0 m	**RL:** 2.66 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250305.3 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HAADP				0.0–1.0	ASPHALT
ADT				1.0–2.0	CONCRETE
ADT				2.0–3.5	SAND, fine to coarse grained, dark brown-grey
CA				3.5–5.2	SAND, medium to coarse grained, dark brown
CA				5.2–6.3	CLAY, brown to grey-brown
CA				6.3–8.0	SAND, medium to coarse grained, yellow-brown
CA				8.0–9.0	CLAY, dark grey
CA				9.0–11.5	Clayey SAND, fine to medium grained, dark grey to dark brown-grey
HQ3	Run 1	100	92	11.5–12.5	SAND, coarse grained, dark grey
HQ3	Run 2	98	79	12.5–14.2	Clayey SAND, fine to medium grained, dark grey
HQ3				14.2–15.2	CLAY, dark grey
HQ3	Run 3	100	96	15.2–16.3	CLAY, grey to light grey
HQ3				16.3–17.4	Sandy CLAY, grey
HQ3				17.4–18.5	CLAY, dark grey-black
HQ3	Run 4	100	97	18.5–19.5	SAND, coarse grained, brown-grey
HQ3				19.5–21.2	SANDSTONE, medium to coarse grained, light grey
HQ3	Run 5	100	93	21.2–22.3	SANDSTONE, medium grained, light brown
HQ3				22.3–24.0	SANDSTONE, medium to coarse grained, light grey to light yellow
HQ3				24.0–24.9	NO CORE
HQ3	Run 6	100	96	24.9–26.0	SANDSTONE, medium grained, light grey
HQ3				26.0–27.0	SANDSTONE, medium grained, light grey
HQ3				27.0–28.0	SANDSTONE, medium grained, light grey
HQ3	Run 7	98	84	28.0–30.0	SANDSTONE, medium grained, light grey

Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 28.0 mBGL
Screen Top: 25.0 mBGL
Screen/Sensor Base: 28.0 mBGL
Instrument Details: -
Installation Date: 28/06/2016
Development Date: -

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 21.0 m	GROUT
Depth 21.0 to 23.0 m	BENTONITE
Depth 23.0 to 25.0 m	FILTER SAND
Depth 25.0 to 28.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 28.0 to 30.0 m	FILTER SAND

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. **TC_BH01**

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** NB/TC	**Checked by:** BF
Location: Brenan Street, Lilyfield		**Start Date:** 24/06/2016	**End Date:** 28/06/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330662.0 m	**RL:** 2.66 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250305.3 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 8	98	80		to 32.0	SANDSTONE, medium grained, light grey *continued*
						Clayey GRAVEL, fine to coarse grained, dark grey
	Run 9	100	95			SANDSTONE, medium grained, light grey
						SANDSTONE, medium grained, light grey
	Run 10	100	92			
	Run 11	100	98			
	Run 12	100	97			
					44.0	SANDSTONE, medium grained, light grey
	Run 13	100	80			
						SANDSTONE, medium to coarse grained, light grey
	Run 14	100	100			SILTSTONE, dark grey
					50.0	SANDSTONE, medium grained, light grey
						TC_BH01 Terminated at 50.00 m.

Reduced Level (m): -28.0, -30.0, -32.0, -34.0, -36.0, -38.0, -40.0, -42.0, -44.0, -46.0, -48.0, -50.0, -52.0, -54.0, -56.0

Depth (m): 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 28.0 mBGL
Screen Top: 25.0 mBGL
Screen/Sensor Base: 28.0 mBGL
Instrument Details: -
Installation Date: 28/06/2016
Development Date: -

Depth	Backfill
Depth 30.0 to 32.0 m	BENTONITE
Depth 32.0 to 50.0 m	BENTONITE + CEMENT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. TC_BH01A

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** TC	**Checked by:** BF
Location: Brenan Street, Lilyfield		**Start Date:** 29/06/2016	**End Date:** 29/06/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330660.6 m	**RL:** 2.63 m
Drill Rig: Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250304.9 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Asphalt

Field Data | Rock Description | Piezometer Details

Method | Core Run | TCR (%) | RQD (%) | Ground Water | Reduced Level (m) | Depth (m) | Graphic Log

Summary Geology (refer to geological log for full descriptions)

Defect Spacing (mm): 20, 60, 200, 600, 2000

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 6.0 mBGL
Screen Top: 3.5 mBGL
Screen/Sensor Base: 6.0 mBGL
Instrument Details: -
Installation Date: 29/06/2016
Development Date: -

Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Summary Geology
ASPHALT
CONCRETE
SAND, fine to coarse grained, dark brown-grey
SAND, medium to coarse grained, dark brown
CLAY, brown to grey-brown
SAND, medium to coarse grained, yellow-brown
CLAY, dark grey
Clayey SAND, fine to medium grained, dark grey to dark brown-grey
SAND, coarse grained, dark grey
Clayey SAND, fine to medium grained, dark grey
CLAY, dark grey
CLAY, grey to light grey
Sandy CLAY, grey

TC_BH01A Terminated at 8.50 m.

Depth	Piezometer Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 2.0 m	GROUT
Depth 2.0 to 3.0 m	BENTONITE
Depth 3.0 to 3.5 m	FILTER SAND
Depth 3.5 to 6.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 6.0 to 6.5 m	FILTER SAND
Depth 6.5 to 8.0 m	BENTONITE

REMARKS:
GROUNDWATER MONITORING NOTES:

Engineering Log

PIEZOMETER No. **TC_BH06A**

Sheet: 1 of 1

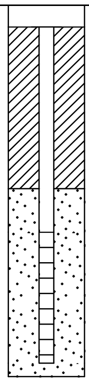
Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	JR	**Checked by:**	BF
Location:	The Crescent	**Start Date:**	29/06/2016	**End Date:**	5/07/2016
Driller:	Hagstrom Drilling Pty Ltd	**Easting:**	330611.4 m	**RL:**	2.72 m
Drill Rig:	Hydrapower Scout	**Northing:**	6250298.3 m	**Ver. Datum:**	AHD
Hole Diameter:	96 mm	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Grass
Inclination:	-90°				
Bearing:	N/A				

Field Data / Rock Description / Piezometer Details

Columns: Method | Core Run | TCR (%) | RQD (%) | Ground Water | Reduced Level (m) | Depth (m) | Graphic Log | Summary Geology (refer to geological log for full descriptions) | Defect Spacing (mm) 20 60 200 600 2000

Reduced Level (m)	Depth (m)	Summary Geology
2.0		Sandy SILT, dark brown
	2.0	Sandy GRAVEL, fine to coarse grained, dark brown
0.0		Clayey SAND, fine to medium grained, light brown/orange to dark grey
	4.0	
-2.0		CLAY, grey
	6.0	Clayey SAND, fine grained, grey-dark grey
-4.0		SAND, fine to medium grained, light grey
	8.0	
-6.0		*TC_BH06A Terminated at 8.50 m.*
	10.0	
-8.0		
	12.0	
-10.0		
	14.0	
-12.0		
	16.0	
-14.0		
	18.0	
-16.0		
	20.0	
-18.0		
	22.0	
-20.0		
	24.0	
-22.0		
	26.0	
-24.0		
	28.0	
-26.0		
	30.0	

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 8.5 mBGL
Screen Top: 5.2 mBGL
Screen/Sensor Base: 8.2 mBGL
Instrument Details: -
Installation Date: 6/07/2016
Development Date: -



Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 4.2 m	BENTONITE
Depth 4.2 to 5.2 m	FILTER SAND
Depth 5.2 to 8.2 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 8.2 to 8.5 m	FILTER SAND

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. TC_BH07

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	TC	**Checked by:**	BF
Location:	Grass Verge, Railway Parade, Annandale	**Start Date:**	1/07/2016	**End Date:**	4/07/2016
Driller:	Hagstrom Drilling Pty Ltd	**Easting:**	330746.0 m	**RL:**	2.12 m
Drill Rig:	Hydrapower Scout	**Northing:**	6250373.6 m	**Ver. Datum:**	AHD
Hole Diameter:	96 mm	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	
Inclination:	-90°				
Bearing:	N/A				

Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
AD				0.0–1.0	SILT
AD				1.0–2.0	SILT, brown
AD				2.0–4.0	SAND, fine to coarse grained, orange-brown
AD				4.0–5.0	Silty CLAY, dark grey
AD				5.0–6.0	SAND, medium grained, dark brown
HQ3	Run 1	100	90	6.0–8.0	SAND, fine to coarse grained, light yellow-brown and orange-brown mottled grey
HQ3				8.0–9.0	Sandy CLAY
HQ3	Run 2	100	80	9.0–10.5	SAND, fine to coarse grained, orange-brown
HQ3				10.5–12.0	SANDSTONE, medium to coarse grained, orange-brown
HQ3	Run 3	100	95	12.0–13.0	SANDSTONE, medium grained, light grey
HQ3				13.0–14.5	SANDSTONE, medium grained, light grey
HQ3	Run 4	100	100	14.5–16.0	SANDSTONE, medium grained, light yellow-brown
HQ3				16.0–17.0	SANDSTONE, medium grained, light grey
HQ3	Run 5	100	85	17.0–18.0	SANDSTONE, medium grained, light grey
HQ3				18.0–19.5	SANDSTONE, medium grained, light grey
HQ3				19.5–21.0	SANDSTONE, medium to coarse grained, light grey
HQ3	Run 6	100	90	21.0–22.5	SHALE BRECCIA, medium grained, light grey
HQ3	Run 7	100	100	22.5–28.0	SANDSTONE, medium grained, light grey
HQ3	Run 8	100	98	28.0–29.5	SANDSTONE, medium grained, light grey

Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 22.0 mBGL
Screen Top: 19.0 mBGL
Screen/Sensor Base: 22.0 mBGL
Instrument Details: -
Installation Date: 5/07/2016
Development Date: -

Depth	Material
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 1.0 m	BENTONITE
Depth 1.0 to 15.0 m	BENTONITE + CEMENT MIX
Depth 15.0 to 17.0 m	BENTONITE
Depth 17.0 to 19.0 m	FILTER SAND
Depth 19.0 to 22.0 m	PVC SLOTTED SECTION with FILTER SAND
Depth 22.0 to 24.0 m	FILTER SAND
Depth 24.0 to 26.0 m	BENTONITE
Depth 26.0 to 40.0 m	BENTONITE + CEMENT MIX

REMARKS:
GROUNDWATER MONITORING NOTES:

Engineering Log

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	TC	**Checked by:**	BF
Location:	Grass Verge, Railway Parade, Annandale	**Start Date:**	1/07/2016	**End Date:**	4/07/2016
Driller:	Hagstrom Drilling Pty Ltd	**Hole Diameter:**	96 mm	**Easting:**	330746.0 m
RL:	2.12 m	**Drill Rig:**	Hydrapower Scout	**Inclination:**	-90°
Northing:	6250373.6 m	**Ver. Datum:**	AHD	**Bearing:**	N/A
Hor. Proj/Dat:	MGA94/GDA94-56H	**Surface:**			

Field Data / Rock Description / Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 22.0 mBGL
Screen Top: 19.0 mBGL
Screen/Sensor Base: 22.0 mBGL
Instrument Details: -
Installation Date: 5/07/2016
Development Date: -

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 9	100	100		-28.0		SANDSTONE, medium grained, light grey *continued*
					-30.0	32.0	SANDSTONE, medium grained, light grey
	Run 10	100	98		-32.0	34.0	SANDSTONE, medium grained, light grey
	Run 11	100	98		-34.0 / -36.0	36.0 / 38.0	
	Run 12	100	100			40.0	
					-38.0		*TC_BH07 Terminated at 40.00 m.*

Defect Spacing (mm): 20, 60, 200, 600, 2000

Reduced Level (m): -40.0, -42.0, -44.0, -46.0, -48.0, -50.0, -52.0, -54.0, -56.0
Depth (m): 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0

Depth 26.0 to 40.0 m — BENTONITE + CEMENT MIX

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. TC_BH07A

Sheet: 1 of 1

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	TC	**Checked by:**	BF
Location:	Grass Verge, Railway Parade, Annandale	**Start Date:**	1/07/2016	**End Date:**	4/07/2016
Driller:	Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330747.4 m	**RL:**	2.13 m
Drill Rig:	Hydrapower Scout	**Inclination:** -90°	**Northing:** 6250375.0 m	**Ver. Datum:**	AHD
		Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:**	

Field Data / Rock Description / Piezometer Details

Method: AD

Columns: Method, Core Run, TCR (%), RQD (%), Ground Water, Reduced Level (m), Depth (m), Graphic Log, Summary Geology (refer to geological log for full descriptions), Defect Spacing (mm) 20 60 200 600 2000

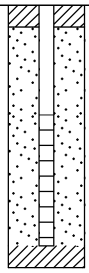
Summary Geology
SILT
SILT
SAND
Silty CLAY, dark grey
SAND
SAND
Sandy CLAY
SAND

TC_BH07A Terminated at 6.00 m.

Depth scale (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Reduced level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 5.5 mBGL
Screen Top: 2.5 mBGL
Screen/Sensor Base: 5.5 mBGL
Instrument Details: -
Installation Date: 6/07/2016
Development Date: -



Depth	Material
Depth 0.0 to 0.5 m	BENTONITE
Depth 0.5 to 2.5 m	FILTER SAND
Depth 2.5 to 5.5 m	PVC SLOTTED SECTION with FILTER SAND
Depth 5.5 to 6.0 m	BENTONITE

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. TC_BH08

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** LH	**Checked by:** BF
Location: Railway Parade, Annandale		**Start Date:** 5/07/2016	**End Date:** 11/07/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330818.3 m	**RL:** 2.32 m
Drill Rig: Delta 550	**Inclination:** -90°	**Northing:** 6250435.9 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

Field Data

Method	Core Run	TCR (%)	RQD (%)
HA			
CA			
HQ3	Run 2	100	75
HQ3	Run 3	43	43
HQ3	Run 4	86	48
HQ3	Run 5	100	80
HQ3	Run 5	100	100
HQ3	Run 6	100	100
HQ3	Run 7	100	100
HQ3	Run 8	100	100
HQ3	Run 9	100	93
HQ3	Run 10	100	80
HQ3	Run 11	100	93
HQ3	Run 12	100	73
HQ3	Run 13	100	100
HQ3	Run 14	100	100
HQ3	Run 15	100	100
HQ3	Run 16	100	100
HQ3	Run 17	100	100
HQ3	Run 18	100	100

Ground Water | Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Graphic Log

Rock Description

Summary Geology (refer to geological log for full descriptions)

- Silty SAND, black
- Silty SAND, fine to medium grained
- Clayey SAND, fine to medium grained, brown
- SAND, medium grained, light brown
- SAND, medium grained, light brown
- CLAY, black
- Sandy CLAY
- Sandy CLAY, medium grained, red-orange
- SAND, medium grained, red
- SANDSTONE, fine grained
- SANDSTONE, medium to coarse grained, brown
- NO CORE
- SANDSTONE, medium to coarse grained, brown
- NO CORE
- SANDSTONE, medium to coarse grained, brown
- MUDSTONE, dark grey
- SANDSTONE, medium grained, light grey mottled grey
- SANDSTONE, medium grained, light grey
- MUDSTONE, dark grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium grained, light grey

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 8.0 mBGL
Screen Top: 5.0 mBGL
Screen/Sensor Base: 8.0 mBGL
Instrument Details: -
Installation Date: 12/07/2016
Development Date: -

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 3.5 m	BENTONITE
Depth 3.5 to 5.0 m	FILTER SAND
Depth 5.0 to 8.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 8.0 to 8.2 m	FILTER SAND
Depth 8.2 to 10.0 m	BENTONITE
Depth 10.0 to 40.0 m	BENTONITE + CEMENT

REMARKS:
GROUNDWATER MONITORING NOTES:

Engineering Log

PIEZOMETER No. TC_BH08

Client: Sydney Motorway Corporation	**Project No:** 60493796		
Project: M4-M5 Link Geotech Investigation	**Logged by:** LH	**Checked by:** BF	
Location: Railway Parade, Annandale	**Start Date:** 5/07/2016	**End Date:** 11/07/2016	
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330818.3 m	**RL:** 2.32 m
Drill Rig: Delta 550	**Inclination:** -90°	**Northing:** 6250435.9 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

Field Data / Rock Description

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Graphic Log	Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm) 20 60 200 600 2000
HQ3	Run 19	100	100		-28.0				
	Run 20	100	100					SANDSTONE, medium grained, light grey	
	Run 21	100	100			32.0			
	Run 22	100	100		-30.0				
	Run 23	100	100			34.0		SANDSTONE, medium grained, light grey	
	Run 24	100	100		-32.0				
	Run 25	100	100			36.0			
	Run 26	100	93		-34.0				
	Run 27	100	100		-36.0	38.0			
	Run 28	100	80			40.0			
					-38.0			*TC_BH08 Terminated at 40.00 m.*	
					-40.0	42.0			
					-42.0	44.0			
					-44.0	46.0			
					-46.0	48.0			
					-48.0	50.0			
					-50.0	52.0			
					-52.0	54.0			
					-54.0	56.0			
					-56.0	58.0			
						60.0			

Piezometer Details

Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 8.0 mBGL
Screen Top: 5.0 mBGL
Screen/Sensor Base: 8.0 mBGL
Instrument Details: -
Installation Date: 12/07/2016
Development Date: -

Depth 10.0 to 40.0 m — BENTONITE + CEMENT

REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. TC_BH09

Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** LH	**Checked by:** BF
Location: Railway Parade, Annandale		**Start Date:** 27/06/2016	**End Date:** 1/07/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330830.3 m	**RL:** 2.32 m
Drill Rig: Delta 550	**Inclination:** -90°	**Northing:** 6250444.5 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

Field Data

Method	Core Run	TCR (%)	RQD (%)
HA			
ADB			
CA			
HQ3	Run 1	92	22
HQ3	Run 2	77	27
HQ3	Run 3	100	67
HQ3	Run 4	100	100
HQ3	Run 5	100	97
HQ3	Run 6	100	100
HQ3	Run 7	100	100
HQ3	Run 8	100	100
HQ3	Run 9	100	88
HQ3	Run 10	100	100
HQ3	Run 11	100	100
HQ3	Run 12	93	93
HQ3	Run 13	107	107
HQ3	Run 14	100	100
HQ3	Run 15	100	100
HQ3	Run 16	100	100
HQ3	Run 17	100	100
HQ3	Run 18	100	100

Columns: Method, Core Run, TCR (%), RQD (%), Ground Water, Reduced Level (m), Depth (m), Graphic Log

Reduced Level (m): 2.0, 0.0, -2.0, -4.0, -6.0, -8.0, -10.0, -12.0, -14.0, -16.0, -18.0, -20.0, -22.0, -24.0, -26.0

Depth (m): 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0

Rock Description

Summary Geology (refer to geological log for full descriptions)

- Gravelly SAND, fine to medium grained, brown
- Clayey SAND, fine to medium grained
- SAND, medium grained, light brown
- Clayey SAND, medium grained, dark grey
- Sandy CLAY, brown to light brown
- SANDSTONE, fine to medium grained, red
- NO CORE
- SANDSTONE, fine to medium grained, red-brown
- NO CORE
- SANDSTONE, medium to coarse grained, dark orange-brown
- BRECCIA, medium grained, light grey
- SANDSTONE, medium grained, light grey
- MUDSTONE, dark grey
- SANDSTONE, medium grained, light grey
- SANDSTONE, medium to coarse grained
- SANDSTONE, medium grained, light grey

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	21.0 mBGL
Screen Top:	21.0 mBGL
Screen/Sensor Base:	24.0 mBGL
Instrument Details:	-
Installation Date:	4/07/2016
Development Date:	-

Depth	Detail
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 16.4 m	GROUT
Depth 16.4 to 19.0 m	BENTONITE
Depth 19.0 to 21.0 m	FILTER SAND
Depth 21.0 to 24.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 24.0 to 25.9 m	FILTER SAND
Depth 25.9 to 28.9 m	BENTONITE
Depth 28.9 to 40.0 m	BENTONITE + CEMENT

REMARKS:

GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. TC_BH09

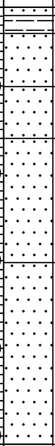
Client: Sydney Motorway Corporation		**Project No:** 60493796	
Project: M4-M5 Link Geotech Investigation		**Logged by:** LH	**Checked by:** BF
Location: Railway Parade, Annandale		**Start Date:** 27/06/2016	**End Date:** 1/07/2016
Driller: Hagstrom Drilling Pty Ltd	**Hole Diameter:** 96 mm	**Easting:** 330830.3 m	**RL:** 2.32 m
Drill Rig: Delta 550	**Inclination:** -90°	**Northing:** 6250444.5 m	**Ver. Datum:** AHD
	Bearing: N/A	**Hor. Proj/Dat:** MGA94/GDA94-56H	**Surface:** Grass

Field Data | **Rock Description** | **Piezometer Details**

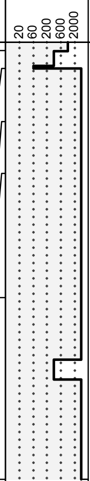
Construction Details: Machine slotted PVC pipe
Pipe Diameter: 50 mm
Pipe Top: 0.0 mBGL
Pipe Base: 21.0 mBGL
Screen Top: 21.0 mBGL
Screen/Sensor Base: 24.0 mBGL
Instrument Details: -
Installation Date: 4/07/2016
Development Date: -

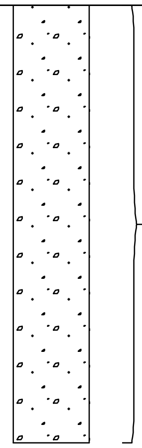
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Summary Geology (refer to geological log for full descriptions)
HQ3	Run 19	100	100		-28.0		MUDSTONE, dark grey
	Run 20	100	100		-30.0	32.0	SANDSTONE, medium to coarse grained, light grey
	Run 21	100	100			34.0	SANDSTONE, medium grained, light grey
	Run 22	100	100		-32.0	36.0	SANDSTONE, medium grained, light grey
	Run 23	100	100		-34.0		SANDSTONE, medium grained, light grey
	Run 24	100	100		-36.0	38.0	
	Run 25	100	100			40.0	
					-38.0		*TC_BH09 Terminated at 40.00 m.*
					-40.0	42.0	
					-42.0	44.0	
					-44.0	46.0	
					-46.0	48.0	
					-48.0	50.0	
					-50.0	52.0	
					-52.0	54.0	
					-54.0	56.0	
					-56.0	58.0	
						60.0	

Graphic Log



Defect Spacing (mm)





REMARKS:
GROUNDWATER MONITORING NOTES:

Engineering Log

PIEZOMETER No. TC_BH09A

Client:	Sydney Motorway Corporation	**Project No:**	60493796		
Project:	M4-M5 Link Geotech Investigation	**Logged by:**	LH	**Checked by:**	BF
Location:	Railway Parade, Annandale	**Start Date:**	27/06/2016	**End Date:**	1/07/2016
Driller:	Hagstrom Drilling Pty Ltd	**Easting:**	330832.7 m	**RL:**	2.35 m
Drill Rig:	Delta 550	**Northing:**	6250445.8 m	**Ver. Datum:**	AHD
Hole Diameter:	96 mm	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:**	Grass
Inclination:	-90°				
Bearing:	N/A				

Field Data

Method | Core Run | TCR (%) | RQD (%) | Ground Water | Reduced Level (m) | Depth (m) | Graphic Log

Rock Description

Summary Geology (refer to geological log for full descriptions)

Defect Spacing (mm): 20 60 200 600 2000

- Gravelly SAND, fine to medium grained, brown
- Clayey SAND, fine to medium grained
- SAND, medium grained, light brown
- Clayey SAND, medium grained, dark grey
- Sandy CLAY, brown to light brown

TC_BH09A Terminated at 7.50 m.

Piezometer Details

Construction Details:	Machine slotted PVC pipe
Pipe Diameter:	50 mm
Pipe Top:	0.0 mBGL
Pipe Base:	2.0 mBGL
Screen Top:	2.0 mBGL
Screen/Sensor Base:	5.0 mBGL
Instrument Details:	-
Installation Date:	4/07/2016
Development Date:	-

Depth	Material
Depth 0.0 to 0.5 m	GATIC COVER
Depth 0.5 to 0.9 m	BENTONITE
Depth 0.9 to 2.0 m	FILTER SAND
Depth 2.0 to 5.0 m	PVC SLOTTED SECTION WITH FILTER SAND
Depth 5.0 to 7.1 m	FILTER SAND
Depth 7.1 to 7.5 m	BENTONITE

REMARKS:The material properties are taken from the adjacent borehole TC_BH09
GROUNDWATER MONITORING NOTES:

Annexure G – Laboratory permeability and porosity data

DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Client:	AECOM	**Source:**	EP_BH04 25.30-25.46m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20465-TP
Job No:	S16175	**Lab No:**	S20465

Test Procedure: ☑ AS1289 6.7.3 DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Undisturbed Sample Condition	Rock Core	Confining Pressure (kPa)	600
		Back Pressure (kPa)	500
		Mean Effective Stress (kPa)	100
		Specimen Saturation Pressure (kPa)	500
		Sample Height (mm)	71.4
		Sample Diameter (mm)	61.0

PERMEABILITY $k_{(20)}$ = **3.2E-08 (m/sec)**

Comments

Permeant Used: Sydney tap water

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Authorised Signatory:

Ian Goldschmidt

25/01/2017

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
Unit 8/10
Bradford Street
Alexandria NSW 2015

DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Client:	AECOM	**Source:**	MT_BH01 59.43-59.61m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20504-TP
Job No:	S16175	**Lab No:**	S20504

Test Procedure: ☑ AS1289 6.7.3 DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Undisturbed Sample Condition	Rock Core	Confining Pressure (kPa)	600
		Back Pressure (kPa)	500
		Mean Effective Stress (kPa)	100
		Specimen Saturation Pressure (kPa)	500
		Sample Height (mm)	81.9
		Sample Diameter (mm)	61.1

PERMEABILITY $k_{(20)}$ = **6.4E-08 (m/sec)**

Comments

Permeant Used: Sydney tap water

Authorised Signatory:

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Date: 25/01/2017

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Alexandria NSW 2015

DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Client:	AECOM	**Source:**	MT_BH07 42.38-42.58m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20535-TP
Job No:	S16175	**Lab No:**	S20535

Test Procedure: ☑ AS1289 6.7.3 DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Undisturbed Sample Condition	Rock Core	Confining Pressure (kPa)	600
		Back Pressure (kPa)	500
		Mean Effective Stress (kPa)	100
		Specimen Saturation Pressure (kPa)	500
		Sample Height (mm)	94.4
		Sample Diameter (mm)	61.1

PERMEABILITY $k_{(20)}$ = **4.8E-08 (m/sec)**

Comments

Permeant Used: Sydney tap water

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DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Client:	AECOM	**Source:**	HB_BH24 18.27-18.45m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20653-TP
Job No:	S16175	**Lab No:**	S20653

Test Procedure: ☑ AS1289 6.7.3 DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Undisturbed Sample Condition	Rock Core	Confining Pressure (kPa)	600
		Back Pressure (kPa)	500
		Mean Effective Stress (kPa)	100
		Specimen Saturation Pressure (kPa)	500
		Sample Height (mm)	79.4
		Sample Diameter (mm)	61.0

PERMEABILITY $k_{(20)}$ = 5.3E-08 (m/sec)

Comments

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DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Client:	AECOM	**Source:**	MT_BH19 35.16-35.41m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Mudstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20925-TP
Job No:	S16175	**Lab No:**	S20925

Test Procedure: ☑ AS1289 6.7.3 DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Undisturbed Sample Condition	Rock Core	Confining Pressure (kPa)	600
		Back Pressure (kPa)	500
		Mean Effective Stress (kPa)	100
		Specimen Saturation Pressure (kPa)	500
		Sample Height (mm)	65.3
		Sample Diameter (mm)	61.2

PERMEABILITY $k_{(20)}$ = **1.0E-10 (m/sec)**

Comments

Permeant Used: Sydney tap water

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DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Client:	AECOM	**Source:**	MT_BH20 42.70-42.85m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	SW Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20978-TP
Job No:	S16175	**Lab No:**	S20978

Test Procedure: ☑ AS1289 6.7.3 DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Undisturbed Sample Condition	Rock Core	Confining Pressure (kPa)	600
		Back Pressure (kPa)	500
		Mean Effective Stress (kPa)	100
		Specimen Saturation Pressure (kPa)	500
		Sample Height (mm)	65.3
		Sample Diameter (mm)	61.2

PERMEABILITY $k_{(20)}$ = **8.9E-10 (m/sec)**

Comments

Permeant Used: Sydney tap water

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DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Client:	AECOM	**Source:**	RZ_BH64 38.43-38.61m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S21050-TP
Job No:	S16175	**Lab No:**	S21050

Test Procedure: ☑ AS1289 6.7.3 DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Undisturbed Sample Condition	Rock Core	Confining Pressure (kPa)	600
		Back Pressure (kPa)	500
		Mean Effective Stress (kPa)	100
		Specimen Saturation Pressure (kPa)	500
		Sample Height (mm)	65.3
		Sample Diameter (mm)	61.2

PERMEABILITY $k_{(20)}$ = **2.1E-09 (m/sec)**

Comments

Permeant Used: Sydney tap water

Authorised Signatory:

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Date: 23/02/2017

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DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Client:	AECOM	**Source:**	RZ_BH67 42.00-42.20m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR SANDSTONE
Project:	M4-M5 Link Project (60493796)	**Report No:**	S21086-TP
Job No:	S16175	**Lab No:**	S21086

Test Procedure: ☑ AS1289 6.7.3 DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Undisturbed Sample Condition	Rock Core	Confining Pressure (kPa)	600
		Back Pressure (kPa)	500
		Mean Effective Stress (kPa)	100
		Specimen Saturation Pressure (kPa)	500
		Sample Height (mm)	65.3
		Sample Diameter (mm)	61.2

PERMEABILITY $k_{(20)}$ = 1.4E-09 (m/sec)

Comments

Permeant Used: Sydney tap water

Authorised Signatory:

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Date: 23/02/2017

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DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Client:	AECOM	**Source:**	MT_BH11 53.38-53.56m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20577-TP
Job No:	S16175	**Lab No:**	S20577

Test Procedure: ☑ AS1289 6.7.3 DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Undisturbed Sample Condition	Rock Core	Confining Pressure (kPa)	600
		Back Pressure (kPa)	500
		Mean Effective Stress (kPa)	100
		Specimen Saturation Pressure (kPa)	500
		Sample Height (mm)	79.7
		Sample Diameter (mm)	61.1

PERMEABILITY $k_{(20)}$ = **4.4E-09 (m/sec)**

Comments

Permeant Used: Sydney tap water

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DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Client:	AECOM	**Source:**	MT_BH12 46.11-46.25m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20618-TP
Job No:	S16175	**Lab No:**	S20618

Test Procedure: ☑ AS1289 6.7.3 DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Undisturbed Sample Condition	Rock Core	Confining Pressure (kPa)	600
		Back Pressure (kPa)	500
		Mean Effective Stress (kPa)	100
		Specimen Saturation Pressure (kPa)	500
		Sample Height (mm)	65.1
		Sample Diameter (mm)	61.1

PERMEABILITY $k_{(20)}$ = **4.1E-08 (m/sec)**

Comments

Permeant Used: Sydney tap water

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DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Client:	AECOM	**Source:**	MT_BH16 79.45-79.58m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20710-TP
Job No:	S16175	**Lab No:**	S20710

Test Procedure: ☑ AS1289 6.7.3 DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Sampling: Sampled by Client **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

Undisturbed Sample Condition	Rock Core	Confining Pressure (kPa)	600
		Back Pressure (kPa)	500
		Mean Effective Stress (kPa)	100
		Specimen Saturation Pressure (kPa)	500
		Sample Height (mm)	61.2
		Sample Diameter (mm)	60.1

PERMEABILITY $k_{(20)}$ = 1.5E-07 (m/sec)

Comments

Permeant Used: Sydney tap water

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DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Client:	AECOM	**Source:**	RZ_BH60 49.15-49.30m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20741-TP
Job No:	S16175	**Lab No:**	S20741

Test Procedure: ☑ AS1289 6.7.3 DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Undisturbed Sample Condition	Rock Core	Confining Pressure (kPa)	600
		Back Pressure (kPa)	500
		Mean Effective Stress (kPa)	100
		Specimen Saturation Pressure (kPa)	500
		Sample Height (mm)	70.0
		Sample Diameter (mm)	61.0

PERMEABILITY $k_{(20)}$ = **1.4E-09 (m/sec)**

Comments
Permeant Used: Sydney tap water

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DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Client:	AECOM	**Source:**	MT_BH16 39.25-39.43m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Mudstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20757-TP
Job No:	S16175	**Lab No:**	S20757

Test Procedure: ☑ AS1289 6.7.3 DETERMINATION OF PERMEABILITY OF A SOIL - CONSTANT HEAD METHOD USING A FLEXIBLE WALL PERMEAMETER

Sampling:	Sampled by Client	**Date Sampled:**	Unknown
Preparation:	Prepared in accordance with the test method		

Undisturbed Sample Condition	Rock Core	Confining Pressure (kPa)	600
		Back Pressure (kPa)	500
		Mean Effective Stress (kPa)	100
		Specimen Saturation Pressure (kPa)	500
		Sample Height (mm)	81.3
		Sample Diameter (mm)	60.8

PERMEABILITY $k_{(20)}$ = **2.3E-09 (m/sec)**

Comments

Permeant Used: Sydney tap water

Authorised Signatory:

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Date: 31/01/2017

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ROCK POROSITY & DENSITY REPORT

Client:	AECOM	**Source:**	EP_BH04 25.30-25.46m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20465-RP
Job No:	S16175	**Lab No:**	S20465

Test Procedure: ☑ AS4133 2.1.1 Rock porosity and density tests - Determination of rock porosity and dry density - Saturation and caliper techniques

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

	Sample # 1	Sample # 2	Sample # 4	Sample # 4	**Sample Average**
Dry Density (t/m^3)	2.187	2.213	2.192	2.084	**2.169**
Porosity Value (%)	14.8	12.8	12.4	14.3	**13.6**
Change In Shape	None	None	None	None	**-**
Change in Competency	None	None	None	None	**-**

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ROCK POROSITY & DENSITY REPORT

Client:	AECOM	**Source:**	HB_BH24 18.27-18.45m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20653-RP
Job No:	S16175	**Lab No:**	S20653

Test Procedure: ☑ AS4133 2.1.1 Rock porosity and density tests - Determination of rock porosity and dry density - Saturation and caliper techniques

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

	Sample # 1	Sample # 2	Sample # 4	Sample # 4	**Sample Average**
Dry Density (t/m^3)	2.289	2.237	2.214	2.213	**2.238**
Porosity Value (%)	13.2	14.6	14.6	13.9	**14.1**
Change In Shape	None	None	None	None	-
Change in Competency	None	None	None	None	-

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ROCK POROSITY & DENSITY REPORT

Client:	AECOM	**Source:**	MT_BH01 59.43-59.61m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20504-RP
Job No:	S16175	**Lab No:**	S20504

Test Procedure: ☑ AS4133 2.1.1 Rock porosity and density tests - Determination of rock porosity and dry density - Saturation and caliper techniques

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

	Sample # 1	Sample # 2	Sample # 4	Sample # 4	**Sample Average**
Dry Density (t/m^3)	2.129	2.021	2.181	2.064	**2.099**
Porosity Value (%)	13.4	10.8	14.3	13.8	**13.1**
Change In Shape	None	None	None	None	-
Change in Competency	None	None	None	None	-

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ROCK POROSITY & DENSITY REPORT

Client:	AECOM	**Source:**	MT_BH07 42.38-42.58m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20535-RP
Job No:	S16175	**Lab No:**	S20535

Test Procedure: ☑ AS4133 2.1.1 Rock porosity and density tests - Determination of rock porosity and dry density - Saturation and caliper techniques

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

	Sample # 1	Sample # 2	Sample # 4	Sample # 4	**Sample Average**
Dry Density (t/m^3)	2.260	2.223	2.235	2.290	**2.252**
Porosity Value (%)	11.6	11.5	10.7	11.3	**11.3**
Change In Shape	None	None	None	None	-
Change in Competency	None	None	None	None	-

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ROCK POROSITY & DENSITY REPORT

Client:	AECOM	**Source:**	MT_BH11 53.38-53.56m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20577-RP
Job No:	S16175	**Lab No:**	S20577

Test Procedure: ☑ AS4133 2.1.1 Rock porosity and density tests - Determination of rock porosity and dry density - Saturation and caliper techniques

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

	Sample # 1	Sample # 2	Sample # 4	Sample # 4	**Sample Average**
Dry Density (t/m^3)	2.059	2.193	2.230	2.170	**2.163**
Porosity Value (%)	13.5	16.1	14.7	10.0	**13.6**
Change In Shape	None	None	None	None	-
Change in Competency	None	None	None	None	-

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ROCK POROSITY & DENSITY REPORT

Client:	AECOM	**Source:**	MT_BH12 46.11-56.25m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20618-RP
Job No:	S16175	**Lab No:**	S20618

Test Procedure: ☑ AS4133 2.1.1 Rock porosity and density tests - Determination of rock porosity and dry density - Saturation and caliper techniques

Sampling: Sampled by Client **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

	Sample # 1	Sample # 2	Sample # 4	Sample # 4	**Sample Average**
Dry Density (t/m^3)	2.095	2.060	2.041	2.012	**2.052**
Porosity Value (%)	19.2	19.1	18.4	18.1	**18.7**
Change In Shape	None	None	None	None	**-**
Change in Competency	None	None	None	None	**-**

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ROCK POROSITY & DENSITY REPORT

Client:	AECOM	**Source:**	MT_BH16 79.45-79.58m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20710-RP
Job No:	S16175	**Lab No:**	S20710

Test Procedure: ☑ AS4133 2.1.1 Rock porosity and density tests - Determination of rock porosity and dry density - Saturation and caliper techniques

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

	Sample # 1	Sample # 2	Sample # 4	Sample # 4	**Sample Average**
Dry Density (t/m^3)	2.236	2.251	2.253	2.253	**2.249**
Porosity Value (%)	14.5	15.0	14.0	14.9	**14.6**
Change In Shape	None	None	None	None	-
Change in Competency	None	None	None	None	-

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ROCK POROSITY & DENSITY REPORT

Client:	AECOM	**Source:**	MT_BH16 39.25-39.43m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Mudstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20757-RP
Job No:	S16175	**Lab No:**	S20757

Test Procedure: ☑ AS4133 2.1.1 Rock porosity and density tests - Determination of rock porosity and dry density - Saturation and caliper techniques

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

	Sample # 1	Sample # 2	Sample # 4	Sample # 4	**Sample Average**
Dry Density (t/m^3)	2.519	2.452	2.505	2.530	**2.502**
Porosity Value (%)	5.3	5.8	5.6	5.8	**5.6**
Change In Shape	None	None	None	None	-
Change in Competency	None	None	None	None	-

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

19/01/2017

Date:

Macquarie Geotechnical
Unit 8/10
Bradford Street
Alexandria NSW 2015

ROCK POROSITY & DENSITY REPORT

Client:	AECOM	**Source:**	RZ_BH60 49.15-49.30m
Address:	PO Box Q410, QVB PO Sydney NSW 1230	**Sample Description:**	FR Sandstone
Project:	M4-M5 Link Project (60493796)	**Report No:**	S20741-RP
Job No:	S16175	**Lab No:**	S20741

Test Procedure: ☑ AS4133 2.1.1 Rock porosity and density tests - Determination of rock porosity and dry density - Saturation and caliper techniques

Sampling: Sampled by Client | **Date Sampled:** Unknown

Preparation: Prepared in accordance with the test method

	Sample # 1	Sample # 2	Sample # 4	Sample # 4	**Sample Average**
Dry Density (t/m^3)	2.010	2.049	2.089	2.065	**2.053**
Porosity Value (%)	13.7	14.1	14.5	15.0	**14.3**
Change In Shape	None	None	None	None	-
Change in Competency	None	None	None	None	-

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

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Date:

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Unit 8/10
Bradford Street
Alexandria NSW 2015

Annexure H – Groundwater modelling report – HydroSimulations

HYDROSIMULATIONS

WESTCONNEX M4-M5 LINK

Groundwater Modelling Report

FOR

AECOM Pty Ltd

BY
C. Turvey, W.Minchin and Dr N.P. Merrick
NPM Technical Pty Ltd
trading as
HydroSimulations

Project number: AEC003

Report: HS2017/01

Date: August 2017

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1 INTRODUCTION

NSW Roads and Maritime Services (Roads and Maritime) is seeking approval to construct and operate the WestConnex M4-M5 Link (the project), which would comprise a new multi-lane road link between the M4 East Motorway at Haberfield and the New M5 Motorway at St Peters. The project would also include an interchange at Lilyfield and Rozelle (the Rozelle interchange) and a tunnel connection between Anzac Bridge and Victoria Road, east of Iron Cove Bridge (Iron Cove Link). In addition, construction of tunnels, ramps and associated infrastructure to provide connections to the proposed future Western Harbour Tunnel and Beaches Link project would be carried out at the Rozelle interchange. An overview of the project is shown in (**Figure 1-1**).

Together with the other components of the WestConnex program of works and the proposed future Sydney Gateway, the project would facilitate improved connections between western Sydney, Sydney Airport and Port Botany and south and south-western Sydney, as well as better connectivity between the important economic centres along Sydney's Global Economic Corridor and local communities.

Approval is being sought under Part 5.1 of the Environmental Planning and Assessment Act 1979 (NSW) (EP&A Act) for the project. A request has been made for the NSW Minister for Planning to specifically declare the project to be State significant infrastructure and also critical State significant infrastructure. An environmental impact statement (EIS) is therefore required.

The construction and operation of the project will potentially impact on groundwater levels and groundwater quality due to tunnelling activities and associated works. A groundwater assessment is being undertaken by AECOM to outline the predicted impacts of the project, as well as the cumulative impacts with other stages of WCX works. HydroSimulations (HS) has been requested to develop a three-dimensional numerical groundwater model to quantify groundwater impacts due to construction and throughout the operations phase. This groundwater assessment will form a component of the EIS.

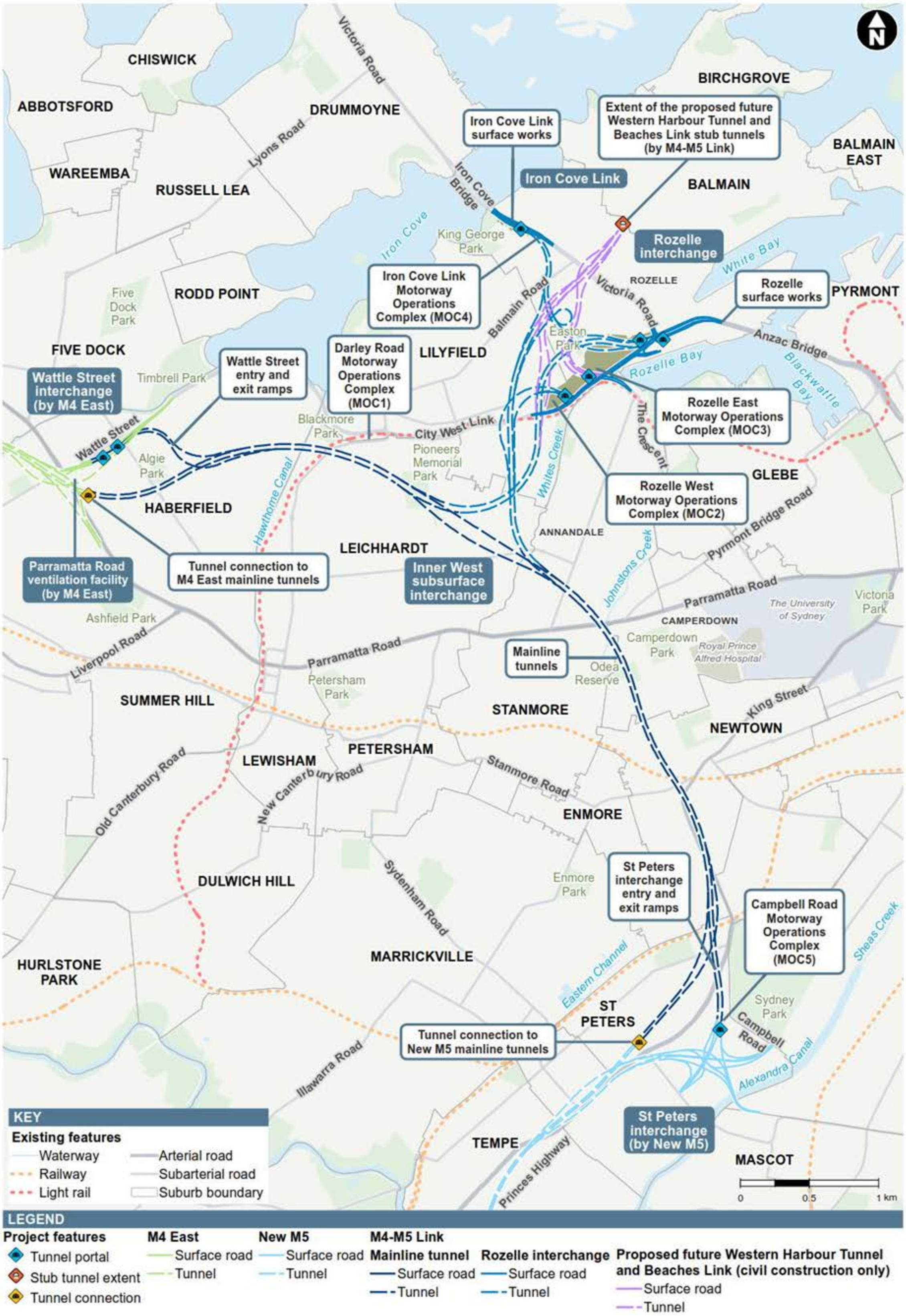

Figure 1-1 Project location

1.1 SCOPE OF WORK

The key tasks for this groundwater modelling assessment are:

1. Review of literature and data, as well as of tunnel design.
2. Analysis of data, namely geology, groundwater levels, groundwater recharge, permeability and porosity parameters, and any groundwater inflow data from existing tunnel projects in combination with AECOM.
3. Construction of a groundwater model (e.g. geology/layers, recharge, permeability, tunnels, boundary conditions).
4. Calibration of this model under steady state and transient conditions to historical groundwater levels and potentially considering any available groundwater inflow data from nearby tunnels.
5. Run a 'null' run to determine baseline conditions (as per Barnett *et al*., 2012) and predictive scenarios (2) to predict groundwater inflow into the tunnel during construction and long-term operations for both the project and the cumulative WCX program of works.
6. Predict the groundwater drawdown around the tunnel due to groundwater inflow to the tunnel during construction and long-term operations.
7. Predict the impacts (groundwater drawdown and water quality) to nearby registered groundwater users and groundwater dependant ecosystems, in accordance with the Aquifer Interference Policy and other requirements.
8. Predict impacts to groundwater quality due to salt water intrusion.
9. Preparation of a groundwater modelling report outlining the model development, assumptions, calibration and predictions in accordance with the Australian Groundwater Modelling Guidelines (Barnett *et al*., 2012).

Groundwater modelling has been conducted in accordance with the *Australian Groundwater Modelling Guidelines* (Barnett *et al.*, 2012) as well as the *MDBC Groundwater Flow Modelling Guideline* (MDBC 2001). Analysis and assessment has been carried out with consideration of the following groundwater-related technical and policy guidelines:

- NSW Aquifer Interference Policy (Department of Primary Industries Office of Water), September 2012;
- NSW Guidelines for Controlled Activities on Waterfront Land (NOW, 2012);
- National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (Agriculture and Resource Management Council of Australia and Australian and New Zealand Environment and Conservation Council [ARMCANZ & ANZECC, 2000]);
- NSW State Groundwater Policy Framework Document (NSW Department of Land and Water Conservation [DLWC, 1998]);
- NSW Wetlands Policy (DECCW, 2010);
- NSW State Groundwater Quality Protection Policy (DLWC, 1998);
- NSW State Groundwater Quantity Management Policy (DLWC, undated) Draft;
- NSW Groundwater Dependent Ecosystem Policy (DLWC, 2002);
- Groundwater Modelling Guidelines, namely:
  - Murray-Darling Basin Groundwater Quality. Sampling Guidelines. Technical Report No 3 (Murray-Darling Basin Commission [MDBC, 1997]);
  - Australian National Groundwater Modelling Guidelines, published by the National Water Commission (Barnett *et al*, 2012); and
- Draft Guidelines for the Assessment & Management of Groundwater Contamination (NSW Department of Environment and Climate Change [DECC, 2007]).

1.2 GROUNDWATER MANAGEMENT AREA

The WCX project is located within the Water Sharing Plan (WSP) for the *Greater Metropolitan Region Groundwater Sources*. The relevant Groundwater Management Areas (GMAs), as defined by the DPI Water, are:

1. The Sydney Basin - Central GMA area covers the majority of the project. This is a porous hard rock aquifer.
2. Zone 2 of The Botany Sands Groundwater Source Management Zone – an alluvial and coastal sand bed aquifer occurring in a small portion of the project area near St Peters.

The locations of these GMAs are shown in **Figure 1-2** relative to the WCX program of works.

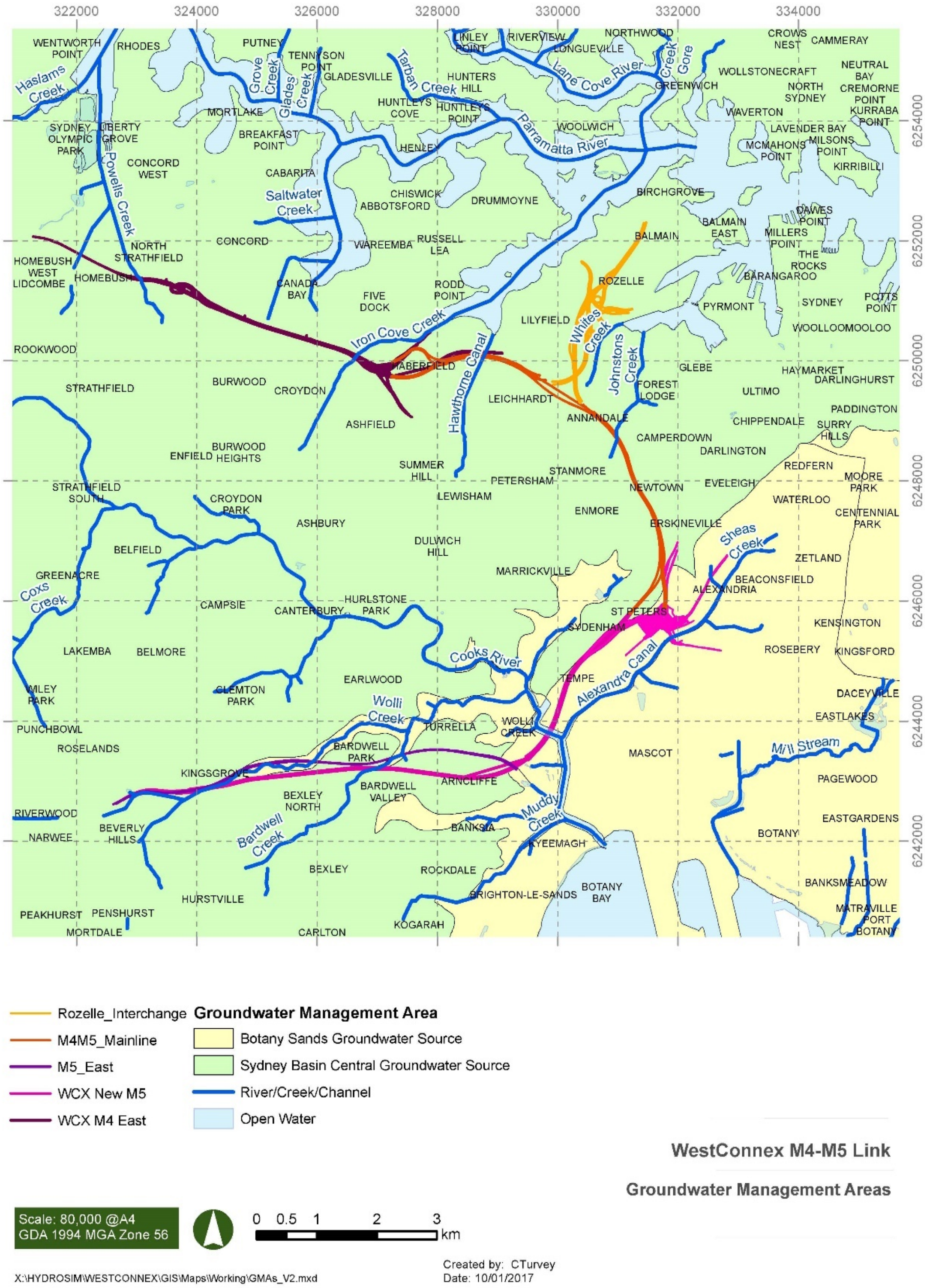

Figure 1-2 Groundwater management areas

1.2.1 GROUNDWATER PRODUCTIVITY

The *NSW Aquifer Interference Policy* (the AI Policy) (NSW Government, 2012) establishes minimal impact considerations for 'Highly Productive' and 'Less Productive' groundwater.

The Botany Sands aquifer and the land overlying it has been subject to contamination from historical unregulated industrial activity, and therefore parts of the aquifer are under embargo for certain uses. Within Zone 2 domestic bore use is banned to protect the health of users and minimise the risk of contamination spread through pumping. Industrial bores are permitted providing annual testing and reporting requirements are followed. However, there are no industrial bores registered within the project area in the Botany Sands Aquifer. Despite the contamination, DPI Water still classify this aquifer as "highly productive".

The porous hard rock units of the Sydney Basin are considered "less productive". In this area, this is because groundwater in the Ashfield Shale is generally saline and corrosive, and while groundwater in the underlying Hawkesbury Sandstone is typically of better quality and often potable, typical bore yields from the Hawkesbury Sandstone are not high enough to be considered "highly productive".

1.3 REQUIREMENTS FOR THE EIS

Requirements for the EIS are outlined in AECOM (2017) Groundwater Technical Assessment Report, to which this report is an Annexure.

2 BACKGROUND TO WESTCONNEX AND M4-M5 LINK PROJECT

The following subsections describe the background to the WestConnex program of works with specific regard for the M4-M5 Link portion.

Three terms are used frequently in the following sections and are defined as:

- **The Project** – Specific to the M4-M5 Link portion of WCX inclusive of the M4-M5 Link mainline tunnel, Rozelle Interchange and the Iron Cove Link (Figure 1-1).
- **Study area** – a 11 x 11 km area, as shown on **Figure 2-1**, and defined as such to encompass the geological and hydrological features that might be important to the M4-M5 Link project and to the numerical model built for the purpose of impact assessment for this portion of the overall WCX program of works.

2.1 WESTCONNEX PROGRAM OF WORKS

The M4-M5 Link is part of the WestConnex program of works. Separate planning applications and assessments have been completed for each of the approved WestConnex projects. Roads and Maritime has commissioned Sydney Motorway Corporation (SMC) to deliver WestConnex, on behalf of the NSW Government. However, Roads and Maritime is the proponent for the project.

In addition to linking to other WestConnex projects, the M4-M5 Link would provide connections to the proposed future Western Harbour Tunnel and Beaches Link, the Sydney Gateway (via the St Peters interchange) and the F6 Extension (via the New M5).

The WestConnex program of works, as well as related projects, are shown in **Figure 2-1** and described in **Table 2-1**.

Table 2-1 WestConnex and related projects

PROJECT	DESCRIPTION	STATUS
WESTCONNEX PROGRAM OF WORKS		
M4 WIDENING	Widening of the existing M4 Motorway from Parramatta to Homebush.	Planning approval under the EP&A Act granted on 21 December 2014. Open to traffic.
M4 EAST	Extension of the M4 Motorway in tunnels between Homebush and Haberfield via Concord. Includes provision for a future connection to the M4-M5 Link at the Wattle Street interchange.	Planning approval under the EP&A Act granted on 11 February 2016. Under construction.
KING GEORGES ROAD INTERCHANGE UPGRADE	Upgrade of the King Georges Road interchange between the M5 West and the M5 East at Beverly Hills, in preparation for the New M5 project.	Planning approval under the EP&A Act granted on 3 March 2015. Open to traffic.
NEW M5	Duplication of the M5 East from King Georges Road in Beverly Hills with tunnels from Kingsgrove to a new interchange at St Peters. The St Peters interchange allows for	Planning approval under the EP&A Act granted on 20 April 2016. Commonwealth approval under the *Environment Protection and*

PROJECT	DESCRIPTION	STATUS
	connections to the proposed future Sydney Gateway project and an underground connection to the M4-M5 Link. The New M5 tunnels also include provision for a future connection to the proposed future F6 Extension.	*Biodiversity Conservation Act 1999* (Commonwealth) granted on 11 July 2016. Under construction.
M4-M5 LINK (THE PROJECT)	Tunnels connecting to the M4 East at Haberfield (via the Wattle Street interchange) and the New M5 at St Peters (via the St Peters interchange), a new interchange at Rozelle and a link to Victoria Road (the Iron Cove Link). The Rozelle interchange also includes ramps and tunnels for connections to the proposed future Western Harbour Tunnel and Beaches Link project.	The subject of this EIS.
RELATED PROJECTS		
SYDNEY GATEWAY	A high-capacity connection between the St Peters interchange (under construction as part of the New M5 project) and the Sydney Airport and Port Botany precinct.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval.
WESTERN HARBOUR TUNNEL AND BEACHES LINK	The Western Harbour Tunnel component would connect to the M4-M5 Link at the Rozelle interchange, cross underneath Sydney Harbour between the Birchgrove and Waverton areas, and connect with the Warringah Freeway at North Sydney. The Beaches Link component would comprise a tunnel that would connect to the Warringah Freeway, cross underneath Middle Harbour and connect with the Burnt Bridge Creek Deviation at Balgowlah and Wakehurst Parkway at Seaforth. It would also involve the duplication of the Wakehurst Parkway between Seaforth and Frenchs Forest.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval.
F6 EXTENSION	A proposed motorway link between the New M5 at Arncliffe and the existing M1 Princes Highway at Loftus, generally along the alignment known as the F6 corridor.	Planning underway by Roads and Maritime and subject to separate environmental assessment and approval.

Figure 2-1 Overview of WestConnex and related projects and study area

2.2 M4-M5 LINK AND IRON COVE LINK

The project would be generally located within the City of Sydney and Inner West local government areas (LGAs). The project is located about two to seven kilometres south, southwest and west of the Sydney central business district (CBD) and would cross the suburbs of Ashfield, Haberfield, Leichhardt, Lilyfield, Rozelle, Annandale, Stanmore, Camperdown, Newtown and St Peters.

Key components of the project include:

- Twin motorway tunnels between the M4 East at Haberfield and the New M5 at St Peters. Each tunnel would be around 7.5 km in length and would be built to accommodate a maximum of four lanes of traffic in each direction. Each tunnel would integrate with tunnel stubs constructed underground as part of the proposed M4 East at the Wattle Street interchange and proposed New M5 at St Peters Interchange.
- A new road interchange at Rozelle at the disused Rozelle Rail Yard, to provide connections to and from the M4-M5 Link with City West Link, Victoria Road and the Anzac Bridge intersection.
- Tunnel stubs to allow for a potential future connection to the Western Harbour Tunnel and Beaches Link (an additional Sydney Harbour Tunnel road crossing) in the vicinity of the Rozelle interchange.
- Connections to the St Peters interchange (constructed as part of the proposed New M5), including the construction of the M4-M5 Link southern portal and integration works within the interchange.
- Ancillary infrastructure and operational facilities for electronic tolling, signage (including electronic signage), ventilation structures and systems, fire and life safety systems, and emergency evacuation and smoke extraction infrastructure.
- New service utilities and modifications to existing service utilities.

- Modifications to the surface road network to integrate the new interchanges, including but not limited to the City West Link and Victoria Road.
- Temporary construction ancillary facilities and temporary works to facilitate the construction of the project.

The indicative construction program for the mainline tunnels and the Rozelle interchange that the groundwater model was based on is shown in **Table 2.1**. Since the modelling has been completed, there have been minor changes to program. The current indicative program shows construction of the mainline tunnels starting in Q3 2018 and finishing in Q4 2022 and the Rozelle interchange starting in Q4 2018 and finishing in Q3 2023. This change has no potential impact on the findings of the groundwater modelling report.

Table 2-2 Construction program overview

Construction activity	Indicative construction timeframe																							
	2018				2019				2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Mainline tunnels																								
Site establishment and establishment of construction ancillary facilities		■	■	■	■	■	■	■	■															
Tunnel construction			■	■	■	■	■	■	■	■	■	■												
Portal construction			■	■	■	■	■																	
Construction of permanent operational facilities											■	■	■	■	■									
Mechanical and electrical fitout works													■	■	■									
Establishment of tolling facilities														■	■									
Site rehabilitation and landscaping															■	■	■	■						
Demobilisation and rehabilitation																		■	■					
Testing and commissioning															■	■	■	■	■					
Rozelle interchange and Iron Cove Link																								
Site establishment and establishment of construction ancillary facilities			■	■	■	■	■	■																
Utility diversions and site remediation			■	■	■	■	■																	
Tunnel construction								■	■	■	■	■	■	■	■	■								
Portal construction					■	■	■	■																
Construction of surface road works					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
Construction of permanent operational facilities					■	■	■	■	■	■	■	■	■	■	■									
Mechanical and electrical fitout works												■	■	■	■	■	■	■	■					
Establishment of tolling facilities																	■	■						
Site rehabilitation and landscaping																		■	■	■				
Demobilisation and rehabilitation																					■	■		
Testing and commissioning																		■	■	■	■	■		

2.2.1 DESIGN EVOLUTION OF THE M4-M5 LINK PROJECT

The above project scenario as summarised in **Figure 1-1** and detailed in AECOM (2017) was assessed in the groundwater modelling. However, project design is an iterative process taking into consideration the results of various studies and late design alterations have been proposed including the following minor (potential) changes:

- Possible increase of around 200m of construction access tunnelling from the Parramatta Road West civil and tunnel site as part of EIS construction “Option B”, **Figure 2-2** shows the difference in location, with the blue dots (Option A) representing the situation simulated in the model and purple dots (Option B) showing the alternative configuration;
- Minor changes in the mainline tunnel design (bifurcation) to improve merging and weaving traffic movements at various locations in the tunnel including:
  - Wattle Street interchange at Haberfield
  - The Inner-West interchange at Leichhardt
  - North of the St Peters interchange.

These changes in the mainline tunnel design are shown in **Figure 2-3**, **Figure 2-4** and **Figure 2-5**.

Refer to AECOM (2017) for full detail of proposed construction sites and options. The proposed changes in design are minor and have no material impact on the findings of this groundwater modelling report.

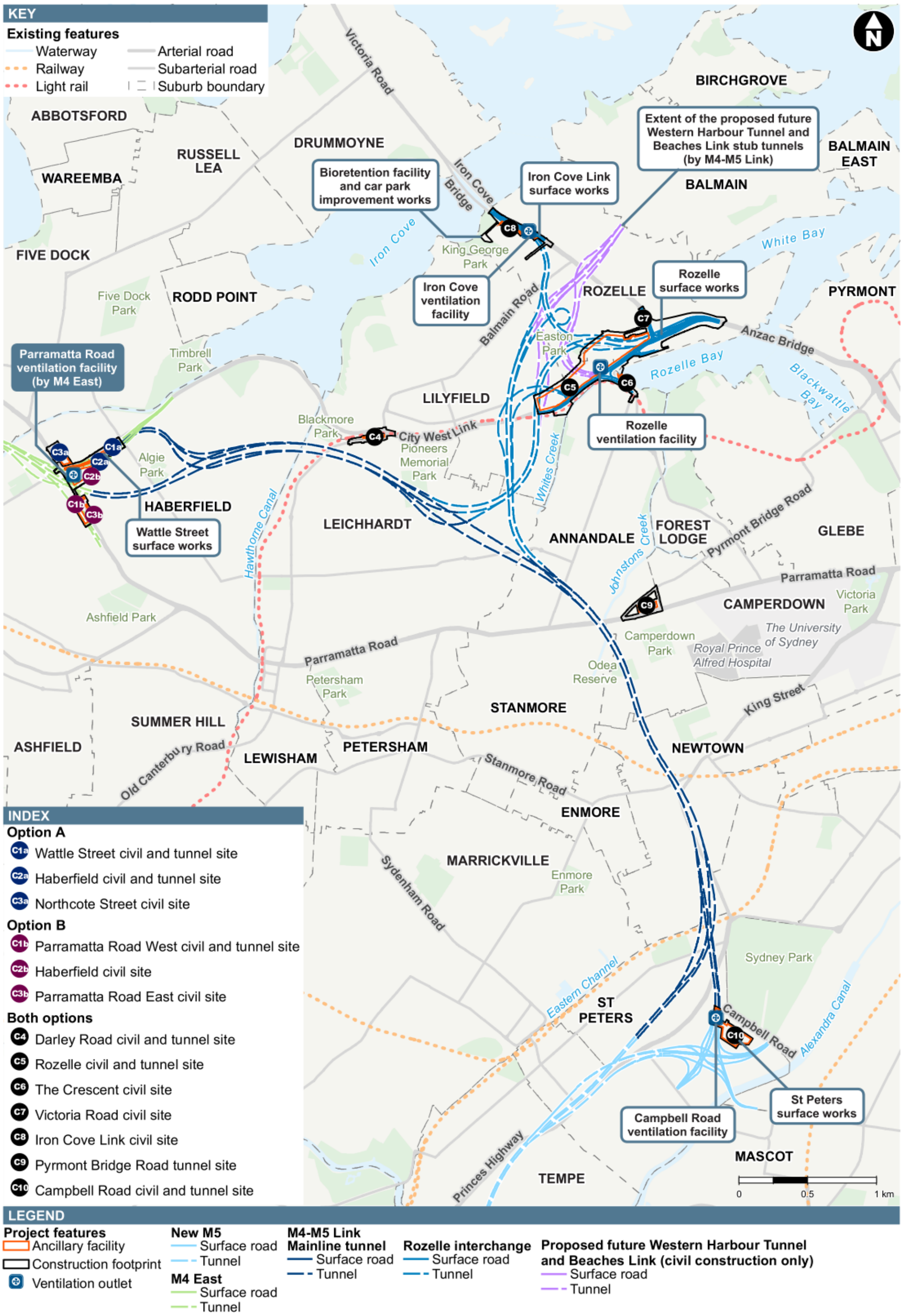

Figure 2-2 Construction ancillary facility locations

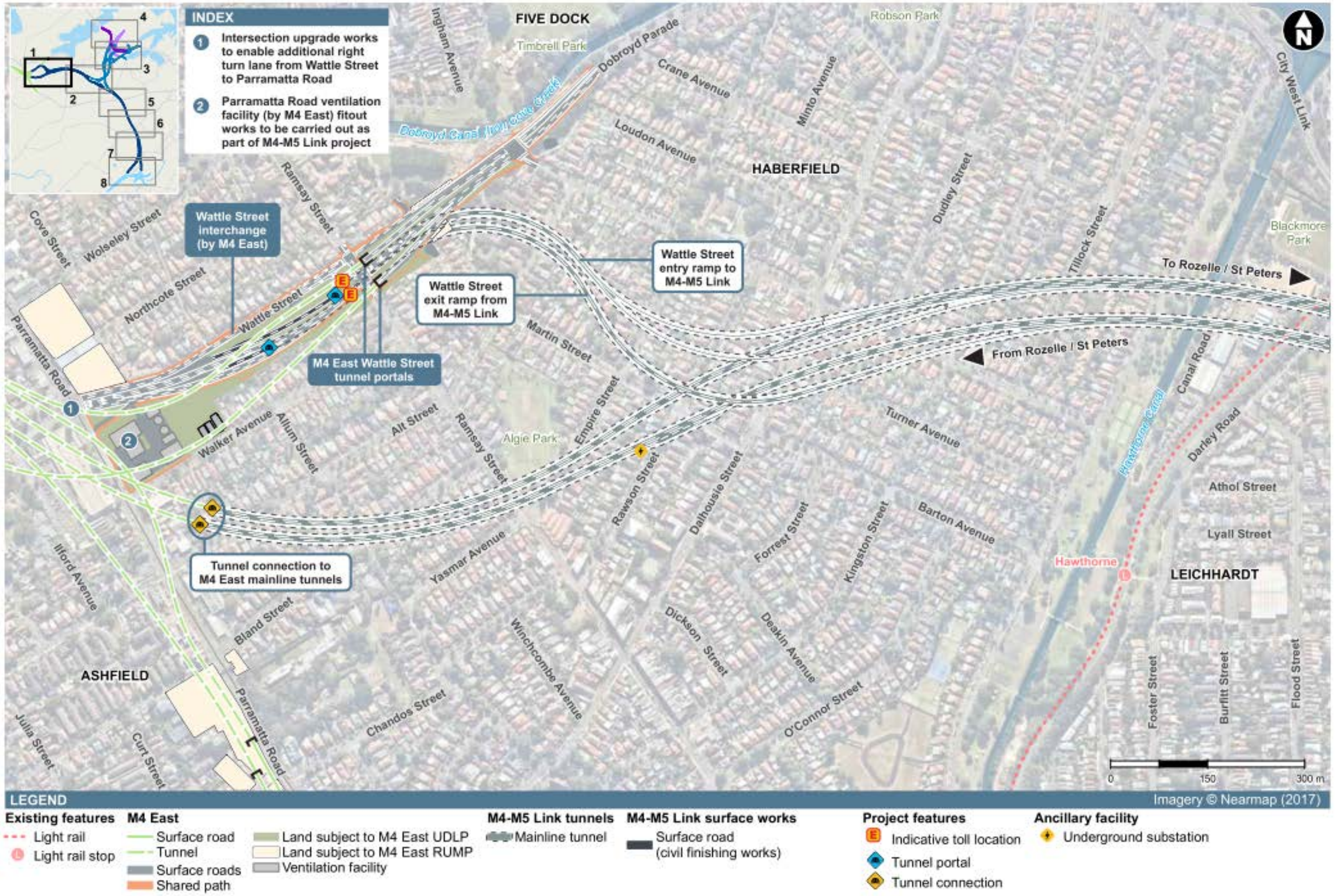

Figure 2-3 Proposed bifurcation at Haberfield

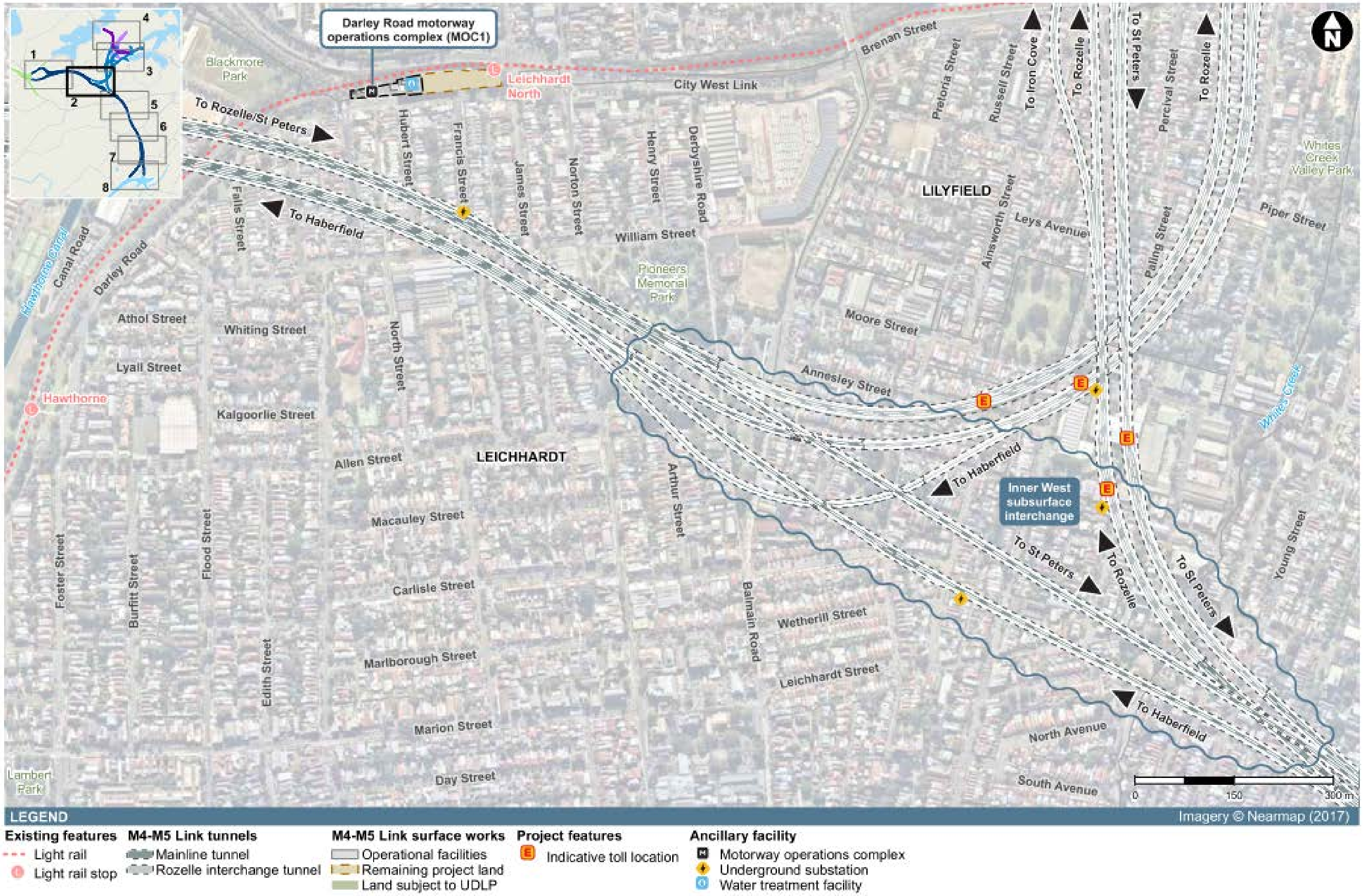

Figure 2-4 Proposed bifurcation at Leichhardt

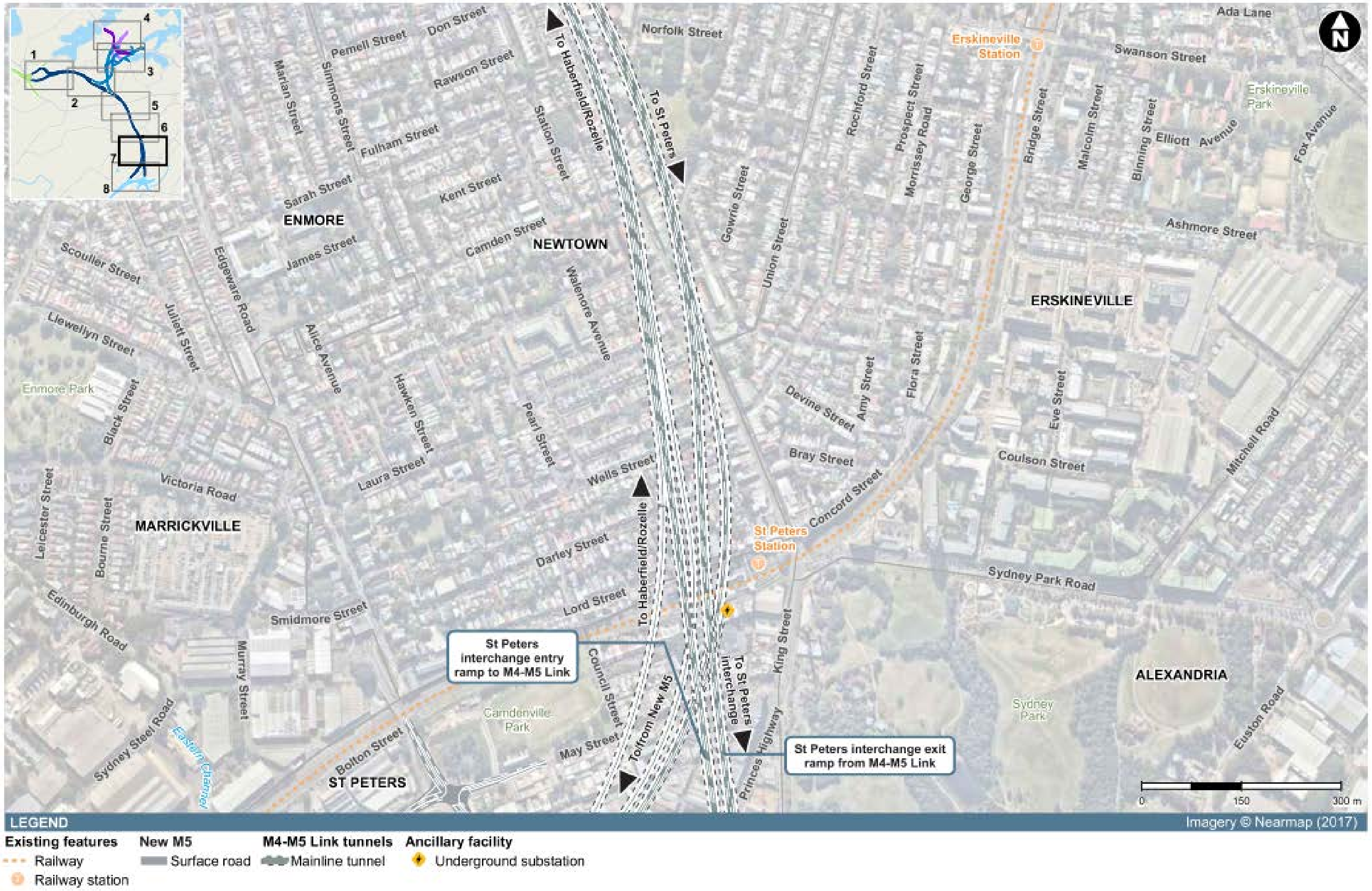

Figure 2-5 Proposed bifurcation at St Peters

2.3 M4 EAST AND NEW M5 PROJECTS

As part of this assessment it is a requirement to determine the cumulative impacts of existing infrastructure and the greater WCX project as well as determining the individual potential impacts due to this project.

The relevant components of the early stages of WCX are the tunnelling associated with the M4 East and New M5. The New M5 is located just south of the existing M5 East motorway tunnel and consists of 9 km of unlined twin tube tunnels, with the exception of a lined component where the tunnel passes beneath Cooks River. The tunnels are of variable width being constructed to accommodate up to three lanes between the western portals and Arncliffe and up to five lanes between Arncliffe and St Peters in both directions. The New M5 is planned for completion in 2019, as per **Table 2-3**. The M4 East project includes 5.5 km of unlined tunnel of up to 3 lanes width in both directions. The M4 East is planned for completion in 2019. Scheduling for M4 East is shown in **Table 2-4**.

Table 2-3 New M5 Construction program overview

Construction Activity	Indicative construction timeframe			
	2016	2017	2018	2019
Site establishment and establishment of construction compounds				
Landfill closure works				
Construction of western surface works				
Tunnel construction				
Construction of St Peters Interchange				
Portal construction				
Construction of local road upgrades				
Construction of permanent operational facilities				
Mechanical and electrical fitout works				
Establishment of tolling facilities				
Demobilisation and rehabilitation				

from RMS, 2015

Table 2-4 M4 East Construction program overview

Construction Activity	Indicative construction timeframe															
	2016				2017				2018				2019			
Shaft and decline excavations (all sites)		■	■	■												
Tunnelling (excavation)			■	■	■	■	■	■								
Tunnel drainage and pavement works						■	■	■	■	■						
Tunnel mechanical and electrical fitout								■	■	■	■					
Tunnel completion works											■	■	■			
Homebush Bay Drive ramps			■	■	■	■	■	■	■	■						
M4 Surface works		■	■	■	■	■	■	■	■	■	■	■				
Western ventilation facility							■	■	■	■	■					
Powells Creek on-ramp		■	■	■	■	■										
Concord Road interchange			■	■	■	■	■	■	■	■	■	■				
Wattle Street interchange		■	■	■	■	■	■	■	■	■	■	■	■			
Parramatta Road interchange		■	■	■	■	■	■	■	■	■	■	■	■			
Eastern ventilation facility		■	■	■	■	■	■	■	■	■	■	■				
Cintra Park fresh air supply facility				■	■	■	■	■	■	■	■	■	■			
Cintra Park water treatment facility										■	■	■				
Motorway operations complex						■	■	■								
Mechanical and electrical fitout works							■	■	■	■	■	■				
Site rehabilitation and landscaping						■	■	■	■	■	■	■	■			

from WDA, 2015

Other proposed motorway and public transport projects that are yet to obtain approval include:

- Western Harbour Tunnel: linking Rozelle Interchange with tunnels beneath Sydney Harbour.
- Sydney Metro: railway connecting the north-west region to the Sydney CBD and further south to Bankstown, including 15.5 km of twin tunnels from Chatswood to Sydenham.
- Sydney Gateway: linking the New M5 at St Peters Interchange with the airport precinct and Port Botany.
- SouthLink: linking the New M5 from Arncliffe to Sutherland along the F6 motorway corridor, including twin drained tunnels.

The northern part of Sydney Metro was approved in early January 2017 but was not approved when preparing the groundwater model for this report. The twin tunnels are to be fully tanked undrained tunnels and consequently the impacts to the local hydrogeological regime after construction will be negligible as groundwater will not flow into the tunnel and consequently there will be no associated impacts due to groundwater extraction such as groundwater drawdown, settlement or saline water intrusion. The tunnels are not expected to create a groundwater barrier as the infrastructure will be constructed within the Hawkesbury Sandstone (a thick geological unit, see Section 3.2.6) allowing groundwater to flow around the tunnels. Since there are to be no significant groundwater impacts caused by the Sydney Metro it was not considered necessary to include the alignment in the model.

As the designs for Sydney Gateway, SouthLink and Western Harbour Tunnel are not yet available they are not simulated by the groundwater model. It is expected that as each of these projects proceeds through the approvals process the cumulative impacts with WCX will be included within their respective EISs.

The methodology for assessing these cumulative impacts is discussed in the Groundwater Modelling (Section 4).

3 HYDROGEOLOGICAL CONCEPTUAL MODEL

3 HYDROGEOLOGICAL CONCEPTUAL MODEL

3.1 TOPOGRAPHY

Topography within the study area has been defined based on 1 m contour interval LIDAR information. The M4-M5 Link project area can be divided into five main catchment areas (**Figure 3-1**). These are the Iron Cove catchment to the west, Alexandra Canal catchment to the east, Eastern Channel catchment to the south, Rozelle catchment at the centre and White Bay catchment at the north. The New M5 project lies within the Cooks River Catchment to the south-west, and the M4 East project within the Parramatta River Catchment to the north-west. Topographical highs of up to 50 mAHD (Australian Height Datum) form a topographic dived across the centre of the study area (running from approximately Ashbury to Darlington), as well as at the south-west corner of the study area (Earlwood), and topographical lows of around 0 mAHD within the Botany Bay precinct and along major waterways (**Figure 3-2**).

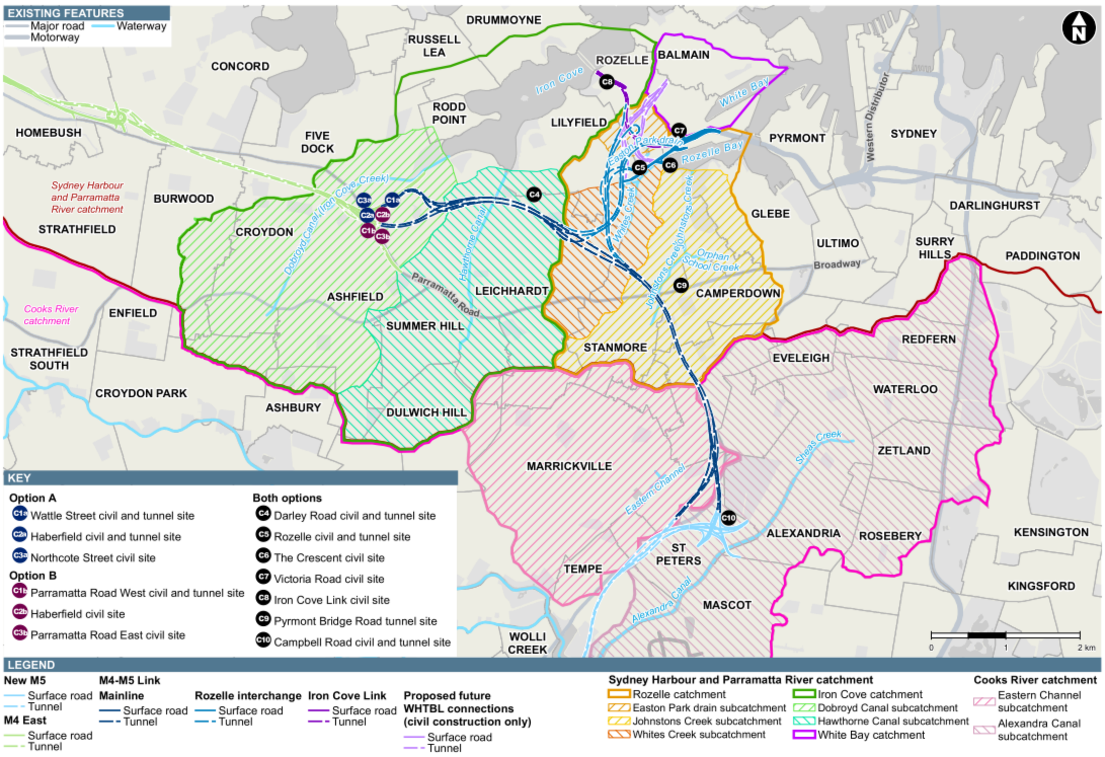

Figure 3-1 Surface water catchment areas

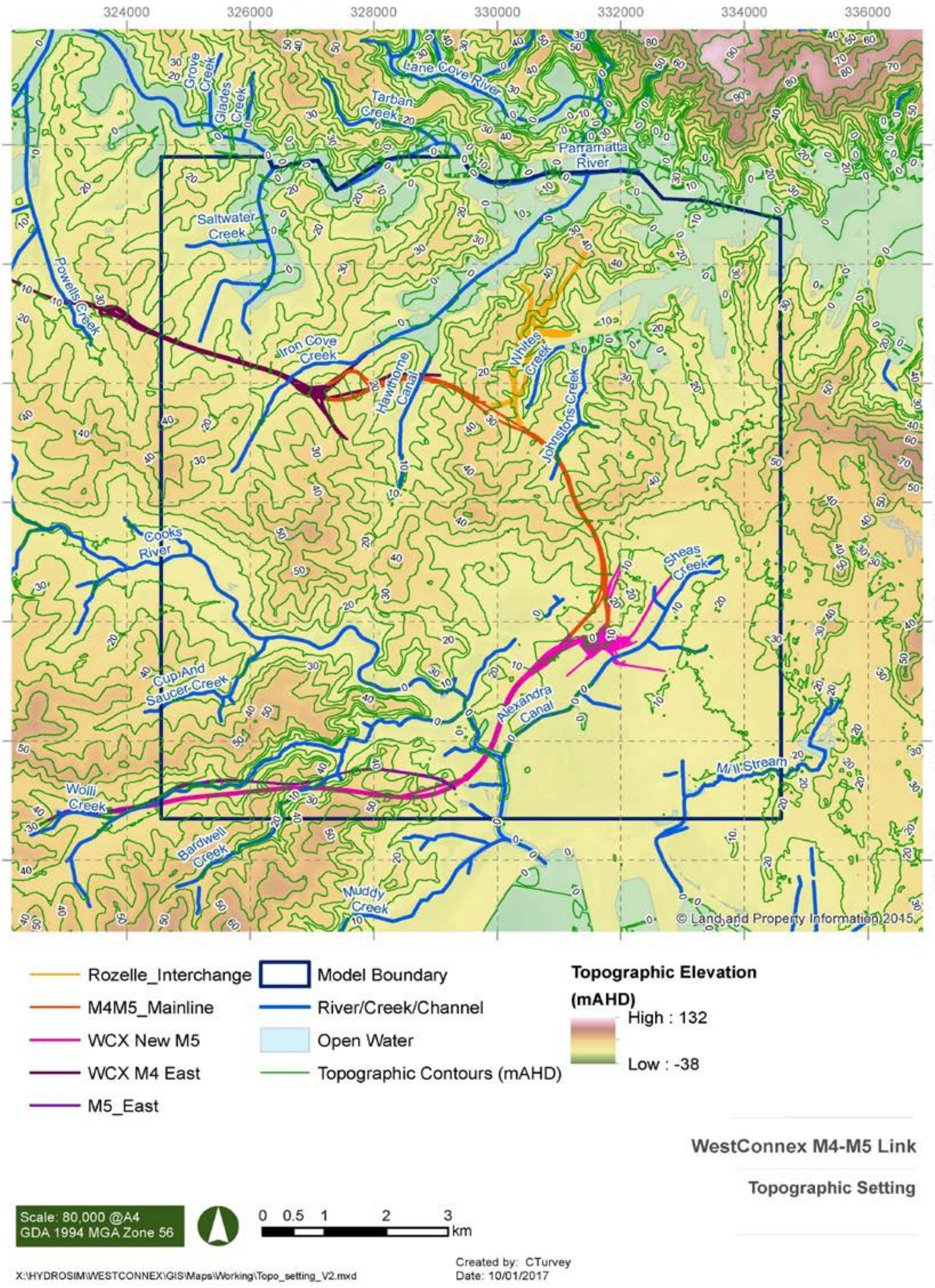

Figure 3-2 Topographic setting

3.2 GEOLOGY

The Project is situated within the Permo-Triassic Sydney Basin. The Sydney Basin is a regional foreland basin comprising sub-horizontal layered clastic sedimentary successions of mostly sandstone and shale, with some interbedded coal seams and localised igneous volcanic rocks and dykes (Och *et al*., 2009). To the east of the main tunnel alignment is the Botany Basin, which comprises sediment eroded from the Triassic basement and is centred at Botany Bay (Hatley, 2004).

The stratigraphy of the project area is summarised in **Table 3-1**. The outcrop geology is shown in **Figure 3-3**.

Table 3-1 Stratigraphy

Age	Stratigraphic Unit	Description
Quaternary	Fill	Waste material and engineered fill
	Botany Sands	Aeolian sand and clay
	Estuarine and alluvial sediments	Interbedded sands and clay
	Marine Sediments	Clayey sediments with sand lenses
Jurassic	Volcanics	Dykes
Triassic	Wianamatta Group – Bringely Shale, Ashfield Shale	Shale sometimes weathered to clay
	Mittagong Formation	Interlaminated siltstone and sandstone
	Hawkesbury Sandstone	Fine to coarse quartz sandstone with minor shale lenses

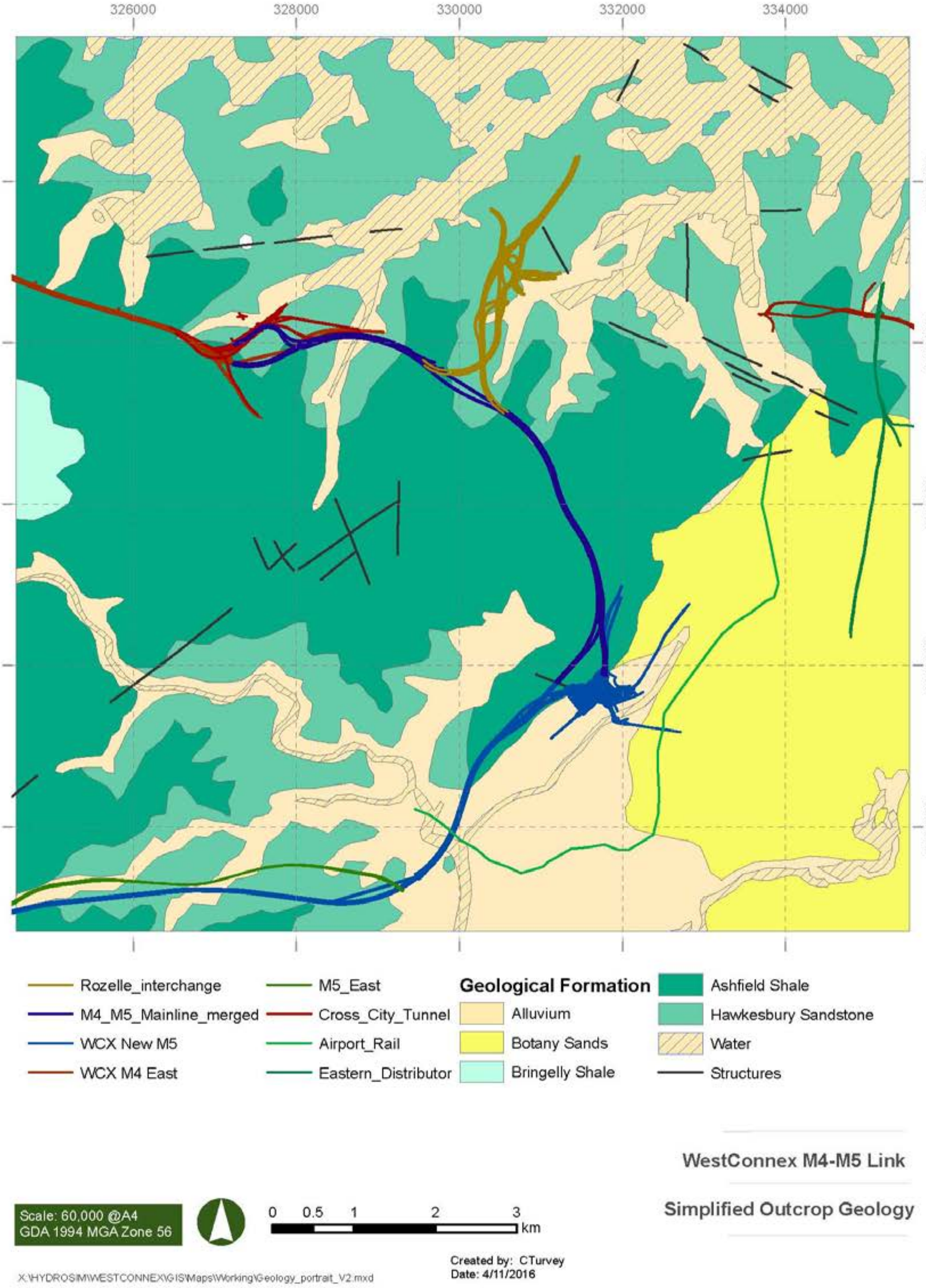

Figure 3-3 Simplified outcrop geology

3.2.1 FILL MATERIALS

Fill material is extensive across the project area due to the urban environment in which it is situated. The fill is highly variable ranging from well compacted engineered fill to unconsolidated waste. Substantial filling has occurred along low lying areas such as reclamation works associated with the perimeter of Rozelle Bay and Iron Cove, Rozelle Rail Yards, Hawthorne Canal and Alexandra Canal, Tempe, and St Peters Brick Pit Fill materials typically consist of local dredged material and imported rubble and waste. The most substantial fill deposits occur at the Alexandria Landfill which has been infilled with uncompacted fill to depths of 35 to 40 m.

3.2.2 ALLUVIUM

Alluvial sediments consisting of sand, silt, clay and gravel are found along the major creeks and gullies within the study area. Paleochannels up to 28 m thick, associated with the alluvium are found beneath Hawthorne Canal, Whites Creek and Johnstons Creek underlying the Rozelle Rail Yards to the south of the proposed Rozelle interchange (AECOM, 2017).

3.2.3 BOTANY SANDS

The Botany Sands overlie the Ashfield Shale and Hawkesbury Sandstone at the south east of the study area and underlie part of the St Peters Interchange. The Botany Sands consist of unconsolidated clayey sand, silty sand, muds with occasional gravel (Hatley, 2004).

3.2.4 WIANAMATTA GROUP

The Wianamatta Group of sedimentary rocks consists of the Bringelly Shale, Minchinbury Sandstone and Ashfield Shale, of which the Ashfield Shale is the only member intercepted by the project at the southern part of the alignment at St Peters and Alexandria. The Ashfield Shale is a laminated fine grained sequence of clay, silt and sand that was deposited in a marine environment and has undergone minor deformation. Where the Ashfield Shale outcrops at the surface it has a typical weathering profile of 3 m to 10 m consisting of stiff to hard clay of medium to high plasticity (AECOM, 2017).

3.2.5 MITTAGONG FORMATION

The Mittagong Formation is a transitional unit between the Ashfield Shale and Hawkesbury Sandstone, containing an interbedded sequence of silty sandstone and shales. The Mittagong Shale rarely outcrops within the study area and for the purposes of this project has been included within the Ashfield Shale.

3.2.6 HAWKESBURY SANDSTONE

The Hawkesbury Sandstone extends across the entire Sydney Basin and is therefore present across the whole study area. The Hawkesbury Sandstone is a fluvial sequence up to 290 m thick and contains massive fine to medium grained sandstones, cross-bedded sandstone and sandstone interlaminated with siltstone. Jointing and fracturing are common in the Hawkesbury Sandstone, predominantly where it is at or close to the surface.

3.3 CLIMATE

3.3.1 RAINFALL

The nearest long-term Bureau of Meteorology (BoM) climate stations to the Project are Sydney Airport AMO (station 066037), with records going back to 1929, and Sydney Observatory (station 066062) with records going back to 1858.

Rainfall records show a long-term average annual rainfall of 1087 mm at Sydney Airport AMO and 1226 mm at Sydney Observatory (**Table 3-2**). Average monthly rain records (**Table 3-2**) show that the highest rainfall occurs in June and the lowest in September, with the first six months of the year (January to June) typically having higher rainfall than the latter six months (July to December).

Table 3-2 Average monthly rainfall [mm]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Sydney Airport AMO	95.9	111.1	115.8	108.9	97.6	124.3	70.2	77.4	60.3	70.3	81.5	74.0	1087.3
Sydney Observatory	111.2	122.4	133.0	119.9	108.4	143.0	77.7	86.8	66.1	79.9	94.4	82.7	1225.6

Data period 1929-2016

Information on long-term rainfall trends is provided by the Residual Mass Curve (RMC). This curve is generated by aggregating the residuals between actual monthly rainfall and long-term average rainfall for each month. The procedure is essentially a low-pass filter operation which suppresses the natural spikes in rainfall and enhances the long-term trends.

Given the usually slow response of groundwater levels to rainfall inputs, the RMC can be expected to correlate well with groundwater hydrographs over the long term. The groundwater levels recorded during periods of rising RMC are expected to rise while those recorded during periods of declining RMC are expected to decline.

The RMC plot using rainfall data from the Sydney Airport AMO and Sydney Observatory stations since 1929 (**Figure 3-4**) shows that the long-term trend in rainfall comprises a long period of lower than average rainfall between during 1936-1950. This was followed by a sustained period of mostly above average rainfall until the early 1990s, with short-lived droughts interspersed, including 1980-83. The ‘Millennium Drought’ (1997-2011), which affected much of South-eastern Australia, shows a strong signature in the record. Rainfall levels approach average to slightly above average conditions from 2012.

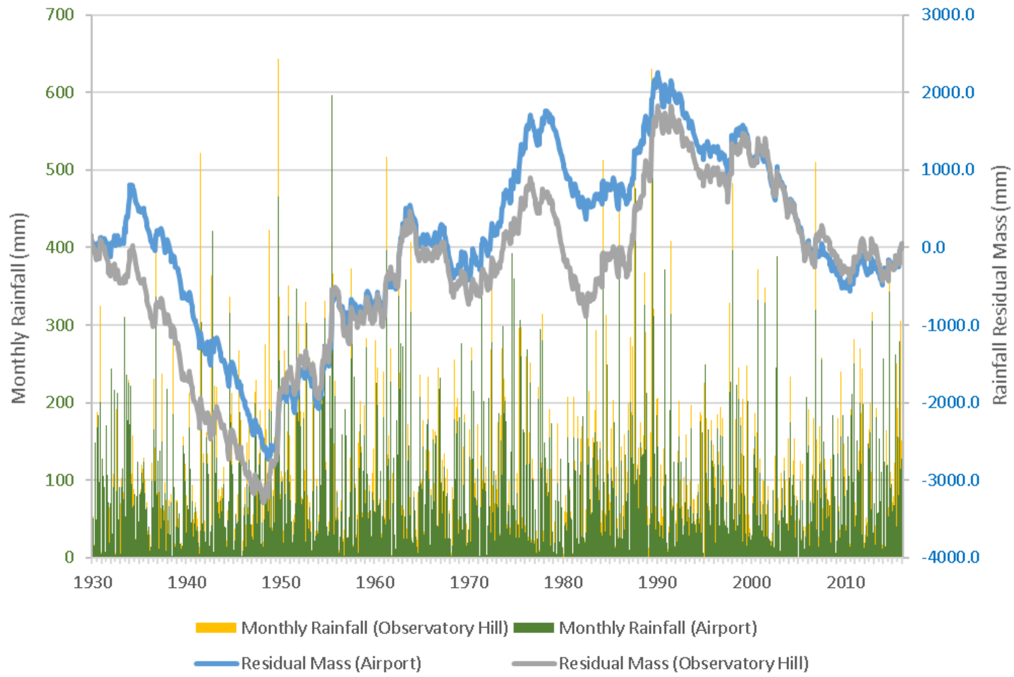

Figure 3-4 Rainfall residual mass

3.3.2 EVAPORATION

Potential evaporation (PE) for the region is approximately 1220 mm/a, while actual evapotranspiration (AE) for the region is up to approximately 620 mm/a (BoM, 2009)[1] (**Table 3-3**).

Table 3-3 Summary of evaporation data [mm]

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
Potential ET	181	134	122	78	51	38	40	55	80	127	153	162	1221
Actual ET	109	78	66	32	20	22	21	17	23	62	85	88	623

The derived average pattern of PE is compared against rainfall in **Figure 3-5**. This shows that there is a rainfall deficit (i.e. PE is higher than rainfall) from September to March, and a rainfall surplus April to August. Actual evapotranspiration only exceeds rainfall November through January.

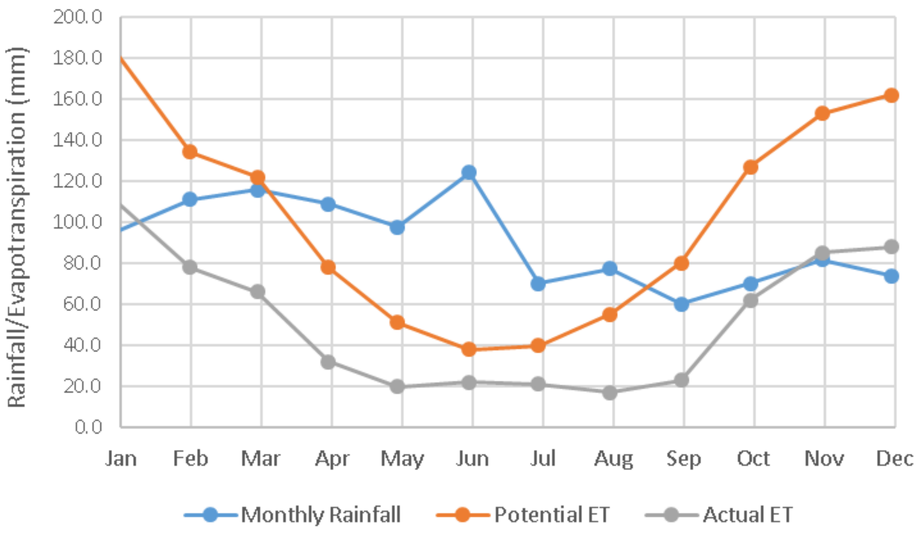

Figure 3-5 Monthly rainfall vs potential and actual evapotranspiration

3.4 SURFACE WATER

The major watercourses in the project area are the creeks and infilled creeks that drain into Sydney Harbour and the various coves and bays in Sydney Harbour.

To the north, major tributaries Johnstons Creek and Whites Creek drain to Rozelle Bay. Iron Cove Creek and Hawthorne Canal discharge into Iron Cove. To the south Alexandra Canal drains into Cooks River. (**Figure 3-2**). The majority of these watercourses have been modified to improve drainage during urbanisation, and most rivers are now in fact concrete lined channels along much of their length.

[1] These regional PE and Actual Evapotranspiration (AE) values have been obtained from the BoM map viewer. AE is the evapotranspiration that takes place under current water supply or rainfall conditions, calculated or averaged over a large area so as to remove local variation. See http://www.bom.gov.au/jsp/ncc/climate_averages/evaporation/index.jsp.

3.5 LAND USE

The project area is situated to the south-west of Sydney CBD and consists largely of highly urbanised developments such as low to medium density housing, commercial and industrial precincts, and scattered parklands and recreational areas. AECOM (2017) provides a detailed description of the major uses of the land adjacent to the project.

3.6 GROUNDWATER DEPENDENT ECOSYSTEMS

The NSW State Groundwater Dependent Ecosystems Policy (DLWC, 2002) describes the five broad types of groundwater systems in NSW, each with associated dependent ecosystems as follows:

- **Deep Alluvial Groundwater Systems** – occurring under floodplains of major rivers west of the Great Dividing Range (e.g. Namoi, Macquarie, Lachlan, Murrumbidgee and Murray alluvium).
- **Shallow Alluvial Groundwater Systems** – coastal rivers and higher reaches west of the Great Dividing Range (e.g. Hunter, Peel and Cudgegong alluvium, and beds and lateral bars of the lower Macleay, Bellinger and Nambucca Rivers).
- **Fractured Rock Groundwater Systems** – outcropping and sub-cropping rocks containing a mixture of fractures, joints, bedding planes and faults that contain and submit small and occasionally large amounts of groundwater (e.g. Alstonville Basalt, Molong Limestone and the Young Granite).
- **Sedimentary Rock Groundwater Systems** – sedimentary rock aquifers including sandstone, shale and coal (e.g. Great Artesian Basin, Sydney Basin and Clarence Moreton Basin).
- **Coastal Sand Bed Groundwater Systems** – significant sand beds along the coast of NSW (e.g. Botany and Tomago sand beds).

There are no high priority GDEs listed within the Greater Metropolitan WSP within the project area. The closest high priority GDE is Lachlan Swamp which is located within the Botany Sands approximately 5 km east from the easternmost point of the WCX work and falls outside of the project study area. It is most unlikely that this location would be affected by construction of the WCX tunnels.

A review of the BoM GDE Atlas[2] and relevant legislation and other literature has been conducted. Inspection of the BoM GDE Atlas indicated that there are 24 potential GDEs which access groundwater in the subsurface (i.e. 'terrestrial GDEs'). Of these, 6 are identified as having high potential for groundwater interaction, 7 have moderate potential and 11 have low potential (**Table 3-4**). All are in the southern area of the study area near Wolli Creek, Bardwell Creek and Mill Stream (**Figure 3-6** and **Figure 3-7**). The closest GDEs to the M4-M5 project are approximately 1.5 km from the connect at St Peters Interchange (at Wolli Creek in Turrella). Impact assessments for some of these potential GDEs were included in the New M5 EIS.

[2] http://www.bom.gov.au/water/groundwater/gde/map.shtml

Table 3-4 Potential GDEs listed in BoM GDE Atlas

BoM Identifier	Easting	Northing	Potential for GW Interaction	Location
1975350	333654	6243381	High potential for GW interaction	Mill Stream Wetlands at Lakes Golf Club
1975328	334127	6243434	High potential for GW interaction	Mill Stream Wetlands at Lakes Golf Club
1975556	334310	6243249	Low potential for GW interaction	Mill Stream Wetlands at Lakes Golf Club
1975531	334310	6243249	Low potential for GW interaction	Mill Stream Wetlands at Lakes Golf Club
1975590	334310	6243249	Low potential for GW interaction	Mill Stream Wetlands at Lakes Golf Club
1974035	328775	6244399	Moderate potential for GW interaction	Wolli Creek Turrella
1974071	328750	6244408	Moderate potential for GW interaction	Wolli Creek Turrella
1974062	328733	6244428	Low potential for GW interaction	Wolli Creek Turrella
1974150	328408	6244329	High potential for GW interaction	Wolli Creek Turrella
1974138	328161	6244308	Low potential for GW interaction	Wolli Creek Turrella
1974223	328060	6244267	High potential for GW interaction	Wolli Creek Turrella
1974416	327802	6243997	High potential for GW interaction	Wolli Creek Turrella
1974540	327676	6243933	High potential for GW interaction	Wolli Creek Turrella
1974116	328030	6244369	Low potential for GW interaction	Wolli Creek Turrella
1974462	327575	6244046	Low potential for GW interaction	Wolli Creek Turrella
1974496	327536	6244028	Low potential for GW interaction	Wolli Creek Turrella
1975211	327216	6243370	Moderate potential for GW interaction	Bardwell Valley Golf Club
1975149	327071	6243393	Low potential for GW interaction	Bardwell Valley Golf Club
1975262	326892	6243328	Moderate potential for GW interaction	Bardwell Valley Golf Club
1975237	326680	6243362	Moderate potential for GW interaction	Bardwell Valley Golf Club
1975206	326646	6243374	Low potential for GW interaction	Bardwell Valley Golf Club
1975273	326612	6243342	Low potential for GW interaction	Bardwell Valley Golf Club
1975433	326286	6243194	Moderate potential for GW interaction	Bardwell Valley Stotts Reserve
1975481	326111	6243151	Moderate potential for GW interaction	Bardwell Valley Stotts Reserve

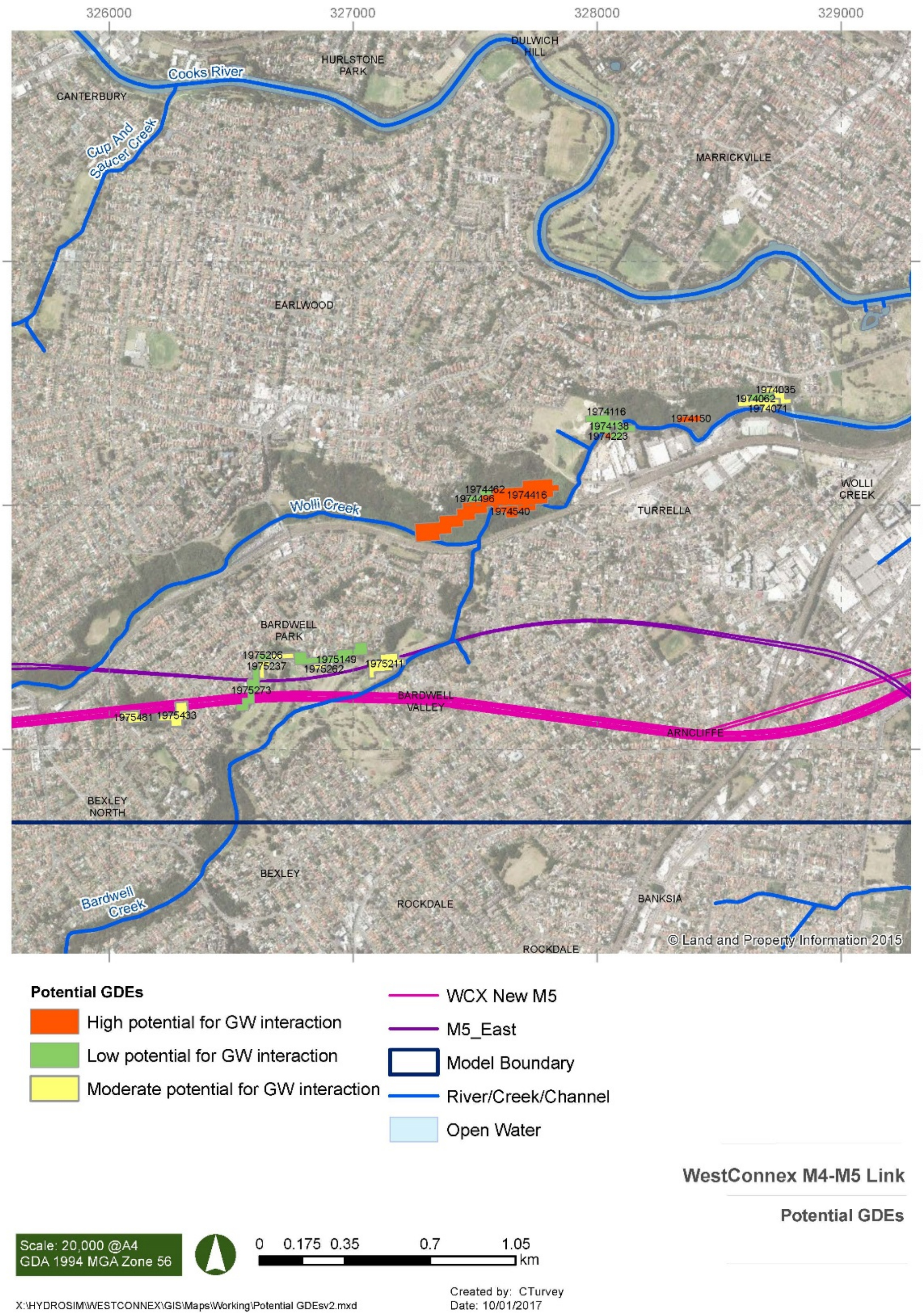

Figure 3-6 Potential GDEs at Bardwell Valley

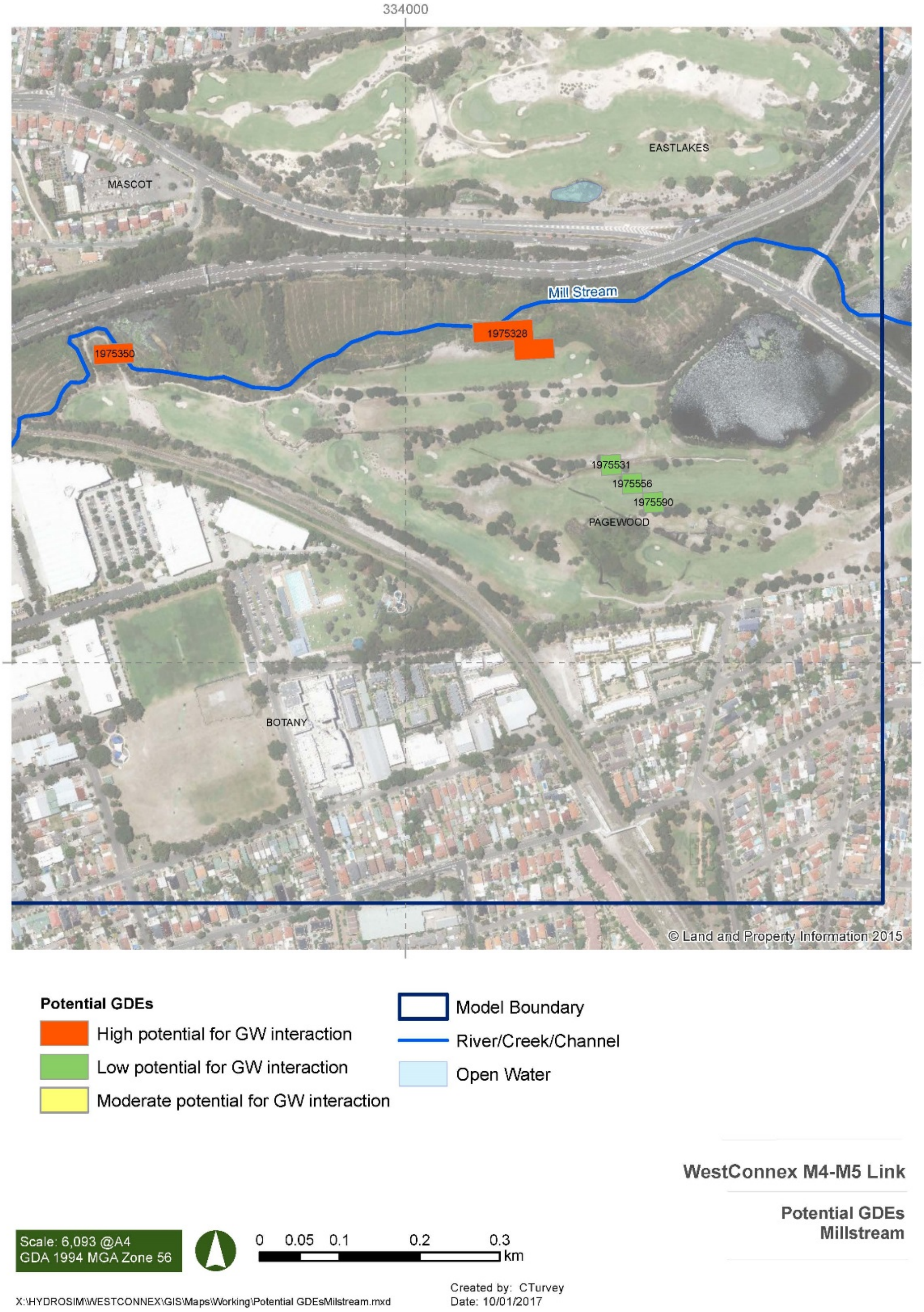

Figure 3-7 Potential GDEs at Mill Stream

3.7 HYDROGEOLOGY

3.7.1 ANTHROPOGENIC GROUNDWATER USE

Based on data received from BoM's National Groundwater Information System (NGIS) and the DPI(Water) Pinneena groundwater database in September 2016, there are 398 registered groundwater works within the study area (11x11 km), mostly shallow bores located within Botany Sands or from alluvial aquifers. The numbers of bores and their registered uses are summarised in **Table 3-5**. The majority of bores are shallow monitoring bores assumed to be constructed for the purposes of investigation/monitoring of contamination, particularly within the Botany Sands. As noted in Section 1.2.1, abstraction of groundwater from much of the Botany Sands for domestic use is no longer allowed due to the risk of spreading contamination, therefore many of these bores will no longer be operational.

Table 3-5 Registered groundwater bores in Pinneena and the NGIS

Purpose	Number	Min Depth (m)	Max Depth (m)
Domestic	81	0	210
Water Supply	27	2.1	13.2
Industrial	31	0	148
Recreation	18	0	186
Unknown	12	0	90
Monitoring	226	0	40
Exploration	1	18.2	18.2
Drinking	2	3.5	15

3.7.2 GROUNDWATER LEVELS

A review of groundwater levels from both WCX monitoring bores and other data sources, including bores registered on the NGIS database has been conducted. The majority of historical data from the NGIS registered bores is limited to notes on levels and salinity records taken at the time of drilling or installation.

Groundwater monitoring along the M4-M5 Link project alignment commenced in June 2016, with boreholes being added to the monitoring network as drilling investigation continues. The monitoring network constructed by AECOM consists of 58 monitoring bores constructed to depths between 6 and 73 m as shown in **Figure 3-8.** The majority of monitoring bores were constructed in the Hawkesbury Sandstone but are also screened in the Ashfield Shale and alluvium. At some locations dual monitoring bores were installed to screen the alluvium and underlying Hawkesbury Sandstone. Monitoring bores are equipped with automatic data loggers, and are manually dipped on a monthly basis.

Groundwater level monitoring for the first two stages of WCX (M4 East and New M5) began in early 2015 and available data has been included in the model dataset. Some sporadic water level data is available from these and other tunnel infrastructure projects. NGIS boreholes with ongoing monitoring records are restricted to the Botany Sands.

The water level records available across the study area show that water table elevation tends to mimic topography, with the water-table closely reflecting topography within the surficial unconsolidated layers and showing more of a subdued reflection of topography within the consolidated Triassic units (**Figure 3-9**). A detailed discussion of the spatial water levels near to the project can be found in AECOM (2017).

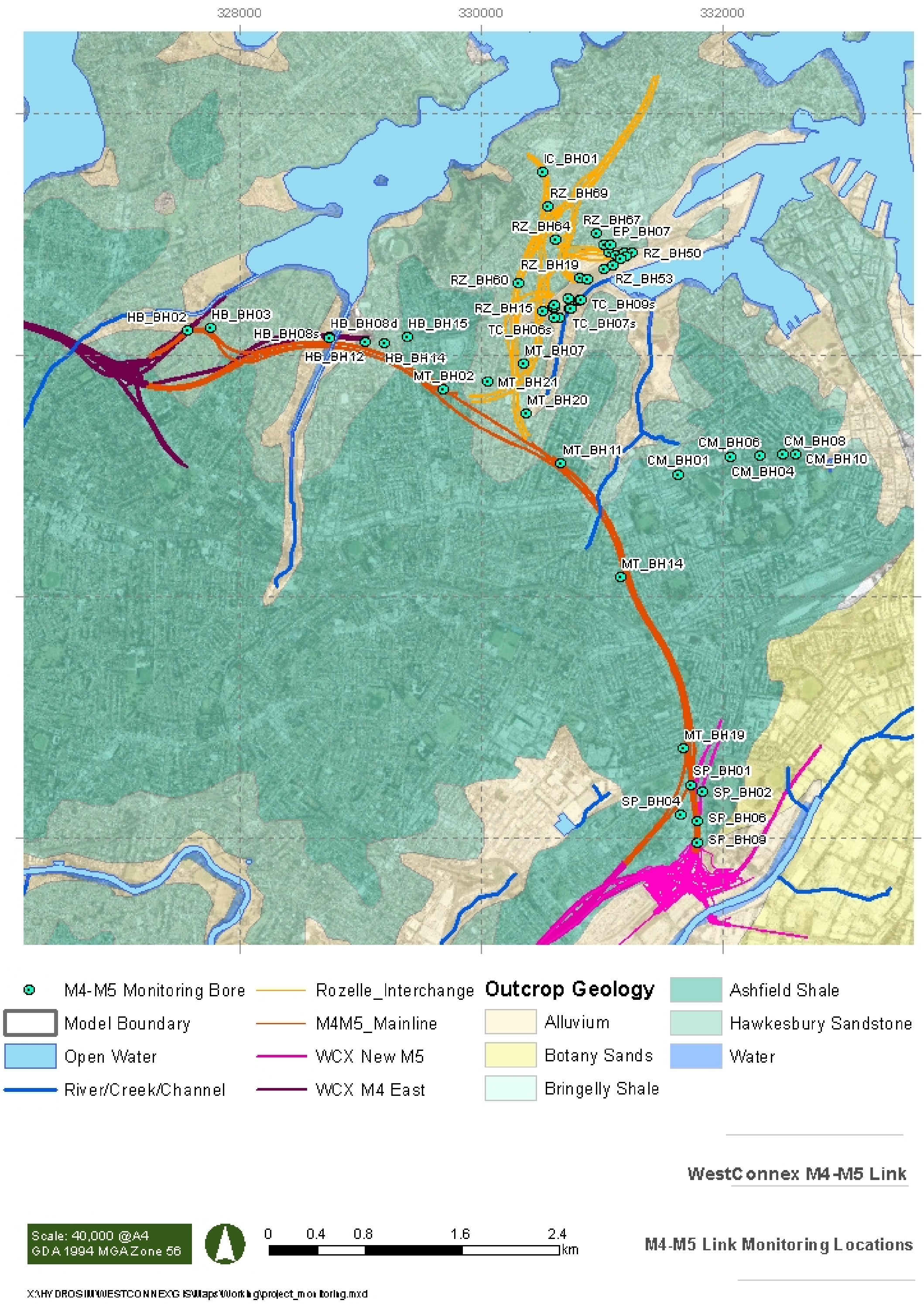

Figure 3-8 Project monitoring bore locations

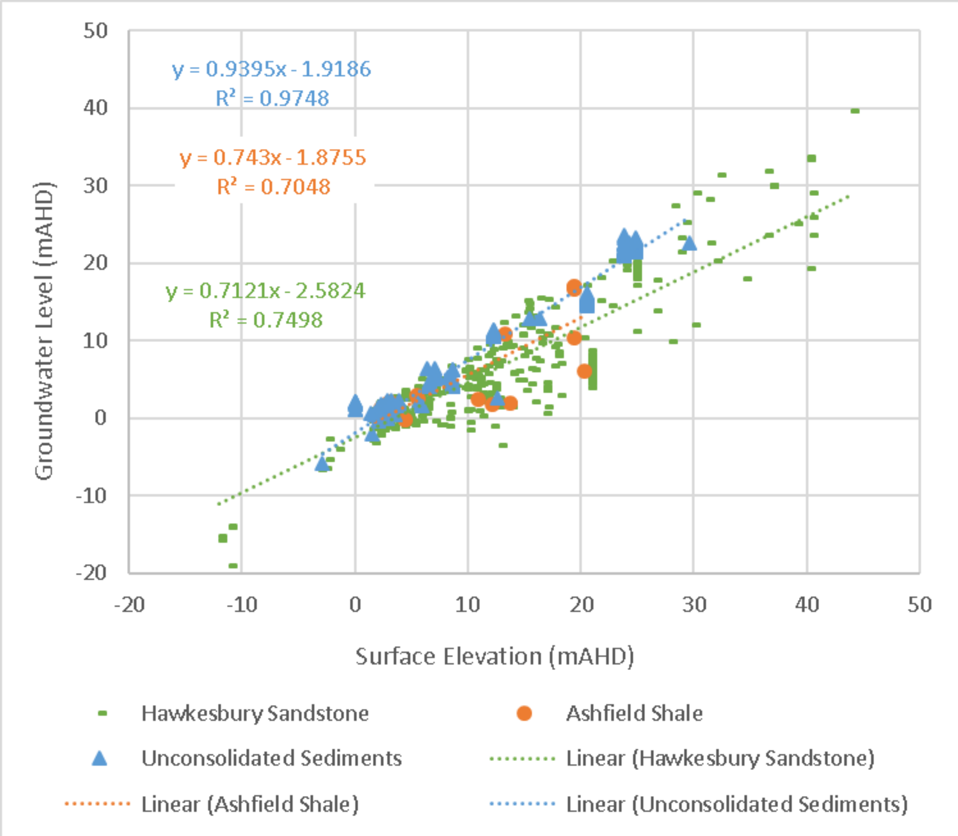

Figure 3-9 Water table relationship to topography

3.7.3 GROUNDWATER HYDROGRAPHS

The AECOM (2017) interpretive report provides a detailed description of all water levels monitored as part of the Project. A selection of key hydrographs for each formation is discussed here. **Figure 3-10** shows the locations of the selected bore hydrographs. The following example hydrographs are from boreholes located at Rozelle and St Peters where the longest records are available. Additional hydrographs for the other monitoring bore locations are shown in AECOM (2017).

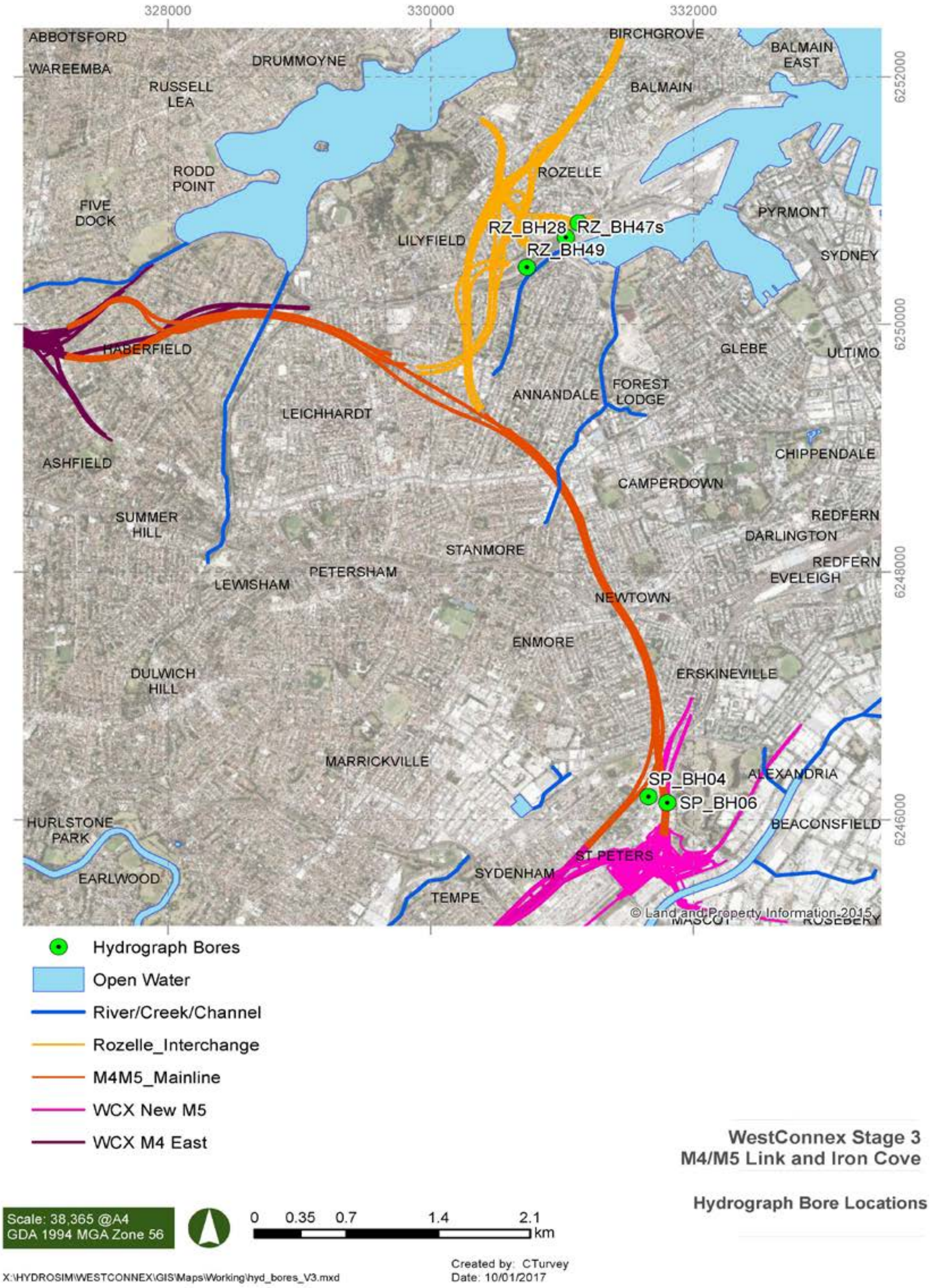

Figure 3-10 Selected hydrograph bore locations

Alluvium

Figure 3-11 and **Figure 3-12** show alluvial hydrographs located at Rozelle for boreholes RZ_BH49 and RZ_BH47s respectively. The daily rainfall and Rainfall Residual Mass Curve (RMC) are also plotted. Both boreholes show a gradual decline in water level with a fall of approximately 0.5 m of groundwater head over the period between August 2016 and early February 2017, which is consistent with the RMC trend. A sharp increase in water level of 0.3 m occurs after the 85 mm rainfall even on 8th February 2017, and data available to the February 15th appears to be following the RMC trend which indicates above average rainfall for the February-March 2017 period. Small oscillations in water level are likely to be associated with the tidal influence of Rozelle Bay. These oscillations tend to mask any notable change in water level due to small rainfall events, particularly in RZ_BH47s, however overall the groundwater level trend tends to follow that of the RMC.

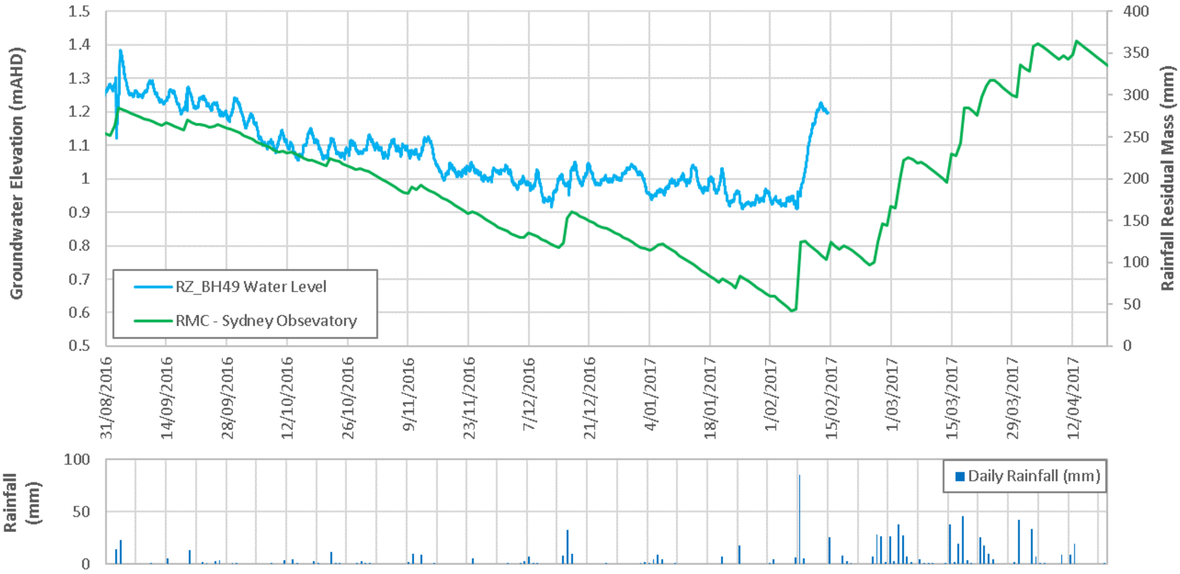

Figure 3-11 Hydrograph RZ_BH49 screened in alluvium

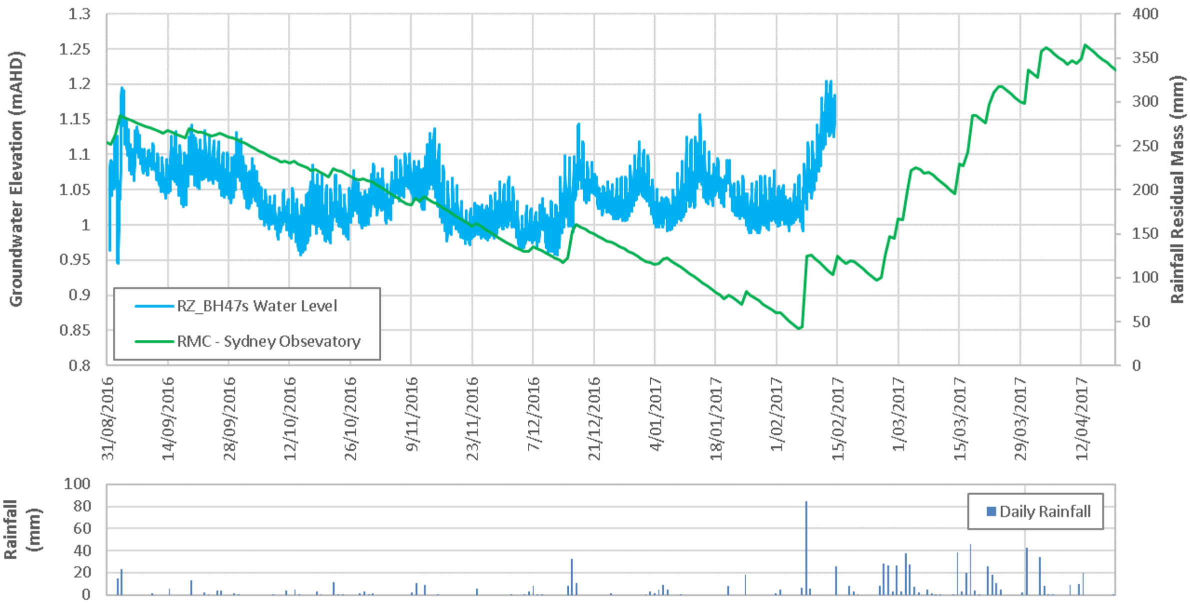

Figure 3-12 Hydrograph RZ_BH47s screened in alluvium

Ashfield Shale

Water levels in borehole SP_BH06 within Ashfield Shale at St Peters Interchange are shown in **Figure 3-13**. The Ashfield Shale water levels follow the RMC trend very closely indicating that rainfall recharge is still a significant mechanism in maintaining the hydraulic head in the shale. Similar to the alluvium, heads decline by about 0.5 m over the monitoring duration to December 2016. At the time of writing this report no data for the first quarter of 2017 was available.

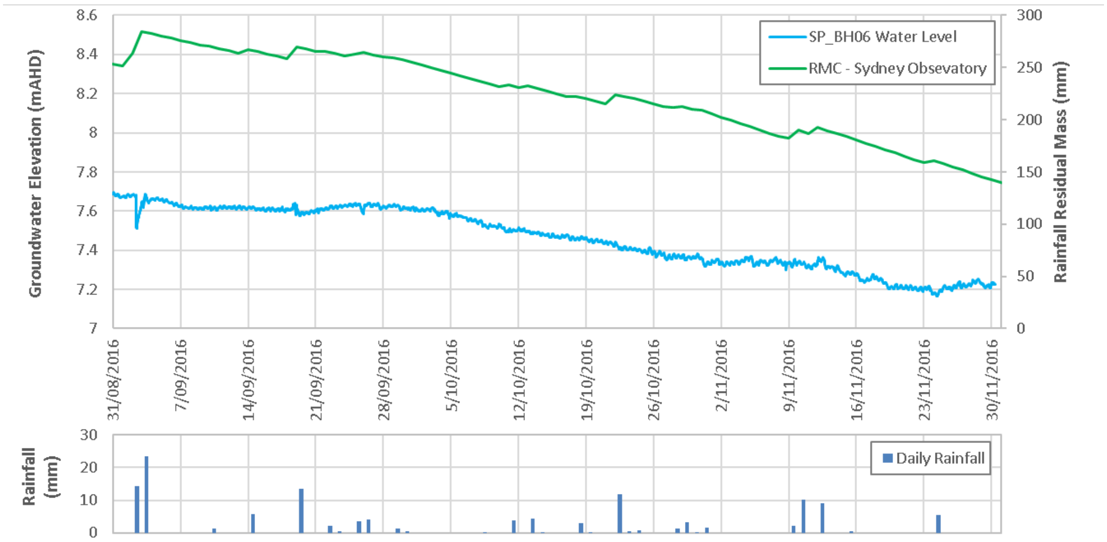

Figure 3-13 Hydrograph SP_BH06 screened in Ashfield Shale

Hawkesbury Sandstone

Boreholes RZ_BH28 and SP_BH04 are screened within the Hawkesbury Sandstone (**Figure 3-14** and **Figure 3-15**). RZ_BH28 shows the same declining trend and similar magnitude as the overlying units, with sub-daily oscillations of 0.1 m again assumed to be a tidal influence from Rozelle Bay.

Borehole SP_BH04 located at the St Peters Interchange shows a less-definitive correlation with the RMC, with water levels showing a slight recovery from mid-November 2016 due to a relaxation of stress that is not corresponding with climate trends. Water levels are drawn down again from mid-January 2017. It is not clear what is causing these changes in water level, however the levels do appear to respond to the high rainfall in February 2017 with a groundwater level trend that again appears to follow the RMC for the last period of available data. The monitoring data is also less smooth than expected, with daily variations and bi-weekly oscillations that are yet to be understood. These variations could be due to a combination of the commencement of the New M5 tunnel construction at St Peters and/or leachate pumping from the Alexandria Landfill.

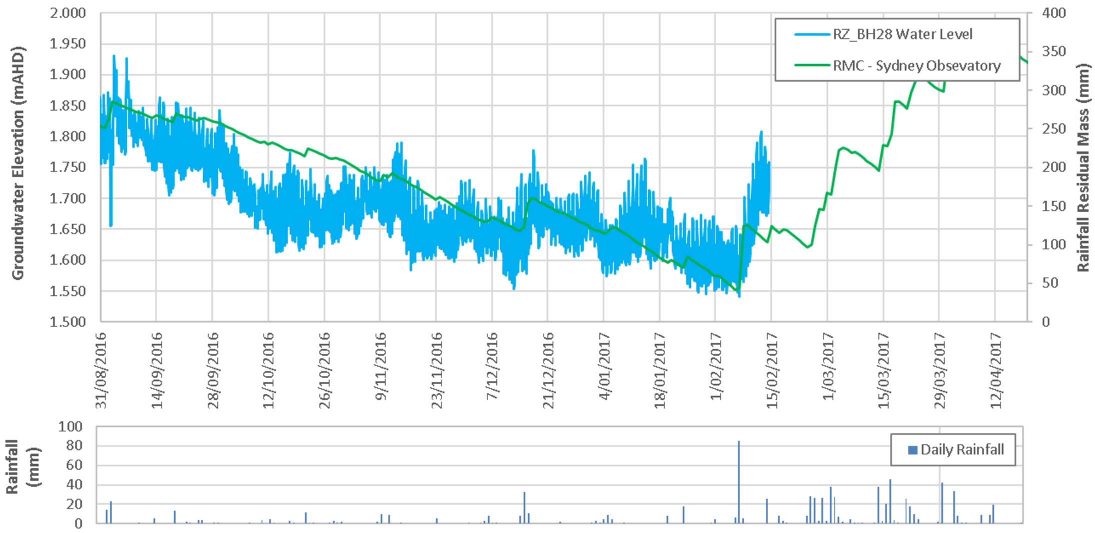

Figure 3-14 Hydrograph RZ_BH28 screened in Hawkesbury Sandstone

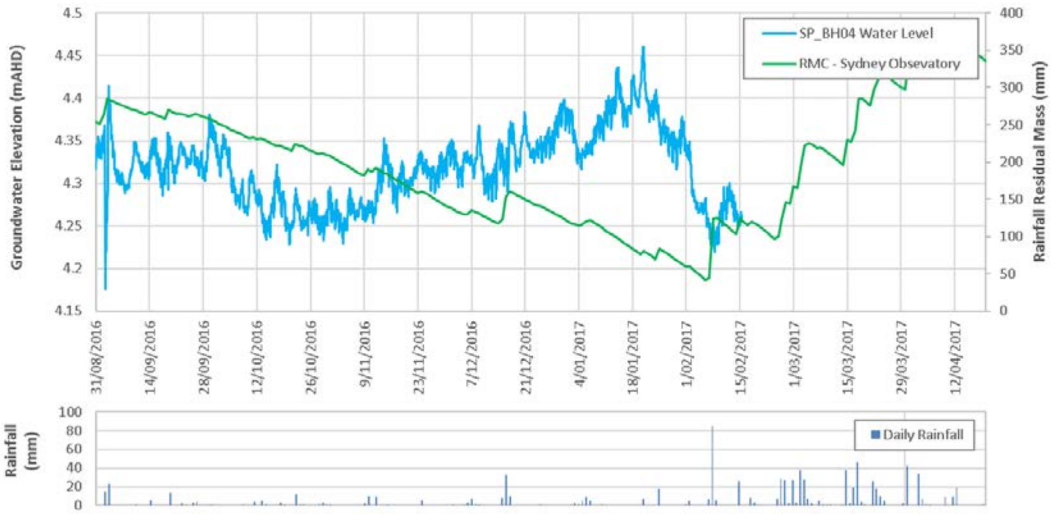

Figure 3-15 Hydrograph SP_BH04 screened in Hawkesbury Sandstone

3.7.4 HYDRAULIC PROPERTIES

Four major hydrogeologic units exist within the study area, the unconsolidated sediments of the alluvium, the Botany Sands aquifer, and the layered sedimentary sequences of the Ashfield Shale and Hawkesbury Sandstone. For the purposes of this project the Mittagong Formation is considered to be comparable in properties to the Ashfield Shale and therefore these units are grouped together. **Table 3-6** presents a summary of the hydraulic properties reported for the study area.

Table 3-6 Summary of hydraulic properties from nearby studies

	AGE	TYPE	Kh [m/d]	Kv [m/d]	Sy	Ss [m^{-1}]	SOURCE
ALLUVIUM	Quaternary	Aquifer	4.32E-1	8.64E-3			1
			5.00E-1	5.00E-2			2
			1.00E+0				3
			1.00E+0				4
			1.00E-2 to 1.00E+0	Ratio Kv:Kh 1:10 to 100	2.00E-1		6
BOTANY SANDS	Quaternary	Aquifer	8.64E-1	1.73E-2			1
			1.00E-2 to 1.00E+1	Ratio Kv:Kh 1:10 to 100	2.00E-1		6
ASHFIELD SHALE	Triassic	Leaky aquitard	8.00E-4	8.00E-4			1
			1.00E-3	1.00E-4			2
			1.08E-2				3
			1.91E-4 to 6.62E-3				4
			1.00E-4 to 1.00E-2				5
			1.00E-4 to 1.00E-2		1.00E-2	1.00E-5	6
MITTAGONG FORMATION	Triassic	Leaky aquitard	5.00E-3	Ratio Kv:Kh 1:10 to 1000			4
HAWKESBURY SANDSTONE	Triassic	Aquifer	1.00E-2	1.00E-2			1
			1.00E-2	5.00E-4			2
			1.00E-3 to 5.16E-3				3
			1.00E-3 to 5.00E-2				4
			1.00E-3 to 1.00E-1				5
			1.00E-3 to 1.00E-0	Ratio Kv:Kh 1:10 to 100	2.50E-2	5.00E-6 to 5.00E-5	6

sources: 1. Golder, 2016 M4 East model calibration (SS). 2. CDM Smith, 2016 New M5 Model calibration (SS). 3. GHD, 2015 M4 East Model Calibration (steady-state). 4. GHD, 2015 M4 East Model Calibration (transient). 5. Hewitt (2005). 6. Golder, 2016 Regional Literature Review

3.7.5 QUATERNARY ALLUVIUM

Alluvium is found along the edges of the watercourses within the study area and forms localised unconfined aquifers. As the water level is typically connected to adjacent water courses the water levels are typically shallow and strongly controlled by topography. Lower in the catchments groundwater within the alluvial aquifers is typically influenced by tidal fluctuations. Reported hydraulic conductivity values within the study area range from 0.1 m/day to 1 m/day, with vertical hydraulic conductivity being an order of magnitude or more less than horizontal due to the layered depositional sequence.

3.7.6 ASHFIELD SHALE

The Ashfield Shale is considered a regional leaky aquitard due to its low ability to transmit water through its fine-grained sequence and tight bedding planes. Groundwater flow is mostly restricted to flow through fractures and joints (secondary porosity), although the bulk hydraulic conductivity is typically low, in the order of 0.01 to 0.00001m/day.

Packer testing conducted by AECOM (2017) indicates that the horizontal hydraulic conductivity of the shale in the areas of Camperdown and St Peters typically averages close to 0.01 m/day, although a zone of higher hydraulic conductivity (up to 0.8 m/day) seems to occur at depths between 10 and 20 m below ground surface (**Figure 3-16**). This is likely due to the surficial shales being weathered to plastic clays, while the fresher material beneath the weathered zone is likely to contain a higher fracture/joint density thereby increasing the hydraulic conductivity. Testing of shale below 40 m depth has not been undertaken but it is expected that the hydraulic conductivity will continue to decrease with depth as a function of decreasing density of fracturing and tighter bedding partitions.

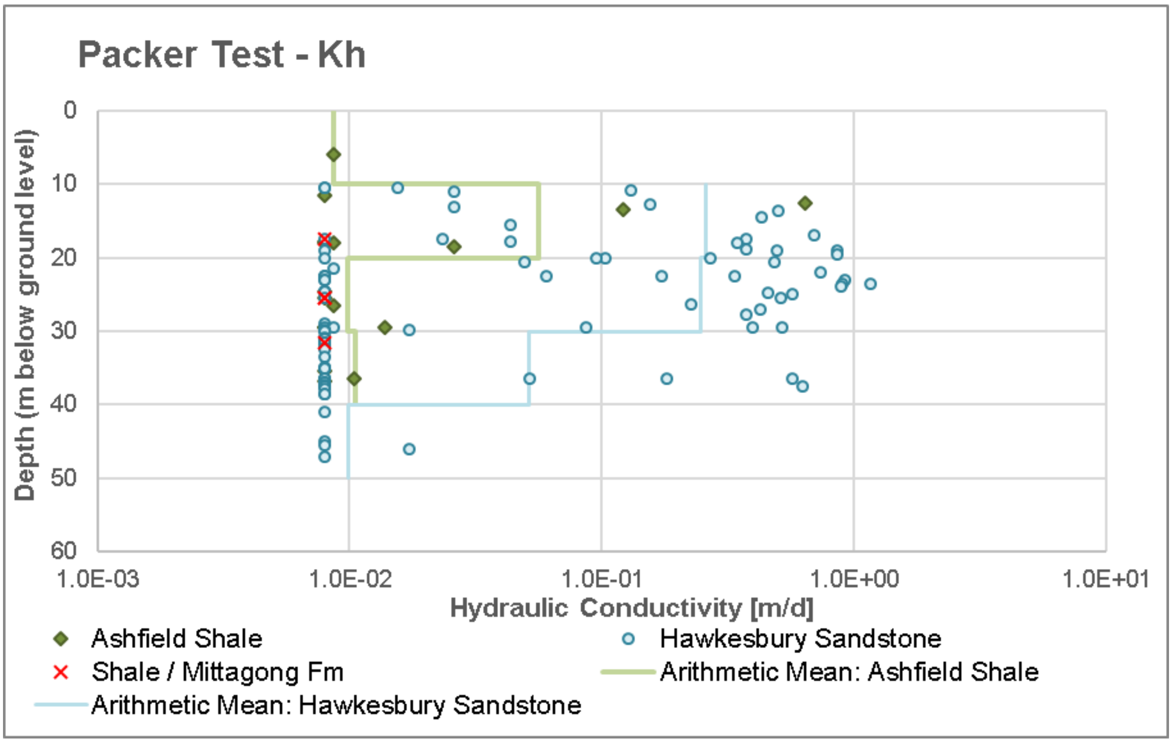

Figure 3-16 Hydraulic conductivity from packer testing along M4-M5 alignment

3.7.7 HAWKESBURY SANDSTONE

The Hawkesbury Sandstone is a dual porosity aquifer with groundwater dominantly transmitted via interconnected fracturing. The bulk hydraulic conductivity of the Hawkesbury Sandstone is typically in the order of 0.001 to 0.1 m/day (**Table 3-6**). Vertical anisotropy (K_V:K_H) is in the range of 1:10 to as low as 1:100. Extensive packer testing has been undertaken in the Hawkesbury Sandstone across the Sydney Basin. Tammetta and Hawkes (2009) have compiled the results of many of these tests (**Figure 3-17**), with the horizontal conductivities reported ranging from over 1m/day in the upper 50m to as low at 0.00003 m/day at 400 m depth. There is a clear trend of decreasing hydraulic conductivity with depth from ground surface, which is again most likely to be due to less frequent fracture spacing with depth.

Packer testing has been undertaken for the Hawkesbury Sandstone as part of the current Project (**Figure 3-16**). However, hydraulic conductivities in the Hawkesbury Sandstone are likely to be lower in several instances than has been indicated by packer testing due to the lower bounds of readings being restricted to 1 Lugeon, which is equivalent to approximately 0.009 m/day. 43% of Hawkesbury Sandstone readings returned the minimum value of "<1 Lugeon", therefore calculation of averages using this data are likely to be higher than the actual average of hydraulic conductivities. Results suggest hydraulic conductivities range between 1 m/day and 0.009 m/day (lower limit of recording). Packer testing that was undertaken for the New M5 alignment (**Figure 3-18**) appears to have been able to record lower values than that completed during the M4-M5 Link investigations, with minimum recorded values of 0.000004 m/day. The majority of test results indicate that the conductivity in the Hawkesbury Sandstone is highly variable, with most measurements within 0.00001 to 0.0001 m/day. Again a general trend of decreasing hydraulic conductivity with depth can be seen in packer test results associated with the WCX projects.

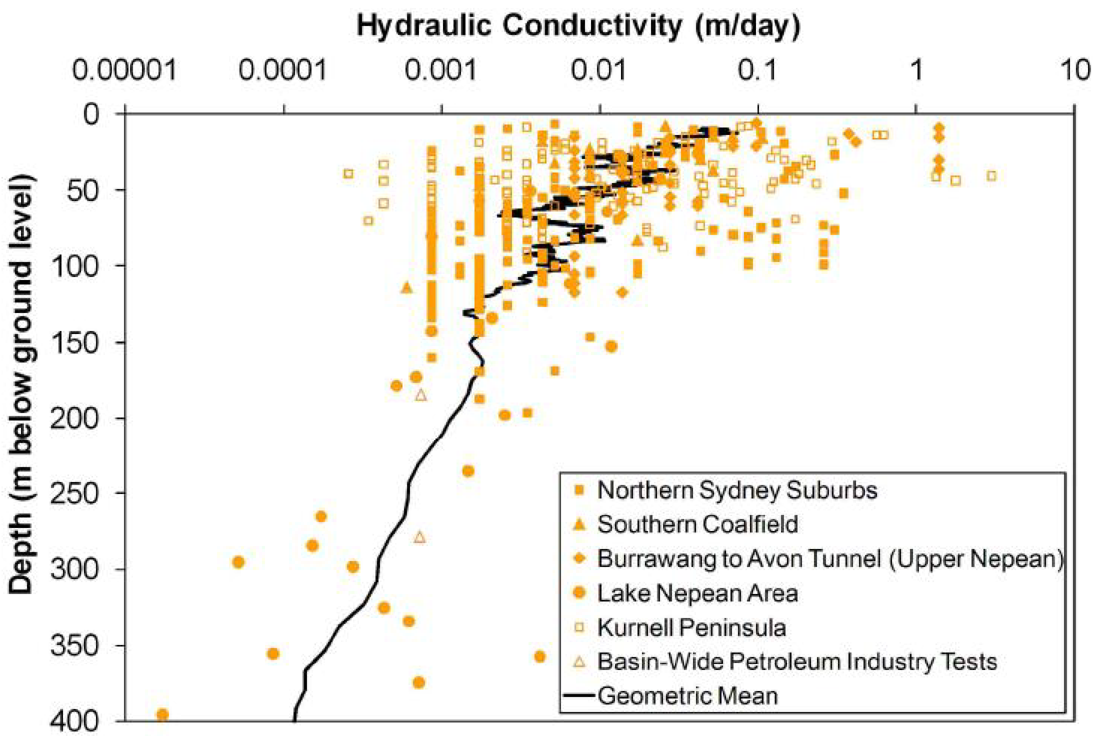

Figure 3-17 Hydraulic conductivity from packer testing of Mesozoic sandstones in Sydney Basin (Tammetta & Hawkes, 2009)

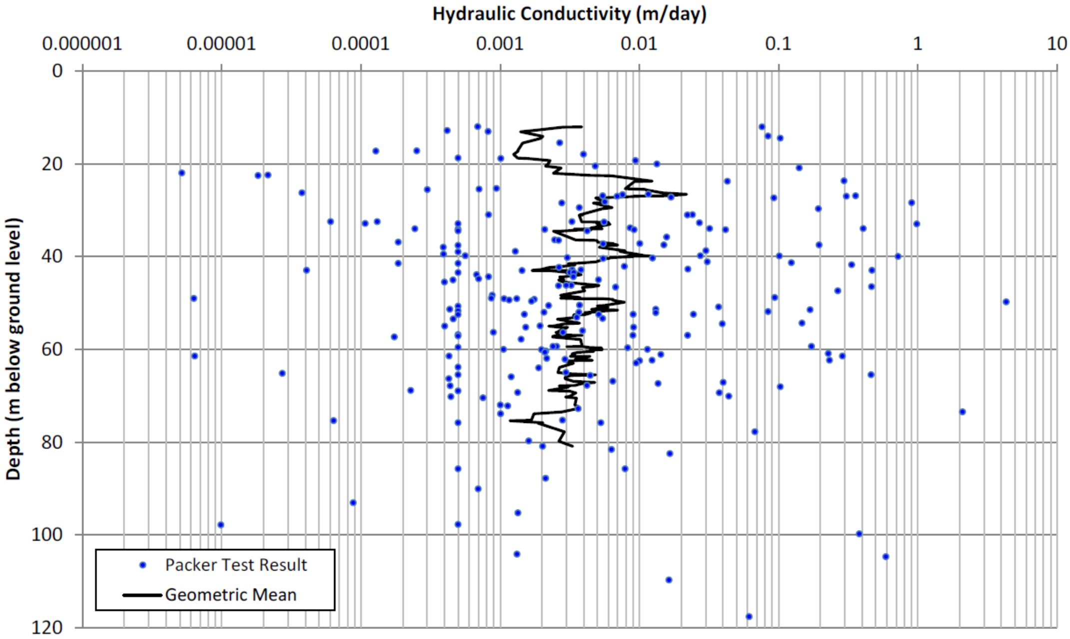

Figure 3-18 Hydraulic conductivity from packer testing along the New M5 alignment (RMS, 2015)

Studies conducted in the Sydney metropolitan area and elsewhere indicate a specific yield of between 0.01 and 0.02 (i.e. 1-2%) is reasonable for typical Hawkesbury Sandstone (Tammetta and Hewitt, 2004).

Core porosity (total) and permeability testing was undertaken for a few boreholes within the M4-M5 alignment, with results shown in **Table 3-7**. Total porosity ranges from 11 to 19% in the Hawkesbury Sandstone. Measured vertical hydraulic conductivity ranges between 0.01 m/day in the Ashfield Shale to 0.0001 m/day in the Hawkesbury Sandstone, typically decreasing with depth.

Table 3-7 M4-M5 Link core porosity and permeability testing

Monitoring	Sample Interval (m)	Lithology	Vertical Hydraulic Conductivity	Total Porosity
Well			m/day	%
EP_BH04	25.3 - 25.46	Hawkesbury Sandstone	2.76E-03	13.6
HB_BH24	18.27 - 18.45	Hawkesbury Sandstone	4.58E-03	14.1
MT_BH01	59.43 - 59.61	Hawkesbury Sandstone	5.53E-03	13.1
MT_BH07	42.38 - 42.58	Hawkesbury Sandstone	4.15E-03	11.3
MT_BH11	53.38 - 53.56	Hawkesbury Sandstone	3.80E-04	13.6
MT_BH12	46.11 - 46.25	Hawkesbury Sandstone	3.54E-03	18.7
MT_BH16	79.45 - 79.58	Hawkesbury Sandstone	1.99E-04	14.6
RZ_BH60	49.15 - 49.30	Hawkesbury Sandstone	1.21E-04	14.3
MT_BH16	39.25 - 39.43	Mudstone (Ashfield Shale)	1.30E-02	5.6

3.7.8 GROUNDWATER INFLOW TO TUNNELS

The tunnels associated with the WCX program of works are primarily designed to be free draining, under the restriction of a maximum inflow rate of 1L/sec/km during tunnel operation. Local grouting will be undertaken as necessary where high inflow features (such as conductive faults and large fractures) are intercepted during tunnel excavation. The tunnelling that passes under the Cooks River in the New M5 alignment is planned to be tanked, as are some of the tunnels that approach roads to the Rozelle Interchange in poor ground conditions near to the Whites Creek Palaeochannel in the M4-M5 Link alignment. Water cut-off walls are adopted locally in cut and cover structures across the Rozelle Rail Yard. These tanked and lined structures are assumed to be impermeable and therefore groundwater inflow will be zero **Figure 3-19**).

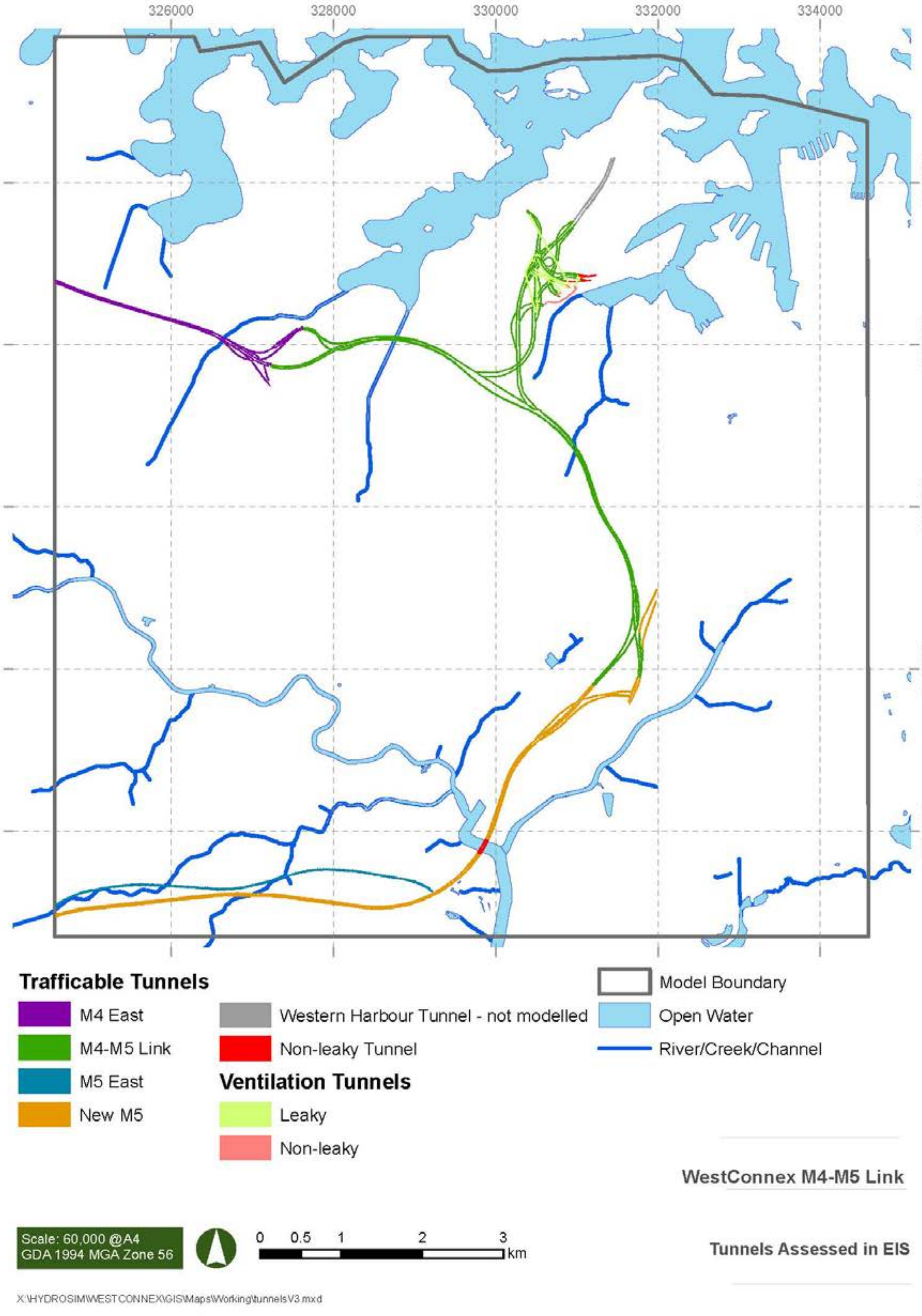

Figure 3-19 WestConnex tunnels assessed as part of the groundwater model

Hewitt (2005) has compiled a list of the long term inflow to existing tunnels in Sydney metropolitan area (**Table 3-8**). Drainage inflow rates range from 0.1L/sec/km to <3L/sec/km. The M5 East motorway is the only existing drained tunnel within the project area, having a long term inflow rate of 0.8 to 0.9 L/sec/km.

Tunnel	Type	Length (km)	Span/diameter (m)	Maximum rock cover (m)	Long-term measured inflow (L/s/km)
Northside Storage	Water	20	6	90	0.9 (10 without extensive grouting)
Epping to Chatswood	Rail	13	7.2 (twin)	60	0.9
M5 East	Road	3.9	8 (twin)	60	0.8–0.9
Eastern Distributor	Road	1.7	12 (double deck)	40	1
Hazelbrook	Water	9.5	2	50	0.1
Cross City	Road	2.1	8 (twin)	53	<3
Lane Cove	Road	3.6	9 (twin)	60	<3

Table 3-8 Long term inflow to existing tunnels (Hewitt, 2005)

Modelling for M4 East and the New M5 of WCX has been undertaken prior to this project. Modelling results from those projects predict inflow values of between 0.16 L/sec/km to 3.76 L/sec/km (recharge dependant) for the M4 East (GHD, 2015) and 0.67 L/sec/km for the New M5 (CDM Smith, 2015). The groundwater inflow design criteria for M4 East, the New M5 and NorthConnex was also set at 1L/sec/km.

3.7.9 RAINFALL RECHARGE

The Coastal porous rock aquifer recharge study by EMM (2015) completed a literature review of the reported recharge values for areas east of the NSW Great Dividing Range, with 5% mean annual rainfall being the average for the Hawkesbury Sandstone. There is limited data for the Wianamatta Formation, but it is suggested that recharge to the shales will be equal to or less than the sandstone.

Crosbie (2015) conducted a study to estimate recharge based on the chloride mass balance method in the Sydney Basin, and provided recharge estimates as follows (**Figure 3-20**):

- Botany Sands – 40 to 100% rainfall;
- Hawkesbury Sandstone – 2 to 10% rainfall;
- Wianamatta Shale – 1 to 2 % rainfall.

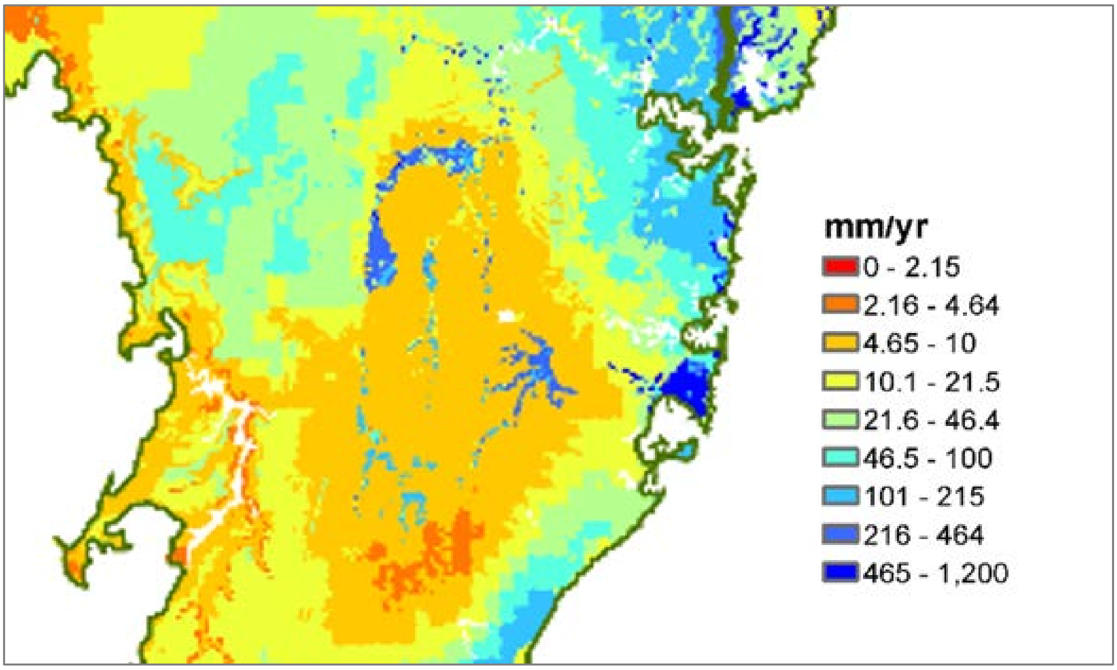

Figure 3-20 Estimated recharge from Crosbie (2015)

Hatley (2004) conducted a literature review of rainfall recharge to the Botany Basin, with values between 6% to 37% of rainfall reported, based primarily on transient model calibration by Merrick (1994).

Due to the study area being within an urban setting, the recharge received in natural environments with unmodified surface cover is likely to be significantly reduced with increased surface runoff to stormwater drains and surface channels. However localised recharge from leaky pipes and stormwater drains may partially counteract this reduction, as well as the reduced evapotranspiration associated with lower density vegetation and an impervious ground cover.

4 GROUNDWATER MODELLING

4.1 MODEL SOFTWARE AND COMPLEXITY

Numerical modelling has been undertaken using Geographic Information Systems (GIS) in conjunction with MODFLOW-USG, which is distributed by the United States Geological Survey (USGS). MODFLOW-USG is a relatively new version of the popular MODFLOW code (McDonald and Harbaugh, 1988) developed by the United States Geological Survey (USGS). MODFLOW is the most widely used code for groundwater modelling and has long been considered an industry standard.

MODFLOW-USG represents a major revision of the MODFLOW code, in that it uses a different underlying numerical scheme: control volume finite difference (CVFD), rather than traditional MODFLOW's finite difference (FD) scheme. 'USG' is an acronym for Un-Structured Grid, meaning that MODFLOW-USG supports a variety of structured and unstructured model grids, including those based on cell shapes including prismatic triangles, rectangles, hexagons, and other cell shapes (Panday *et al*., 2013). The CVFD method also means that a model cell can be connected to an arbitrary number of adjacent cells, which is not the case with a standard FD scheme.

In contrast with structured rectangular finite-difference grids, flexible meshes have a number of advantages. Firstly, they allow finer grid resolution to be focused solely in areas of a model that require it (e.g. along the tunnel alignments), as opposed to refinement over the entire grid, significantly decreasing cell count and consequently model runtimes. Secondly, spatial areas not required in the model may be omitted rather than deactivating cells or retaining "dummy" layers (e.g. for layer pinch-outs). Thirdly, flexible meshes allow cell boundaries to follow important geographical or geological features, such as watercourses or outcrop traces, more accurately modelling the physical system. Finally, the orientation of the flow interfaces between cells may vary, allowing preferential flow directions to be modelled with higher accuracy.

Additionally, MODFLOW-USG is able to simulate variably saturated flow and can handle desaturation and re-saturation of multiple hydrogeological layers without the "dry cell" problems of traditional MODFLOW. This is pertinent to models which simulate layers, such as surficial regolith, which frequently alternate between unsaturated and saturated, as well as the depressurisation and desaturation that occurs due to tunnel excavation. Traditional versions of MODFLOW can handle depressurisation and desaturation to some extent, but model cells that are dewatered (reduced below atmospheric pressure) are replaced by "dry" cells, which can interfere with the simulation of various processes and also cause model instability.

4.2 MODEL GEOMETRY

4.2.1 MODEL EXTENT

The maximum extent of the groundwater model for the project is shown in **Figure 4-1**, and is the same as the study area shown on many figures in this report. This area is roughly 11 x 11 km, with the northern boundary being represented by the central channel of Sydney Harbour/Parramatta River. This extent is based on the need for inclusion of adjoining WCX works and other major tunnel infrastructure (M5 East) as part of the cumulative impact assessment, and practical considerations for modelling (most notably model run time, file size and processing of results).

The active domain is centred on the Project, and partially includes neighbouring M4 East and New M5 WCX works. Consideration was given to including the Eastern Distributor and Cross City Tunnel within the model boundary (both approximately 3 km from the nearest WCX tunnelling at their closest points), however due to lack of water level data and tunnel inflow data it was considered that modelling the Eastern Distributor/Cross City Tunnel would result in increased model uncertainty; thus they were not included. In any case, any drawdown associated with these tunnels is not expected to interact with the planned WCX tunnels nor contribute to the cumulative impacts of the project. Fully lined tunnels such as the Airport Rail Link and Harbour Tunnel were also excluded from the model on the basis that they would not impact the regional flow regime, as there is no drawdown associated with their operation and local groundwater is able to flow around the tunnels.

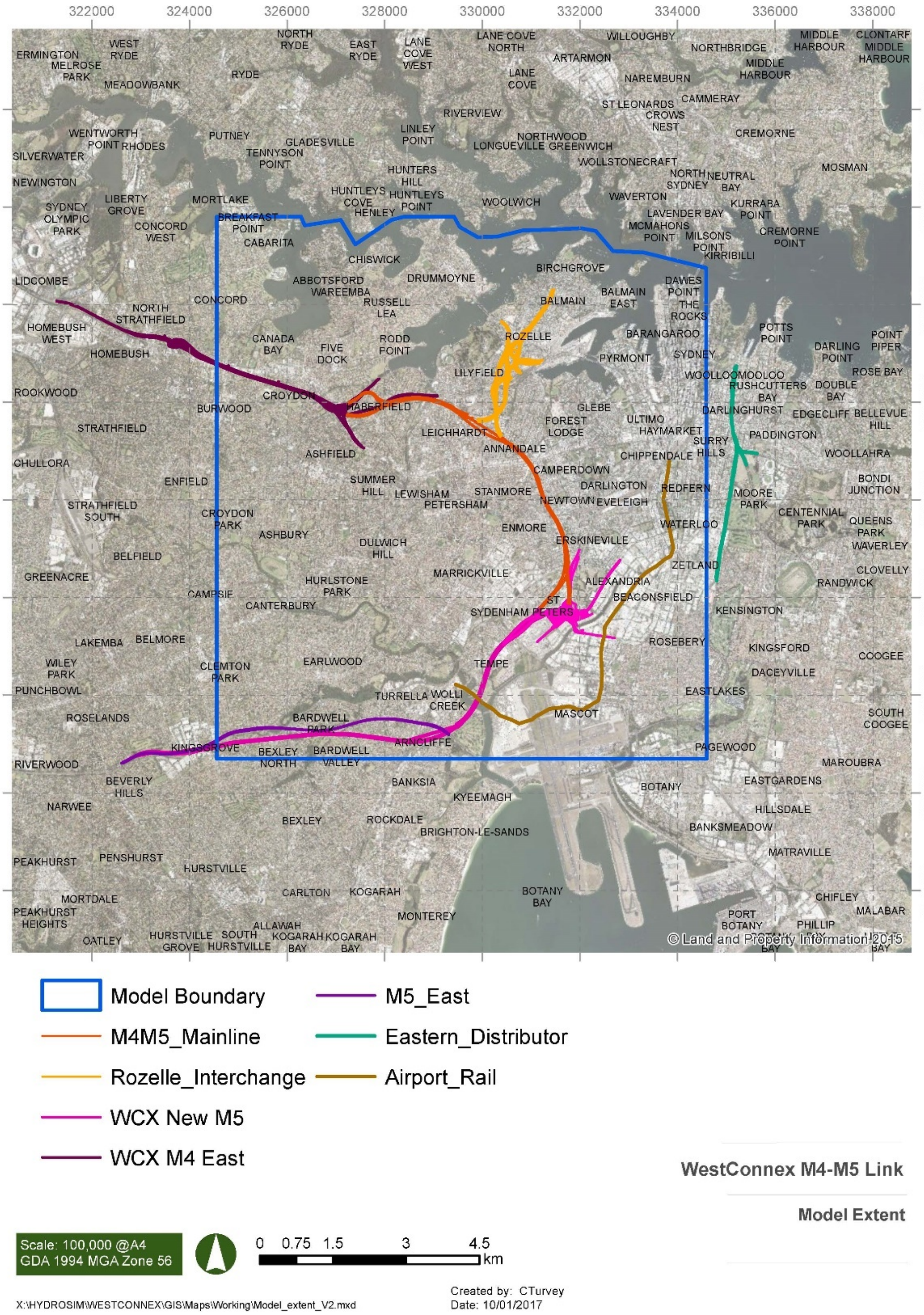

Figure 4-1 Model extent

4.2.2 MODEL LAYERING

The topography of the model relies on LiDAR data provided by AECOM. The model domain is discretised into eight (8) layers, as shown in **Table 4-1.** All layers are fully extensive, however where a particular hydrogeological unit is not present (e.g, because of erosion), the model layer representing that unit has been assigned a layer thickness of 0.5 m and the layer has been given the same hydraulic properties as the layer below. This approach ensures that each layer represents a discrete hydrogeological unit.

Table 4-1 Model layering and hydrostratigrahpy

Layer	Unit	Average Thickness# (m)	Min Thickness (m)	Max Thickness (m)
1	Fill, Regolith, Alluvium, Botany Sands	7.8	0.5	64.6
2	Upper Ashfield Shale	4.2	0.5	5
3	Lower Ashfield Shale/ Mittagong Formation	7.8	0.5	41.5
4	Hawkesbury Sandstone	16.2	0.5	70.5
5	Hawkesbury Sandstone	19.4	0.5	20
6	Hawkesbury Sandstone	19.9	3.2	20
7	Hawkesbury Sandstone	20	20	20
8	Hawkesbury Sandstone	20	20	20

Average thickness does not include 0.5m thickness assigned where the geological unit is not present

The lateral boundaries of the geological model are based on the Sydney 1:100,000 Geological Map. Vertical boundaries were developed using:

- The intersection of LIDAR data with the Sydney 1:100,000 geology outcrop extents.
- Geological logs from drilling investigations specific to the M4-M5 project.
- Compiled GINT database information provided by AECOM for nearby road infrastructure projects.

The two main rock units, the Ashfield Shale and the Hawkesbury Sandstone have been subdivided into multiple model layers. This is particularly important in the Hawkesbury Sandstone, and has been done for the following reasons:

- The Hawkesbury Sandstone cannot be considered to be a single aquifer. HydroSimulations experience in the wider Sydney Basin but also observed here, is that multiple aquifers often exist through the Hawkesbury Sandstone sequence. There are usually a perched water table or two, plus the 'regional' water table or confined aquifer.
- When simulating a tunnel with a discrete height, it is best that the model layers approximate this height. If the Hawkesbury Sandstone were represented as a single layer with a thickness of 100 m (or more), the effective transmissivity of the stratum that controls inflow to the void would be based on that thickness, not the actual tunnel height. Additionally, the drawdown imposed by tunnel dewatering would occur across the model layer thickness, so using thicker layers would cause overestimation of the upward transmission of drawdown.
- On this last point, it is acknowledged that the tunnel height is not 20 m (it is typically 8 m to 10 m). However, the model layers do not follow the tunnel invert elevation (rather the proposed tunnel cross-cuts the model layers), therefore it is not possible

to directly replicate the upper and lower tunnel surfaces by using thinner layers. Given this constraint, a 20 m layer thickness is considered an appropriate compromise between model precision and model run times to represent the changing vertical head gradient due to tunnel excavation while maintaining a workable model size.

4.2.3 MODEL ZONES

As discussed in Hydraulic Properties data analysis (**Section 3.7.4**) the hydraulic conductivity of the geological units typically decreases with depth. Accordingly, zonation within the Ashfield Shale and Hawkesbury sandstone was applied as per **Table 4-2**, using the top of Layer 1 minus the layer mid-point elevation to determine the relevant zone within each layer. Thus each layer contained several depth-dependant hydraulic zones for calibration.

Table 4-2 Model hydraulic zonation

Depth (mbgl)	Ashfield Shale Model Zone Number	Hawkesbury Sandstone Model Zone Number
0 to 10	21	41
10 to 20	22	42
20 to 40	23	43
40 to 60	24	44
60 to 80	25	45
80 to 100	NA	46
>100	NA	47

As the Alluvium, Botany Sands and Fill/regolith occur only in Layer 1, a single zone was applied to each and no variation in hydraulic conductivity with depth was modelled. Although within the alluvium in the Whites Creek Palaeochannel two sub aquifers were identified it was considered that separating these two aquifers in the model would not provide additional model accuracy since the differential head of approximately 0.5m would be within the range of model uncertainty.

4.2.4 MODEL GRID

The use of MODFLOW-USG (**Section 4.1**) allows the use of an unstructured or irregular mesh. For this project, a Voronoi-based mesh has been adopted (Amenta and Bern, 1998), which has the advantage of being not only irregular but maintaining the property that a line connecting adjacent cell-centres is perpendicular to the shared cell boundary. Use of the unstructured mesh allows refinement by using small cell sizes along road tunnels and watercourses while letting the cell size increase in areas that are not near features of interest.

The model domain is discretised into 69,701 cells for each layer, with a total cell count of 557,608 cells. The use of MODFLOW-USG could have been better optimised by allowing layers to pinch out where the layer thickness was less than 0.5m; however due to the use of the relatively new program mod-PATH3DU (which has had some issues with models incorporating pinch-outs) it was considered more efficient to leave all layers fully extensive given the time constraints on the project. This does not compromise model results; rather it simply increases the model run-time slightly due to a greater cell count. Where a model layer extends across an area where the geological unit represented by that layer is not present (e.g. where the Ashfield Shale has been eroded away in Layer 2 and 3), the layer is given a thickness of 0.5m and assigned the hydraulic properties of the next present geological unit below it (in this example the Hawkesbury Sandstone in Layer 4), creating a continuous vertical profile.

The Voronoi mesh was generated using the proprietary HydroAlgorithmics software 'AlgoMesh' (Merrick and Merrick, 2015), which provides significant control over the mesh generation process, and can export MODFLOW-USG files, in addition to other formats.

The following general approach was taken when using AlgoMesh:

- Polylines mapped along the proposed tunnel alignments were used to create a mesh of Voronoi cells to define the tunnel with a maximum single tube width of 20m.
- Polylines along mapped rivers and creeks were used to ensure the mesh conformed to mapped drainage networks, and to enforce variable spatial detail along streams (e.g. greater detail along streams closest to the Project).
- Calibration target boreholes were included in the mesh generation process to ensure sufficient spatial detail in areas with observations (bores) located close to one another.
- Maximum grid cell resolution in key areas of interest is as follows:
    - 12.5 m in 2-lane road tunnels;
    - 14.5 m in 3-lane road tunnels;
    - 18 m in 4-lane road tunnels;
    - 20 m in 5-lane road tunnels;
    - 25 m along waterways;
    - 50 m in alluvium areas.

Maximum cell width is approximately 500 m, with cells gradually grading to this size in areas away from tunnels and watercourses.

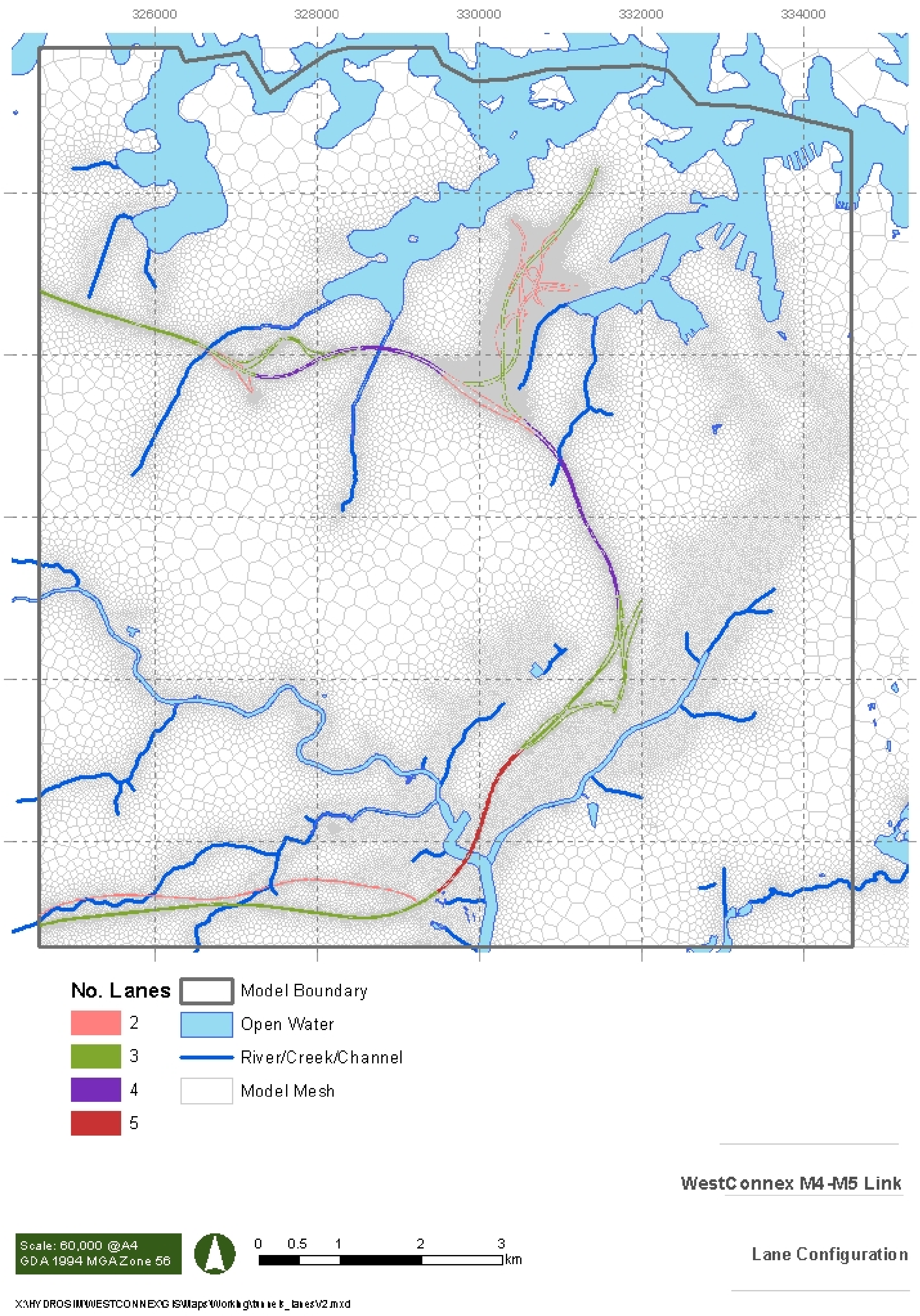

Figure 4-2 Lane configuration

4.3 MODEL VARIANTS

Both steady-state and transient models have been developed:

- Steady-state model of inferred existing conditions, including any drawdown associated with existing tunnels including the M5 East Motorway. The purpose of the steady-state model is to generate plausible initial conditions for the start of the transient simulation.
- Transient model of the transition from recent and existing conditions to the end of WCX construction (inclusive of the current project and the M4 East project and New M5 Project) and extending to year 2100 (total simulation time of 85 years). The purpose of the transient model is to simulate the changing groundwater regime over time with tunnel construction and long-term operation.

An additional transient model was run without the M4-M5 Link in order to determine the project's individual contribution to the modified groundwater regime by comparing the model predictions with the run that includes the M4-M5 Link.

The steady-state and transient periods are incorporated into a single run (i.e. the steady-state period automatically provides initial conditions for the subsequent transient period). The transient model is broken into phases of calibration, construction and prediction, although the actual construction of the WCX programs of works occurs in all three model phases. For the purpose of the modelling the "calibration" period reflects the period for which monitoring data exists (i.e. 2015 to early 2017), and is inclusive of the initial tunnelling activities for M4 East and New M5. The "construction" phase represents the period from the end of calibration to the end of proposed tunnelling activities (M4-M5 Link ventilation tunnels at Rozelle at the end of 2022) and "long-term" reflects the ongoing operational inflows into the tunnel after tunnel excavation is complete. The timing of the model is described in **Figure 4-3**.

	SP	From	To	No Days	Num months	Total days	Total years
Initial Conditions	1	STEADY STATE					
Transient Calibration	2	1/01/2015	31/01/2015	31	1	31	0.08
	3	1/02/2015	28/02/2015	28	1	59	0.16
	4	1/03/2015	31/03/2015	31	1	90	0.25
	5	1/04/2015	30/04/2015	30	1	120	0.33
	6	1/05/2015	31/05/2015	31	1	151	0.41
	7	1/06/2015	30/06/2015	30	1	181	0.5
	8	1/07/2015	31/07/2015	31	1	212	0.58
	9	1/08/2015	31/08/2015	31	1	243	0.67
	10	1/09/2015	30/09/2015	30	1	273	0.75
	11	1/10/2015	31/10/2015	31	1	304	0.83
	12	1/11/2015	30/11/2015	30	1	334	0.91
	13	1/12/2015	31/12/2015	31	1	365	1
	14	1/01/2016	31/01/2016	31	1	396	1.08
	15	1/02/2016	29/02/2016	29	1	425	1.16
	16	1/03/2016	31/03/2016	31	1	456	1.25
	17	1/04/2016	30/04/2016	30	1	486	1.33
	18	1/05/2016	31/05/2016	31	1	517	1.42
	19	1/06/2016	30/06/2016	30	1	547	1.5
	20	1/07/2016	31/07/2016	31	1	578	1.58
	21	1/08/2016	31/08/2016	31	1	609	1.67
	22	1/09/2016	30/09/2016	30	1	639	1.75
	23	1/10/2016	31/10/2016	31	1	670	1.83
	24	1/11/2016	30/11/2016	30	1	700	1.92
	25	1/12/2016	31/12/2016	31	1	731	2
	26	1/01/2017	31/01/2017	31	1	762	2.09
	27	1/02/2017	28/02/2017	28	1	790	2.16
	28	1/03/2017	31/03/2017	31	1	821	2.25
	29	1/04/2017	30/04/2017	30	1	851	2.33

	SP	From	To	No Days	Num months	Total days	Total years
Prediction - Construction	30	1/05/2017	31/05/2017	31	1	882	2.41
	31	1/06/2017	30/06/2017	30	1	912	2.5
	32	1/07/2017	31/07/2017	31	1	943	2.58
	33	1/08/2017	31/08/2017	31	1	974	2.67
	34	1/09/2017	30/09/2017	30	1	1004	2.75
	35	1/10/2017	31/10/2017	31	1	1035	2.83
	36	1/11/2017	30/11/2017	30	1	1065	2.92
	37	1/12/2017	31/12/2017	31	1	1096	3
	38	1/01/2018	31/03/2018	90	3	1186	3.25
	39	1/04/2018	30/06/2018	91	3	1277	3.5
	40	1/07/2018	30/09/2018	92	3	1369	3.75
	41	1/10/2018	31/12/2018	92	3	1461	4
	42	1/01/2019	31/03/2019	90	3	1551	4.25
	43	1/04/2019	30/06/2019	91	3	1642	4.5
	44	1/07/2019	30/09/2019	92	3	1734	4.75
	45	1/10/2019	31/12/2019	92	3	1826	5
	46	1/01/2020	31/03/2020	91	3	1917	5.25
	47	1/04/2020	30/06/2020	91	3	2008	5.5
	48	1/07/2020	30/09/2020	92	3	2100	5.75
	49	1/10/2020	31/12/2020	92	3	2192	6
	50	1/01/2021	31/03/2021	90	3	2282	6.25
	51	1/04/2021	30/06/2021	91	3	2373	6.5
	52	1/07/2021	30/09/2021	92	3	2465	6.75
	53	1/10/2021	31/12/2021	92	3	2557	7
	54	1/01/2022	31/03/2022	90	3	2647	7.25
	55	1/04/2022	30/06/2022	91	3	2738	7.5
	56	1/07/2022	30/09/2022	92	3	2830	7.75
	57	1/10/2022	31/12/2022	92	3	2922	8

	SP	From	To	No Days	Num months	Total days	Total years
Prediction - Long Term	58	1/01/2023	31/03/2023	90	3	3012	8.25
	59	1/04/2023	30/06/2023	91	3	3103	8.5
	60	1/07/2023	30/09/2023	92	3	3195	8.75
	61	1/10/2023	31/12/2023	92	3	3287	9
	62	1/01/2024	31/03/2024	91	3	3378	9.25
	63	1/04/2024	30/06/2024	91	3	3469	9.5
	64	1/07/2024	30/09/2024	92	3	3561	9.75
	65	1/10/2024	31/12/2024	92	3	3653	10
	66	1/01/2025	31/03/2025	90	3	3743	10.25
	67	1/04/2025	30/06/2025	91	3	3834	10.5
	68	1/07/2025	30/09/2025	92	3	3926	10.75
	69	1/10/2025	31/12/2025	92	3	4018	11
	70	1/01/2026	31/12/2026	365	12	4383	12
	71	1/01/2027	31/12/2027	365	12	4748	13
	72	1/01/2028	31/12/2028	366	12	5114	14
	73	1/01/2029	31/12/2029	365	12	5479	15
	74	1/01/2030	31/12/2030	365	12	5844	16
	75	1/01/2031	31/12/2035	1826	60	7670	21
	76	1/01/2036	31/12/2040	1827	60	9497	26
	77	1/01/2041	31/12/2045	1826	60	11323	31
	78	1/01/2046	31/12/2050	1826	60	13149	36
	79	1/01/2051	31/12/2099	17897	586	31046	85

Figure 4-3 Model stress period timing

4.4 MODEL STRESSES AND BOUNDARY CONDITIONS

The model domain and boundaries shown in **Figure 4-4** have been selected to incorporate the significant hydrological processes identified in the conceptual model (**Section 3**), including features such as watercourses that could be affected by tunnelling. Following is a detailed description of each of the modelled boundary conditions.

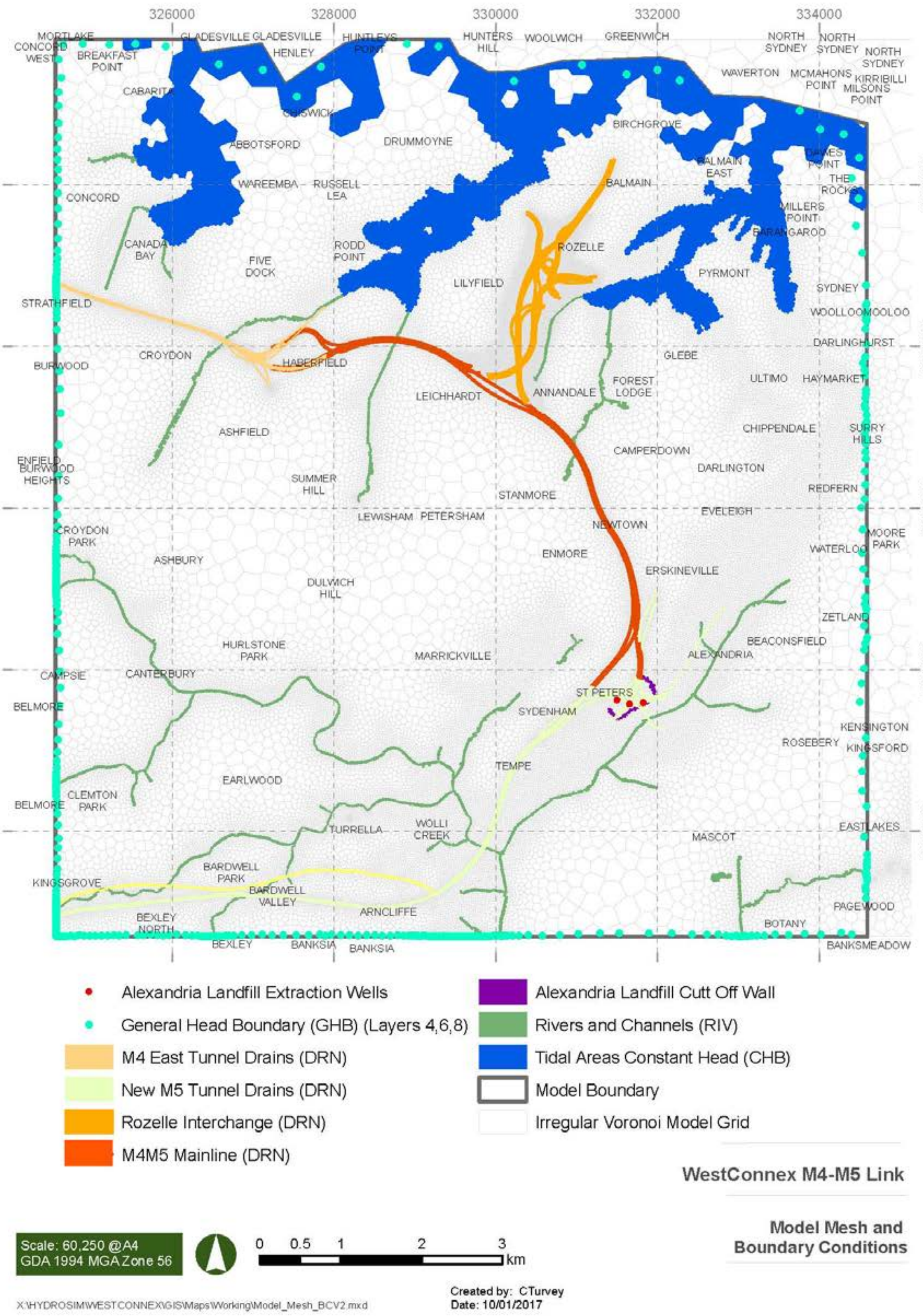

Figure 4-4 Model mesh and boundary conditions

4.4.1 RECHARGE

The MODFLOW Recharge (RCH) package is used to simulate diffuse rainfall recharge. Rainfall recharge has been imposed as a percentage of actual rainfall (for transient calibration) or long term average rainfall (for steady-state calibration and prediction). Refer to the rainfall recharge analysis and discussion in **Section 3.7.9**.

Spatially and temporally variable groundwater recharge rates were applied to the groundwater model. Spatial variations are based on the outcropping hydrogeological units (Botany Sands, Ashfield Shale and Hawkesbury Sandstone). These are then divided into further zones based on paved vs unpaved areas identified from open-source land use data (DP&E, 2016), giving a total of six recharge zones as per **Figure 4-5**. No differentiation of paved areas into density of urbanisation/use has been attempted, and no specific recharge due to stormwater drainage pipes/culverts/channels, as this is difficult to quantify both volumetrically and spatially. Any leakage from the urban infrastructure is assumed to balance out with overall recharge estimation.

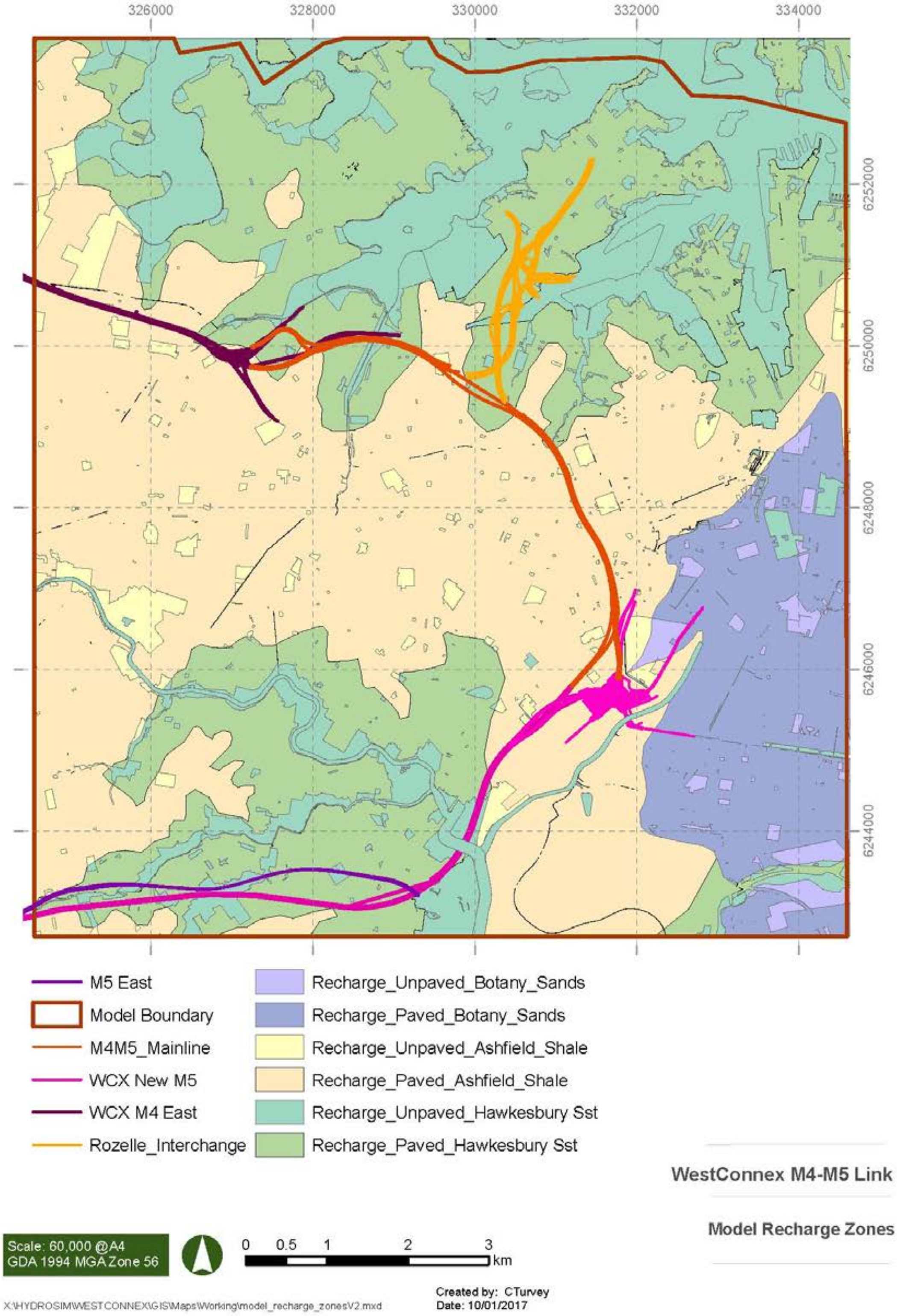

Figure 4-5 Model recharge zones

Temporal variation to recharge for the transient simulation has been calculated using the ratio between actual observed monthly rainfall data and the long term monthly/annual averages, with resulting multipliers applied to the steady-state recharge as per **Figure 4-6**.

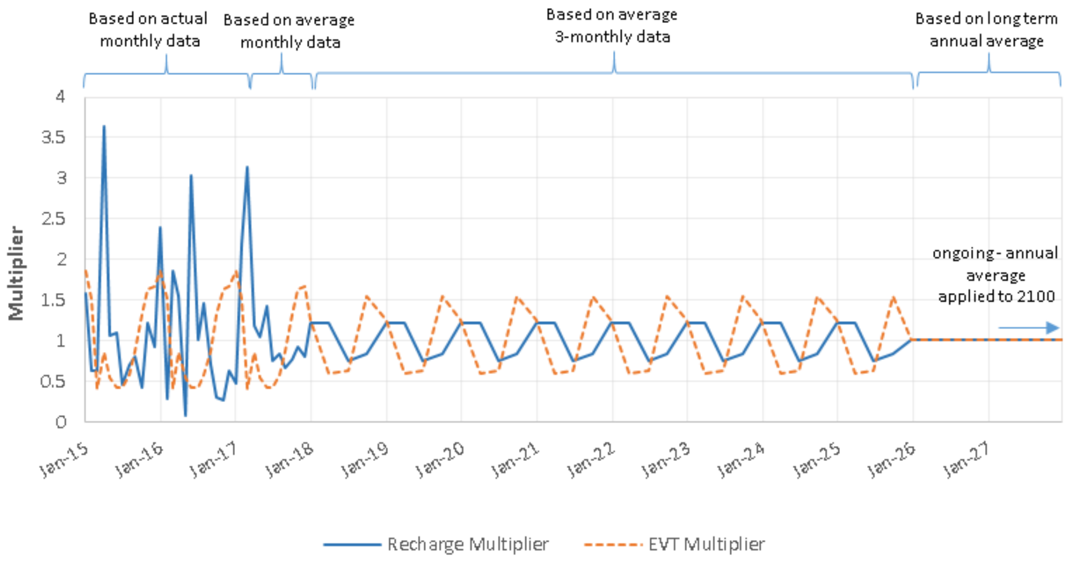

Figure 4-6 Recharge and evapotranspiration transient multipliers

4.4.2 EVAPOTRANSPIRATION FROM GROUNDWATER

The MODFLOW Evapotranspiration (EVT) package was used to simulate evapotranspiration from the groundwater system. Extinction depths were set to 0.5 m below ground across most of the model domain to reflect the reduced evapotranspiration in paved areas, and extinction depths of 1 m for open grassland areas and 5 m for forested areas (based upon average rooting depths reported in Canadell (1996)). Evapotranspiration zones are shown in **Figure 4-7**). Maximum potential rates were set using potential evapotranspiration values and transient multipliers in the same manner as described above for recharge.

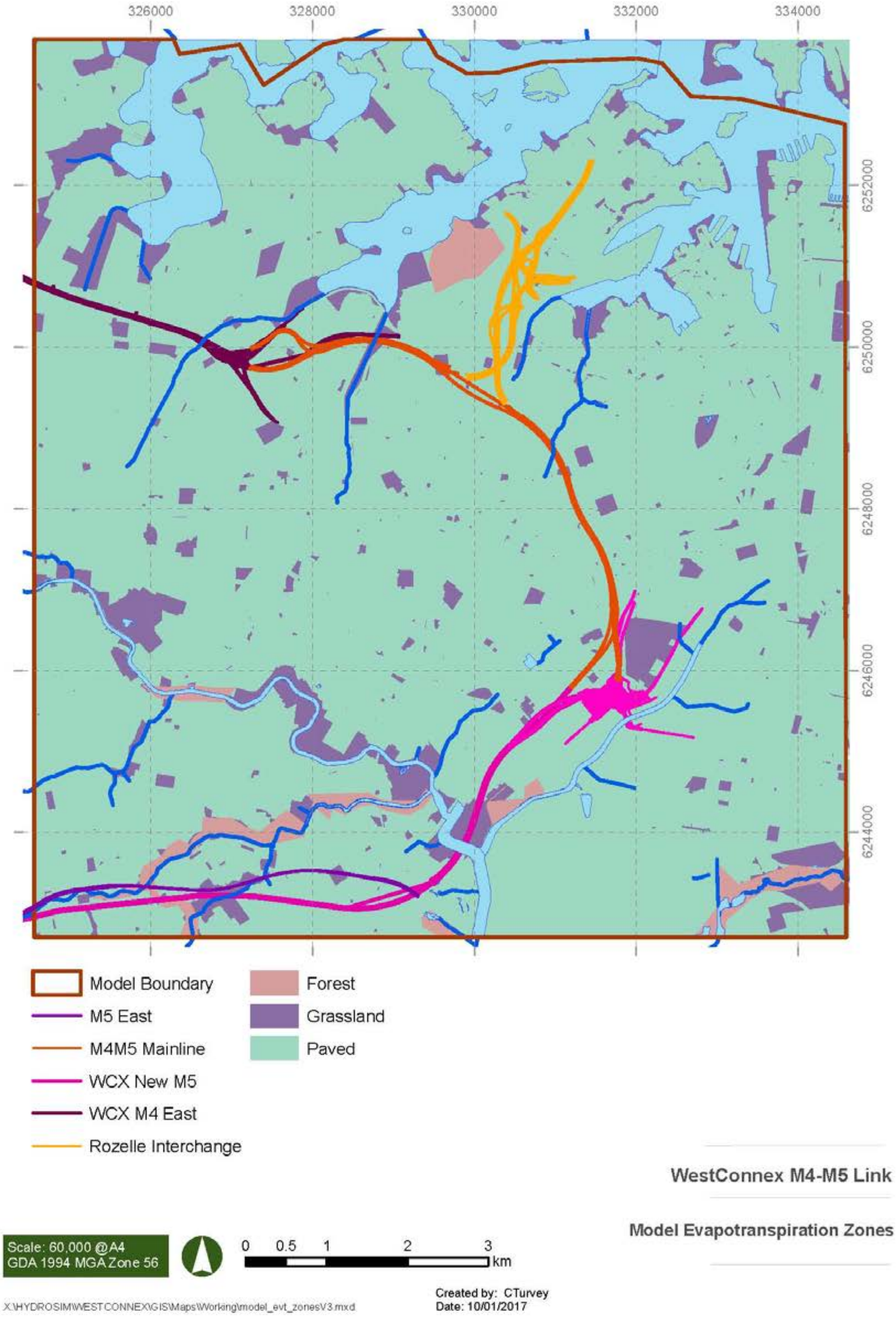

Figure 4-7 Model evapotranspiration zones

4.4.3 WATERCOURSES

The watercourses in the area are mostly lined channels designed to rapidly transmit surface water runoff and shallow groundwater drainage out of the urbanised areas. Major lined channels include Cooks River and Alexandra Canal flowing towards Botany Bay in the south, and Iron Cove Creek, Whites Creek, Johnstons Creek and Hawthorne Canal discharging to Parramatta River and its tributaries in the north. These lined channels are established as "River" cells in model Layer 1 (denoted by green cells in **Figure 4-4**) using the MODFLOW RIV package, with the river stage equal to the river bed elevation (set at the topographic surface). This allows water to flow unrestricted into the channel from the aquifer if/when the groundwater level reaches the ground surface, but not allowing unrestricted leakage out of the channels, effectively acting as "drains".

It is assumed some leakage will occur from these lined channels due to the deterioration of the lining (disintegration, cracking, root damage etc.). A second set of RIV boundary cells has been applied beneath the aforementioned freely draining cells to enable the model to simulate minor recharge from the lined channels. Leakage from the channels has been restricted by using a channel conductance equivalent to a hydraulic conductivity of 0.001m/day, approximately 3 orders of magnitude lower than the hydraulic conductivity of the alluvium. Wolli Creek and Bardwell Creek have bed conductance values of 1 m/day (roughly equal to the hydraulic conductivity of alluvium) as they have unmodified (natural) banks. Due to the lack of surface water gauge levels, river stage elevations have been set as static across the model, with a constant stage of 2 m applied in channels known to be influenced by the tide, 0.5 m in non-tidal major channels, and 0.1 m in minor channels.

Major water bodies including Parramatta River and Sydney Harbour were represented using constant head (CHD) boundary conditions of 1 m AHD to represent mean annual tide (shown in blue in **Figure 4-4**). This is based on an approximate average of tidal ranges reported for Botany Bay and Port Denison by BoM (2016b).

4.4.4 REGIONAL GROUNDWATER FLOW

The model perimeter is set as a 'no-flow' boundary by default, except where regional groundwater flow is likely to enter or leave the active model area in which case a general head boundary (GHB) is specified. The GHB boundary condition is used to represent the regional flow into and out of the model area and has been assigned using GHBs in Hawkesbury Sandstone model layers 4, 6 and 8 using the relationship of observed water level to topography for bores screened in the relevant layer (as per **Figure 4-8**). Groundwater will enter the model where the head set in the GHB is higher than the modelled head in the adjacent cell, and leave the model when the water level is lower in the GHB. Conductance is calculated using the modelled hydraulic conductivity of the Hawkesbury Sandstone divided by the cell area, and is therefore variable in this model due to variable cell-size.

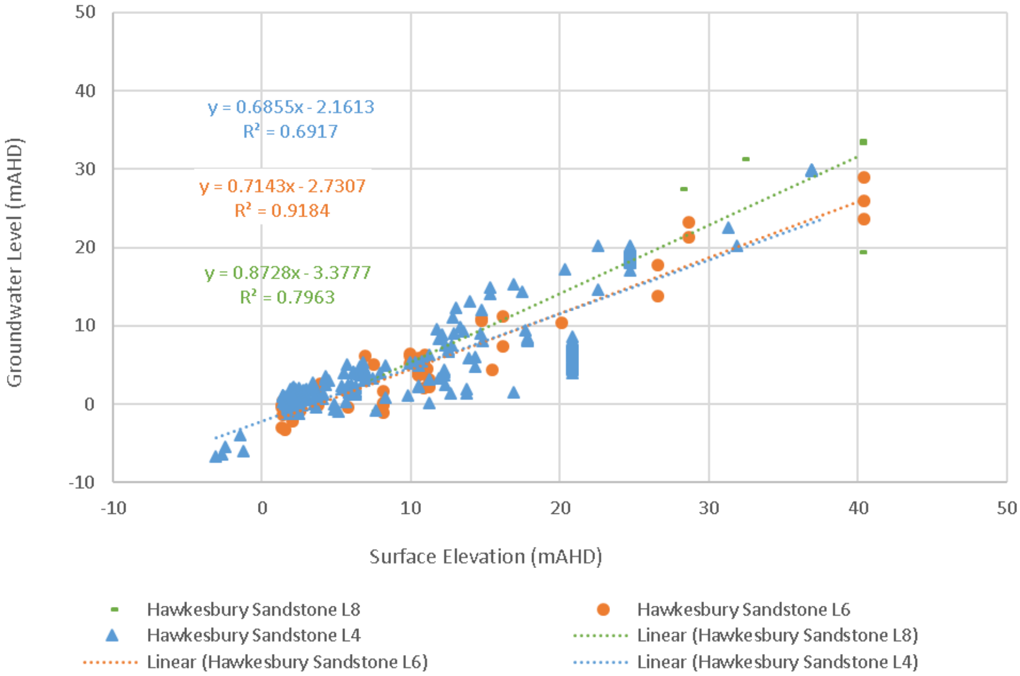

Figure 4-8 Relationship between topography and water level in the Hawkesbury Sandstone

4.4.5 GROUNDWATER USE

With one exception, groundwater pumping bores have not been included in the modelling due to lack of abstraction data. Due to low groundwater abstraction across the model area it is likely that the bores have very localised drawdowns and will not significantly impact model results.

The exception is the groundwater abstraction carried out at Alexandria Landfill. At this site, pumping is known to have occurred since 2001 to present day, at a rate of about 0.18 ML/day. Water level monitoring carried out for this project shows the drawdown effect of this pumping (AECOM, 2017). In order to calibrate the groundwater model to this data, it is therefore necessary to include the two extraction wells situated in the Botany Sands to the east of the landfill, and the pumping from the landfill sump which collects leachate from the waste as well as drainage from the Ashfield Shale and Botany Sands (**Figure 4-9**). The rates applied to each of these extraction points is given in **Table 4-3**.

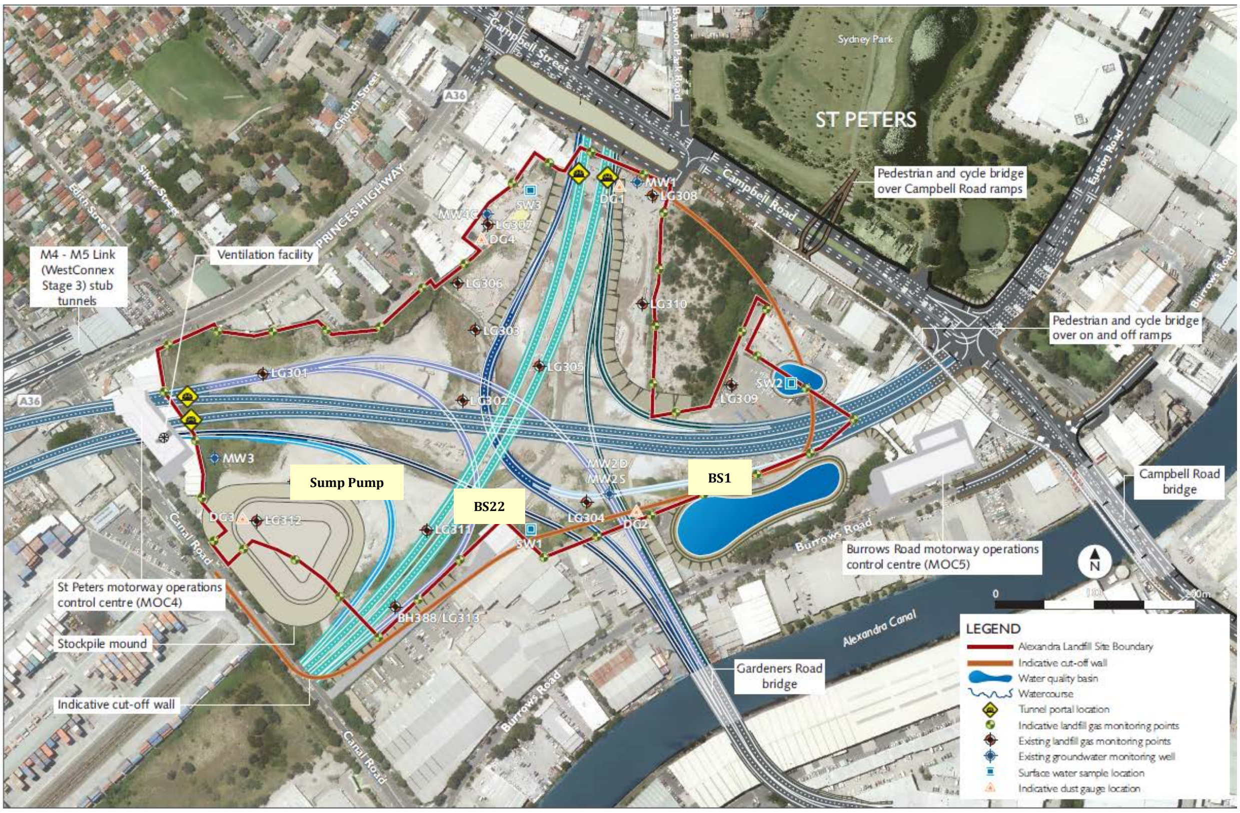

Figure 4-9 Alexandria Landfill layout and proposed cut-off wall alignment

Table 4-3 Modelled extraction rates from Alexandria Landfill

Bore	Current Abstraction Rate (ML/day)	Post July 2017 Abstraction Rate (ML/day)
BS1	0.018	0
BS2	0.025	0
Sump Pump	0.14	0.1
Total	0.183	0.10

Based on AECOM (2015) it is anticipated that a cut-off wall will be installed around the south-eastern extent of the landfill during the development of the St Peters Interchange. The approximate timing of this is expected to be mid to late-2017. Once the cut-off wall is in place, pumping will be discontinued from the Botany Sands bores, and leachate pumping will be reduced to approximately 0.1 ML/day. This assumption has been incorporated into predictive modelling by the use of a reduced hydraulic conductivity zone implemented with the Time-Variant Materials (TVM) package available with USG-Beta software. The Hydraulic Flow Barrier (HFB) package in MODFLOW could not be used to represent the cut-off wall due to the inability to turn this feature on part way through the model simulation. The cut-off wall has a design hydraulic conductivity of 1.0E-08 m/sec (8.6E-04 m/day) which was applied in the model zone used to represent the wall. Pumping from the Botany Sands bores will be turned off simultaneously with the addition of the cut-off wall.

4.4.6 TUNNEL WORKINGS

“Drain” (DRN) cells are used to represent the tunnel alignment. Invert levels were determined from .dxf design files provided by AECOM, with the invert level of the DRN cell calculated to be the minimum elevation of all features on the design files that are positioned within each model cell (**Figure 4-10**). For the M4-M5 Link and Rozelle, the minimum elevation of modelled tunnel is -53 mAHD, with the deepest areas located at the Rozelle Interchange. The deepest point for the greater WCX program of works is where the New M5 passes under Cooks River, with an elevation of -75 mAHD. The timing for activating the drain cells in the model was interpreted as much as possible from the published Environmental Impact Statement (EIS) documents for the M4 East and New M5 projects, and from preliminary scheduling data provided by AECOM for the M4-M5 Link and Iron Cove project. Relative timing of drain activation applied in the model is shown in **Figure 4-11**. Refer to **Figure 4-3** for dates corresponding with model periods.

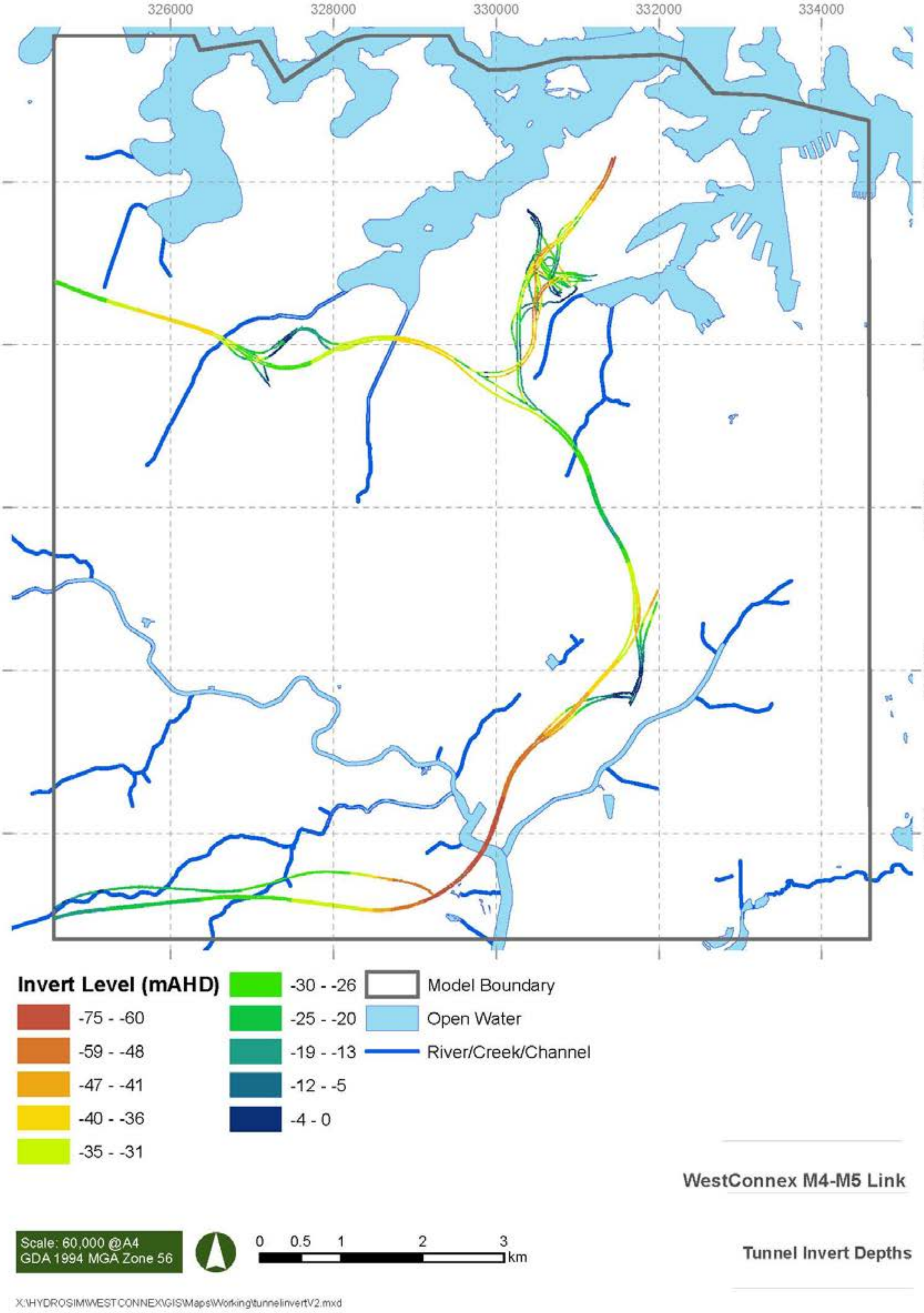

Figure 4-10 Tunnel invert elevations

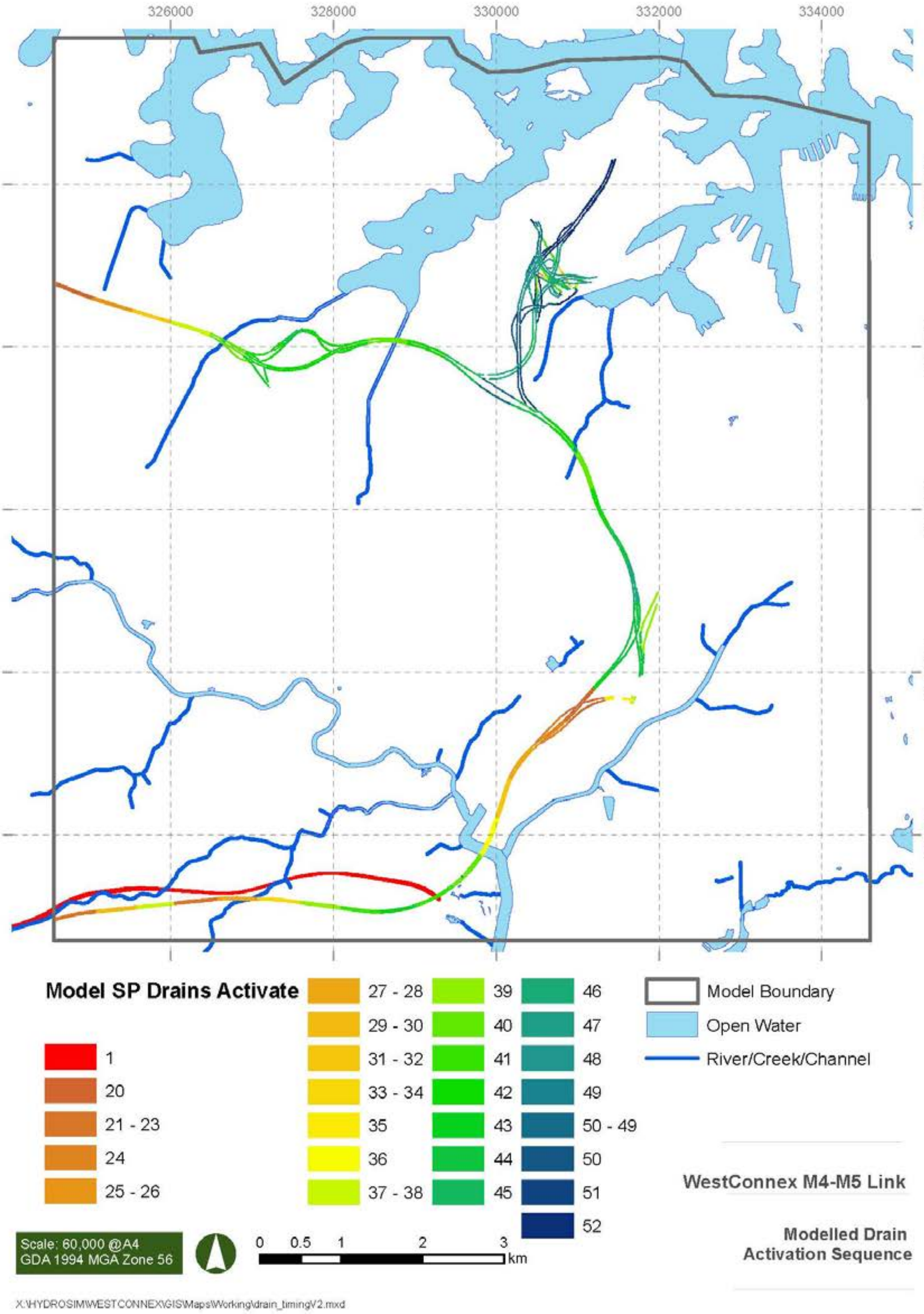

Figure 4-11 Tunnel drain activation sequence

The existing M5 East tunnel opened in 2001, therefore it is considered likely that the drawdown associated with the long-term inflows to the tunnel will have begun to approximate steady-state levels. Thus, the M5 East tunnels drains were included in the steady-state model simulation, and throughout the entire transient simulation.

The conductance of the DRN cells associated with tunnels was initially set to 1000 m^2/day and adjusted as required to constrain inflows to 1 L/sec/km under the assumption that areas of high inflow will be shotcreted during construction (AECOM, 2017), as per the conditions of approval set for the WCS program of works and NorthConnex. A conductance of 0.1 m2/day was required to constrain inflows to less than or equal to 1 L/sec/km.

4.5 MODEL CALIBRATION

4.5.1 STEADY STATE CALIBRATION

Steady-state calibration was undertaken using the automated calibration utility PEST (Doherty, 2010) with 280 groundwater targets. Manual parameter tweaking was then undertaken to ensure the calibrated parameters were consistent with the conceptual understanding of the hydrogeological system, most specifically with the trend of declining hydraulic conductivity with depth. Calibration focused on both horizontal and vertical hydraulic conductivity, with parameter bounds informed as per **Table 4-4**. Vertical hydraulic conductivity was calibrated as a factor of horizontal conductivity (K_V/K_H) with a maximum ratio of 0.5 to represent the reduced vertical hydraulic conductivity typically observed due to sedimentary layering in the Hawkesbury Sandstone and Ashfield Shale.

Table 4-4 Parameter calibration limits used during PEST calibration

Layer	Zone	Units	Depth Below Ground (m)	Initial K_H (m/day)	Min K_H (m/day)	Max K_H (m/day)	Initial K_V (m/day)	Allowed K_V/K_H Ratio
1	10	Alluvium	Any	1.0E+00	1.0E-02	1.0E+01	5.0E-02	*0.1 to 0.001*
1	11	Botany Sands	Any	1.0E+01	1.0E-02	3.0E+01	2.0E-02	*0.1 to 0.001*
1	12	Regolith	Any	1.0E-01	1.0E-03	1.0E+00	1.0E-02	*0.1 to 0.001*
2-3	21	Ashfield Shale	<10	5.0E-02	1.0E-04	1.0E-01	5.0E-03	*0.1 to 0.001*
2-3	22	Ashfield Shale	10 - 20	5.0E-02	1.0E-04	1.0E-01	5.0E-03	*0.1 to 0.001*
2-3	23	Ashfield Shale	20 - 40	1.0E-02	2.0E-04	2.0E-01	1.0E-03	*0.1 to 0.001*
2-3	24	Ashfield Shale	40 - 60	5.0E-03	2.0E-05	2.0E-01	5.0E-04	*0.1 to 0.001*
2-3	25	Ashfield Shale	>60	1.0E-03	5.0E-05	5.0E-01	1.0E-04	*0.1 to 0.001*
4-8	41	Hawkesbury Sandstone	<10	1.0E-01	5.0E-04	5.0E-01	1.0E-02	*0.5 to 0.001*
4-8	42	Hawkesbury Sandstone	10 - 20	8.0E-02	5.0E-04	5.0E-01	8.0E-03	*0.5 to 0.001*
4-8	43	Hawkesbury Sandstone	20 - 40	5.0E-02	5.0E-04	5.0E-01	5.0E-03	*0.5 to 0.001*
4-8	44	Hawkesbury Sandstone	40 - 60	1.0E-02	5.0E-04	5.0E-01	1.0E-03	*0.5 to 0.001*
4-8	45	Hawkesbury Sandstone	60 - 80	9.0E-03	5.0E-04	5.0E-01	9.0E-04	*0.5 to 0.001*
4-8	46	Hawkesbury Sandstone	80 - 100	8.0E-03	5.0E-04	5.0E-01	8.0E-04	*0.5 to 0.001*
4-8	47	Hawkesbury Sandstone	>100	6.0E-03	5.0E-04	5.0E-01	6.0E-04	*0.5 to 0.001*

Storage parameters are not required during steady-state calibration. Recharge was calibrated as per **Table 4-5**.

Table 4-5 Recharge values used in steady-state

Zone	Recharge (m/day)	Equivalent Recharge (mm/year)	% Mean Annual Precipitation
Botany Sands (paved)	4.00E-04	146	12%
Botany Sands (unpaved)	5.00E-04	183	15%
Ashfield Shale (paved)	3.00E-05	11	1%
Ashfield Shale (unpaved)	3.00E-05	11	1%
Hawkesbury Sandstone (paved)	6.00E-05	22	2%
Hawkesbury Sandstone (unpaved)	1.00E-04	37	3%

The conductance of the M5 East Motorway drain cells was varied during calibration in order to obtain a flow of approximately 0.8 to 0.9 L/sec/km (as per Hewitt, 2005 (see **Section 3.7.8**)).

Calibrated parameters are shown in **Table 4-6**. Relative sensitivity of each of the calibrated parameters is shown in **Figure 4-12** (as calculated by PEST using Jacobian sensitivity matrices), indicating that the horizontal hydraulic conductivity of the alluvium and the vertical conductivity of the Hawkesbury Sandstone (at depths of 40-80 m below ground level) tend to dominate the calibration results.

Table 4-6 Steady-state calibrated parameters

Layer	Zone	Units	Depth Below Ground (m)	Calibrated K_H	Calibrated K_V
1	10	Alluvium	Any	1.00E+00	5.03E-01
1	11	Botany Sands	Any	2.00E+01	7.61E-01
1	12	Regolith	Any	1.00E+00	4.30E-01
2-3	21	Ashfield Shale	<10	6.00E-02	2.00E-04
2-3	22	Ashfield Shale	10 - 20	5.00E-02	2.00E-04
2-3	23	Ashfield Shale	20 - 40	2.00E-02	1.85E-04
2-3	24	Ashfield Shale	40 - 60	1.00E-02	1.70E-04
2-3	25	Ashfield Shale	>60	1.00E-03	1.00E-04
4-8	41	Hawkesbury Sandstone	<10	1.30E-01	6.65E-02
4-8	42	Hawkesbury Sandstone	10 - 20	6.25E-02	3.10E-02
4-8	43	Hawkesbury Sandstone	20 - 40	8.00E-03	1.60E-04
4-8	44	Hawkesbury Sandstone	40 - 60	6.00E-03	1.20E-04
4-8	45	Hawkesbury Sandstone	60 - 80	2.00E-03	4.00E-05
4-8	46	Hawkesbury Sandstone	80 - 100	1.50E-03	3.00E-05
4-8	47	Hawkesbury Sandstone	>100	1.50E-03	3.00E-05

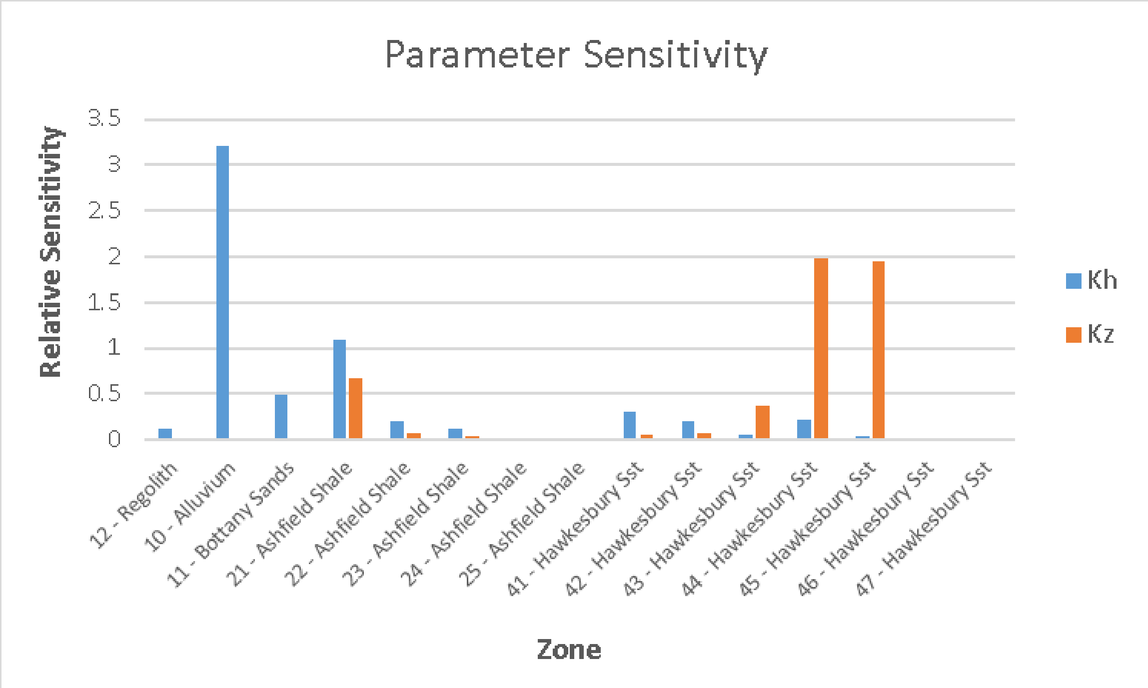

Figure 4-12 Relative parameter sensitivity as determined by PEST

4.5.2 CALIBRATION STATISTICS

Steady-state calibration was assessed against groundwater levels provided by AECOM for the M4-M5 Link project, as well as those collated from other WCX and tunnelling projects. Water levels recorded in the NGIS database / Pinneena were also used. Some quality analysis of calibration targets was undertaken, and dubious targets were removed. Key reasons for selected target removal include:

- Locations where the only water level record was taken on the date of borehole drilling in the Ashfield Shale and Hawkesbury Sandstone (as slow recovery to standing water level is expected in these sediments);
- Where there were two or more levels within the same borehole at similar times with significantly different readings (likely to be due to water quality sampling and/or aquifer testing); and
- Where there is uncertainty regarding which model layer the bore is monitoring.

Resulting calibration statistics for the steady-state simulation are shown in **Table 4-7**. Spatial plots of the target residuals for each lithology are presented in **Figure 4-13** to **Figure 4-15,** and average residuals are shown in **Table 4-8**. A graphical plot of observed vs modelled water levels is shown in **Figure 4-16**. Predictions within ±2 m of target levels are distributed evenly across the model domain (**Figure 4-17**). The scaled RMS error is 5.1% and is satisfactory according to the suggested statistical target below 5% to 10% indicated in groundwater modelling guidelines (MDBC, 2001 and Barnett *et al.*, 2012) to indicate "goodness of fit". A lower scaled RMS indicates a closer match between modelled and observed water levels. Most of the RMS error comes from the Hawkesbury Sandstone, which is primarily due to the majority of targets being within the Hawkesbury Sandstone. No layers consistently over or under predict groundwater elevation, and it is probable that the monitored heads in the Hawkesbury Sandstone show local variations (due to it being a multi-layered aquifer system) that have not been represented in the regional scale of the model.

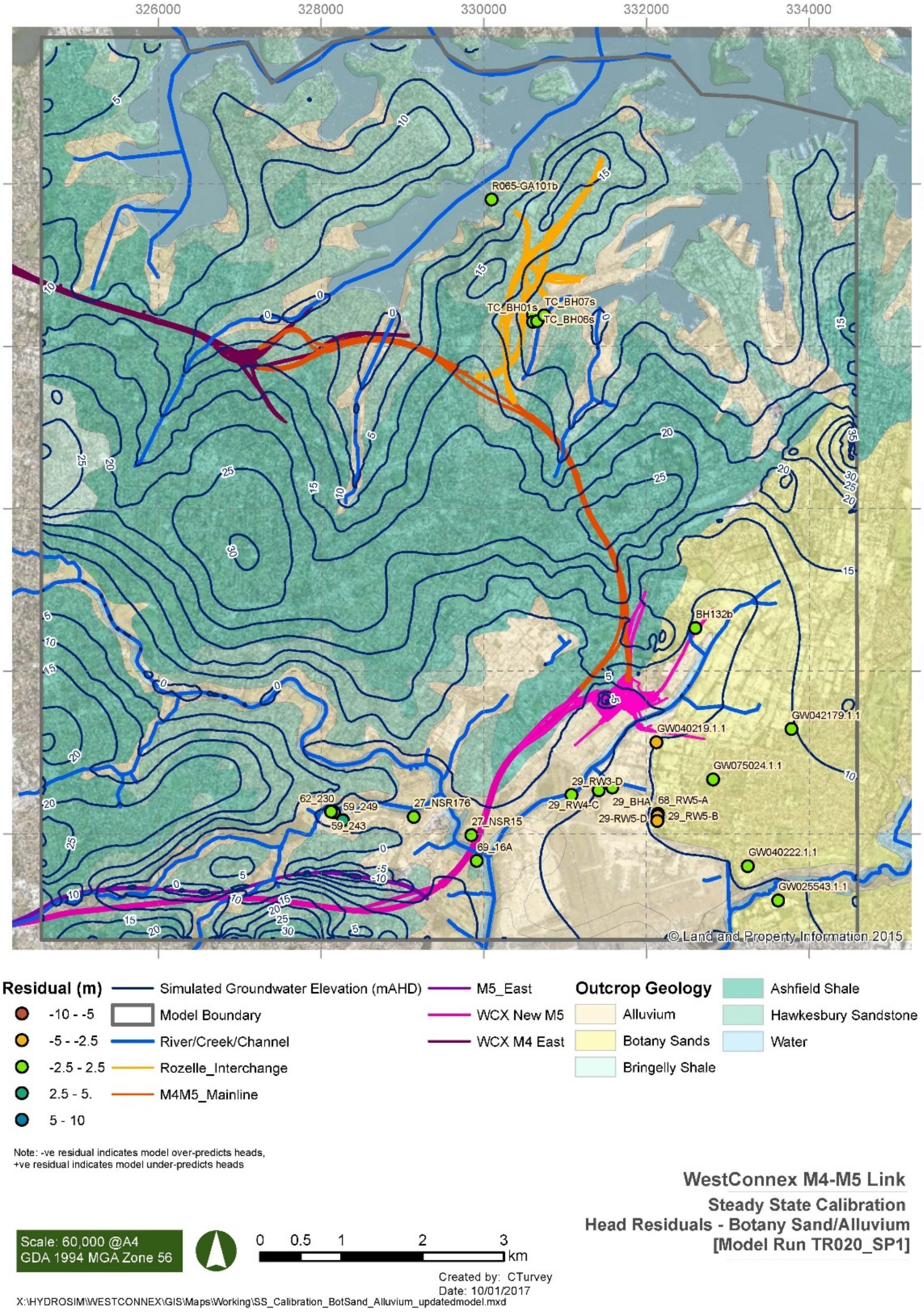

Figure 4-13 Steady-state calibration head residuals and groundwater levels – alluvium, Botany Sands and fill

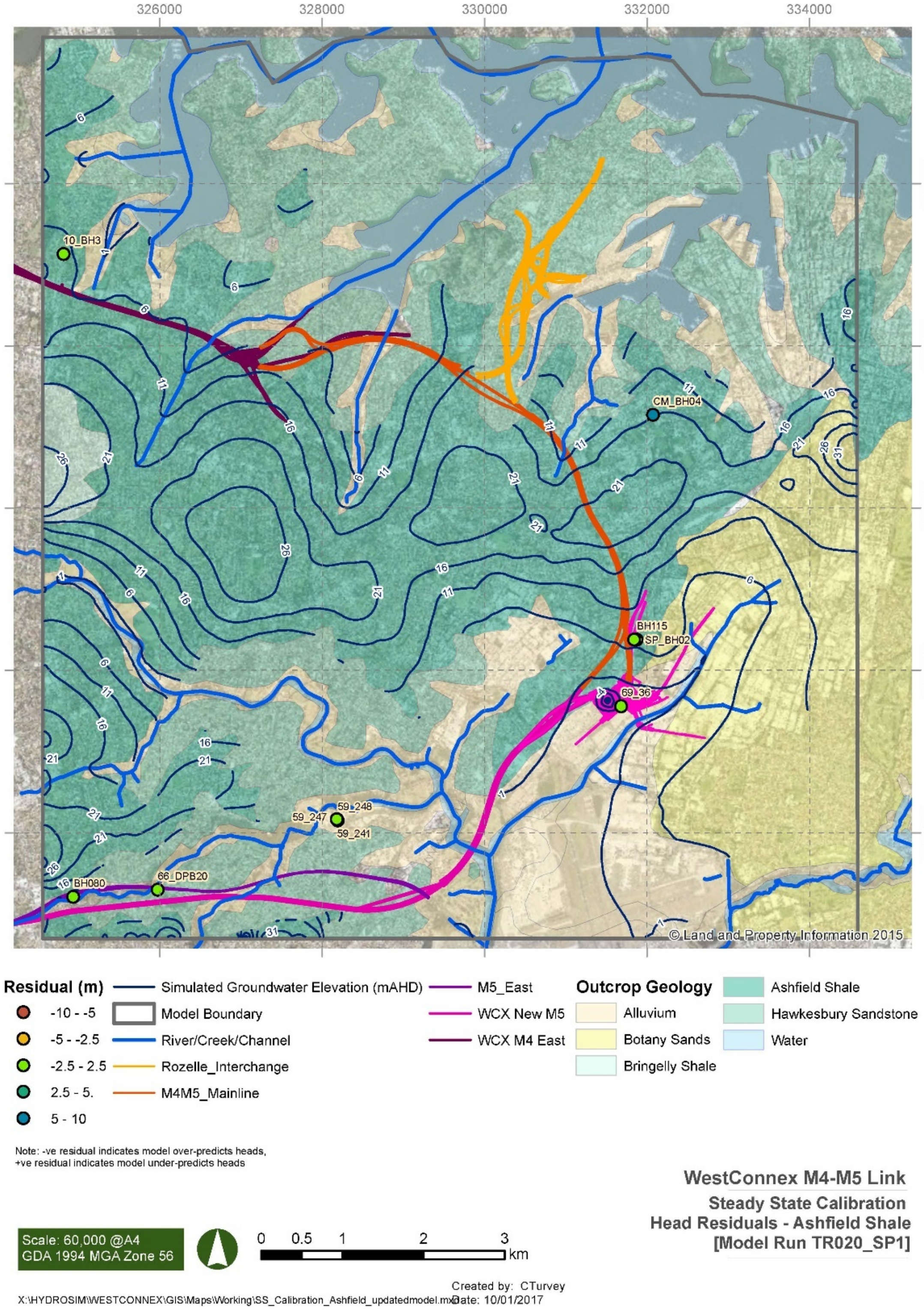

Figure 4-14 Steady-state calibration head residuals and groundwater levels – Ashfield Shale

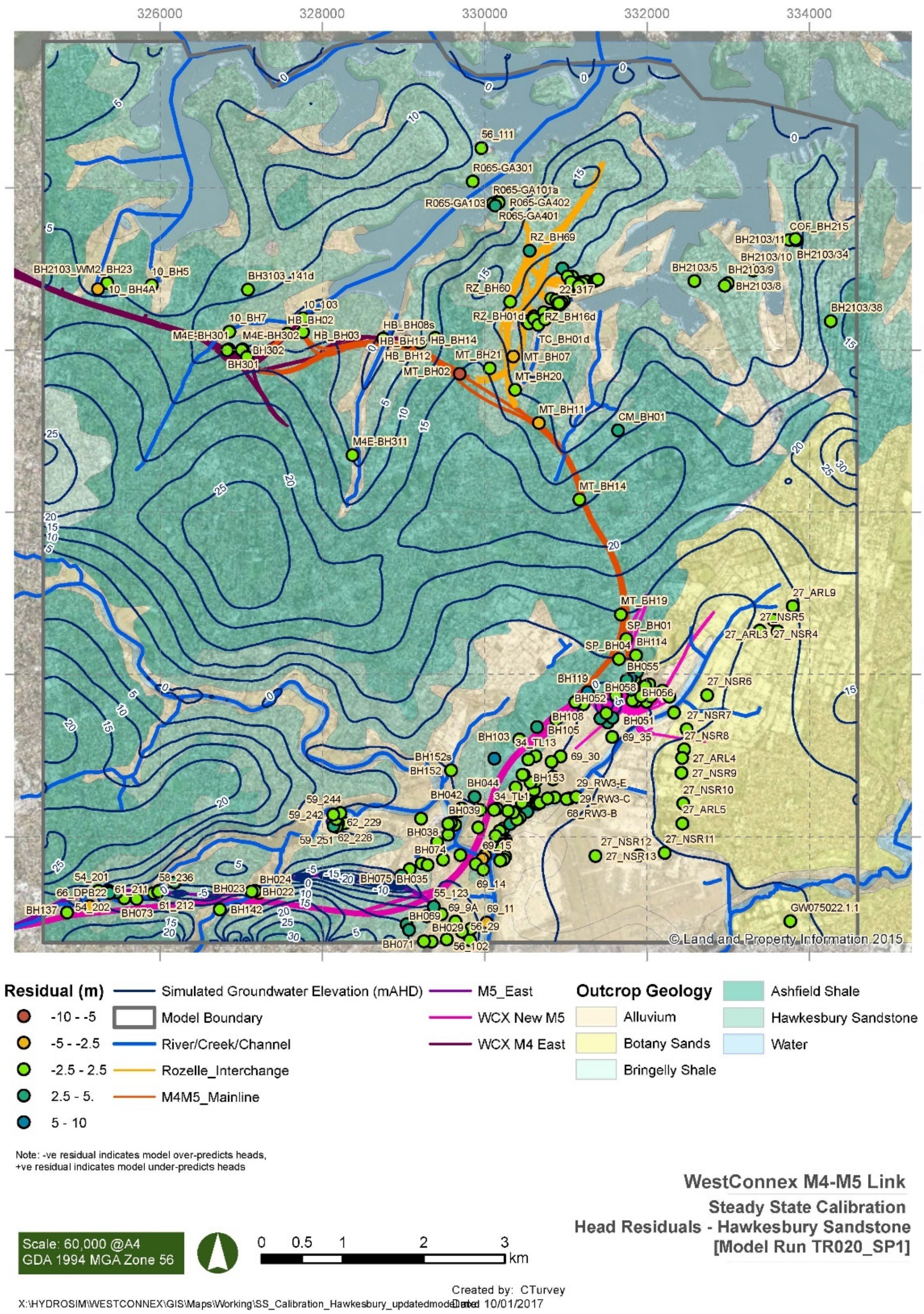

Figure 4-15 Steady-state calibration head residuals and groundwater levels – Hawkesbury Sandstone

Table 4-7 Steady-state calibration statistics (from model run WCX_020TR_SP1)

Statistic	Value
Residual Mean (m)	0.53
RMS Error (m)	1.88
Minimum Residual (m)	-6.80
Maximum Residual (m)	6.61
Scaled RMS Error	5.1%
% Targets within ±2m	79%
% Targets within ±5m	98%

Table 4-8 Average residual by model layer (from model run WCX_020TR_SP1)

Model Layer	Formation	Average Residual (m)	Number of Locations
1	Fill, Regolith, Alluvium, Botany Sands	-0.05	23
2	Ashfield Shale	0.21	7
3	Ashfield Shale	1.77	10
4	Hawkesbury Sandstone	0.72	159
5	Hawkesbury Sandstone	0.03	49
6	Hawkesbury Sandstone	0.40	19
7	Hawkesbury Sandstone	0.28	13

Negative residuals indicate modelled heads too high, positive indicate modelled heads too low.

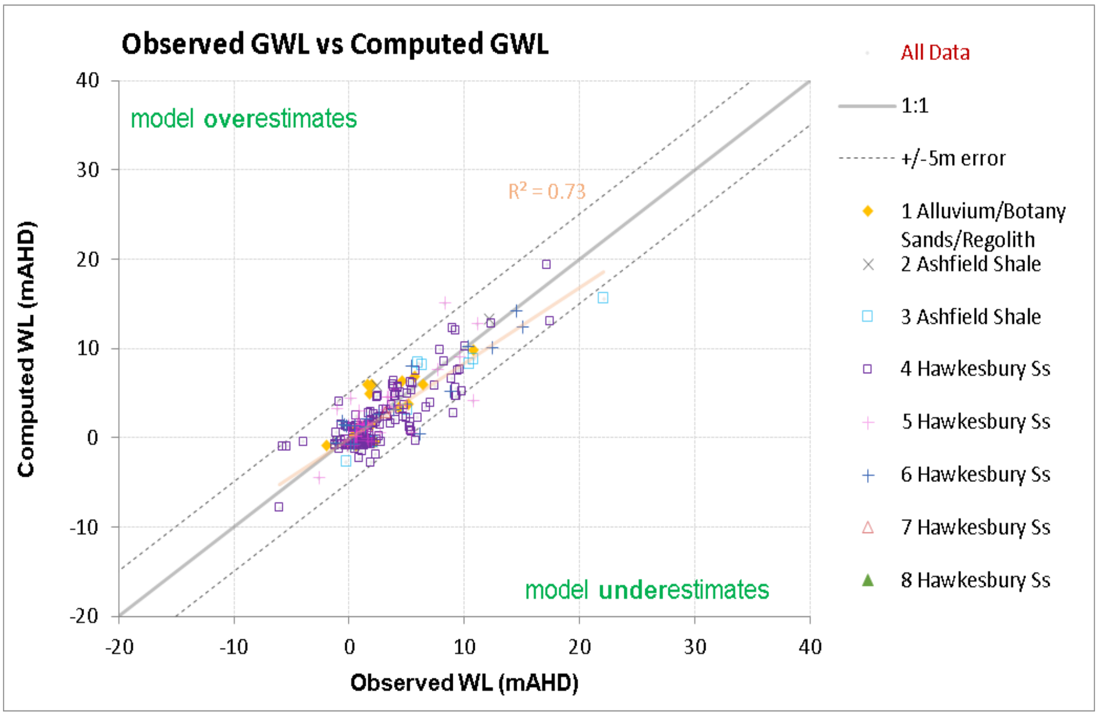

Figure 4-16 Plot of observed vs computed water levels for steady-state model

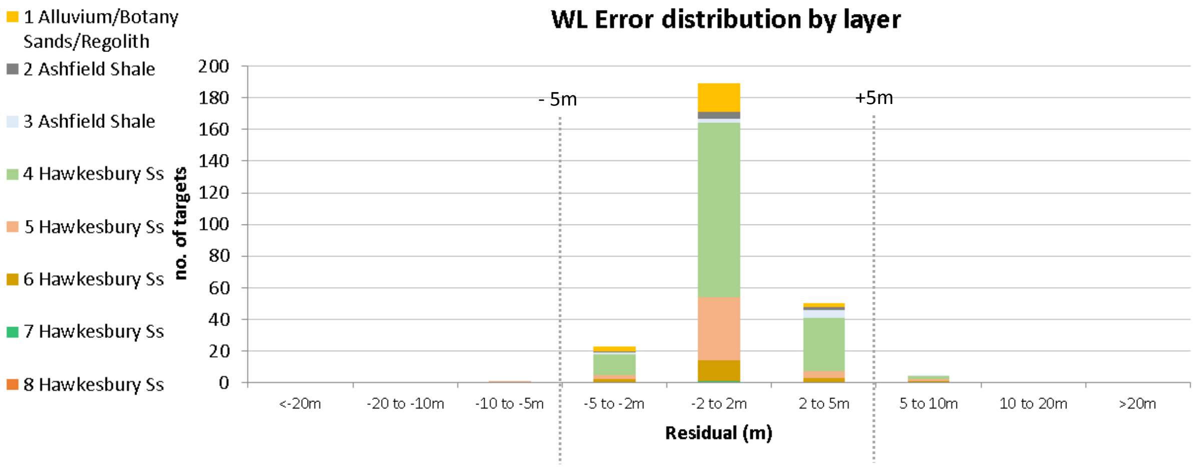

Figure 4-17 Residual error distribution for steady-state model

4.5.3 STEADY-STATE MASS BALANCE

The water balance for the steady-state simulation is presented in **Table 4-9**. It can be observed that over half of the recharge to groundwater comes from regional groundwater inflow at model boundaries, with rainfall recharge also a key input. Most of the losses to the system occur via regional outflow at the model edges and drainage to creeks/channels. Evapotranspiration also represents a significant mechanism of loss from the system.

Outflow to drains (in this case solely representing M5 East) is 0.44 ML/day, which equals 5.9 L/sec. The modelled length of the M5 East is approximately 6 km, thus this volume of flow represents 0.85 L/sec/km of tunnel, which is consistent with the long term inflows of 0.8 to 0.9 L/sec/km reported by Hewitt (2005). Zonebudget (Harbaugh, 1990) software was used to confirm the flow was fairly uniform along the length of the tunnel (i.e. there was not one unique area providing a significant amount of the inflow volume).

The model mass balance indicates that the man-made impacts to the groundwater system (i.e. drainage to the M5 East tunnel and pumping at Alexandria Landfill) are very small compared to the natural recharge and discharge processes, in particular regional groundwater throughflow.

Table 4-9 Steady-state model mass balance

	INFLOW (ML/DAY)	OUTFLOW (ML/DAY)
RECHARGE (RCH)	8.98	0.0
ET (FROM GW) (EVT)	0.0	1.56
GW EXTRACTION ALEXANDRIA LANDFILL (WEL)	0.0	0.08
SW-AQUIFER INTERACTION RIVERS/CHANNELS (RIV)	1.46	12.5
REGIONAL GW FLOW (GHB)	24.9	21.3
TIDAL AREAS CONSTANT HEAD (CHD)	1.4	0.85
TUNNELS (DRN)	0.0	0.44
STORAGE	NA	NA
TOTAL	36.8	36.8
% ERROR	0.0	0.0

GHB = General Head Boundary

4.5.4 TRANSIENT CALIBRATION

Transient calibration was performed for the period January 2015 to April 2017 using monthly stress periods. The use of these periods allows the groundwater model to replicate the transitional behaviour of key groundwater hydrographs with seasonal fluctuations. In all, 397 target heads were established for 82 sites.

Due to limited data for transient calibration, hydraulic conductivity parameters calibrated in the steady-state model were held constant for transient calibration, while calibration was attempted using only changes to specific storage (Ss) and specific yield (Sy) (**Table 4-10**). Recharge was set to vary with time using the multiplication factors calculated from monthly rainfall (**Section 4.3.1**).

Table 4-10 Calibrated storage parameters (WCX_020TR)

Layer	Zone	Units	Depth Below Ground (m)	Calibrated Ss (m^{-1})	Calibrated Sy
1	10	Alluvium	Any	1.0E-05	2.0E-01
1	11	Botany Sands	Any	1.0E-05	2.0E-01
1	12	Regolith	Any	1.0E-05	1.0E-01
2-3	21	Ashfield Shale	<10	1.0E-05	2.5E-02
2-3	22	Ashfield Shale	10 - 20	1.0E-05	2.0E-02
2-3	23	Ashfield Shale	20 - 40	1.0E-05	2.0E-02
2-3	24	Ashfield Shale	40 - 60	1.0E-05	2.0E-02
2-3	25	Ashfield Shale	>60	1.0E-05	2.0E-02
4-8	41	Hawkesbury Sandstone	<10	1.0E-05	5.0E-02
4-8	42	Hawkesbury Sandstone	10 - 20	1.0E-05	5.0E-02
4-8	43	Hawkesbury Sandstone	20 - 40	1.0E-05	3.0E-02
4-8	44	Hawkesbury Sandstone	40 - 60	1.0E-05	3.0E-02
4-8	45	Hawkesbury Sandstone	60 - 80	1.0E-05	2.0E-02
4-8	46	Hawkesbury Sandstone	80 - 100	5.0E-06	2.0E-02
4-8	47	Hawkesbury Sandstone	>100	5.0E-06	2.0E-02

Resulting calibration statistics for the transient simulation are shown in **Table 4-11** and average residuals are shown in **Table 4-12**. The model scaled RMS is 4.7%, again considered a good fit using statistical targets suggested by the MDBC (2001) and Barnett *et al.* (2012). The spatial distribution of residuals is shown in **Figure 4-18**. The calibration scatter plot is shown in **Figure 4-19** and the distribution of error by layer in **Figure 4-20**. Transient calibration hydrographs are presented in **Annexure A.**

The transient calibration hydrographs are plotted for the period January 2015 to April 2017 and display observed groundwater levels, modelled groundwater levels and the rainfall residual mass curve (from Sydney Observatory). Seven hydrographs are simulated within the Botany Sands and alluvium in Layer 1. Within the alluvium the modelled data tends to be flatter than observed data, reflecting hydraulic influences from surface water bodies (that have been represented as constant stages in in the model while the observed data show a head variation of up to almost 1 m). Three hydrographs represent groundwater trends within the Ashfield Shale (Layer 3). Modelled groundwater levels are between one and four metres of the observed groundwater levels. The remainder of the hydrographs (67) simulate groundwater levels within the Hawkesbury Sandstone with 30 representing Layer 4, 10 representing Layer 5, 16 representing Layer 6 and 11 representing Layer 7. Overall the modelled hydraulic heads within the Hawkesbury Sandstone tend to be slightly below observed levels, typically in the order of 0.3 m, except in model Layer 4 where modelled heads are typically slightly higher than observed (0.52 m on average) as outlined in **Table 4-12**. Similar to hydrographs for the alluvium, modelled water levels in the Hawkesbury Sandstone for bores near watercourses tend to show flatter trends than the observed data. This is likely to be due to the application of constant stage levels for the RIV boundary conditions causing local modelled levels to remain relatively consistent, while monitoring data records show fluctuations of up to 1 m typically following the rainfall trend.

Table 4-11 Transient calibration statistics (from model run WCX_020TR)

Statistic	Value
Residual Mean (m)	-0.21
RMS Error (m)	1.25
Minimum Residual (m)	-5.87
Maximum Residual (m)	4.48
Scaled RMS Error	4.7%
% Targets within ±2m	88%
% Targets within ±5m	97%

Table 4-12 Average residual by model layer (from model run WCX_020TR)

Model Layer	Formation	Average Residual (m)	Number of Observations
1	Fill, Regolith, Alluvium, Botany Sands	-0.21	44
2	Ashfield Shale	-1.01	1
3	Ashfield Shale	1.41	4
4	Hawkesbury Sandstone	-0.52	205
5	Hawkesbury Sandstone	0.21	110
6	Hawkesbury Sandstone	0.30	30
7	Hawkesbury Sandstone	0.33	6

Negative residuals indicate modelled heads too high, positive indicate modelled heads to low.

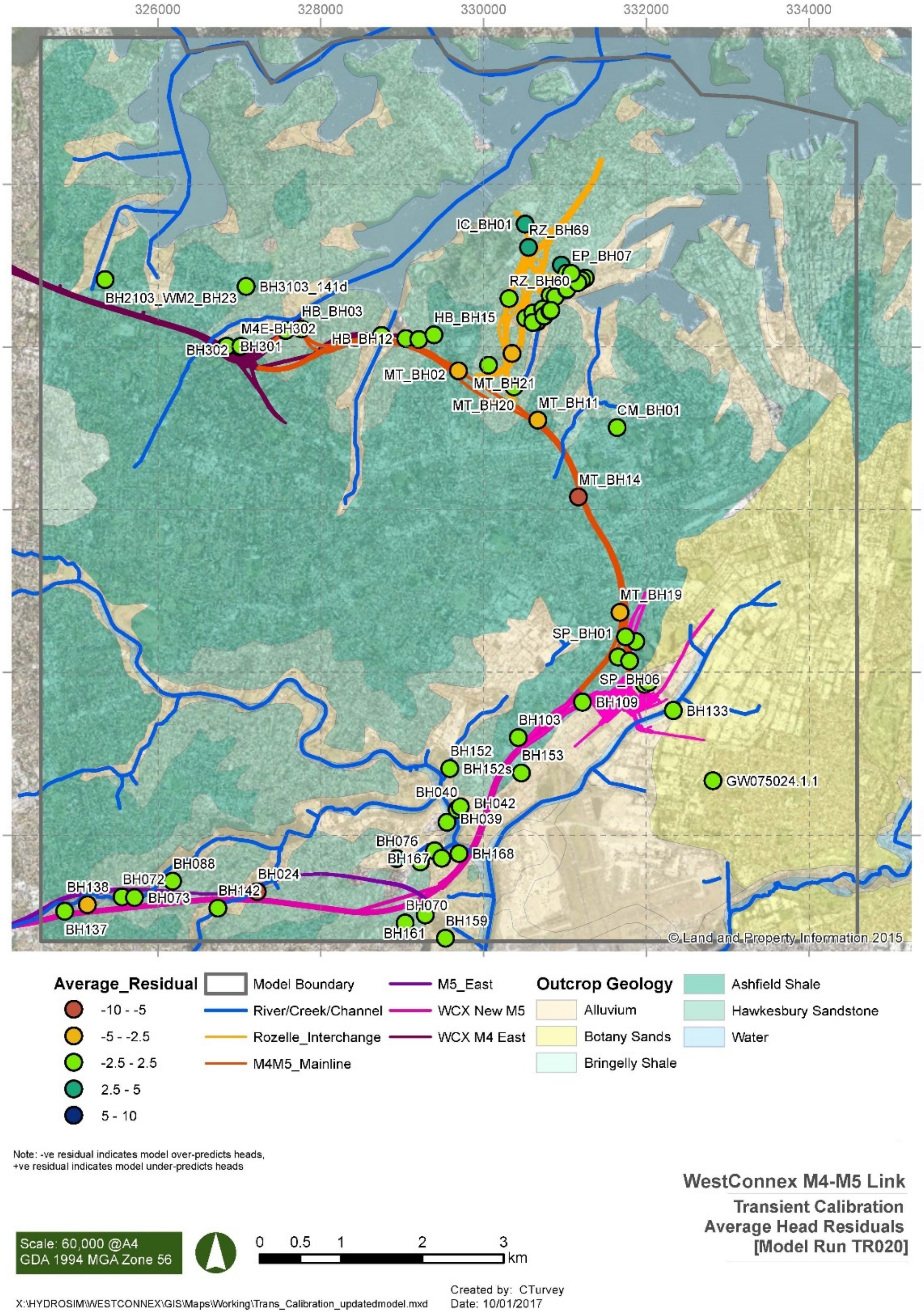

Figure 4-18 Transient calibration average head residuals

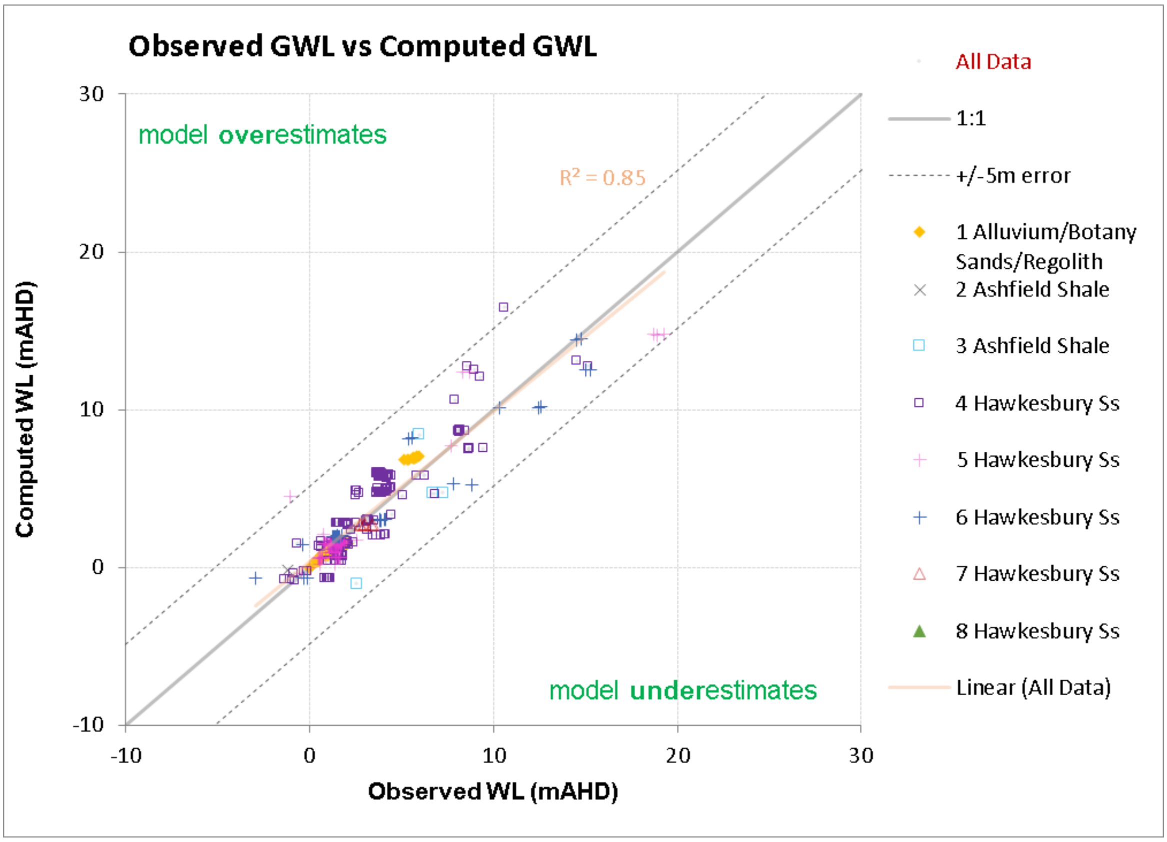

Figure 4-19 Plot of observed vs computed water levels for transient model

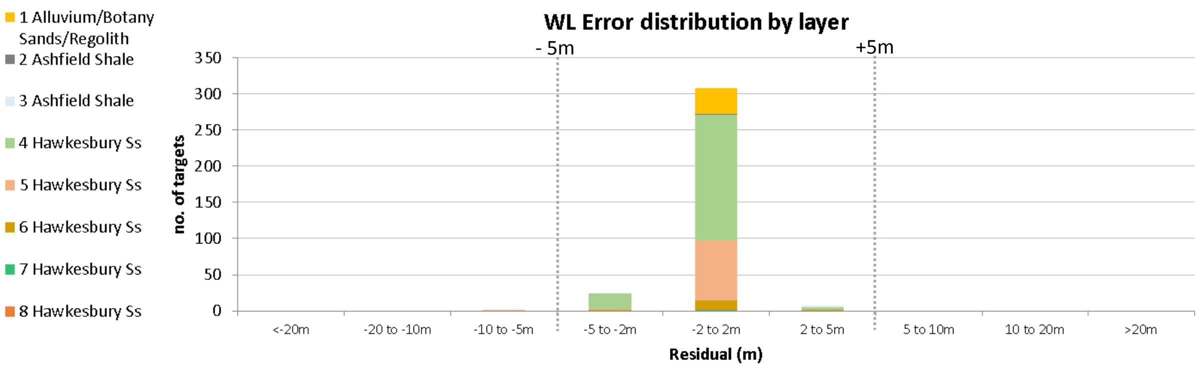

Figure 4-20 Residual error distribution for transient model

4.5.5 TRANSIENT MASS BALANCE

The water balance for the transient simulation is presented in **Table 4-13**. Regional groundwater inflow at model edges is shown to be the most significant sources of groundwater inflow to the model, followed by rainfall recharge and minor leakage from creeks/channels. Regional outflow at model edges and drainage to creeks/channels are the major losses of water from the system, and to a lesser amount evapotranspiration. Over the calibration period, there was a net gain to storage of 0.41 ML/day, which is likely attributable to above average rainfall during the calibration period (as indicated by the upwards trend on the rainfall residual mass curve (see **Section 3.3.1**)).

Tunnel inflow (i.e. model outflow via drains) is 0.67 ML/day, including the M5 East as well as minor contributions from the M4 East tunnel construction (western end) and New M5 construction (western end and near St Peters Interchange). The average inflow attributed to the WCX tunnels excavated during the calibration period is 0.87 L/sec/km.

Table 4-13 Transient model mass balance (averaged over calibration period)

	INFLOW (ML/DAY)	OUTFLOW (ML/DAY)
RECHARGE (RCH)	10.8	0.0
ET (FROM GW) (EVT)	0.0	1.61
GW EXTRACTION ALEXANDRIA LANDFILL (WEL)	0.0	0.08
SW-AQUIFER INTERACTION RIVERS/CHANNELS (RIV)	1.44	12.8
REGIONAL GW FLOW (GHB)	24.6	21.1
TIDAL AREAS CONSTANT HEAD (CHD)	1.2	0.89
TUNNELS (DRN)	0.0	0.67
STORAGE	2.87	3.58
TOTAL	40.8	40.8
% ERROR	0.0	0.0

GHB = General Head Boundary

4.6 ASSESSMENT OF MODEL PERFORMANCE AND LIMITATIONS

4.6.1 MODEL CONFIDENCE LEVEL

Under the earlier MDBC, 2001 modelling guideline, the model is best categorised as an Impact Assessment Model of medium complexity. That earlier guide (MDBC, 2001) describes this model type as follows:

> *"Impact Assessment model - a moderate complexity model, requiring more data and a better understanding of the groundwater system dynamics, and suitable for predicting the impacts of proposed developments or management policies."*

Barnett *et al.*, 2012, developed a system within the modelling guidelines to classify the confidence level for groundwater models. Models are classified as Class 1, Class 2 or Class 3 in order of increasing confidence based on key indicators such as available data, calibration procedures, consistency between calibration and predictive analysis and level of stresses. Under these guidelines, this model would be classified as a Confidence Level 2 (Class 2) groundwater model, with the following key indicators (based on **Table 2-1** of Barnett *et al.*, 2012):

- daily rainfall and evaporation data are available (Level 3 – higher than Level 2);
- groundwater head observations and bore logs are available and with a reasonable coverage around the WCX works, but without spatial coverage throughout the full model domain (Level 2);
- seasonal fluctuations not accurately replicated in all parts of the model domain (Level 2);
- scaled RMS error and other calibration statistics are acceptable (Level 3);
- suggested use is for prediction of impacts of proposed developments in medium value aquifers (Level 2).

4.6.2 MODEL LIMITATIONS

Model calibration data is limited to approximately 9 months of monitoring data for the Project at the time of model construction, and limited data from the other WCX phases and surrounding projects (up to 23 months of intermittent data for the greater WCX program of works). The consequence of this is a poor calibration to seasonal variations in water level.

Similarly, tidal variations of up to 1.5 m (which occur on a bi-daily basis) are not able to be represented in a model that simulates only monthly variations in groundwater stress conditions. Therefore it is assumed that the data used for calibration represents a median water level in areas that are tidally affected.

The use of a MODFLOW-USG unstructured grid allows optimal grid mesh design to represent tunnel workings and other key areas of interest. The groundwater model mesh is based on the design plans issued 21 October and 19 November of 2016. If the final reference design contains significant changes to the tunnel depth and/or alignment, major reworking to the model would be required due to the requirement to recreate a mesh specific to the new design.

All tunnels are assumed to be constructed as unlined except where information is available to indicate areas of lining as part of the design (e.g. beneath Cooks River and specific locations within the Rozelle Interchange, see **Section 3.7.8**). Any changes to this design may affect the predicted impacts from the Project. The existing M5 East tunnels have been simulated with the invert levels set to the design invert level of the New M5 located to the south.

Only major tunnelling works are included in the model to induce drawdown to the water table or reduce potentiometric heads. No other interferences to the water table from pumping, dewatering activities, stormwater drainage channels is included, other than the leachate pumping at Alexandria Landfill. Similarly, recharge from leaking pipeworks and drainage lines, or any artificial recharge (e.g. irrigation) is not included in the model.

The scheduling of tunnel excavation within the model is a best estimate interpretation of the available data within the existing EIS documentation and preliminary draft scheduling for this Project. It is not considered that the model accurately represents the inflows that are likely to be obtained during construction and should not be used for the purposes of planning water management during the construction phase. Rather the model simulates an approximate scenario with enough detail to represent indicative impacts from the construction phase.

The project design and timing may change from what has been modelled once the contractor undertakes detailed design.

The purpose of the groundwater modelling presented in this report is to provide a regional model and represents predicted regional changes due to the M4-M5 Link and interfacing projects. The model inputs are not necessarily sufficiently refined for assessment of groundwater response to the project works in localised areas. Should a particular local area require more detailed assessment of groundwater drawdown and inflow, further analysis should be undertaken as part of the detailed design process.

5 PREDICTIVE MODELLING

5.1 MODELLING APPROACH

Three main predictive model scenarios were run:

1. Scenario 1: A 'No-WCX' or 'Null' run (as per Barnett *et al.*, 2012), without any of the stages of WCX works, but including the existing tunnel M5 East. Hereafter referred to as the 'Null' run or condition.

2. Scenario 2: "Null" run plus the current approved WCX tunnelling (M4 East, New M5), with scheduling as per **Figure 4-11**.

3. Scenario 3: A run the same as Scenario 2, but including the current project (M4-M5 Link) as per **Figure 4-11**.

Comparison of these three runs then allows project-specific and cumulative impact assessment to be carried out. It is not appropriate to run only the current project without the other components of WCX, as the M4-M5 Link will not operate in isolation without M4 East and New M5. Additionally, construction of the M4 East and New M5 has already commenced.

The Aquifer Interference Policy requests impacts assessments to be carried out inclusive of all stresses to the groundwater condition that are known to exist at the time of assessment, therefore in the following sections the cumulative model inclusive of all WCX works is considered representative of the expected changed groundwater regime. Where appropriate the impacts specific to the Project are quantified for its relative contribution.

All models use the calibrated transient historical period, as described in **Section 4.5.4**, as a run-in precursor to the predictive simulation period.

5.2 WATER BALANCE

The simulated water balance for all three scenarios is presented in **Table 5-1**. The water balance indicates that for all scenarios the major inputs into the model are from regional boundary inflows and rainfall recharge. The key outflows from the model are via regional outflow, river baseflow and evapotranspiration, with the volume of water exiting the model by these outlets reducing with each scenario as a response to additional water being removed with extra lengths of tunnels. The relative impacts of each component of WCX on the water balance is discussed in the following sections. By the project opening in June 2023 there is expected to be a small gain in storage (net volume of water available in the aquifer equating to a slight overall rise in water levels) of about 0.13 ML/day for Scenario 1. This is due to the simulated recharge over the period between 2015 and 2017 being higher than the steady-state (long-term average) recharge which was used to create initial conditions for the model (refer to Section 4.4.1). Scenario 2 and Scenario 3 have a predicted loss in storage of 0.76 ML/day and 1.67 ML/day respectively, indicating that the successive lengths of tunnel are increasingly draining water from the system.

Table 5-1 Simulated groundwater balance to project opening (June 2023)

Component (ML/day)	Inflow (Recharge)			Outflow (Discharge)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
Recharge (RCH)	9.52	9.52	9.52	0.00	0.00	0.00
ET (from GW) (EVT	0.00	0.00	0.00	1.59	1.55	1.53
SW-Aquifer Interaction Rivers/Channels (RIV)	1.46	1.58	1.60	12.78	12.54	12.44
Tunnels (DRN)	0.00	0.00	0.00	0.45	1.80	2.87
GW Extraction Alexandria Landfill	0.00	0.00	0.00	0.06	0.05	0.05
Regional GW Flow (GHB)	24.90	24.95	24.95	21.42	21.40	21.40
Tidal Areas Constant Head (CHD)	1.43	1.43	1.43	0.88	0.88	0.88
Storage	1.54	2.37	3.26	1.67	1.61	1.59
TOTAL	38.84	39.84	40.75	38.84	39.84	40.75

Scenario 1= Null run (M5 East tunnel only), Scenario 2 = Scenario 1 + M4 East + New M5, Scenario 3 = Scenario 2 + M4-M5 Link

5.3 PREDICTED WATER LEVELS

Predicted groundwater levels at the end of construction for the project (model Scenario 3) are shown in **Figure 5-1** to **Figure 5-9.** These figures show groundwater levels for the water table, Ashfield Shale and Hawkesbury Sandstone in representative model layers 1, 3 and 6 (respectively).

5.3.1 SCENARIO 1 – NULL RUN WITH ONLY THE EXISTING M5 EAST TUNNEL OPERATIONAL

Figure 5-1 to **Figure 5-3** show predicted groundwater levels in each unit for Scenario 1 (only M5 East tunnel operational).

Water levels in Scenario 1 with no WCX show the water table in **Figure 5-1** is controlled by topography with drainage towards Parramatta River/Sydney Harbour in the north and Cooks river in the south. Depressed water levels exist along the M5 East alignment. Pre-WCX groundwater levels in the Ashfield Shale (**Figure 5-2**) and Hawkesbury Sandstone (**Figure 5-3)** show dominant flow direction towards Botany Bay and Parramatta River.

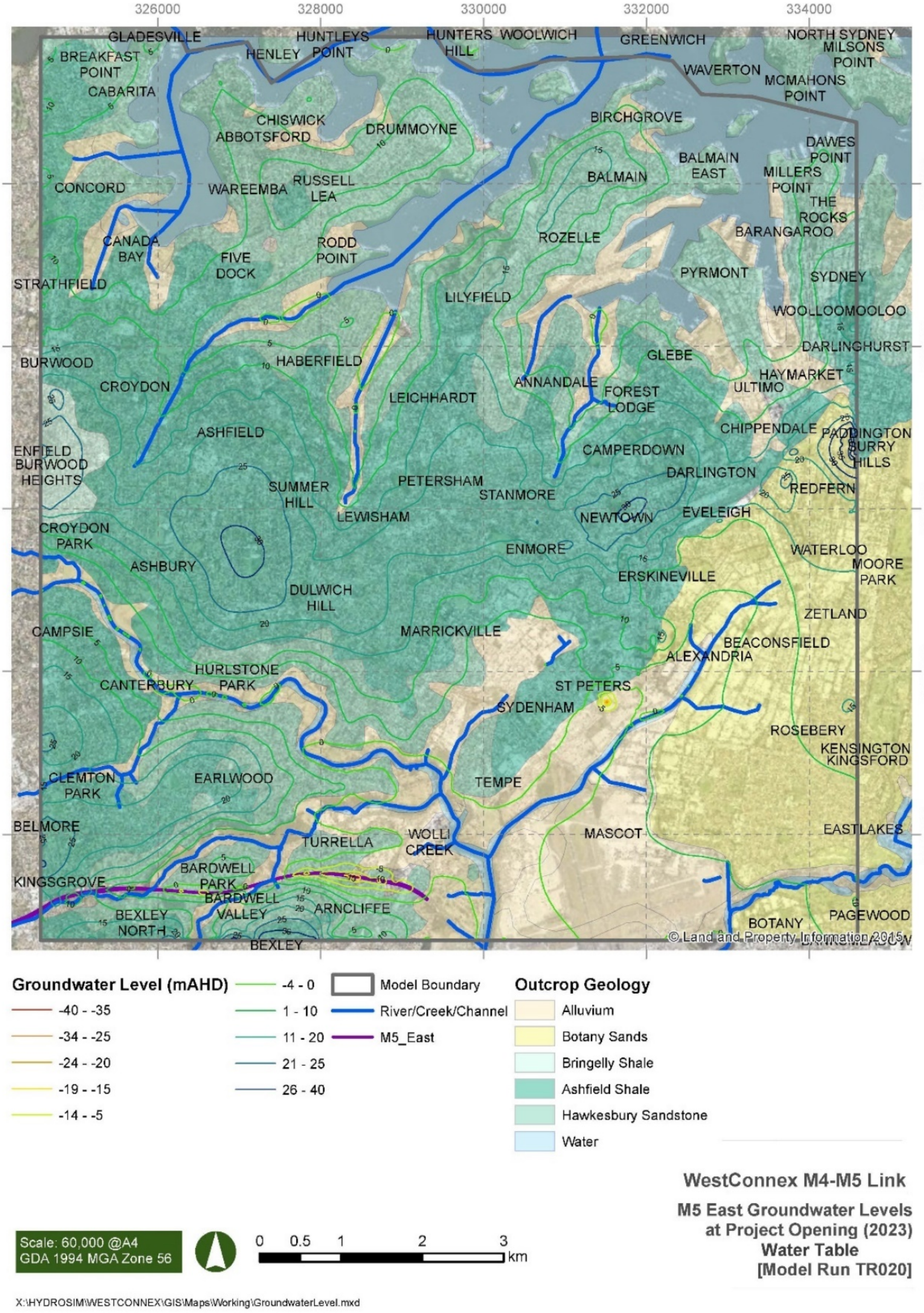

Figure 5-1 Scenario 1 – Water table at June 2023

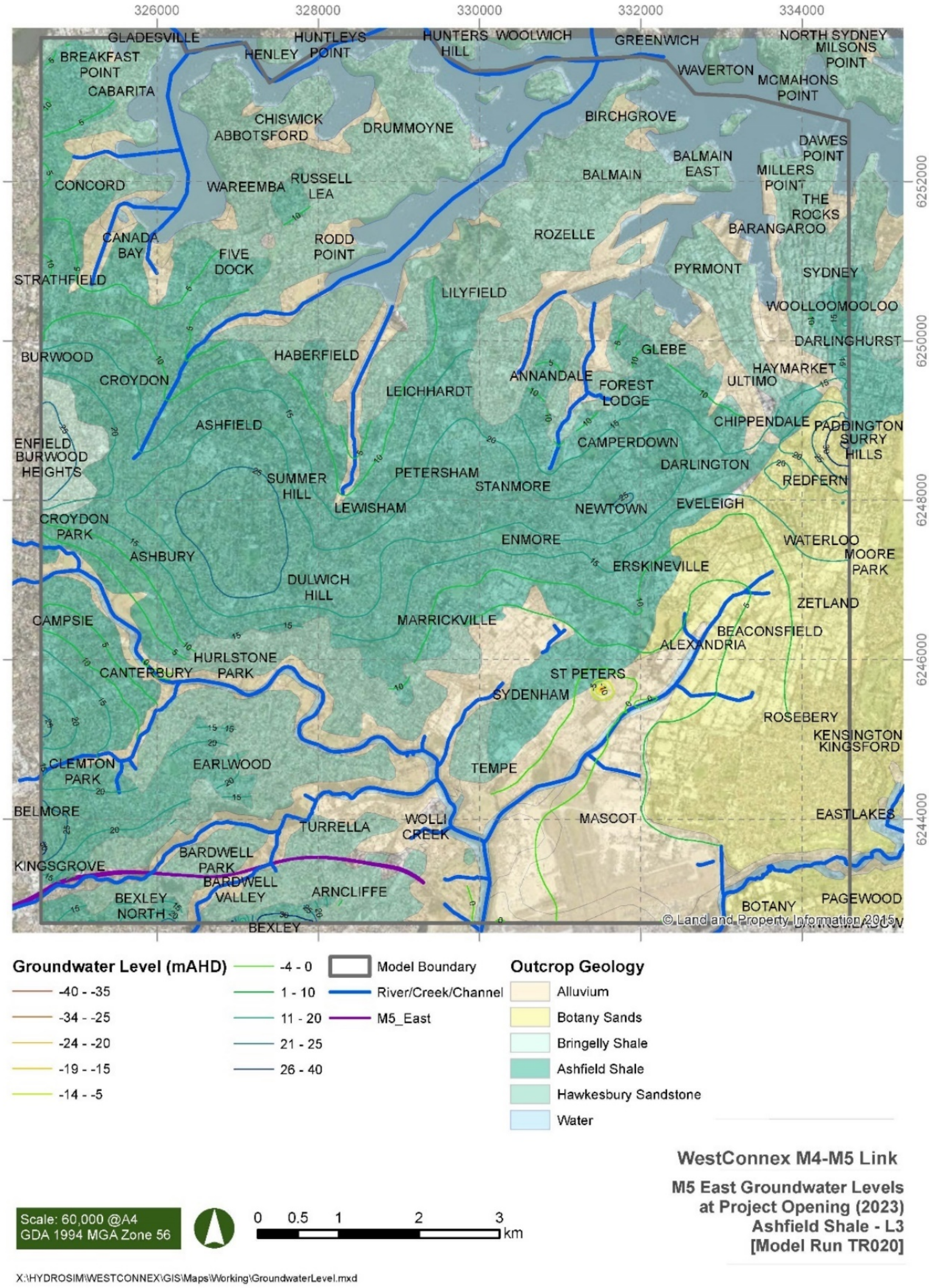

Figure 5-2 Scenario 1 - Groundwater levels in the Ashfield Shale at June 2023

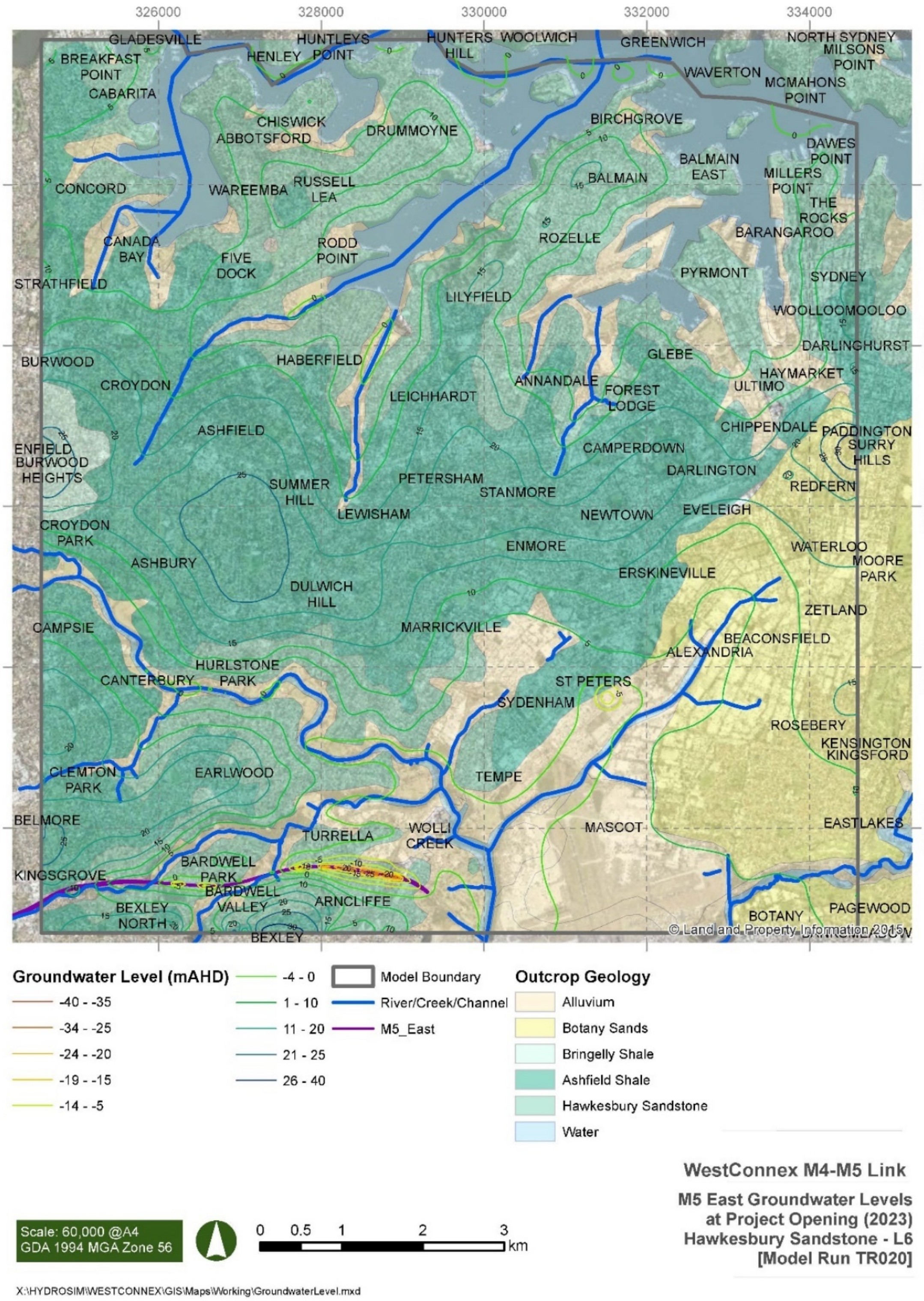

Figure 5-3 Scenario 1 - Groundwater levels in the Hawkesbury Sandstone at June 2023

5.3.2 SCENARIO 2: NULL RUN PLUS THE CURRENT APPROVED WCX TUNNELLING (M4 EAST, NEW M5)

With the addition of the approved WCX works (Scenario 2 with only the M4 East and New M5) shown in **Figure 5-4** to **Figure 5-6** the groundwater levels form steep elongated cones of depression along the tunnel alignments, indicating hydraulic connection between the deeper layers that the tunnel is excavated within (typically Hawkesbury Sandstone) and the surface, with lesser variation in water levels seen in areas of alluvium. The depressed contours are localised, with no variation in contours observable beyond approximately 500 m of the alignments, therefore the regional groundwater flow pattern does not appear to be significantly affected by the construction of the tunnels and only localised flow direction changes towards the tunnels would occur.

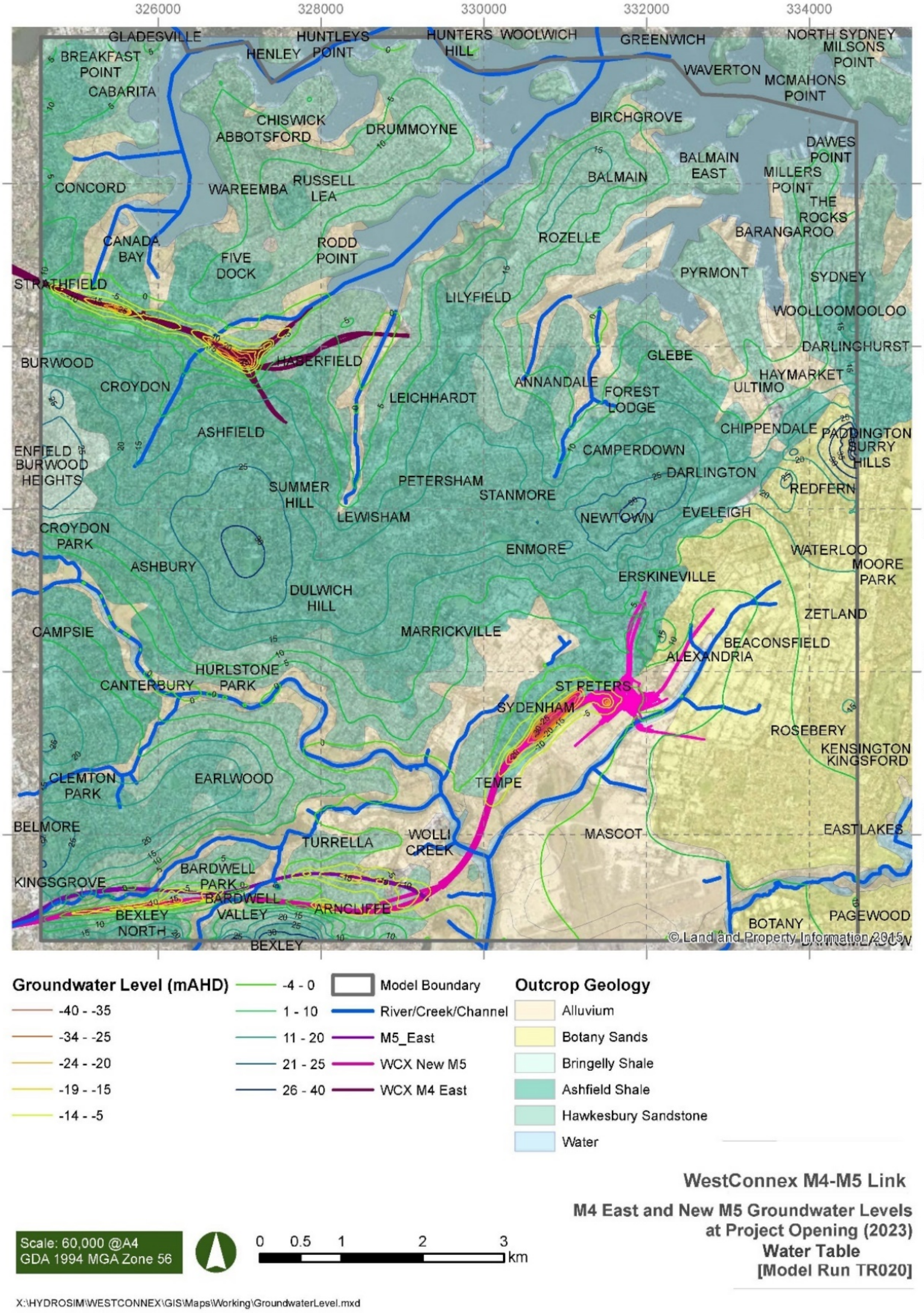

Figure 5-4 Scenario 2 – Water table at June 2023

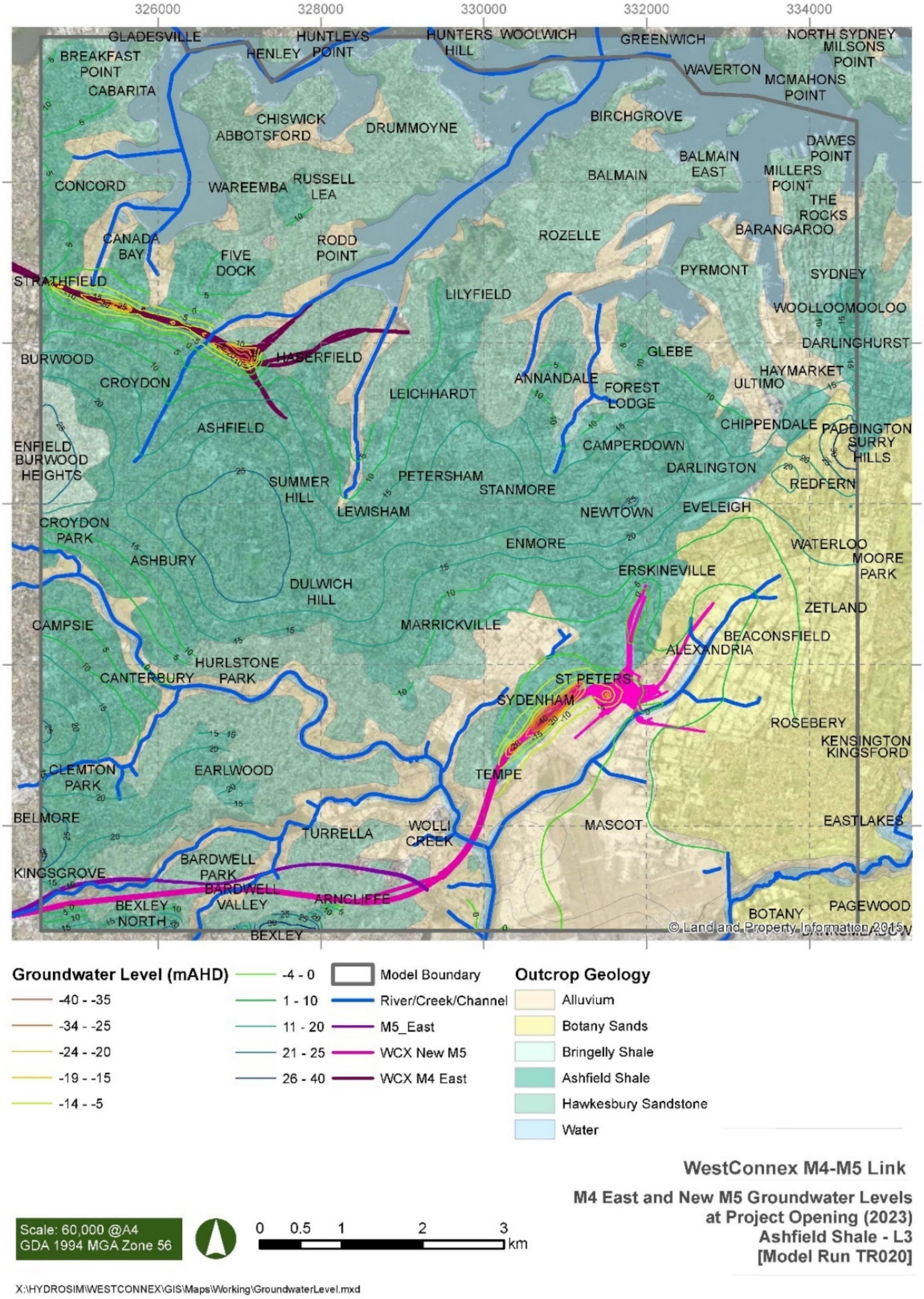

Figure 5-5 Scenario 2 - Groundwater levels in the Ashfield Shale at June 2023

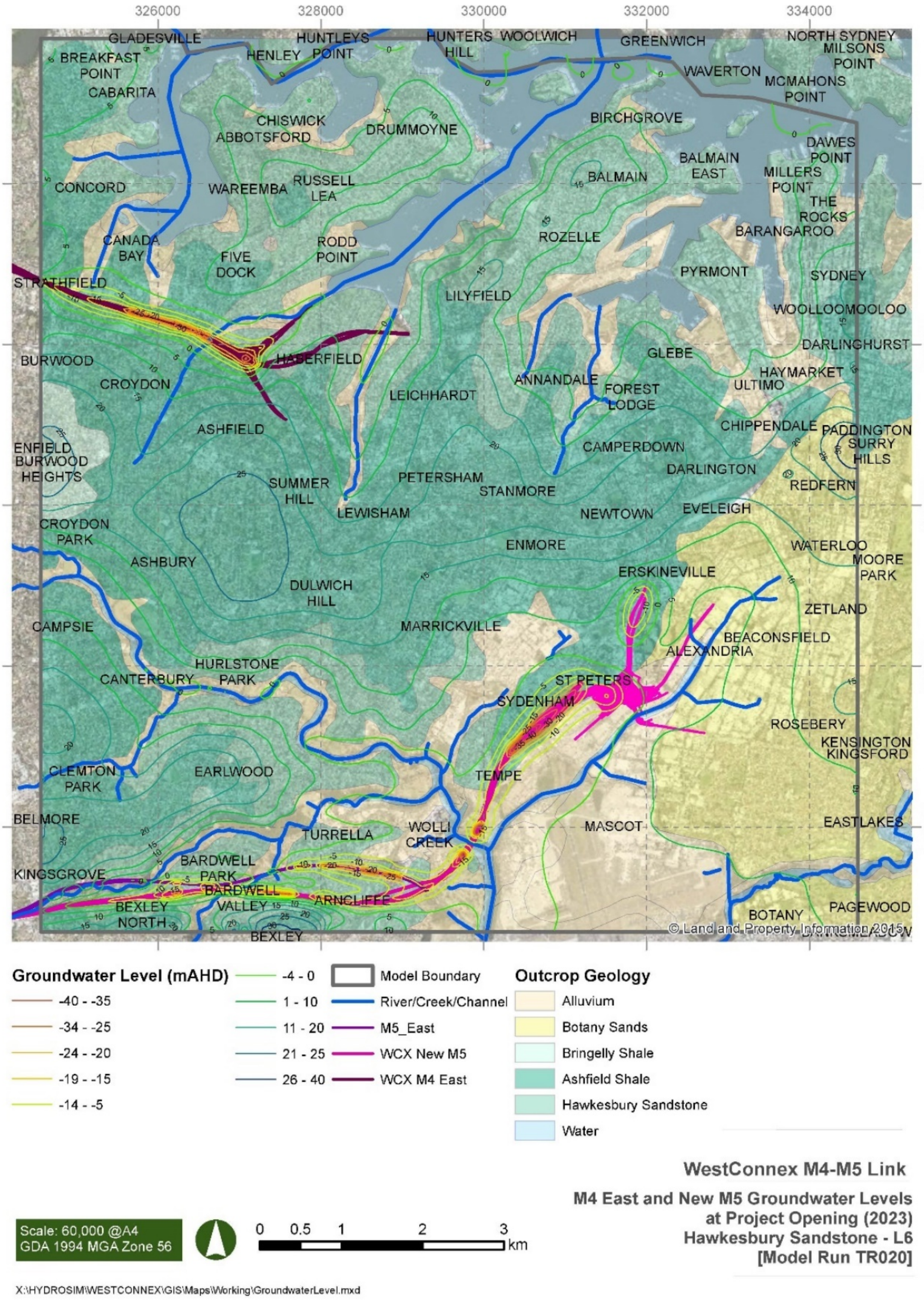

Figure 5-6 Scenario 2 - Groundwater levels in the Hawkesbury Sandstone at June 2023

5.3.3 SCENARIO 3: SCENARIO 2 PLUS THE CURRENT PROJECT (M4-M5 LINK)

Groundwater contours for Scenario 3 with all WCX tunnels operational are shown in **Figure 5-7** to **Figure 5-9.** As with Scenario 2, groundwater flow direction is altered such that flow is towards the WCX tunnels. This remains a relatively localised change, however the tunnel acts as a sink along almost its entire length effectively blocking the transmission of groundwater to its original discharge points. This is particularly evident in the Hawkesbury Sandstone (**Figure 5-9**), in part due to the fact most of the tunnelling occurs with the Hawkesbury Sandstone, and in part due to the fact the other geological units are not fully continuous across the model. It is expected that due to the thickness of the Hawkesbury Sandstone (up to 290 m regionally), groundwater at some depth below the tunnel would cease being drawn upwards towards the tunnels and regional groundwater flow would continue uninterrupted towards natural zones of discharge; however this process would occur beyond the base of the sandstone modelled (the maximum thickness of Hawkesbury Sandstone modelled is 150 m, with 100 m being the average thickness).

The minor project design changes that have been proposed post groundwater modelling (**Section 2.2.1**) are not anticipated to result in a significant change to the groundwater flow regime from that modelled.

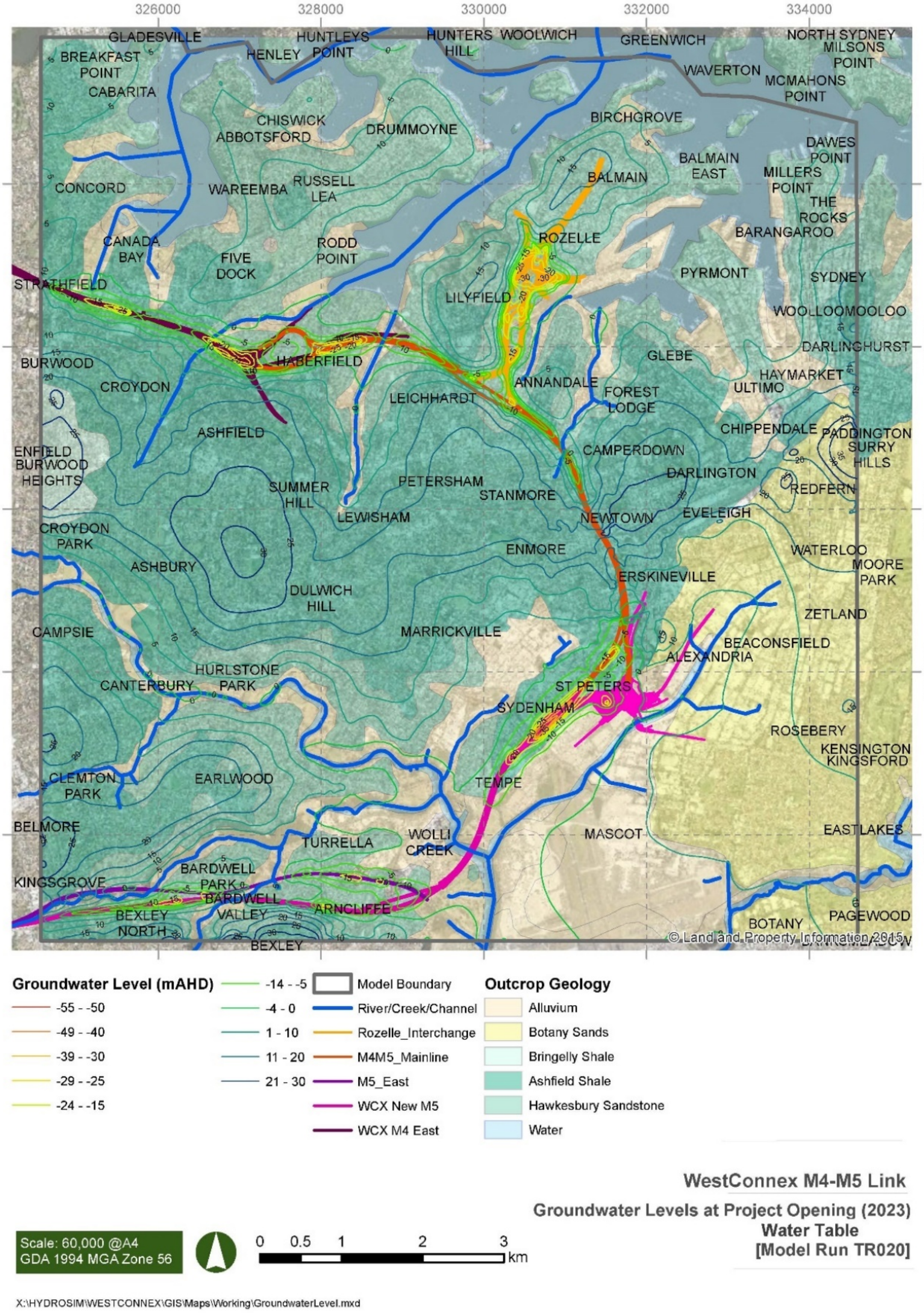

Figure 5-7 Scenario 3 - Water table at June 2023

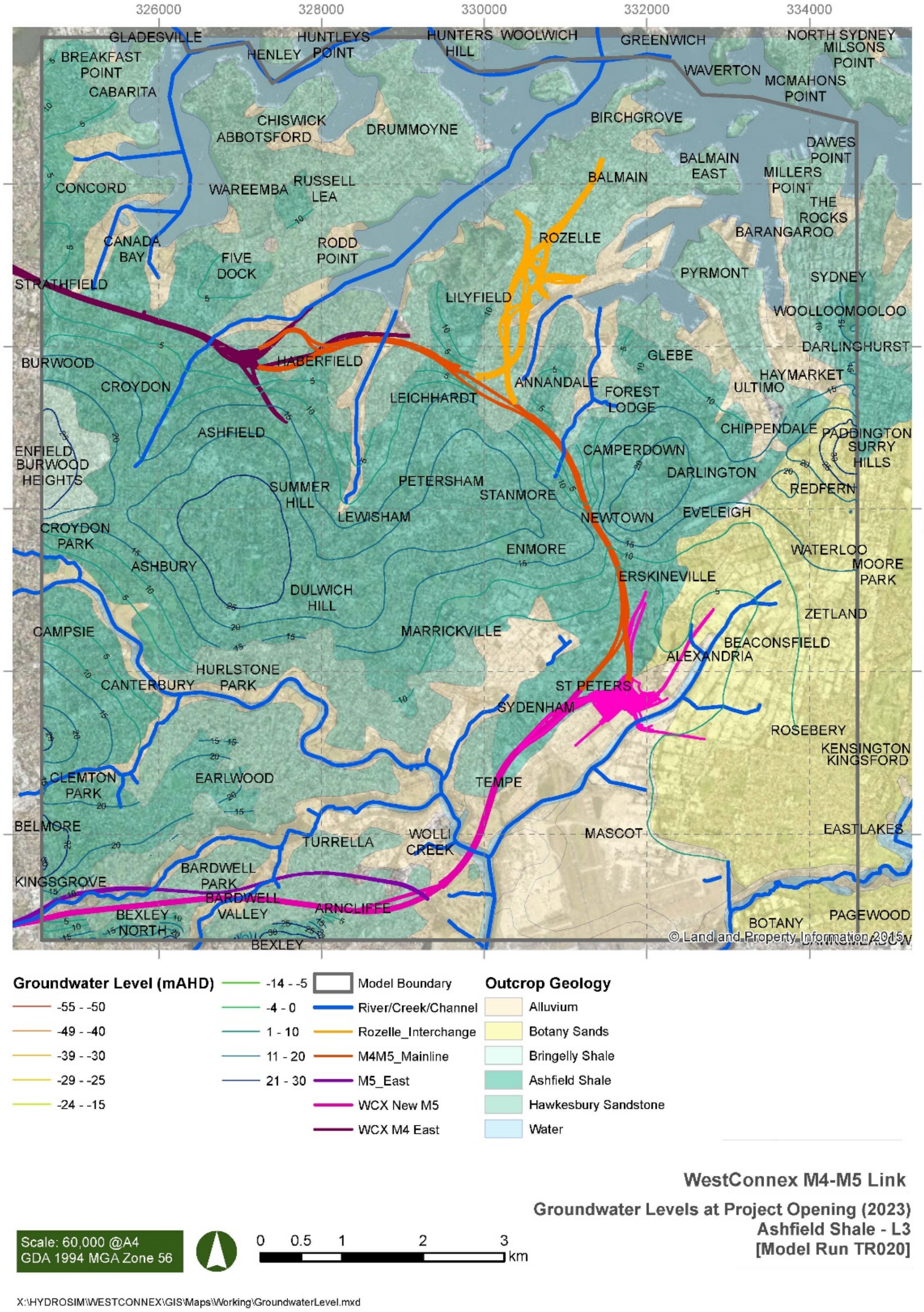

Figure 5-8 Scenario 3 - Groundwater levels in the Ashfield Shale at June 2023

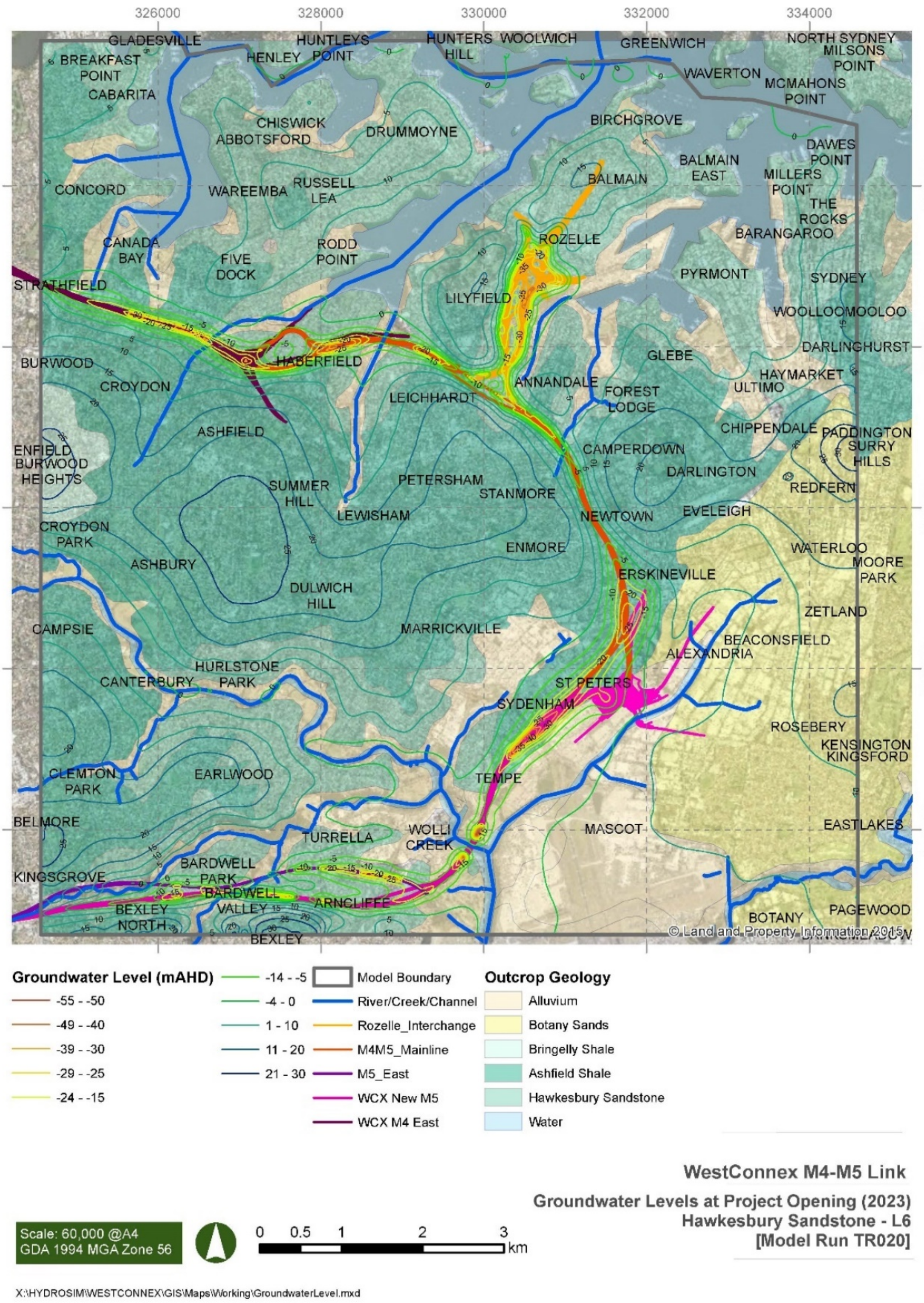

Figure 5-9 Scenario 3 - Groundwater levels in the Hawkesbury Sandstone at June 2023

5.4 PREDICTED TUNNEL INFLOW

5.4.1 BASECASE (M5 EAST ONLY)

Table 5-2 presents the inflow as simulated to the existing M5 East tunnel over the model duration. It is observed that the long term inflow rate to the existing M5 East tunnel gradually declines over time, as is expected with the spread of drawdown from the nearby New M5.

Table 5-2 Predicted tunnel inflows M5 East (Scenario 1)

	M5 East*		
YEAR	**Inflow ML/day**	**Inflow L/sec/km**	**Total Tunnel Length (km)**
2016	0.45	0.86	6.00
2017	0.44	0.85	6.00
2018	0.43	0.83	6.00
2019	0.42	0.82	6.00
2020	0.42	0.81	6.00
2021	0.41	0.80	6.00
2022	0.41	0.79	6.00
2023	0.41	0.79	6.00
2024	0.41	0.78	6.00
2025	0.40	0.78	6.00
2030	0.39	0.76	6.00
2041	0.39	0.74	6.00
2051	0.38	0.74	6.00
2100	0.38	0.73	6.00

5.4.2 PROJECT SPECIFIC INFLOWS

The WCX tunnels are being constructed as leaky tunnels (unlined) with design criteria of a maximum of 1L/sec/km of on-going “drainage” water into each tunnel during operation. **Table 5-3** summarises the predicted annual inflow rates simulated by the model for the M4-M5 Link (inclusive of the mainline tunnel, Rozelle interchange and adjoining ramps from St Peters Interchange and Haberfield where tunnelled), and the ventilation tunnel system to be excavated at Rozelle. Inflow rates (calculated as inflow volume to the entire tunnel) peaks at 2.45 ML/day for the M4-M5 Link in 2021 corresponding with the end of trafficable tunnel construction, when the greatest length of tunnel is excavated (approximately 37 km for the M4-M5 Link project inclusive of both directions along the mainline and interchanges). Inflow to the ventilation tunnels represents a much lesser volume, peaking at 0.14 ML/day in 2022, again coinciding with the finalisation of excavation of these tunnels.

Table 5-3 Predicted tunnel inflows M4-M5 (Scenario 3 minus Scenario 2)

	Trafficable Tunnels			Ventilation Tunnels		
YEAR	Inflow ML/day	Inflow L/sec/km	Total Tunnel Length (km) #	Inflow ML/day	Inflow L/sec/km	Total Tunnel Length (km)
2016	0.00	0.00	0.00	0.00	0.00	0.00
2017	0.00	0.00	0.00	0.00	0.00	0.00
2018	0.16	0.72	2.51	0.00	0.00	0.00
2019	1.34	0.85	18.10	0.00	0.00	0.00
2020	2.21	0.87	29.34	0.00	0.00	0.52
2021	2.45	0.77	36.81	0.10	0.37	3.02
2022	2.00	0.63	36.81	0.14	0.33	4.89
2023	1.68	0.53	36.81	0.13	0.31	4.89
2024	1.49	0.47	36.81	0.11	0.25	4.89
2025	1.36	0.43	36.81	0.10	0.23	4.89
2030	1.06	0.33	36.81	0.08	0.20	4.89
2041	0.92	0.29	36.81	0.08	0.19	4.89
2051	0.86	0.27	36.81	0.08	0.19	4.89
2100	0.81	0.25	36.81	0.08	0.18	4.89

represents tunnelling in both directions and at interchanges
Colours in table indicate the following project phases:

- Tunnel excavation
- Project opening
- Surface works / fit out
- Ongoing operation

5.4.3 M4 EAST AND NEW M5 TUNNELLING INFLOWS

Predicted inflows for the New M5 and M4 East components of the WestConnex program of works are shown in **Table 5-4**. It should be noted that the volumes tabulated only reflect the extent of the tunnels that have been included in the current model for the purposes of cumulative drawdown impact assessment, and therefore the values of inflow may differ when averaged over the full length of the tunnels including that which is not modelled. Peak inflows for the New M5 and M4 East tunnels are predicted to be 1.3 ML/day and 0.91 ML/day respectively. The maximum rate in L/sec/km for each tunnel is predicted to be 0.69 L/sec/km for the New M5, similar to that predicted by CDM Smith (2015) of 0.67 L/sec/km. The maximum rate of 1.05 L/sec/km for the M4 East tunnel is at the lower end of reported values for the M4 East modelling undertaken by GHD (2015) where a range of possible inflows between 0.16 L/sec/km and 3.76 L/sec/km were reported, however the inflow is restricted by the MODFLOW-DRN package conductance in this model to not exceed the design criteria of 1 L/sec/km. Tunnelling along the M4 East alignment has a simulated inflow rate approximating the maximum allowable 1L/sec/km for the duration of tunnelling, indicating that shotcreting is likely to be required to reduce the inflows to an acceptable level.

Table 5-4 Predicted tunnel inflows for New M5 and M4 East (Scenario 2)

	New M5 Tunnels*			M4 East Tunnels*		
YEAR	Inflow ML/day	Inflow L/sec/km	Total Tunnel Length (km) #	Inflow ML/day	Inflow L/sec/km	Total Tunnel Length (km)#
2016	0.20	0.35	6.66	0.06	0.61	1.18
2017	0.84	0.69	14.06	0.31	1.05	3.44
2018	1.24	0.68	21.06	0.56	1.01	6.49
2019	1.30	0.68	22.17	0.91	1.03	10.28
2020	1.21	0.63	22.17	0.70	0.79	10.28
2021	1.15	0.60	22.17	0.58	0.65	10.28
2022	1.10	0.58	22.17	0.52	0.59	10.28
2023	1.07	0.56	22.17	0.48	0.54	10.28
2024	1.05	0.55	22.17	0.45	0.51	10.28
2025	1.03	0.54	22.17	0.43	0.48	10.28
2030	0.97	0.51	22.17	0.37	0.42	10.28
2041	0.93	0.49	22.17	0.34	0.39	10.28
2051	0.92	0.48	22.17	0.33	0.37	10.28
2100	0.91	0.47	22.17	0.32	0.36	10.28

*represents the portion of tunnelling included in current model only
represents tunnelling in both directions and at interchanges
Colours in table indicate the following project phases:

Tunnel excavation

Project opening

Surface works / fit out

Ongoing operation

5.4.4 CUMULATIVE INFLOWS

Table 5-5 presents the cumulative tunnel inflows for the WCX program of works (to the extent simulated). Total inflow volumes are predicted to peak at 4.28 ML/day in 2021, corresponding with final tunnelling at Rozelle (minor excavation of ventilation tunnels is expected to occur into the start of 2022). The declining inflow rate with time indicates that the modelled recharge does not supply enough water to the system to maintain the initial inflow rates. It is possible long term inflows may be slightly higher if rainfall recharge is higher than simulated, or if additional recharge is induced to the system due to the lowered hydraulic head along the tunnel alignment.

Table 5-5 Cumulative tunnel inflows for entire WCX program of works (Scenario 3)

	Cumulative WCX*		
YEAR	Inflow ML/day	Inflow L/sec/km	Total Tunnel Length (km) #
2016	0.26	0.39	7.84
2017	1.15	0.76	17.50
2018	1.96	0.76	30.05
2019	3.54	0.81	50.54
2020	4.11	0.76	62.31
2021	4.28	0.68	72.28
2022	3.76	0.59	74.15
2023	3.36	0.53	74.15
2024	3.10	0.48	74.15
2025	2.92	0.46	74.15
2030	2.48	0.39	74.15
2041	2.27	0.35	74.15
2051	2.18	0.34	74.15
2100	2.12	0.33	74.15

*represents the portion of M4 East and New M5 tunnelling included in current model only
represents tunnelling in both directions and at interchanges
Colours in table indicate the following project phases:

Tunnel excavation

Project opening

Surface works / fit out

Ongoing operation

5.4.5 INFLOW DUE TO DESIGN CHANGE

The modelling has been undertaken for EIS Option A therefore above results reflect this original design. If Option B of the construction program occurs there will likely be a slight increase in inflow volume due to the increased tunnel length required for the construction access tunnel. It is expected that the change to the rate of inflow (in L/sec/km) will be negligible due to the additional tunnelling occurring in the Ashfield Shale (i.e. there will be no increased inflow from alluvium/unconsolidated sediments).

Similarly the bifurcation of tunnels at Wattle Street, the Mid-West interchange and north of St Peters Interchange are also likely to increase the total volume of inflow over a given time period due to the addition of extra length of drained tunnels. This will be partly offset by a reduction in inflow to the mainline tunnels due to a decreased tunnel width, however it is expected that there will be a minimal overall net increase in flow due to an increased extent of tunnelling leading to increased groundwater drainage. All of the proposed bifurcation tunnel lanes are to be constructed in Hawkesbury Sandstone and Ashfield Shale therefore no increased connectivity of the project to the alluvium or unconsolidated sediments is expected.

5.5 PREDICTED CAPTURE AREA

MODPATH3DU (Muffels *et al.,* 2014) was used to simulate particle tracking in order to determine the capture area of the tunnels during operation, with the main aim of this analysis being to identify the potential for saline intrusion due to water being drawn from tidal regions towards the tunnels. The calibrated steady-state model (as opposed to the transient model) was used for this investigation. The steady-state model represents equilibrium conditions with constant stresses applied to the model, whereas transient models represent variable groundwater stresses and groundwater conditions dependant on the length of each stress-period in the model. The use of the transient model was not suitable for this analysis due to many of the particle traces generated indicating total travel times much greater than the 85 year duration simulated in the transient model. The steady-state model includes averaged groundwater stresses (e.g. recharge and evapotranspiration) based on long term climatic conditions, and includes all the operational tunnels (M5 East and all stages of WCX), thereby demonstrating the greatest possible capture area (as constrained by hydraulic parameters used in the calibrated model).

Backwards tracking of particles set at the tunnel inverts shows the “path” each “particle” of water would take from its origin (at the water table or a model boundary condition e.g. river). Thus the time displayed at the point along the path-line indicates the travel time from that point to its entry (via seepage) into the tunnel.

The travel time (but not overall capture area) is sensitive to the effective porosity values applied in the model. Total porosity values obtained from core testing are shown in **Table 5-6** (greater detail can be found in **Section 3.2.6**), averaging between 10 to 20% for the Hawkesbury Sandstone and around 6% for the Ashfield Shale. The effective porosity is less than the total porosity, as it includes only interconnected porosity through which water is able to be transmitted (i.e. excludes isolated voids and “dead-end” pore space). The effective porosity values applied in this analysis are also summarised in **Table 5-6.** It is assumed that the effective porosity is close to the total porosity typical of unconsolidated sands in model Layer 1.

Table 5-6 Total porosity values from laboratory testing and simulated effective porosity

Layer	Unit	Total Porosity (%)	Effective Porosity (%)
1	Alluvium/Botany Sands/Regolith	20 – 30	20
2	Weathered Ashfield Shale		18
3	Ashfield Shale	6	3
4	Hawkesbury Sandstone	10 - 20	15
5	Hawkesbury Sandstone	10 - 20	20
6	Hawkesbury Sandstone	10 - 20	10
7	Hawkesbury Sandstone	10 - 20	8
8	Hawkesbury Sandstone	10 - 20	5

A total of 5310 particles were simulated from the base of the tunnels. **Figure 5-10** shows the travel time for the particles, and **Figure 5-11** shows the layers that the particles pass through along their path. Comparing these figures shows that the particles that travel from regions of groundwater mounding (corresponding with topographic highs) have the longest travel times (greater than 1000 years) and pass through the deepest model layers before emerging at the tunnel. Water originating at the water table closer to the tunnel alignment does not pass through the deep layers and therefore takes significantly less time to reach the tunnel (less than 100 years).

The implications for potential saline intrusion are discussed in **Section 6.7**.

The capture area is not expected to be affected by the late design changes described in **Section 2.2.1**.

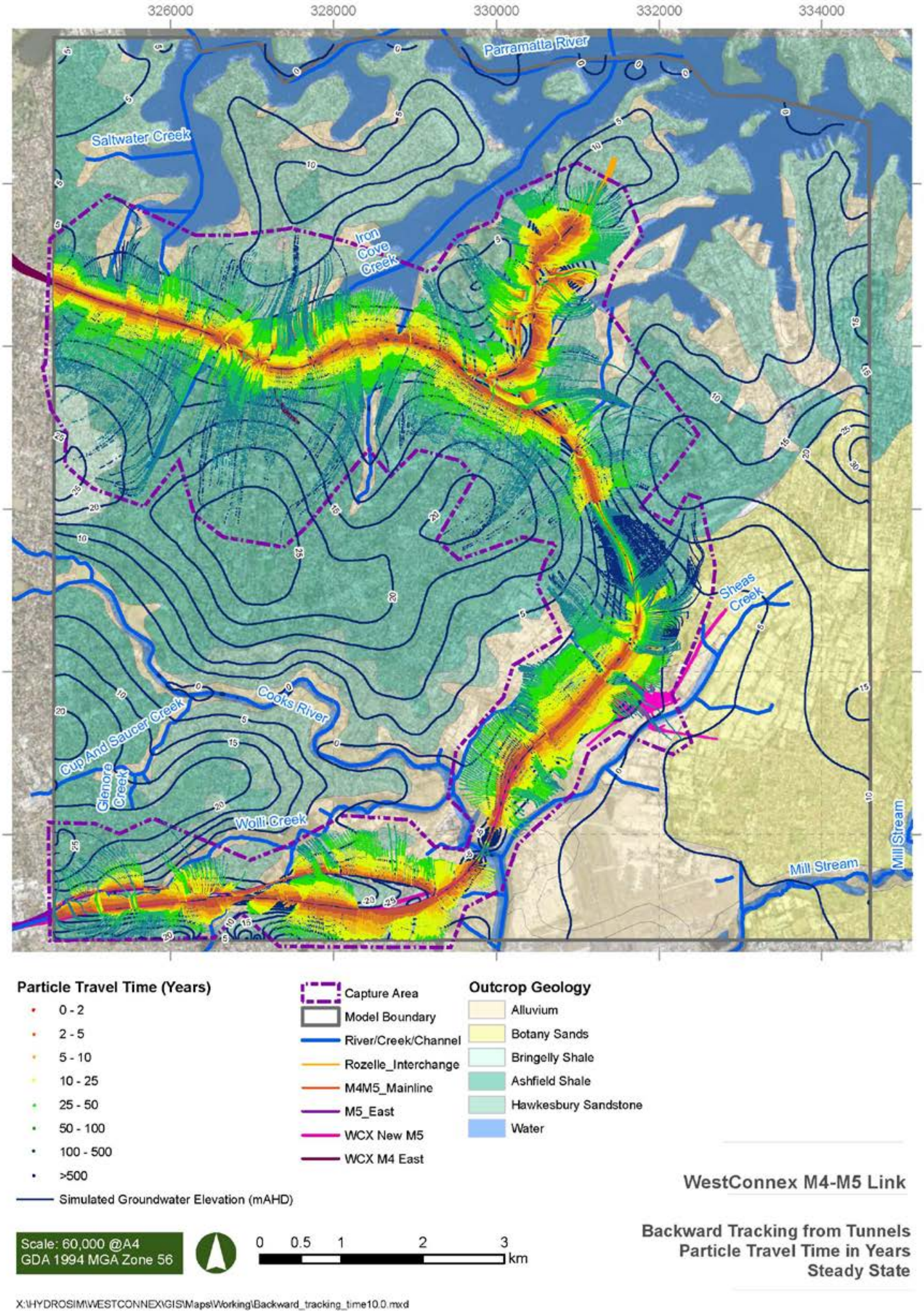

Figure 5-10 Pathlines and travel times

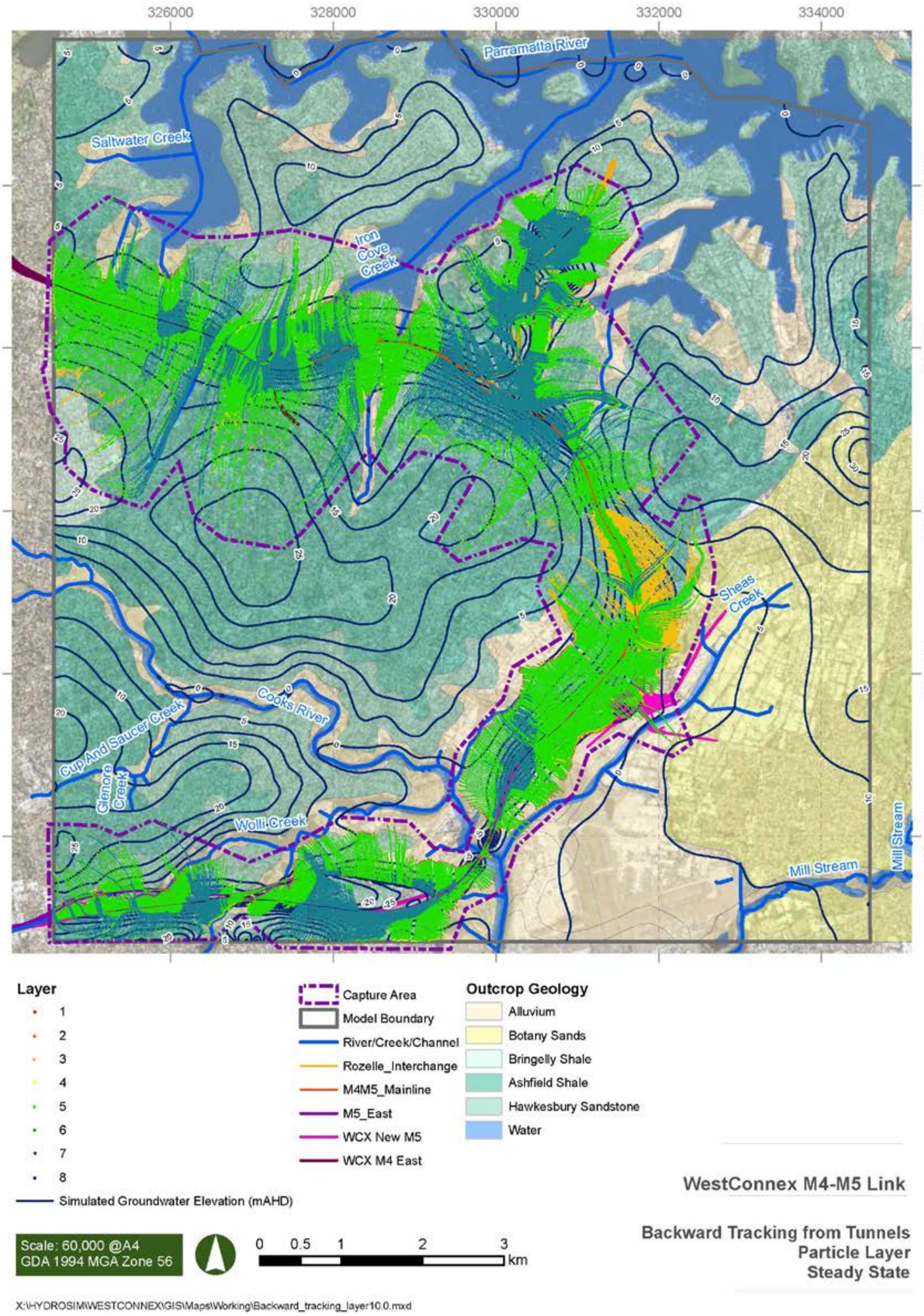

Figure 5-11 Pathlines and model layer

6 POTENTIAL IMPACTS OF THE PROJECT

The main effect of the construction of the tunnels on the groundwater regime is groundwater inflow and subsequent pumping out of groundwater that enters the tunnel void at variable rates not exceeding 1L/sec/km. This localised extraction of groundwater from the system has a number of possible effects that may arise during both the construction phase and on-going operation of the tunnels. These can be summarised as follows:

- inflow of groundwater to the tunnels and water management;
- drawdown of groundwater levels and depressurisation of groundwater, both within the Triassic hard rock strata and the Quaternary alluvium/Botany Sands;
- saline intrusion where the tunnel inflow is hydraulically connected to surface water bodies either directly or via the alluvium; and
- effects on baseflow to nearby non-tidal rivers including the upper reaches of Cooks River, Wolli Creek, Bardwell Creek, Alexandra Canal, Iron Cove Creek, Hawthorne Canal, Whites Creek and Johnstons Creek.

6.1 PREDICTED INFLOW TO TUNNELS

6.1.1 PROJECT SPECIFIC INFLOW

The predicted annual inflow and cumulative inflow with time for the M4-M5 Link tunnelling are presented in **Table 6-1**. Maximum inflows for the project peak at 930 ML/year in 2021, coinciding with the finalization of construction of trafficable tunnels. A total of 3.7GL of water is expected to inflow to the tunnels by project opening in 2023. Long-term inflow rates decline due to declining storage, with inflows at 2100 predicted to have reduced to 323 ML/yr.

Table 6-1 Predicted annual and cumulative tunnel inflows for the M4-M5 Link

	Annual Inflow			Cumulative Total Inflow		
YEAR	M4-M5 Link Trafficable Tunnels Inflow (ML/yr)	M4-M5 Link Ventilation Tunnels Inflow (ML/yr)	M4-M5 Link Combined Inflow (ML/yr)	M4-M5 Link Trafficable Tunnels Cumulative Inflow (ML)	M4-M5 Link Ventilation Tunnels Cumulative Inflow (ML)	M4-M5 Link Cumulative Combined Inflow (ML)
2016	0	0	0	0	0	0
2017	0	0	0	0	0	0
2018	57	0	57	57	0	57
2019	487	0	487	544	0	544
2020	805	0	805	1,350	0	1,350
2021	895	35	930	2,245	35	2,280
2022	730	51	780	2,975	86	3,061
2023	613	48	661	3,587	134	3,721
2024	543	39	582	4,130	173	4,303
2025	497	35	532	4,627	208	4,835
2030	387	31	417	6,561	361	6,922
2041	335	29	364	9,909	651	10,560
2051	312	29	341	13,030	938	13,968
2100	295	28	323	27,784	2,356	30,141

Colours in table indicate the following project phases:

- Tunnel excavation
- Project opening
- Surface works / fit out
- Ongoing operation

6.1.2 CUMULATIVE INFLOW

The maximum annual inflow for the M4 East and New M5 peaks at 806 ML/year in 2019, which is the final year of tunnel construction for these projects. The cumulative inflow to tunnels at the end of all WCX trafficable tunnel excavation (2021) is 5.6 GL, and 8.2 GL of groundwater is predicted to have drained to the greater WCX tunnels by the time of M4-M5 Link opening in 2023. Annual inflow volumes decrease with time after the peak inflows are reached, as water in storage is drained and recharge does not replenish the volumes lost.

Table 6-2 Predicted annual and cumulative tunnel inflows for the WCX program of works

	Annual Inflow			Cumulative Total Inflow		
YEAR	M4 East and New M5 (ML/yr)	M4-M5 Link (ML/yr)	Combined Cumulative Inflow (ML/yr)	M4 East and New M5 (ML)	M4-M5 Link (ML)	Combined Cumulative Inflow (ML)
2016	96	0	96	96	0	96
2017	421	0	421	517	0	517
2018	660	57	717	1,176	57	1,233
2019	806	487	1,293	1,982	544	2,526
2020	696	805	1,501	2,678	1,350	4,028
2021	630	930	1,561	3,309	2,280	5,589
2022	593	780	1,374	3,902	3,061	6,962
2023	567	661	1,228	4,469	3,721	8,190
2024	548	582	1,130	5,017	4,303	9,320
2025	533	532	1,065	5,549	4,835	10,384
2030	489	417	907	7,997	6,922	14,918
2041	465	364	829	12,649	10,560	23,209
2051	455	341	796	17,201	13,968	31,169
2100	449	323	773	39,673	30,141	69,814

Colours in table indicate the following project phases:

- Tunnel excavation
- Project opening
- Surface works / fit out
- Ongoing operation

6.1.3 INFLOW DUE TO DESIGN CHANGES

As discussed in **Section 5.4.5** the inflow volume is expected to increase slightly due to the proposed increase in total tunnel length, however this increase is expected to be negligible in the scale of the overall project inflows.

6.2 PREDICTED DRAWDOWN DUE TO THE M4-M5 LINK

Project specific drawdowns related to the construction of the M4-M5 Link are shown in **Figure 6-1** to **Figure 6-8**. Zoomed in images for these maps can be found in **Annexure C**. This drawdown was calculated by subtracting the results of model Scenario 3 (inclusive of the M5 East, M4 East, New M5 and M4-M5 Link project) from model Scenario 2 (inclusive of the M5 East, M4 East, New M5 only). Model Scenario 2 forms an appropriate “baseline” for calculating drawdown due to the M4-M5 project as this project will not go ahead without the earlier WCX tunnels. Drawdowns are presented for the modelled water table which represents the change in the water table surface due to the project, and may exist in any model layer (the uppermost partially saturated layer).

Drawdown is also presented for Layer 1 restricted to the lateral and vertical extent of the alluvium and Botany Sands (unconsolidated sediments) to aid in the calculation of potential settlement in these units. Therefore, the maximum drawdown shown in these figures is limited to the base of the unconsolidated material, even if the predicted water levels are deeper (as shown in the water table figures). Maximum drawdown for the Ashfield Shale and Hawkesbury Sandstone are also shown. Layer 3 represents the greater thickness of Ashfield Shale and Layer 6 represents the mid-layer of the Hawkesbury Sandstone. Layer 6 also contains the majority of drain cell boundary conditions representing the WCX tunnel inverts. The drawdown in the other Ashfield Shale and Hawkesbury Sandstone model layers may vary slightly from those depicted, however not significantly.

6.2.1 DRAWDOWN AT PROJECT OPENING

At the proposed time of project opening (June 2023) the drawdown on the water table is expected to be up to 42 m with major drawdown centred over the Rozelle Interchange. Drawdown extends up to 500 m either side of the tunnel alignment, with the widest areas being mid-way along the M4-M5 mainline around Newtown and at the interchanges as shown in **Figure 6-1**. The lateral extent of drawdown is narrower where the alignment passes under watercourses due to the transmission of water through the higher hydraulic conductivity of the alluvium preventing the drawdown from propagating far. Drawdown centres are discontinuous along the alignment and are a reflection of tunnel depth and timing of excavation, as well as geological boundaries. There is no drawdown in the area surrounding Cooks River in Layer 1 partly due to the tunnel being lined in the Hawkesbury Sandstone beneath the Cooks River, and partly due to the large alluvial channel continually feeding tidal water to replenish storage removed by tunnelling.

Drawdown that is limited to the base of the alluvium/Botany Sands (**Figure 6-2**) suggests that there may be substantial drawdown in the alluvium at Rozelle in the Whites Creek paleochannel. This indicates that there is a hydraulic connection between the Hawkesbury Sandstone and the alluvium, with the significant drawdown in the Hawkesbury Sandstone creating a local sink drawing groundwater downwards from the alluvium. Water levels directly beneath and adjacent to the Whites Creek drainage channel are not significantly impacted due to the low volumes of recharging water simulated from the tidally influenced channel (that is assumed to be slightly leaky).

Within the Ashfield Shale (**Figure 6-3**) the drawdown is presented from the top of the shale extending into the underlying Hawkesbury Sandstone. The drawdown distribution reflects that of the overlying layer, but with a greater lateral extent (about 700 m either side of the M4-M5 alignment at Newtown).

In the Hawkesbury Sandstone (**Figure 6-4**) drawdowns of up to 55 m occur at Rozelle, with drawdown shown to undercut Whites Creek in the sandstone. Along the mainline the sporadic drawdown epicentres observed in the upper geological units are becoming more continuous with depth and following the tunnel alignments, with a maximum extent of approximately 800 m drawdown either side of the alignment around Newtown/Erskineville.

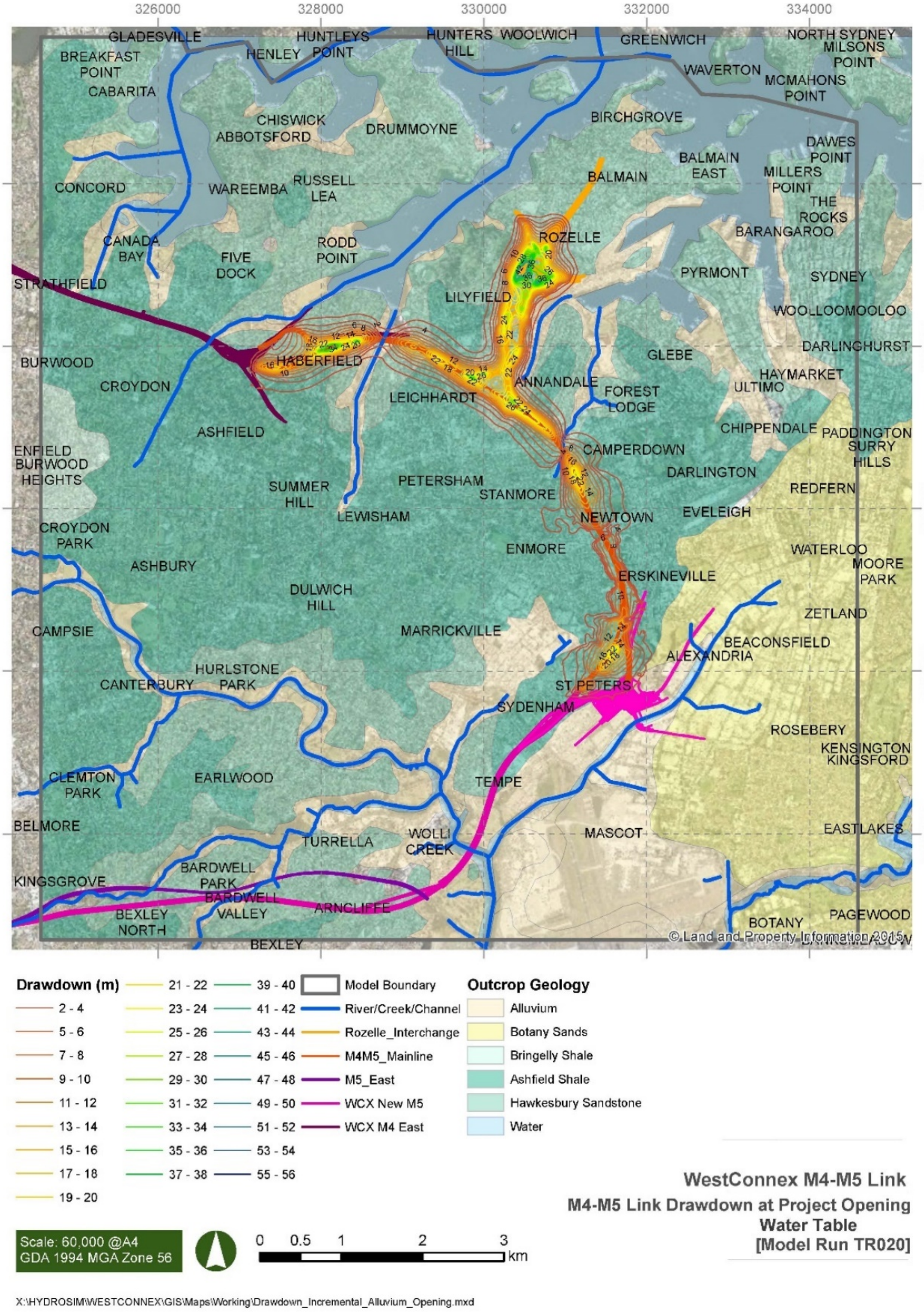

Figure 6-1 M4-M5 Link water table drawdown at project opening (June 2023)

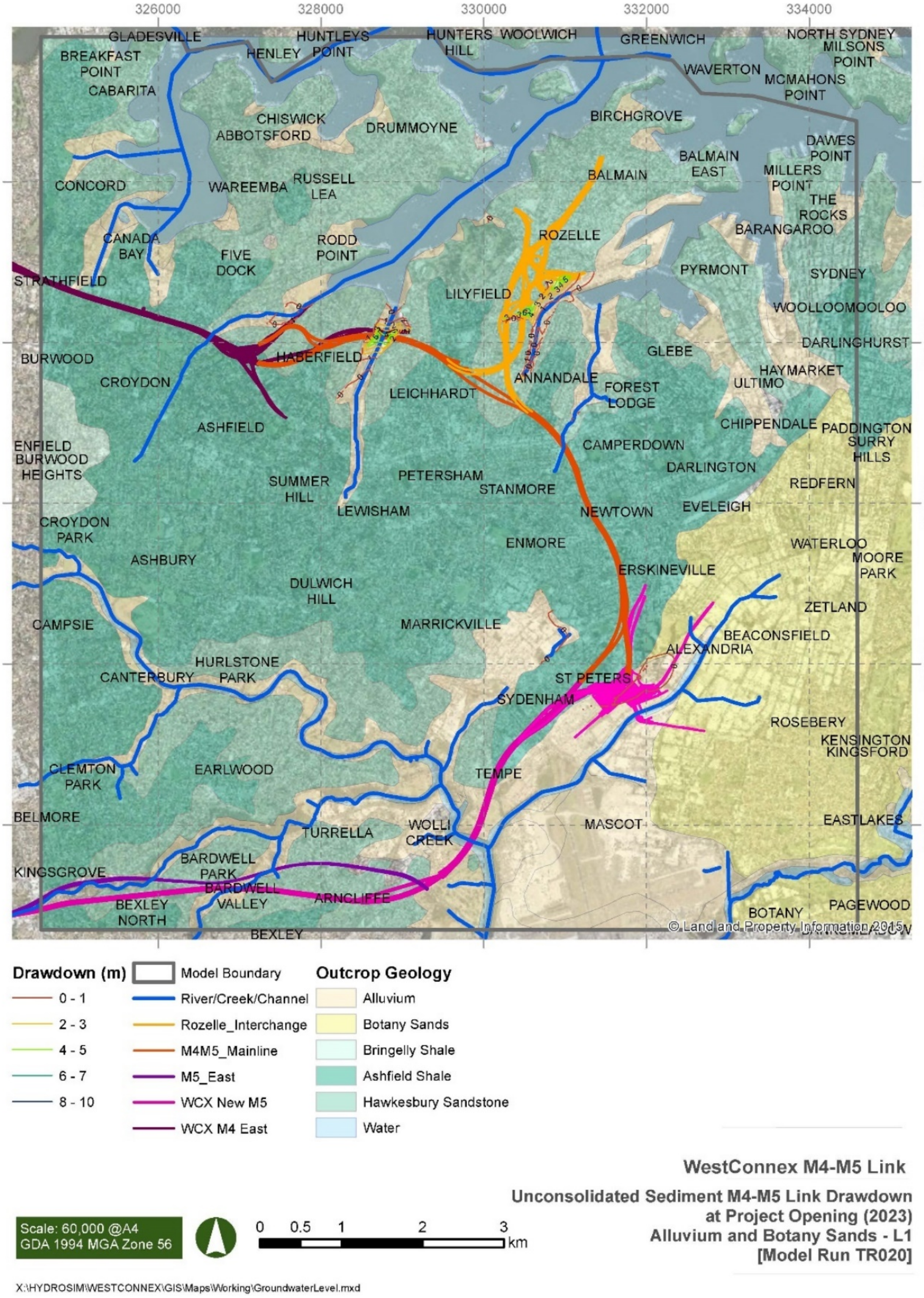

Figure 6-2 M4-M5 Link drawdown in alluvium at project opening (June 2023)

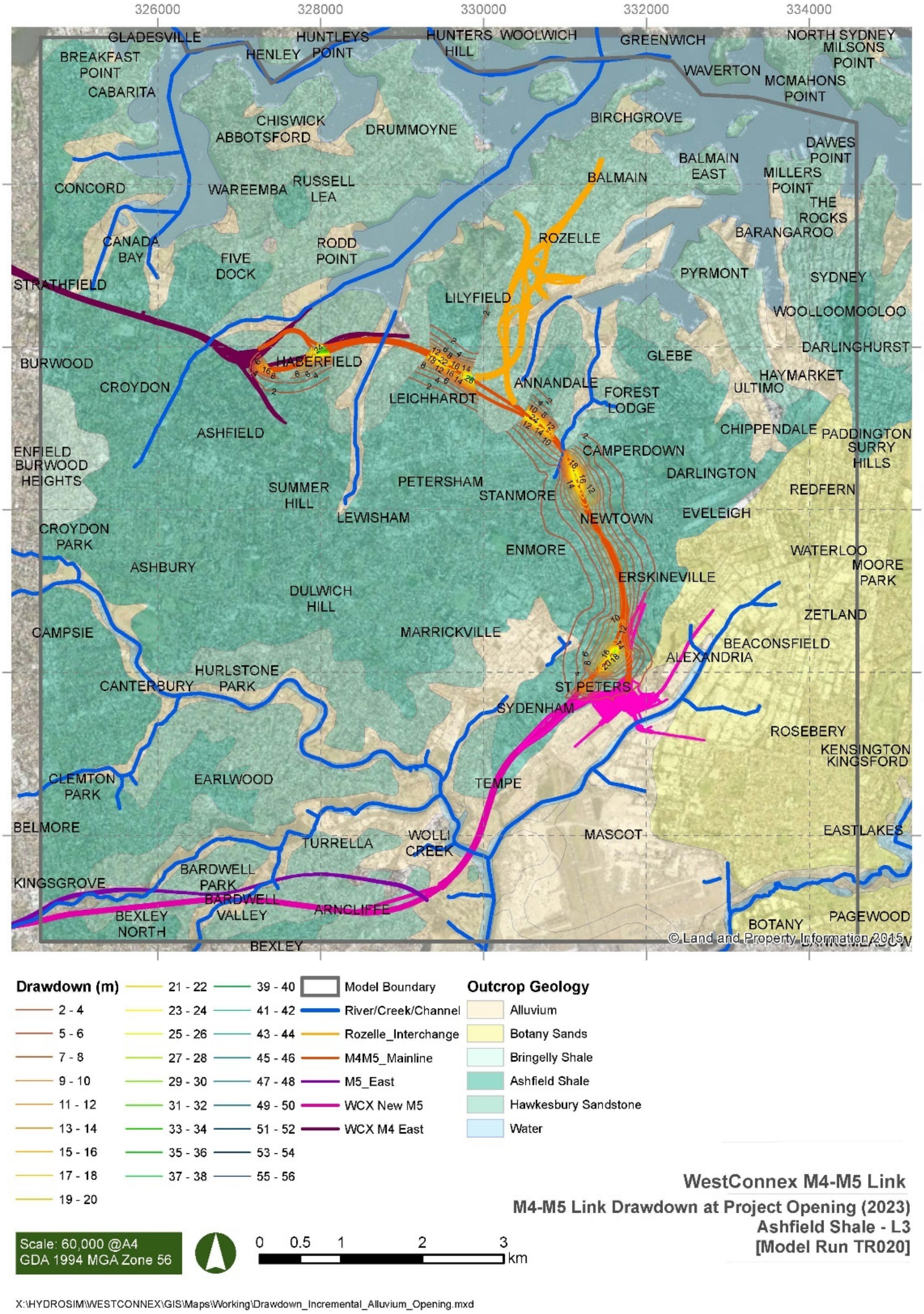

Figure 6-3 M4-M5 Link drawdown in the Ashfield Shale at project opening (June 2023)

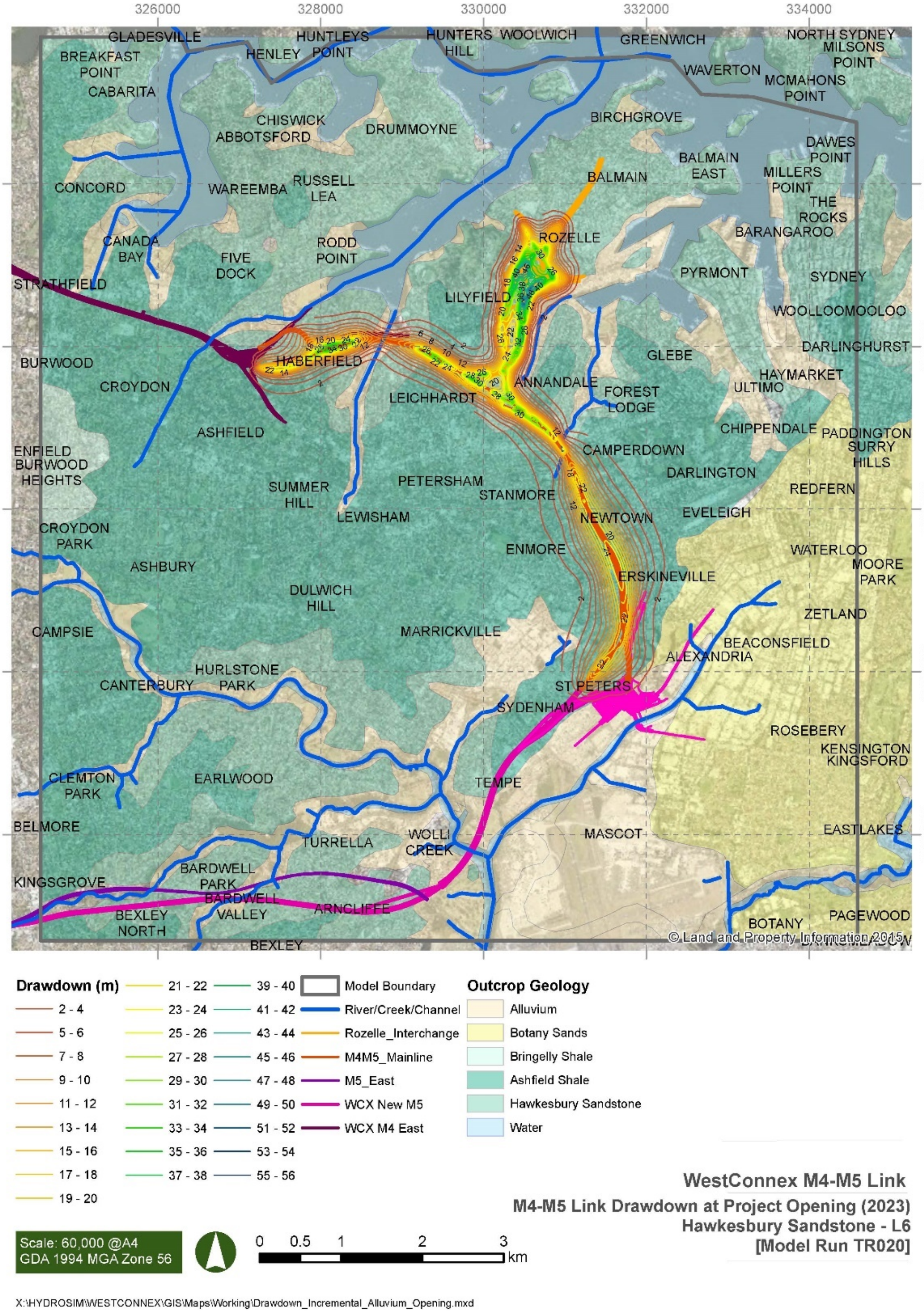

Figure 6-4 M4-M5 Link drawdown in the Hawkesbury Sandstone at project opening (June 2023)

6.2.2 LONG TERM

Drawdown at the end of the long-term simulation (extending to year 2100) shows that the drawdown depth has reached the tunnel inverts and the extent continues to spread with time. It is expected that these water levels represent a pseudo steady-state condition due to the inflows to tunnels stabilising (see **Section 5.4**); however it is possible the drawdown cone may continue to propagate further than has been simulated in the transient model. Drawdown to the water table has a maximum depth of 55 m at Rozelle and a maximum extent at the end of the long-term simulation of 1.4 km either side of the tunnel at Newtown (**Figure 6-5**). Drawdown in the alluvium at Rozelle continues to propagate away from the network of tunnels and extends underneath Whites Creek, indicating the recharge through the alluvium and directly from the creek is less than that removed from the alluvium due to drainage from the tunnels. In the Ashfield Shale (**Figure 6-7**) the maximum extent is 1.5 km towards Enmore and Darlington, and is the same in the Hawkesbury Sandstone (**Figure 6-8**).

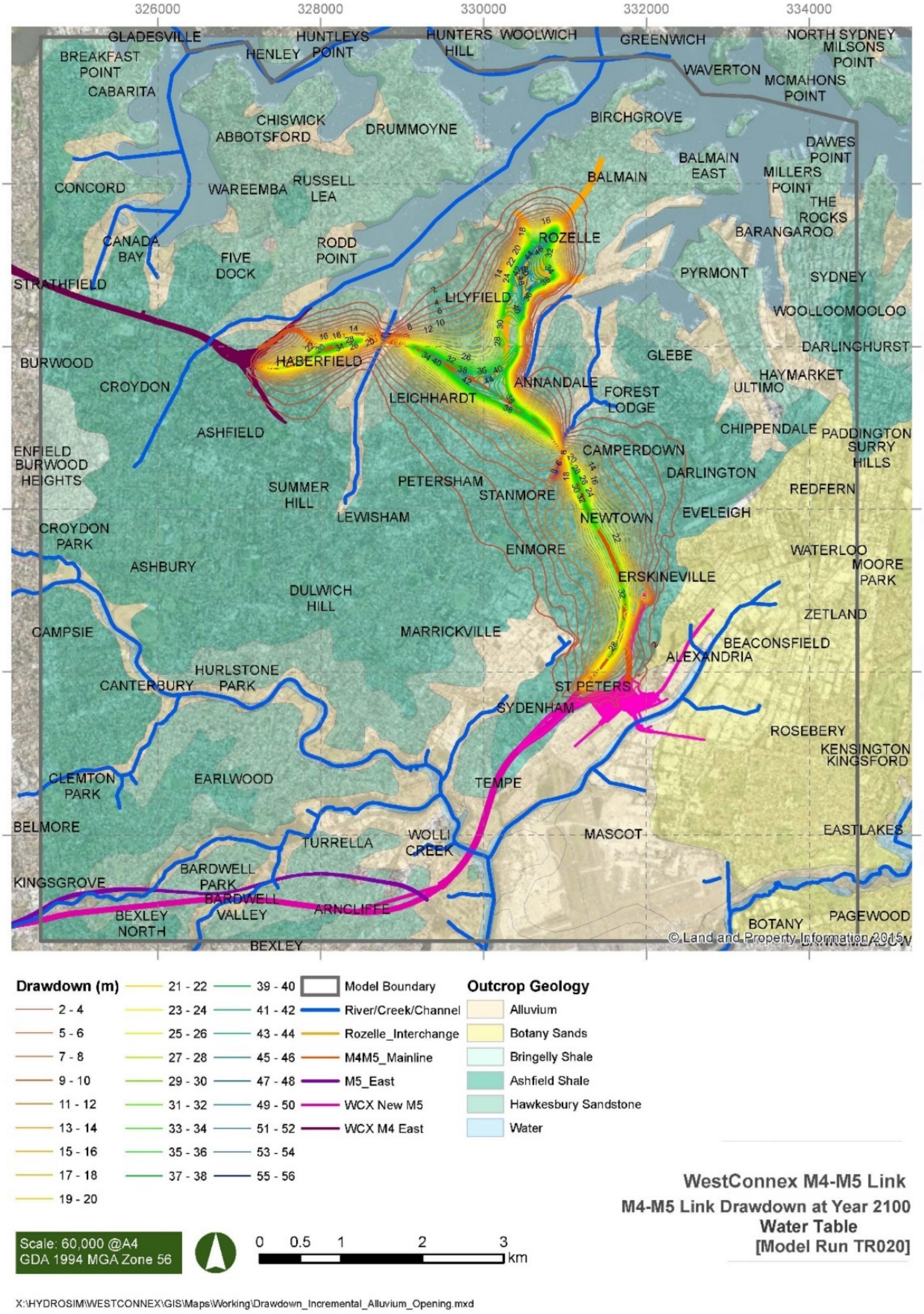

Figure 6-5 M4-M5 Link water table long term drawdown (year 2100)

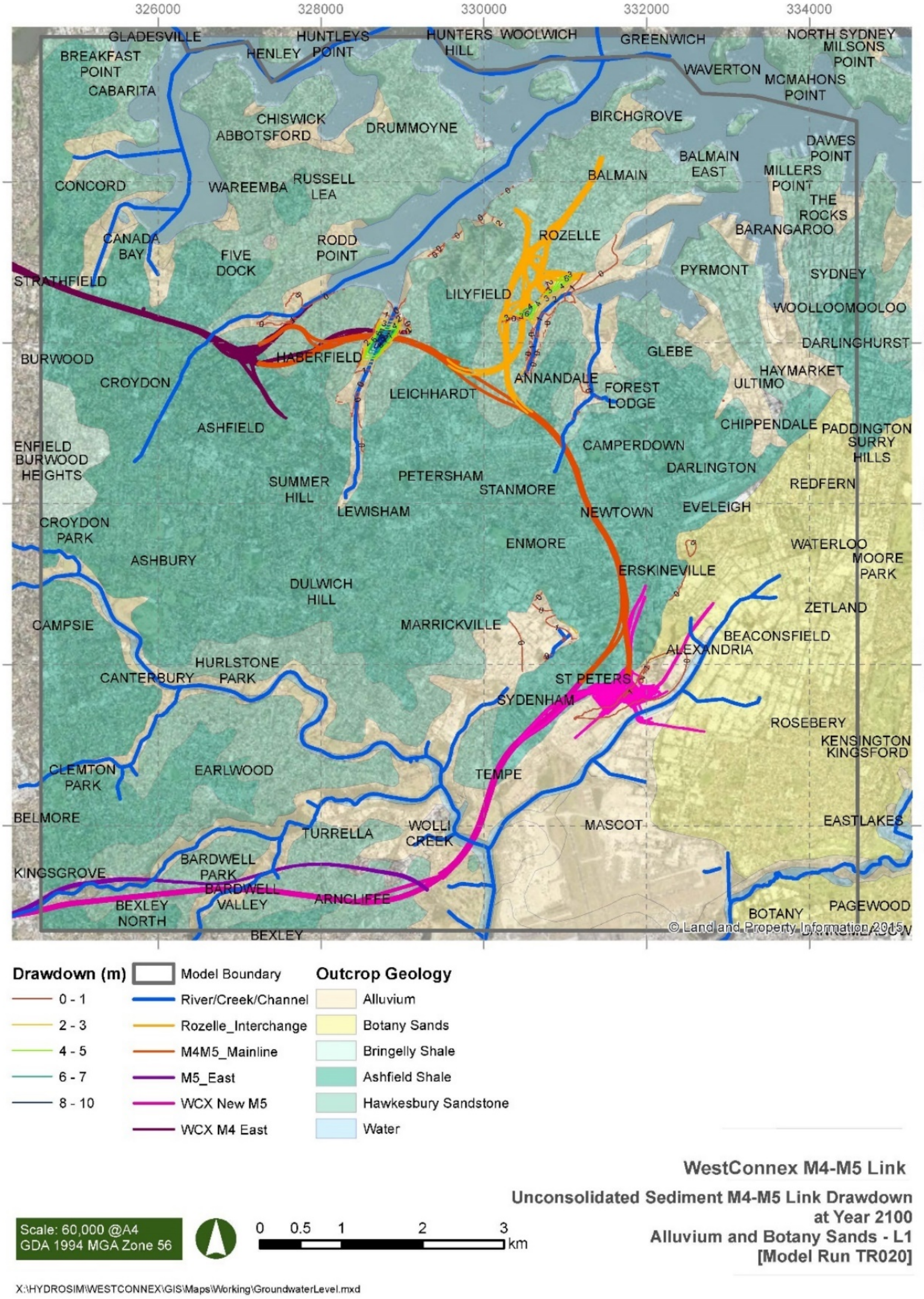

Figure 6-6 M4-M5 Link long term drawdown in alluvium (year 2100)

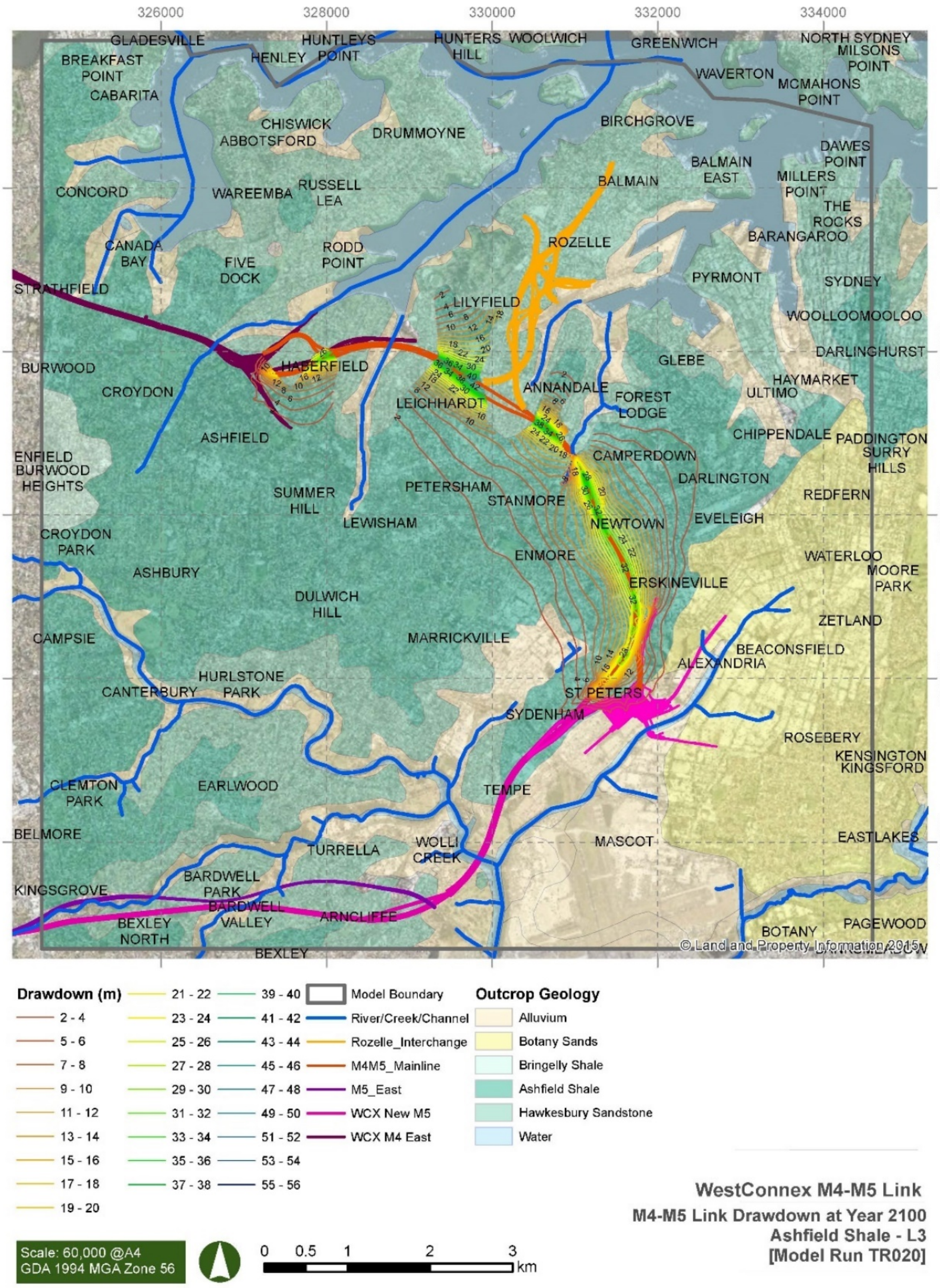

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Figure 6-7 M4-M5 Link long term drawdown in the Ashfield Shale (year 2100)

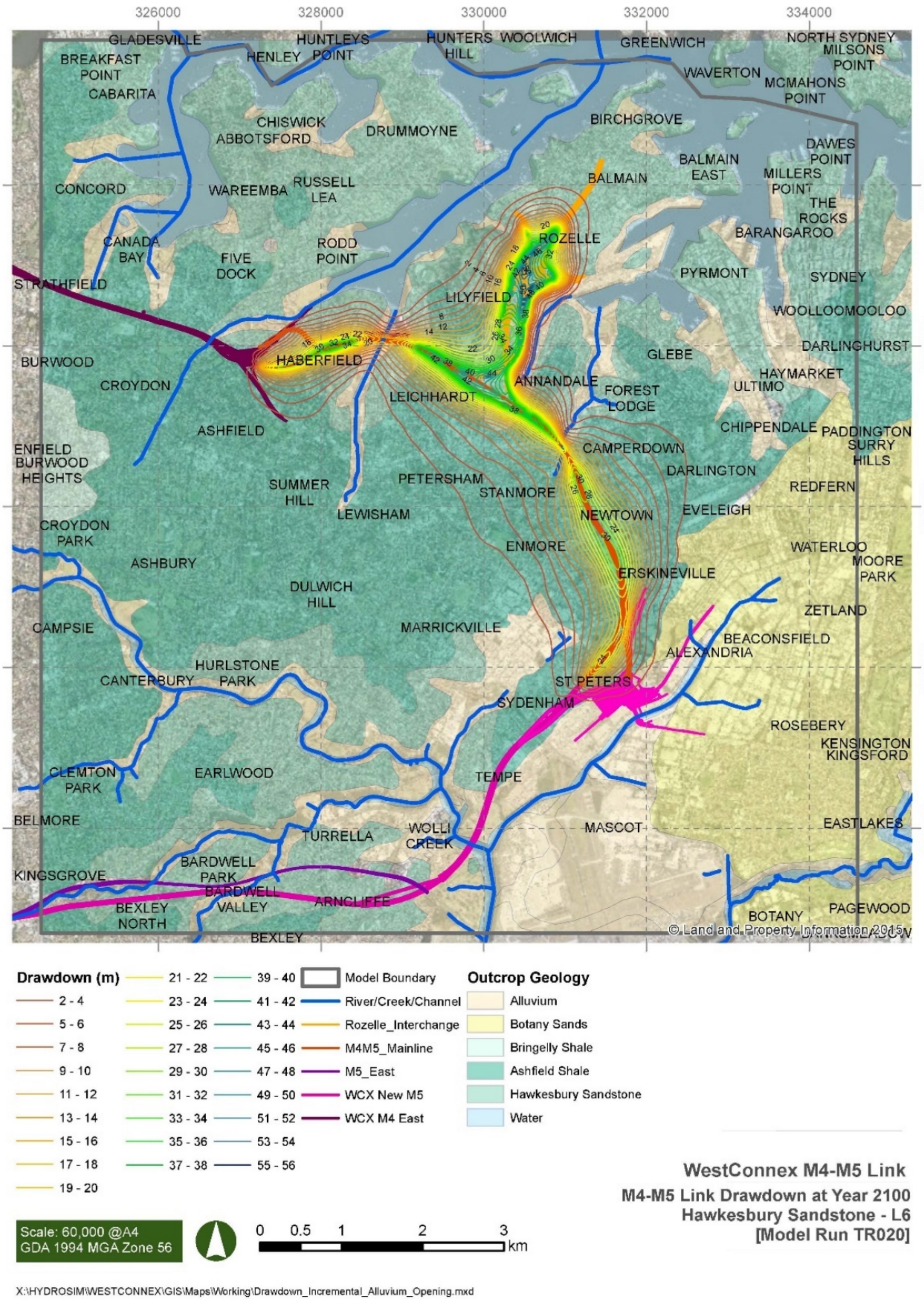

Figure 6-8 M4-M5 Link long term drawdown in the Hawkesbury Sandstone (year 2100)

6.2.3 DRAWDOWN DUE TO DESIGN CHANGES

Additional drawdown due to the extension of exit ramp tunnelling at Haberfield under Option B is expected to be minimal due to the shallow depth of tunnelling. The extent of drawdown to the 2m contour along Parramatta Road will likely shift slightly south of the existing drawdown extent to follow the additional line of tunnels but this is not likely to be significant in terms of potential impacts due to the shallow depth of the tunnels and the lack of nearby environmental receptors or anthropogenic groundwater uses.

Bifurcation of tunnelling is also expected to slightly increase the overall extent of drawdown local to the secondary tunneling due to increased overall project width. The depth of drawdown is expected to approach the tunnel inverts for all tunnels with time. Again, this slight increase in drawdown is not expected to be significant in terms of potential impacts due to the shallow depth of the tunnels and the lack of nearby environmental receptors or anthropogenic groundwater uses. The increased extent of drawdown will only occur on the side of the mainline tunnel at which the bifurcation tunnels are proposed as drawdown resulting from the mainline will act as a hydraulic barrier to prevent the propagation of drawdown on both sides (assuming the inverts of the bifurcation tunnels are not deeper than the mainline).

6.3 PREDICTED CUMULATIVE DRAWDOWN

6.3.1 DRAWDOWN AT PROJECT OPENING

Cumulative drawdown to the water table at June 2023 for the greater WCX program of works is most significant over the Rozelle Interchange (**Figure 6-13**), which isn't unexpected given the complex multi-level tunnelling network to be constructed here. Other key areas of water table drawdown include the Haberfield Interchange (up to 34 m of drawdown), and south of St Peters Interchange at Sydenham (up to 44 m of drawdown). The extent of drawdown is fairly consistent along the entire project, with typically between 200 m and 600 m of drawdown extent either side of the alignment. The depth and extent of drawdown are reduced under the watercourses due to recharge directly from the leaking channels and from the higher conductivity alluvium.

Drawdown that is limited to the base of the unconsolidated sediments (**Figure 6-14**) shows that there is no change to drawdown at Rozelle due to the cumulative tunnelling (i.e drawdown in the alluvium at Rozelle is entirely attributable to the M4-M5 Link project), and only a negligible change for the sediments at Hawthorne Canal and Haberfield with the intersection of the M4 East and M4-M5 Link, however an increase in drawdown of up to 3 m can be seen in alluvial sediments along Iron Cove due to the combined projects. At the St Peters Interchange, less than 1 m of drawdown in the alluvium occurs due to M4-M5 Link tunnelling, however with the inclusion of the New M5 drawdowns of up to 1.5 m occur at the location of the interchange, and up to 3 m of drawdown occurs in the Cooks River alluvium to the south of the interchange due to the New M5.

Drawdown in the Ashfield Shale (**Figure 6-15**) is presented from the top of the shale extending into the underlying Hawkesbury Sandstone. The drawdown in the shale is predicted to be greatest at Sydenham where 44 m of drawdown in predicted. Other deep areas of drawdown in the Ashfield Shale occur at Haberfield and Strathfield.

Drawdown in the Hawkesbury Sandstone again shows a more continuous pattern along the complete WCX program of works (**Figure 6-8**), with the greatest drawdowns observed over Rozelle. Significant drawdown depths are also expected in the deepest parts of the New M5 alignment, being the areas adjacent to the tanked tunnels passing under Cooks River, and the south of the St Peters Interchange at Sydenham. The greatest horizontal extent of drawdown is largely associated with the M4-M5 Link tunnels at Newtown extending to the St Peters Interchange with the cumulative drawdown from the New M5 tunnelling.

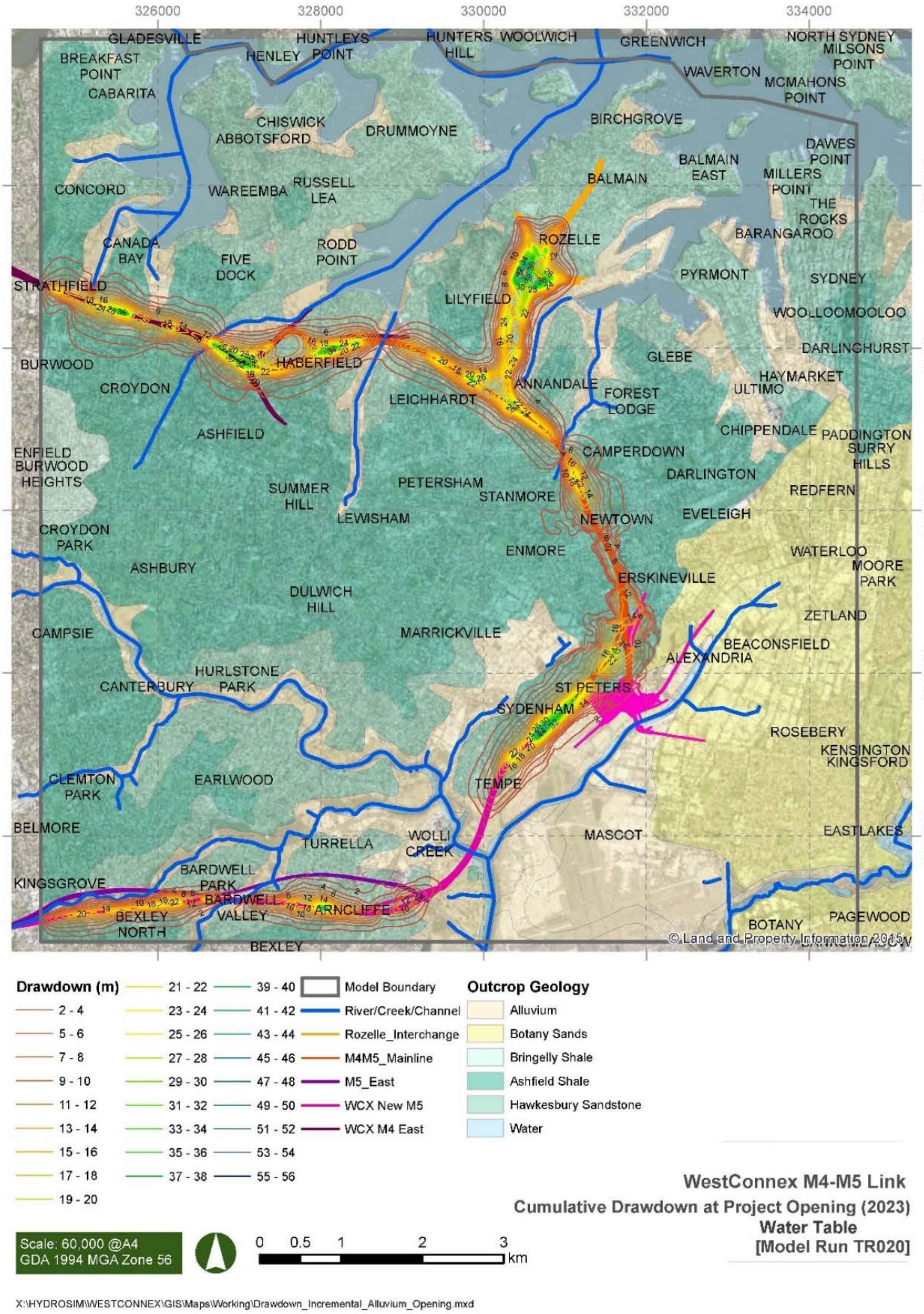

Figure 6-9 Cumulative WCX works water table drawdown at project opening (June 2023)

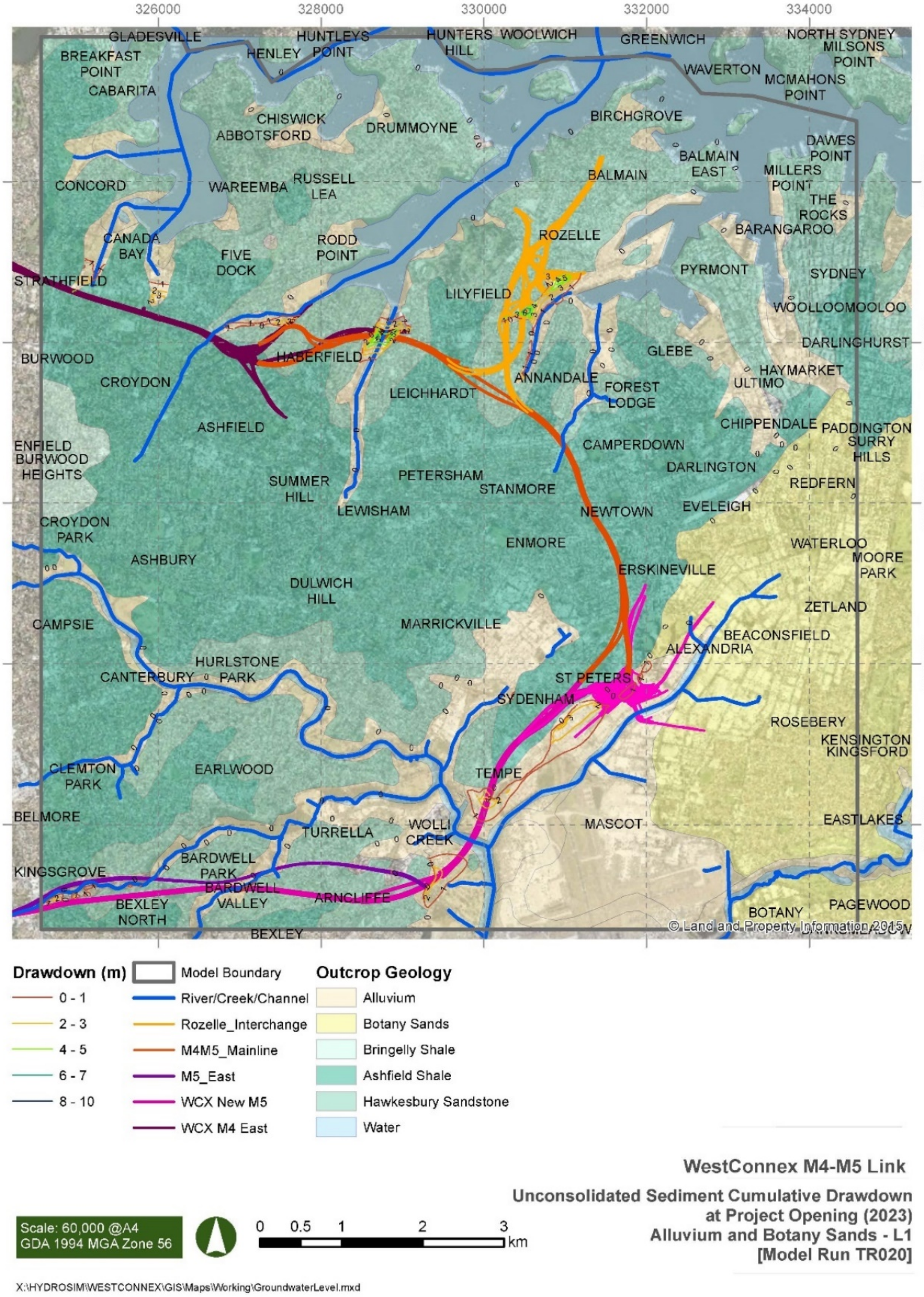

Figure 6-10 Cumulative WCX works drawdown in the alluvium at project opening (June 2023)

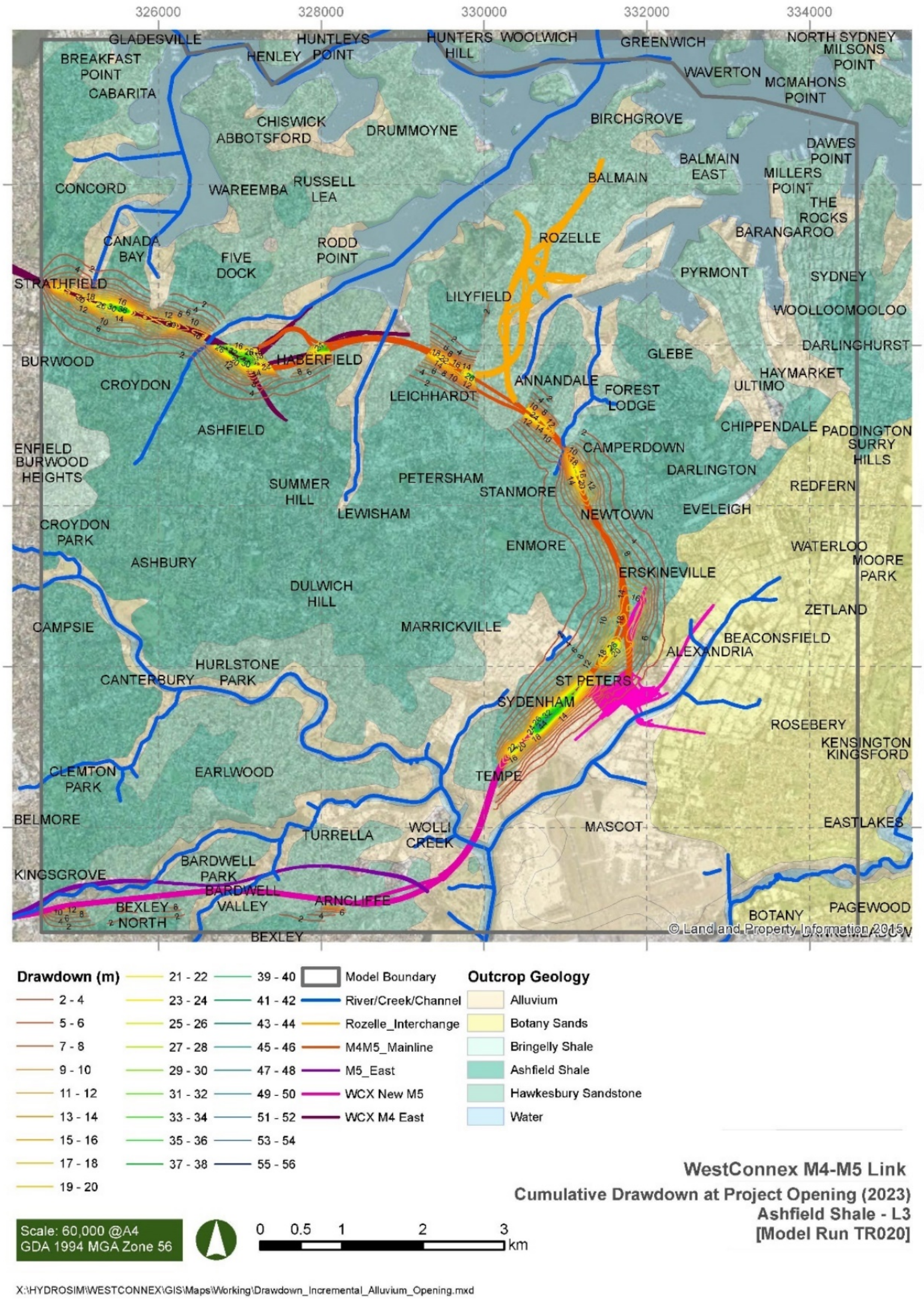

Figure 6-11 Cumulative WCX works drawdown in the Ashfield Shale at project opening (June 2023)

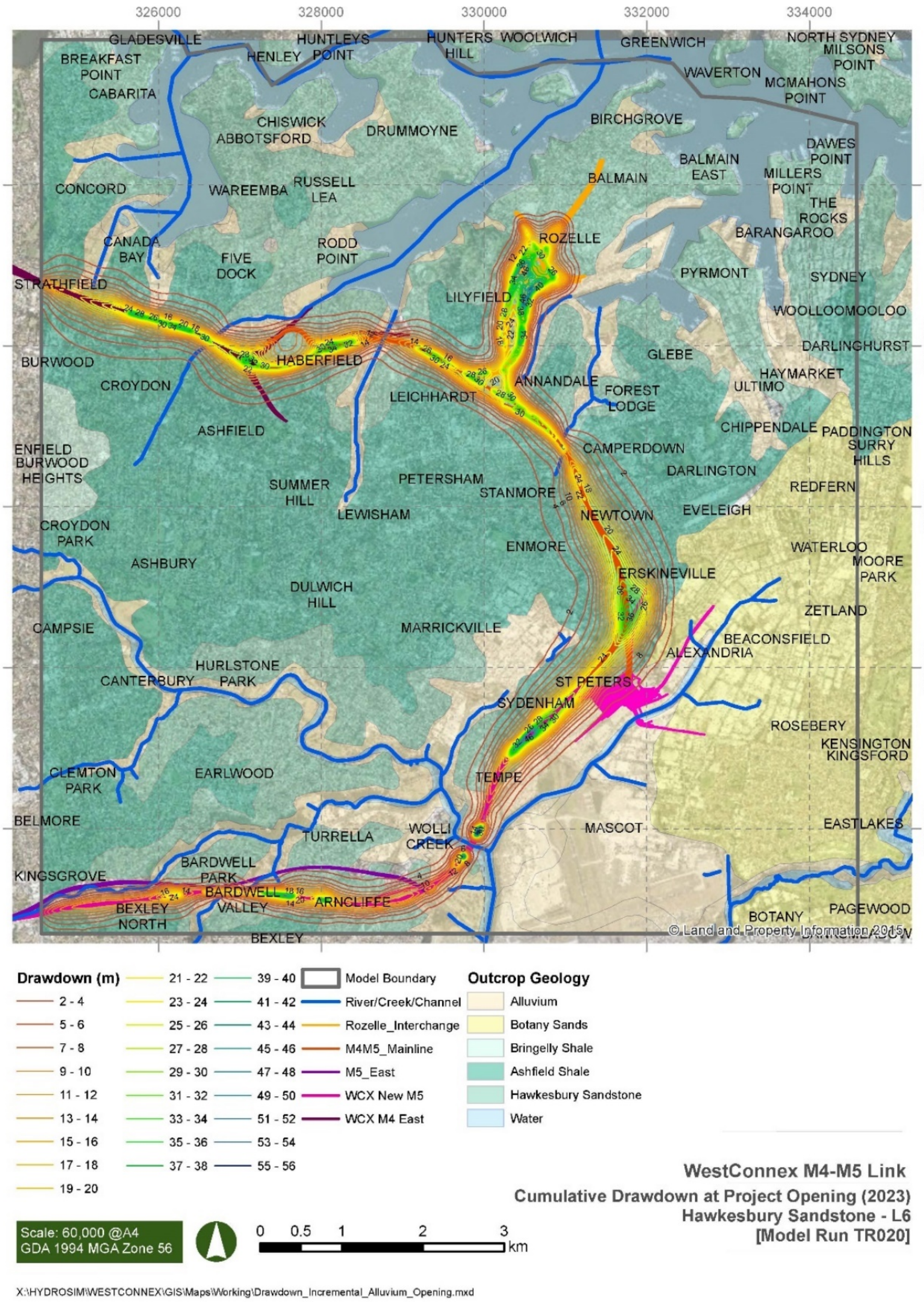

Figure 6-12 Cumulative WCX works drawdown in the Hawkesbury Sandstone at project opening (June 2023)

6.3.2 LONG TERM

Long-term drawdown to the water table (**Figure 6-13**) shows water levels are drawn-down to the tunnel inverts for all components of the WCX program of works, except under watercourses where recharge from the channels is preventing complete drawdown in these locations. Similarly, water table drawdown does not extend into the neighbouring Botany Sands, where higher hydraulic conductivity and recharge replenish any removal of water due to drainage to tunnels. The extent of drawdown is largest along the M4-M5 Link tunnels, with up to 1.4 km of drawdown to the 2 m interval. The M4 East tunnels show a drawdown extent of up to 1 km from the tunnels, greatest to the south of the alignment. It is likely water levels to the north are sustained by tidally influenced water bodies and alluvium. The New M5 has the least simulated drawdown extent, however the southern model boundary is likely to be artificially limiting the simulated drawdown to the south. The existing M5 East tunnel limits the drawdown extent simulated to the north (as drawdown from the M5 East tunnel is already included in the baseline run from which this drawdown is calculated).

Long term drawdowns in the unconsolidated material (**Figure 6-14**) remain as per the M4-M5 Link specific impacts at Rozelle (7 m), and minimal change to long-term drawdown occurs in the Hawthorne Canal sediments at Haberfield due to the combined M4 East and M4-M5 Link project impacts, again indicating the impacts here are largely attributed to the M4-M5 Link tunnelling. There is a very small increase in the drawdown extent in Iron Cove Creek sediments by year 2100. The greatest increase in longterm drawdown in the alluvium is seen at St Peters Interchange and along the Cooks River alluvium on the southern side of the New M5 tunnels. Drawdown reaches over 4 m near Sydenham and Tempe by 2100.

Drawdown in the Ashfield Shale is presented from the top of the shale extending into the underlying Hawkesbury Sandstone. (**Figure 6-15**) Drawdown within the Ashfield Shale and Hawkesbury Sandstone (**Figure 6-16**) again extends down to the tunnel invert levels. They show similar distributions to the water table drawdown with the exception of increased drawdown under watercourses. Drawdown in these deeper units also extends beneath the Botany Sands over the long term, suggesting the drainage to tunnels removes a larger volume of water than is able to be replenished from the overlying sediments (i.e. water is removed at a faster rate than the vertical leakage between the Botany Sands and shale/sandstone).

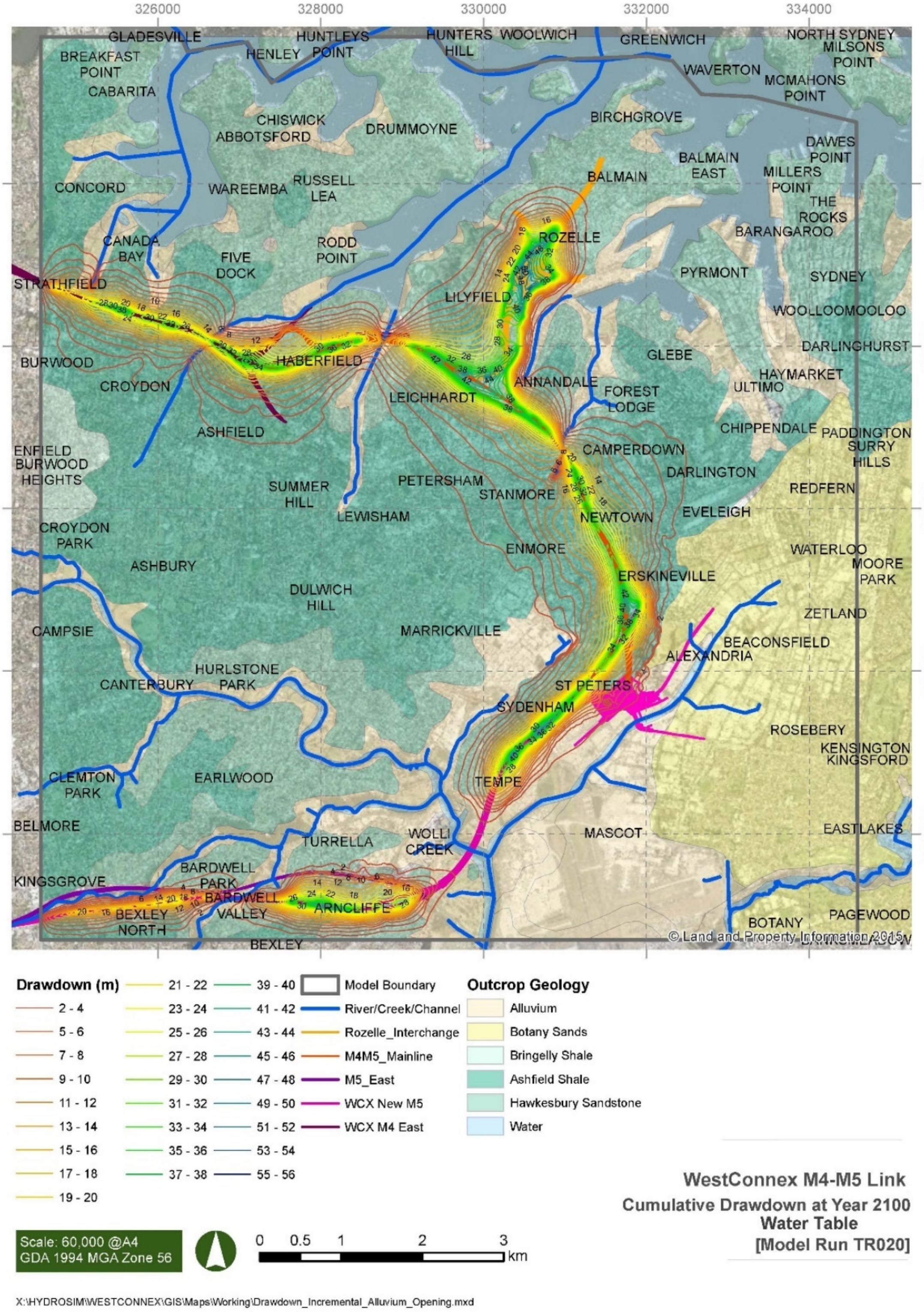

Figure 6-13 Cumulative WCX works water table long term drawdown (year 2100)

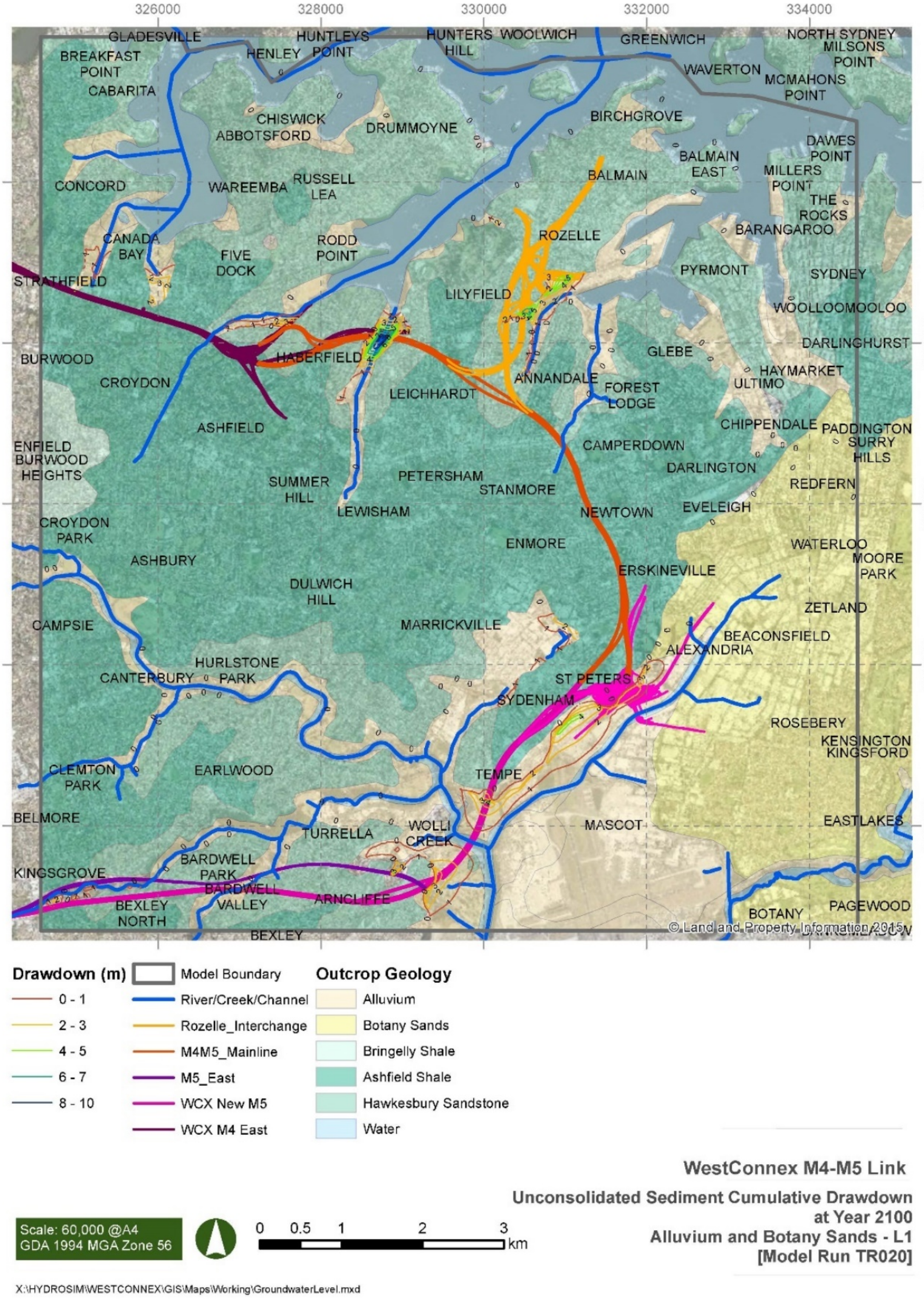

Figure 6-14 Cumulative WCX works long term drawdown in the alluvium (year 2100)

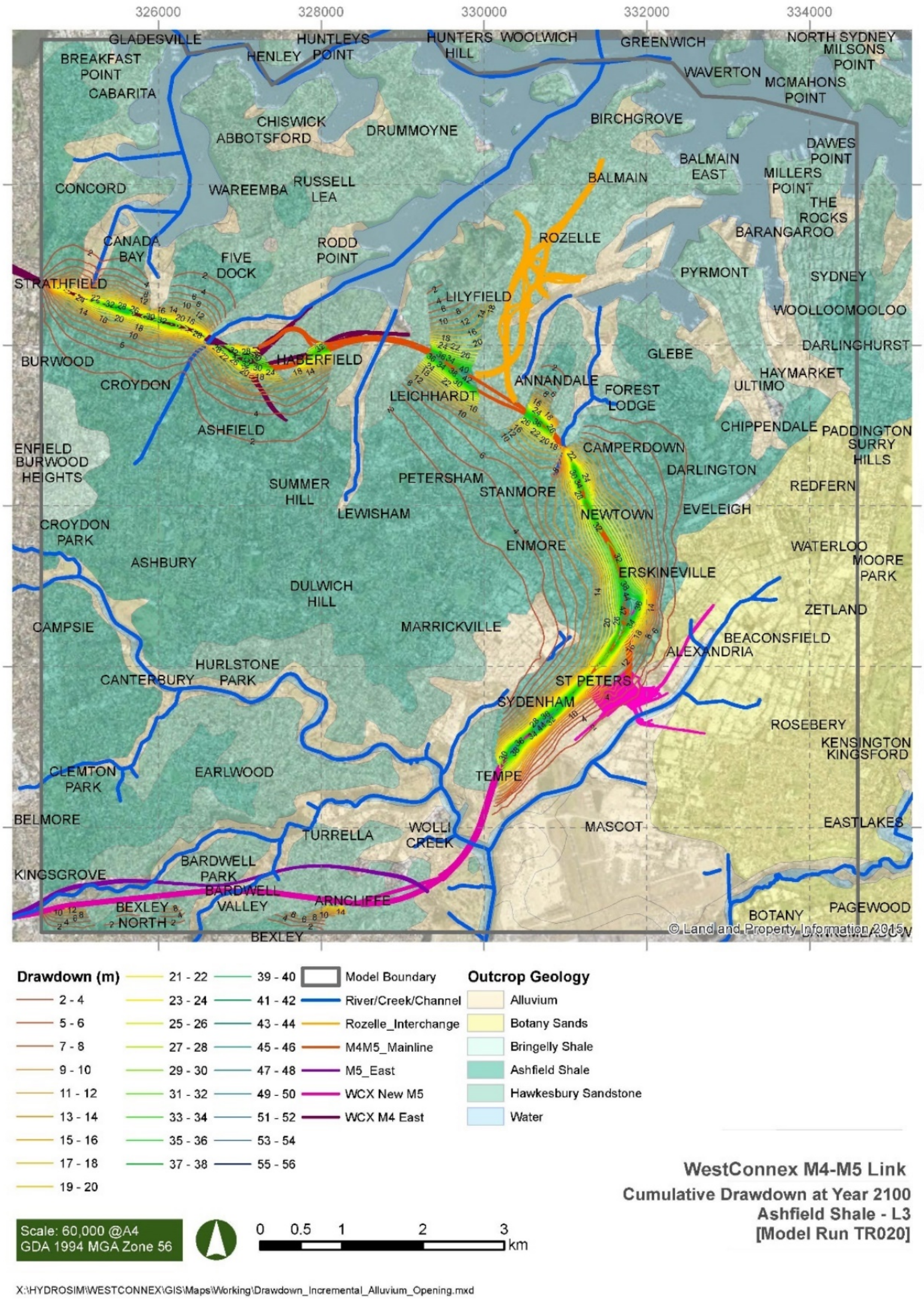

Figure 6-15 Cumulative WCX works long term drawdown in the Ashfield Shale (year 2100)

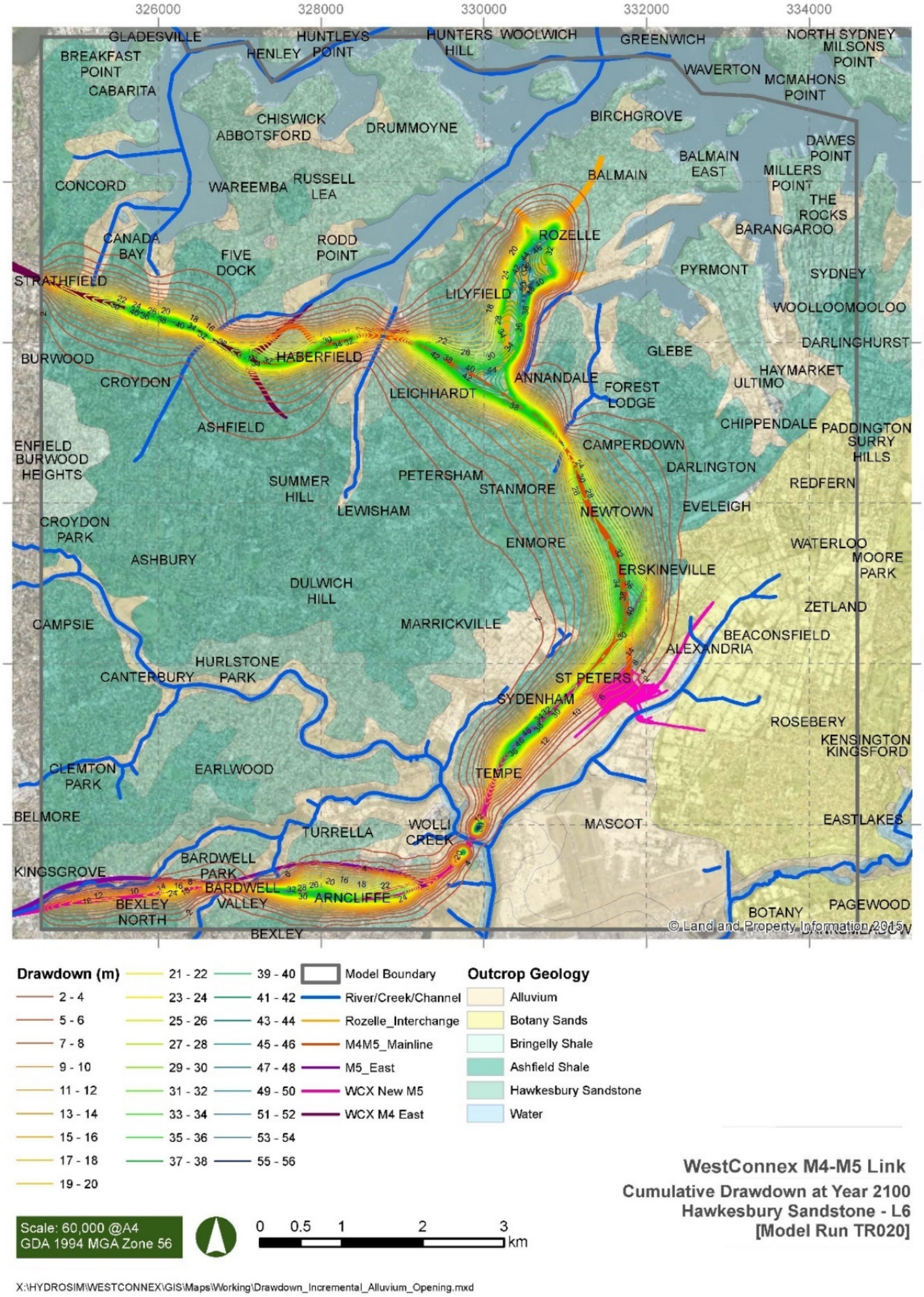

Figure 6-16 Cumulative WCX works long term drawdown in the Hawkesbury Sandstone (year 2100)

6.3.3 CUMULATIVE DRAWDOWN DUE TO DESIGN CHANGES

Cumulative drawdown extents are likely to increase subtly in locations where the design changes have occurred to the M4-M5 Link (as discussed in **Section 6.2.3**) with drawdown ultimately expected to extend to the revised tunnel inverts. Cumulative effects due to the combined WestConnex program of works will only be observed at the project interfaces (Haberfield Interchange and the St Peters Interchange).

6.4 PREDICTED IMPACTS ON STREAM FLOW

6.4.1 BASEFLOW

Baseflow is defined here as the groundwater that discharges to a creek or a river and occurs when the groundwater elevation is higher than the stage of the river. Modelled changes in baseflow for the major rivers simulated in the model are summarized in **Table 6-3** for the impact on baseflow at project opening in 2023 and **Table 6-4** for the long-term impact on baseflow (at 2100).

The combined M4 East and New M5 projects are expected to reduce the baseflow input to Iron Cove Creek and Bardwell Creek by 38% and 21% respectively, with minimal to no impacts in any of the other streams. The M4-M5 Link project adds a further 5% baseflow reduction to Iron Cove Creek, as well as reducing baseflow to Hawthorne Canal by 32%, Whites Creek by 75% and Johnstons Creek by 20%.

The baseflows to the watercourses continues to reduce over time as the drawdown propagates away from the tunnels, with cumulative impacts of a 48% reduction in baseflow to Hawthorne Canal, 56% reduction to Iron Cove Creek, 28% to Johnstons Creek, 22% to Bardwell Creek and an 83% loss of baseflow to Whites Creek which is situated below the Rozelle Interchange.

It should be noted that although the baseflow component of stream flow is significantly reduced in several of the watercourses, it is expected that the overall contribution to river flow from groundwater input is relatively small due to the streams being mostly lined channels, several of which are tidally influenced near the project. Baseflow simulated in this model only represents the occasions when groundwater reaches the ground surface and enters the drainage system, and it is expected that the majority of stream flow would be derived from the runoff of surface storm water and tidal inflow. The actual proportions of total stream flow attributed to groundwater baseflow was unable to be determined as part of this study due to lack of stream gauging data.

Table 6-3 Predicted changes in baseflow at the end of construction (2023)

June 2023		Hawthorne Canal	Iron Cove Ck	Whites Ck	Johnstons Ck	Cooks River	Wolli Ck	Bardwell Ck
Base Case	Baseflow m3/day	298	281	177	289	666	625	311
Early WCX	Baseflow m3/day	298	174	177	289	664	540	247
	Reduction in baseflow m3/day	0	107	0	0	2	85	64
	% reduction	0	38	0	0	0.3	13	21
All WCX	Baseflow m3/day	202	160	45	230	664	540	247
	Reduction in baseflow m3/day	95	121	132	58	2	85	64
	% reduction	32	43	75	20	0.3	13	21
Change due to M4-M5	Reduction in baseflow m3/day	96	14	132	59	0	0	0
	% reduction	32	5	75	20	0	0	0

Table 6-4 Predicted long-term changes in baseflow (2100)

January 2100		Hawthorne Canal	Iron Cove Ck	Whites Ck	Johnstons Ck	Cooks Rv	Wolli Ck	Bardwell Ck
Base Case	Baseflow m3/day	291	274	174	282	643	613	308
Early WCX	Baseflow m3/day	287	142	174	282	635	516	240
	Reduction in baseflow m3/day	4	132		0	8	96	68
	% reduction	1	48	0	0	1	16	22
All WCX	Baseflow m3/day	150	121	29	203	635	516	240
	Reduction in baseflow m3/day	141	153	145	79	8	96	68
	% reduction	48	56	83	28	1	16	22
Change due to m4m5	Reduction in baseflow m3/day	136	20	145	79	0	0	0
	% reduction	47	7	83	28	0	0	0

6.4.2 LEAKAGE

Leakage is the process of water exiting the surface water flow channel and recharging the groundwater. In this model it is restricted by a low stream bed conductance of 0.001 m/day, a value arbitrarily applied to represent the degraded lining of the majority of water-courses in the study area (except Wolli Creek and Bardwell Creek which are natural). An increase in leakage from rivers occurs when the drawdown due to tunneling lowers the groundwater elevation is below the river stage. All simulated rivers (except Bardwell Creek) have a tidal influence in the areas where WCX tunneling will occur, therefore the leakage from these water courses induced as a result of tunneling is likely to have an electrical conductivity approaching that of sea-water. Modelled changes in leakage for the major rivers simulated in the model are summarized in **Table 6-5** at project opening in 2023 and **Table 6-6** for the long-term change in leakage (at 2100).

The combined M4 East and New M5 projects are expected to induce additional leakage to Iron Cove Creek, Wolli Creek and Bardwell Creek of 128%, 17% and 19% respectively, with minimal to no impacts in any of the other streams. The M4-M5 Link project adds a further 27% leakage to Iron Cove Creek, as well as inducing 26% of additional leakage to Hawthorne Canal, 115% to Whites Creek and 73% to Johnstons Creek.

As drawdown from tunneling continues to increase over time, so does induced leakage from the channels, with cumulative impacts of a 40% additional leakage from Hawthorne Canal, 222% from Iron Cove Creek, 104% from Johnstons Creek, 20% from Bardwell Creek and 189% from Whites Creek.

Table 6-5 Predicted changes in leakage at the end of construction (2023)

June 2023		Hawthorne Canal	Iron Cove Ck	Whites Ck	Johnstons Ck	Cooks River	Wolli Ck	Bardwell Ck
Base Case	Leakage m3/day	16	16	38	30	66	586	436
Early WCX	Leakage m3/day	16	36	38	30	66	686	517
	Increase in Leakage m3/day	0	20	0	0	0	100	81
	%increase	0	128	0	0	0	17	19
All WCX	Leakage m3/day	20	40	81	52	66	686	517
	Increase in Leakage m3/day	4	25	43	22	0	100	81
	% increase	26	155	115	73	0	17	19
Change due to M4-M5	Increase in Leakage m3/day	4	4	43	22	0	0	0
	% increase	26	27	115	73	0	0	0

Table 6-6 Predicted long-term changes in leakage (2100)

January 2100		Hawthorne Canal	Iron Cove Ck	Whites Ck	Johnstons Ck	Cooks Rv	Wolli Ck	Bardwell Ck
Base Case	Leakage m3/day	16	16	38	31	67	591	438
Early WCX	Leakage m3/day	17	46	38	31	67	696	527
	Increase in Leakage m3/day	0	30	0	0	0	106	89
	% increase	1	185	0	0	1	18	20
All WCX	Leakage m3/day	23	52	110	62	67	696	527
	Increase in Leakage m3/day	7	36	72	32	0	106	89
	% increase	40	222	189	104	1	18	20
Change due to m4m5	Increase in Leakage m3/day	6	6	72	32	0	0	0
	% increase	39	37	189	104	0	0	0

6.4.3 BASEFLOW AND LEAKAGE DUE TO DESIGN CHANGES

It is not expected that the project design changes (either construction Option B or the bifurcation of tunneling) would result in significant changes to the above reported predicted impacts to channel flow due to lack of connection with the alluvium.

6.5 PREDICTED TAKE FROM BOTANY SANDS

Groundwater within the Botany Sands is known to have areas of contamination resulting from past and present industrial activities, therefore any groundwater drainage induced from the Botany Sands due to WCX tunneling has the potential to cause localised spreading of contamination. The Ashfield Shale is present in the areas where the tunneling occurs in the vicinity of the Botany Sands (at St Peters Interchange) which, combined with the high hydraulic conductivity and rainfall recharge in the Botany Sands, appears to minimise the drawdown propagation into the Botany Sands (**Section 6.2** and **Section 6.3**). This in turn results in a negligible change in natural groundwater flow direction within the Botany Sands, therefore groundwater take from the Botany Sands aquifer due to tunneling is minimal. Predicted take from the Botany Sands increases with time due to increasing extent of drawdown associated with tunnel operational inflows (1.7 KL/day at project opening and 7.6 KL/day at 2100 for the M4-M5 Link Project and 5.7 KL/day at project opening and 15.5 KL/day at 2100 for the combined WCX program of works (**Table 6-7**)). If all the water drained from the Botany Sands where to reach the tunnels, it would provide a very small relative input to the total inflow to tunnels (**Section 6.1**) for the WCX works (typically less than 0.5%).

Table 6-7 Predicted take from Botany Sands

	M4-M5 Link		Cumulative WCX Works	
YEAR	KL/day	Total ML	KL/day	Total ML
2016	0.0	0	0.0	0
2017	0.0	0	0.0	0
2018	0.0	0	0.0	0
2019	0.1	0	1.8	1
2020	0.8	1	3.5	3
2021	1.7	1	4.9	5
2022	1.6	2	5.2	7
2023	1.7	3	5.7	10
2024	2.1	4	6.4	12
2025	2.4	5	7.0	15
2030	3.8	11	10.5	32
2041	5.2	30	12.7	81
2051	6.1	49	13.9	126
2100	7.6	178	15.5	395

Colours in table indicate the following project phases:

Tunnel excavation

Project opening

Surface works / fit out

Ongoing operation

There is unlikely to be any change to the above predicted values due to the project design changes (**Section 2.2.1**). The proposed bifurcation at St Peters Interchange is only applied to the north bound tunnel, therefore any minor changes in the groundwater regime/drawdown due to the bifurcation will be limited to the western side of the tunnels only.

6.6 PREDICTED IMPACTS ON GDES

There are no high priority GDEs identified within the study area, however there are several wetlands identified as potential GDEs in the BoM GDE Atlas (**Figure 3-6** to **Figure 3-7**). The potential for drawdown at these locations has been investigated and the results are shown in **Table 6-8**. Six of the 24 potential GDEs located within the model boundary would experience drawdowns of greater than 2 m if they are in direct hydraulic connection with the regional water table. However, the GDEs are more likely to sustain perched water tables in a natural condition. None of the impacted GDEs are considered as having a high potential for groundwater interaction (as per the BoM GDE Atlas). The GDEs that may be affected by WCX works drawdown are all located in the vicinity of the New M5 and all drawdown is due to the New M5 tunnelling, with no additional impacts associated with the M4-M5 Link project works.

Table 6-8 Drawdown >2m at potential GDE locations

BoM Identifier	Easting	Northing	Potential for GW Interaction	Location	Drawdown (m) at June 2023	Drawdown (m) at Jan 2100
1975237	326679	6243362	Moderate potential for GW interaction	Bardwell Valley Golf Club	4.60	5.84
1975206	326645	6243374	Low potential for GW interaction	Bardwell Valley Golf Club	3.40	6.16
1975273	326611	6243342	Low potential for GW interaction	Bardwell Valley Golf Club	4.95	6.15
1975433	326285	6243194	Moderate potential for GW interaction	Stotts Reserve Bardwell Valley	18.35	20.94
1975481	326110	6243151	Moderate potential for GW interaction	Stotts Reserve Bardwell Valley	21.04	23.01
1975262	326892	6243328	Moderate potential for GW interaction	Bardwell Valley Golf Club	2.50	2.96

The design changes discussed in **Section 2.2.1** are not likely to result in any increased potential for impact to the listed GDEs due to the proposed changes being more than 3 km from any listed GDEs. Additionally, Cooks River and Wolli Creek recharge the alluvium which is likely to sustain the GDEs closest to the project changes (at Turrella).

6.7 PREDICTED IMPACTS ON EXISTING GROUNDWATER USERS

Drawdown due to the construction and operation of the overall WCX works would affect 11 registered groundwater abstraction bores, screened within the Alluvium and Hawkesbury Sandstone. Only one of these bores (GW110247) is predicted to have drawdown directly attributable to the project. Domestic bore GW110247 (located at Sydney University) is predicted to have a drawdown of approximately 2.4 m to the piezometric head in the Hawkesbury Sandstone by the year 2100, however this would have a negligible effect on the capacity of the bore given its significant depth (210m).

The effects at other bores used for domestic supply or irrigation of recreational areas are attributed to drawdown from the New M5 tunnelling. One domestic bore (GW109966) is predicted to have water levels drawn down below its base (3 m depth) and will therefore no longer be usable without deepening the hole. Assuming the pumps are set at reasonable depths in the boreholes, the only other bore that is likely to have a drawdown impact that will significantly affect its operation is GW107993, which is located at Arncliffe Park and is only 14 m deep. A drawdown of over 10 m at this location will result in an insufficient head of water above the pump for it to remain in operation.

Drawdowns predicted by this modelling project are compared to those predicted by the New M5 Modelling Project (CDM Smith, 2015) in the last column of **Table 6-9**. Drawdown at GW072161 is approximately 5 m greater in this model, but is comparable at the other affected locations. It is unknown why the drawdown differs between the models at this location, but is likely to be an effect of differences in either the model geometry or the invert levels applied for the M5 East tunnel.

Figure 6-17 and **Figure 6-18** show the impacted bores and drawdown in the Alluvium and Hawkesbury Sandstone respectively.

A list of drawdowns predicted at all registered bore locations is presented in **Annexure B**.

Table 6-9 Drawdown >2m at registered abstraction bore locations

Reg. Bore ID	Easting	Northing	Screened Geology	Use	Depth (m)	Drawdown (m)		
						June 2023 (m)	Jan 2100 (m)	Previous M5 Model* Prediction (m)
GW110247#	332357	6248363	Sandstone	Domestic	210	0.21	2.40	NA
GW024109	329430	6243538	Alluvium	Water Supply	2	1.34	2.15	2.2
GW109965	329489	6243467	Alluvium	Domestic	8	1.73	2.62	2.4
GW108406	329510	6243455	Alluvium	Domestic	8	1.70	2.55	2.4
GW109966	329373	6243465	Alluvium	Domestic	3	2.35	3.75	4.5
GW108588	329440	6243429	Alluvium	Domestic	8	2.07	3.14	2.7
GW072161	329636	6243437	Sandstone	Recreation	91	6.14	6.51	1.9
GW109964	329426	6243419	Sandstone	Domestic	8	2.28	3.40	2.8
GW109963	329446	6243406	Sandstone	Domestic	8	2.32	3.40	2.7
GW107993	328242	6243424	Sandstone	Recreation	14	1.71	10.13	11.5
GW109191	325255	6243188	Sandstone	Recreation	186	6.66	6.89	5.7

impacted due to construction of M4-M5 link. All other bores impacted by New M5.

* Previous New M5 modelling was steady-state only, therefore results from previous modelling are more comparable with long-term model results

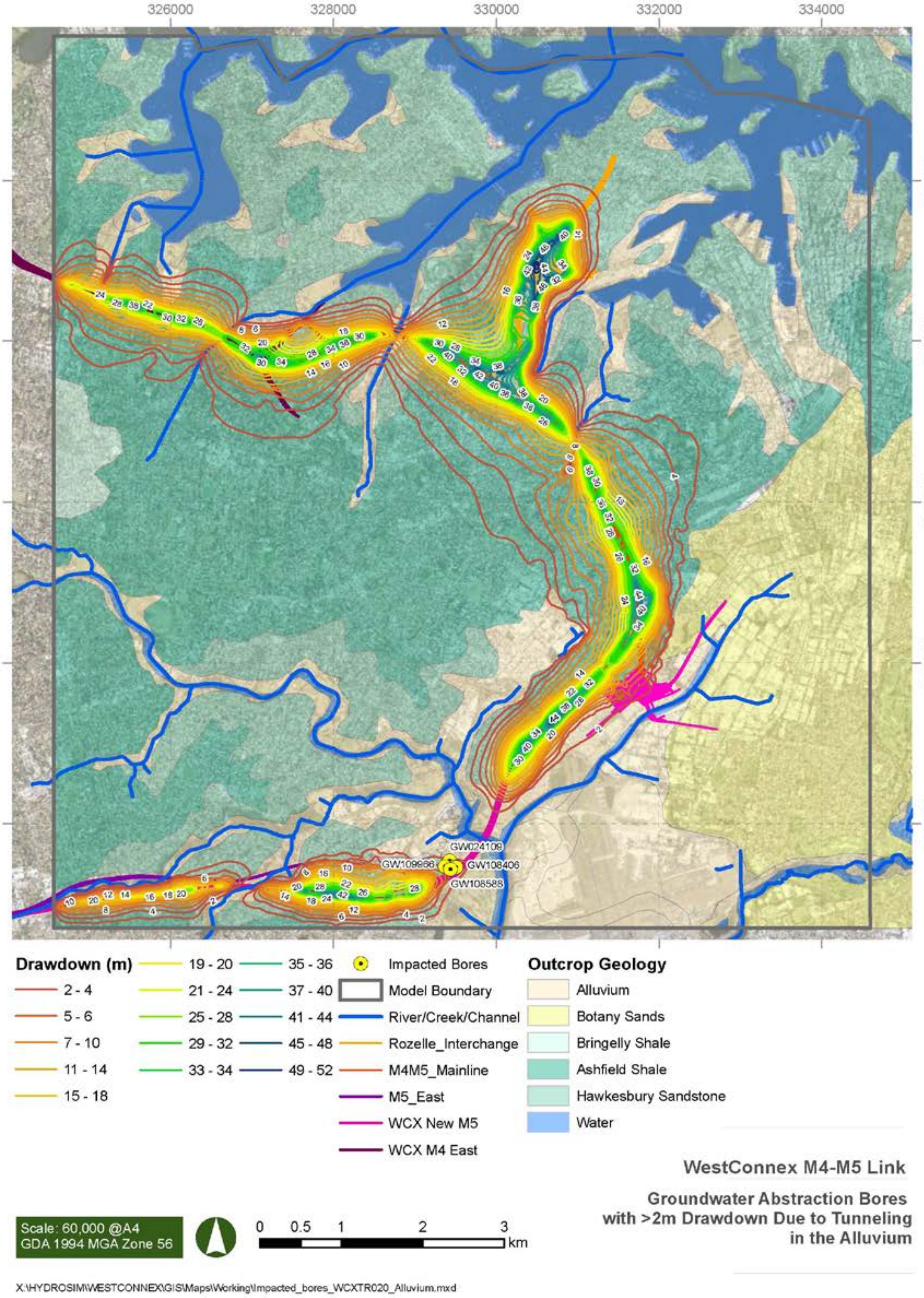

Figure 6-17 Groundwater abstraction bores with >2m drawdown screened in alluvium

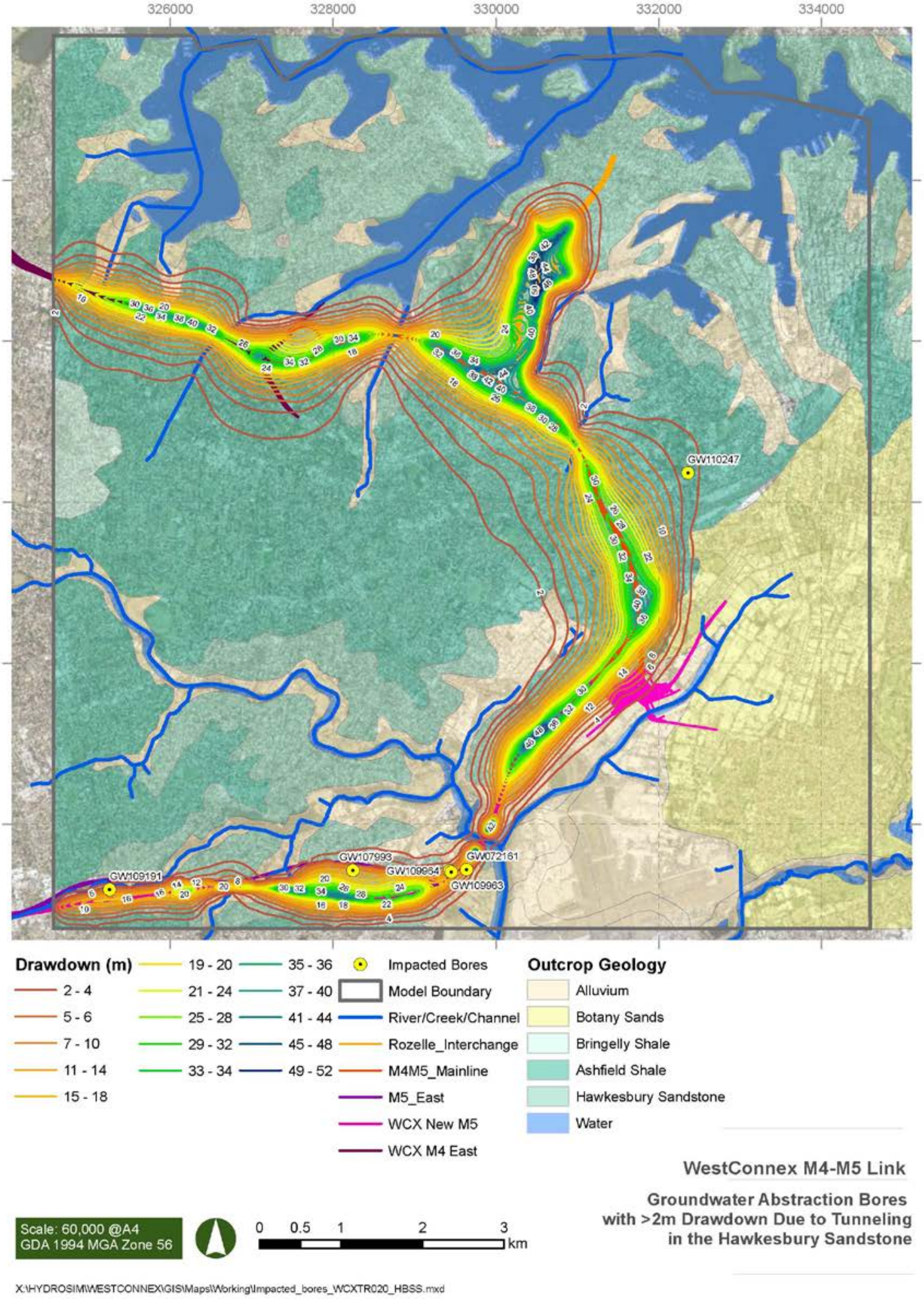

Figure 6-18 Groundwater abstraction bores with >2m drawdown screened in Hawkesbury Sandstone

There are no registered groundwater bores (other than those used for monitoring) near to any of the proposed project changes, therefore no additional bores will be impacted by the late design changes indicated in **Section 2.2.1**.

6.8 PREDICTED IMPACTS ON GROUNDWATER QUALITY

It is not possible to quantify volumes or concentrations of saline[3]/contaminated water entering the tunnels at any given time using the groundwater flow model created for the Project; therefore the following discussion of potential for saltwater intrusion is qualitative only.

The backwards particle tracking analysis undertaken in **Section 5.5** indicates that water from tidal alluvial areas (likely to have similar salinity to seawater) and the western-most area of the Botany Sands (known to have large areas of contamination) will eventually enter the tunnel. The capture zone differs from the drawdown area shown in **Section 6.2.** The reported drawdown reflects the area where the hydraulic gradient has been changed due to tunnelling, while the capture area shows where the water that ultimately enters the tunnel originates from, and is controlled by both regional flow and localised drawdown. All water within the capture zone will at some stage enter the drawdown cone of depression and increase in velocity due to the increased hydraulic gradient towards the tunnel associated with the drawdown. Areas where drawdown brings the groundwater level to below sea level (approximately 0-1 mAHD) will have ingress of water from tidal areas over time due to a reversal of hydraulic gradient away from the natural groundwater discharge areas.

The capture zone indicates that water from the alluvium associated with Parramatta River and its tributaries will be drawn into the M4 East tunnels and the tunnels at Rozelle Interchange. Similarly water from the alluvium associated with Cooks River will enter the New M5 Tunnels and the M4-M5 Link tunnels near St Peters Interchange. The capture for a few particles extends into the very edge of the Botany Sands, however this does not appear to be a dominant source of water to the tunnels (based on a low density of particle traces originating in the Botany Sands).

Table 6-10 summarises the travel times computed from each major alluvial area (and Botany Sands) to the tunnel. These times are based on the end-point time for all path-lines and do not include intermediate times. Saline water from areas of alluvium is predicted to flow into the tunnels in time frames varying from days to thousands of years. Early saline inflows are from water in alluvium directly above and adjacent to the tunnels which is rapidly drained into the tunnels in the areas of Cooks River, Whites Creek and Iron Cove Creek. The volume of saline water is expected to increase with time as water is drawn from more distant areas of the alluvium.

[3] .Note the term "saline" as used in this discussion refers to water of greater quantities of dissolved salts than the average regional water quality due to mixing with tidal waters, and is not representative of a specific range in concentrations

Table 6-10 Travel times from major alluvium areas (backward tracking)

Alluvium Area	Tunnel Entering	Minimum Time	Maximum Time	Average Time
Lower Cooks River / Alexandra Canal	New M5/St Peters Interchange	2 days	150 years	30 years
Wolli Creek	New M5	82 days	150 years	80 years
Parramatta River and Bays	M4 East and M4-M5 Link	>1,000 years	>1,000 years	>1,000 years
Iron Cove Creek	M4 East	15 days	70 years	35 years
Hawthorne Canal	M4-M5 Link	90 days	280 years	75 years
Whites Creek	Rozelle Interchange	8 days	26 years	13 years
Botany Sands	St Peters Interchange, M4-M5 Link	100 days	>1,000 years	>1,000 years

Forward tracking from tidal watercourses has been used to identify where there is potential for water to be drawn towards the tunnels from these saline water bodies, and therefore potential for saline intrusion to occur. **Figure 6-19** and **Figure 6-20** show the travel pathways of water originating in the tidal watercourses. Particle tracking using particles originating at the base of the tidal watercourses verifies the previously discussed backward particle tracking, showing that flow induced towards the tunnels from watercourses ultimately ends up in the tunnels, with the shortest times seen from the lower Cooks River/Alexandra Canal intersection, Whites Creek, Iron Cove Creek and Hawthorne Canal. **Annexure E** contains a series of snapshots in time and highlights the relatively slow migration of saline water towards the tunnels. The majority of water takes over 25 years to travel from the waterways to the tunnels, however there is potential for saline intrusion of water from these watercourses to impact the water quality in areas intermediate between the source and the tunnels within the space of a few years, particularly at Rozelle.

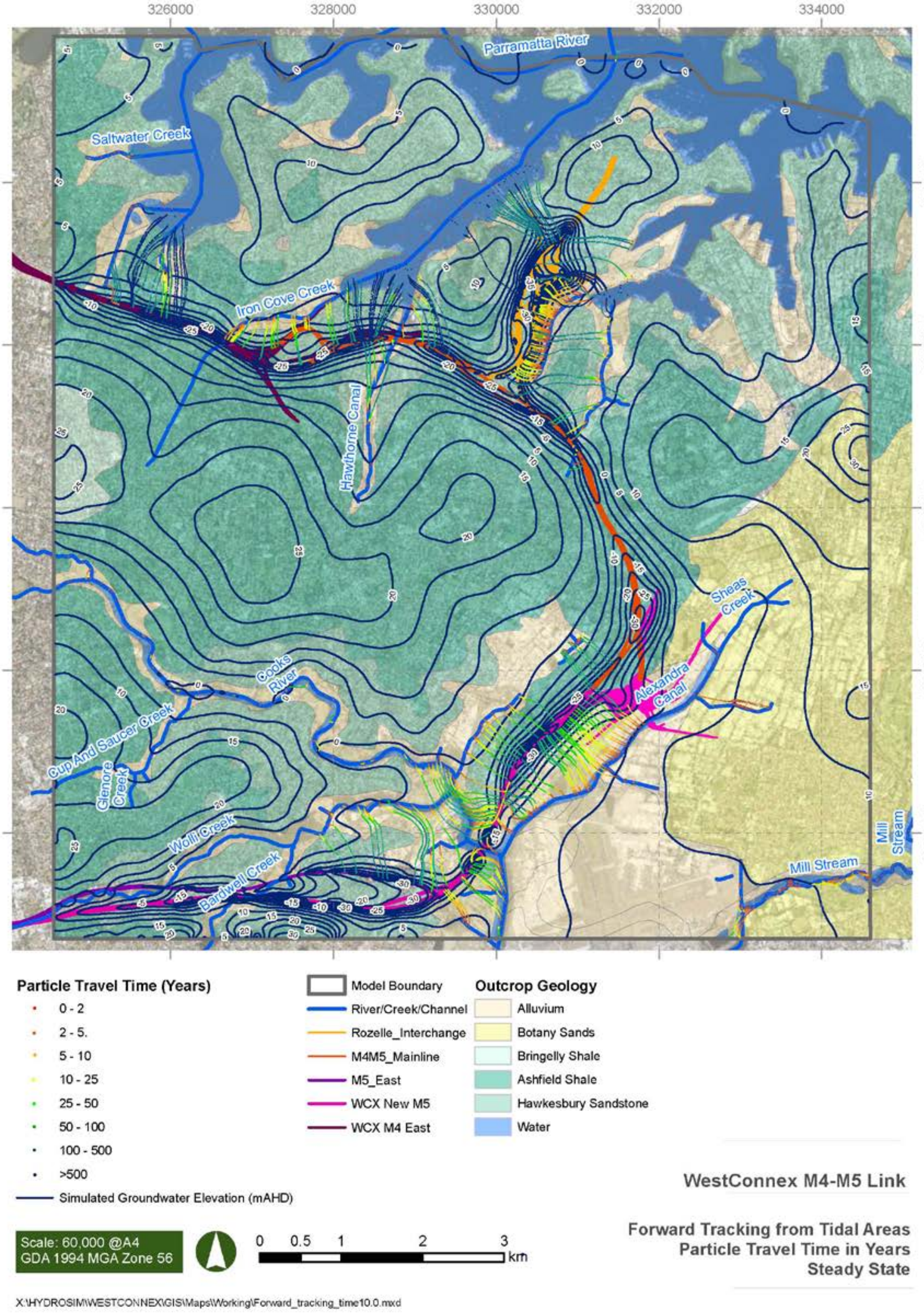

Figure 6-19 Forward tracking from tidal areas showing particle travel time in years

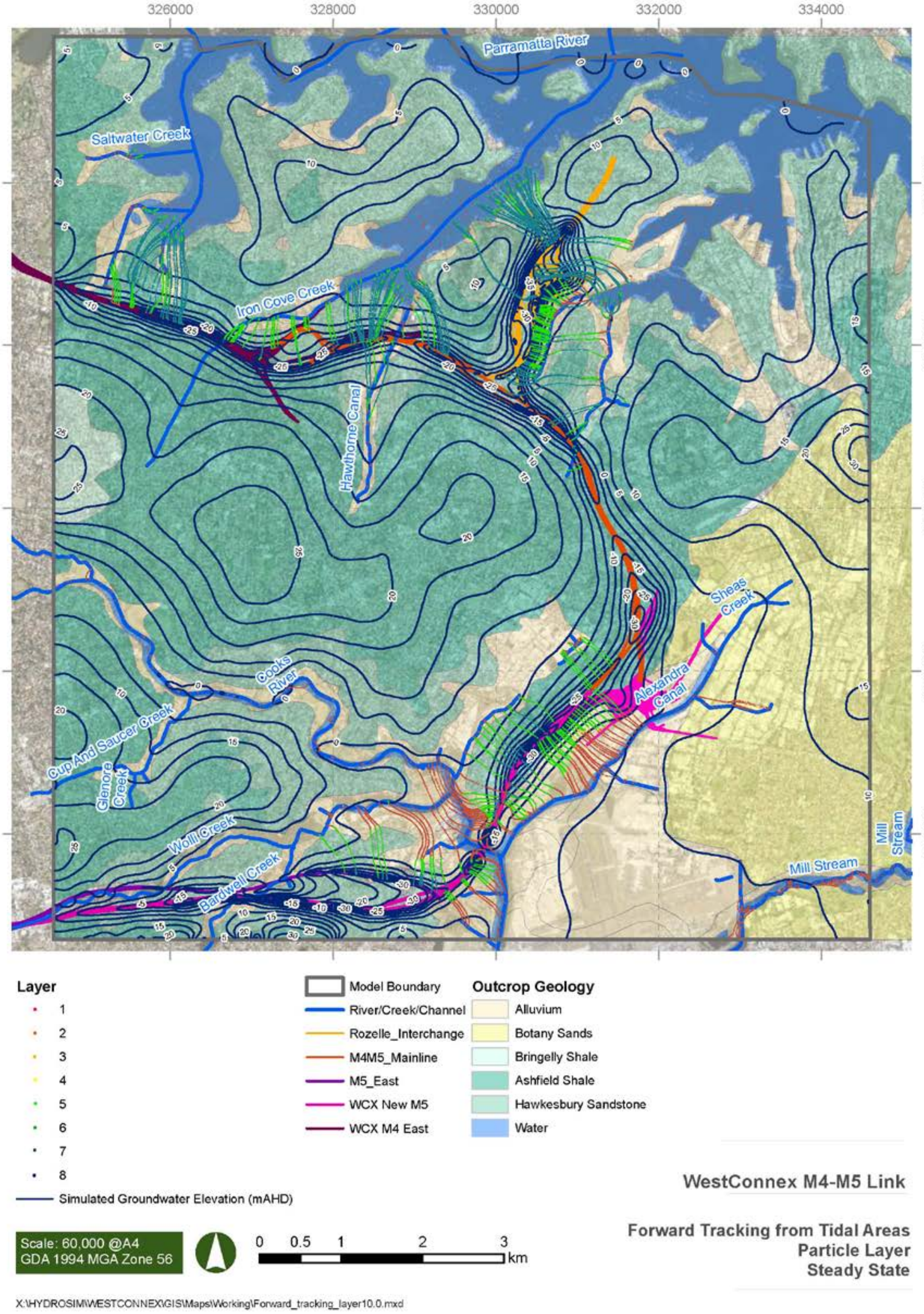

Figure 6-20 Forward tracking from tidal areas showing particle layer

Groundwater inflows to the tunnel should be tested and treated accordingly before disposal, as it is likely the concentration of salts and other contaminants will continue to increase over the operational life of the tunnels as a greater volume of saline water flows towards the tunnels. It is expected however that the contribution of saline water from tidal areas will be relatively small in comparison to overall tunnel inflow, therefore the combined tunnel seepage should not have excessively high salinities. As water entering the tunnels will be treated and then ultimately discharged to watercourses that drain to the tidal water bodies, the salt content of water entering the tunnels is less of an environmental issue and more of an operational/corrosivity issue. The tunnels adjoining St Peters Interchange are likely to see the most risk of saline water seepage due to its proximity to the Botany Sands and the large alluvial /paleochannel feature associated with Cooks River. The capture area and travel times also suggest that the Rozelle Interchange will receive saline water originating in White Bay and Rozelle Bay, and water from the Parramatta River will enter the M4 East tunnels and western extent of the M4-M5 Link Mainline.

7 CONCLUSIONS

A regional scale groundwater model has been prepared by HydroSimulations to provide input to the predicted effects of the M4-M5 Link project required as part of the Technical Groundwater Assessment (AECOM, 2017). The model was also required to consider the cumulative impacts of the earlier stages of WCX (M4 East and New M5).

The model has been built consistent with methods outlined in the *Australian Groundwater Modelling Guidelines* (Barnett *et al.*, 2012) as well as the MDBC Groundwater Flow Modelling Guideline (MDBC 2001), and provides a Class 2 confidence lLevel, which is suitable for its intended use of predicting the impacts of the proposed developments.

The key findings of this assessment are:

- The maximum annual inflow for the M4 East and New M5 components of WCX peaks at 806 ML/year in 2019, which is the final year of tunnel construction for these projects.
- The peak inflow to the M4-M5 Link project (inclusive of ventilation tunnels) does not occur until 2021, where a peak volume of 930 ML/year is obtained (again coinciding with the end of tunnel excavation).
- The cumulative inflow to WCX tunnels at the end of all phases of tunnel construction (end of 2021) is 5.6 GL, and 8.2 GL at project opening (2023).
- Long term tunnel inflow rates are 0.44 L/sec/km for combined M4 East and New M5 projects, and 0.24 L/sec/km for the M4-M5 Link project based on overall tunnel lengths of 32.5 km and 41.5 km respectively (inclusive of tunnels in two directions for the mainline and interchanges). This is well below the maximum allowable rate of 1 L/sec/km.
- Drawdown is expected to remain localised to the tunnel alignments, with a maximum modelled drawdown extent of less than 800 m either side of the alignment (near to Newtown) for all layers at project opening (2023), extending to 1.5 km at the end of the long-term model prediction (2100).
- The M4 East and New M5 projects reduce the baseflow input to Iron Cove Creek and Bardwell Creek by 38% and 21% respectively at the end of construction, with minimal to no impacts in any of the other streams. The M4-M5 phase of WCX adds a further 5% baseflow reduction to Iron Cove Creek, as well as reducing baseflow to Hawthorne Canal by 32%, Whites Creek by 75% and Johnstons Creek by 20%.
- The baseflow to the watercourses continues to reduce over time as the drawdown propagates away from the tunnels, with cumulative impacts of a 48% reduction in baseflow to Hawthorne Canal, 56% reduction to Iron Cove Creek, 28% to Johnstons Creek, 22% to Bardwell Creek and an 83% loss of baseflow to Whites Creek which is situated below the Rozelle Interchange. However it is important to note that the baseflow contribution to stream flow is expected to be very small due to the channels being concrete lined, with the majority of flow coming from tidal supplied water and surface runoff. Therefore the loss in baseflow is not expected to have a significant impact on overall flow.
- There are no high priority GDEs in the study area. Six locations identified by BoM as being potential GDEs would experience predicted drawdowns of greater than 2 m if they were in contact with the regional water table, however none of the GDEs are considered as having a high potential for groundwater interaction. All of the affected

GDEs are located in the vicinity of the New M5 and no predicted impacts to these locations are associated with the M4-M5 Link project.

- Drawdown due to the construction and operation of the overall WCX works is expected to have drawdown greater than 2 m at 11 registered groundwater abstraction bores (GW110247, GW02109, GW109965, GW108406, GW109966, GW108588, GW072161, GW109964, GW109963, GW107993 and GW109191) screened within the alluvium or Hawkesbury Sandstone. Only one of these bores (GW110247 located at Sydney University) is predicted to have drawdown directly attributable to the M4-M5 Link project, the other bores being impacted by the New M5.
- Capture zone analysis qualitatively suggests groundwater from tidal alluvium areas (assumed to have a high salinity due to direct connection with water bodies with concentrations at or approaching sea water) is likely to enter the tunnels. The first saline water would enter a tunnel within a few days to weeks in areas where a tunnel underlies alluvium (e.g. near Cooks River, Whites Creek and Iron Cove Creek). This would increase in volume (and therefore overall concentration) with time as water is increasingly drawn towards the tunnel from further afield. The drainage of groundwater from saline water bodies is expected to increasingly reduce the groundwater quality over time in the aquifers between the sources and the tunnels. However, the actual concentrations of water over time is not able to be quantified with this groundwater flow model.
- Due to time restrictions, minor changes to the project that were made after completion of groundwater modelling have been qualitatively assessed. These changes include a small increase in the length of tunneling for entry/exit ramps at Parramatta Road and bifurcation of tunnels at Haberfield, Leichhardt and St Peters to allow for smoother traffic flow between intersections. It is expected that there will be a small increase in groundwater inflow volume and the extent of drawdown local to the project alterations, however these increases are expected to be relatively minor. It is not anticipated that these changes would result in any additional impacts to groundwater users or GDEs due to the location of the changes relative to the potential receptors. Any changes in stream flow due to the changes would be negligible.

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ANNEXURE A – TRANSIENT CALIBRATION HYDROGRAPHS

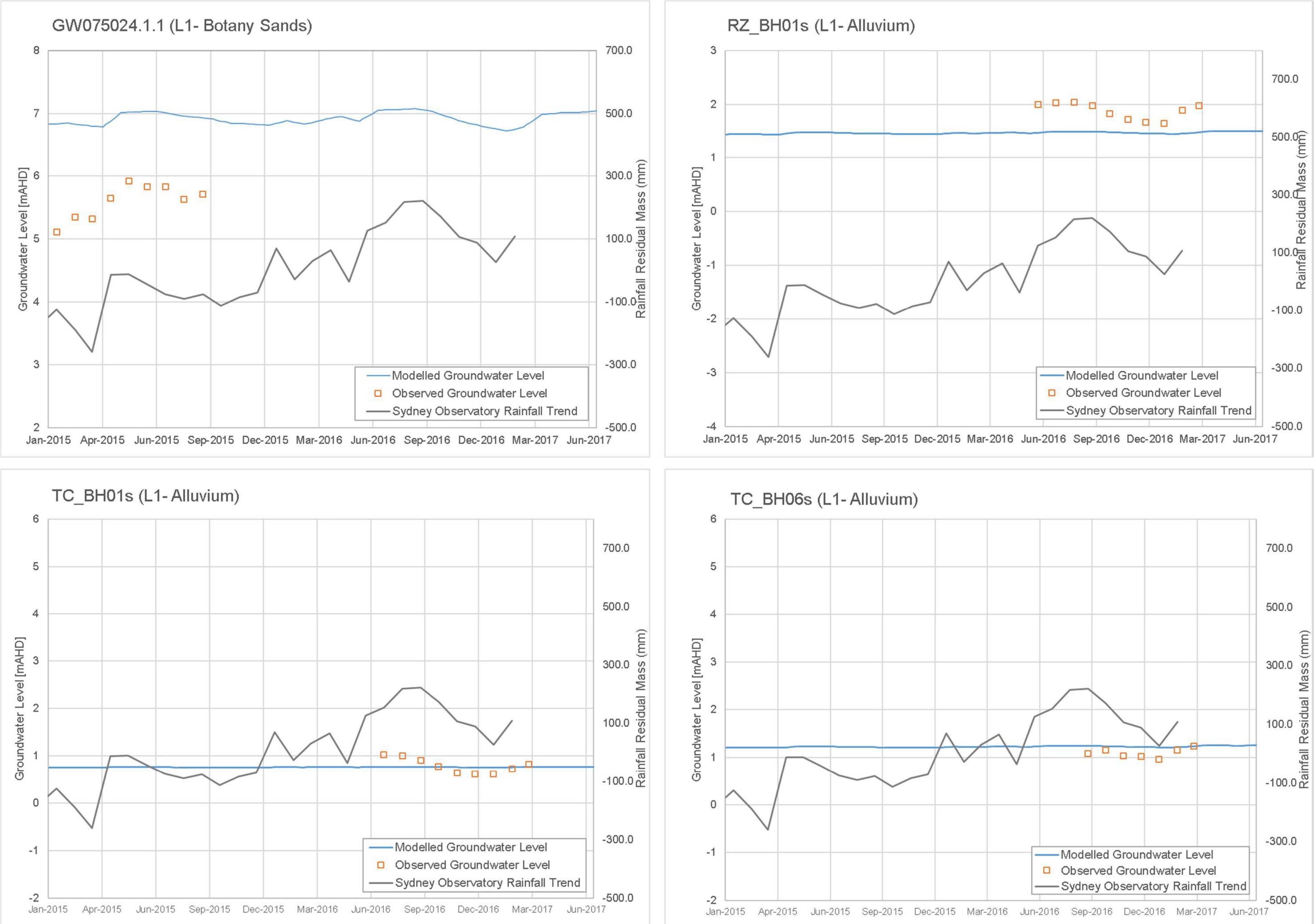


Figure A 1 - Calibration Hydrographs (Layer 1)

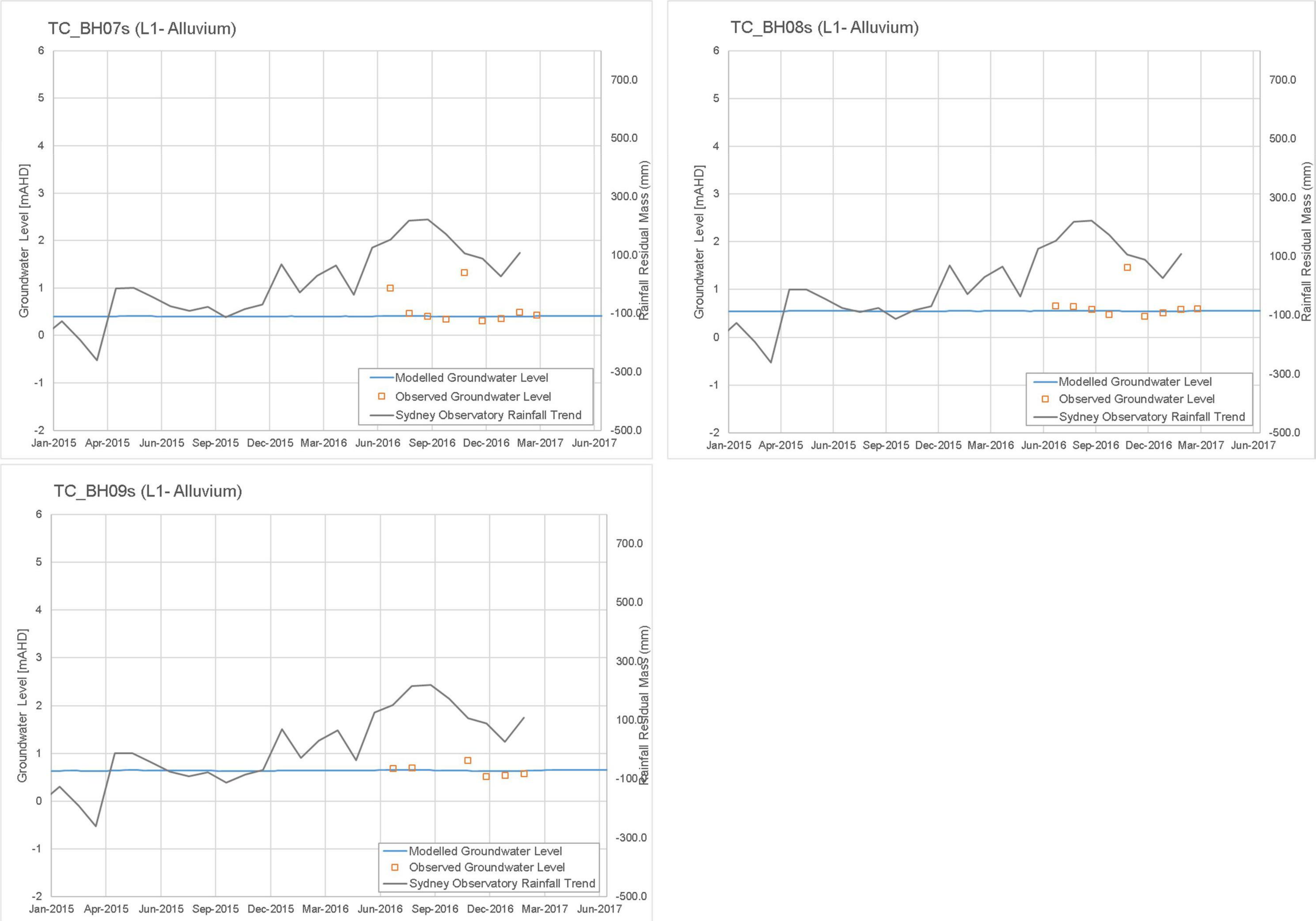


Figure A 2 - Calibration Hydrographs (Layer 1)

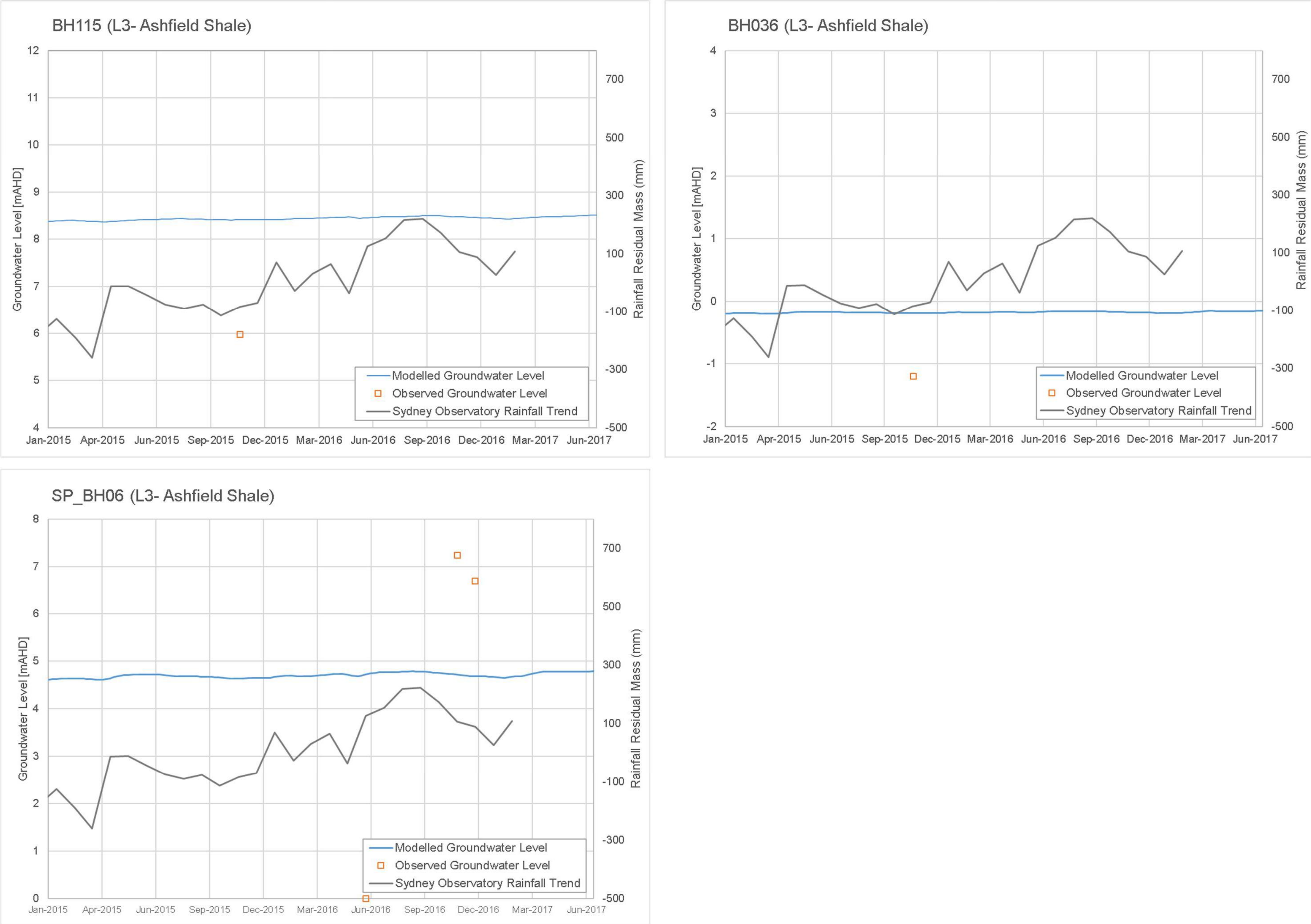
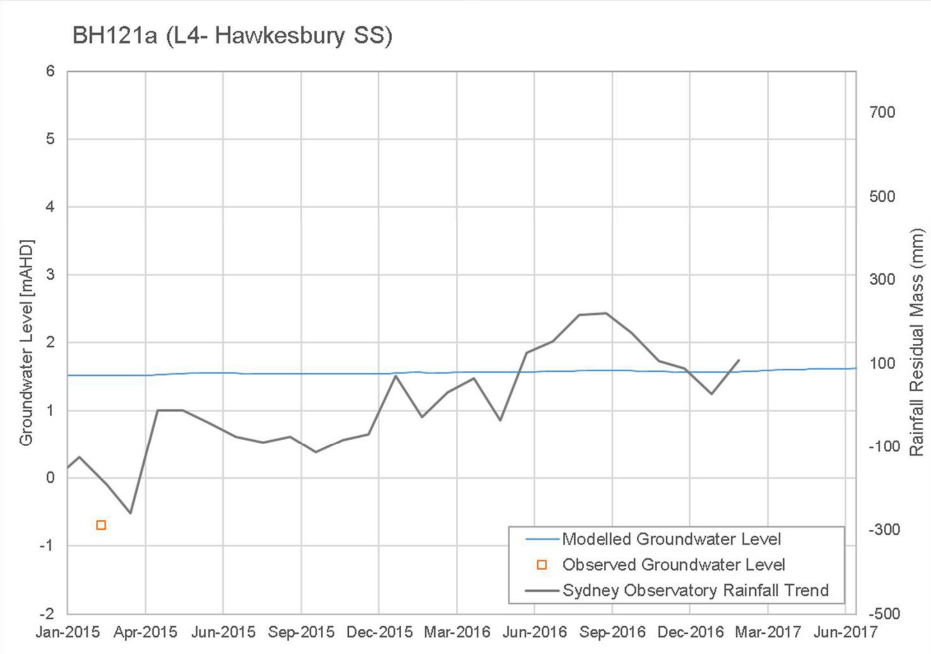
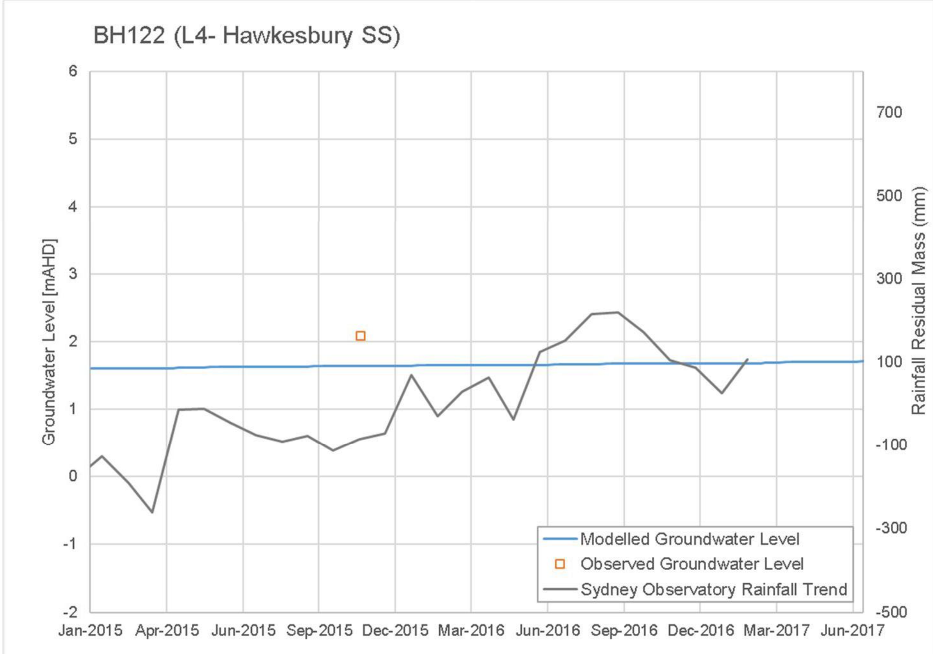
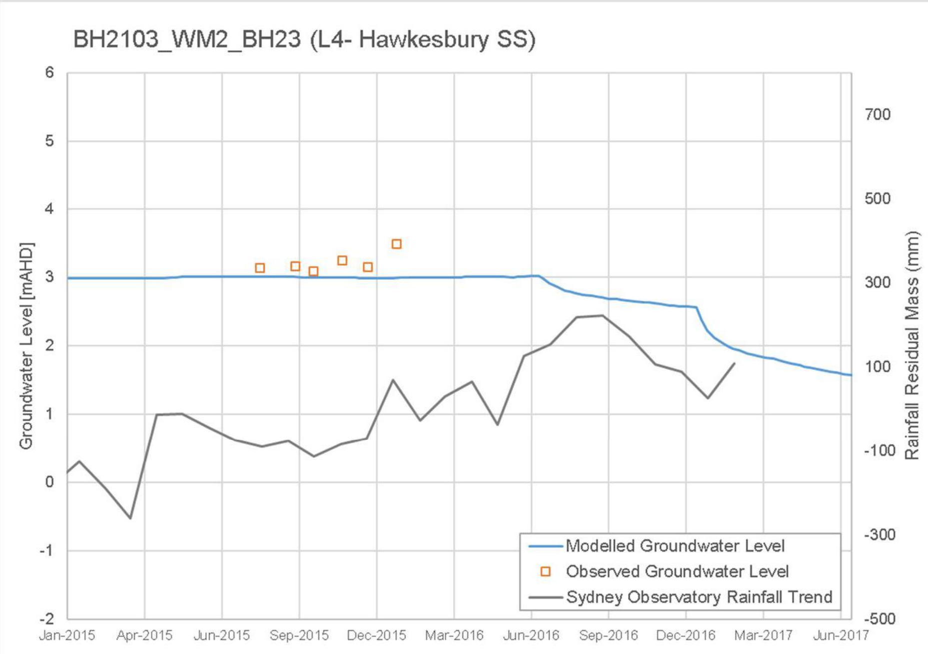
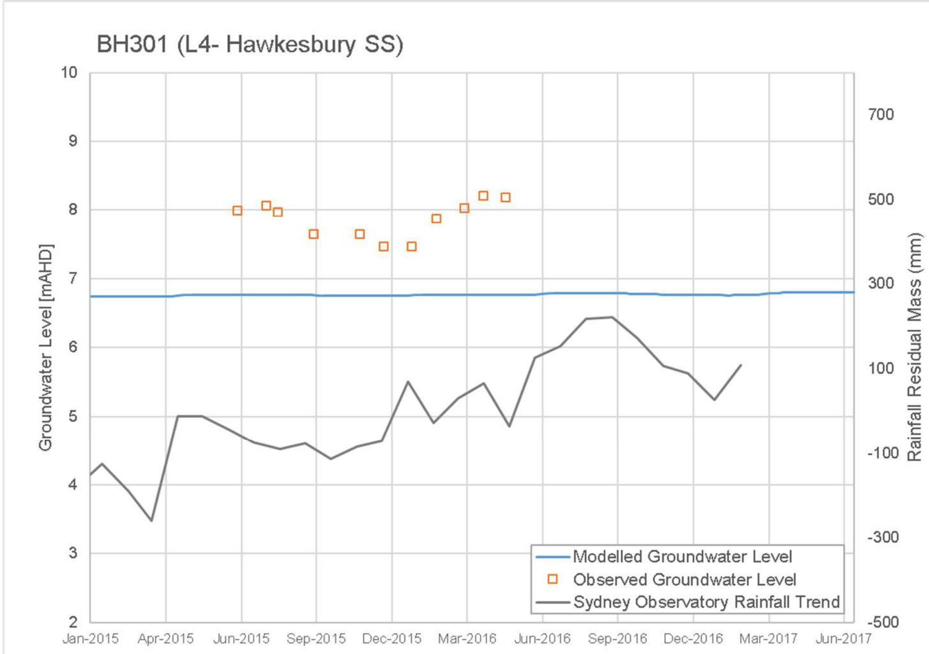


Figure A 3 - Calibration Hydrographs (Layer 3)









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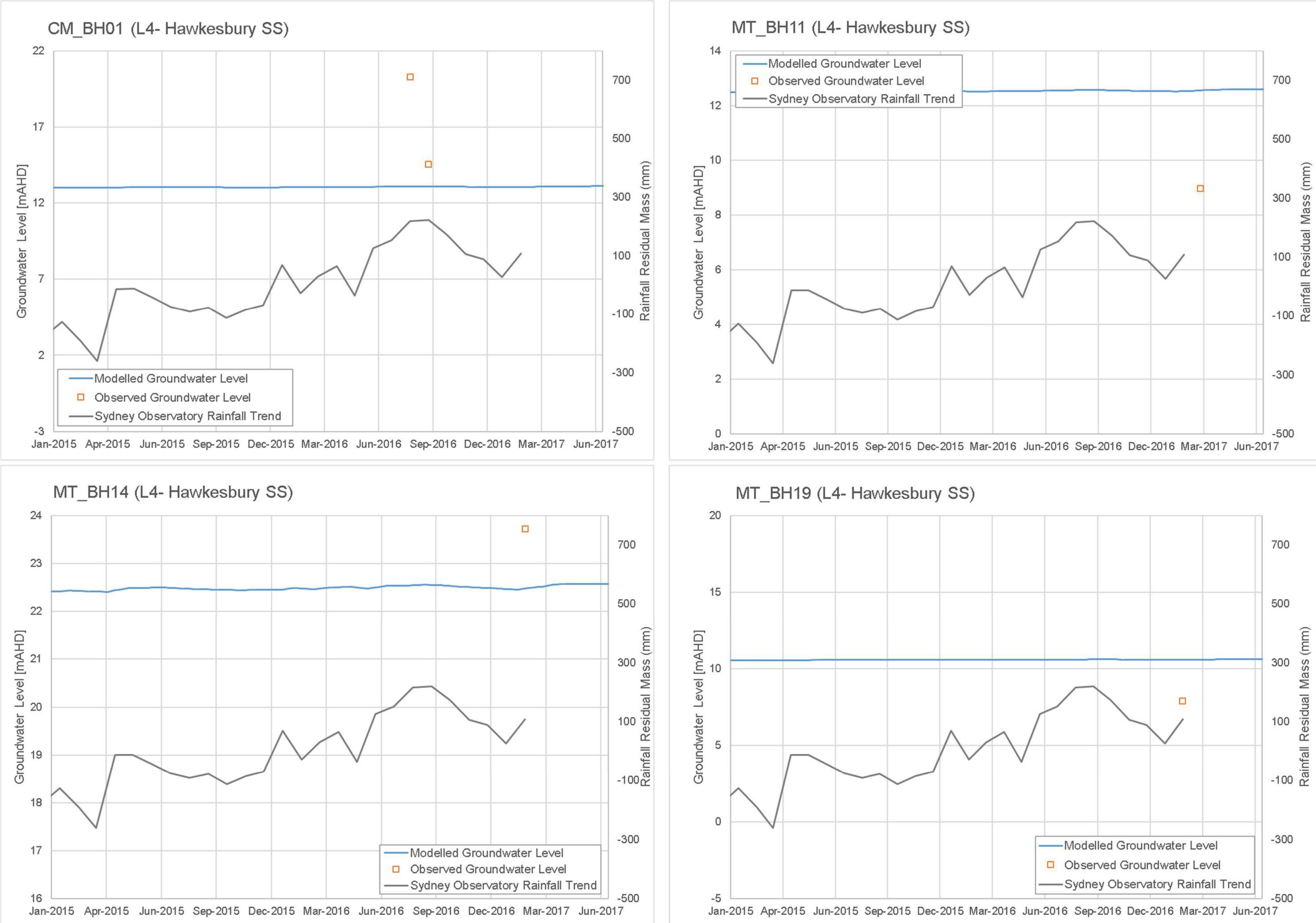

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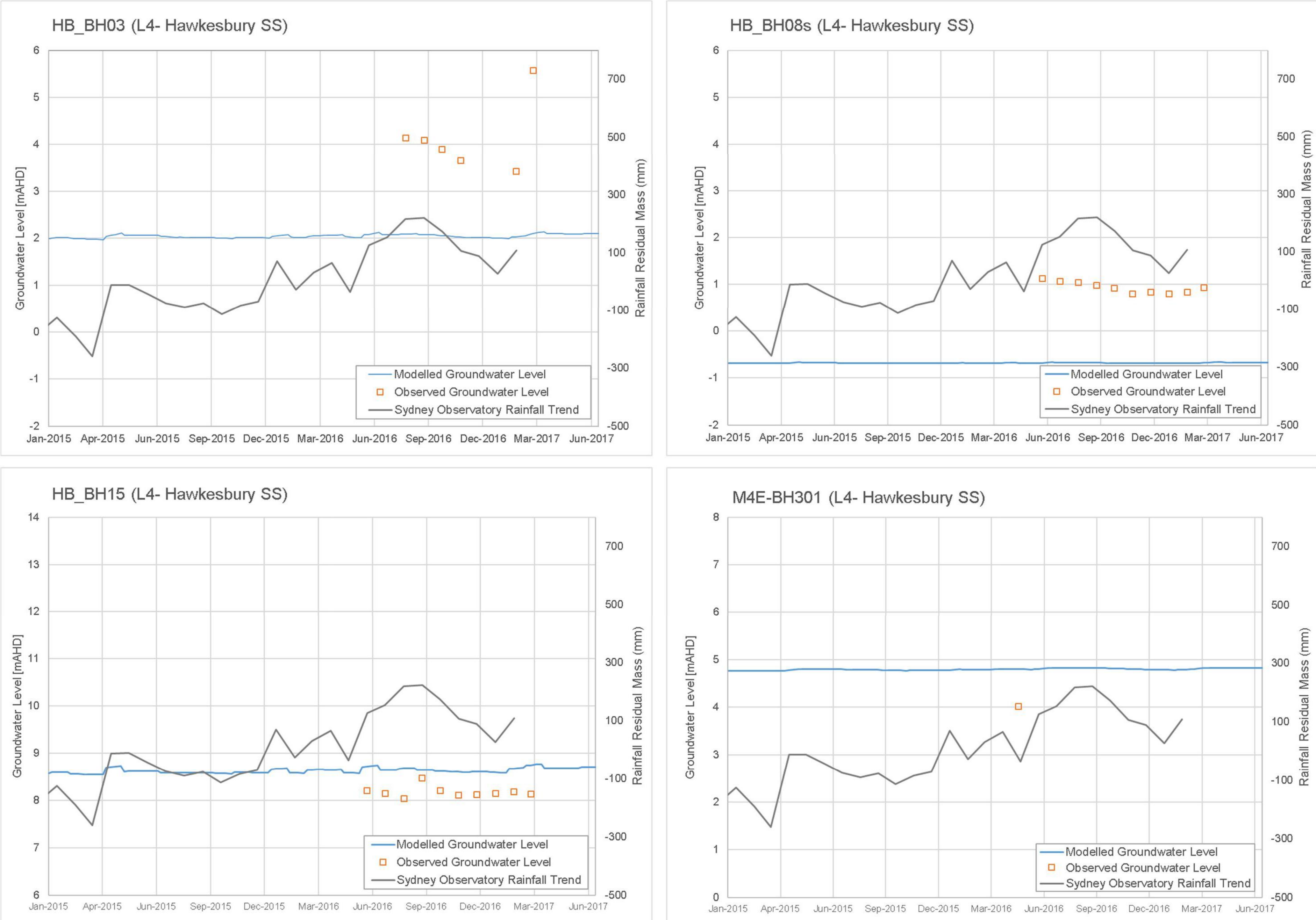


Figure A 6 - Calibration Hydrographs (Layer 4)

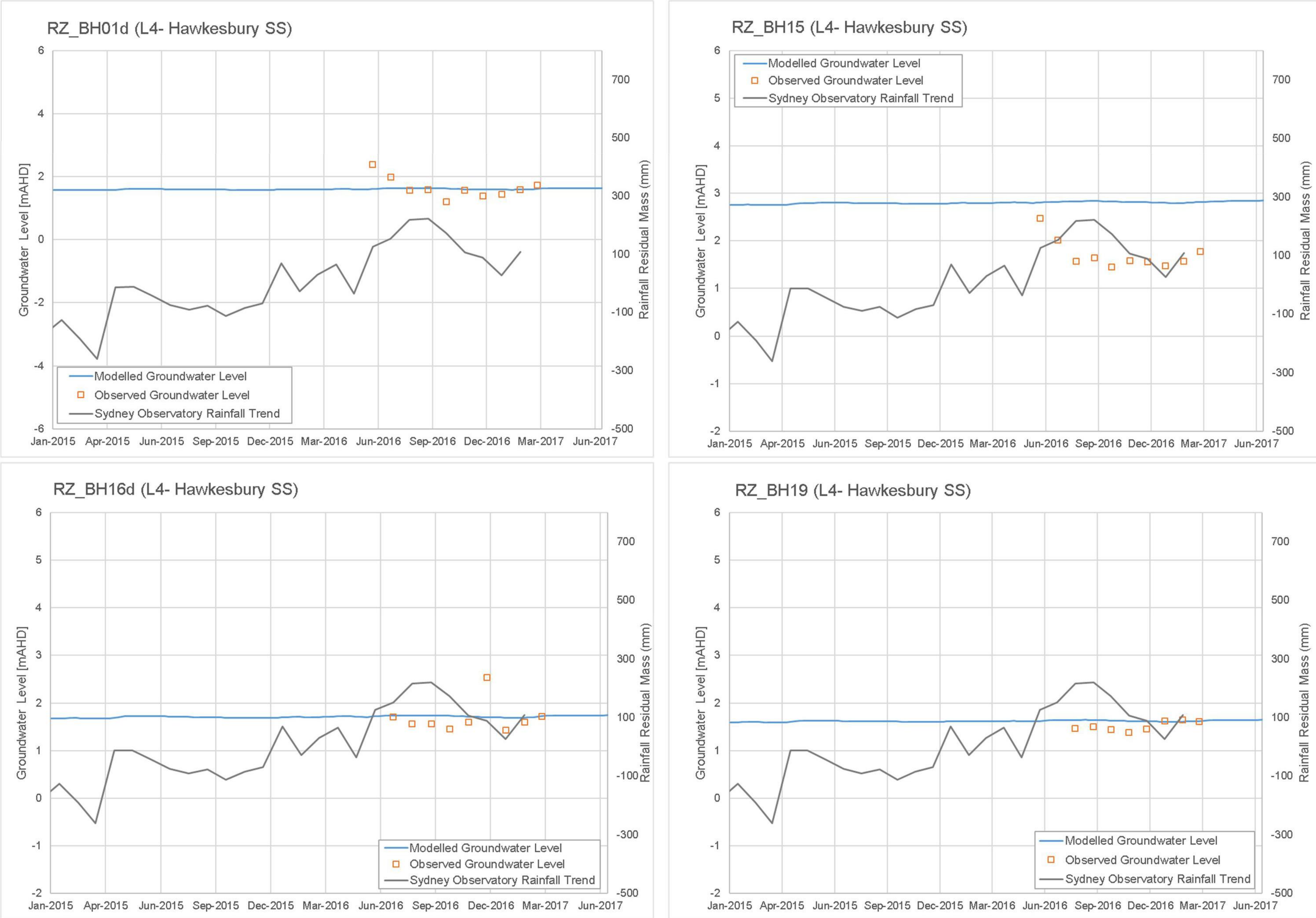


Figure A 7 - Calibration Hydrographs (Layer 4)

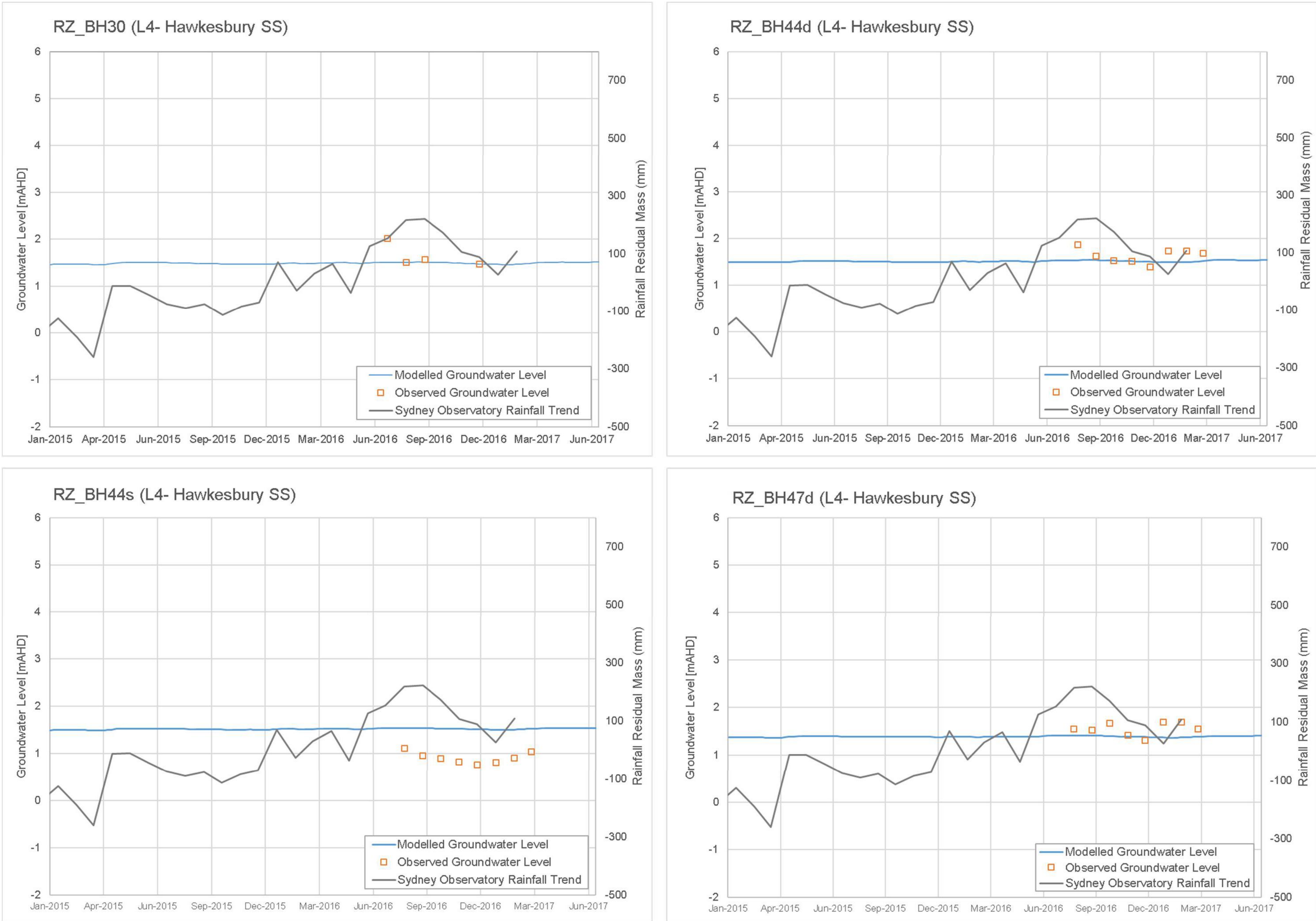


Figure A 8 - Calibration Hydrographs (Layer 4)

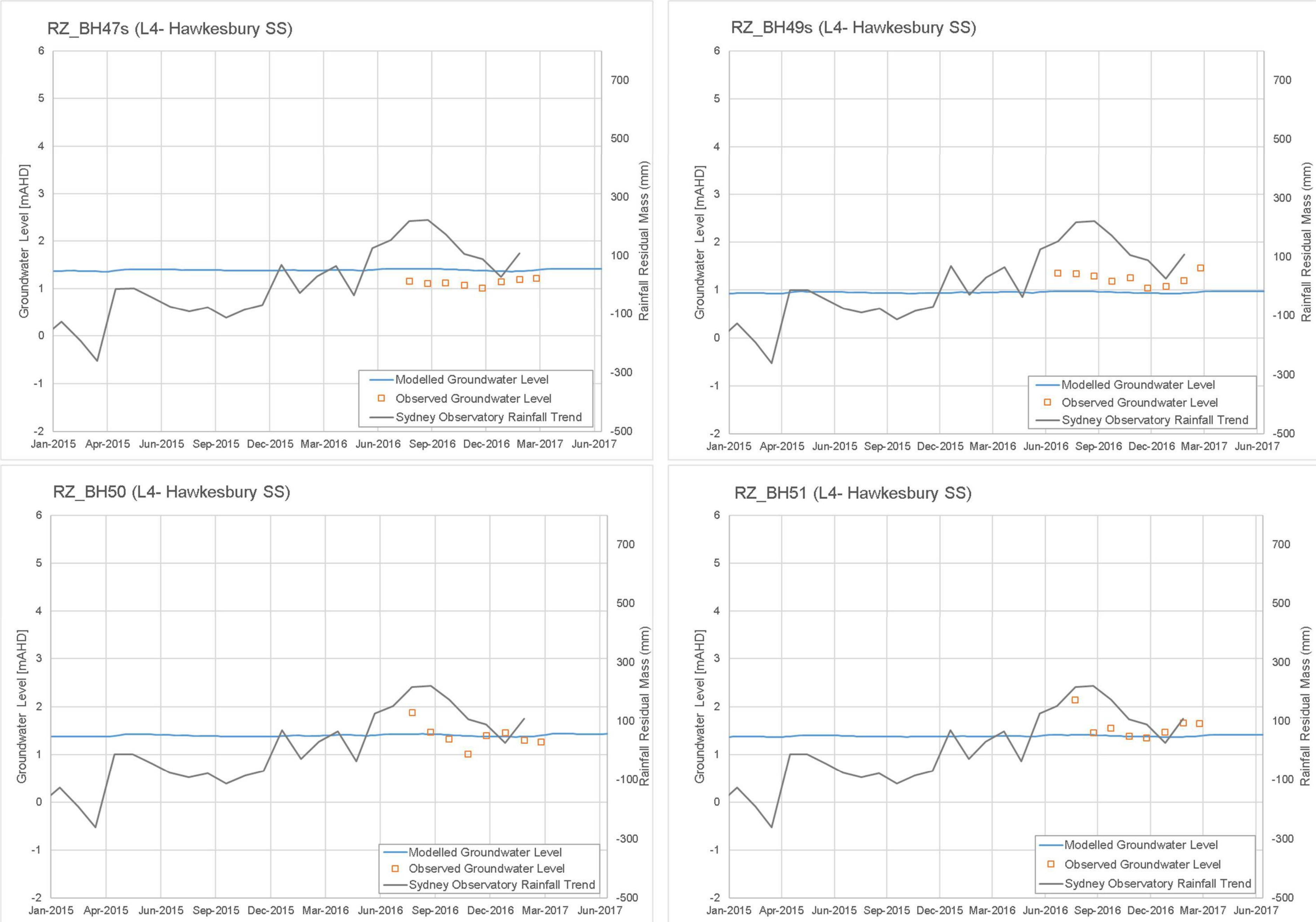


Figure A 9 - Calibration Hydrographs (Layer 4)

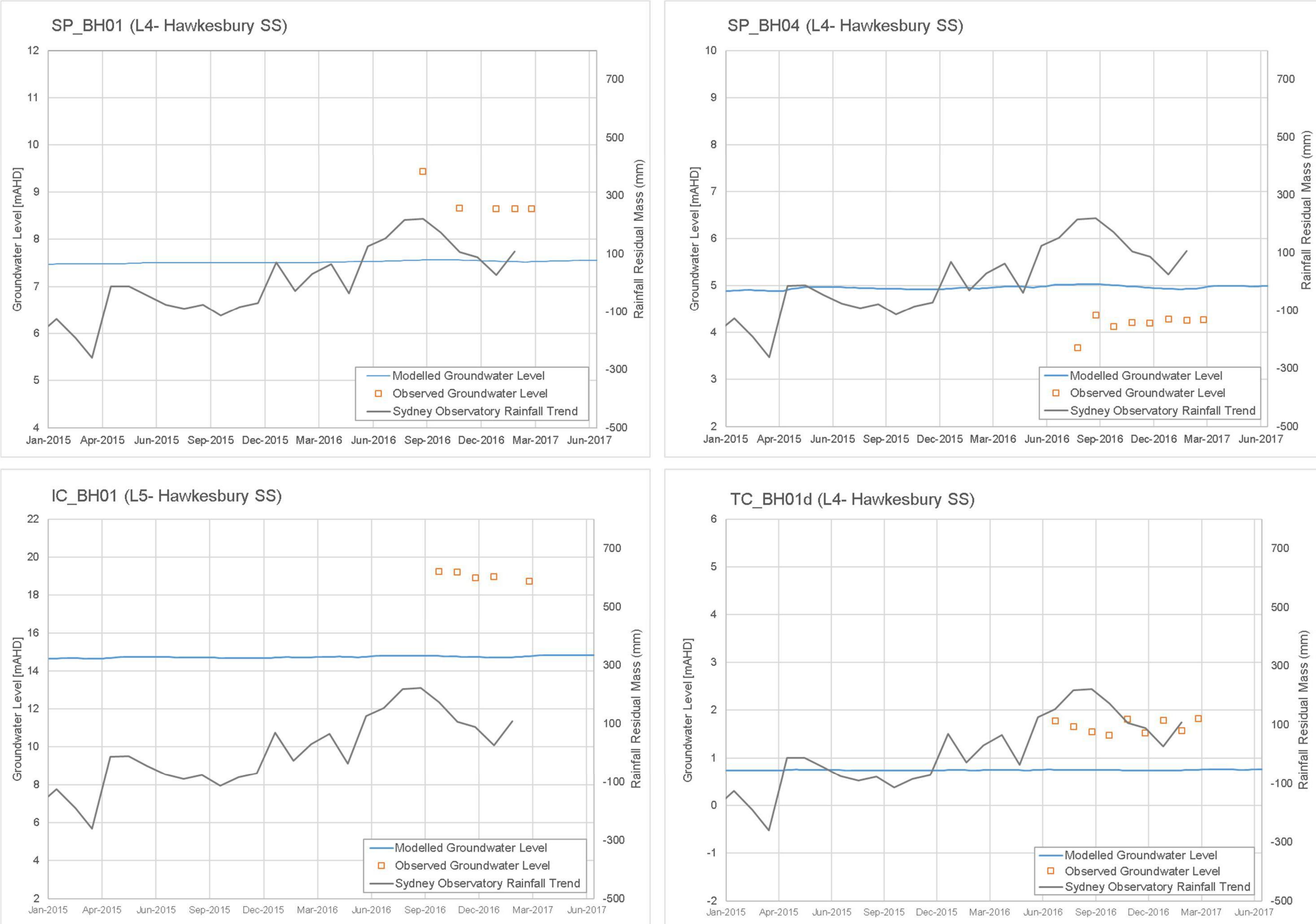
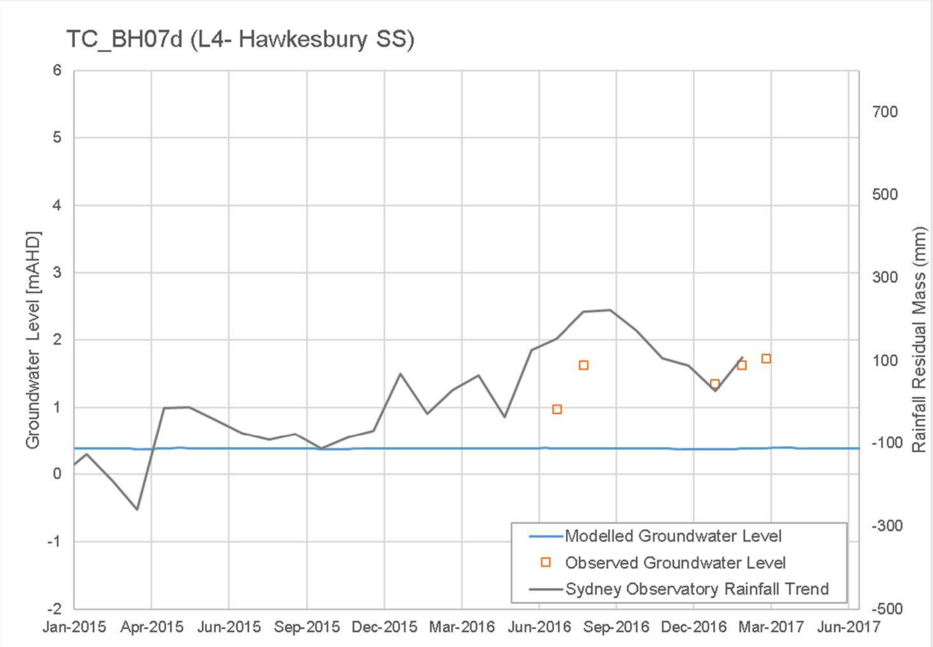
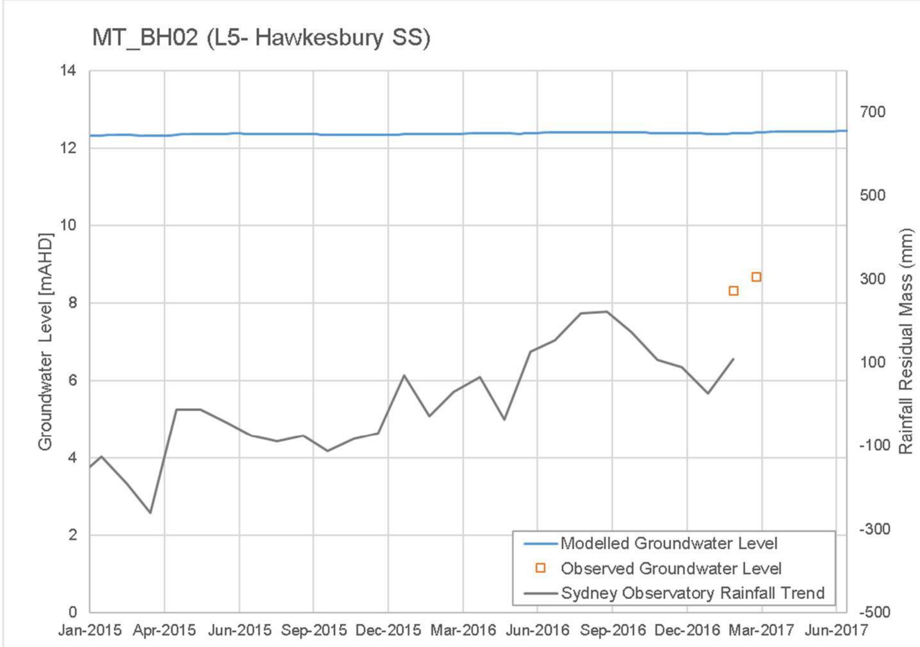


Figure A 10 - Calibration Hydrographs (Layer 4)





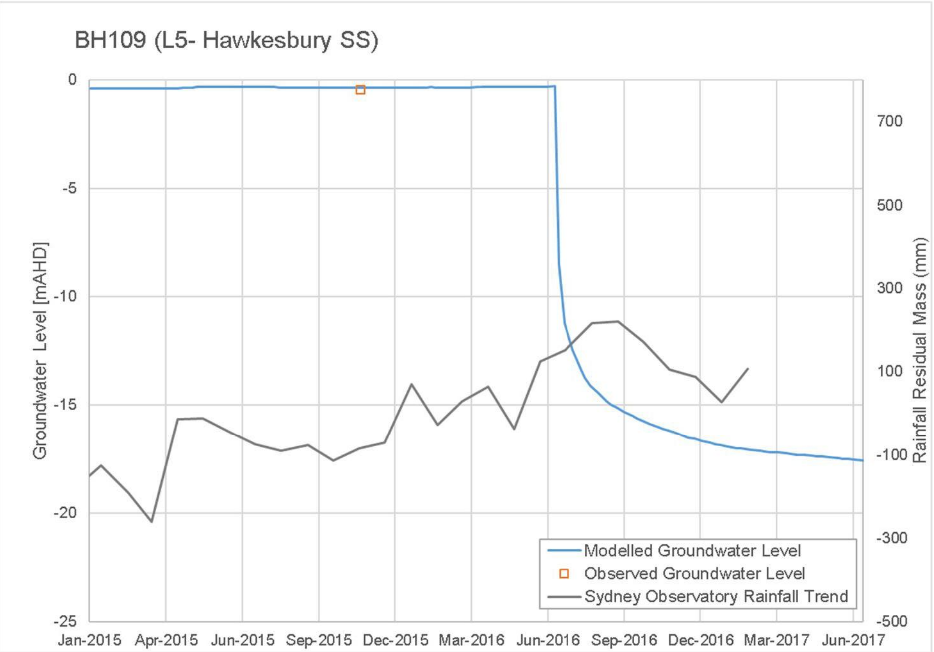


Figure A 11 - Calibration Hydrographs (Layer 4 & Layer 5)

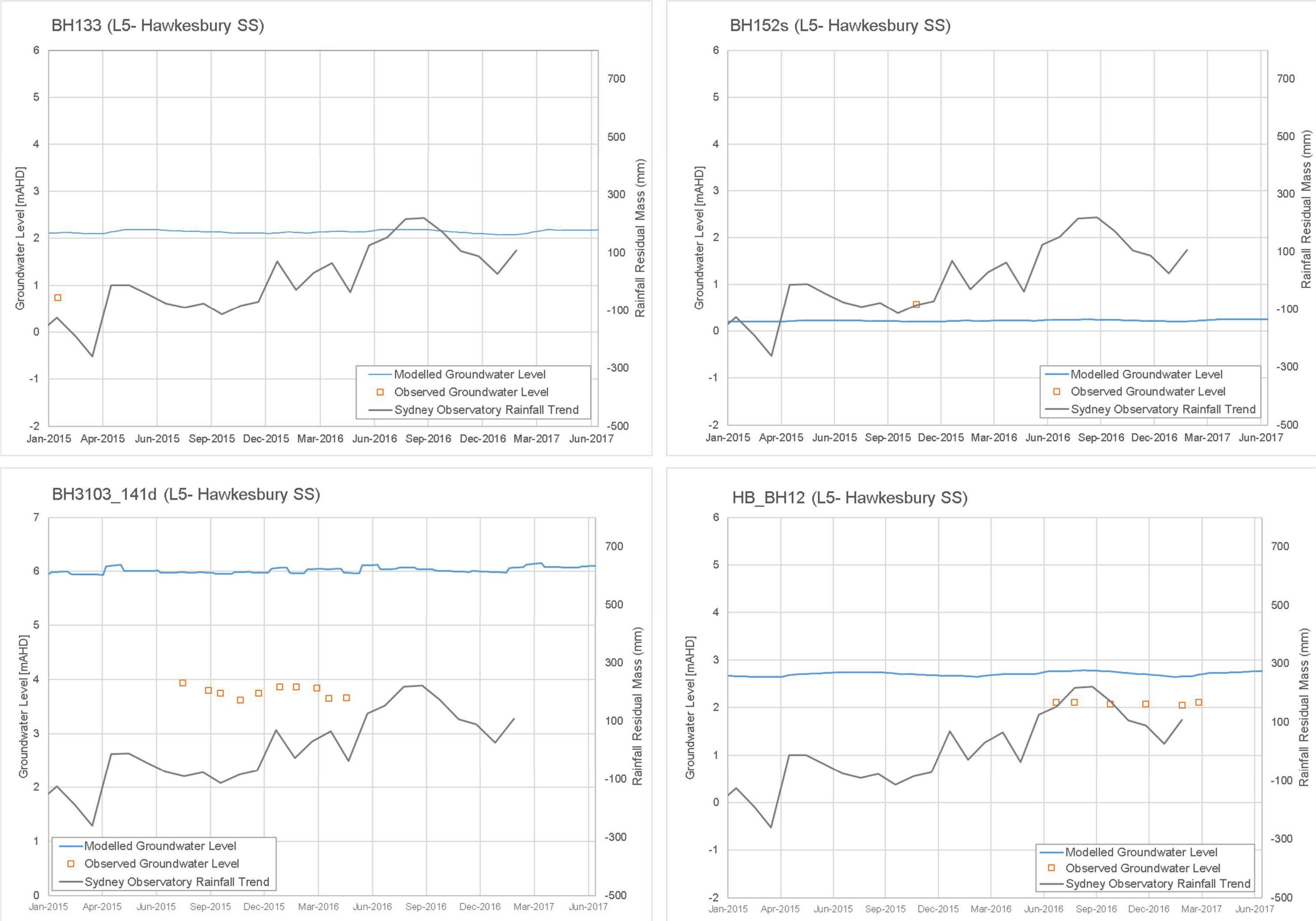


Figure A 12 - Calibration Hydrographs (Layer 5)

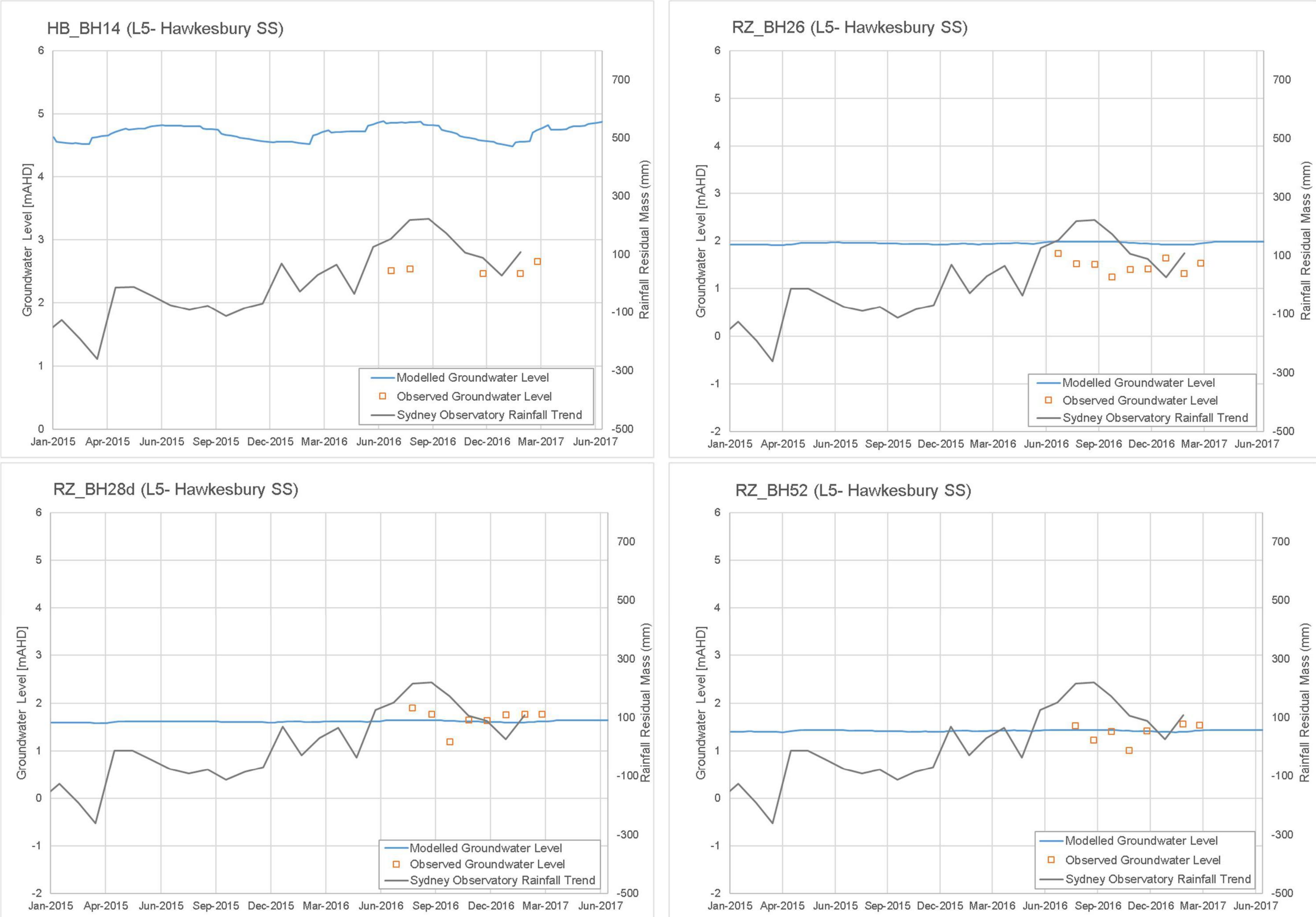


Figure A 13 - Calibration Hydrographs (Layer 5)

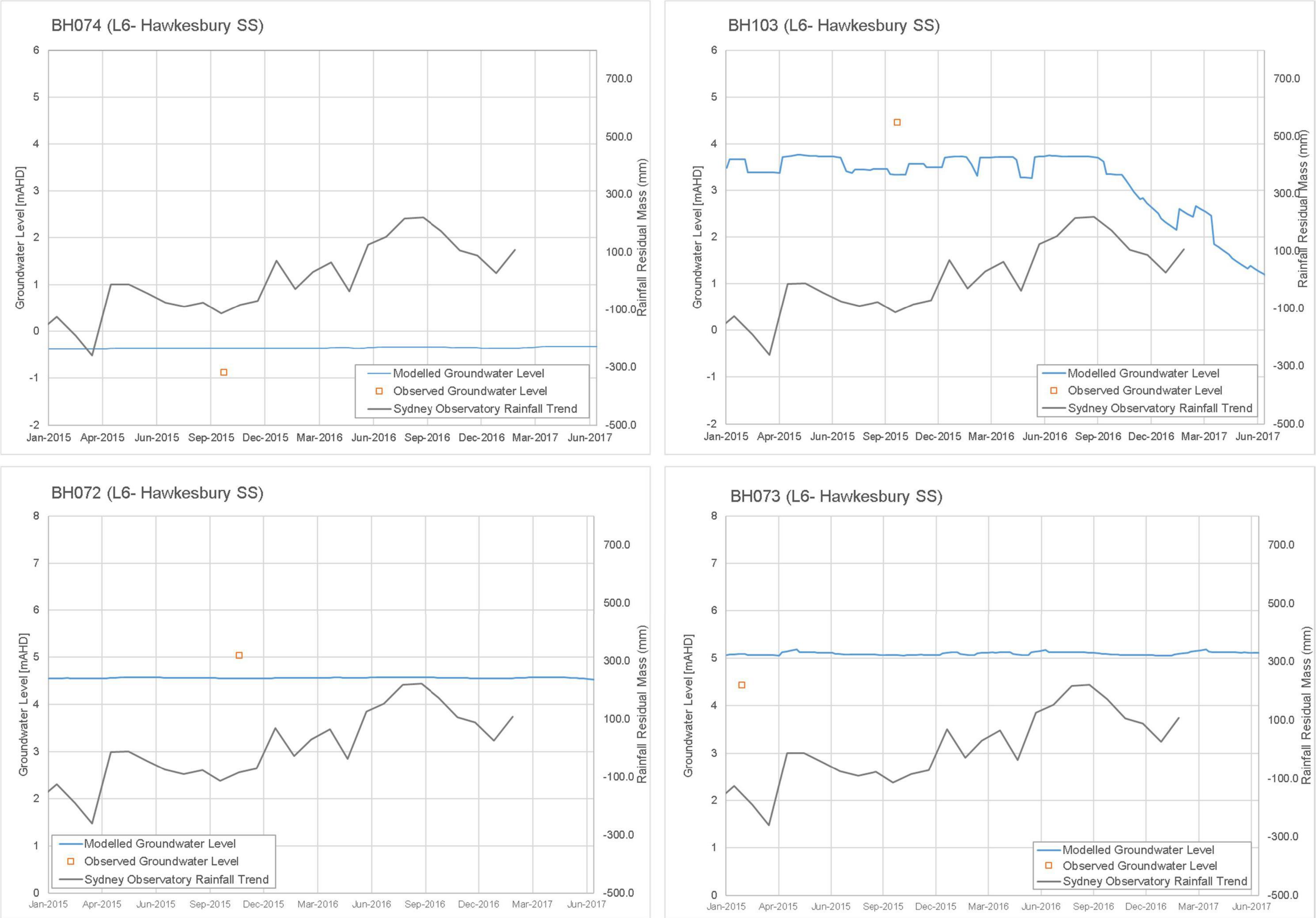


Figure A 14 - Calibration Hydrographs (Layer 6)

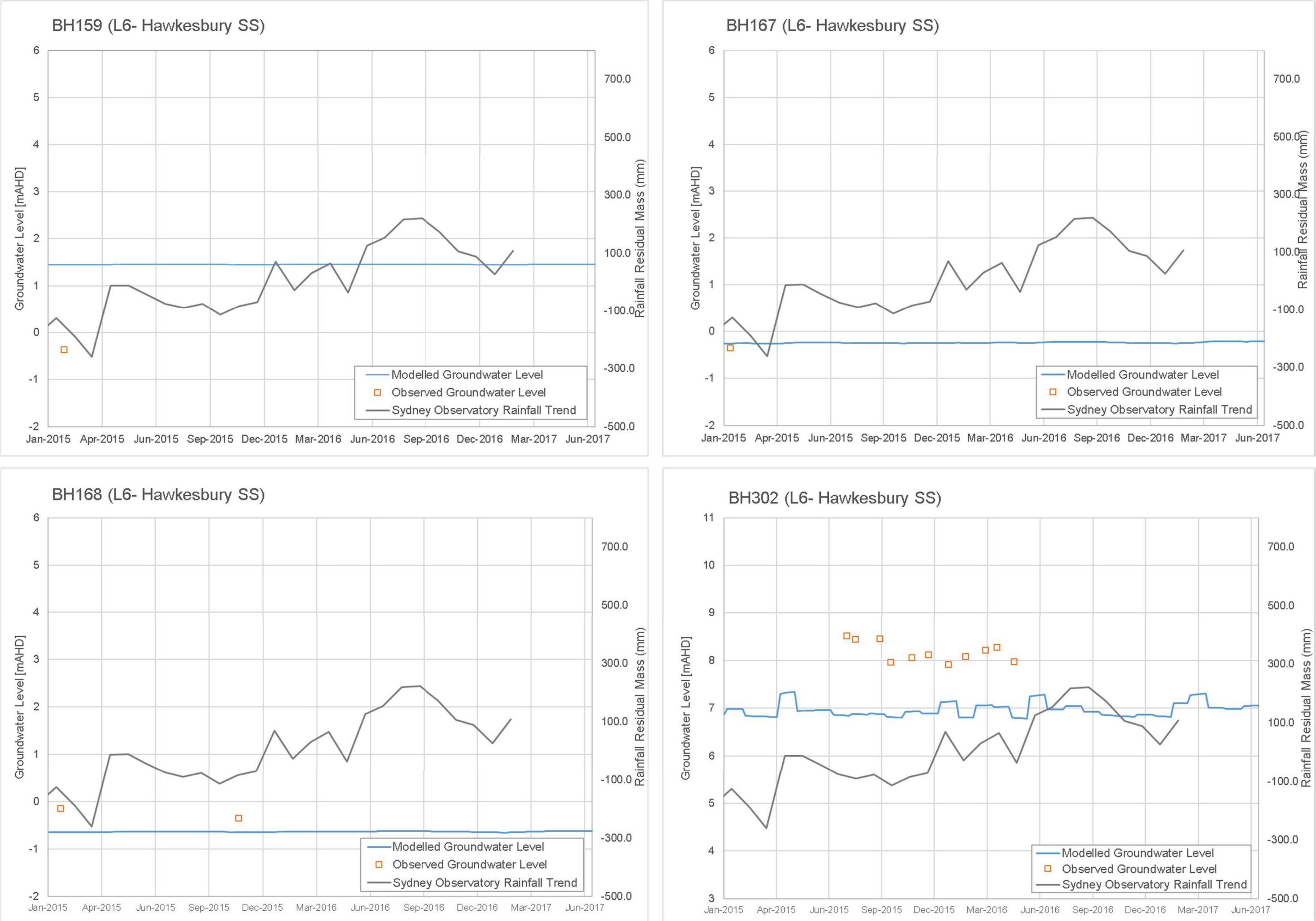


Figure A 15 - Calibration Hydrographs (Layer 6)

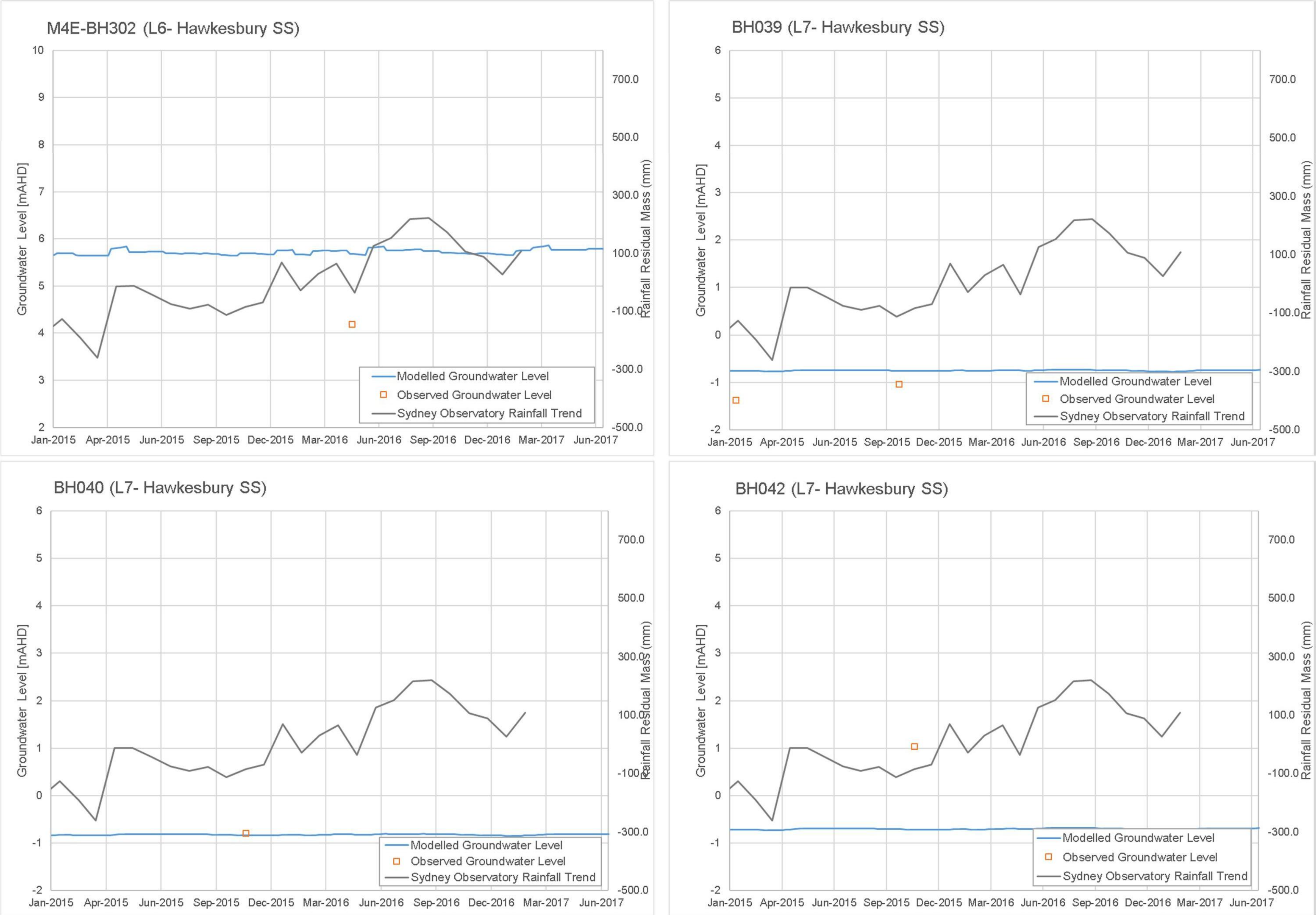


Figure A 16 - Calibration Hydrographs (Layer 6)

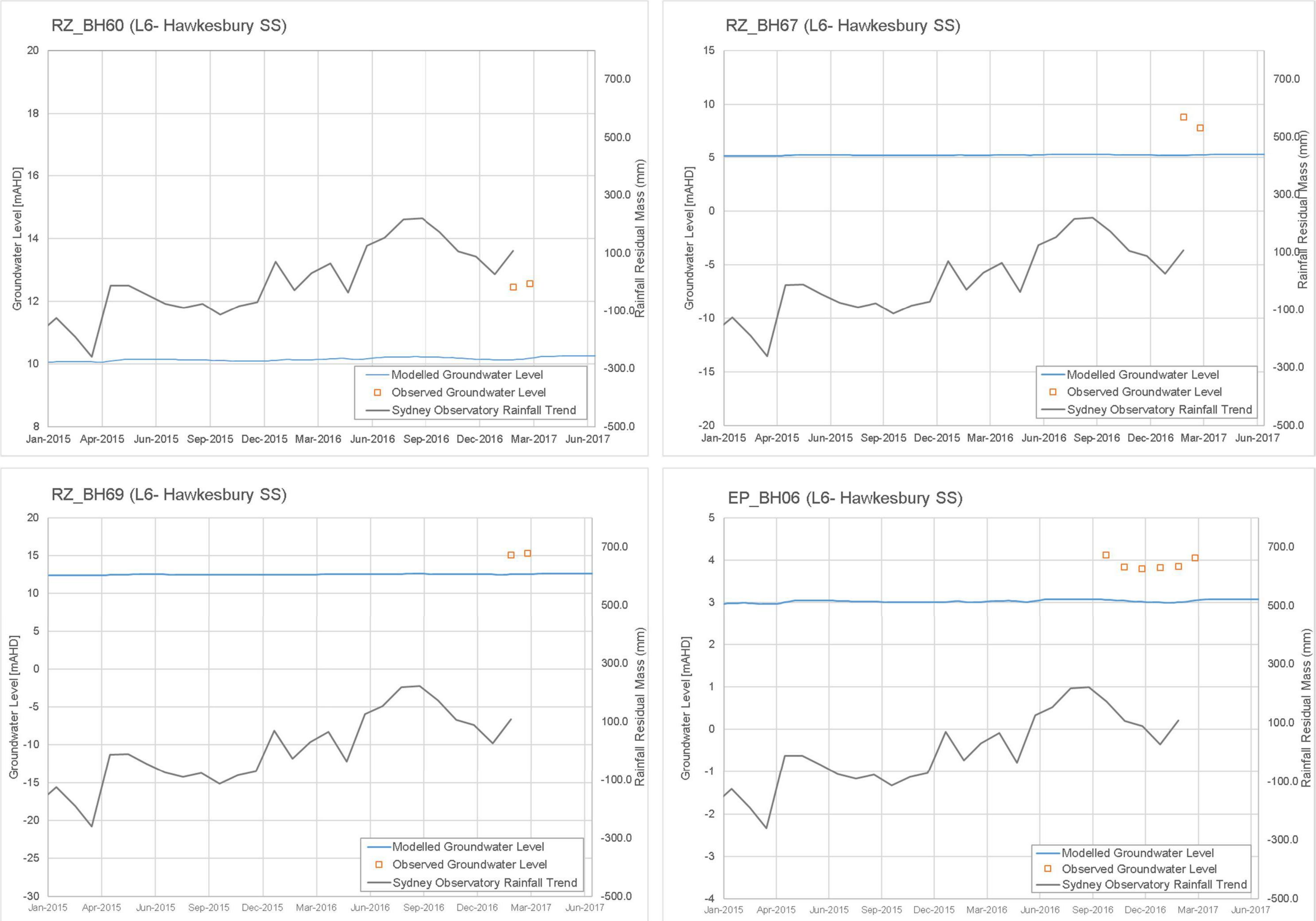
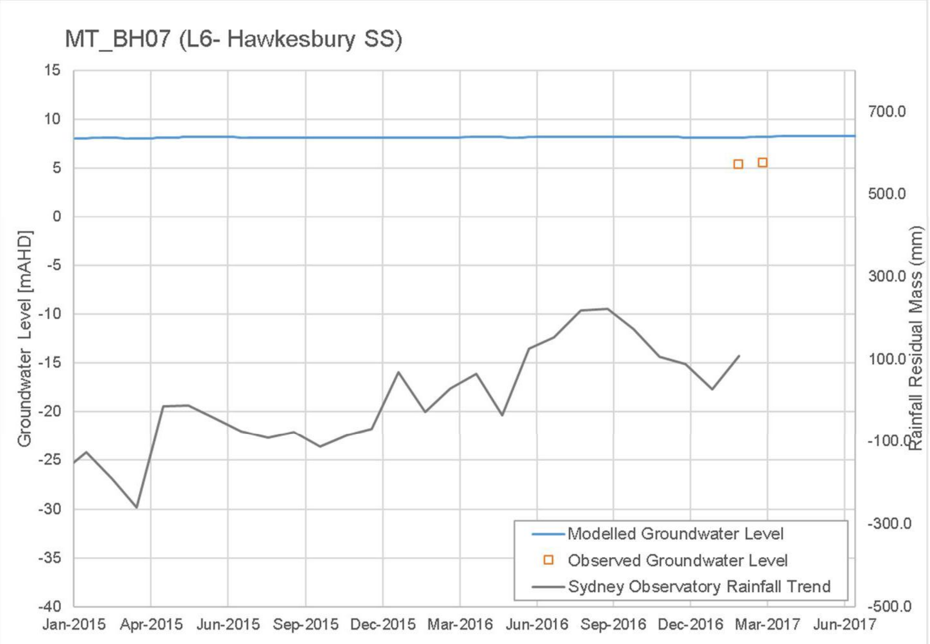
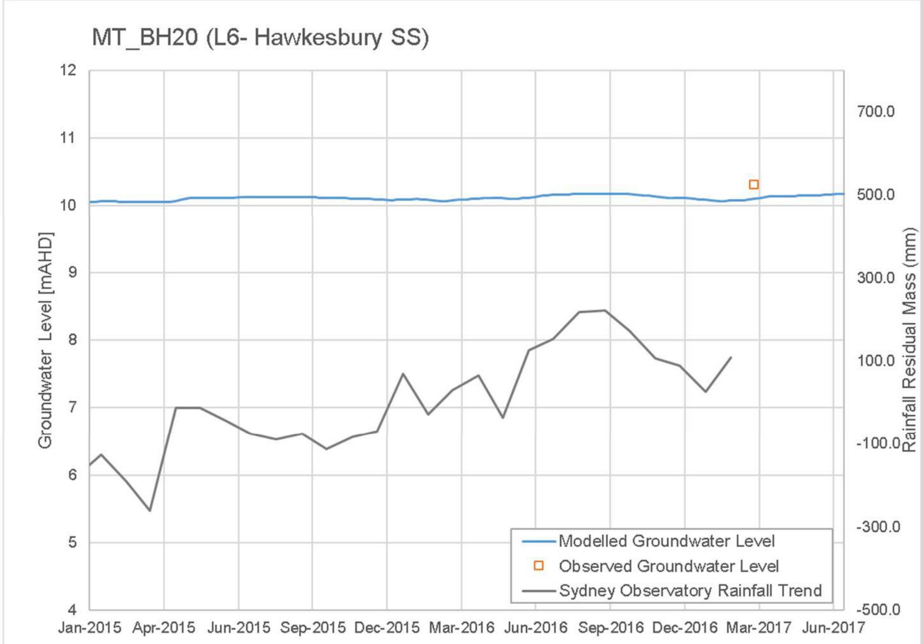


Figure A 17 - Calibration Hydrographs (Layer 6)





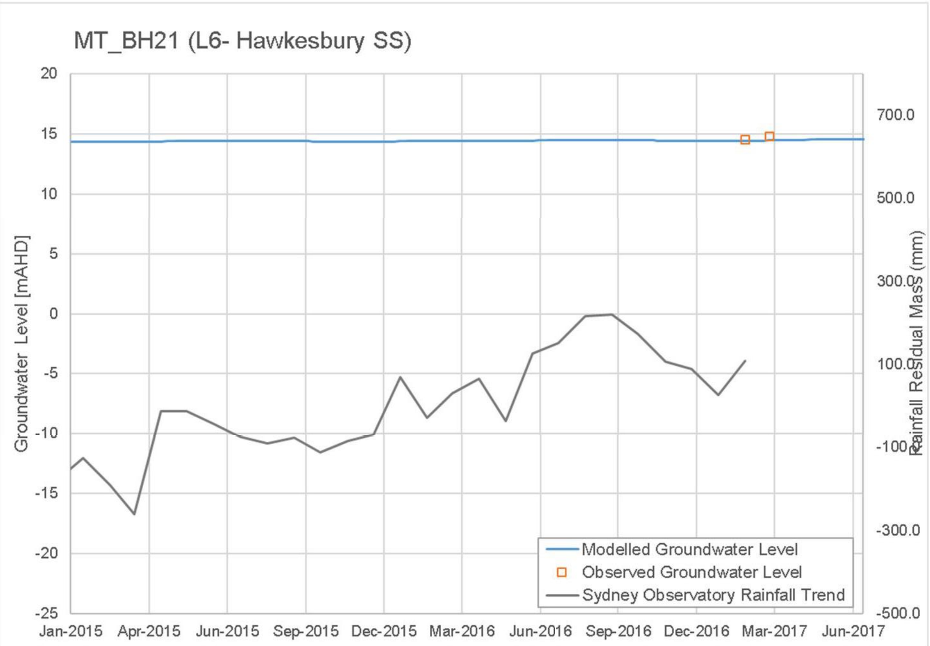


Figure A 18 - Calibration Hydrographs (Layer 6)

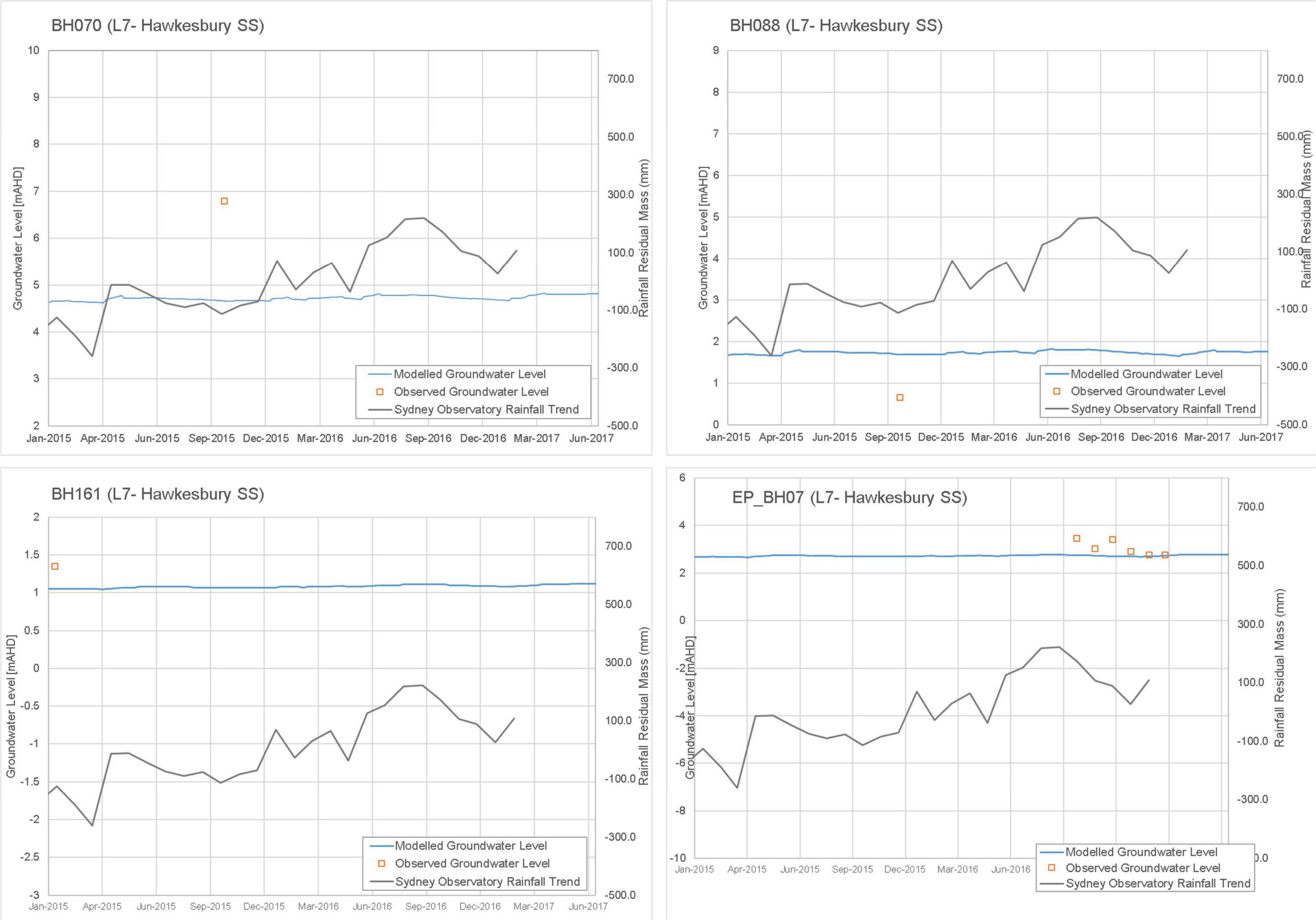


Figure A 19 - Calibration Hydrographs (Layer 6 & Layer 7)

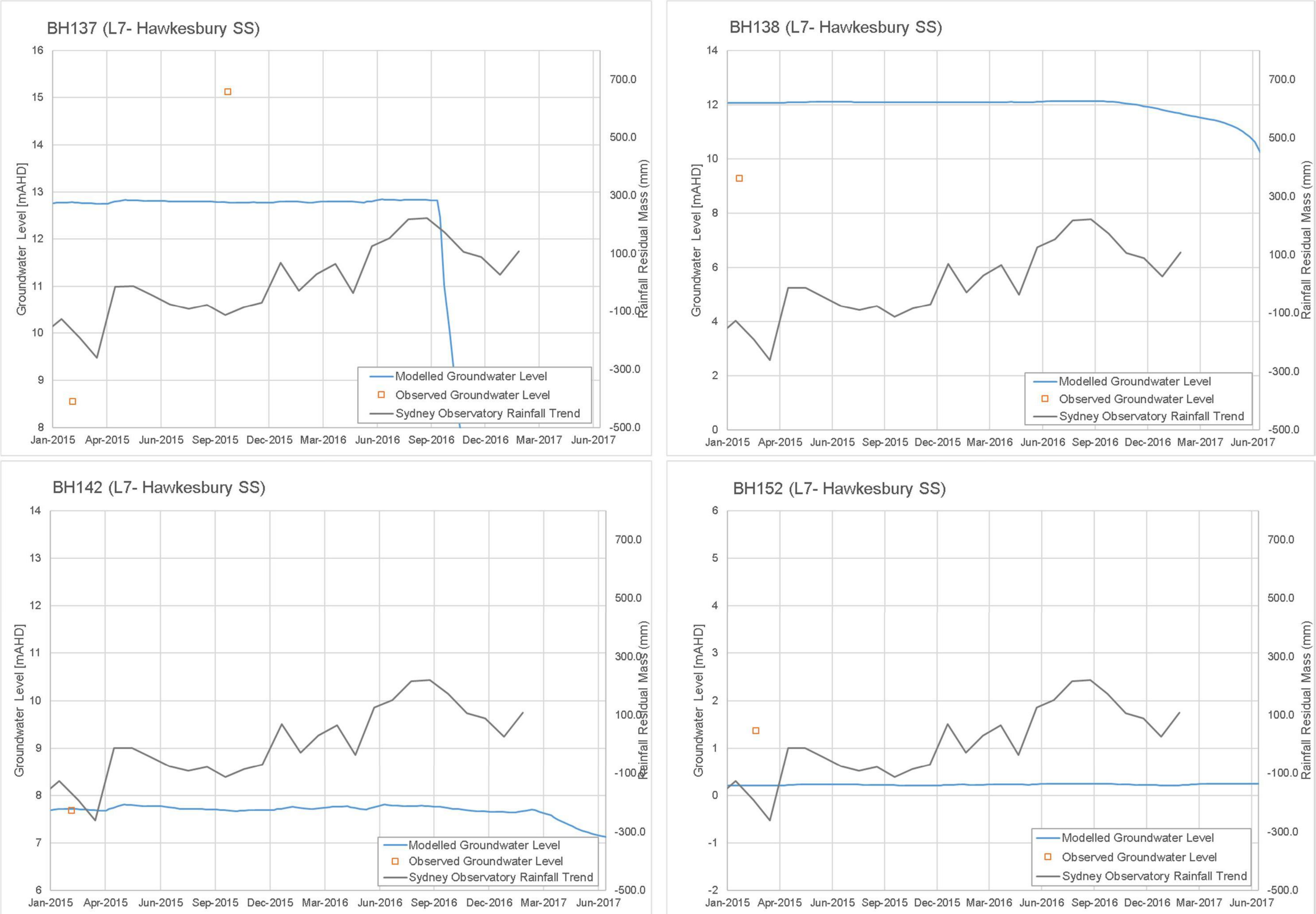


Figure A 20 - Calibration Hydrographs (Layer 7)

ANNEXURE B – DRAWDOWN AT REGISTERED BORES

Bore	Model Layer	Model Node	Use	Depth	Easting	Northing	Drawdown 2023	Drawdown 2100
GW013331	1	24088	Industrial	14.9	332765	6245200	0.00	0.00
GW013514	1	20831	Industrial	9.1	333946	6246040	0.00	0.00
GW013515	1	28988	Domestic	8.2	333075	6244732	0.00	0.00
GW015954	1	25061	Industrial	20.1	332868	6245171	0.00	0.00
GW017195	1	23021	Water Supply	3.3	334484	6243843	0.00	0.00
GW017344	1	32118	Industrial	13.8	333180	6243543	0.00	0.00
GW017345	1	19725	Industrial	13.7	334289	6246182	0.00	0.00
GW017354	1	21934	Industrial	16.4	334320	6245905	0.00	0.00
GW017684	4	231991	Industrial	14.9	333662	6246787	0.00	0.00
GW017718	1	28035	Industrial	21.3	334168	6242852	0.00	0.00
GW017720	1	28034	Industrial	20.4	333987	6242910	0.00	0.00
GW017722	1	29023	Industrial	18.1	334067	6242727	0.00	0.00
GW017782	1	20836	Industrial	15.5	333705	6245833	0.00	0.00
GW017834	1	21936	Industrial	14.9	334295	6245843	0.00	0.00
GW020094	1	26076	Industrial	45.7	334346	6242947	0.00	0.00
GW022240	1	26080	Industrial	25.2	334402	6242702	0.00	0.00
GW023162	1	27004	Water Supply	4.8	333934	6245020	0.00	0.00
GW023164	1	29021	Water Supply	3.6	333835	6242815	0.00	0.00
GW023168	1	21998	Water Supply	4.5	333504	6245479	0.00	0.00
GW023194	4	290126	Water Supply	4.8	329156	6242811	0.79	1.85
GW023408	1	27003	Water Supply	7	334208	6244979	0.00	0.00
GW023443	1	24138	Water Supply	7.6	334575	6243044	0.00	0.00
GW023472	1	27990	Water Supply	3.6	333964	6244204	0.00	0.00
GW023500	1	27005	Water Supply	5.4	333795	6245095	0.00	0.00
GW023525	1	34292	Water Supply	5.9	333046	6243849	0.00	0.00
GW023561	1	27004	Water Supply	5.4	334002	6244975	0.00	0.00
GW023600	1	26015	Water Supply	7.3	334225	6243962	0.00	0.00
GW023605	1	28981	Water Supply	4.5	333711	6243984	0.00	0.00
GW023967	1	27003	Water Supply	2.7	334155	6245070	0.00	0.00
GW023968	1	27004	Water Supply	4.5	334002	6245006	0.00	0.00
GW024023	1	25019	Water Supply	8.2	334227	6245318	0.00	0.00
GW024036	1	39429	Water Supply	6	332099	6243647	0.00	0.00
GW024068	1	31046	Domestic	4.2	332846	6244382	0.00	0.00
GW024109	1	56438	Water Supply	2.1	329430	6243538	1.34	2.15
GW024222	1	25100	Industrial	23.7	334369	6243071	0.00	0.00
GW024244	1	28000	Water Supply	3	333569	6244783	0.00	0.00
GW024374	1	26041	Water Supply	5.1	333100	6245175	0.00	0.00
GW024377	1	23020	Water Supply	4.5	334534	6243937	0.00	0.00
GW024616	1	27006	Domestic	5.6	334153	6244690	0.00	0.00
GW024655	1	36464	Water Supply	9.1	332454	6243843	0.00	0.00
GW024694	1	21948	Water Supply	3	334573	6243890	0.00	0.00
GW025543	1	26065	Industrial	18.5	333623	6243181	0.00	0.00
GW025553	1	28031	Industrial	17	333599	6243088	0.00	0.00

Bore	Model Layer	Model Node	Use	Depth	Easting	Northing	Drawdown 2023	Drawdown 2100
GW025574	1	28035	Water Supply	4.8	334156	6242880	0.00	0.00
GW025729	1	24120	Industrial	21.3	333596	6243242	0.00	0.00
GW025818	1	24133	Recreation	23.7	334368	6243164	0.00	0.00
GW025994	1	35377	Water Supply	13.2	333039	6243705	0.00	0.00
GW026070	1	28979	Domestic	3.6	333926	6244233	0.00	0.00
GW026142	1	20830	Water Supply	12.4	334379	6246075	0.00	0.00
GW026482	1	25019	Water Supply	5.4	334256	6245407	0.00	0.00
GW026787	1	26074	Industrial	24.8	334044	6243100	0.00	0.00
GW026788	1	26072	Industrial	20.4	333944	6243167	0.00	0.00
GW027248	1	15710	Industrial	4.8	332260	6244792	0.00	0.00
GW027749	1	28991	Recreation	16.4	332802	6244553	0.00	0.00
GW027750	1	27997	Recreation	17.3	332774	6244676	0.00	0.00
GW028844	1	21936	Industrial	13.7	334218	6245873	0.00	0.00
GW031808	1	36463	Exploration	18.2	332469	6243842	0.00	0.00
GW033371	1	38498	Industrial	11.8	332654	6243840	0.00	0.00
GW033372	1	38498	Industrial	11.8	332663	6243840	0.00	0.00
GW040219	1	6758	Industrial	6.3	332128	6245128	0.00	0.00
GW040222	1	32088	Industrial	7	333252	6243604	0.00	0.00
GW042179	1	25050	Unknown	24	333786	6245289	0.00	0.00
GW046837	1	28029	Recreation	14.8	333806	6243000	0.00	0.00
GW047122	1	27058	Recreation	19.5	333959	6243033	0.00	0.00
GW047123	1	30019	Recreation	18.9	333143	6244560	0.00	0.00
GW047525	1	27999	Recreation	17.1	333343	6244859	0.00	0.00
GW051725	1	19724	Monitoring	8	334057	6246240	0.00	0.00
GW051726	1	19724	Monitoring	8	334083	6246209	0.00	0.00
GW051727	1	19724	Monitoring	8	334084	6246178	0.00	0.00
GW051728	1	18648	Monitoring	8.3	334185	6246273	0.00	0.00
GW051729	1	19725	Monitoring	8.5	334264	6246181	0.00	0.00
GW051730	1	19725	Monitoring	0	334213	6246150	0.00	0.00
GW051731	1	21936	Monitoring	8	334210	6245956	0.00	0.00
GW060218	1	26079	Recreation	18.3	334374	6242825	0.00	0.00
GW065460	1	11492	Industrial	12	334428	6247078	0.00	0.00
GW065532	1	20836	Industrial	18	333730	6245833	0.00	0.00
GW071907	8	531826	Recreation	180	334034	6247997	0.00	0.00
GW072018	4	258403	Monitoring	18	327883	6251400	0.00	0.02
GW072161	8	581998	Recreation	90.5	329636	6243437	6.14	6.51
GW072214	1	26014	Domestic	5	334258	6244118	0.00	0.00
GW072293	1	28978	Domestic	6.6	333769	6244339	0.00	0.00
GW072328	1	20836	Unknown	0	333730	6245833	0.00	0.00
GW072413	1	28978	Domestic	6	333696	6244333	0.00	0.00
GW072455	1	27010	Domestic	5.8	333968	6243885	0.00	0.00
GW072479	1	26007	Domestic	5.8	334574	6244930	0.00	0.00
GW072622	1	18647	Recreation	0	334406	6246273	0.00	0.00

Bore	Model Layer	Model Node	Use	Depth	Easting	Northing	Drawdown 2023	Drawdown 2100
GW072632	1	27991	Domestic	5	333872	6243961	0.00	0.00
GW072633	1	27991	Domestic	5	333950	6243957	0.00	0.00
GW072634	1	27010	Domestic	6.1	333956	6243873	0.00	0.00
GW072643	1	11954	Unknown	0	331951	6245584	0.06	0.25
GW072897	1	24043	Domestic	5.8	334585	6244006	0.00	0.00
GW072901	1	31047	Domestic	7	332915	6244474	0.00	0.00
GW072958	1	24043	Domestic	5	334566	6244090	0.00	0.00
GW072993	5	326333	Unknown	48.77	333819	6245047	0.00	0.00
GW073477	1	28977	Domestic	5	333780	6244735	0.00	0.00
GW073515	1	26014	Domestic	7	334369	6244109	0.00	0.00
GW073521	1	31049	Domestic	3	332994	6244389	0.00	0.00
GW075022	4	253514	Monitoring	15.75	333767	6242958	0.00	0.00
GW075023	1	30014	Monitoring	18.5	333638	6244016	0.00	0.00
GW075024	4	252501	Monitoring	19.5	332822	6244671	0.00	0.00
GW100003	1	29023	Domestic	5.8	334089	6242726	0.00	0.00
GW100053	1	21445	Recreation	0	332163	6245867	0.34	0.91
GW100209	8	578962	Domestic	108	329946	6243253	0.35	0.50
GW100367	1	27003	Domestic	6	334229	6245090	0.00	0.00
GW100466	1	23012	Domestic	5	334035	6245642	0.00	0.00
GW100484	1	27027	Unknown	0	332935	6245035	0.00	0.00
GW100484	1	27027	Monitoring	4	332935	6245035	0.00	0.00
GW100484	1	27027	Unknown	0	332935	6245035	0.00	0.00
GW100487	1	28974	Unknown	5	333505	6243671	0.00	0.00
GW100493	1	25019	Domestic	9.75	334246	6245360	0.00	0.00
GW100575	1	27004	Domestic	5	334037	6245055	0.00	0.00
GW100674	1	21949	Domestic	5.49	334570	6243812	0.00	0.00
GW100754	8	565778	Industrial	148	332719	6243180	0.00	0.00
GW100803	1	27010	Unknown	6	333971	6243907	0.00	0.00
GW100813	1	25019	Domestic	10.98	334238	6245329	0.00	0.00
GW100852	1	26033	Domestic	6.1	333758	6245165	0.00	0.00
GW100904	1	24036	Domestic	9.76	334373	6245583	0.00	0.00
GW100945	1	27004	Domestic	7.1	334080	6245113	0.00	0.00
GW100966	1	27989	Domestic	5.5	333930	6244441	0.00	0.00
GW100975	1	24039	Domestic	6.1	333996	6245495	0.00	0.00
GW100993	1	27006	Domestic	5.49	334227	6244560	0.00	0.00
GW100997	1	26010	Domestic	8.235	334101	6245153	0.00	0.00
GW101034	1	27059	Domestic	5.185	334280	6242895	0.00	0.00
GW101037	1	25020	Domestic	4.88	334150	6245436	0.00	0.00
GW101136	1	25103	Domestic	7.32	334451	6242969	0.00	0.00
GW101161	1	27003	Domestic	6.1	334104	6245039	0.00	0.00
GW101215	1	25024	Domestic	7.62	334529	6244214	0.00	0.00
GW101221	1	26010	Domestic	6.1	334099	6245316	0.00	0.00
GW101226	1	26009	Domestic	5.3	334308	6245135	0.00	0.00

Bore	Model Layer	Model Node	Use	Depth	Easting	Northing	Drawdown 2023	Drawdown 2100
GW101231	1	27003	Domestic	7	334104	6245008	0.00	0.00
GW101350	1	23093	Monitoring	5.9	332201	6244281	0.00	0.00
GW101351	1	23093	Monitoring	5.05	332200	6244281	0.00	0.00
GW101352	1	23093	Monitoring	5.7	332200	6244281	0.00	0.00
GW101353	1	23093	Monitoring	6	332201	6244281	0.00	0.00
GW101354	1	23093	Monitoring	6	332200	6244281	0.00	0.00
GW101355	1	23093	Monitoring	6	332200	6244281	0.00	0.00
GW101356	1	23093	Monitoring	5.6	332201	6244281	0.00	0.00
GW101357	1	23093	Monitoring	5.9	332200	6244281	0.00	0.00
GW101358	1	23093	Monitoring	6	332200	6244281	0.00	0.00
GW101359	1	23093	Monitoring	6	332200	6244281	0.00	0.00
GW101360	1	23093	Monitoring	6	332200	6244281	0.00	0.00
GW101361	1	23093	Monitoring	4.3	332200	6244281	0.00	0.00
GW101362	1	23093	Monitoring	5.9	332200	6244281	0.00	0.00
GW101446	1	27989	Domestic	6	334038	6244366	0.00	0.00
GW101457	1	28978	Domestic	6	333647	6244460	0.00	0.00
GW101475	1	27989	Domestic	6	333952	6244327	0.00	0.00
GW101477	1	27989	Domestic	6	333939	6244421	0.00	0.00
GW101523	1	30014	Domestic	6.1	333556	6244074	0.00	0.00
GW101533	1	23078	Industrial	20	333064	6245358	0.00	0.00
GW101787	1	27991	Domestic	5.795	333866	6243929	0.00	0.00
GW101813	1	26010	Domestic	8.54	334133	6245150	0.00	0.00
GW102160	1	24104	Monitoring	5	332302	6244172	0.00	0.00
GW102162	1	24104	Monitoring	5	332302	6244172	0.00	0.00
GW102164	1	24104	Monitoring	5	332302	6244172	0.00	0.00
GW102165	1	24104	Monitoring	5	332302	6244172	0.00	0.00
GW102168	1	24104	Monitoring	5	332302	6244172	0.00	0.00
GW102169	1	24104	Monitoring	4.5	332302	6244172	0.00	0.00
GW102171	1	24104	Monitoring	6	332303	6244172	0.00	0.00
GW102172	1	24104	Monitoring	4.5	332302	6244172	0.00	0.00
GW102173	1	24104	Monitoring	4.5	332302	6244172	0.00	0.00
GW102176	1	24104	Monitoring	4.5	332302	6244172	0.00	0.00
GW102178	1	24104	Monitoring	4.4	332303	6244173	0.00	0.00
GW102184	1	24104	Monitoring	4.2	332302	6244173	0.00	0.00
GW102185	1	24104	Monitoring	4.2	332302	6244172	0.00	0.00
GW102186	1	24104	Monitoring	4.2	332302	6244172	0.00	0.00
GW102187	1	24104	Monitoring	4.2	332302	6244172	0.00	0.00
GW102188	1	24104	Monitoring	4	332302	6244172	0.00	0.00
GW102189	1	24104	Monitoring	4	332303	6244172	0.00	0.00
GW102190	1	24104	Monitoring	4	332303	6244172	0.00	0.00
GW102191	1	24104	Monitoring	4	332302	6244172	0.00	0.00
GW102192	1	24104	Monitoring	4	332303	6244172	0.00	0.00
GW102193	1	24104	Monitoring	3.9	332302	6244173	0.00	0.00

Bore	Model Layer	Model Node	Use	Depth	Easting	Northing	Drawdown 2023	Drawdown 2100
GW102194	1	24104	Monitoring	3.7	332302	6244172	0.00	0.00
GW102195	1	24104	Monitoring	3.6	332302	6244172	0.00	0.00
GW102196	1	24104	Monitoring	3.6	332302	6244172	0.00	0.00
GW102197	1	24104	Monitoring	3.6	332303	6244172	0.00	0.00
GW102198	1	24104	Monitoring	3.5	332302	6244172	0.00	0.00
GW102199	1	24104	Monitoring	3.5	332302	6244172	0.00	0.00
GW102200	1	24104	Monitoring	3.5	332302	6244172	0.00	0.00
GW102201	1	24104	Monitoring	3.5	332302	6244172	0.00	0.00
GW102203	1	24104	Monitoring	3.5	332302	6244172	0.00	0.00
GW102204	1	24104	Monitoring	3.3	332303	6244172	0.00	0.00
GW102205	1	24104	Monitoring	3.3	332303	6244172	0.00	0.00
GW102215	3	193749	Drinking	15	324765	6251338	0.68	1.26
GW102356	1	16185	Monitoring	6	333120	6246963	0.01	0.02
GW102357	1	17219	Monitoring	6	333093	6246993	0.01	0.02
GW102358	1	16186	Monitoring	6	333145	6246994	0.01	0.02
GW102359	1	15161	Monitoring	6	333146	6246901	0.00	0.01
GW102360	1	14135	Monitoring	6	333147	6246871	0.00	0.01
GW102361	1	15161	Monitoring	6	333146	6246901	0.00	0.01
GW102362	1	14123	Monitoring	3	333171	6246963	0.00	0.01
GW102363	1	15165	Monitoring	3	333145	6246963	0.01	0.02
GW102364	1	15165	Monitoring	3	333145	6246963	0.01	0.02
GW102365	1	15164	Monitoring	6	333146	6246932	0.00	0.01
GW102366	1	30012	Domestic	7	333597	6244629	0.00	0.00
GW102402	8	589092	Unknown	90	326938	6246390	0.00	0.00
GW102580	5	362464	Monitoring	40	328186	6244163	0.00	0.02
GW102655	5	322687	Monitoring	25	330131	6251717	0.03	0.37
GW102671	4	231746	Monitoring	4.8	331651	6251559	0.00	0.08
GW102672	4	231746	Monitoring	9	331676	6251590	0.00	0.08
GW102741	1	23021	Domestic	7	334509	6243875	0.00	0.00
GW102800	1	26016	Domestic	6.1	334134	6243944	0.00	0.00
GW103193	1	26010	Domestic	6.7	334071	6245158	0.00	0.00
GW103331	1	62488	Monitoring	3.2	328470	6244126	0.00	0.02
GW103332	1	62488	Monitoring	3.2	328470	6244126	0.00	0.02
GW103333	1	62488	Monitoring	3.2	328470	6244126	0.00	0.02
GW103504	1	20935	Monitoring	6.1	333091	6245467	0.00	0.00
GW103505	1	20935	Monitoring	6	333091	6245458	0.00	0.00
GW103506	1	20935	Monitoring	6	333091	6245458	0.00	0.00
GW103507	1	20935	Monitoring	6	333092	6245458	0.00	0.00
GW103508	1	20935	Monitoring	6	333091	6245457	0.00	0.00
GW103588	1	28001	Domestic	7	332905	6244836	0.00	0.00
GW103705	1	32117	Monitoring	4.7	333097	6244213	0.00	0.00
GW103706	1	32117	Monitoring	4.3	333097	6244213	0.00	0.00
GW103707	1	32117	Monitoring	4.2	333097	6244213	0.00	0.00

Bore	Model Layer	Model Node	Use	Depth	Easting	Northing	Drawdown 2023	Drawdown 2100
GW104039	1	26008	Monitoring	7	334518	6244812	0.00	0.00
GW104040	1	26008	Monitoring	7	334515	6244808	0.00	0.00
GW104297	1	30016	Domestic	0	332708	6244483	0.00	0.00
GW104333	1	35394	Monitoring	3.5	332763	6243980	0.00	0.00
GW104334	1	35394	Monitoring	3.5	332782	6243996	0.00	0.00
GW104335	1	36469	Monitoring	3.5	332753	6243978	0.00	0.00
GW104336	1	35394	Monitoring	3.5	332790	6243972	0.00	0.00
GW104337	1	36469	Monitoring	3.5	332766	6243953	0.00	0.00
GW104338	1	36469	Monitoring	3.5	332802	6243948	0.00	0.00
GW104448	1	9667	Monitoring	3.5	331715	6244936	0.01	0.04
GW104449	1	8679	Monitoring	3.5	331677	6244959	0.02	0.05
GW104450	1	9670	Monitoring	3.5	331630	6244904	0.02	0.05
GW104747	1	23021	Domestic	5.49	334536	6243810	0.00	0.00
GW104866	1	27982	Domestic	6.71	333772	6243773	0.00	0.00
GW104872	1	24036	Domestic	10	334439	6245657	0.00	0.00
GW104902	1	34290	Domestic	7.1	332787	6244151	0.00	0.00
GW104922	1	27992	Domestic	7	333878	6243837	0.00	0.00
GW104988	1	28988	Domestic	7	333077	6244789	0.00	0.00
GW104990	1	31044	Domestic	6	333377	6244086	0.00	0.00
GW105117	1	28980	Recreation	14	333738	6244041	0.00	0.00
GW105141	1	24036	Domestic	10	334465	6245477	0.00	0.00
GW105150	1	28977	Domestic	5	333691	6244772	0.00	0.00
GW105152	1	27989	Domestic	5	334033	6244332	0.00	0.00
GW105215	5	367668	Domestic	15	325448	6246456	0.00	0.00
GW105317	2	120043	Monitoring	6.5	331965	6247846	1.28	9.66
GW105527	1	9536	Monitoring	5	333069	6246148	0.00	0.00
GW105528	1	15548	Monitoring	5	333273	6246037	0.00	0.00
GW105529	1	10498	Monitoring	5	333097	6246168	0.00	0.00
GW105580	1	61514	Monitoring	3.5	328812	6244162	0.01	0.06
GW105581	1	61515	Monitoring	3.5	328792	6244173	0.01	0.05
GW105582	1	61776	Monitoring	3.5	328763	6244179	0.01	0.05
GW105583	1	61776	Monitoring	4	328750	6244154	0.01	0.05
GW105938	1	35844	Unknown	0	332733	6247637	0.00	0.00
GW106046	1	14518	Unknown	0	333636	6246554	0.00	0.00
GW106145	1	26009	Domestic	5.79	334358	6245089	0.00	0.00
GW106159	2	110851	Domestic	3	326801	6252194	0.00	0.00
GW106192	1	21537	Domestic	6	333418	6247611	0.00	0.02
GW106987	1	30009	Domestic	7	333649	6243891	0.00	0.00
GW107233	1	25097	Recreation	21.5	334110	6243199	0.00	0.00
GW107395	1	28980	Monitoring	3.6	333672	6244150	0.00	0.00
GW107396	1	28979	Monitoring	3.5	333740	6244260	0.00	0.00
GW107397	1	28980	Monitoring	3.6	333746	6244110	0.00	0.00
GW107406	4	286023	Monitoring	5	329048	6245678	0.00	0.01

Bore	Model Layer	Model Node	Use	Depth	Easting	Northing	Drawdown 2023	Drawdown 2100
GW107407	4	286023	Monitoring	7	329063	6245678	0.00	0.01
GW107753	1	61779	Monitoring	5	328820	6244219	0.01	0.05
GW107754	1	61777	Monitoring	4.8	328806	6244202	0.01	0.05
GW107755	1	62025	Monitoring	4.8	328797	6244223	0.01	0.05
GW107756	1	62029	Monitoring	5	328784	6244215	0.01	0.05
GW107976	1	28003	Drinking	3.5	333211	6244864	0.00	0.00
GW107993	4	289325	Recreation	13.6	328242	6243424	1.71	10.13
GW108104	1	24089	Industrial	0	333038	6245307	0.00	0.00
GW108406	1	57055	Domestic	8	329510	6243455	1.70	2.55
GW108497	1	17727	Unknown	8	332753	6245547	0.00	0.00
GW108588	1	57655	Domestic	8	329440	6243429	2.07	3.14
GW108616	1	24036	Domestic	18	334451	6245617	0.00	0.00
GW109085	4	229987	Monitoring	5.68	333786	6251263	0.00	0.00
GW109086	4	229987	Monitoring	5.68	333781	6251262	0.00	0.00
GW109087	4	229252	Monitoring	8.5	333783	6251252	0.00	0.00
GW109191	8	597721	Recreation	186	325255	6243188	6.66	6.89
GW109209	4	241938	Domestic	4.5	331813	6252542	0.00	0.02
GW109230	1	45225	Monitoring	1.8	331802	6249055	0.02	0.62
GW109231	3	194889	Monitoring	3.2	331787	6249063	0.16	2.30
GW109253	1	31086	Monitoring	10.3	333499	6242782	0.00	0.00
GW109254	1	32157	Monitoring	9.7	333476	6242768	0.00	0.00
GW109255	1	32156	Monitoring	7.3	333441	6242772	0.00	0.00
GW109500	4	250175	Monitoring	4.8	333698	6248974	0.00	0.00
GW109501	4	254078	Monitoring	6	333441	6249156	0.00	0.02
GW109502	4	255102	Monitoring	6.4	333442	6249090	0.00	0.02
GW109503	1	30605	Monitoring	5.2	333460	6249045	0.00	0.02
GW109504	1	16548	Monitoring	7.48	334296	6246560	0.00	0.00
GW109533	1	29021	Monitoring	6	333919	6242864	0.00	0.00
GW109534	1	29021	Monitoring	6	333893	6242863	0.00	0.00
GW109535	1	29021	Monitoring	6	333891	6242870	0.00	0.00
GW109536	1	29021	Monitoring	6	333891	6242876	0.00	0.00
GW109537	1	29021	Monitoring	6	333887	6242882	0.00	0.00
GW109538	1	29021	Monitoring	6	333885	6242889	0.00	0.00
GW109539	1	29021	Monitoring	6	333928	6242873	0.00	0.00
GW109540	1	29021	Monitoring	6	333890	6242896	0.00	0.00
GW109541	1	29021	Monitoring	6	333890	6242904	0.00	0.00
GW109542	1	29021	Monitoring	6	333895	6242922	0.00	0.00
GW109543	1	17590	Monitoring	11.3	334237	6246484	0.00	0.00
GW109544	1	16547	Monitoring	14	334417	6246524	0.00	0.00
GW109545	1	16548	Monitoring	13.9	334306	6246557	0.00	0.00
GW109546	1	17588	Monitoring	8.14	334355	6246419	0.00	0.00
GW109547	1	17588	Monitoring	13.6	334362	6246437	0.00	0.00
GW109646	4	255088	Monitoring	8.2	333312	6249293	0.00	0.03

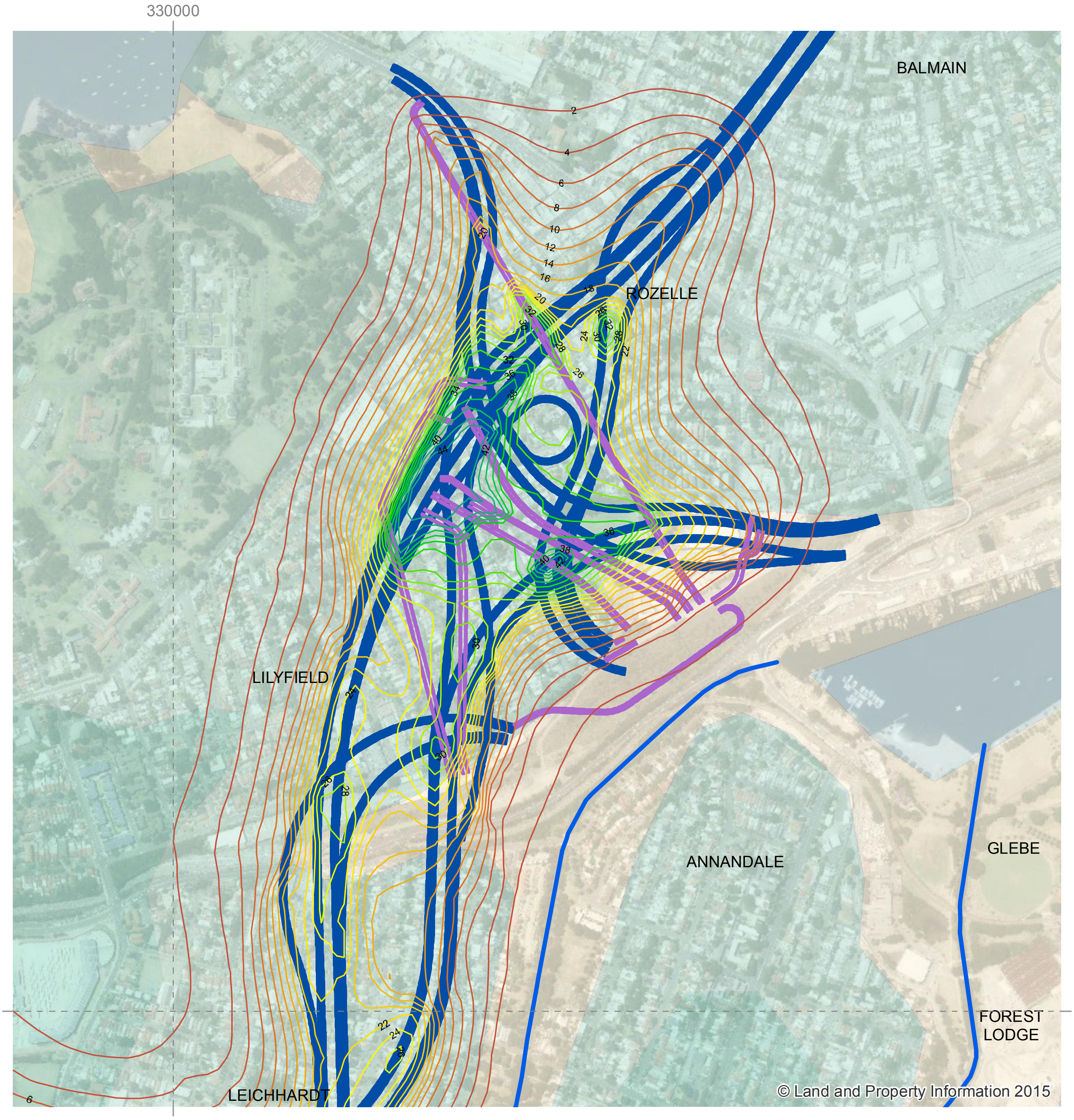
Bore	Model Layer	Model Node	Use	Depth	Easting	Northing	Drawdown 2023	Drawdown 2100
GW109648	4	253090	Monitoring	6.2	333342	6249333	0.00	0.02
GW109649	4	254072	Monitoring	7.2	333320	6249352	0.00	0.02
GW109712	4	235789	Monitoring	5.8	332788	6251938	0.00	0.00
GW109713	4	235789	Monitoring	6	332750	6251951	0.00	0.00
GW109714	4	236822	Monitoring	5.9	332745	6252032	0.00	0.00
GW109715	4	236824	Monitoring	5.9	332556	6252060	0.00	0.00
GW109716	4	235811	Monitoring	6	332729	6251981	0.00	0.00
GW109729	2	118597	Monitoring	6	332074	6247641	0.22	3.61
GW109730	2	118597	Monitoring	6.5	332089	6247634	0.22	3.61
GW109731	2	118597	Monitoring	6	332066	6247634	0.22	3.61
GW109732	2	118593	Monitoring	4.3	332071	6247629	0.22	3.61
GW109733	1	43765	Monitoring	2.4	332082	6247631	0.04	3.34
GW109744	1	8516	Monitoring	4	334420	6247577	0.00	0.00
GW109745	1	8516	Monitoring	3.5	334439	6247544	0.00	0.00
GW109746	1	7542	Monitoring	4.2	334445	6247573	0.00	0.00
GW109747	1	7542	Monitoring	3.8	334469	6247580	0.00	0.00
GW109748	1	7542	Monitoring	3.8	334497	6247592	0.00	0.00
GW109749	1	7542	Monitoring	4.5	334468	6247562	0.00	0.00
GW109750	1	8516	Monitoring	3.5	334461	6247540	0.00	0.00
GW109751	1	7542	Monitoring	3.5	334438	6247592	0.00	0.00
GW109752	1	7542	Monitoring	3.4	334499	6247569	0.00	0.00
GW109789	1	13481	Monitoring	5	333709	6246662	0.00	0.00
GW109790	1	14523	Monitoring	4	333740	6246626	0.00	0.00
GW109791	1	14523	Monitoring	4.1	333721	6246619	0.00	0.00
GW109792	1	14519	Monitoring	4.2	333687	6246622	0.00	0.00
GW109821	4	251948	Monitoring	35	331819	6245899	5.06	6.82
GW109825	3	185449	Monitoring	22	331689	6245853	5.85	8.29
GW109963	4	283173	Domestic	8	329446	6243406	2.32	3.40
GW109964	4	282695	Domestic	8	329426	6243419	2.28	3.40
GW109965	1	57053	Domestic	8	329489	6243467	1.73	2.62
GW109966	1	57652	Domestic	3	329373	6243465	2.35	3.75
GW110010	4	286285	Monitoring	8.5	329035	6245672	0.00	0.01
GW110011	4	286023	Monitoring	8.7	329061	6245687	0.00	0.01
GW110012	4	286023	Monitoring	8	329035	6245705	0.00	0.01
GW110013	4	286023	Monitoring	5	329049	6245718	0.00	0.01
GW110014	4	286023	Monitoring	7	329069	6245707	0.00	0.01
GW110118	4	284154	Monitoring	6	329422	6245830	0.00	0.01
GW110119	1	59529	Monitoring	3.5	329372	6245821	0.00	0.01
GW110120	4	284562	Monitoring	6	329413	6245861	0.00	0.01
GW110121	1	59659	Monitoring	3.5	329454	6245840	0.00	0.01
GW110122	4	283707	Monitoring	3.5	329500	6245833	0.00	0.01
GW110174	5	339230	Monitoring	30.1	328299	6250692	0.02	0.08
GW110175	3	189565	Monitoring	3.75	328303	6250694	0.01	0.04

Bore	Model Layer	Model Node	Use	Depth	Easting	Northing	Drawdown 2023	Drawdown 2100
GW110176	5	338353	Monitoring	37.01	327939	6250491	0.16	0.37
GW110177	1	39025	Monitoring	3.75	327939	6250492	0.09	0.21
GW110182	4	263528	Monitoring	7.2	328036	6250571	0.08	0.23
GW110247	8	569039	Domestic	210	332357	6248363	0.21	2.40
GW110351	5	331931	Recreation	60	332651	6247224	0.11	0.25
GW110352	5	324349	Recreation	40	334026	6245327	0.00	0.00
GW110370	1	31666	Monitoring	4	332598	6250123	0.00	0.00
GW110371	1	31666	Monitoring	4	332598	6250115	0.00	0.00
GW110372	1	31666	Monitoring	4	332606	6250121	0.00	0.00
GW110373	1	31666	Monitoring	4	332590	6250126	0.00	0.00
GW110374	1	31666	Monitoring	4	332603	6250122	0.00	0.00
GW110427	1	26008	Monitoring	7	334587	6244801	0.00	0.00
GW110428	1	25016	Monitoring	4	334591	6244823	0.00	0.00
GW110456	1	5186	Monitoring	3.2	332781	6246011	0.00	0.00
GW110457	1	4322	Monitoring	3.6	332822	6245945	0.00	0.00
GW110496	4	271616	Monitoring	4	330809	6249527	0.76	5.14
GW110497	4	271616	Monitoring	4	330787	6249544	0.75	4.72
GW110498	4	271616	Monitoring	4	330795	6249554	0.43	3.85
GW110899	5	360319	Domestic	48	324658	6248717	0.00	0.01
GW111014	1	6605	Monitoring	6.5	334576	6247666	0.00	0.00
GW111016	1	7542	Monitoring	4.4	334468	6247664	0.00	0.00
GW111080	1	7542	Monitoring	5	334555	6247560	0.00	0.00
GW111081	1	7542	Monitoring	4	334545	6247561	0.00	0.00
GW111082	1	7542	Monitoring	4	334532	6247563	0.00	0.00
GW111087	4	284986	Monitoring	8.7	329693	6248632	0.01	2.48
GW111088	4	284986	Monitoring	9	329706	6248636	0.01	2.48
GW111089	4	284986	Monitoring	9	329715	6248641	0.01	2.48
GW111164	1	28343	Domestic	8	332686	6246860	0.04	0.09
GW111320	1	15101	Monitoring	5.2	332305	6245845	0.16	0.52
GW111321	1	11983	Monitoring	5	332322	6245742	0.08	0.29
GW111329	4	243978	Monitoring	6	332704	6250560	0.00	0.00
GW111330	1	19498	Monitoring	4	332729	6250538	0.00	0.00
GW111331	1	19499	Monitoring	6	332742	6250509	0.00	0.00
GW111344	1	59889	Monitoring	4	329132	6244166	0.04	0.17
GW111345	1	59478	Monitoring	4	329154	6244179	0.04	0.18
GW111346	1	59476	Monitoring	4	329177	6244147	0.05	0.21
GW111351	3	204327	Monitoring	9	331436	6247601	9.37	28.01
GW111352	2	128744	Monitoring	8	331445	6247600	9.03	28.99
GW111353	2	129495	Monitoring	7	331440	6247590	8.57	28.00
GW111405	1	7542	Monitoring	4.8	334518	6247580	0.00	0.00
GW111406	1	7542	Monitoring	4.8	334513	6247557	0.00	0.00
GW111407	1	7542	Monitoring	4.8	334508	6247572	0.00	0.00
GW111408	3	193457	Monitoring	4.4	332066	6249142	0.02	1.01

Bore	Model Layer	Model Node	Use	Depth	Easting	Northing	Drawdown 2023	Drawdown 2100
GW111456	1	33251	Monitoring	5.2	333201	6242889	0.00	0.00
GW111457	1	33252	Monitoring	6.2	333244	6242859	0.00	0.00
GW111487	1	17565	Monitoring	2.4	334579	6246369	0.00	0.00
GW111570	1	14384	Monitoring	6	333701	6252417	0.00	0.00
GW111571	1	14384	Monitoring	6	333707	6252420	0.00	0.00
GW111653	1	45682	Monitoring	2.4	329146	6250135	8.93	16.22
GW111654	2	119813	Monitoring	3	329345	6250163	4.69	13.73
GW111663	4	270182	Monitoring	4	329182	6250138	7.30	15.50
GW111686	4	285907	Monitoring	3.5	329728	6246909	0.00	0.07
GW111687	4	285907	Monitoring	4.25	329742	6246916	0.00	0.07
GW305694	4	296098	Domestic	5	326438	6244811	0.00	0.01

ANNEXURE C – ZOOMED IN M4-M5 LINK DRAWDOWN MAPS

WATER TABLE DRAWDOWN AT PROJECT OPENING



Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 10,000 @A4
GDA 1994 MGA Zone 56

0 0.075 0.15 0.3 0.45 km

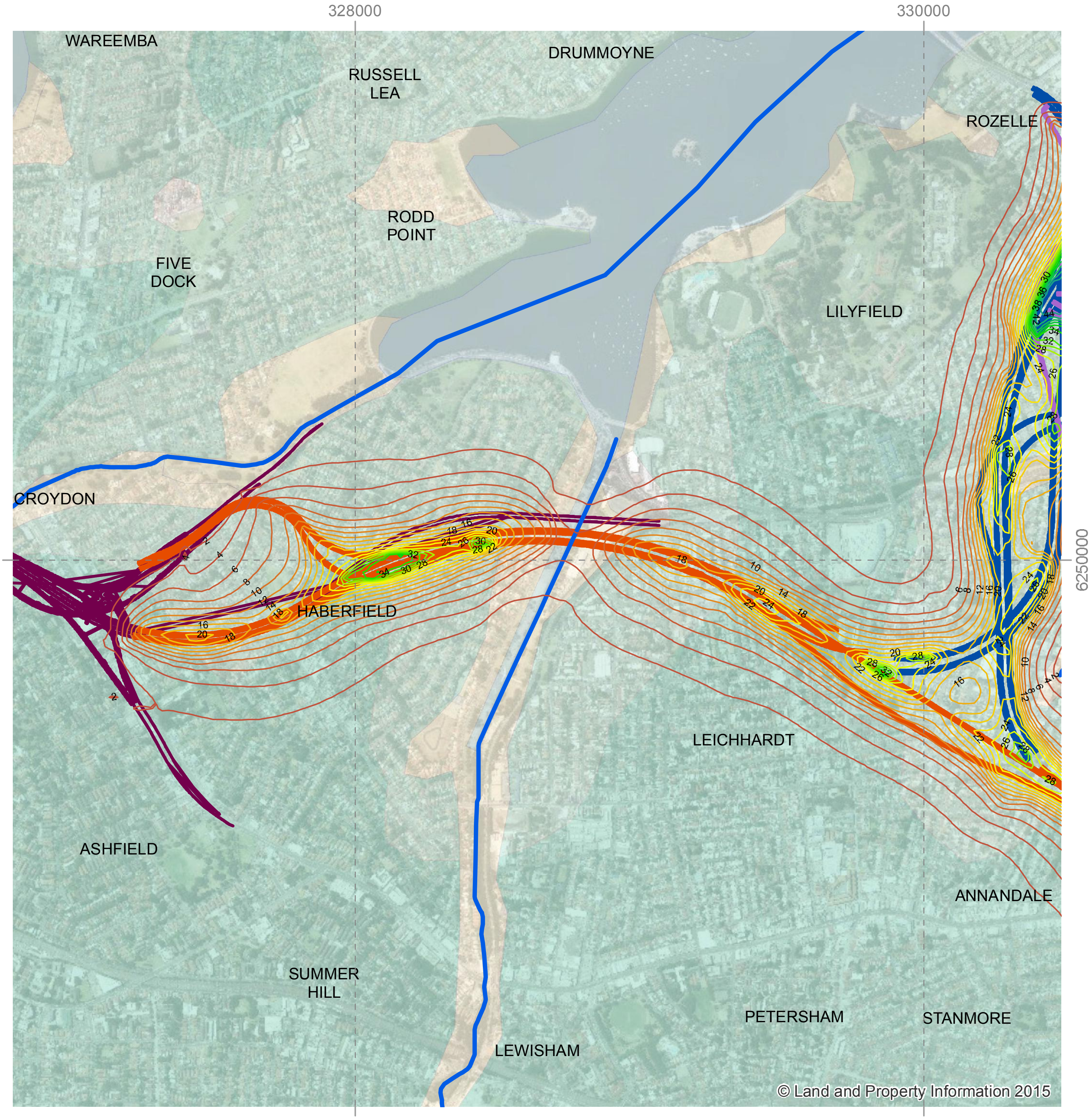
WestConnex M4-M5 Link

M4-M5 Link Drawdown at Project Opening (2023)

Water Table - Rozelle

[Model Run TR020]

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Drawdown_Incremental_Alluvium_Opening_Rozelle.mxd



Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

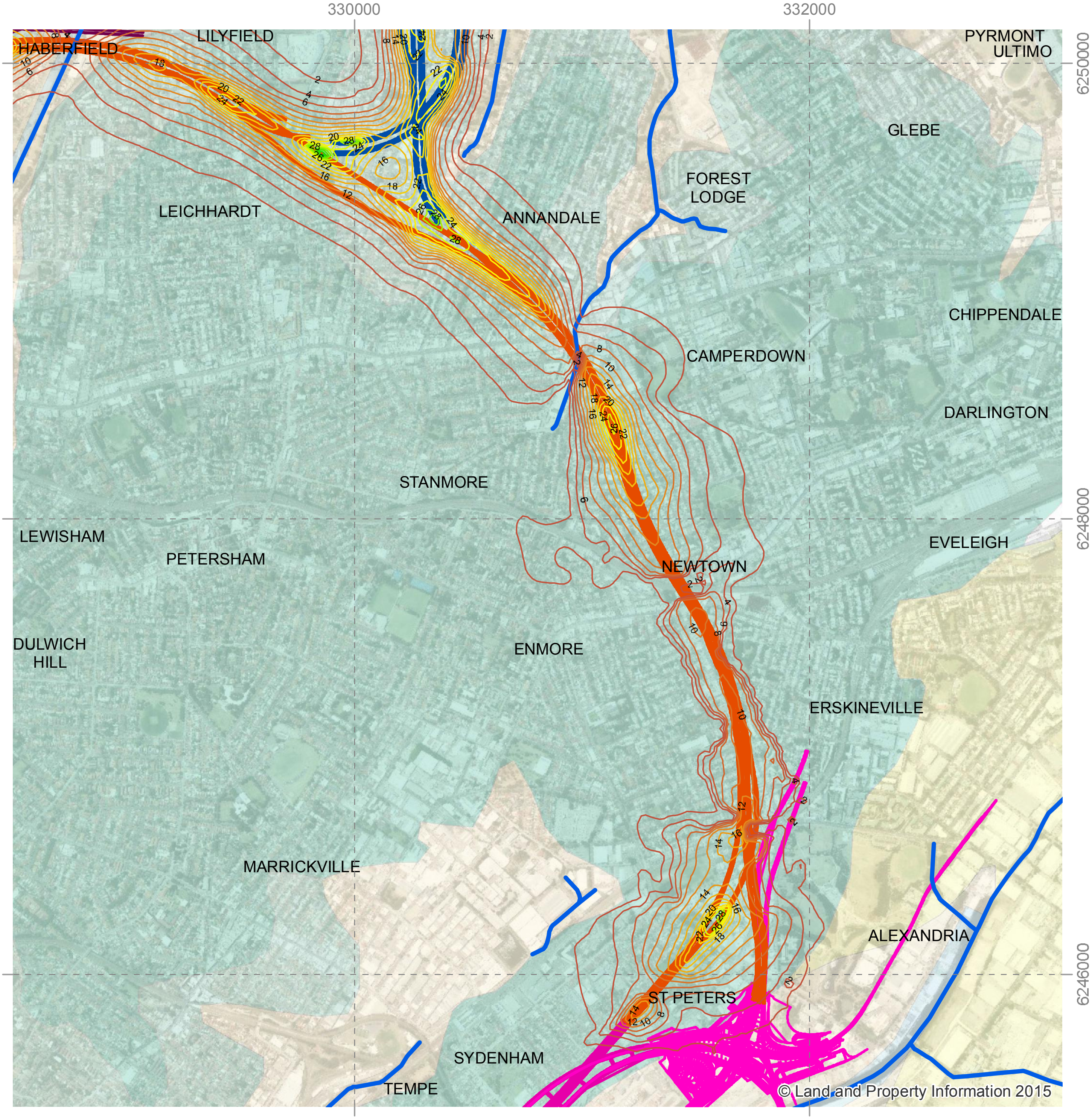
Scale: 20,000 @A4
GDA 1994 MGA Zone 56

0 0.15 0.3 0.6 0.9 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Proiect Opening (2023)
Water Table - Mainline NW
[Model Run TR020]

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Drawdown_Incremental_Alluvium_Opening_MainlineNW.mxd



Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
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- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 25,000 @A4
GDA 1994 MGA Zone 56

0 0.2 0.4 0.8 1.2 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Project Opening (2023)

Water Table - Mainline SE

[Model Run TR020]

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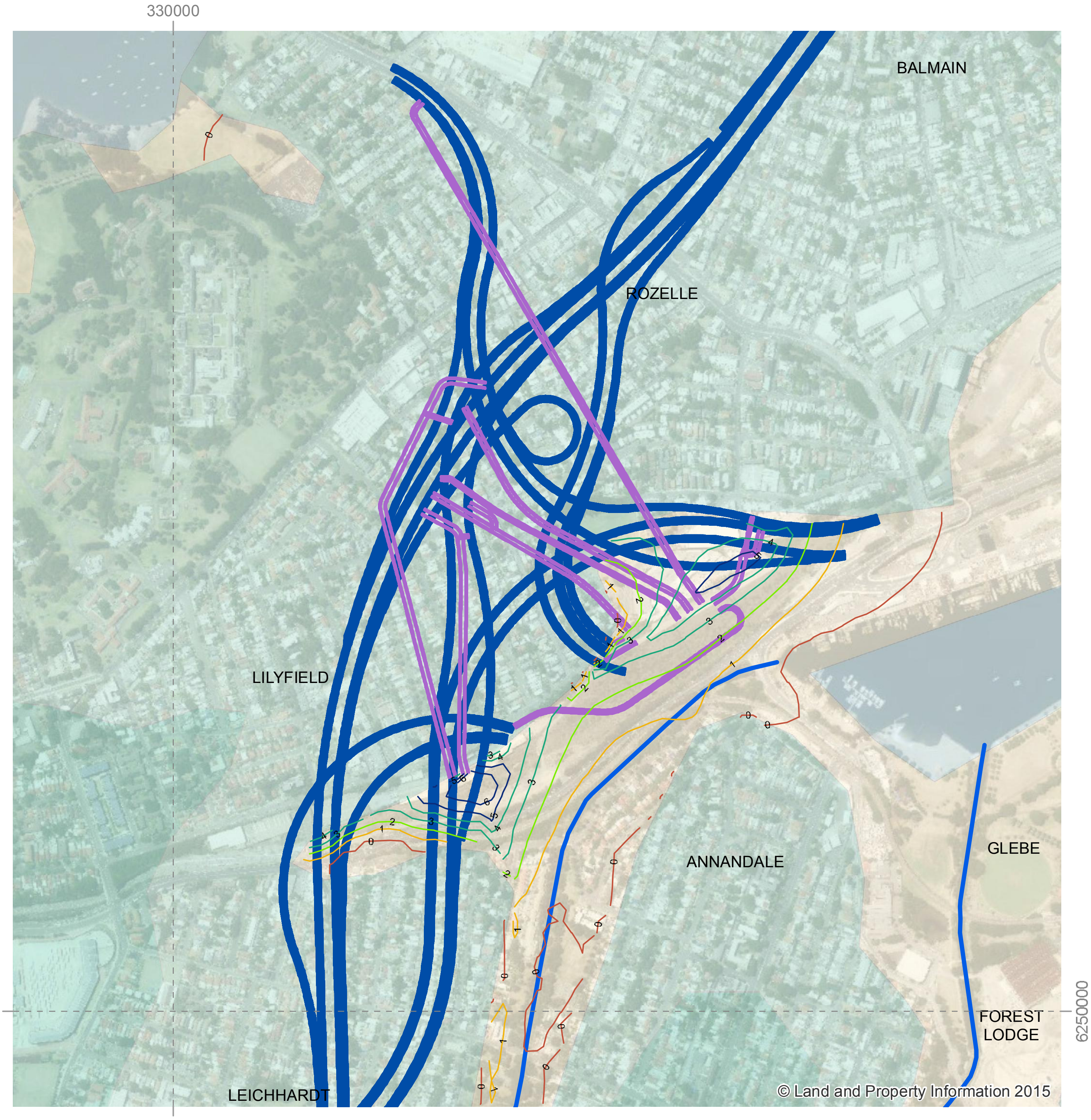
UNCONSOLIDATED SEDIMENT DRAWDOWN AT PROJECT OPENING



Drawdown (m)

- 0
- 1
- 2
- 3 - 4
- 5 - 6
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 10,000 @A4
GDA 1994 MGA Zone 56

0 0.075 0.15 0.3 0.45 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Project Opening (2023) Alluvium and Botany Sands - L1 - Rozelle [Model Run TR020]

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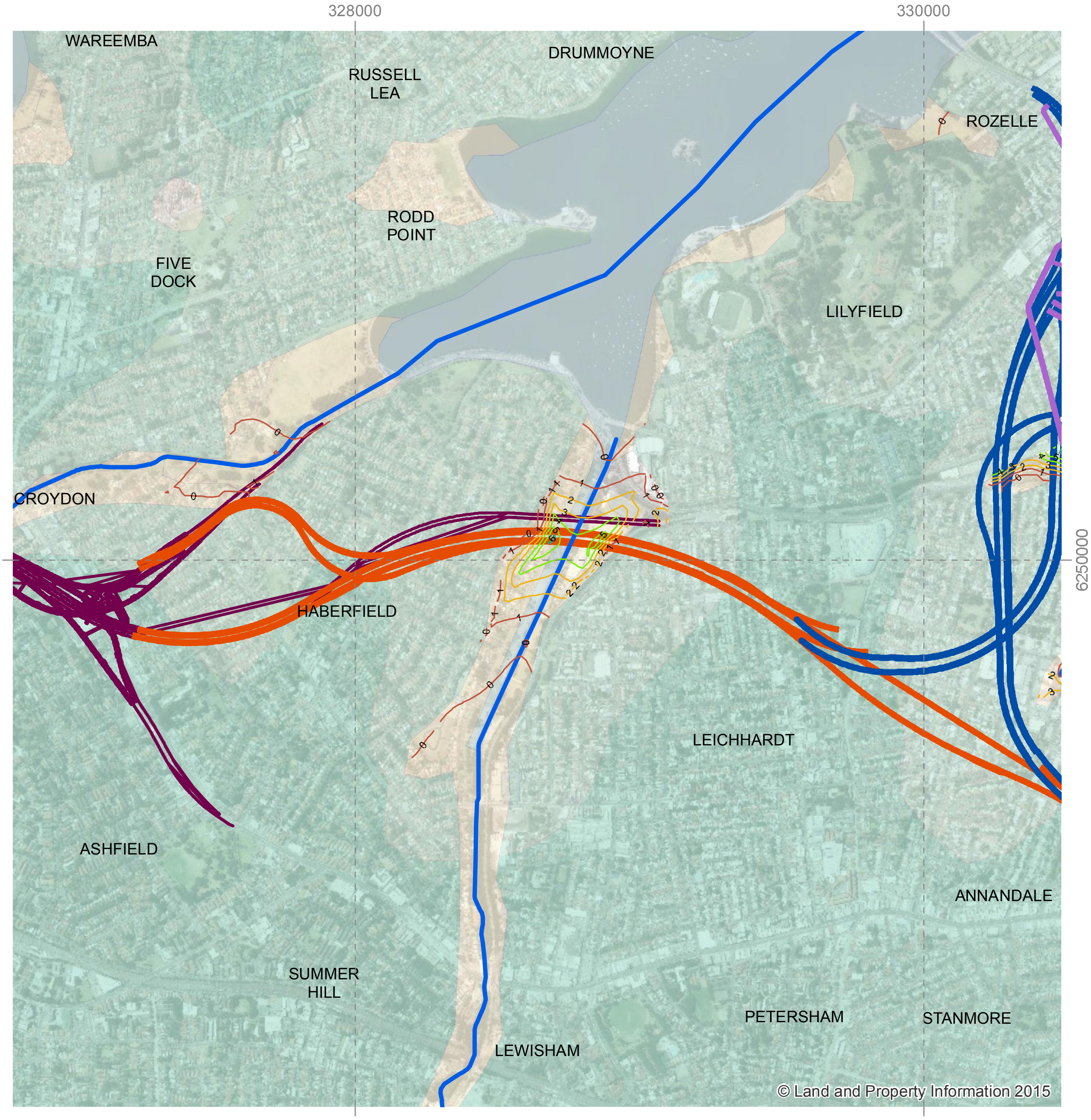

Drawdown (m)

- 0 - 1
- 2 - 3
- 4 - 5
- 6 - 7
- 8 - 10
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 20,000 @A4
GDA 1994 MGA Zone 56

0 0.15 0.3 0.6 0.9 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Project Opening (2023) Alluvium and Botany Sands - L1 - Mainline NW [Model Run TR020]

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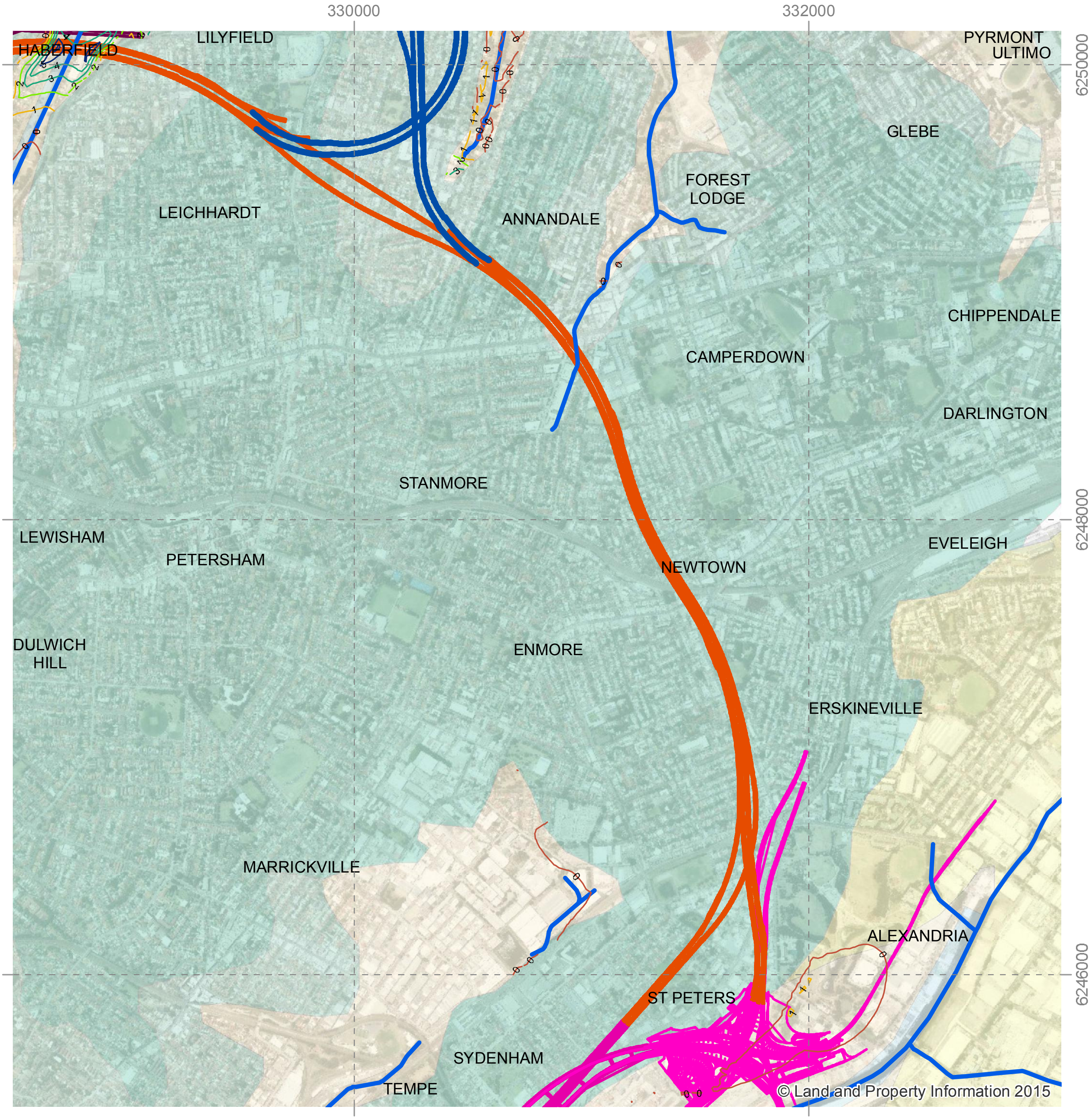

Drawdown (m)

- 0
- 1
- 2
- 3 - 4
- 5 - 6
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 25,000 @A4
GDA 1994 MGA Zone 56

0 0.2 0.4 0.8 1.2 km

WestConnex M4-M5 Link
M4-M5 Link Drawdown
at Project Opening (2023)
Alluvium and Botany Sands - L1 - Mainline SE
[Model Run TR020]

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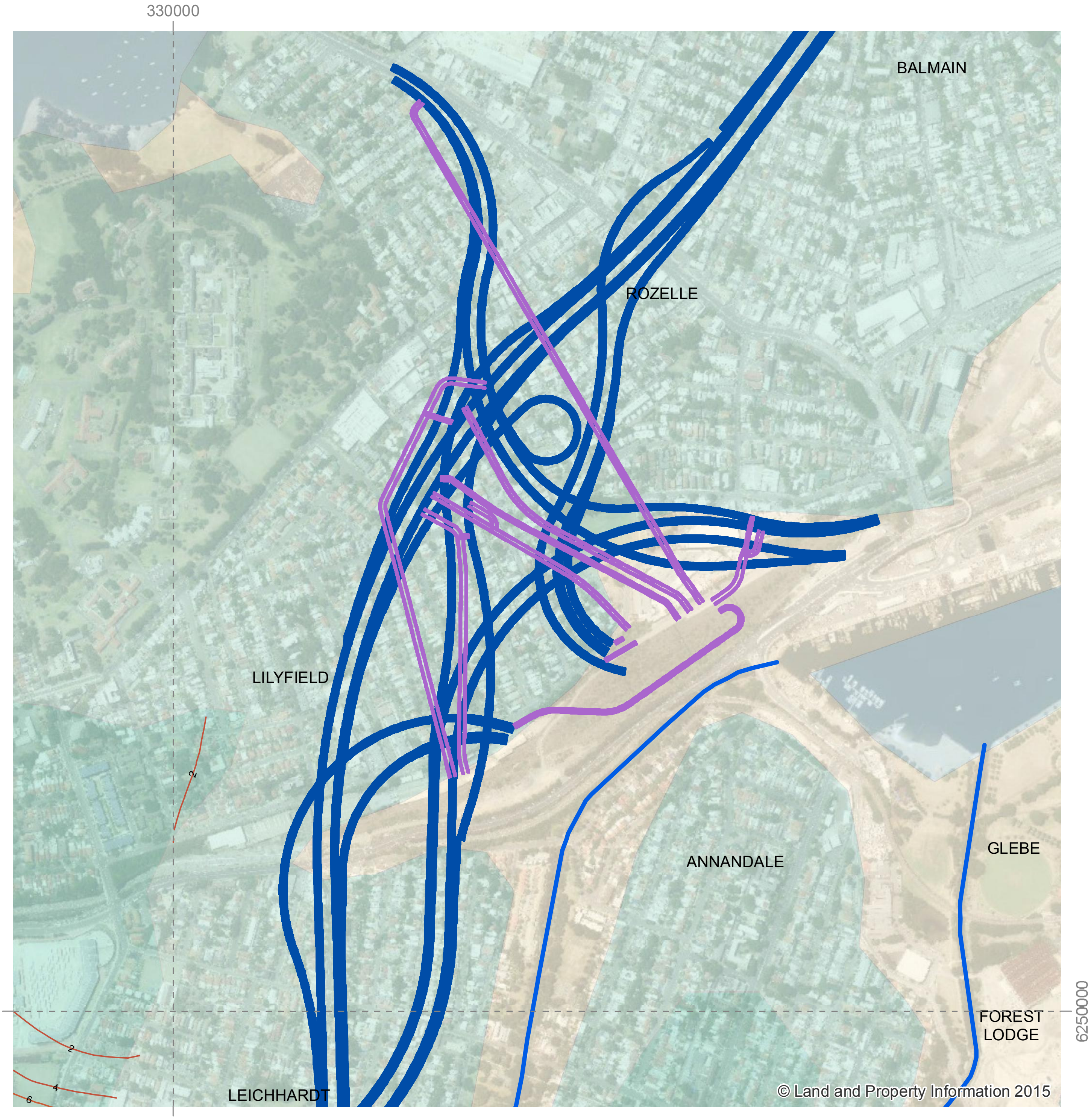
ASHFIELD SHALE DRAWDOWN AT PROJECT OPENING



Drawdown (m)

2 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 14
15 - 16
17 - 18
19 - 20
21 - 22
23 - 24
25 - 26
27 - 28
29 - 30
31 - 32
33 - 34
35 - 36
37 - 38
39 - 40
41 - 42
43 - 44
45 - 46
47 - 48
49 - 50
51 - 52
53 - 54
55 - 56
Ventilation_Tunnels

Model Boundary
River/Creek/Channel
Rozelle_Interchange
M4M5_Mainline
M5_East
WCX New M5
WCX M4 East

Outcrop Geology

Alluvium
Botany Sands
Bringelly Shale
Ashfield Shale
Hawkesbury Sandstone
Water

Scale: 10,000 @A4
GDA 1994 MGA Zone 56

0 0.075 0.15 0.3 0.45 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Project Opening (2023)
Ashfield Shale - L3 - Rozelle
[Model Run TR020]

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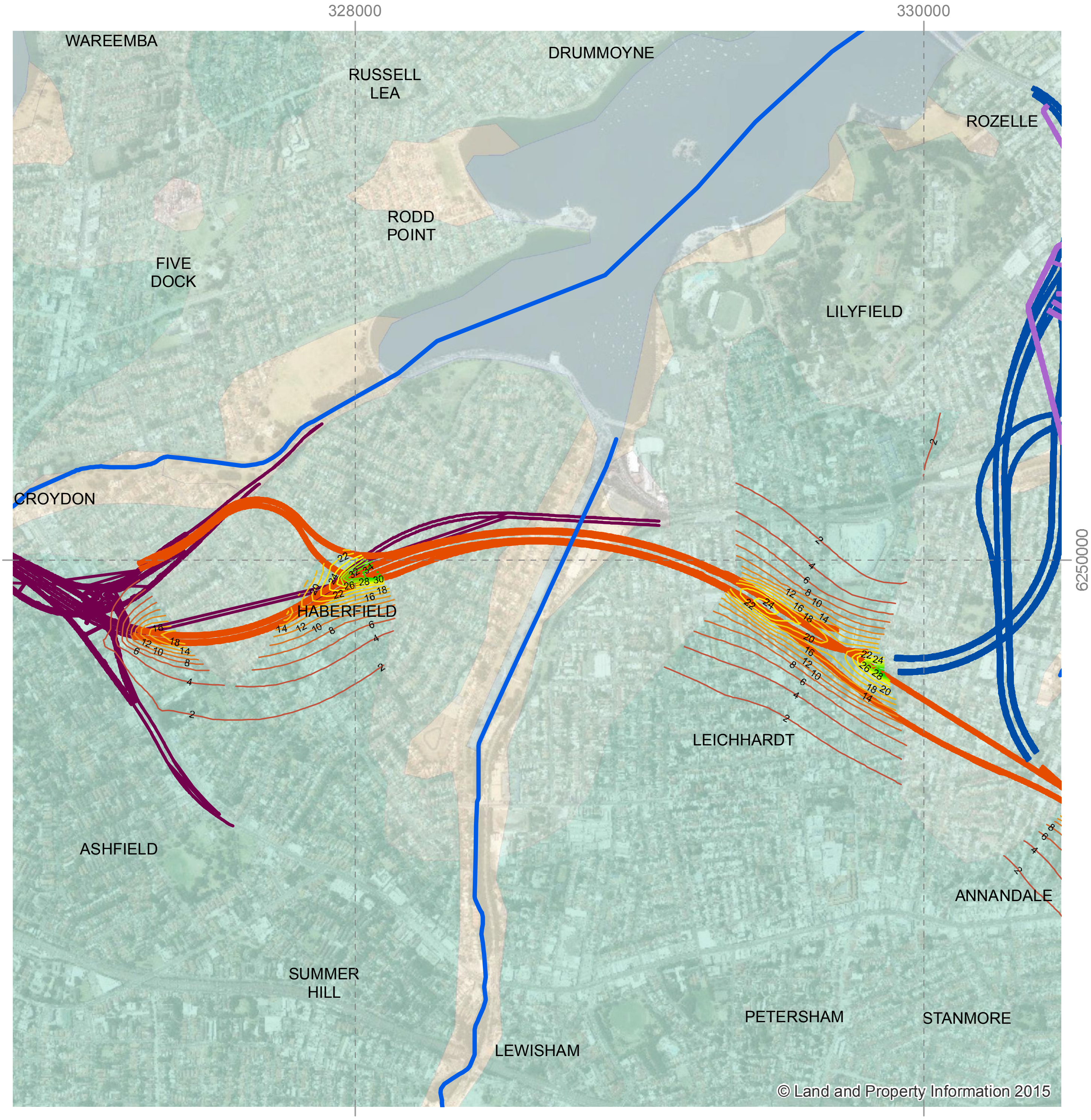

Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 20,000 @A4
GDA 1994 MGA Zone 56

0 0.15 0.3 0.6 0.9 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Project Opening (2023)
Ashfield Shale - L3 - Mainline NW
[Model Run TR020]

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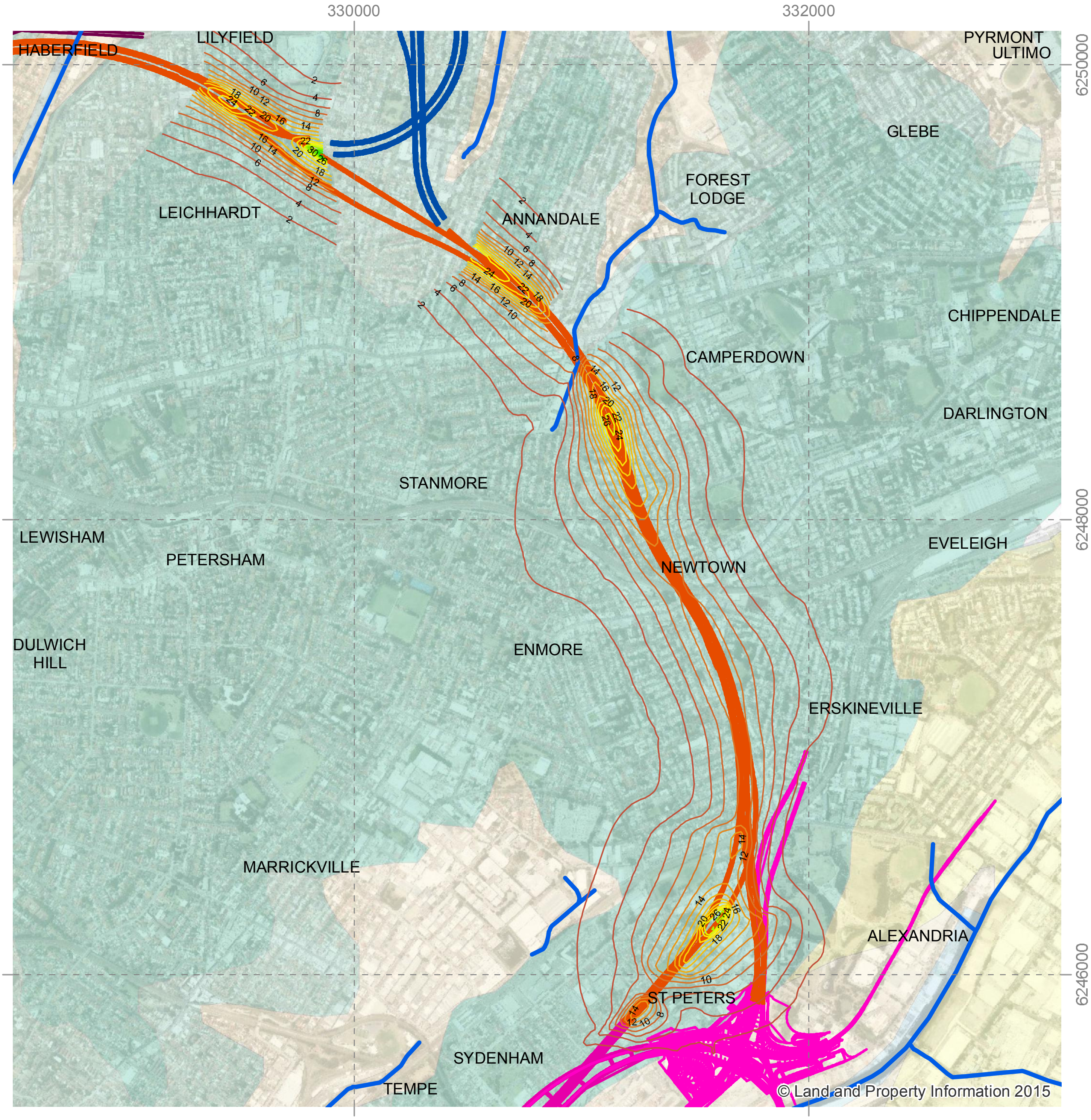

Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 25,000 @A4
GDA 1994 MGA Zone 56

0 0.2 0.4 0.8 1.2 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Project Opening (2023)
Ashfield Shale - L3 - Mainline SE
[Model Run TR020]

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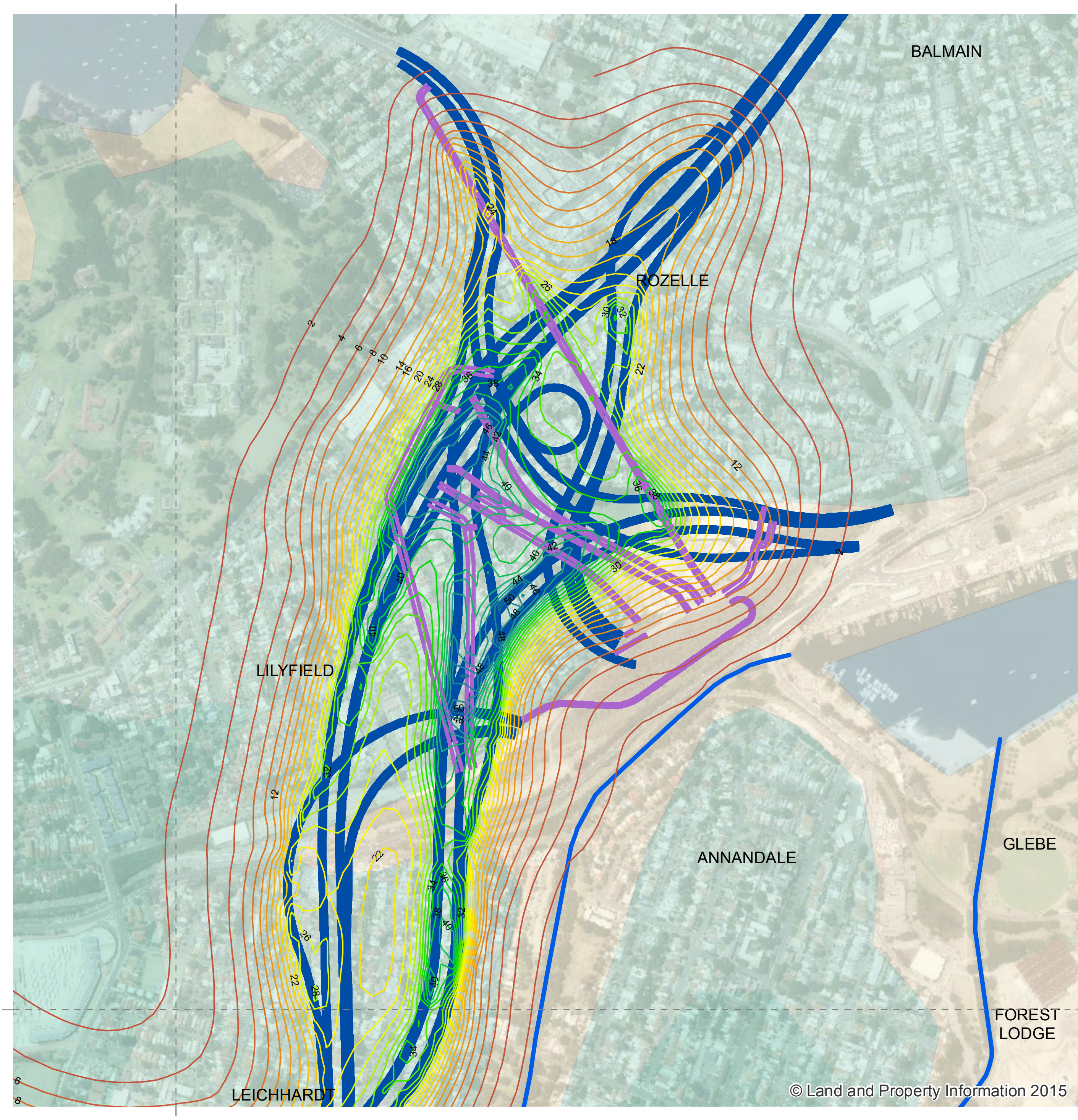
HAWKESBURY SANDSTONE DRAWDOWN AT PROJECT OPENING



Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 10,000 @A4
GDA 1994 MGA Zone 56

0 0.075 0.15 0.3 0.45 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Project Opening (2023)
Hawkesbury Sandstone - L6 - Rozelle
[Model Run TR020]

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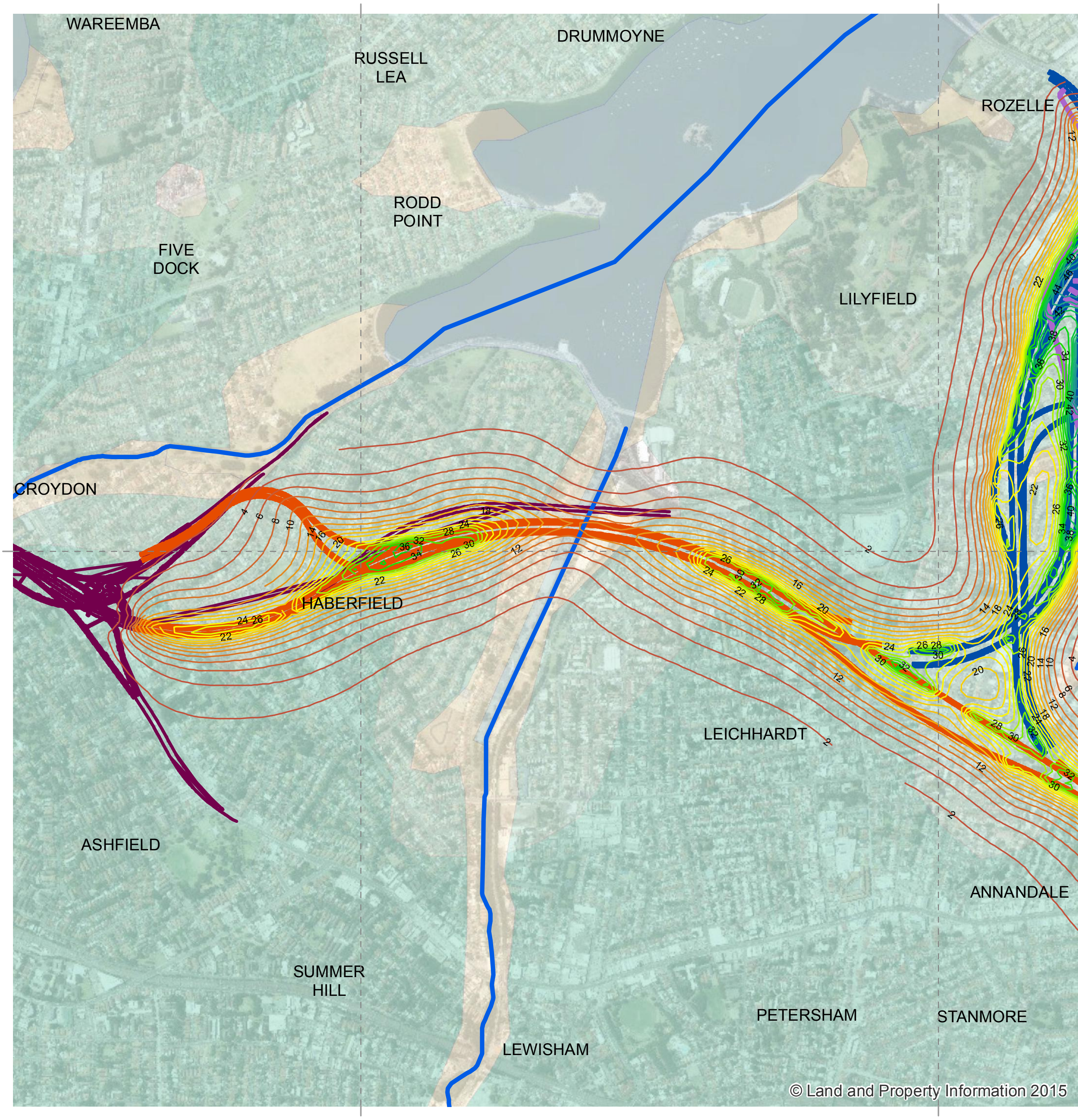

Drawdown (m)

2 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 14
15 - 16
17 - 18
19 - 20
21 - 22
23 - 24
25 - 26
27 - 28
29 - 30
31 - 32
33 - 34
35 - 36
37 - 38
39 - 40
41 - 42
43 - 44
45 - 46
47 - 48
49 - 50
51 - 52
53 - 54
55 - 56
Ventilation_Tunnels

Model Boundary
River/Creek/Channel
Rozelle_Interchange
M4M5_Mainline
M5_East
WCX New M5
WCX M4 East

Outcrop Geology

Alluvium
Botany Sands
Bringelly Shale
Ashfield Shale
Hawkesbury Sandstone
Water

Scale: 20,000 @A4
GDA 1994 MGA Zone 56

0 0.15 0.3 0.6 0.9 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Project Opening (2023)
Hawkesbury Sandstone - L6 - Mainline NW
[Model Run TR020]

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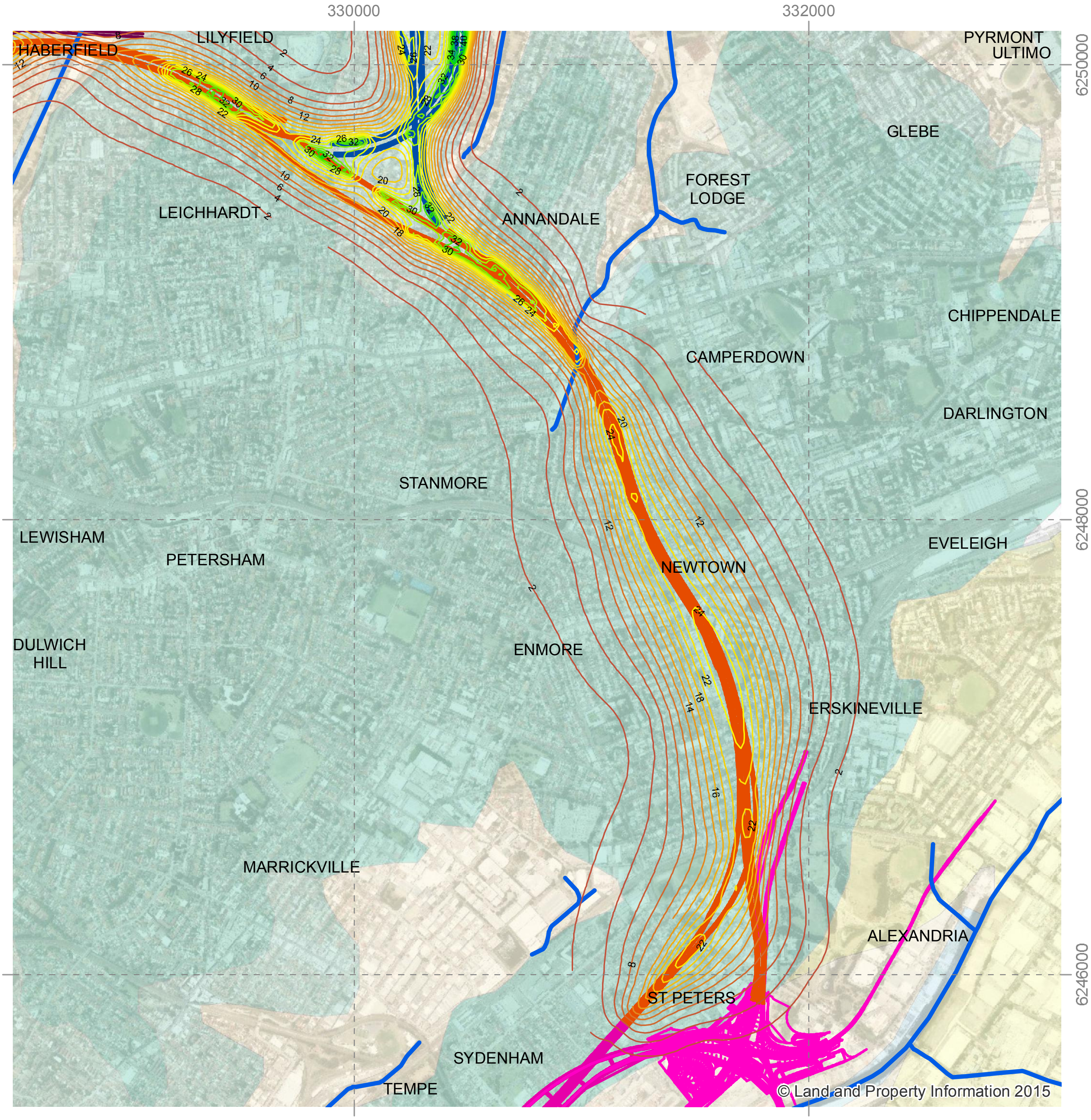

Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 25,000 @A4
GDA 1994 MGA Zone 56

0 0.2 0.4 0.8 1.2 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Project Opening (2023)
Hawkesbury Sandstone - L6 - Mainline SE
[Model Run TR020]

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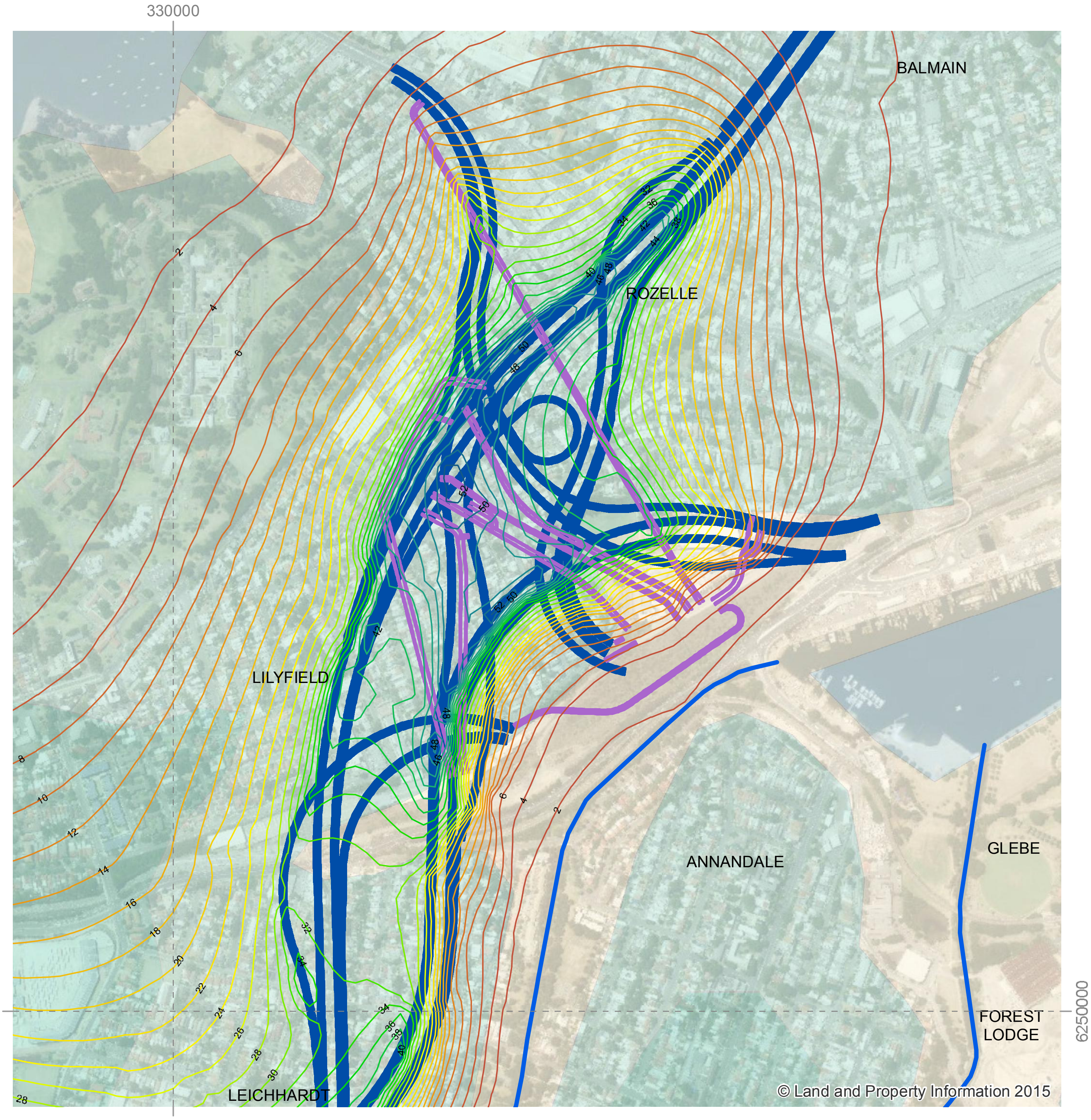
WATER TABLE DRAWDOWN AT YEAR 2100



Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 10,000 @A4
GDA 1994 MGA Zone 56

0 0.075 0.15 0.3 0.45 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Year 2100
Alluvium and Botany Sands - L1 - Rozelle
[Model Run TR020]

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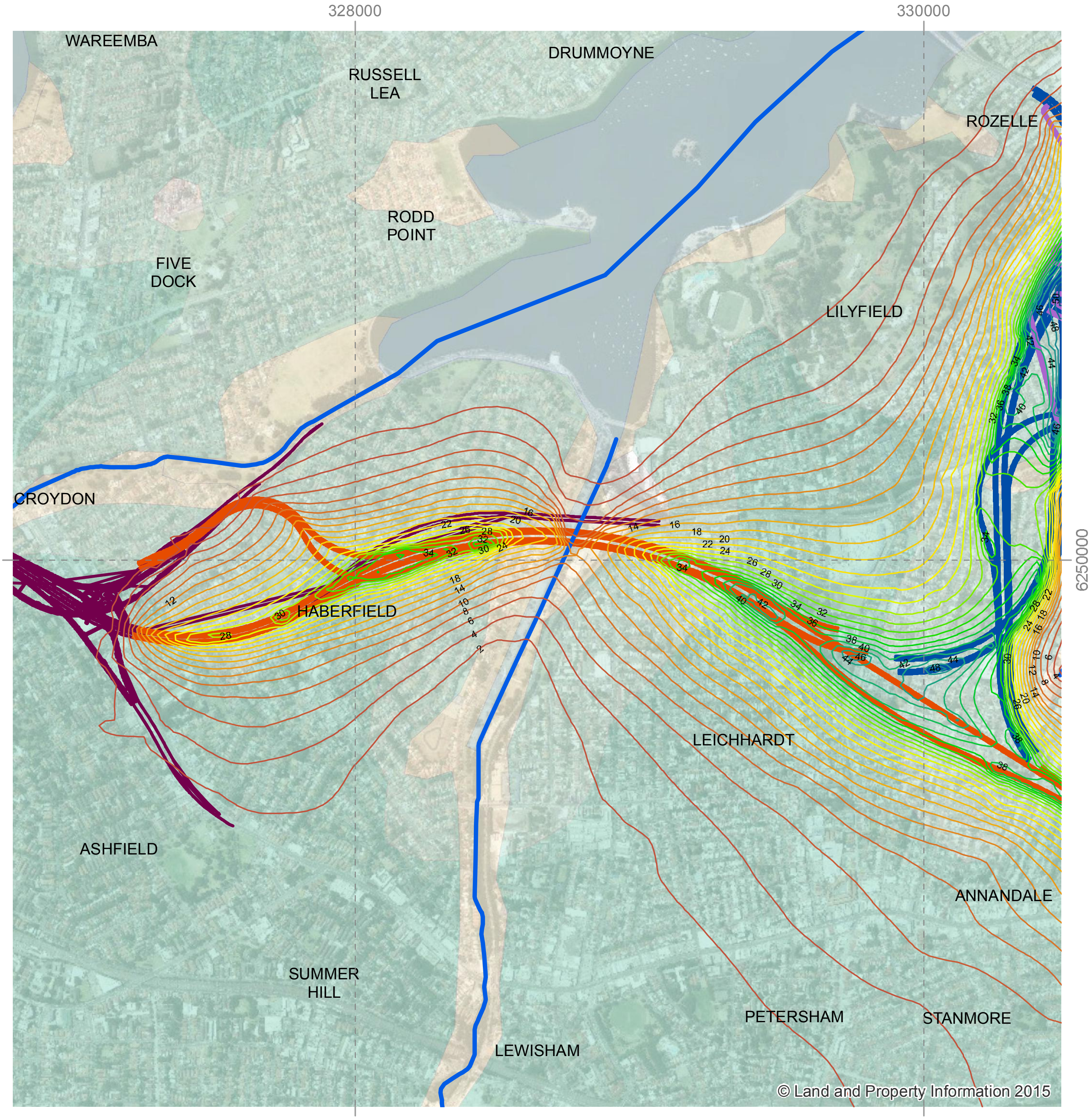

Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 20,000 @A4
GDA 1994 MGA Zone 56

0 0.15 0.3 0.6 0.9 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Year 2100
Alluvium and Botany Sands - L1 - Mainline NW
[Model Run TR020]

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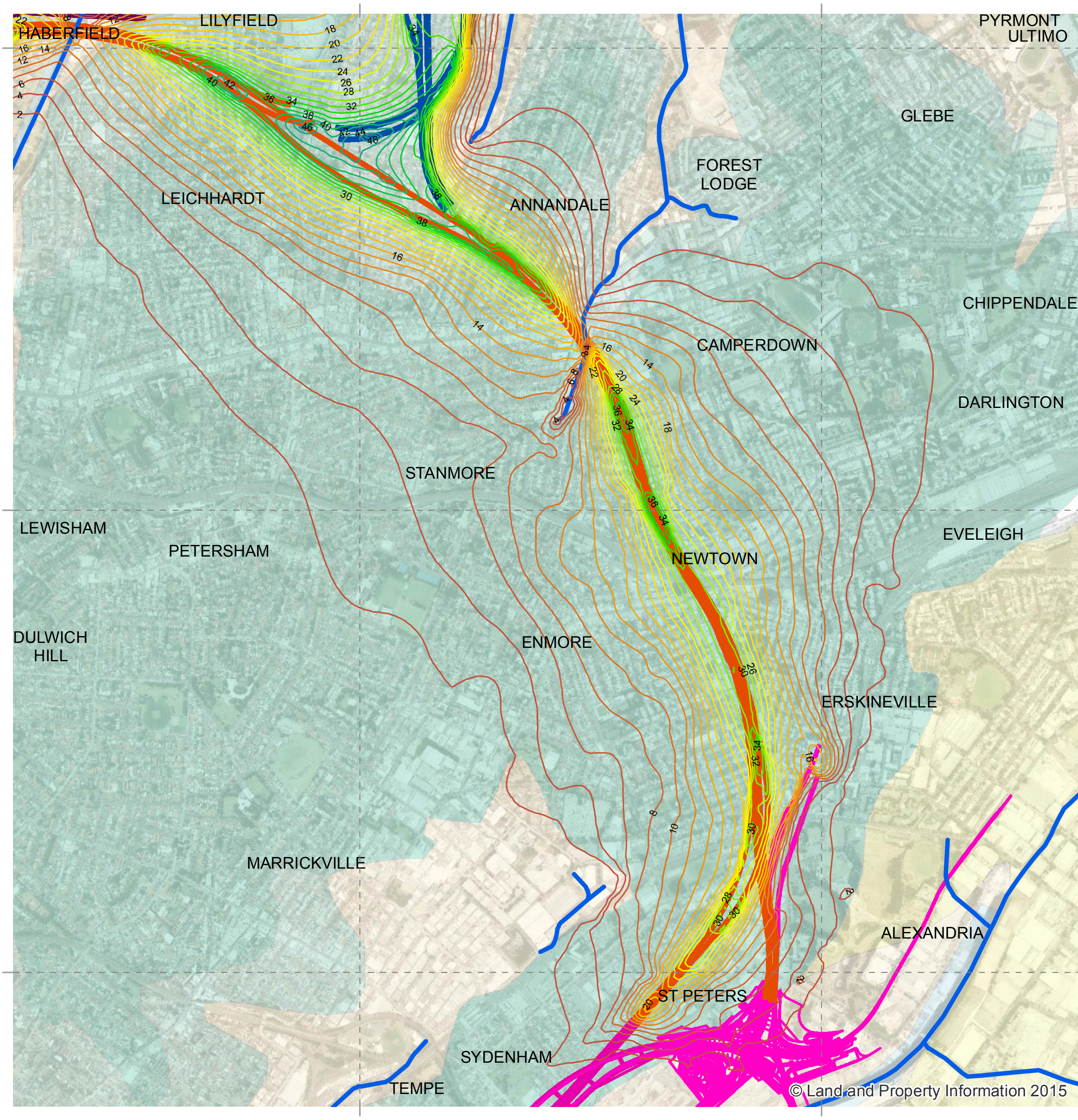

Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 25,000 @A4
GDA 1994 MGA Zone 56

0 0.2 0.4 0.8 1.2 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Year 2100
Alluvium and Botany Sands - L1 - Mainline SE
[Model Run TR020]

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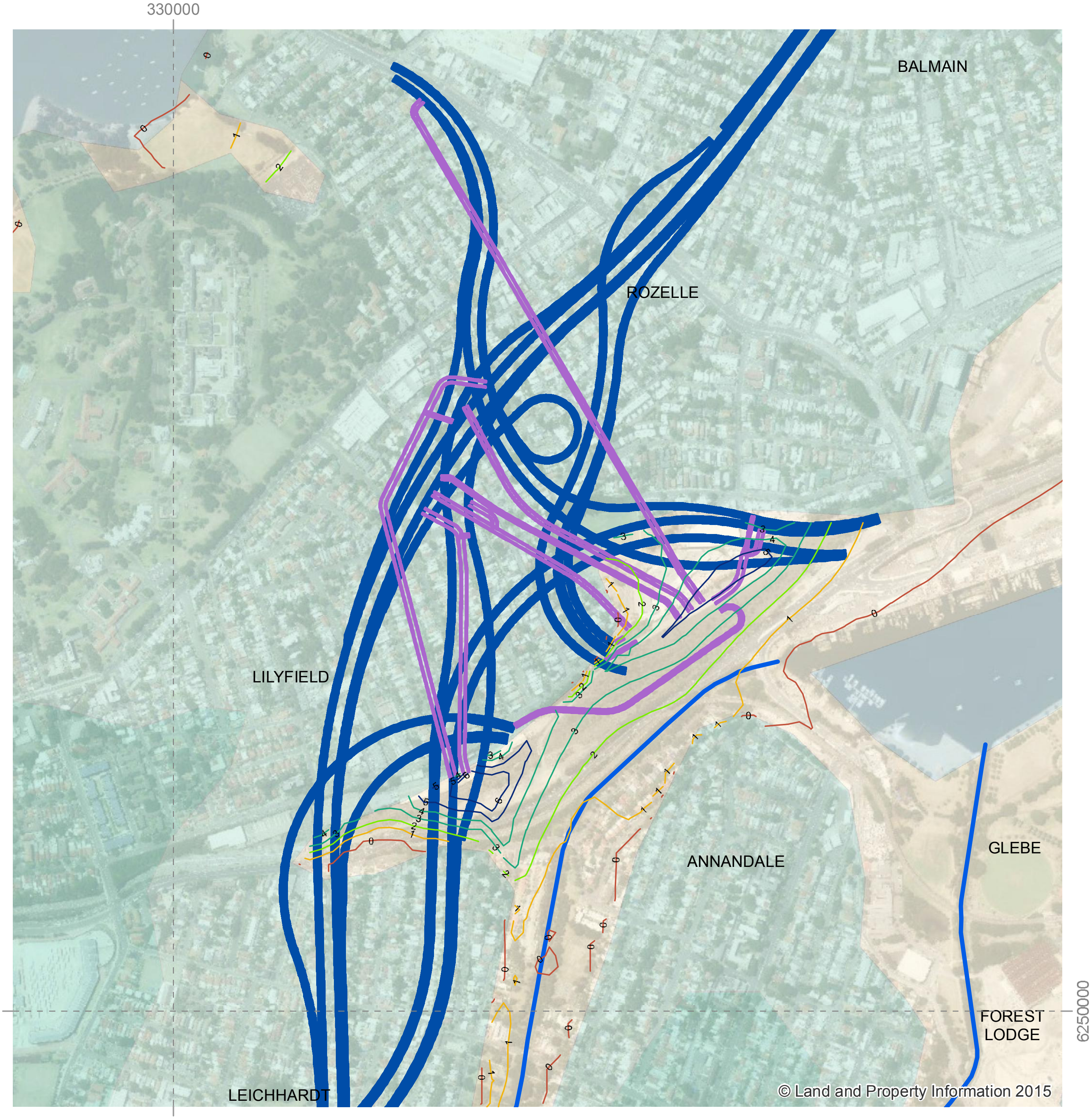
UNCONSOLIDATED SEDIMENT DRAWDOWN AT YEAR 2100



Drawdown (m)

- 0
- 1
- 2
- 3 - 4
- 5 - 6
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

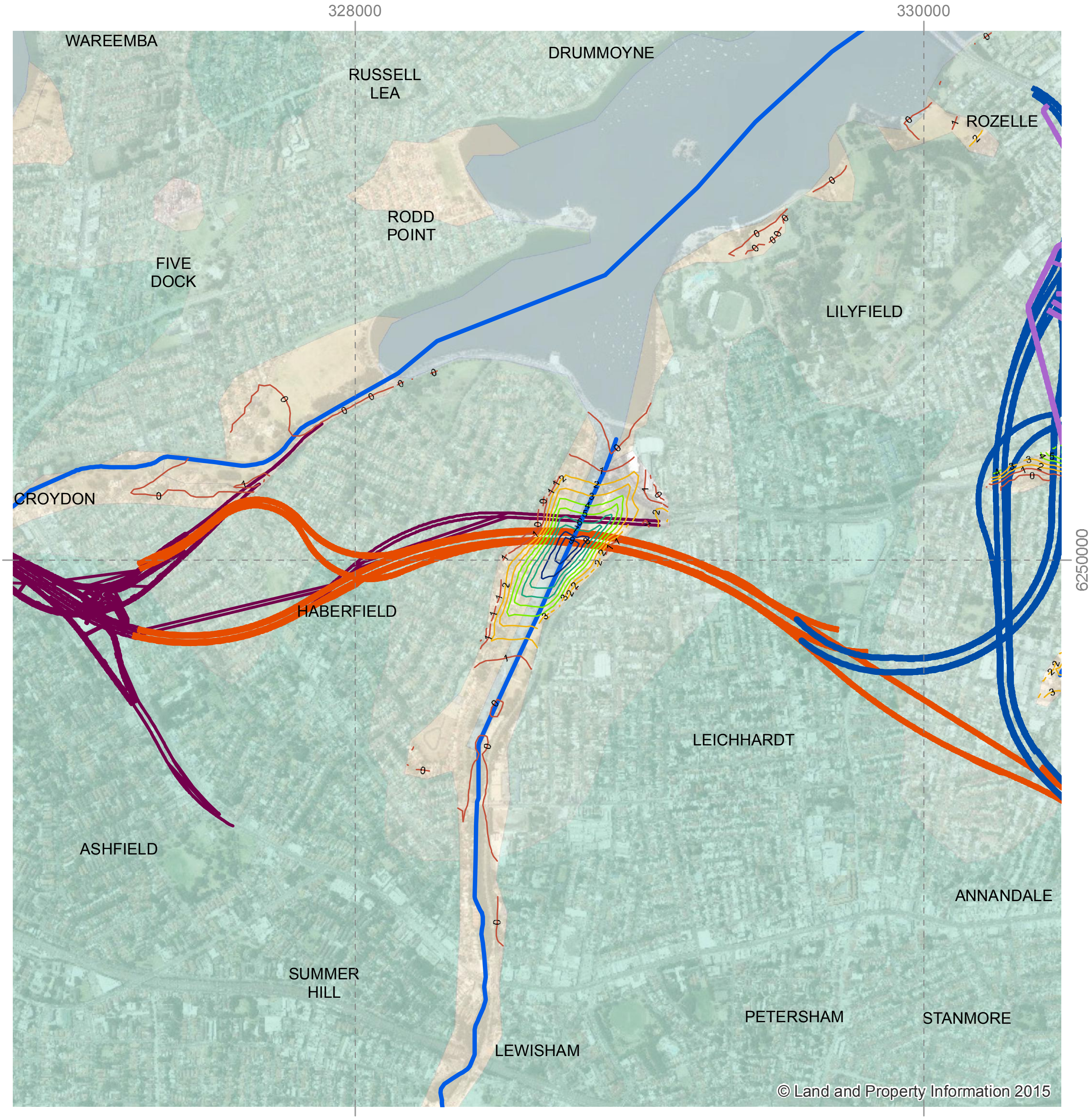
Scale: 10,000 @A4
GDA 1994 MGA Zone 56

0 0.075 0.15 0.3 0.45 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Year 2100 Alluvium and Botany Sands - L1 - Rozelle [Model Run TR020]

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Drawdown_Incremental_Alluvium_Opening_Rozelle.mxd



WestConnex M4-M5 Link

M4-M5 Link Drawdown at Year 2100

Alluvium and Botany Sands - L1 - Mainline NW [Model Run TR020]

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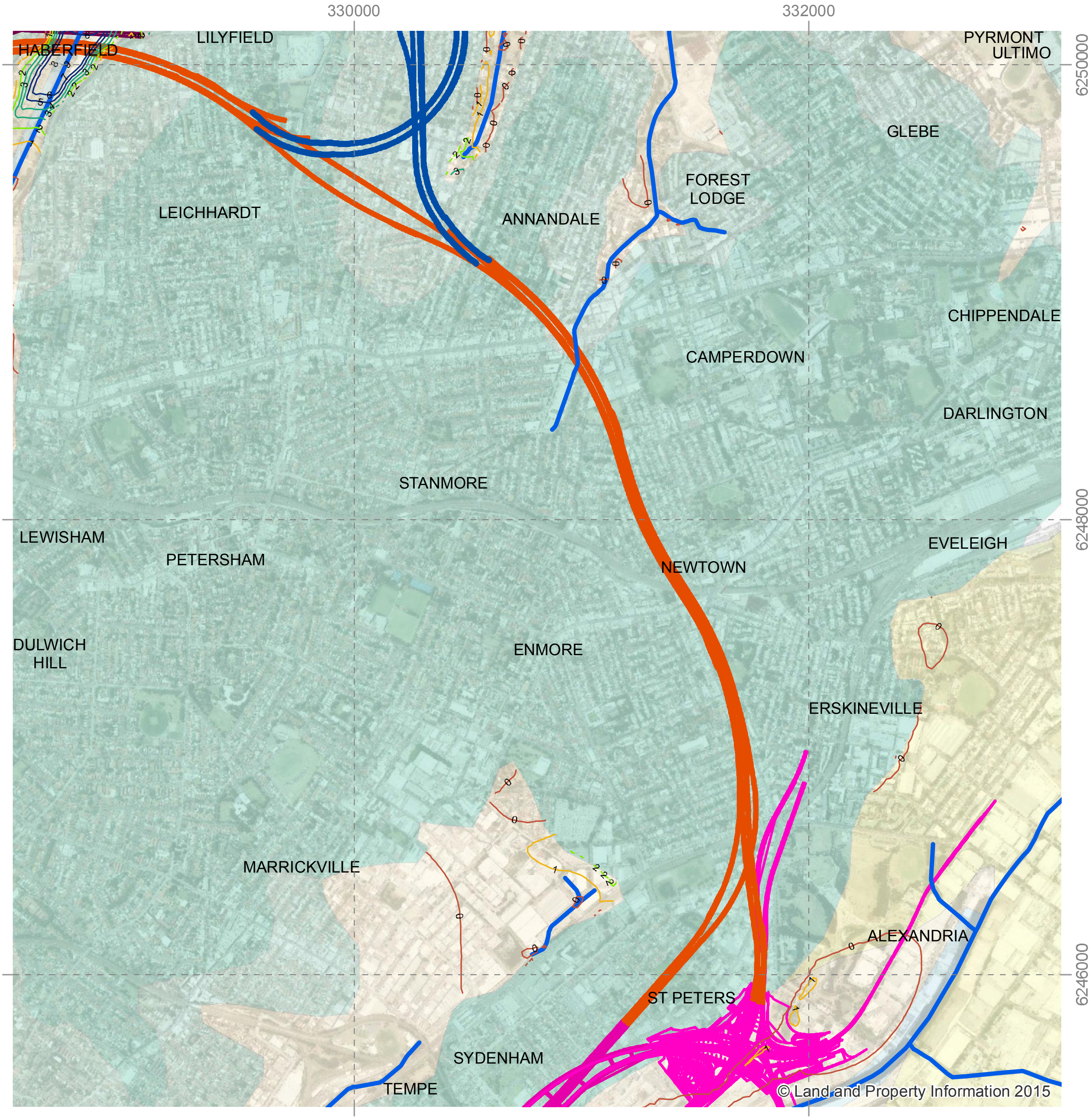

Drawdown (m)

- 0
- 1
- 2
- 3 - 4
- 5 - 6
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 25,000 @A4
GDA 1994 MGA Zone 56

0 0.2 0.4 0.8 1.2 km

WestConnex M4-M5 Link
M4-M5 Link Drawdown at Year 2100
Alluvium and Botany Sands - L1 - Mainline SE [Model Run TR020]

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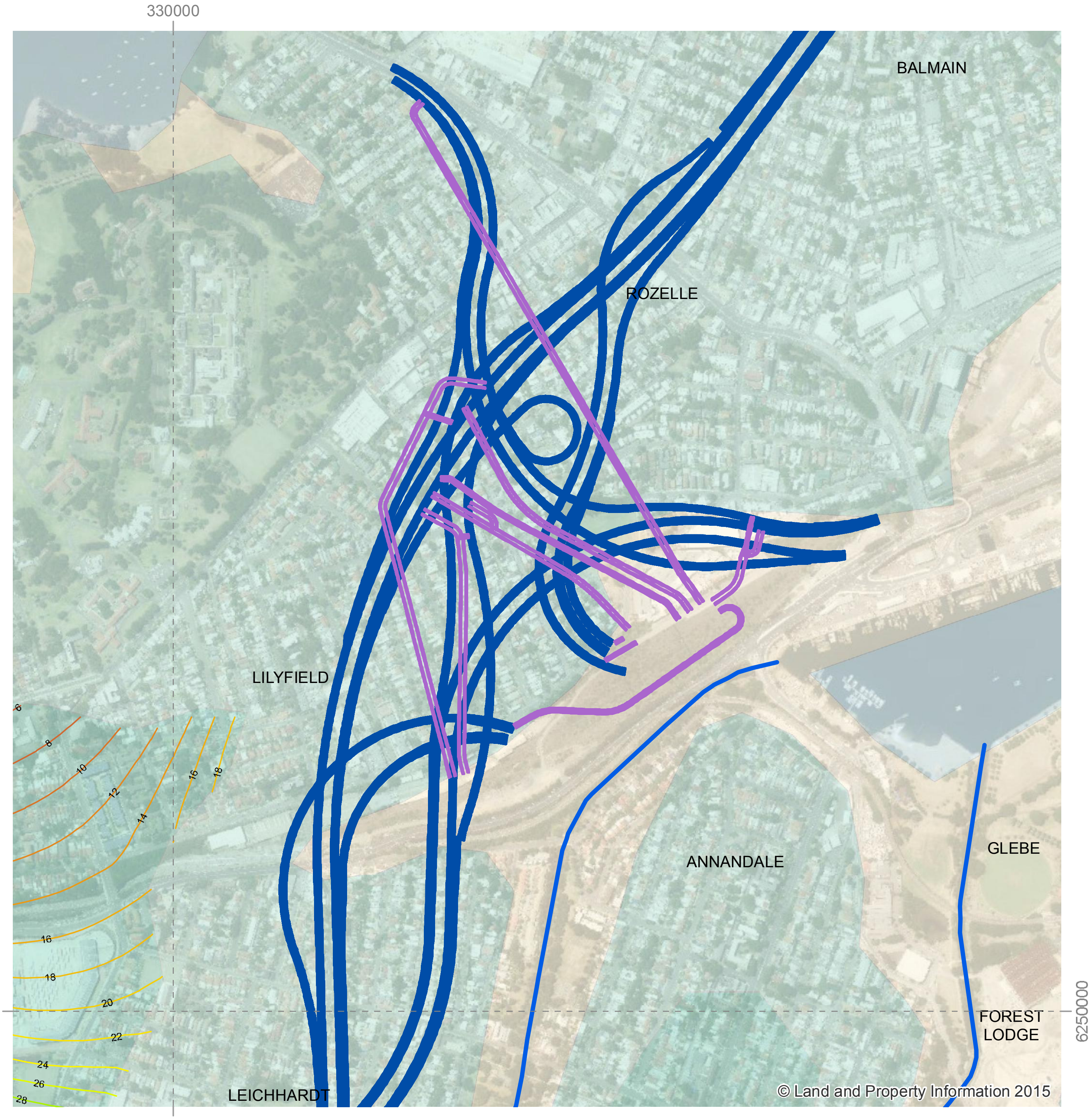
ASHFIELD SHALE DRAWDOWN AT YEAR 2100



Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Year 2100
Ashfield Shale - L3 - Rozelle
[Model Run TR020]

Scale: 10,000 @A4
GDA 1994 MGA Zone 56

0 0.075 0.15 0.3 0.45 km

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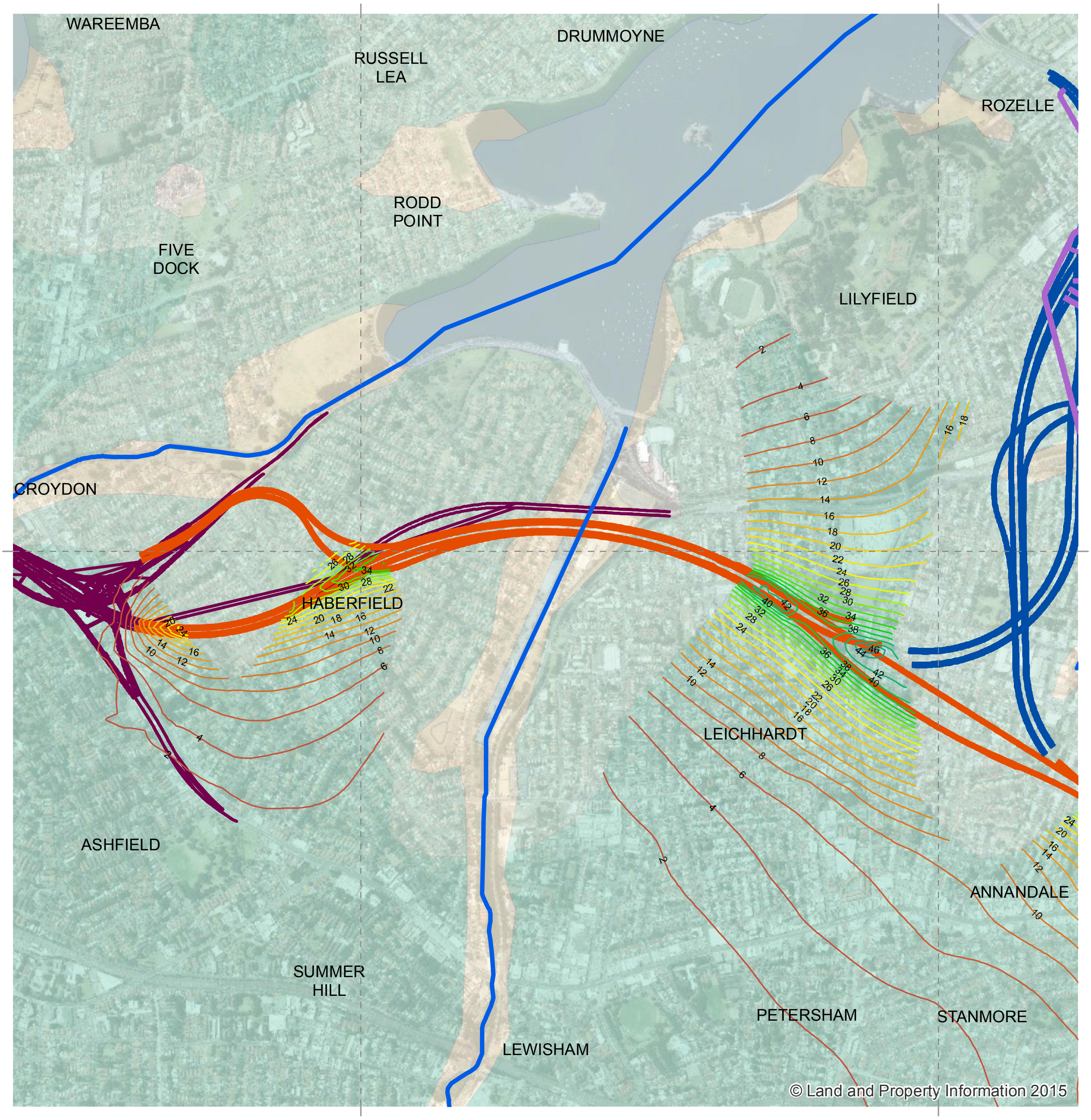

Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 20,000 @A4
GDA 1994 MGA Zone 56

0 0.15 0.3 0.6 0.9 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Year 2100
Ashfield Shale - L3 - Mainline NW
[Model Run TR020]

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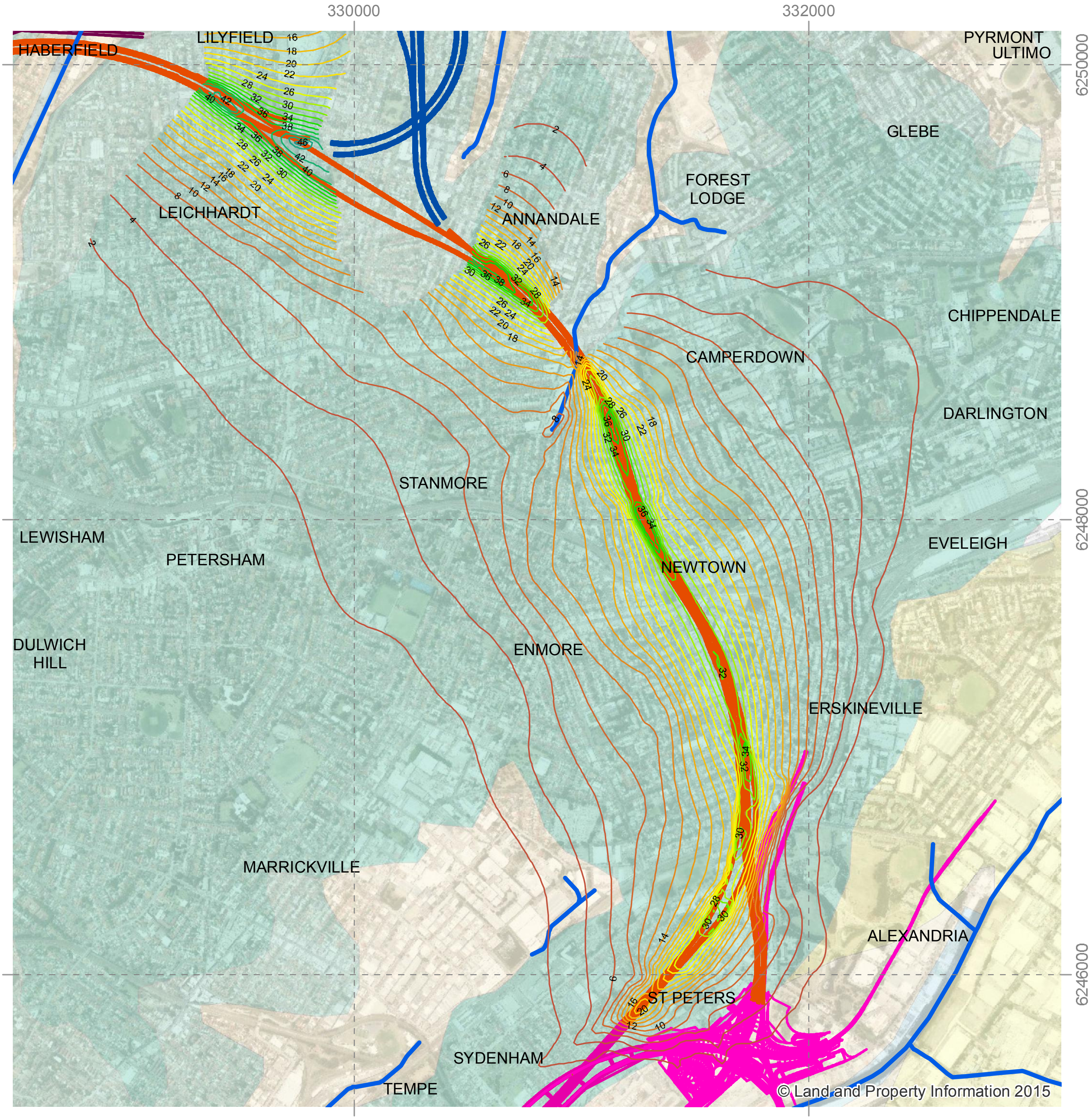


Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 25,000 @A4
GDA 1994 MGA Zone 56

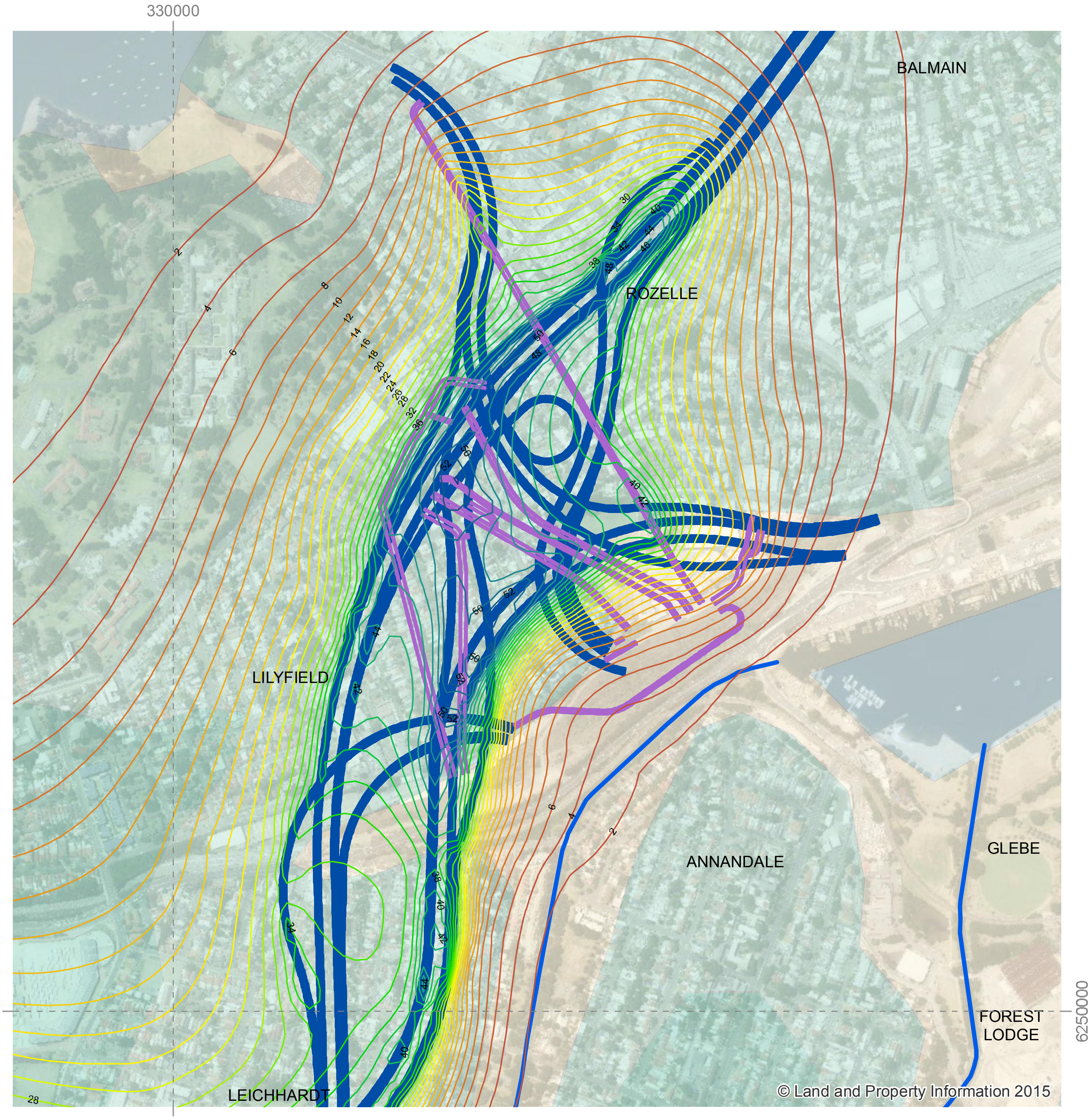
0 0.2 0.4 0.8 1.2 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Year 2100
Ashfield Shale - L3 - Mainline SE
[Model Run TR020]

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Drawdown_Incremental_Alluvium_Opening_MainlineSE.mxd

HAWKESBURY SANDSTONE DRAWDOWN AT YEAR 2100



Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

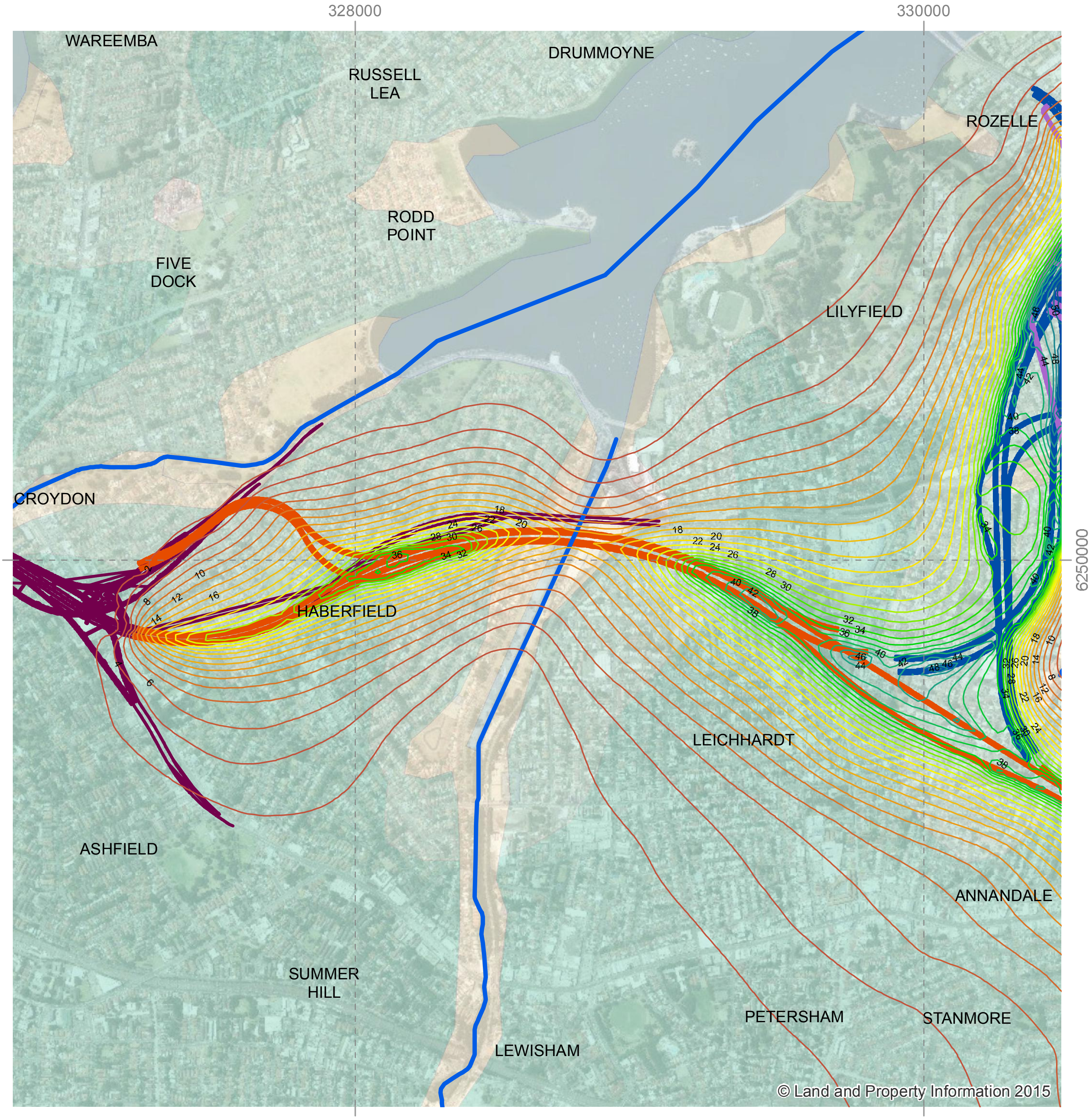
Scale: 10,000 @A4
GDA 1994 MGA Zone 56

0 0.075 0.15 0.3 0.45 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Year 2100
Hawkesbury Sandstone - L6 - Rozelle
[Model Run TR020]

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Drawdown_Incremental_Alluvium_Opening_Rozelle.mxd



Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

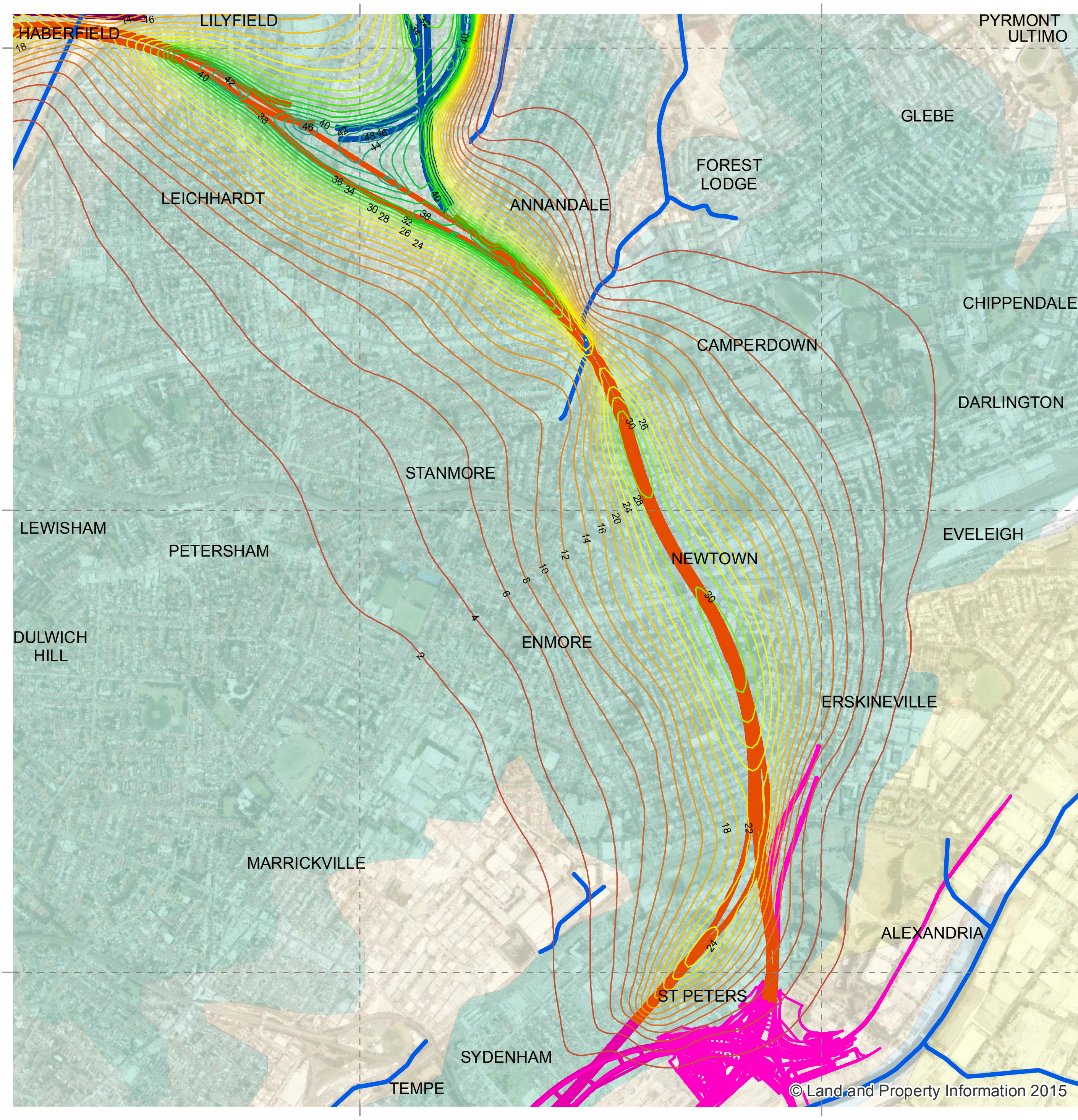
Scale: 20,000 @A4
GDA 1994 MGA Zone 56

0 0.15 0.3 0.6 0.9 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Year 2100
Hawkesbury Sandstone - L6 - Mainline NW
[Model Run TR020]

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Drawdown_Incremental_Alluvium_Opening_MainlineNW.mxd



Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56
- Ventilation_Tunnels

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 25,000 @A4
GDA 1994 MGA Zone 56

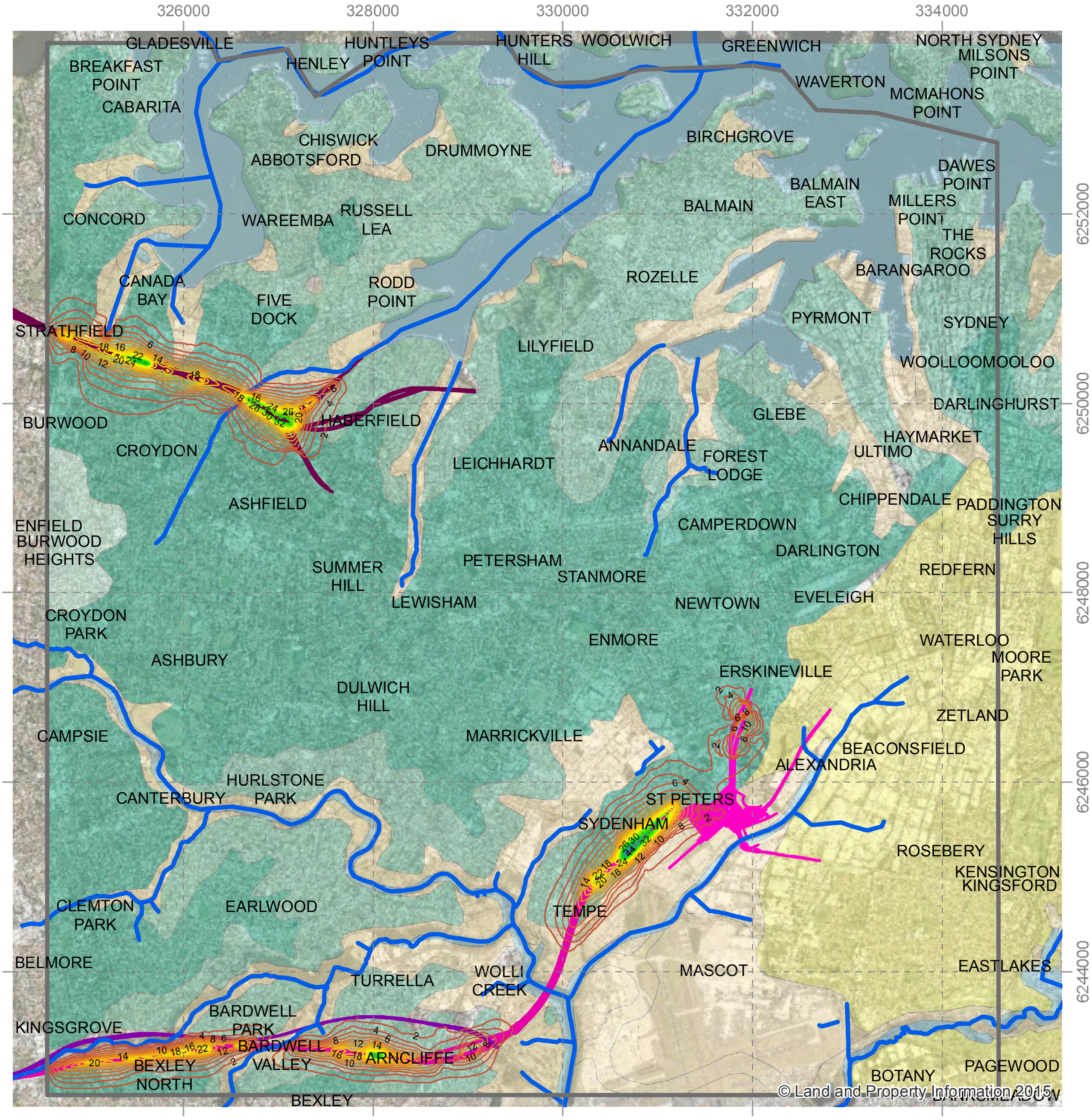
0 0.2 0.4 0.8 1.2 km

WestConnex M4-M5 Link

M4-M5 Link Drawdown at Year 2100
Hawkesbury Sandstone - L6 - Mainline SE
[Model Run TR020]

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Drawdown_Incremental_Alluvium_Opening_MainlineSE.mxd

ANNEXURE D – DRAWDOWN DUE TO M4 EAST AND NEW M5 (NO M4-M5 LINK)



Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56

- Model Boundary
- River/Creek/Channel
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 60,000 @A4
GDA 1994 MGA Zone 56

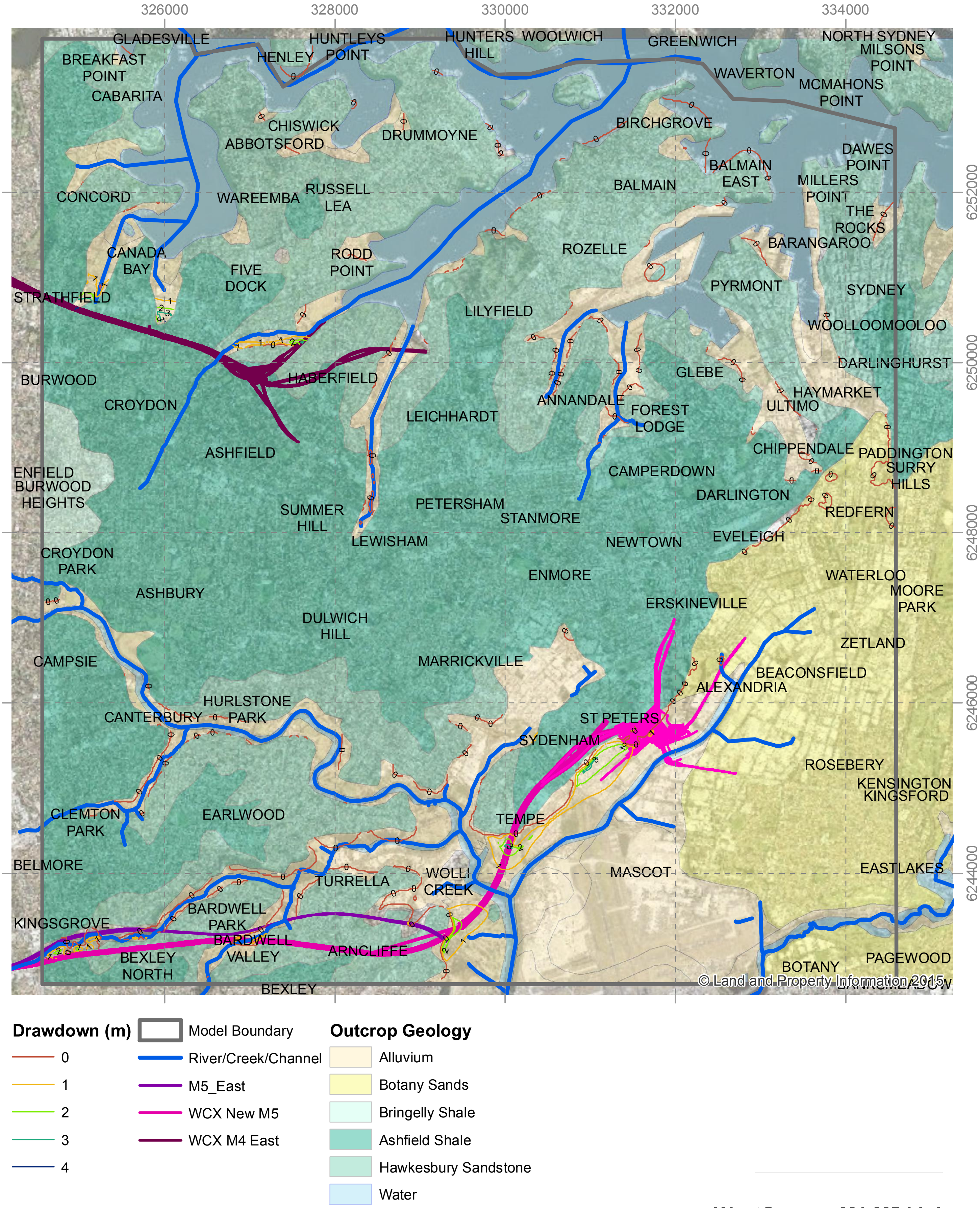
0 0.5 1 2 3 km

WestConnex M4-M5 Link

M4 East and New M5 Cumulative Drawdown at Project Opening (2023)

Water Table [Model Run TR020]

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Drawdown_Incremental_Alluvium_Opening.mxd



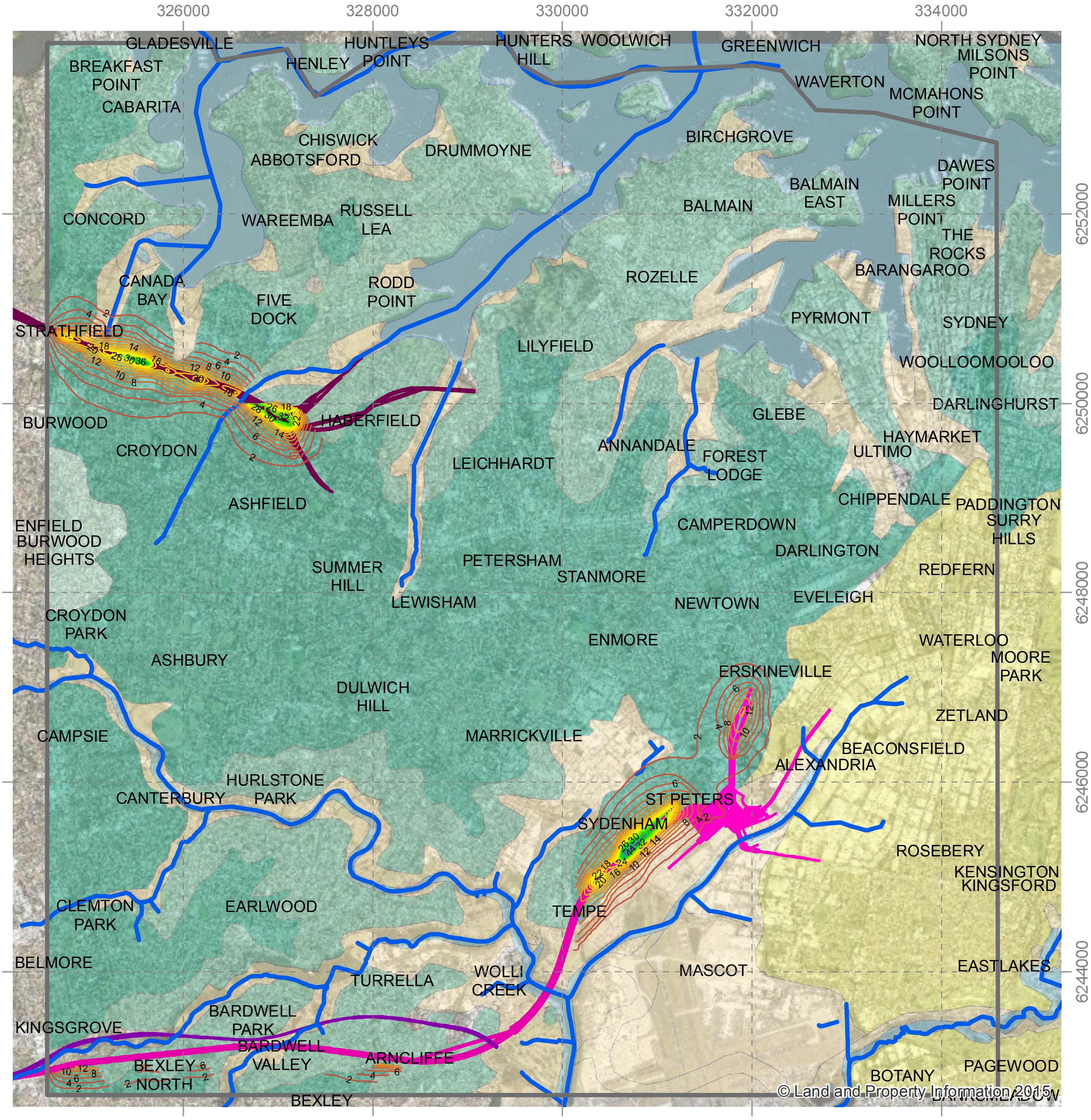
WestConnex M4-M5 Link

M4 East and New M5
Unconsolidated Sediment Cumulative Drawdown
at Project Opening (2023)
Alluvium and Botany Sands - L1
[Model Run TR020]

Scale: 60,000 @A4
GDA 1994 MGA Zone 56

0 0.5 1 2 3 km

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\GroundwaterLevel.mxd



Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56

- Model Boundary
- River/Creek/Channel
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

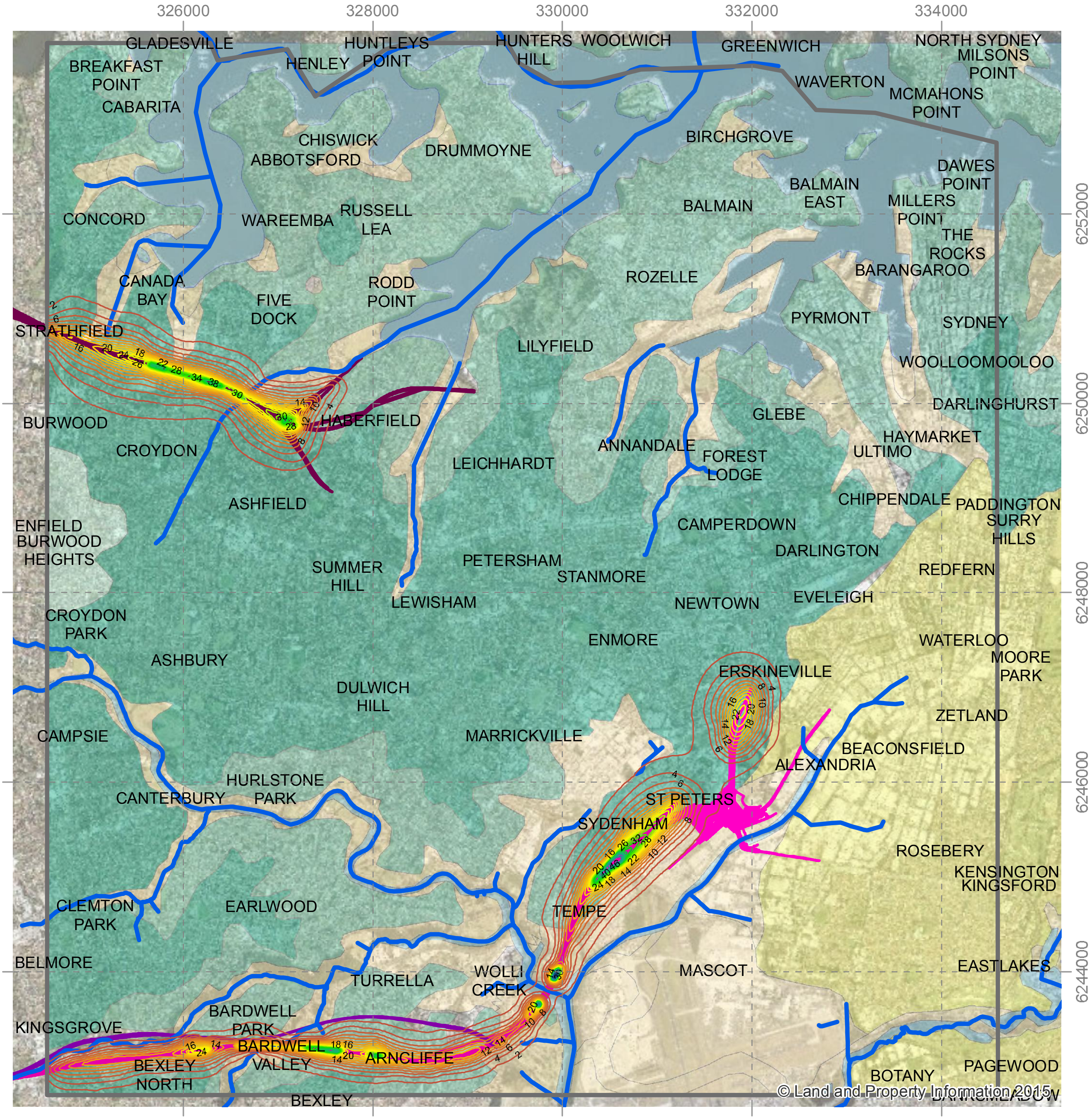
Scale: 60,000 @A4
GDA 1994 MGA Zone 56

0 0.5 1 2 3 km

WestConnex M4-M5 Link

M4 East and New M5 Cumulative Drawdown at Project Opening (2023) Ashfield Shale - L3 [Model Run TR020]

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Drawdown_Incremental_Alluvium_Opening.mxd



Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56

- Model Boundary
- River/Creek/Channel
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

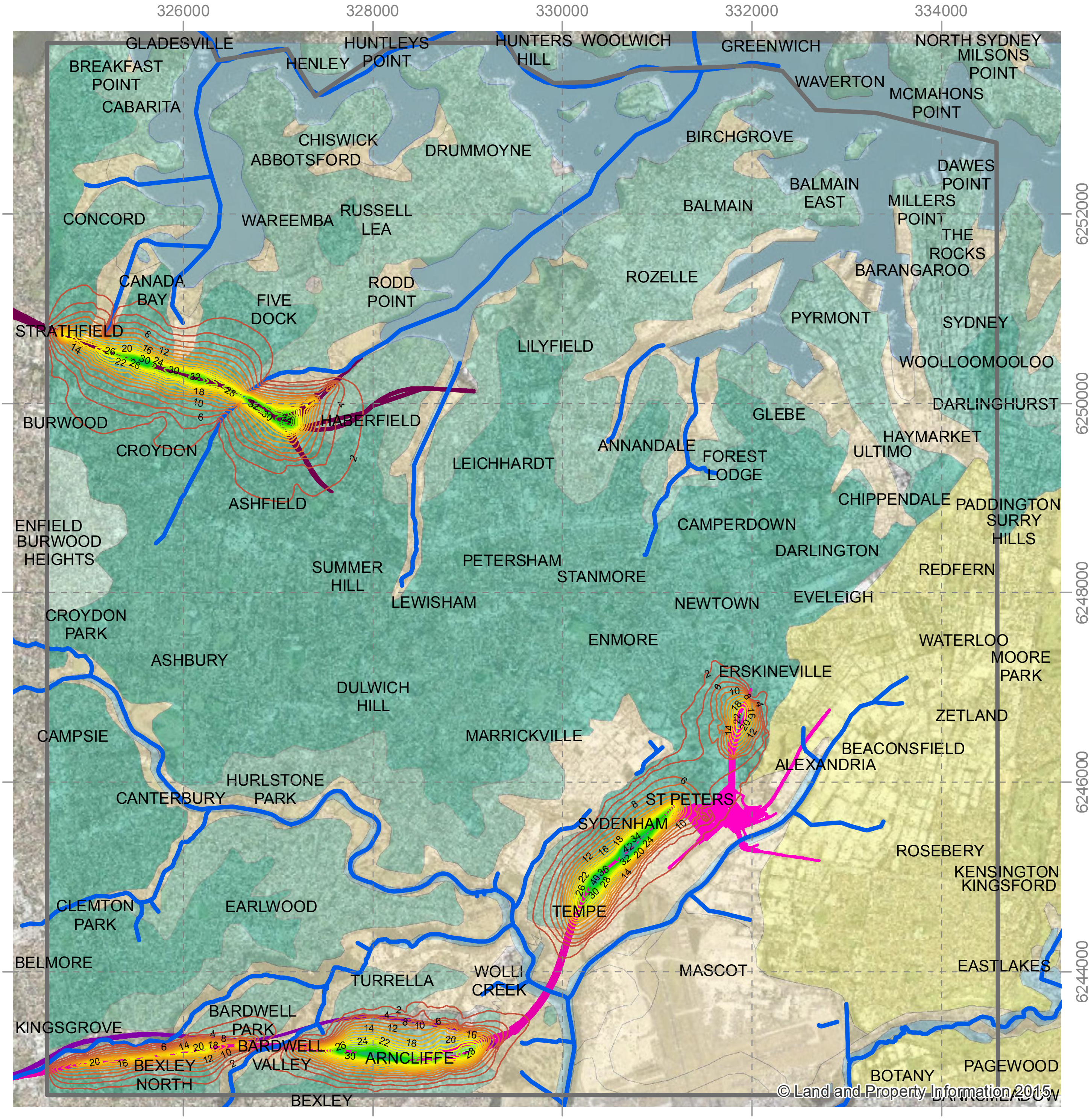
Scale: 60,000 @A4
GDA 1994 MGA Zone 56

0 0.5 1 2 3 km

WestConnex M4-M5 Link

M4 East and New M5 Cumulative Drawdown at Project Opening (2023) Hawkesbury Sandstone - L6 [Model Run TR020]

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Drawdown_Incremental_Alluvium_Opening.mxd



Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56

- Model Boundary
- River/Creek/Channel
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

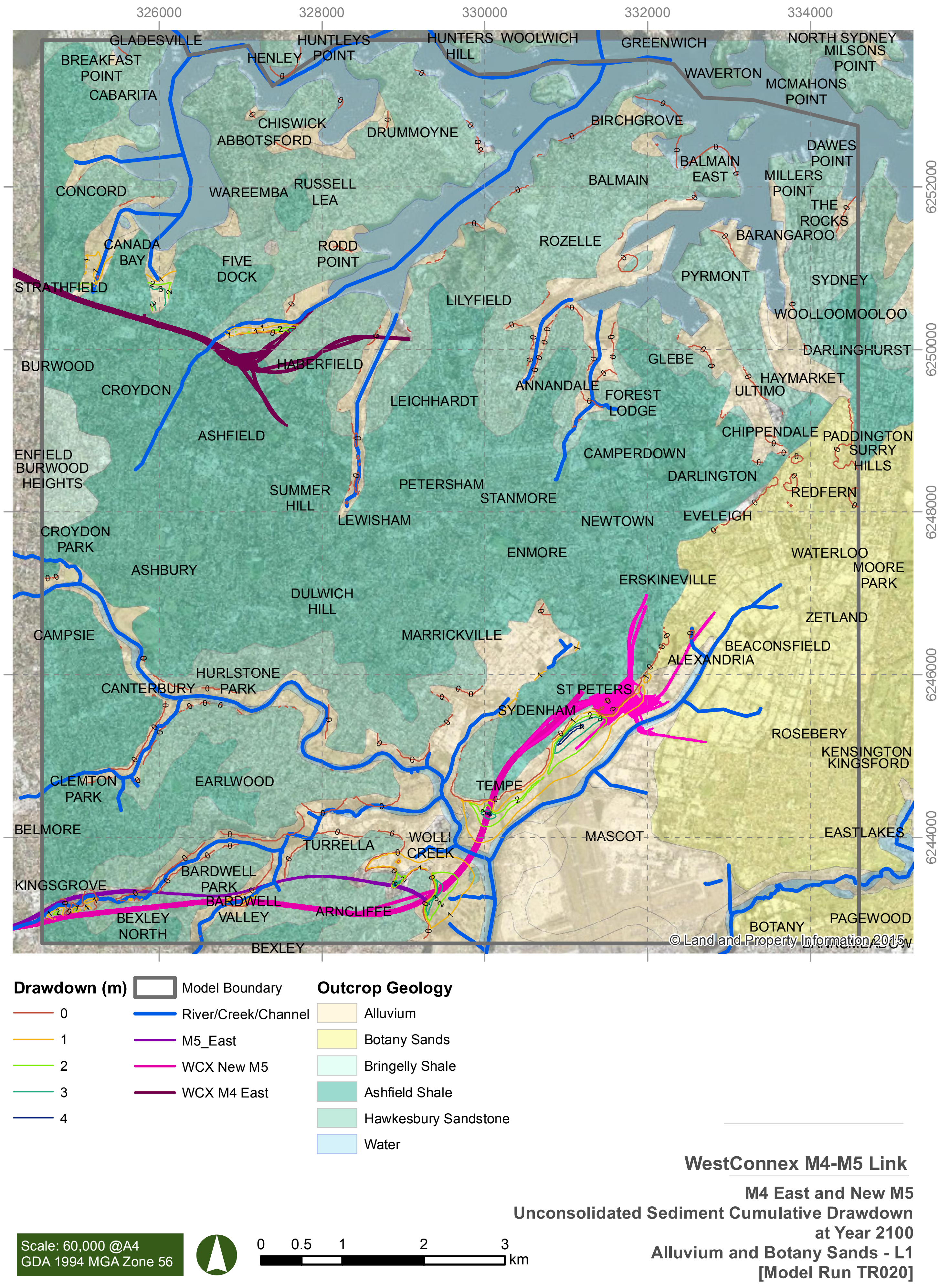
Scale: 60,000 @A4
GDA 1994 MGA Zone 56

0 0.5 1 2 3 km

WestConnex M4-M5 Link

M4 East and New M5 Cumulative Drawdown at Year 2100 Water Table [Model Run TR020]

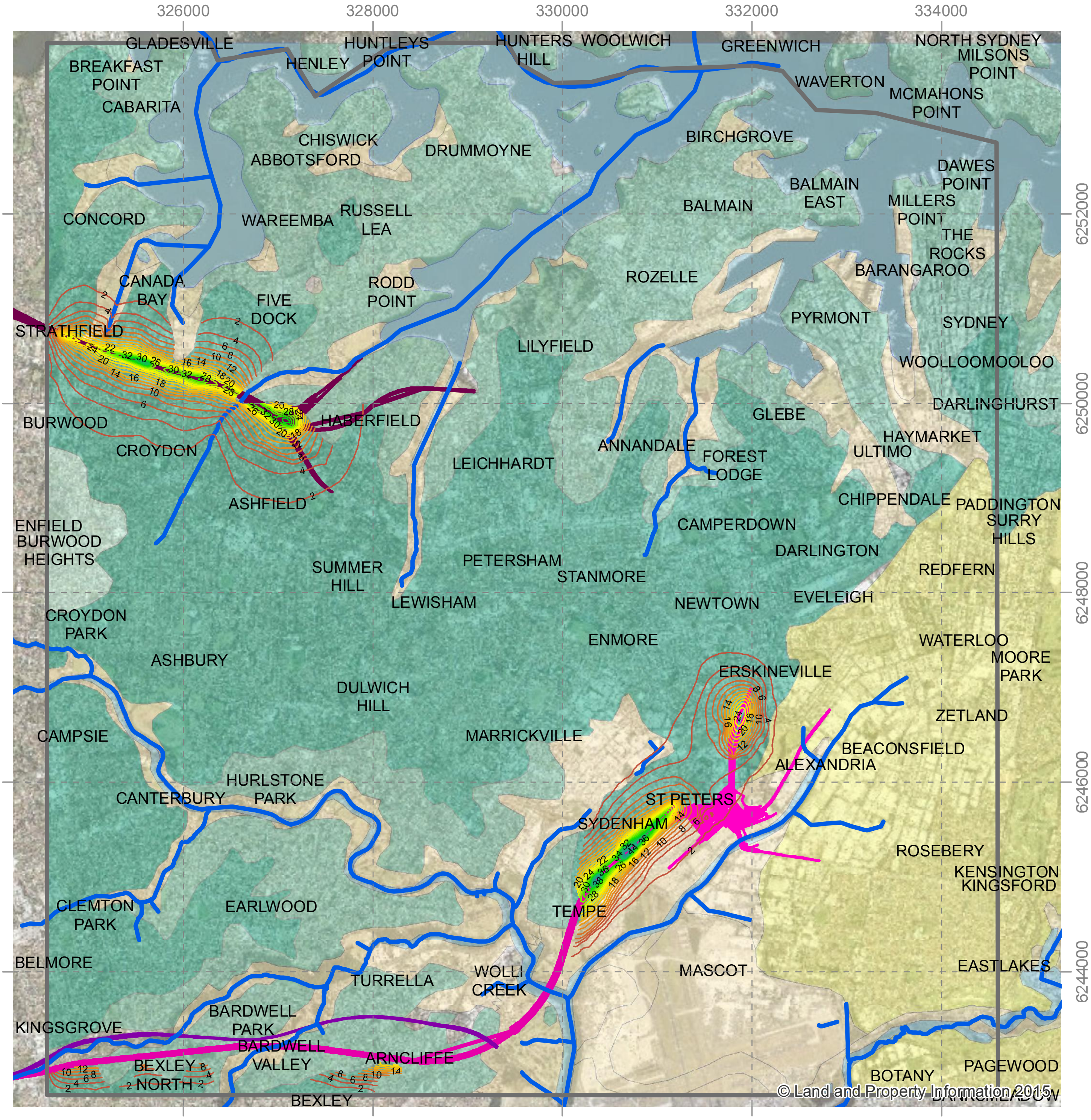
X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Drawdown_Incremental_Alluvium_Opening.mxd



WestConnex M4-M5 Link

M4 East and New M5
Unconsolidated Sediment Cumulative Drawdown at Year 2100
Alluvium and Botany Sands - L1
[Model Run TR020]

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\GroundwaterLevel.mxd



Drawdown (m)

2 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 14
15 - 16
17 - 18
19 - 20
21 - 22
23 - 24
25 - 26
27 - 28
29 - 30
31 - 32
33 - 34
35 - 36
37 - 38
39 - 40
41 - 42
43 - 44
45 - 46
47 - 48
49 - 50
51 - 52
53 - 54
55 - 56

Model Boundary
River/Creek/Channel
M5_East
WCX New M5
WCX M4 East

Outcrop Geology

Alluvium
Botany Sands
Bringelly Shale
Ashfield Shale
Hawkesbury Sandstone
Water

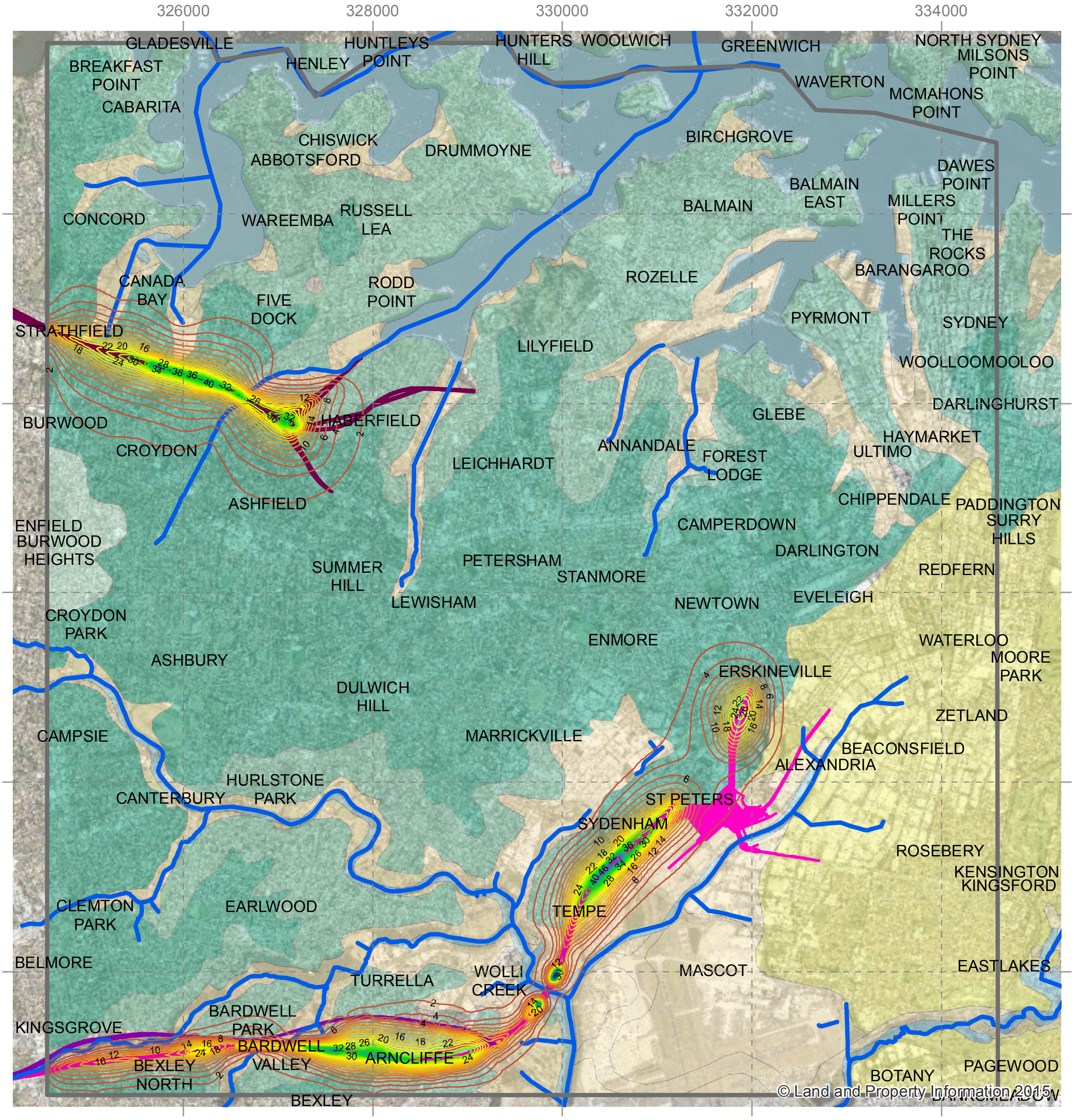
Scale: 60,000 @A4
GDA 1994 MGA Zone 56

0 0.5 1 2 3 km

WestConnex M4-M5 Link

M4 East and New M5 Cumulative Drawdown at Year 2100 Ashfield Shale - L3 [Model Run TR020]

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Drawdown_Incremental_Alluvium_Opening.mxd



Drawdown (m)

- 2 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18
- 19 - 20
- 21 - 22
- 23 - 24
- 25 - 26
- 27 - 28
- 29 - 30
- 31 - 32
- 33 - 34
- 35 - 36
- 37 - 38
- 39 - 40
- 41 - 42
- 43 - 44
- 45 - 46
- 47 - 48
- 49 - 50
- 51 - 52
- 53 - 54
- 55 - 56

- Model Boundary
- River/Creek/Channel
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 60,000 @A4
GDA 1994 MGA Zone 56

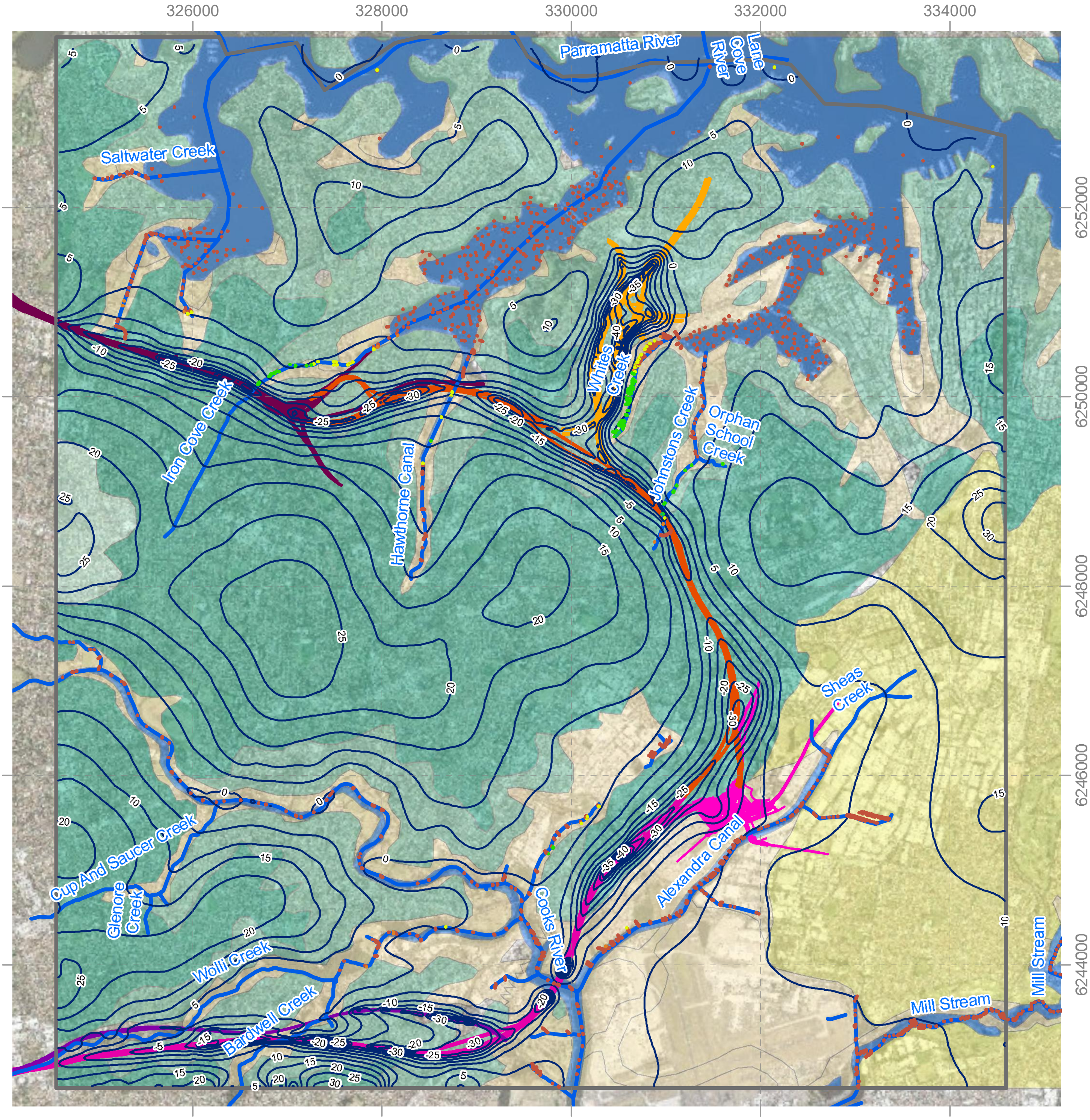
0 0.5 1 2 3 km

WestConnex M4-M5 Link

M4 East and New M5 Cumulative Drawdown at Year 2100
Hawkesbury Sandstone - L6
[Model Run TR020]

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Drawdown_Incremental_Alluvium_Opening.mxd

ANNEXURE E – FORWARD PARTICLE TRACKING FROM TIDAL WATER COURSES AT 2, 5, 10, 50, 100 AND 1000 YEARS



Layer

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Simulated Groundwater Elevation (mAHD)

Model Boundary
River/Creek/Channel
Rozelle_Interchange
M4M5_Mainline
M5_East
WCX New M5
WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

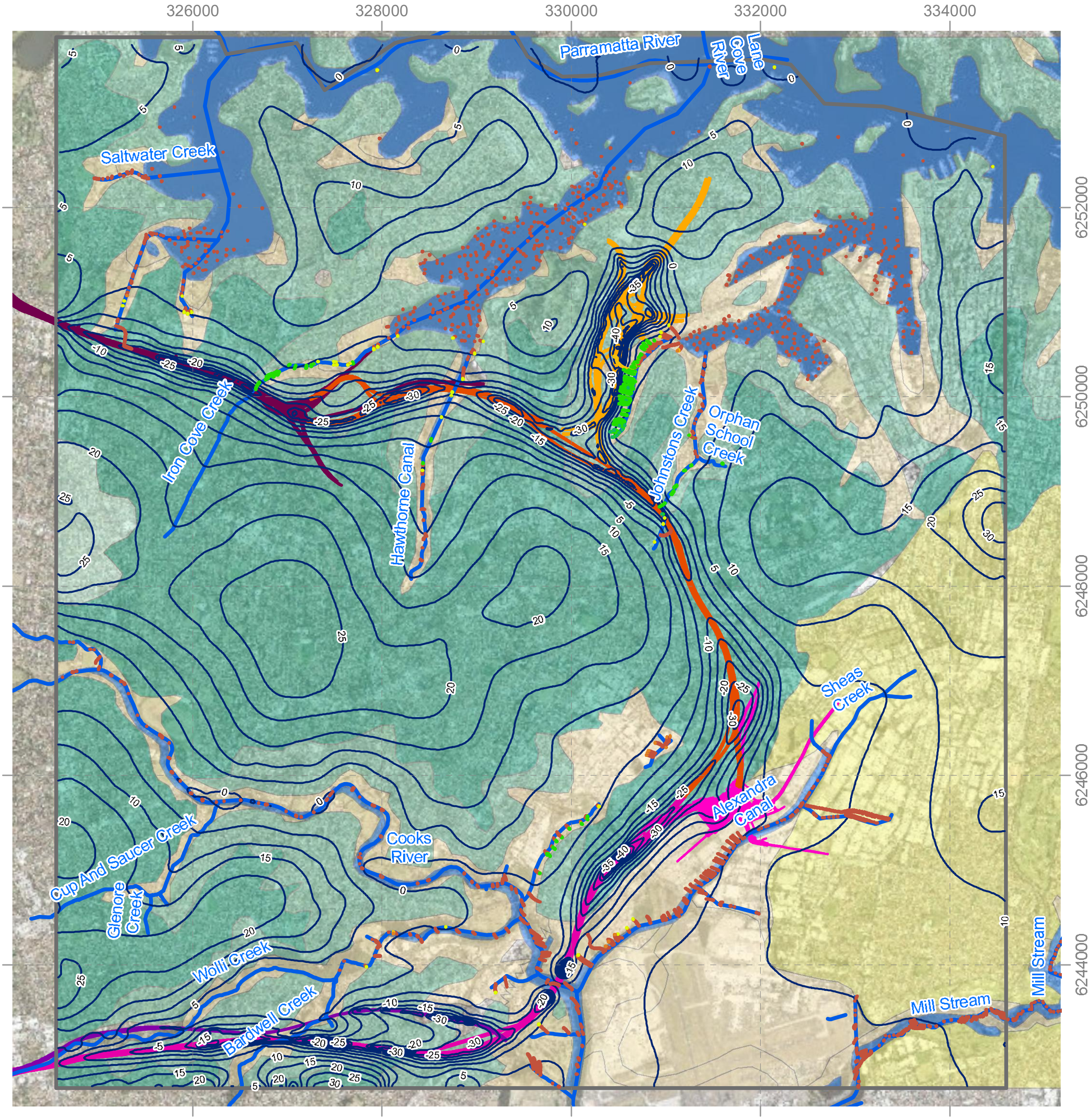
Scale: 60,000 @A4
GDA 1994 MGA Zone 56

0 0.5 1 2 3 km

WestConnex M4-M5 Link

Forward Tracking from Tidal Areas
Particle Layer
Travel Time <2yrs

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Forward_tracking_layer10.0_2yrs.mxd



Layer

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Simulated Groundwater Elevation (mAHD)

Model Boundary
River/Creek/Channel
Rozelle_Interchange
M4M5_Mainline
M5_East
WCX New M5
WCX M4 East

Outcrop Geology

Alluvium
Botany Sands
Bringelly Shale
Ashfield Shale
Hawkesbury Sandstone
Water

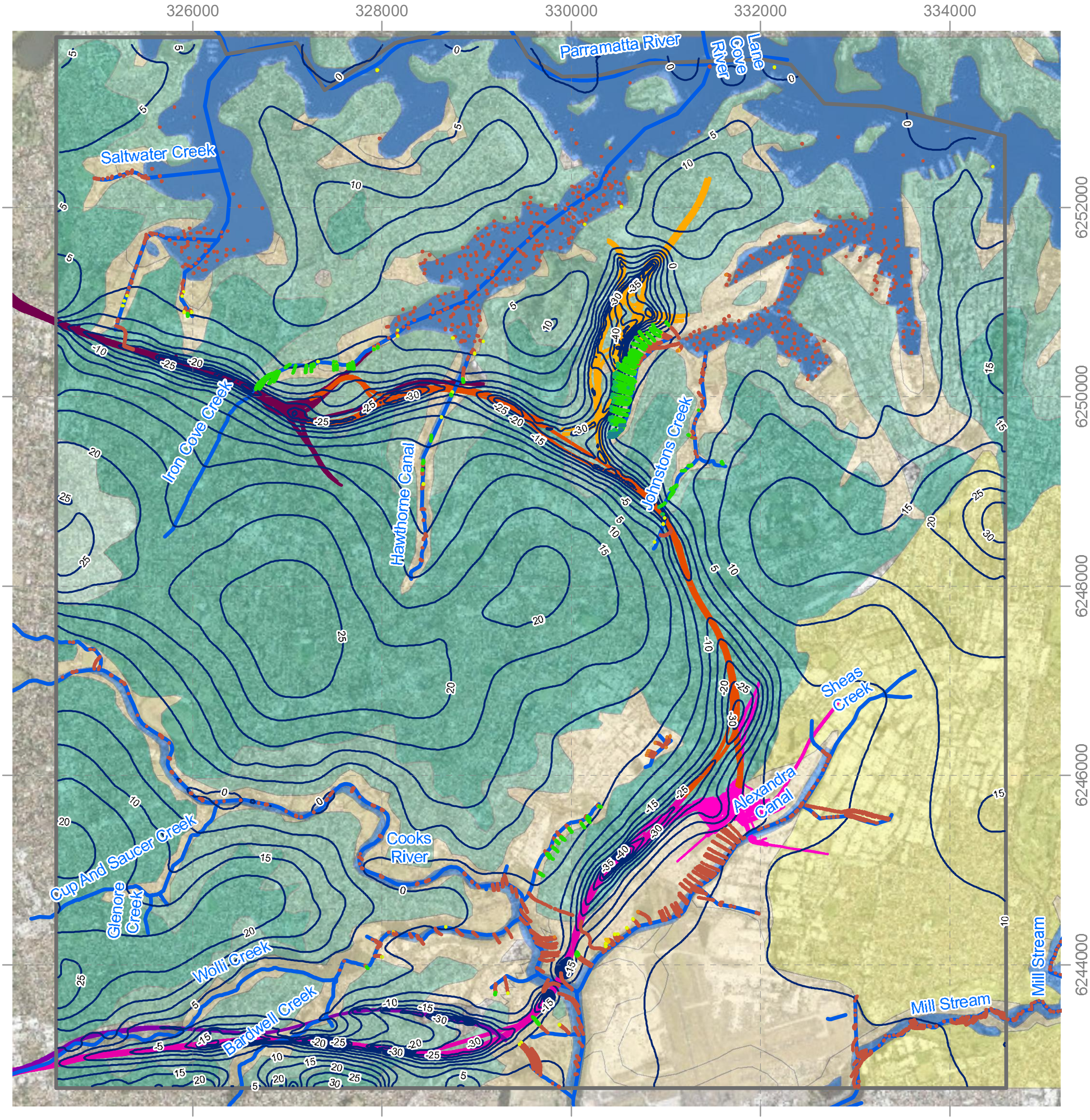
Scale: 60,000 @A4
GDA 1994 MGA Zone 56

0 0.5 1 2 3 km

WestConnex M4-M5 Link

Forward Tracking from Tidal Areas
Particle Layer
Travel Time <5yrs

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Forward_tracking_layer10.0_2yrs.mxd



Layer

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Simulated Groundwater Elevation (mAHD)

Model Boundary
River/Creek/Channel
Rozelle_Interchange
M4M5_Mainline
M5_East
WCX New M5
WCX M4 East

Outcrop Geology

Alluvium
Botany Sands
Bringelly Shale
Ashfield Shale
Hawkesbury Sandstone
Water

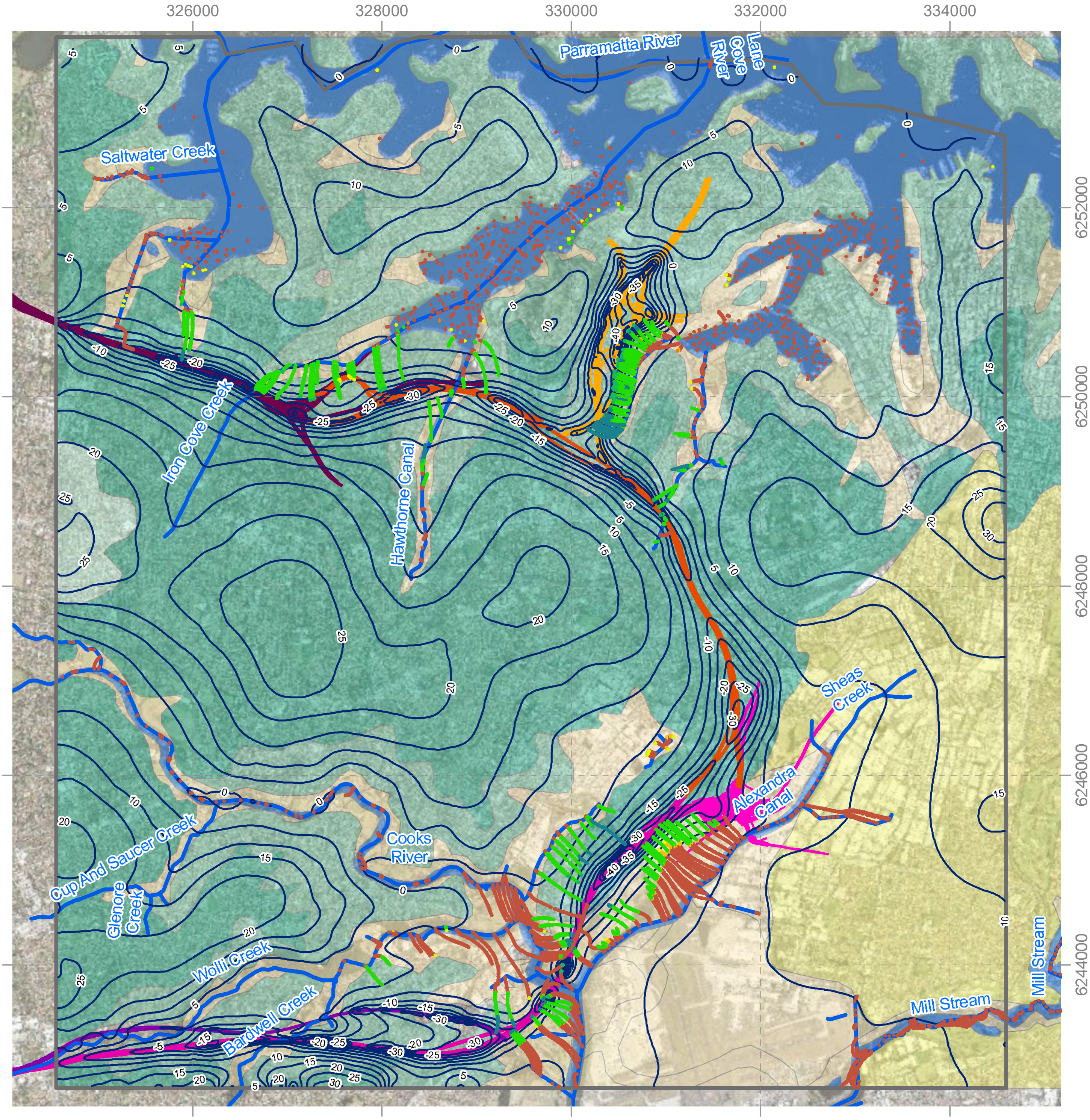
Scale: 60,000 @A4
GDA 1994 MGA Zone 56

0 0.5 1 2 3 km

WestConnex M4-M5 Link

Forward Tracking from Tidal Areas
Particle Layer
Travel Time <10yrs

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Forward_tracking_layer10.0_2yrs.mxd



Layer

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Simulated Groundwater Elevation (mAHD)

Model Boundary
River/Creek/Channel
Rozelle_Interchange
M4M5_Mainline
M5_East
WCX New M5
WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

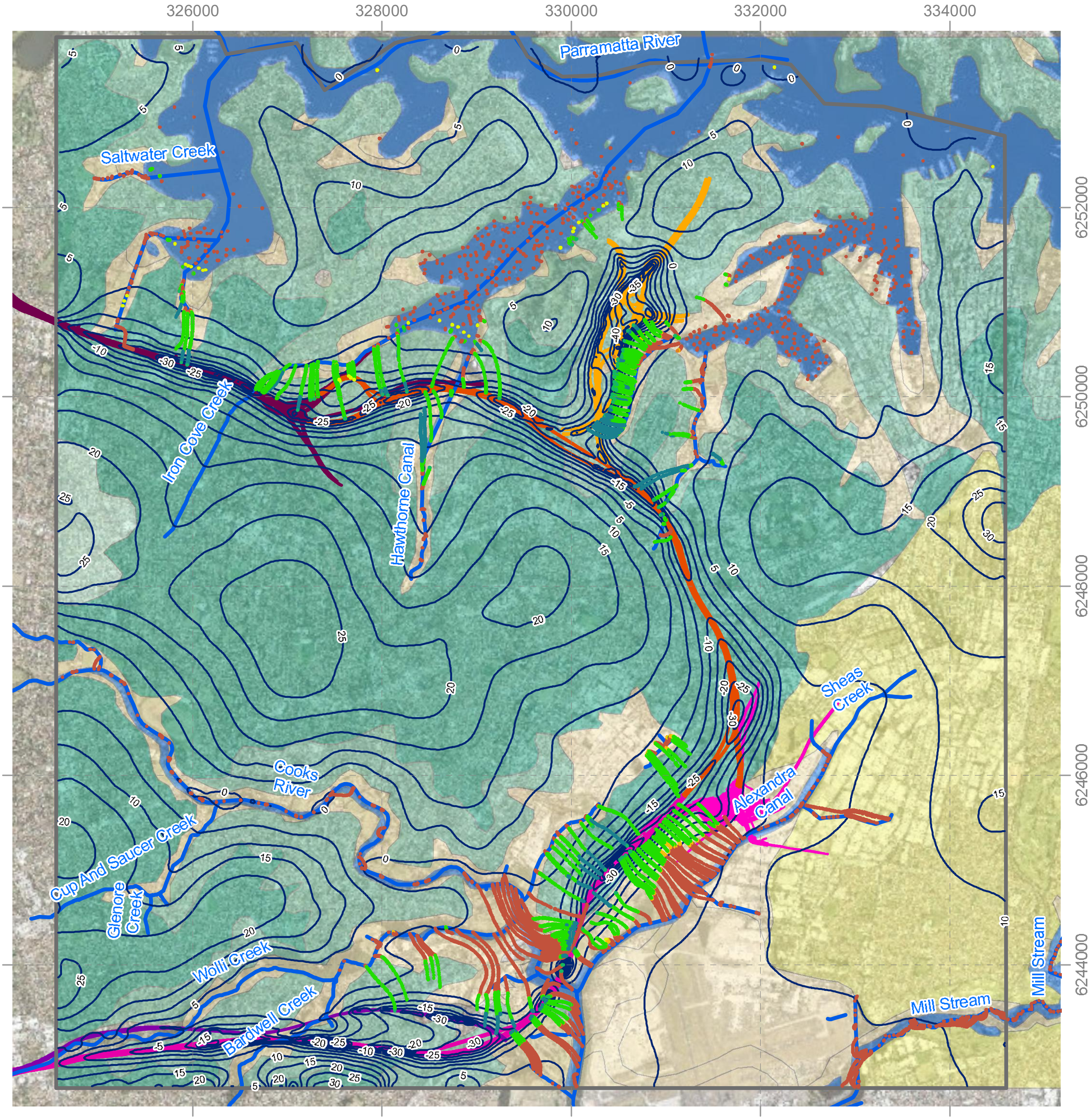
Scale: 60,000 @A4
GDA 1994 MGA Zone 56

0 0.5 1 2 3 km

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Forward_tracking_layer10.0_2yrs.mxd

WestConnex M4-M5 Link

Forward Tracking from Tidal Areas
Particle Layer
Travel Time <50yrs



Layer

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Simulated Groundwater Elevation (mAHD)

Model Boundary
River/Creek/Channel
Rozelle_Interchange
M4M5_Mainline
M5_East
WCX New M5
WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

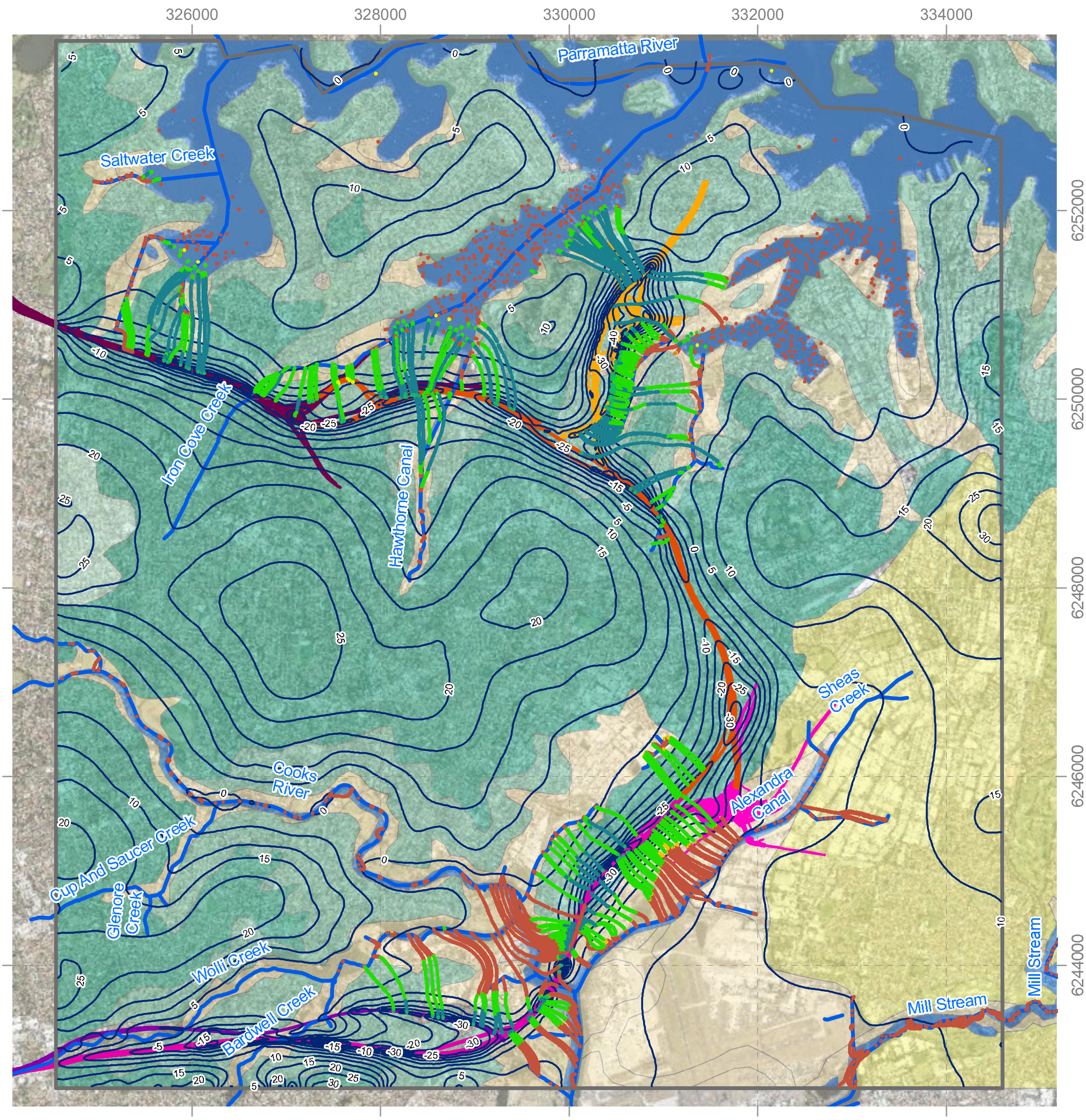
Scale: 60,000 @A4
GDA 1994 MGA Zone 56

0 0.5 1 2 3 km

WestConnex M4-M5 Link

Forward Tracking from Tidal Areas
Particle Layer
Travel Time <100yrs

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Forward_tracking_layer10.0_2yrs.mxd



Layer

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Simulated Groundwater Elevation (mAHD)

- Model Boundary
- River/Creek/Channel
- Rozelle_Interchange
- M4M5_Mainline
- M5_East
- WCX New M5
- WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

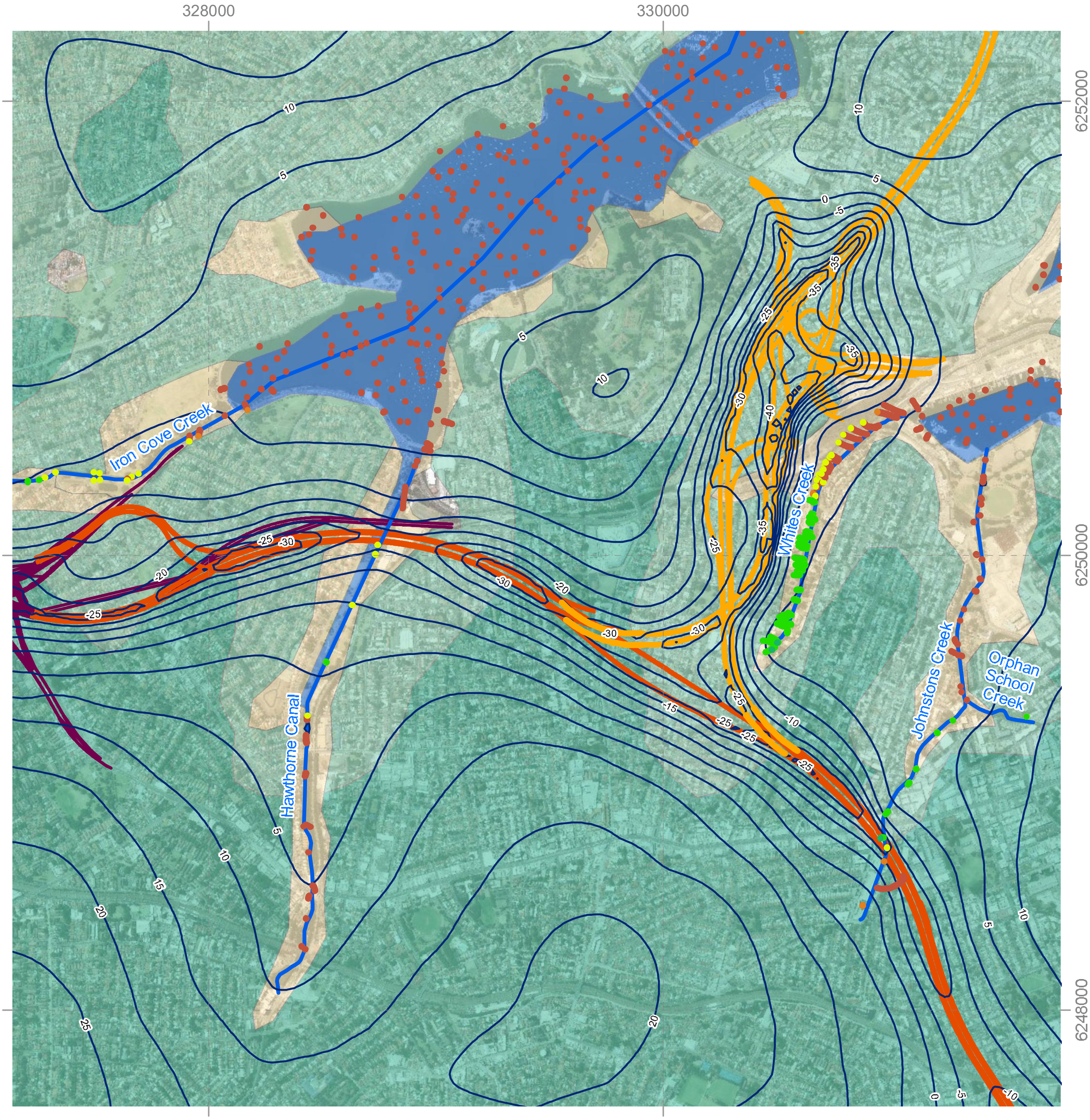
Scale: 60,000 @A4
GDA 1994 MGA Zone 56

0 0.5 1 2 3 km

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Forward_tracking_layer10.0_2yrs.mxd

WestConnex M4-M5 Link

Forward Tracking from Tidal Areas
Particle Layer
Travel Time <1000yrs



Layer

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Simulated Groundwater Elevation (mAHD)

Model Boundary
River/Creek/Channel
Rozelle_Interchange
M4M5_Mainline
M5_East
WCX New M5
WCX M4 East

Outcrop Geology

Alluvium
Botany Sands
Bringelly Shale
Ashfield Shale
Hawkesbury Sandstone
Water

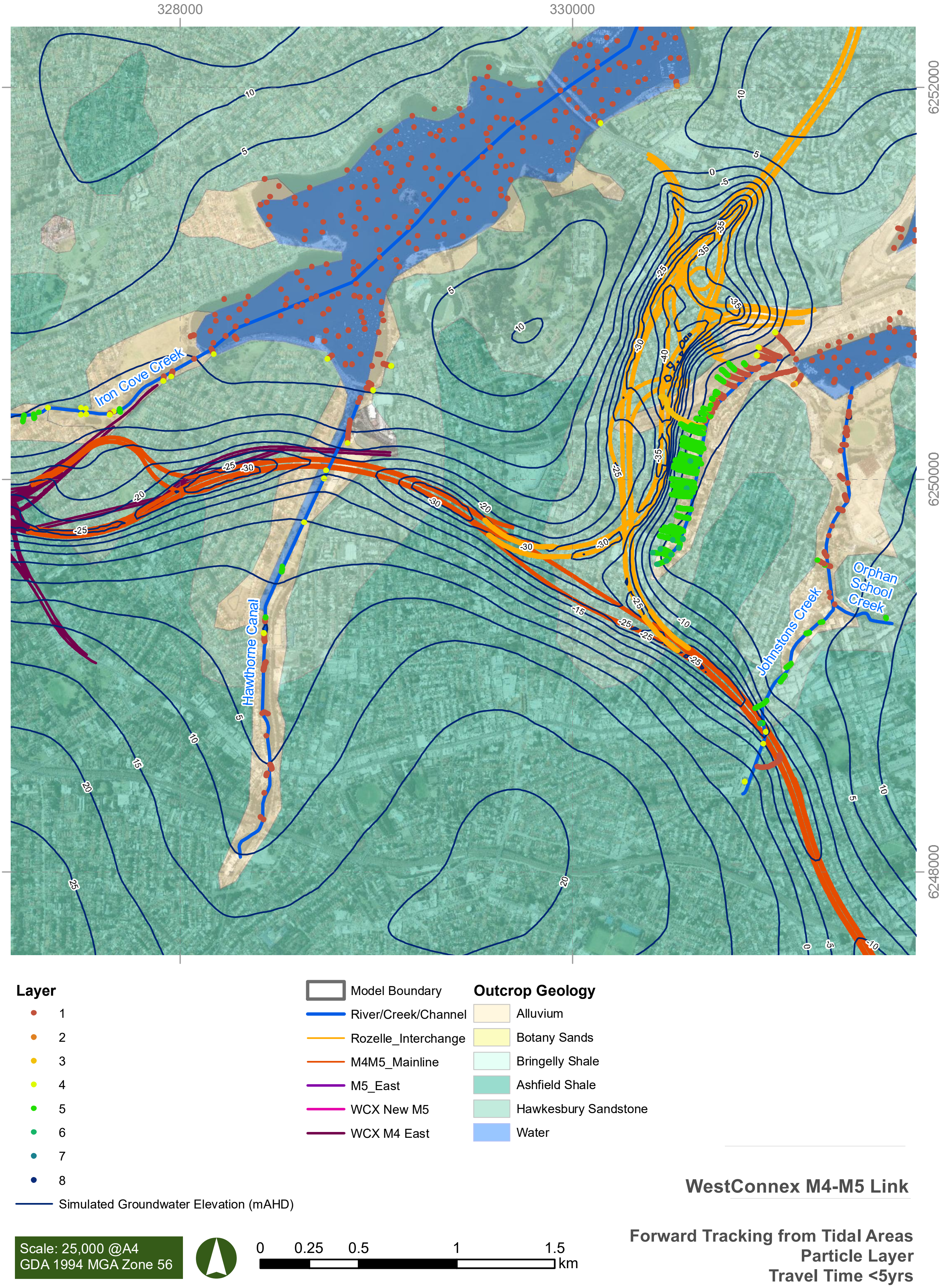
Scale: 25,000 @A4
GDA 1994 MGA Zone 56

0 0.25 0.5 1 1.5 km

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Forward_tracking_layer10.0_2yrs.mxd

WestConnex M4-M5 Link

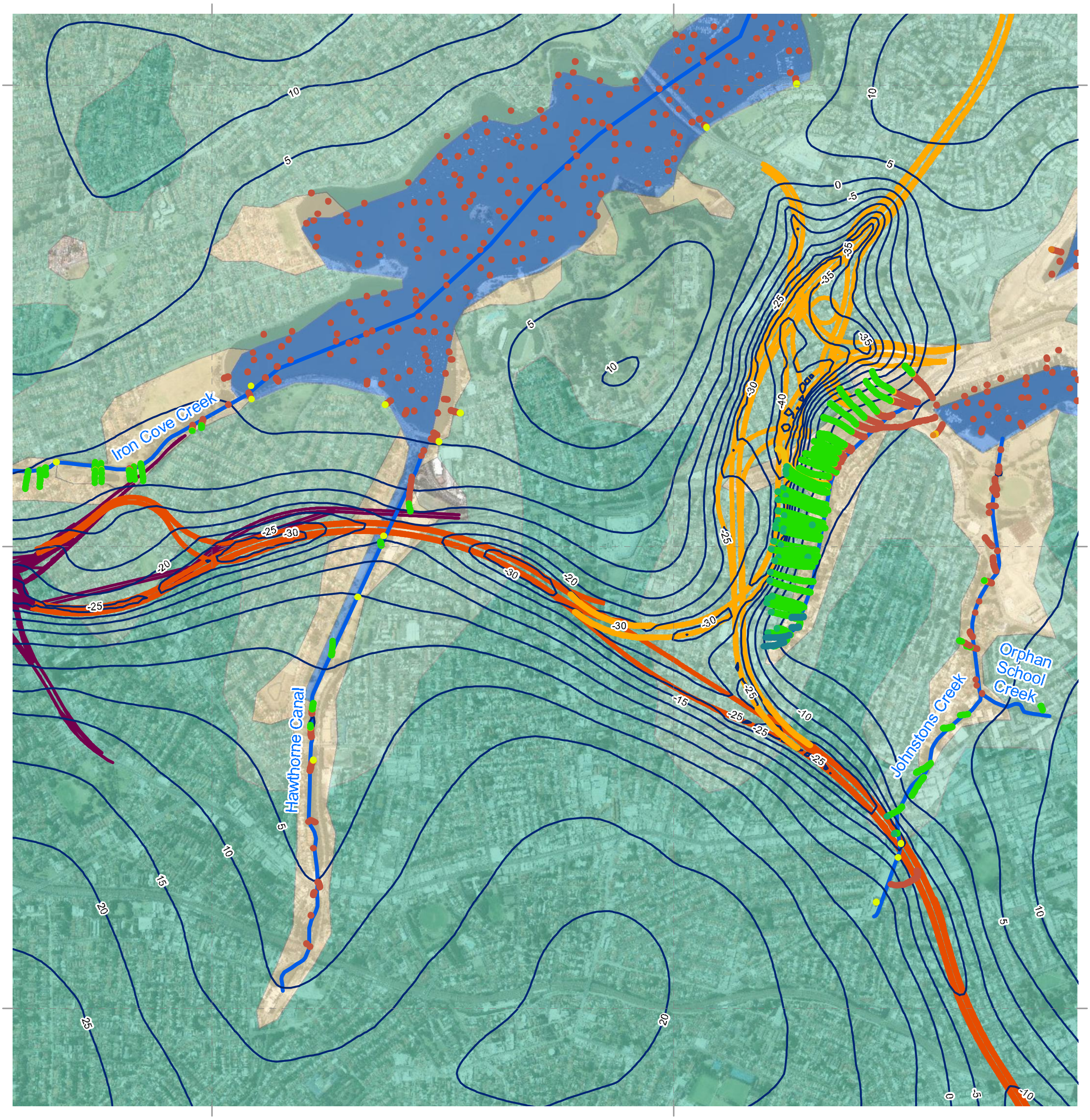
Forward Tracking from Tidal Areas
Particle Layer
Travel Time <2yrs



WestConnex M4-M5 Link

Forward Tracking from Tidal Areas
Particle Layer
Travel Time <5yrs

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Forward_tracking_layer10.0_2yrs.mxd



Layer

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Simulated Groundwater Elevation (mAHD)

Model Boundary
River/Creek/Channel
Rozelle_Interchange
M4M5_Mainline
M5_East
WCX New M5
WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

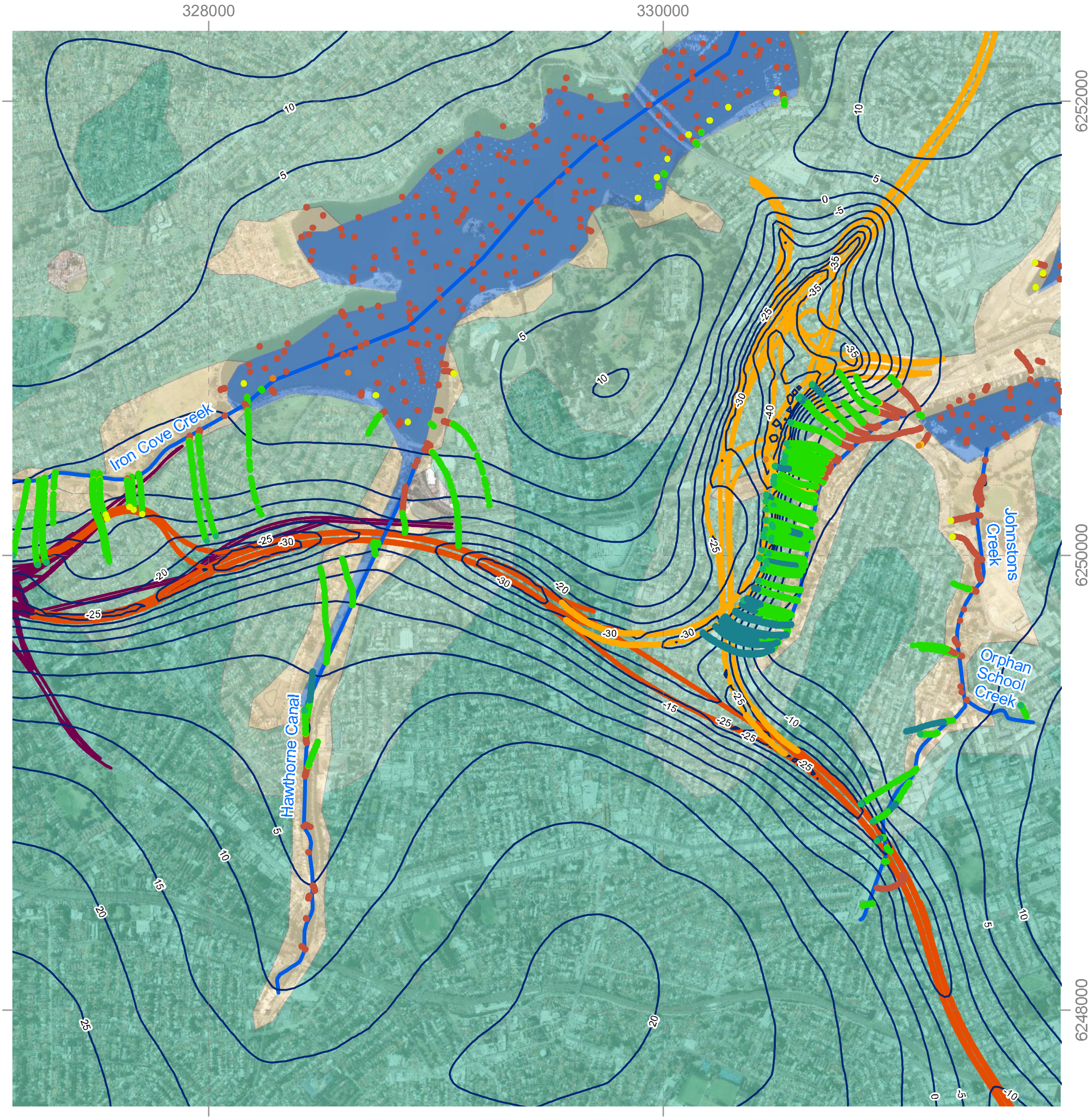
Scale: 25,000 @A4
GDA 1994 MGA Zone 56

0 0.25 0.5 1 1.5 km

WestConnex M4-M5 Link

Forward Tracking from Tidal Areas
Particle Layer
Travel Time <10yrs

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Forward_tracking_layer10.0_2yrs.mxd



Layer

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Simulated Groundwater Elevation (mAHD)

Model Boundary
River/Creek/Channel
Rozelle_Interchange
M4M5_Mainline
M5_East
WCX New M5
WCX M4 East

Outcrop Geology

Alluvium
Botany Sands
Bringelly Shale
Ashfield Shale
Hawkesbury Sandstone
Water

Scale: 25,000 @A4
GDA 1994 MGA Zone 56

0 0.25 0.5 1 1.5 km

WestConnex M4-M5 Link

Forward Tracking from Tidal Areas
Particle Layer
Travel Time <50yrs

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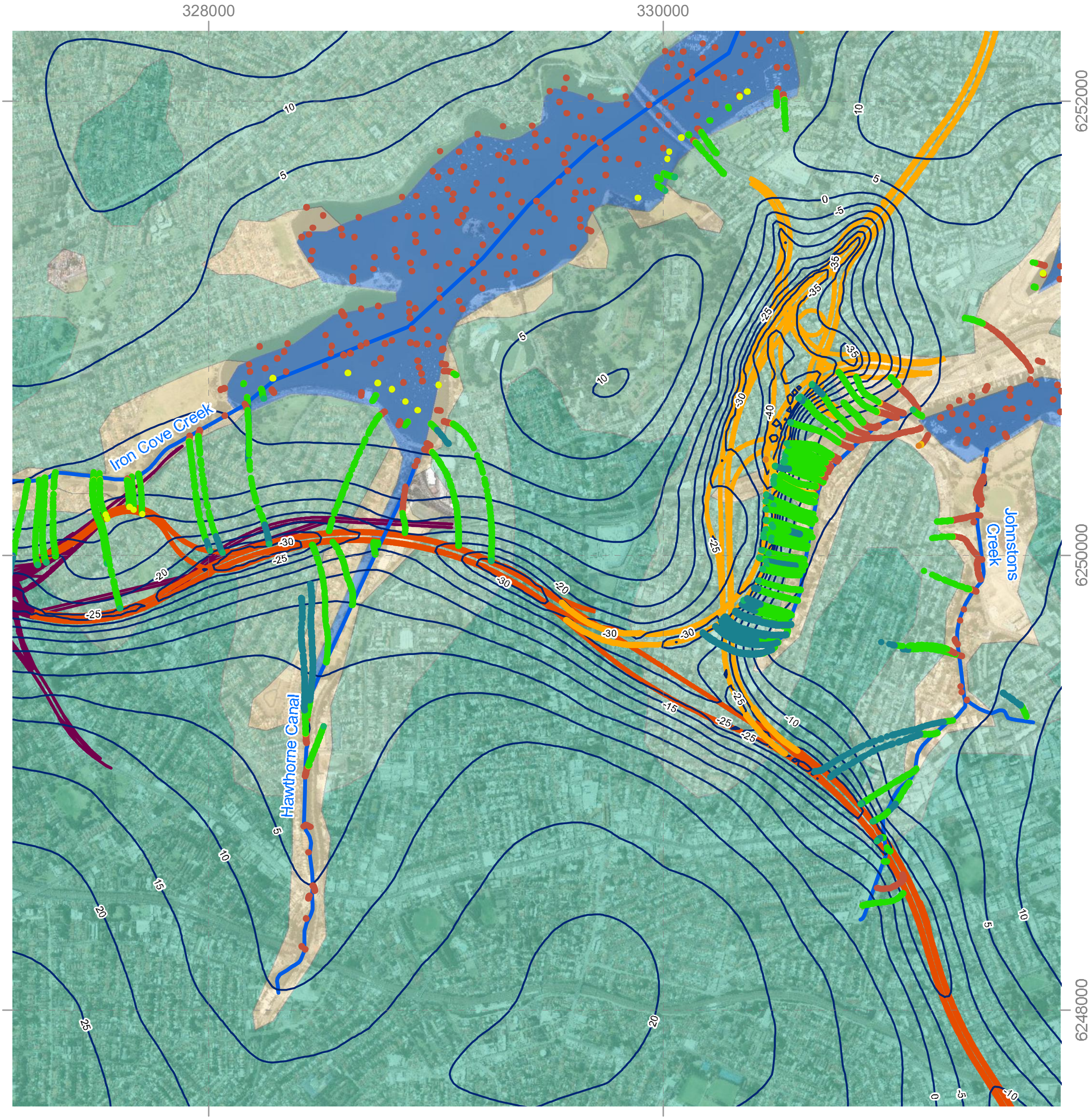


Layer

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Simulated Groundwater Elevation (mAHD)

Model Boundary
River/Creek/Channel
Rozelle_Interchange
M4M5_Mainline
M5_East
WCX New M5
WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

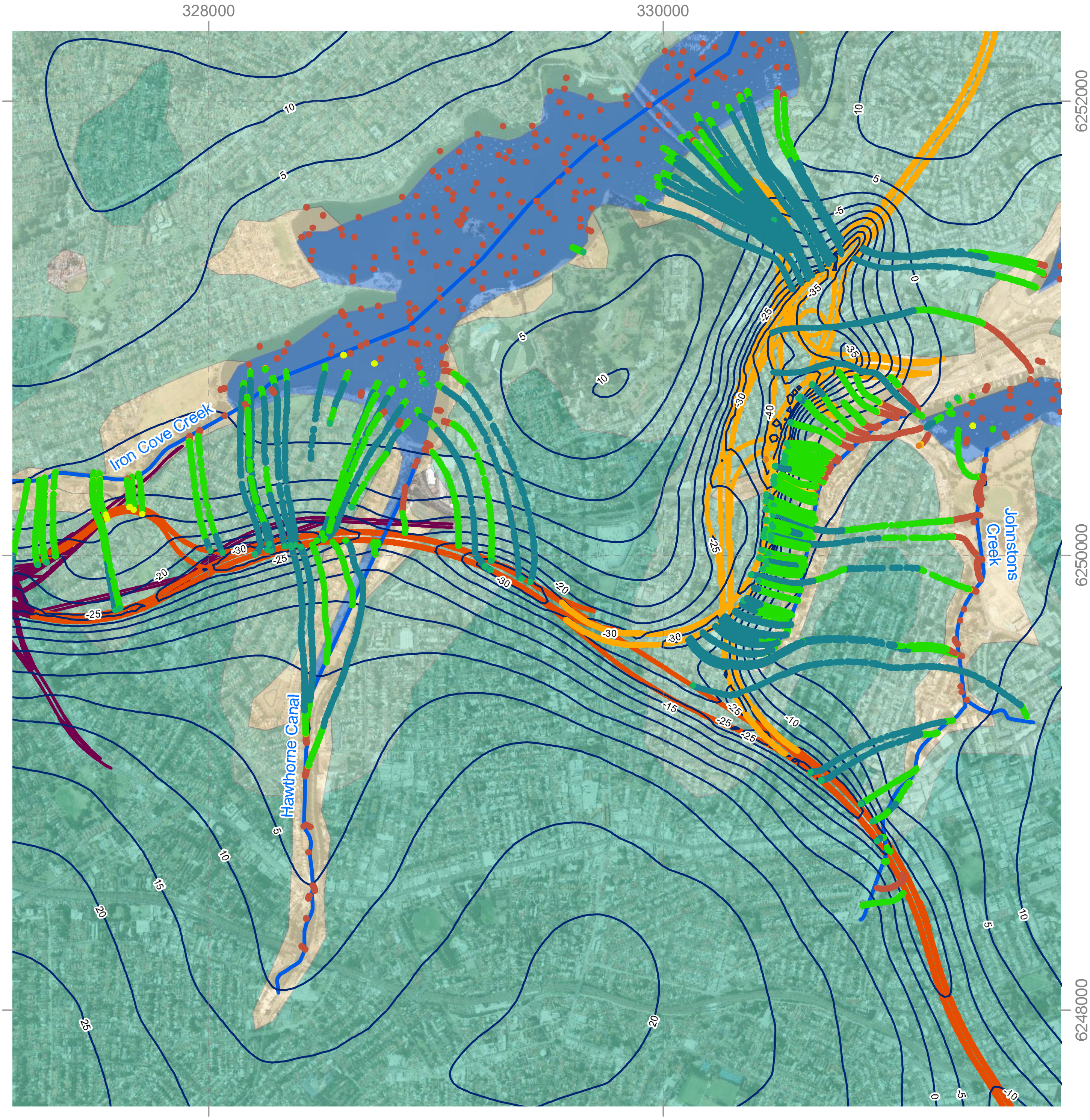
Scale: 25,000 @A4
GDA 1994 MGA Zone 56

0 0.25 0.5 1 1.5 km

WestConnex M4-M5 Link

Forward Tracking from Tidal Areas
Particle Layer
Travel Time <100yrs

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Forward_tracking_layer10.0_2yrs.mxd



Layer

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Simulated Groundwater Elevation (mAHD)

Model Boundary
River/Creek/Channel
Rozelle_Interchange
M4M5_Mainline
M5_East
WCX New M5
WCX M4 East

Outcrop Geology

- Alluvium
- Botany Sands
- Bringelly Shale
- Ashfield Shale
- Hawkesbury Sandstone
- Water

Scale: 25,000 @A4
GDA 1994 MGA Zone 56

0 0.25 0.5 1 1.5 km

WestConnex M4-M5 Link

Forward Tracking from Tidal Areas
Particle Layer
Travel Time <1000yrs

X:\HYDROSIM\WESTCONNEX\GIS\Maps\Working\Forward_tracking_layer10.0_2yrs.mxd