Appendix N

GROUNDWATER REPORT

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Powering Sydney's Future
TransGrid

Potts Hill to Alexandria transmission cable project

Groundwater Technical Report

Potts Hill to Alexandria transmission cable project

Groundwater Technical Report

Client: TransGrid

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Table of contents

List of tables

List of figures

Glossary, acronyms and abbreviations

Glossary

Term	Definition
Acid sulfate soils	Naturally occurring soils, sediments or organic substrates (e.g. peat) that are formed under waterlogged conditions. These soils contain iron sulfide minerals (predominantly as the mineral pyrite) or their oxidation products. In an undisturbed state below the watertable, acid sulfate soils are benign. However, if the soils are drained, excavated or exposed to air by a lowering of the watertable, the sulfides react with oxygen to form sulfuric acid.
Alternating current	An electric current that reverses its direction (of the flow of electrons) many times a second at regular intervals and is typically used in power supplies.
Australian height datum (AHD)	The standard reference level used to express the relative height of various features. A height given in metres AHD is the height above mean sea level.
Bore	Constructed connection between the surface and a groundwater source, that enables groundwater to be transferred to the surface either naturally or through artificial means.
Busbar	A series of elevated metallic bars within an electrical substation which comprises a system of electrical conductors on which power is concentrated for high capacity distribution.
Cable bridges	A purpose built bridge made typically of reinforced concrete structures, through which the transmission cables are integrated for support and protection.
Cable circuit	A series of three phase alternating current transmission cables which make up an electrical circuit to carry an electrical current. A single circuit transmission cable typically comprises a minimum of three cables per circuit.
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular site.
Conduit	A protective tube or pipe system for individual electric cables. Sometimes referred to as a ‘duct’.
Community	A group of people living in a specific geographical area or with mutual interests that could be affected by the project.
Construction	Includes all physical work required to construct the project and also includes construction planning such as the development of construction management plans.
Construction laydown areas	Areas required for temporarily storing materials, plant and equipment and providing space for other ancillary facilities, such as project offices, during construction. Some construction laydown areas would be used for stockpiling.
Detailed design	The stage of the project following concept design where the design is refined, and plans, specifications and estimates are produced, suitable for construction.
Deviation	An alteration to the alignment of a portion of linear infrastructure such as a road or pipeline.
Discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per section (m^3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving (e.g. metres per second (m/s)).
Earthworks	All operations involved in loosening, excavating, placing, shaping and compacting soil or rock.

Term	Definition
Easement	A ‘right of way’ around infrastructure that allows access to authorised personnel for inspections, repairs and maintenance. The establishment of an easement also restricts certain activities on the land that could endanger members of the public or impact on the safe operation of the infrastructure.
Ecological community	An ecological community is a naturally occurring group of native plants, animals and other organisms that are interacting in a habitat.
Egress	Exit.
Embankment	An artificially raised structure (usually an earthen or gravel wall) used especially to hold back water (to prevent flooding) or to carry a roadway/rail line (across low-lying or wet areas).
Erosion	A natural process where wind or water detaches a soil particle and provides energy to move the particle.
Fill	The material placed in an embankment.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
Flood prone land	Land susceptible to flooding by the probable maximum flood. Also known as flood liable land.
Floodplain	Area of land which is inundated by floods up to and including the probable maximum flood event (i.e. flood prone land).
Frac-out	A release of drill slurry at a fracture zone which has occurred on the surface through the building up of pressure in the bore hole.
Hazard	A source of potential harm that can cause injury/loss of human life and/or damage to the environment or property.
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
Infiltration	The downward movement of water into soil and rock. It is largely governed by the structural condition of the soil, the nature of the soil surface (including presence of vegetation) and the antecedent moisture content of the soil.
Ingress	Enter.
inner Sydney	Includes the Sydney Central Business District (CBD) and eastern suburbs.
Joint bay	An enlarged section of excavated trench in which cables are joined together.
Potentiometric head	The level to which water in a confined aquifer would rise were it pierced with wells.
Pre-construction	All work prior to, and in respect of the state significant infrastructure, that is excluded from the definition of construction.
Project area	The project area comprises the overall potential area of direct disturbance by the project, which may be temporary (for construction) or permanent (for operational infrastructure) and extend below the ground surface. The project area includes the location of operational infrastructure and construction work sites for: • the transmission cable route (including the entire road reserve of roads traversed); • special crossings of major infrastructure or watercourses; • substation sites requiring upgrades (noting that all works would be contained within the existing site boundaries); and • construction laydown areas.

Term	Definition
Roadway	Any one part of the width of a road devoted particular to the use of vehicles, inclusive of shoulders and auxiliary lanes.
Road reserve	The area comprising roads, footpaths and public transport infrastructure.
Secretary's Environmental Assessment Requirements (SEARs)	Requirements and specifications for an environmental assessment prepared by the Secretary of the NSW Department of the Planning and Environment under section 5.16 of the NSW *Environmental Planning and Assessment Act 1979*.
Sediment	Material, both mineral and organic, that is being or has been moved from its site of origin by the action of wind, water or gravity and comes to rest either above or below water level.
Sensitive receiver/receptor	Includes residences, educational institutions (including preschools, schools, universities, TAFE colleges), health care facilities (including nursing homes, hospitals), religious facilities (including churches), child care centres, passive recreation areas (including outdoor grounds used for teaching), active recreation areas (including parks and sports grounds), commercial premises (including film and television studios, research facilities, entertainment spaces, temporary accommodation such as caravan parks and camping grounds, restaurants, office premises, retail spaces and industrial premises).
Stakeholders	Government departments/agencies, local councils, utility and service providers and other relevant parties.
state significant infrastructure (SSI)	Infrastructure projects for which approval is required under Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979*.
Switch bay	Part of a substation within which the switch and control equipment relating to a given circuit are contained.
Thrust boring	This is a jack and bore drilling method typically used for installing a steel or concrete pipe casing beneath an existing surface where there is risk of trench collapse. Typically used to cross under major infrastructure such as railways and highways.
Transmission cable	An insulated wire that conducts an electrical current at voltages greater than 132 kV.
Underboring	This is a trenchless method for installing cables involving passing the conduits under infrastructure (such as a road or railway corridor) or a watercourse. Underboring could be via thrust boring (also known as micro tunnelling) or horizontal directional drilling.
Warning tape	Tape that is buried directly above underground services to provide visual warning during subsequent excavation.
Work site	A specific section of the project area for carrying out project construction activities such as trenching and excavation, establishment of a joint bay or installing a cable bridge. The work site would be fenced off from public access and may include associated activities such as traffic management measures.

Abbreviations and acronyms

Abbreviation/ Acronym	Definition
AHD	Australian Height Datum
AIP	*NSW Aquifer Interference Policy*
CEMP	Construction Environmental Management Plan
CSWMP	Construction Soil and Water Management Plan
EPL	Environment Protection Licence
ESCP	Erosion and Sediment Control Plan
FMS	Flood Mitigation Strategy
GDE	Groundwater Dependent Ecosystem
GMS	Groundwater Management Strategy
LEP	Local Environment Plan
ML	Mega Litre (one million Litres)
PASS	Potential acid sulfate soils
WAL	Water Access Licence

Executive summary

TransGrid is the manager and operator of the major high-voltage electricity transmission network in New South Wales (NSW) and the Australian Capital Territory (ACT). TransGrid is seeking approval under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the construction and operation of a new 330 kilovolt (kV) underground transmission cable circuit between the existing Rookwood Road substation in Potts Hill and the Beaconsfield West substation in Alexandria (the project).

The project has been identified as a solution to address existing issues in the electricity supply network for inner Sydney, which is characterised by ageing and deteriorating electricity infrastructure and forecast increases in consumer demand.

As the project is state significant infrastructure under section 5.12 of the EP&A Act, an Environmental Impact Statement (EIS) has been prepared to assess the impacts of the project. This technical report has been developed in support of the EIS.

During construction, potential groundwater impacts would be associated with:

- interception and potential dewatering of groundwater; and
- accidental leaks or spills of chemicals, fuels and oils during construction.

Potential impacts on groundwater during construction of the project are considered minor and manageable with the implementation of standard mitigation measures.

Measures that would be implemented to avoid or mitigate potential impacts on groundwater resources during construction would form part of the project's Construction Environmental Management Plan (CEMP) and be confirmed once the detailed design has been developed. The CEMP would include a groundwater management plan which would document measures to manage and monitor potential impact to groundwater. The CEMP would form the overarching management document during construction and would include measures for the collection and disposal of water collected from within the trench or other excavations in accordance with the *Protection of the Environment Operations Act 1997*.

The risk that the proposed infrastructure would create physical barriers to the movement of groundwater has been assessed, including temporary or permanent interruptions to groundwater flow. In the case of the installation of the cable trenches and joint bays, the proposed excavation is unlikely to create hydraulic barriers because the depth is shallow and where the watertable is intersected, it is likely to only be partially intersected which would allow groundwater to flow beneath or around the trench. In cases where it is suspected that groundwater flows may be altered, groundwater mounding could be avoided by the inclusion of drainage blankets beneath the trench. With the appropriate mitigation measures implemented during the detailed design, long term groundwater levels are unlikely to be impacted.

While the assessment has identified potential impacts of the project on the quality and flows of groundwater due to construction and operation activities, it is considered the implementation of management measures would reduce or manage these potential impacts to an appropriate level so as not to result in significant impacts.

1.0 Introduction

TransGrid is the manager and operator of the major high-voltage electricity transmission network in New South Wales (NSW) and the Australian Capital Territory (ACT). TransGrid is seeking approval under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the construction and operation of a new 330 kilovolt (kV) underground transmission cable circuit between the existing Rookwood Road substation in Potts Hill and the Beaconsfield West substation in Alexandria (the project).

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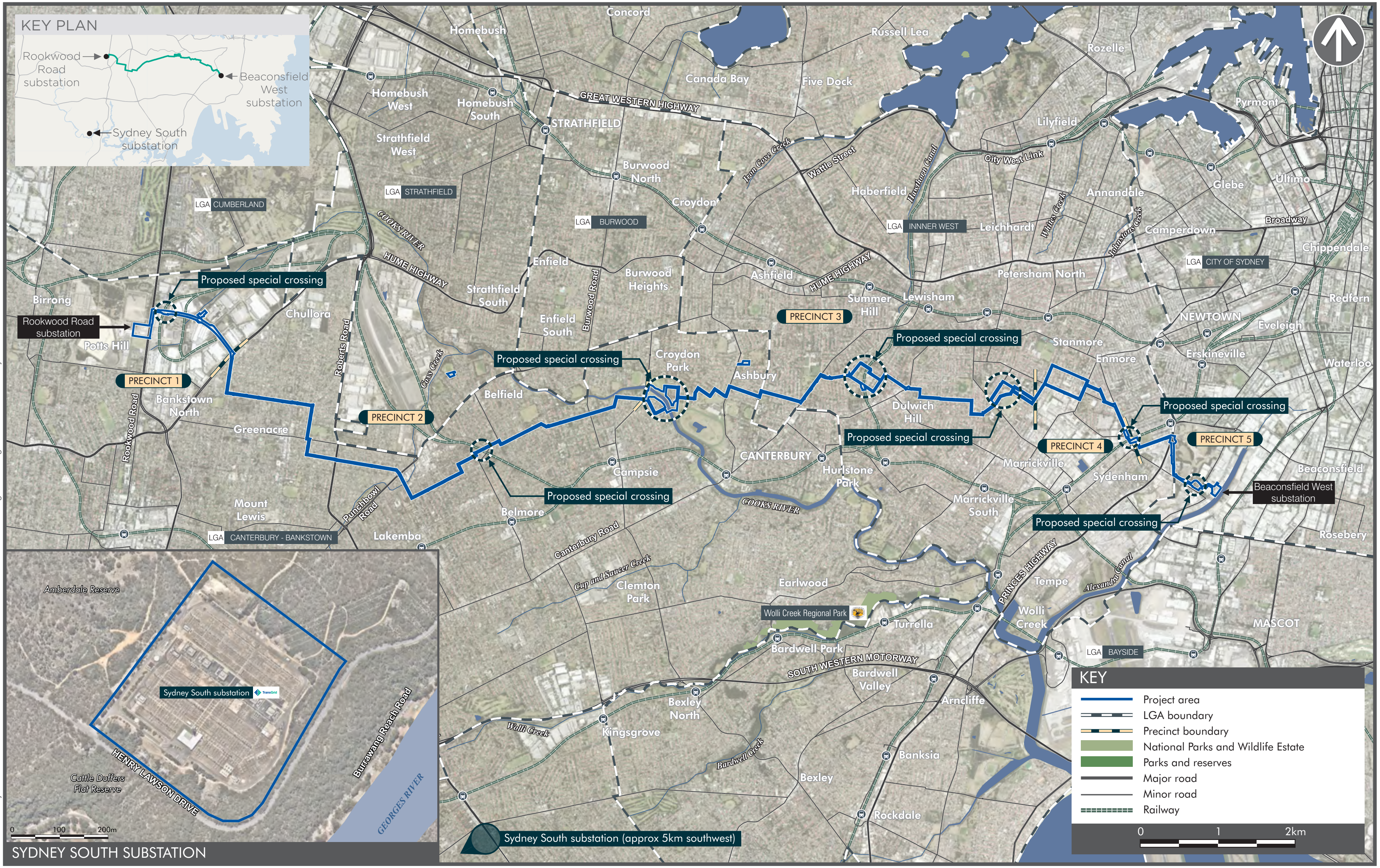
1.1 Project overview

The transmission cable circuit would be about 20 kilometres long and would generally be located within existing road reserves, at existing electrical infrastructure sites, within public open space and on previously disturbed areas as shown in **Figure 1-1**. The project would comprise the following key components:

- cable works connecting Rookwood Road substation with the Beaconsfield West substation;
- special crossings of infrastructure or watercourses;
- upgrade works at the Rookwood Road and Beaconsfield West substations;
- conversion works at the Beaconsfield West and Sydney South substations; and
- temporary construction laydown areas to facilitate construction of the project.



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PROJECT OVERVIEW

Powering Sydney's Future

Potts Hill to Alexandria Transmission Cable Project

Note: The project area is confined to the roadway reserve with the exception of parks and existing substations

Source: Department of Finance, Services and Innovation - Spatial Services (2018), Nearmap (2018)

FIGURE 1-1

1.2 Purpose of this technical report

This technical report has been prepared in accordance with the revised Secretary's Environmental Assessment Requirements (SEARs) issued for the project on 20 August 2019 by the Planning Secretary of the NSW Department of Planning, Industry and Environment (DPIE).

The SEARs relevant to this technical assessment are presented in **Table 1-1**.

Table 1-1 SEARs

SEARs		Section addressed
Water	• an assessment of the impacts of the project on the quantity and/or quality of surface and groundwater resources;	**Section 5.0** and **6.0**. Surface water is assessed in **Appendix L** (Surface water and flooding report) of the EIS.
	• a description of the measures to minimise surface and groundwater impacts, including how works on steep gradient land or erodible soils types would be managed and any contingency requirements to address residual impacts.	**Section 7.2**. Surface water is assessed in **Appendix L** (Surface water and flooding report) of the EIS.

2.0 Description of the project

2.1 Project components

Key components of the project are listed below. A detailed description of the project is provided in **Chapter 4 Project description** of the EIS:

- cable works connecting Rookwood Road substation with the Beaconsfield West substation comprising:
  - a 330 kV underground transmission cable circuit comprising three cables installed in three conduits;
  - another set of three conduits for a possible future 330 kV transmission cable circuit if it is required;
  - four smaller conduits for carrying optical fibres;
  - around 26-30 joint bays, per circuit, where sections of cable would be joined together, located approximately every 600-800 metres along the transmission cable route;
  - link boxes and sensor boxes associated with each joint bay to allow cable testing and maintenance;
  - optical fibre cable pits for optical fibre cable maintenance;
- seven special crossings of infrastructure or watercourses including two rail lines (at Chullora and St Peters), one freight rail line (Enfield Intermodal rail line at Belfield), one light rail line (at Dulwich Hill), the Cooks River and its associated cycleway (at Campsie/Croydon Park), a playground (at Marrickville) and the southern wetland at Sydney Park (at Alexandria);
- upgrade works at the Rookwood Road and Beaconsfield West substations to facilitate the new 330 kV transmission cable circuit;
- conversion works at the Beaconsfield West and Sydney South substations to transition the existing Cable 41 from a 330 kV connection to a 132 kV connection; and
- five temporary construction laydown areas to facilitate construction of the project.

Associated works required to facilitate the construction of the project, such as potential utility relocations, have been considered. No major utility relocations are anticipated and where smaller services may need to be moved to accommodate the transmission cable circuit, this relocation would be restricted to within the project area assessed in this EIS.

The project does not include the cable pulling and jointing works for a possible future second transmission cable circuit. This activity, should it be required, would be subject to separate assessment and approval as per the requirements of the EP&A Act.

Several route options and alternative construction methods are being considered as part of the project. These are described further in **Section 2.4**.

2.2 Project location

The project would be located in the suburbs of Potts Hill, Yagoona, Chullora, Greenacre, Lakemba, Belmore, Belfield, Campsie, Croydon Park, Ashbury, Ashfield, Dulwich Hill, Marrickville, Newtown, St Peters, Alexandria and Picnic Point in the following local government areas (LGAs):

- City of Canterbury-Bankstown;
- Strathfield;
- Inner West; and
- City of Sydney.

The location of the project is shown on **Figure 1-1**.

The project would be located primarily within road reserves, at existing electrical infrastructure sites, within public open space and on previously disturbed areas. The project has been and would continue to be designed to avoid impacts on private property and open spaces where possible; however, there would be a need for both the use of public open space and easements over some private commercial properties due to significant existing constraints within the road reserve. Land uses adjacent to the road reserves in which the project would be located are mainly residential, with relatively short sections of commercial and mixed uses in the suburbs of Dulwich Hill and Petersham. The project would be located close to industrial areas at the western and eastern ends of the project around Potts Hill, Chullora, Greenacre, Marrickville, St Peters and Alexandria. The existing Sydney South substation at Picnic Point is surrounded by the George’s River National Park.

The location of the proposed special crossings is provided in **Table 2-1**.

Table 2-1 Location of proposed special crossings

Location	Crossing type	Infrastructure or watercourse crossed
Muir Road, Chullora	Cable bridge	Rail line
Enfield Intermodal Terminal, Belfield	Underbore	Freight rail line
Cooks River, Campsie/Croydon Park/Ashbury	Cable bridge or underbore (preferred)	Cooks River and cycleway
Arlington Light Rail Station, Dulwich Hill	Underbore	Dulwich Hill light rail line or station
Amy Street, Marrickville	Underbore	Playground near Henson Park
Bedwin Road, St Peters	Cable bridge	Rail line
Sydney Park, Alexandria	Underbore	Wetland

2.3 The project area

The project area comprises the overall potential area of direct disturbance by the project, which may be temporary (for construction) or permanent (for operational infrastructure) and extend below the ground surface. It includes all options under consideration for the project, as described in **Section 2.4**.

The project area includes the location of operational infrastructure and construction work sites for:

- the transmission cable route (including the entire road reserve of roads traversed);
- special crossings of infrastructure or watercourses;
- substation sites requiring upgrades (noting that all works would be contained within the existing site boundaries); and
- construction laydown areas.

While the boundaries of the project area represent the physical extent of where project infrastructure may be located, or construction works undertaken, it does not mean that this entire area would be physically disturbed or that indirect impacts would not be experienced beyond this area. Should the project be approved, the detailed design would aim to refine the location of project infrastructure and work sites within the boundaries of the project area assessed in this EIS.

There is a possibility that to minimise impacts on other utilities or transport corridors (roads and rail), that deviations from the assessed project area may be required. In this event, specific impacts of this approach would be assessed further. Future changes to the project may require additional assessment and approval as described in more detail in **Chapter 5 Statutory planning and approval process**.

The location of joint bays and the location of the transmission cable circuit within the road reserve (e.g. kerbside or non-kerbside) is yet to be determined and is subject to detailed design.

2.4 Options under consideration

The project includes route options and alternative construction methods in locations as outlined below and shown in Figure 4-6 in **Chapter 4 Project description** of the EIS. As the project design develops, a preferred option would be selected for each location. However, approval may be sought for some options where further design and engineering information is required before a preferred option can be selected.

The project options are discussed below by geographical area, from west to east.

2.4.1.1 Cooks River

There are three options for the transmission cable route in the vicinity of the Cooks River at Campsie/Croydon Park and two options for special crossing methods, including:

- Option 1: the transmission cable route travels in a south-easterly direction along Cowper Street from the intersection with Brighton Avenue, Campsie and then east on Lindsay Street. At the cul-de-sac at the end of Lindsay Street, there are two special crossing options of the Cooks River into Lees Park before the transmission cable route continues on to Harmony Street, Ashbury:
  - Option 1a: construct a cable bridge parallel to and to the north of the existing Lindsay Street pedestrian bridge; or
  - Option 1b: install the conduits under the Cooks River via underboring (this is the preferred option); or
- Option 2: the transmission cable route travels in a north-easterly direction from Byron Street at the intersection with Brighton Avenue, Campsie, through Mildura Reserve. From this parkland, the conduits would be underbored beneath the Cooks River, surfacing in Croydon Park near the cul-de-sac of Croydon Avenue in Croydon Park. The transmission cable route then travels north along Croydon Avenue, east along Dunstan Street, and south along Hay Street, before continuing east along Harmony Street; or
- Option 3: the transmission cable route travels in an easterly direction from Byron Street at the intersection with Brighton Avenue, Campsie, then in a south-easterly direction through Mildura Reserve, between residences and the Cooks River until the cul-de-sac at Lindsay Street. From here, there are two special crossing options of the Cooks River into Lees Park before the transmission cable route continues on to Harmony Street, Ashbury, which are the same for Option 1:
  - Option 3a: construct a cable bridge parallel to and to the north of the existing Lindsay Street pedestrian bridge; or
  - Option 3b: install the conduits under the Cooks River via underboring.

A description of the cable bridge and underboring methods is provided in **Section 2.5**, with further detail in **Chapter 4 Project description** of the EIS.

2.4.1.2 Dulwich Hill light rail corridor

There are two options for the transmission cable route crossing of the Dulwich Hill Light Rail corridor in the vicinity of the Arlington Light Rail station, Dulwich Hill. This includes:

- Option 4a: the transmission cable route travels northeast along Windsor Road from the intersection with Arlington Street, then east on Terry Road. At the Terry Road cul-de-sac, the conduits would be underbored beneath the rail corridor, surfacing at the Hill Street cul-de-sac. From here the transmission cable route continues along Hill Street to Denison Road; or
- Option 4b: the transmission cable route travels southeast along Constitution Road from the intersection with Arlington Street, before crossing into the southern end of Johnson Park. From here, the conduits would be underbored beneath the rail corridor near the Arlington light rail station. The transmission cable route then continues along Constitution Road and then north on Denison Road.

2.4.1.3 Henson Park

There are two options for the transmission cable route crossing in the vicinity of Henson Park, Marrickville including:

- Option 5a: the transmission cable route continues northeast on Centennial Street to a car park. From here it travels in an easterly direction through a grassed verge between the tennis courts and Henson Park oval to near the Amy Street playground. The conduits would be underbored beneath the playground, surfacing at Amy Street. The transmission cable route then turns east on to Horton Street; or
- Option 5b: the transmission cable route travels north on Sydenham Road from Centennial Street, turning northeast on to Neville Street, then southeast on Surrey Street to Amy Street before continuing along Charles Street.

2.4.1.4 Marrickville

There are two options for the transmission cable route in the vicinity of Addison Road, Marrickville. Note that the project may include one or both options at this location including:

- Option 6a: the transmission cable route travels north along Agar Street from the intersection with Illawarra Road, then east on to Newington Road and south down Enmore Road to the intersection with Scouller Street; and/or
- Option 6b: splitting the two circuits as there is insufficient space along Addison Road to accommodate both circuits. One circuit would travel along Newington Road (as for Option 6a) and one circuit would travel east on Addison Road from the intersection with Illawarra Road, then north on Enmore Road to the intersection with Scouller Street.

2.5 Construction works

Construction activities would be limited to the identified project area and include the activities summarised in **Table 2-2**. A substantial portion of the transmission cables would be installed using pre-laid conduits. The conduits would only require the excavation of short sections of trench at a time (an average of 20 metres at any one location), with backfilling occurring as soon as each section of the conduits has been installed. Depending on the overall construction program and associated number of work crews required, it is expected that trenching and excavation would occur concurrently at multiple work sites along the transmission cable route.

The project would involve the construction of seven special crossings that would involve either the installation of a cable bridge or underboring (i.e. an underground crossing). Works for these crossings would be undertaken in coordination with the relevant asset owner (e.g. road or rail authorities).

The construction of the project would require a number of work sites along the transmission cable route and at special crossings. Each work site represents an area of disturbance required to undertake the construction activity (e.g. trenching, cable bridge installation, underboring) and would be located within the project area.

Table 2-2 Summary of construction activities

Construction activity	Description
Site preparation	• implementation of traffic management changes (such as safety barriers and road signage) to facilitate access and egress to/from the work sites; • installation of environmental control measures (such as sediment barriers); • vegetation clearing and tree removal, where required; • establishing construction laydown areas and ancillary facilities including temporary offices and worker amenities, site fencing and provision of power/services; and • delivery and storage of plant and equipment at construction laydown areas and work sites.
Trenching and excavation	• clearing of surface vegetation along excavation area if required; • saw cutting of the road surface/pavement and lifting this material using a backhoe/front end loader. If rock is encountered, a rock breaker may be used to loosen the material; • removal of material down to the base of the trench using an excavator and placement of spoil directly onto trucks to be transported to a licensed facility. The trench would typically be around 3 metres wide and 1.2 metres deep but could be deeper or shallower depending on the presence of utilities; and • installation of shoring as a precaution against slump or collapse where necessary, particularly where deeper sections of trench are required (i.e. deeper than 1.4 metres).
Relocation of minor utilities/services	• use of non-destructive digging methods to expose buried services to guide the excavator; and • minor relocations, if required, would occur within the road reserve and be subject to consultation with the relevant asset owner/operator.
Conduit installation and backfilling	• laying the transmission cable conduits on plastic spacers to provide the required clearance from the side walls and bottom of the trench; • placing the optic fibre communication cable conduits into position; • backfilling the trench with engineered backfill; • laying of polymeric covers and warning tape, marked with appropriate warnings in case of accidental excavation; and • installation of the road base and temporary restoration of the road surface to allow vehicles and other road users to travel across the area.

Construction activity	Description
Excavation and establishment of joint bays	• excavation of joint bays via open trenching; • installation of erosion and stormwater flow controls and barriers; • erecting fencing or hard barriers as required; • provision for vehicle access, worker amenities and equipment storage; • temporary covering with steel plates to provide access to adjacent properties where required; and • excavation of nearby pits to facilitate the installation of link and sensor boxes.
Cable pulling and jointing	• installation of a tent or demountable building over the joint bay to provide a controlled work environment and dry work site; • pulling cables through the conduits which is fed from large drums holding 600-800 metres of cable; and • connecting sections of cables at the joint bay.
Permanent road restoration	• removing the temporary road surface; • backfilling with road base up to surface level, where required; • reinstating pavement; and • reinstating the remaining areas that were excavated with spoil or other fill material to pre-construction levels and final finishing to match existing as appropriate (e.g. footpath and/or kerb and gutter), or as otherwise agreed with the relevant roads authority.
Cable markers	• once restoration activities have been completed, cable markers would be installed along the transmission cable route to give warning of the presence of the cables and the need to make enquiries before digging; • markers may include: - small signs attached to road kerbs; - concrete marker posts (between 800-900 millimetres tall) along the transmission cable route in vegetated areas where surface markers would be difficult to see; or - flush-markers constructed of concrete that are around 50-100 millimetres thick.
Cable bridges	• establishment of the work site and access including vegetation clearing (where required); • boring and earthworks for the bridge piers; • installation of the pre-cast cable bridge and steel cage (where required) by crane; • integration with the conduits in the road reserve; and • reinstatement of the work site.
Underboring	• underboring around 4 to 10 metres below the ground surface by either thrust boring or horizontal directional drilling (HDD); • thrust boring would require a launch pit (at least 4 m metres deep) and associated work site of up to around 800 square metres and a receive pit and work site of about 100 square metres; • HDD would require a work site at the drill launch area of up to around 800 square metres and a receive pit for the drill exit of around 1.5 metres deep; and • work sites would be restricted to the road reserve and public open space areas where feasible and reasonable to limit the need for vegetation removal.

Construction activity	Description
Substation upgrades	• site establishment; • earthworks and excavations needed for cable entries and footings for new equipment; • installation of new infrastructure (such as switchbays and busbars); • removal of redundant infrastructure; • installation and connection of new cables; • commissioning of cables; and • demobilisation.

2.5.1 Staging and timing of construction activities

An indicative duration of construction activities is provided in **Table 2-3**. The timing is subject to the detailed design and the final construction approach. For example, some works, such as trenching and excavation, would be undertaken by multiple work crews working along the transmission cable route. Staging of activities outside of certain hours would also influence the construction approach.

Should the project be approved, construction is planned to occur over 24 months, commencing in 2020. It is estimated that around 15 months would be required for civil construction works and conduit installation and about nine months for cable pulling and jointing, testing and commissioning. The transmission cable circuit is expected to be completed and commissioned in 2022/23.

Table 2-3 Indicative timing of typical construction activities

Construction activity	Indicative duration
Excavation, conduit (pipe) installation and trench backfilling	Conduits for each 600-800 metre cable section would take up to eight weeks to install (with most properties exposed to around two weeks of trench excavation activity).
Joint bay construction	Each individual joint bay would take up to three weeks to establish (in addition to trenching works). Each joint bay contains one cable circuit.
Cable pulling	Cable pulling at each joint bay for each 600-800 metre cable section would typically take up to two weeks to complete.
Cable jointing	Cable jointing would typically take up to three weeks to complete at each joint bay.
Cable bridges	Each cable bridge crossing is expected to take around 10 weeks to complete in total, however works would be staged and not continuous over the 10 week period.
Underboring	Each underboring crossing is expected to take around eight to 10 weeks to complete in total, however works would be staged and not continuous over this period.
Substation works	Construction works at the Rookwood Road substation is expected to take around four to six months, while works at the Beaconsfield West and Sydney South substations are expected to take around six to nine months at each site.

2.5.1.1 Construction hours

Construction works would be undertaken during standard daytime construction hours as specified in the *Interim Construction Noise Guideline* (DECC, 2009) where reasonable and feasible to do so. However, it is expected that works outside standard construction hours would also be required, as described below.

Standard construction hours are:

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

- No work on Sundays and public holidays.

It is likely that construction works would be required at night time (after 10pm) due to the requirements of relevant road and rail authorities. These works could include, but are not limited to, works within major road reserves (i.e. on State and regional roads such as Rookwood Road and Old Canterbury Road), through signalised intersections, or at special crossings. Work outside standard construction hours may be required for safety reasons and/or to limit disruption to road traffic and rail services.

Cable jointing works at each joint bay would need to be undertaken continuously i.e. 24 hours. Some works at the substation sites may also need to be undertaken outside of standard construction hours due to outage constraints on the existing infrastructure (i.e. the need to maintain power supply to customers).

Cable bridges and underboring at rail corridors would be timed with other rail works to limit disruption to freight and/or passenger rail services. These works could be undertaken outside of standard construction hours including at night time or over weekends, subject to approval of the relevant rail authority.

Scheduled construction activities, work hours and duration would be further refined through consultation with relevant government agencies and would be outlined in the CEMP for the project.

2.5.2 Construction precincts

The transmission cable route has been divided into five construction precincts to aid the characterisation of the existing environment and assessment of project impacts. These precincts broadly align with similar land uses. A description of each precinct follows:

- **Precinct 1** includes the areas between the Rookwood Road substation and the Hume Highway, including the industrial area of Chullora along Muir Road;
- **Precinct 2** includes the areas between the Hume Highway and Brighton Avenue near the Cooks River including the residential areas of Greenacre, Lakemba, Belmore, Belfield and Campsie;
- **Precinct 3** includes the areas from the Cooks River to Illawarra Road including the residential areas of Croydon Park, Ashbury, Ashfield, Dulwich Hill and Marrickville;
- **Precinct 4** includes the area between Illawarra Road and the Bankstown rail line including the residential areas of Marrickville, Enmore and Newtown; and
- **Precinct 5** includes the areas between the Bankstown rail line and the Beaconsfield West substation including the residential areas of St Peters and the recreational area of Sydney Park in Alexandria.

2.5.3 Construction laydown areas

As part of the construction of the project, temporary construction laydown areas would be required to store materials, equipment, excavated spoil and provide space for other ancillary facilities such as site offices. Five locations have been investigated as potential construction laydown areas. The final number and location is subject to ongoing consultation with the relevant landowners and would be determined during detailed design.

Stockpiling of excavated spoil at the construction laydown areas would be ongoing for the duration of the civil works (around 15 months). Stockpiling would be managed by erosion and sediment controls in accordance with *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004) (The Blue Book).

While it is expected that construction would require the use of transportable roadside facilities for individual work sites, provision for temporary site offices would be located within construction laydown areas for the duration of construction (up to two years).

Construction laydown areas would be fenced and would have lighting for security and to facilitate night works.

Driveways may need to be created from gravel or similar material to enable heavy vehicles to enter/exit the site. At construction laydown areas at Cooke Park and Peace Park, extended driveways would be required to access the laydown area. The construction of these driveways would require ground disturbance and potentially tree removal.

Temporary infrastructure at the construction laydown areas, including noise mitigation controls (such as hoardings), driveways and stockpile areas, would involve minimal subsurface ground disturbance (i.e. excavation) and would be removed once construction is complete.

For works at the Rookwood Road and Sydney South substation sites, sufficient space exists at each location to store materials and equipment; therefore, no additional laydown areas would be required.

The proposed locations and area required for the five potential construction laydown areas are listed in **Table 2-4**.

Table 2-4 Potential construction laydown areas

Potential construction laydown area	LGA	Potential area (hectares)
12 Muir Road, Chullora	City of Canterbury-Bankstown	0.48
Cooke Park, Belfield	Strathfield	0.37
Peace Park, Ashbury	Inner West Council	0.45
Camdenville Park, St Peters	Inner West Council	0.18
Beaconsfield West substation, Alexandria	City of Sydney	0.85

2.6 Cable operation and maintenance

Once the transmission cables have been installed, generally only visual inspections would be required. This would involve regularly driving along the transmission cable route to check for hazards or activities (such as excavation works in the vicinity) that could impact the underground cables or cable bridges. Ongoing physical access to the transmission cables is not required however ongoing monitoring of the cable for damage (missing/worn cable markers) and outages would occur. This would be through access to the link boxes and sensor boxes located near the joint bays. Optical fibre cables installed alongside the transmission cables would be monitored at the optical fibre cable pits.

Pits for link and sensor boxes and optical fibre cables would generally be located in the footpath/road verge but in some cases where there is insufficient space, they may be required in the roadway. Roadway access would be managed with standard traffic controls.

Regular checks of the pits would ensure they are accessible and that the pit does not contain water or tree roots. Cable bridge structures would be inspected to ensure structural integrity and aesthetics are being maintained.

3.0 Assessment methodology

3.1 Study area

This assessment has considered the groundwater systems and resources within a 500 metre radius of the project area, including Rookwood Road, Beaconsfield West and Sydney South substations, such as the Botany Sands Aquifer. The groundwater study area is shown on **Figure 3-1**.

3.2 Statutory context, policy and guidelines

The following section describes the relevant environmental planning and statutory approval requirements for the project relating to groundwater.

3.2.1 NSW legislation

3.2.1.1 Water Act 1912 and Water Management Act 2000

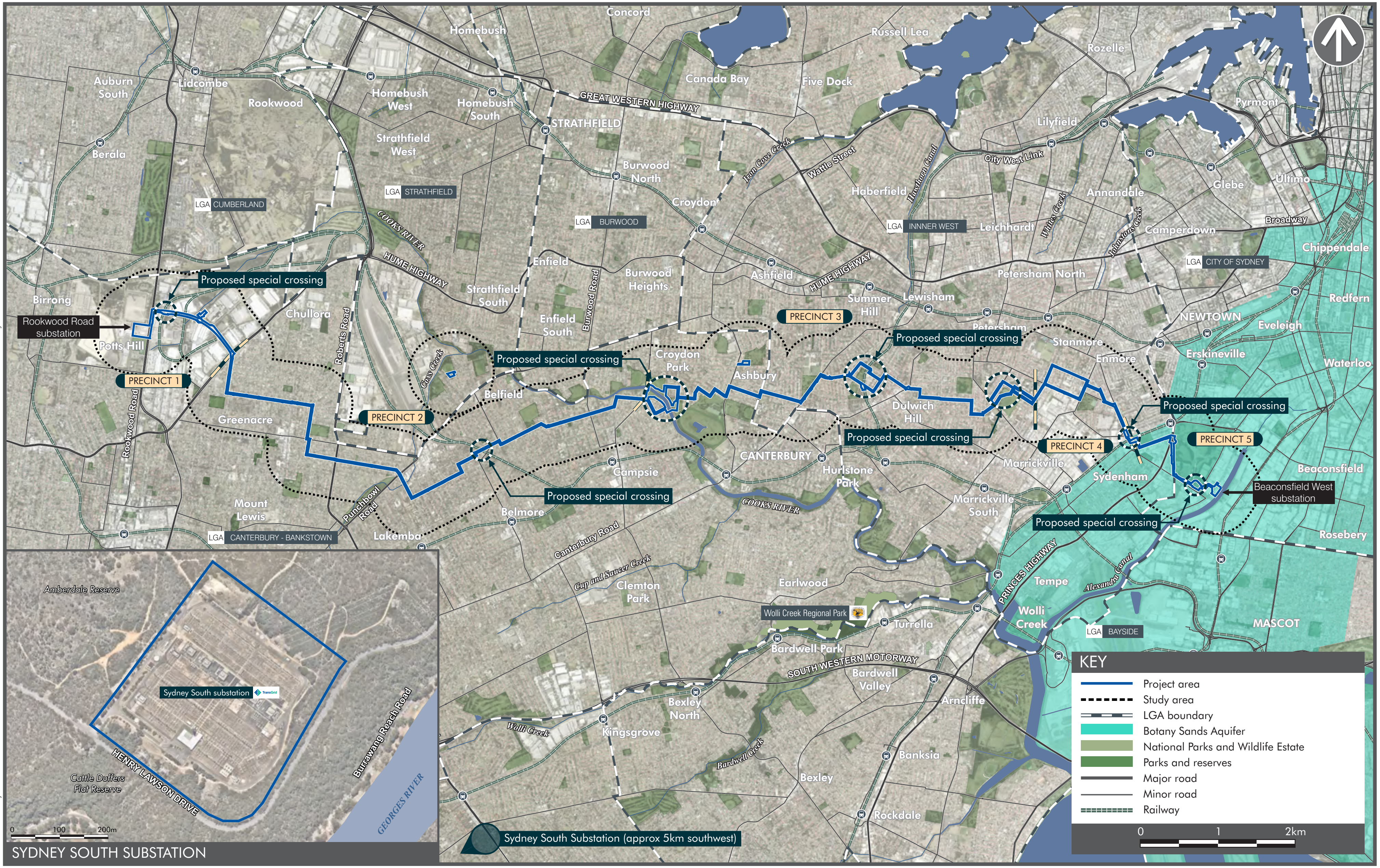
Water in NSW is regulated by Department of Industry (DI) - Water under the *Water Act 1912* (Water Act) and the *Water Management Act 2000* (WM Act). The WM Act is gradually replacing the planning and management frameworks in the Water Act although some provisions of the Water Act remain in operation. 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 net loss of either groundwater or surface water from a source covered by a water sharing plan, then an approval and/or licence is required.

The *NSW Aquifer Interference Policy* (Department of Primary Industries (DPI), 2012) outlines the requirement for approval of 'aquifer interference activities' under the WM Act (**Section 3.2.1.2**). The project would likely intercept the Botany Sands and Sydney Basin central aquifers managed under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. An assessment of potential groundwater impacts was undertaken in accordance with the *NSW Aquifer Interference Policy*. DI - Water staff advise a groundwater licence would be required if groundwater extraction exceeds 3 megalitres per year (ML/year). The assessment notes that temporary dewatering may be required during construction, but at this stage estimated extraction rates and extraction durations are unknown.

Under section 5.23 of the EP&A Act, certain separate environmental approvals would not be required for the project. Approvals not required for the project include a water use approval under section 89, a water management work approval under section 90 or an activity approval (other than a groundwater interference approval) under section 91 of the WM Act.

The objective of the WM Act is the sustainable and integrated management of the State's water for the benefit of both present and future generations. The WM Act recognises the need to allocate and provide water for the environmental health of NSW rivers and groundwater systems, while also providing licence holders with more secure access to water and greater opportunities to trade water through the separation of water licences from land. The main tool the WM Act provides for managing the State's water resources are water sharing plans. These are used to set out the rules for the sharing of water in a particular water source between water users and the environment and rules for the trading of water in a particular water source. **Section 4.0** provides details of human and environmental users of the waterways within the study area.

The project area is located within an area covered by the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources. This plan includes rules for protecting the environment, extractions, managing licence holders' water accounts, and water trading in the plan area (NSW DPI, 2016). The rules relevant for the waterways apply to the hydrological catchment of Parramatta River up to the mangrove limit and the hydrological catchment of the Cooks River and Botany Bay up to the mangrove limit. These limits are as defined in the Department of Infrastructure, Planning and Natural Resources (DIPNR) *Survey of tidal limits and mangrove limits in NSW estuaries 1996 to 2005* (2006). In practice, these rules apply to the Cooks River downstream of Burwood Road, and to Iron Cove, both of which are receiving waters related to the project.



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GROUNDWATER STUDY AREA

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Note: The project area is confined to the roadway reserve with the exception of parks and existing substations
Source: Department of Finance, Services and Innovation - Spatial Services (2018), Nearmap (2018)

FIGURE 3-1

3.2.1.2 Aquifer Interference Policy

The *Aquifer Interference Policy* (AIP) (NSW Office of Water, 2012) explains the process of administering water policy under the WM Act for activities that interfere with an aquifer. The AIP outlines the assessment process and groundwater modelling criteria that DI-Water apply to assess aquifer interference projects. This hydrogeological assessment has been undertaken in accordance with the AIP. For example, the project has been assessed against the minimum impact considerations required under the AIP.

Key components of the AIP are:

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

WALs entitle licence holders to specified shares in the available water within a particular water management area or water source and to take water at specified times, rates or circumstances from specified areas or locations. The project does not propose to extract any surface water from local urban waterways however groundwater is likely to be encountered due to shallow or perched groundwater in some construction precincts, depending on the depth of excavation. DI Water staff advise a dewatering licence would be required if groundwater extraction exceeds 3 ML/year. Internal guidance from DI-Water indicates that the AIP has not yet been updated to include this 3 ML/year requirement. If a licence is required, it would be issued under Part 5 of the Water Act 1912, as the aquifer interference activities (extraction of groundwater) approvals under the WM Act have not yet commenced.

3.2.1.3 Water Sharing Plan

The project area is located in the *Greater Metropolitan Region Groundwater Source Water Sharing Plan* (NoW 2011) which commenced on 1 July 2011. Within the plan, the project 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 project area 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 (NSW Office of Water 2011). The project area does not extend into the unconsolidated sediments of the Botany Sands aquifer further to the east.

Groundwater within the Sydney Basin Central Groundwater Source is declared a less productive groundwater source by DI-Water 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:

- watertable impacts:
    - when 40 metres from any high priority groundwater dependent ecosystem or high priority culturally significant site listed in the Schedule of the water sharing plan, the cumulative variation in the watertable must be less than or equal to 10 per cent, allowing for typical climatic ‘post-water sharing plan’ variations;

  - a maximum of two metres cumulative groundwater level decline at any water supply works;
- water pressure impacts:
  - a cumulative pressure head decline of not more than two metres at any supply work; and
- 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.

3.2.1.4 Protection of the Environment Operations Act 1997 (POEO Act)

The POEO Act regulates air and water pollution, noise control, waste management and other activities, and is administered by the NSW Environment Protection Authority (EPA). Under this Act, the pollution of waters is prohibited unless the pollution is regulated under an Environment Protection Licence (EPL). Specific activities such as the bulk storage of chemicals, contaminated soil and groundwater treatment, and the transport of trackable waste must also be regulated under an EPL. The project does not include any scheduled activities under Schedule 1 of the POEO Act and is unlikely to result in the pollution of waters provided appropriate management and mitigation measures are implemented. Therefore, an EPL would not be required.

3.2.2 Guidelines and policies

3.2.2.1 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000) (ANZECC Water Quality Guidelines) form part of the *National Water Quality Management Strategy* and list a range of environmental values for waterbodies. Different water quality criteria are set for the waterbodies based on environmental values assigned to that waterbody. The ANZECC Water Quality Guidelines provide water quality criteria (scientifically-based benchmark values) for a wide range of parameters for each of these values. These guidelines provide a useful measure of the potential risks to aquatic systems in the downstream receiving waters, such as the Cooks River or Sydney Harbour.

3.2.2.2 NSW Water Quality and River Flow Objectives

The NSW Water Quality and River Flow Objectives (NSW Department of Environment, Climate Change and Water (DECCW), 2006) are consistent with the agreed national framework of the ANZECC Water Quality Guidelines (noted above). They are *"*primarily aimed at maintaining and improving water quality, for the purposes of supporting aquatic ecosystems, recreation and where applicable water supply and the production of aquatic foods suitable for consumption and aquaculture activities".

3.3 Methodology

A qualitative assessment has been undertaken to address the potential impacts on groundwater systems that may result from the project, including from the construction of the transmission cable circuit, underbores at special crossings, construction laydown areas and substation upgrades. Required water use during the construction process, as well as discharge of water from the project was also considered.

The assessment of the underboring construction method has assumed the following. Underboring by thrust boring would require a launch pit (at least 4 metres deep) and associated work site of up to around 800 square metres and a receive pit and work site of about 100 square metres. Horizontal directional drilling (HDD) would require a vertical borehole to the target depth, proceeding from there with horizontal drilling at the required target depth, typically 4 – 10 mbgs. Drilling fluids would be circulated and then recovered to remove cuttings and provide formation stability and to lubricate the drilling rod and head.

3.3.1 Desktop assessment to determine existing conditions

A desktop review and analysis of existing information was undertaken to determine potential receptors and characterise the existing environment.

Potential groundwater impacts were assessed by considering existing groundwater and geological data including:

- Geological Survey of NSW Sydney 1:100,000 Geological Sheet 9130 (Herbert, 1983);
- previous geotechnical and groundwater investigations for Rookwood Road substation (Douglas Partners, 2010/2017) and Beaconsfield West substation (Parsons Brinckerhoff, 2009);
- *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*;
- National Atlas of Groundwater Dependent Ecosystems (Bureau of Meteorology, 2018); and
- review of bores registered with DI-Water accessed through the Bureau of Meteorology.

3.3.2 Assessment of potential impacts

Potential impacts on groundwater resources including minimal impact considerations under the AIP were assessed by considering:

- the location of registered bores and Groundwater Dependent Ecosystems (GDEs),
- the regional geology and hydrogeology; and
- identifying the areas where there could be impacts on these resources.

Groundwater impacts have the potential to occur where the excavation intersects the watertable in areas such as joint bay excavations, trench excavations in excess of two metres and at underbore locations. Where possible, data from previous investigations have been compiled to identify these areas.

4.0 Description of the existing environment

4.1 Hydrogeological setting

Groundwater across the project area is present in the following three broad hydrostratigraphic units:

- fill, imported and local, used for the construction of infrastructure and waste infilling such as Sydney Park and Camdenville Park;
- alluvium around the edges of major water ways including Cooks River and Alexandra Canal, noting that these channels are concrete lined; and
- bedrock aquifer of the Ashfield Shale and Hawkesbury Sandstone.

Across the project area, the watertable is generally a subdued reflection of the topography with groundwater being deeper beneath hills and shallowest beneath creeks or gullies. Groundwater along the project area is recharged by infiltration of rainfall and runoff. Perched groundwater may be encountered within fill and natural clayey soils. In lower lying areas, tidal influences are typically experienced within close proximity to the foreshore. Groundwater levels fluctuate in response to diurnal variation, tidal influences, variable rainfall, dewatering. seasonal variation and longer term in response to natural climatic variation.

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

Groundwater flow typically follows the surface topographical expression but is also influenced by a number of factors including geological boundaries, palaeochannels, building foundations and groundwater extraction. Groundwater within the alluvium flanking creeks is typically unconfined and flows towards the waterways. The waterways can either be a groundwater discharge or recharge zone depending on the relationship between creek levels and groundwater levels. To the east groundwater flow within the Botany Sands aquifer is eastward discharging into Alexandra Canal. Regionally groundwater flow within the Wianamatta Shale and Hawkesbury Sandstone is predominately fracture controlled with overall flow being eastward towards Sydney Harbour. On a more localised scale groundwater movement within the shale is controlled by the elevation of the watertable (hydraulic head), potentiometric heads[1] and the hydraulic gradient.

4.1.1 Groundwater levels

Groundwater levels are variable across the project area and are influenced by many factors as outlined above. Elevated groundwater levels may be present where the watertable is perched, especially within the residual clay of the Wianamatta Shale. In areas where the watertable is less than two metres below ground level, the trench excavation depth may intersect groundwater and require, temporary dewatering during construction. The volume of water to be extracted would be dependent on a number of factors including the thickness of saturated material to be excavated, the lithology of the material and the duration of the trench excavation. The groundwater quality will also be a factor as this would impact the dewatering options. Dewatering options include disposal to stormwater or sewer, aquifer injection or tankering off-site. If the extracted groundwater is expected to exceed 3 ML/year, a licence from DI-Water would be required in accordance with the AIP.

Groundwater levels in the project area have been collated from previous investigations in Precincts 1 and 5 and are discussed further.

In Precinct 1, eleven boreholes were excavated at the proposed Rookwood Road substation between three metres and ten metres intersecting fill, silty clay and shale (Douglas Partners, 2010). No groundwater was intersected within the excavation depth of 0.0 to 1.5 mbgl. However, after an extended period of wet weather, groundwater could be encountered along the clay and bedrock

[1] The level to which water in a confined aquifer would rise were it pierced with wells.

interface or perched groundwater within the weathered profile or fill. Douglas Partners (2010) suggests that such seepage, if intersected, could be controlled by sump and pump methods during excavation.

In Precinct 5 at the Beaconsfield West substation, groundwater levels within the Botany Sands aquifer are between 0.6 and 3 mbgl (Parsons Brinckerhoff, 2009). Since the substation is adjacent to Alexandra Canal, groundwater levels are expected to be at a similar level to the water level in the canal and oscillate with tidal fluctuations.

In Precinct 5 at Sydney Park, groundwater levels measured in 2001 and 2002 (Douglas Partners, 2017) were below the typical trench depth of 1.5 metres, suggesting the watertable is unlikely to be intersected during trenching where depths are shallower than 1.5 metres, with the exception of the wetlands area. Water management at Sydney Park is complex due to leachate generation from the former landfill. Changes to management practices such as the location of wetlands or leachate extraction could alter the local hydrogeological regime and cause groundwater levels to increase.

No hydrogeological investigations specific to this project have been conducted in Precincts 2 to 4 However, since the transmission cable route within these precincts is predominately in topographically elevated areas and is to be excavated from shale, it is anticipated that groundwater would not be intersected along the majority of the transmission cable route. Areas with the potential to intersect groundwater are immediately adjacent to the Cooks River and locations that require underboring.

4.1.2 Groundwater quality

Groundwater quality across the project area is variable and dependent upon the lithology of the aquifer, tidal influences and current and previous land uses. Groundwater quality within the alluvium is naturally variable being typically of low salinity in upper reaches of creeks and rivers and increasing in salinity downstream due to increased tidal influences. Similarly, natural groundwater quality within the shale and weathered shale is variable but is often saline due to the connate salts within the shale. Groundwater quality within fill is dependent upon the quality and origin of the fill material (i.e. if the fill comprises contamination, groundwater quality could potentially be contaminated).

At Sydney Park, for example the groundwater is known to be contaminated and leachate and landfill gas has generated due to the waste infilling of the former quarries/brick pits. Other known areas of contamination are outlined in the preliminary site investigation (**Appendix K** of the EIS). Elsewhere along the transmission cable route the unconfined alluvial aquifers are susceptible to contamination from former and current land use practices such as leakage from industrial sites, leaky sewage systems or the application of fertilizers. The shales are generally less susceptible to contamination due to the presence of an overlying clayey soil profile restricting groundwater infiltration. Groundwater contamination in the project area is discussed in more detail in **Appendix K** of the EIS.

Groundwater quality within the Botany Sands aquifer, in Precinct 5, under natural conditions is generally of low salinity. However, due to the shallow unconfined nature of the aquifer it is susceptible to groundwater contamination from a variety of historic and current land uses such as tanneries, metal platers, service stations, light industry, landfills, dry cleaners, petrol stations and leaky sewage pipes.

4.1.3 Groundwater dependent ecosystems

Groundwater dependent ecosystems 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. Most wetland communities and many river systems have some degree of dependence on groundwater. GDEs within or near to the project area have been identified following a review of:

- *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* (NSW Office of Water, 2011). Schedule 4 of the plan identifies high priority GDEs and Appendix 2 identifies GDEs; and
- National Atlas of Groundwater Dependent Ecosystems (Bureau of Meteorology, 2018).

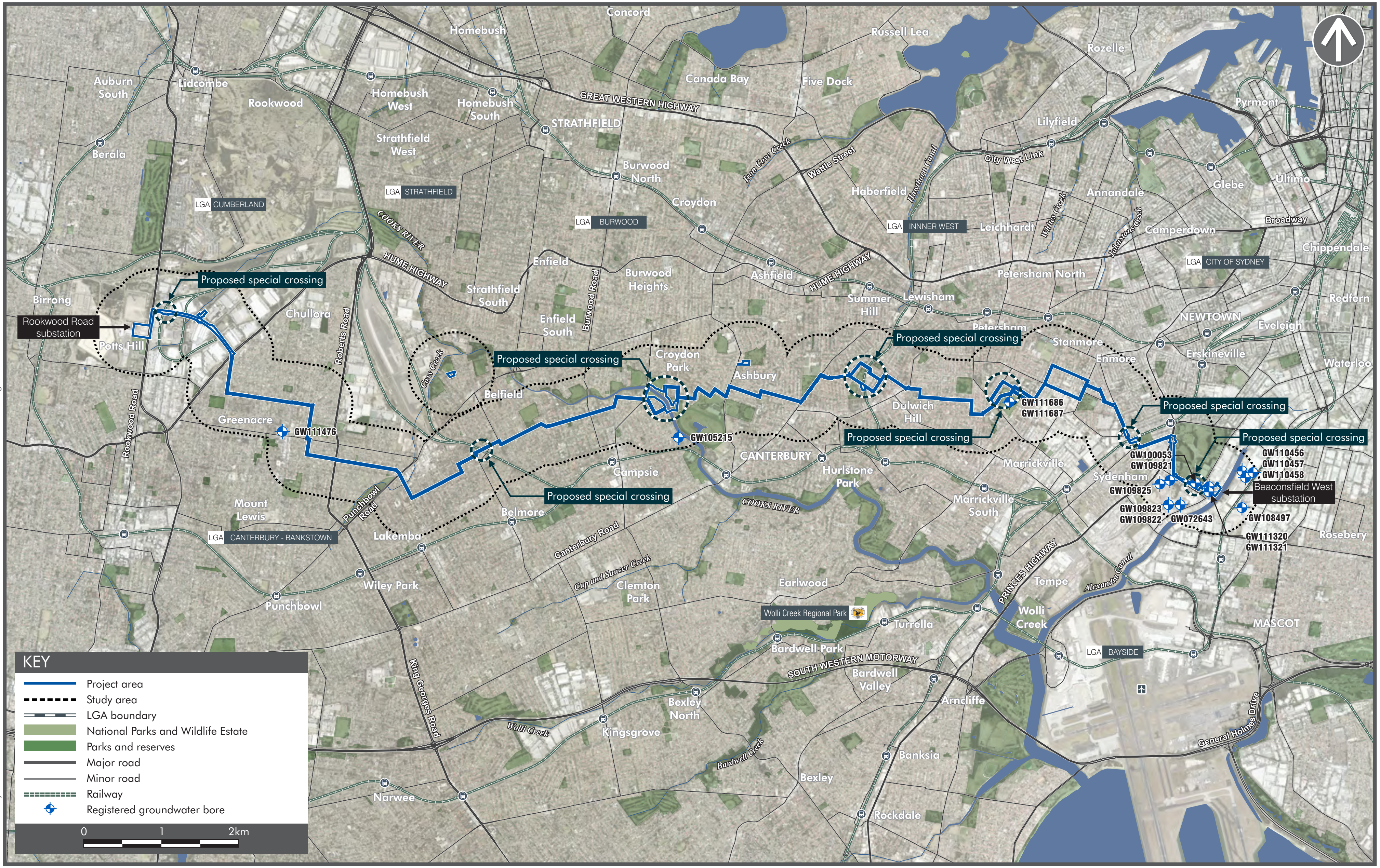
The closest high priority GDEs identified in the Water Sharing Plan are the Botany Wetlands or Lachlan Swamps located in Centennial Park. These wetlands are areas where groundwater surfaces in the Botany Sands aquifer, supporting ecosystems. Since the wetlands are located approximately 4 kilometres northeast of the eastern most extent of the project area and east of Alexandra Canal it is considered unlikely that the GDEs would be impacted by temporary dewatering due to the project.

A search of the GDE Atlas (Bureau of Meteorology, accessed 28 May 2019) for high priority GDEs indicated that there are no ecosystems within the study area that are likely to be dependent on groundwater. The project is not expected to change availability of water for plants due to the low permeability of the clayey soils, frequent rainfall events and nearby GDEs which are located at points of recharge.

4.1.4 Groundwater extraction

Existing groundwater use within the study area is limited as the area is serviced by a reticulated water supply provided by Sydney Water. Groundwater usage to the east of St Peters within the Botany Sands aquifer is higher because groundwater can be extracted for domestic purposes for little cost other than borehole establishment and pumping costs. The extracted water is typically used to water lawns and gardens or wash cars. At Sydney Park, stormwater is harvested to support the Sydney Park wetlands and discharges into Alexandra Canal following extended periods of rainfall.

A review of bores registered with DI-Water accessed through the Bureau of Meteorology (April 2018) within the study area identified 16 registered bores. It is possible there are other private bores present within the 500 metre radius that have not been registered with DI-Water. Review of these boreholes indicates that 14 are registered as monitoring bores, one is for domestic use and one is for recreation and culture (GW1000053). The remainder had no purpose recorded. The dominant purpose of the wells for groundwater monitoring is consistent with low groundwater use within the project area. The wells are typically shallow being less than ten metres deep. Exceptions are domestic bore GW105215 located in Bellombi Street, Canterbury which is drilled to a depth of 15 metres and monitoring wells GW109821 (35 metres) and GW109825 (22 metres) located at Alexandria Landfill, at Sydney Park. Construction details and water quality for domestic bore GW105215 were not recorded. The distribution of registered boreholes extracted from the database is shown on **Figure 4-1**.



G:\ENV\GIS\Projects\60516\60558835 Rookwood to Beaconsfield EIS\FIGURES\2019\Groundwater\60558835 F4.1 Registered Groundwater Bores 26 08 2019

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REGISTERED GROUNDWATER BORES

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Note: The project area is confined to the roadway reserve with the exception of parks and existing substations

Source: Department of Finance, Services and Innovation - Spatial Services (2018), Nearmap (2018)

FIGURE 4-1

4.2 Waterways

Waterways within the study area consist of a mix of concrete lined and modified watercourses that convey stormwater to the Cooks River or in the case of Hawthorne Canal to Rozelle Bay, which is part of the Parramatta River estuary.

The transmission cable route would cross the Cooks River, which is the main hydrological feature within the study area. Coxs Creek, a primary tributary of the Cooks River, would also be crossed by the transmission cable route in the western portion of the study area. At the point of crossing Coxs Creek, the waterway is a concrete channel. The Beaconsfield West substation, to the eastern end of the study area, is located adjacent to the Alexandra Canal, a highly modified waterway (formerly Shea's Creek) which also flows into the Cooks River.

The Sydney South substation is located approximately 150 metres north of the Georges River estuary, which flows into Botany Bay. The Georges River estuary at the Sydney South substation is a tide dominated drowned valley estuary (OEH, 2018). Although much of the catchment is urbanised, the estuary has retained many of its natural characteristics.

Table 4-1 identifies local drainage and waterways and the form of proposed crossing within each construction precinct along the transmission cable route.

Table 4-1 Catchment descriptions and water features which intersect the transmission cable route

Precinct	Catchment description	Intersected water features	Form of water feature at intersection location	Form of proposed crossing
Precinct 1	**Catchment:** Cooks River The Cooks River within this precinct flows past the Yana Badu Wetland approximately 200 metres downstream of Muir Road, which is a naturalised watercourse (artificial wetland) built for flood events.	Cooks River along Muir Road, Chullora	Culvert under the road	Trenching
		Urban drainage network	Stormwater pits and pipes	Measures to temporarily support or relocate the stormwater network would be required
Precinct 2	**Catchment:** Cooks River (Coxs Creek sub-catchment) Coxs Creek has been channelised with a concrete lined channel in this precinct.	Coxs Creek at Wangee Road, Lakemba	Culvert under the road	Trenching under the base slab of the channel. The removal/reinstatement of a small section of the culvert would be required
		Tributary of Cooks River at Rawson Road	Culvert under the road	Trenching through the existing culvert
		Tributary of Cooks River at Omaha Street	Culvert under the road	Trenching through the existing culvert
		Urban drainage network	Stormwater pits and pipes	Measures to temporarily support or relocate the stormwater network would be required.
Precinct 3	**Catchment:** Cooks River (Eastern Channel sub-catchment), Parramatta River The majority of the precinct is within the Cooks River catchment and drains either via drainage channels, or by being discharged to the Sydenham Flood Detention Basin, and then pumped back to the Cooks River. A small portion of this precinct in Dulwich Hill drains to the Hawthorne Canal.	Cooks River at Lindsay Street, Campsie	The Cooks River at this location is a wide, concrete lined channel	The crossing of the Cooks River would require a cable bridge at Lindsay Street or underboring between Mildura Reserve and Croyden Avenue or Lees Park.
		Major urban drainage network	Stormwater pits and pipes	Measures to temporarily support or relocate the stormwater network would be required
Precinct 4	**Catchment:** Cooks River (Eastern Channel sub-catchment)	Major urban drainage network	Stormwater pits and pipes	Measures to temporarily support or relocate the

Precinct	Catchment description	Intersected water features	Form of water feature at intersection location	Form of proposed crossing
	The precinct drains to the Cooks River, either via the Eastern Channel, or by being discharged to the Sydenham Flood Detention Basin, and then pumped back in to the Eastern Channel.			stormwater network would be required
Precinct 5	**Catchment:** Cooks River (Alexandra Canal sub-catchment) West of the Princes Highway, St Peters drains to the Cooks River via the Eastern Channel. There is a detention basin in Camdenville Park which is pumped out into the Eastern Channel. East of the Princes Highway (Alexandria), Precinct 5 drains to the Alexandra Canal. Currently stormwater is harvested from the stormwater culvert in the northeastern corner of Sydney Park.	Urban drainage network	Stormwater pits and pipes	Measures to temporarily support or relocate the stormwater network would be required
		Sydney Park Wetland	Artificial wetland	Options include routing around wetland or underboring.

4.3 Drainage and topography

The majority of land traversed by the transmission cable route drains into catchments and waterways via local piped urban stormwater networks. Localised flooding is known to occur in some areas as a result of overflow to these networks. The transmission cable route is predominately in elevated topographical areas as indicated by available topographic mapping and Light Detection and Ranging data (Department of Finance, Services and Innovation, 2013).

Topography and drainage across the study area is summarised in **Table 4-2**.

Table 4-2 Drainage and topography summary

Precinct	Elevation range	Drainage
1	36-53 metres Australian Height Datum (AHD).	Area drains into a tributary of the Cooks River which drains to the northwest into the Cooks River.
2	Generally 9-50 metres AHD with low point around Cooks River (6 metres AHD).	Western portion drains into a tributary of the Cooks River which drains to the northwest into the Cooks River. Centre portion drains into Coxs Creek which drains to the northwest into the Cooks River. Eastern portion drains into the Cooks River.
3	Generally 9-46 metres AHD with low point around Cooks River (3 metres AHD) and relative low point around Hawthorn Canal (20 metres AHD).	The eastern and western portions drain into the Cooks River to the south. The centre portion drains to Hawthorn Canal in the north.
4	4-16 metres AHD, lowest in the east.	Drains into the Cooks River to the south.
5	6-18 metres AHD, lowest in the eastern most and western most extent of the construction precinct, high point at King Street.	Drains into the Cooks River and Alexandra Canal. A flood detention basin is present in Camdenville Park and man-made wetlands are present within Sydney Park, and local stormwater is harvested from the urban drainage network near Sydney Park Road.

4.4 Soils

Soils within the study area are identified from the *Soil Landscapes of Sydney 1:100,000 sheet*, (Chapman and Murphy, 1989) and are presented on **Figure 4-2**. The project would cross four soil landscapes as follows:

- Blacktown (bt) – a residual landscape generally characterised by poor drainage and low soil fertility. Much of this soil landscape is covered by urban development which may include various pavement types or turf;
- Birrong (bg) – a fluvial landscape generally characterised by localised flooding, high soil erosion potential, saline subsoil, seasonal waterlogging and very low soil fertility. Most drainage lines of this landscape have been artificially lined with concrete;
- Tuggerah (tg) – an aeolian landscape generally characterised by extreme wind erosion potential, highly permeable soils, very low soil fertility, localised flooding and permanently high-watertables; and
- Disturbed Terrain (xx) – a disturbed landscape generally characterised by poor drainage and the potential for contamination, mass movement hazard, sources of sedimentation and groundwater contamination.

As the project area is located within an urban environment, landscape alteration is common and ranges from minor landscaping to extensive cut and fill activities associated with the construction of major buildings and infrastructure. The fill typically consists of locally excavated and imported materials. More substantial filling has occurred along low lying areas such as the Cooks River and Alexandra Canal where some areas have been reclaimed from locally dredged river sediments.

Sydney Park and the nearby former Alexandria Landfill comprised a series of former quarries that were subsequently infilled with waste material, including putrescible waste. These sites generate leachate and landfill gas and are managed to minimise on-going impacts on the environment. Camdenville Park located west of Sydney Park in Marrickville is also crossed by the transmission cable route. As for Sydney Park, Camdenville Park is a former brickpit that has been infilled with municipal waste and converted to a playing field.

The majority of the Sydney South substation site consists of Lucas Heights residual soils, with Hawkesbury colluvial soils along the south eastern boundary as defined in Chapman and Murphy, 1989.

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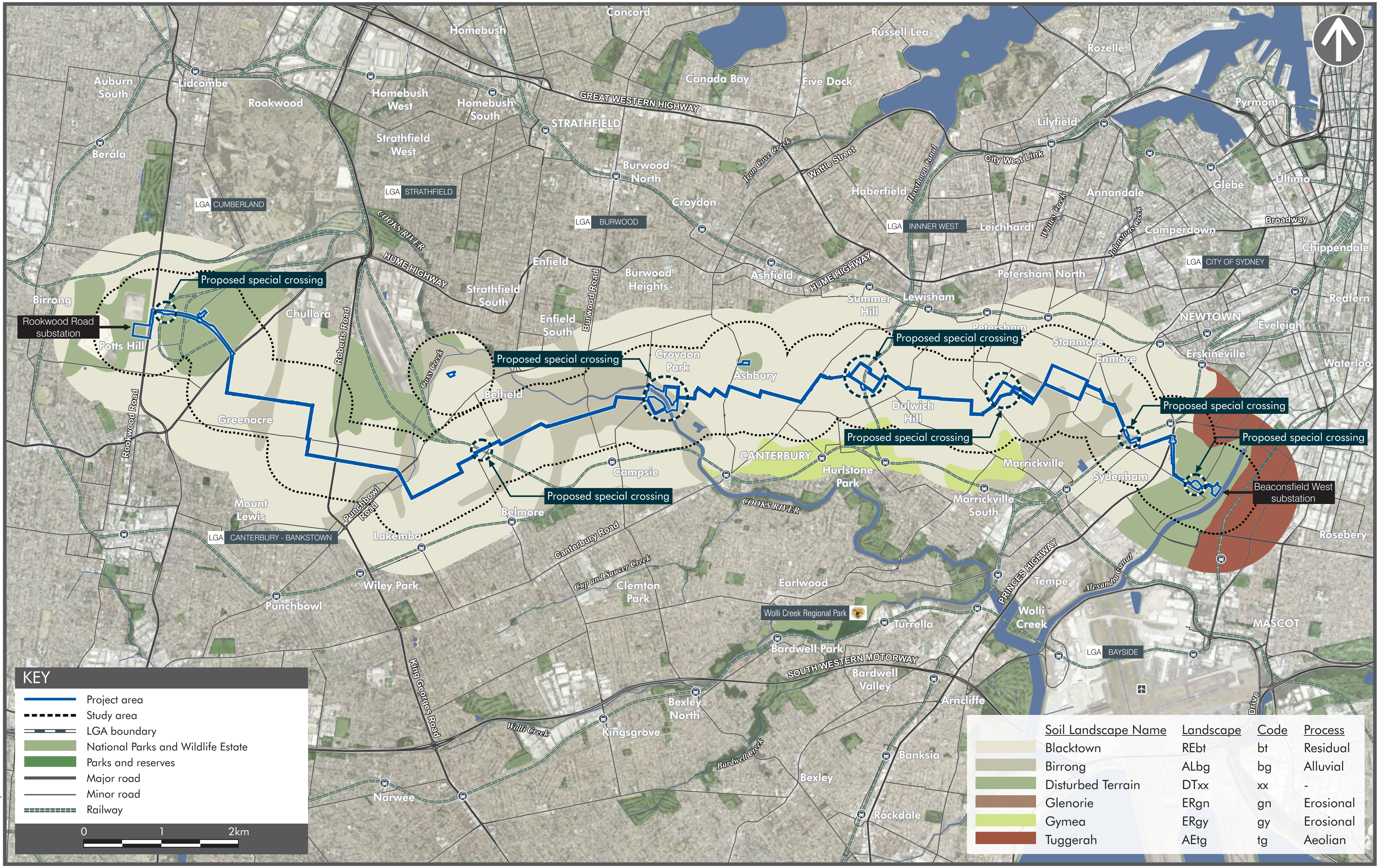

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SOIL LANDSCAPES

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Note: The project area is confined to the roadway reserve with the exception of parks and existing substations

Source: Department of Finance, Services and Innovation - Spatial Services (2018), Nearmap (2018), Office of Environment and Heritage (OEH), 2008

FIGURE 4-2

4.5 Acid sulfate soils

Acid sulfate soil (ASS) is the common name given to a range of soil types containing iron sulfides, the most common being pyrite. ASS may be present as actual ASS (AASS) or potential ASS (PASS).

PASS are sulfidic soils formed in coastal lowlands subject to tidal inundation or saline groundwater that have not been oxidised. PASS form where conditions are conducive for accumulation of iron sulfides in soils (e.g. source of sulfate, source of iron, reducing conditions, and stable low energy environment). When exposed to air due to drainage (watertable lowering/dewatering) or disturbance during earthworks, these soils produce sulfuric acid, often releasing toxic quantities of iron, aluminium and heavy metals. The heavy metals and acid can leach into soil and groundwater or impacted runoff can enter waterways and have negative impacts on water quality and aquatic ecosystems.

AASS occur where natural (e.g. groundwater level changes) or anthropogenic (e.g. land development, drainage works) activity has resulted in PASS being exposed to air, resulting in releasing acidity and reaction products (iron, sulfate, calcium, magnesium, aluminium etc.).

NSW Office of Environment and Heritage acid sulfate soil (ASS) risk maps (OEH, 2012) show areas of ASS risk. The ASS classification is assigned based on the probability and depth of occurrence of ASS. The classes trigger when an acid sulfate soil management plan (ASSMP) should be prepared and are as follows:

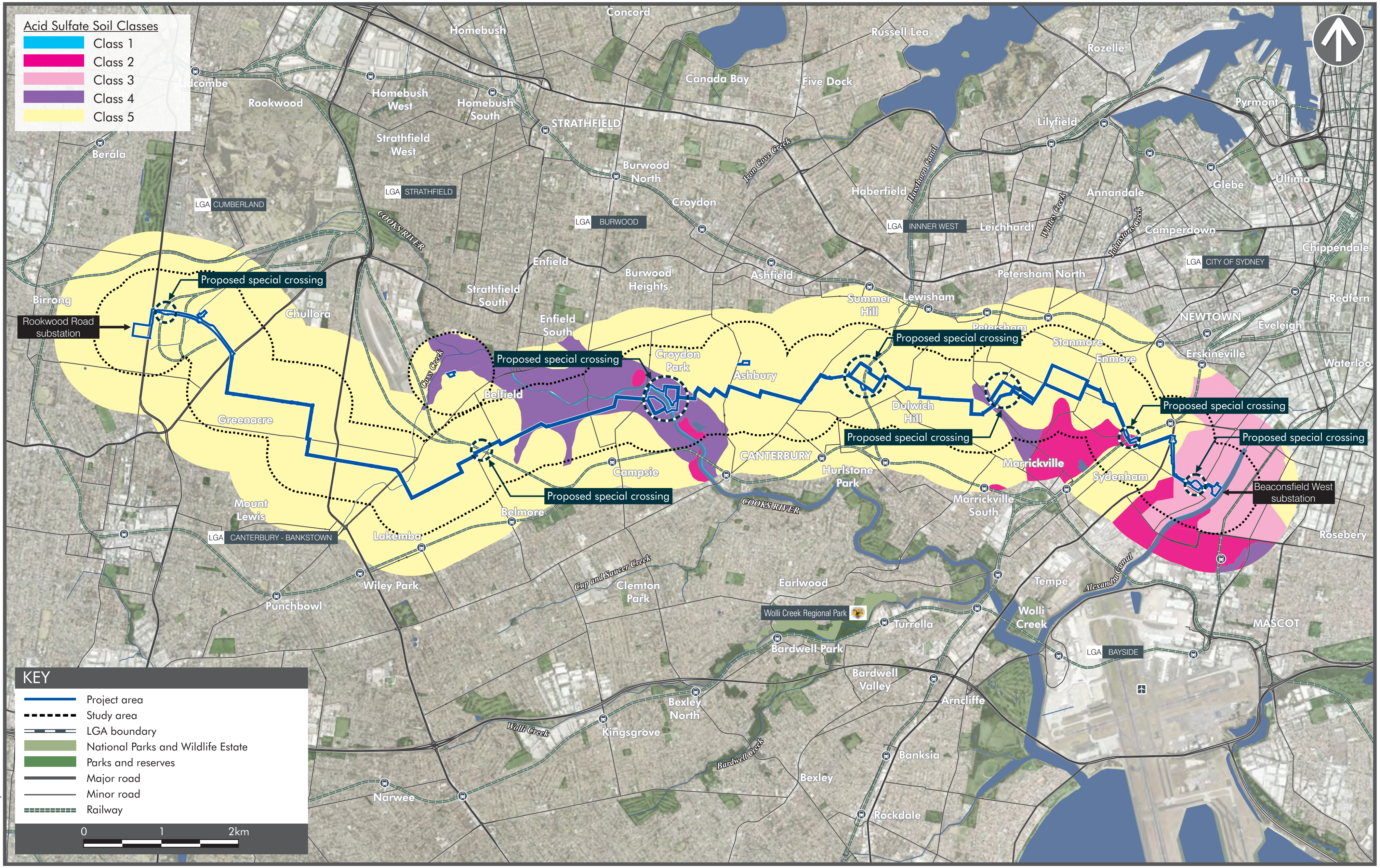
- Class 1: Any works[2] require an ASSMP;
- Class 2: Works below the natural ground surface and/or works by which the watertable is likely to be lowered require an ASSMP;
- Class 3: Works more than 1 metre below the natural ground surface and/or works by which the watertable is likely to be lowered more than 1 metres below the natural ground surface require a ASSMP;
- Class 4: Works more than 2 metres below the natural ground surface or works by which the watertable is likely to be lowered more than 2 metres below the natural ground surface require an ASSMP; and
- Class 5: Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below 5 metres Australian Height Datum, where the watertable is likely to be lowered below 1 metre Australian Height Datum on adjacent Class 1, 2, 3 or 4 land requires an ASSMP.

The ASS risk class in the project area is largely Class 5 (indicating no risk of intercepting acid sulfate soils for activities which do not lower the watertable by more than 1 metre) with the exception of the areas listed in **Table 4-3**. **Figure 4-3** shows the ASS risk classes for the transmission cable route.

[2] Any works that disturb more than one tonne of soil or lower the watertable (OEH, 2012)

Table 4-3 Acid sulfate soil risk and class

Precinct	Section of cable route	Probability	Acid sulfate soil risk classification
2 and 3	Along Omaha Street east of Baltimore Street, Seventh Avenue Campsie to Hay Street/Harmony Street intersection in Canterbury (2.2 km length)	Low	Class 4
3	High probability of acid sulfate soils within the Cooks River (35 metre length)	High	Class 1
3	Centennial Street, Sydenham Road and Neville Street, Marrickville (130 metre length)	Low	Class 4
4	Cable route along Edgeware Road between Darley Street, Marrickville and May Street, St Peters (360 metre length)	Low	Class 2
5	Princes Highway to Alexandra Canal (1.3 km length)	Low	Class 3



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ACID SULFATE SOILS

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Note: The project area is confined to the roadway reserve with the exception of parks and existing substations

Source: Department of Finance, Services and Innovation - Spatial Services (2018), Nearmap (2018), Office of Environment and Heritage (OEH), 2008

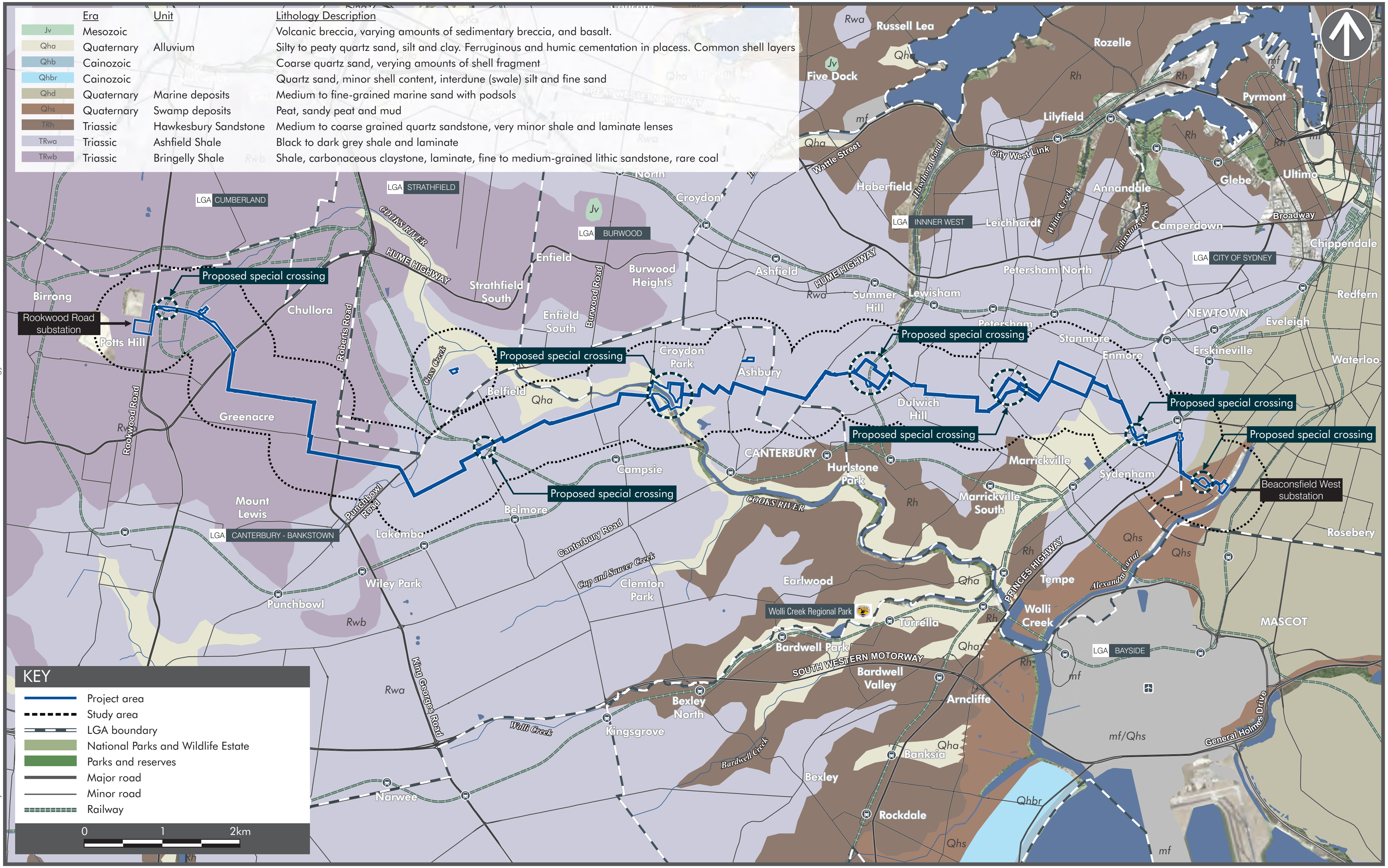
FIGURE 4-3

4.6 Geology

The regional geology of the study area is mapped on the Geological Survey of NSW Sydney 1:100,000 Geological Sheet 9130 (Herbert, 1983). The 1:100,000 geological maps are of regional scale and therefore the unit boundaries are approximate only and may extend beyond the mapped boundaries in the geological maps. Regionally, the study area is located within the Permo-Triassic Sydney Basin that is characterised by sub-horizontal lying sedimentary sequence of shale and sandstone. The geology of the study area is presented on **Figure 4-4**.

The geology within the study area is dominated by the Triassic aged Wianamatta Group that is overlain in part by Quaternary aged alluvium and marine deposits outcropping adjacent to major waterways. The Wianamatta Group includes Bringelly Shale (Rwb) and Ashfield Shale (Rwa) (Precincts 1-5). The Bringelly Shale is expected to underlie the Rookwood Road substation (Precinct 1). The residual soils derived from Bringelly Shale are generally between 3 metres and 6 metres thick and comprise medium to high plasticity clays. The Ashfield Shale comprises black to dark grey shale and laminite. The shale is underlain by the Hawkesbury Sandstone, a medium to coarse grained quartzose sandstone. The Quaternary alluvium (Qha) sandstone outcrops, at the edge of the study area at Marrickville,.are mapped within the flood plains of Cooks River (Precinct 3) and are composed of silty to peaty quartz sand, silt, and clay. Quaternary swamp deposits (Qhs) composed of peat, sandy peat, and mud are also mapped within the flood plains of the Alexandra Canal (Precinct 5). It is expected that about 550 metres of the transmission cable route is underlain by this unit in Precinct 5, between the southern end of Sydney Park to Alexandra Canal. There is a small area of also Quaternary marine deposits (Qhd) mapped within Sydney Park, comprised of medium to fine-grained marine sand with podsols. The Beaconsfield West substation is expected to be underlain by Quaternary swamp deposits along with about 500 metres of the transmission cable route. The Sydney South substation, located north of the Georges River, is expected to be underlain by weathered Hawkesbury Sandstone.

Igneous intrusions of Jurassic age including dykes are mapped within the study area. The cross cutting dykes are composed of basalt, dolerite and volcanic breccia. The transmission cable route passes through these dykes in Dulwich Hill at Arlington Street, Constitution Road, Terry Road, Hill Street, Denison Road and Pigott Street.



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GEOLOGY

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Note: The project area is confined to the roadway reserve with the exception of parks and existing substations

Source: Department of Finance, Services and Innovation - Spatial Services (2018), Nearmap (2018), Office of Environment and Heritage (OEH), 2008

FIGURE 4-4

5.0 Assessment of potential construction impacts

Construction of the project would involve a variety of activities with potential to impact on quality and flow of groundwater. These are discussed in the following sections. Measures identified to avoid, minimise and manage potential impacts are presented in **Section 7.0**.

5.1 Impacts on groundwater

Groundwater impacts could potentially arise from:

- spills of fuels, oils, chemicals or construction materials or drilling muds may infiltrate to groundwater through underboring activities or open excavations;
- construction activities could introduce foreign contaminants such as oil or greases, and disturb contaminated sediments, potentially having an adverse impact on groundwater quality;
- contaminated or ASS sediments that may be mobilised by construction activities; and
- intersecting existing contaminated groundwater during excavation or creating a more permeable pathway for contamination to reach groundwater.

Underboring using thrust boring would typically require a pit 4 mbgs, underboring using HDD would typically be between 4 – 10 mbgs Potential impacts during underboring are accidental spills or leaks (such as frac-outs, leaks along vertical fractures). These potential impacts would be managed by:

- protocols outlined in the Construction Soil and Water Management Plan (CSWMP) which could include quick spill response times and the use of spill kits to contain and capture contaminated water; and
- drilling of horizontal wells by suitably qualified and experienced drilling contractors and adherence to the guidelines set out in the Minimum Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee, 2011).

5.2 Temporary dewatering

At locations within the project area where perched groundwater or the watertable are intersected, temporary dewatering may be required to maintain dry conditions in the excavation during construction. There are many options to remove water from the excavation, some of which include pump and sump techniques, installation of temporary barriers and pumping from temporary bores. Licensing of groundwater extraction through DI-Water in accordance with the AIP would be required if the extracted groundwater exceeds 3 ML/year.

Dewatering needs to be managed correctly to ensure that the local urban and natural environments are not adversely impacted. Potential impacts include loss of water from existing registered bores, damage to nearby infrastructure caused by ground settlement or degradation of water in local waterways due to unmonitored discharge.

Dewatering discharge options are dependent on water quality and include discharge to stormwater or to sewer. Should groundwater be discharged to sewer, the groundwater discharge criteria would be in accordance with the Sydney Water acceptance standards (Sydney Water, 2019). Should groundwater be discharged to stormwater, the groundwater quality discharge criteria would be in accordance with the ANZECC Water Quality Guidelines at a 95% protection level for marine ecosystems as water would be discharged in highly disturbed receiving environments, such as Alexandra Canal or Cooks River. For analytes not covered by the ANZECC Water Quality Guidelines, the amended National Health and Medical Research Council (NHMRC) *Australian Drinking Water Guidelines* (2015) would be adopted.

Monitoring wells would be installed prior to the construction to calculate likely groundwater levels and potential dewatering volumes. Baseline groundwater quality monitoring would be undertaken to provide an initial assessment of water quality prior to the commencement of excavation in areas where it is expected that dewatering may be required.

Open excavations such as thrust bore launch and receive pits, cable trenches and joint bays, would be protected to prevent rainfall runoff and overland flow ingress in accordance with measures outlined in the CSWMP.

5.2.1 Groundwater levels

During dewatering, local groundwater levels are expected to be temporarily lowered during the dewatering program but are expected to return to their former levels following the cessation of dewatering. Groundwater levels fluctuate naturally over different time periods due to a number of natural factors including diurnal, tidal, seasonal and climate change influences. Seasonal and climate change oscillations are related to the variability of rainfall conditions and recharge. Groundwater levels are influenced by topography, proximity to creeks, rainfall and evapotranspiration. Groundwater levels can also be influenced by artificial means. For example, groundwater levels can be lowered by pumping or increased by deep foundations altering groundwater flows and causing groundwater mounding. Under natural conditions, groundwater levels would be expected to naturally fluctuate over an amplitude of approximately 1 metre.

Predicted groundwater level drawdown is not expected to be substantial and in the order of less than 2 metres locally. This is due to the watertable in the study area being typically deeper than 1 or 2 mbgl and the base of the excavation (for the transmission cable conduits and joint bays) being approximately 2 metres deep and up to 4 metres deep for localised underbore launch and receive pits. Consequently, groundwater levels that intersect the trench may need to be lowered by up to 1 metre to facilitate trenching and avoid ponding and in the case of the underbore launch and receive pits, lowered by no more than 2 metres. The actual drawdown in the surrounding area would be limited over most of the transmission cable route because:

- the deeper excavations for the thrust bore launch and receive pits would occur in the shale bedrock, which has a low hydraulic conductivity;
- the trench excavations would not be open for a significant amount of time (only a matter of a few days before being backfilled); and
- joint bay excavations are unlikely to intersect groundwater, being typically no deeper than 2 metres but will potentially be left open and dewatered for up to three weeks should groundwater be intersected. This amount is expected to be minimal.

Since the predicted groundwater level drawdown is in the order of 2 metres, the impacts are considered to be a Level 1 minimal impact (as defined in the AIP) and thus these impacts are considered acceptable in accordance with the AIP. Consequently Level 2 impacts are not triggered and thus no groundwater modelling is required to assess dewatering impacts to satisfy the AIP. Similarly since the predicted impacts on groundwater levels are considered minimal (i.e. less than 1 metre) and temporary, potential impacts on nearby registered bores, GDEs or wetlands are considered acceptable in accordance with the AIP.

Where excavations intersect the watertable, a Groundwater Management Strategy (GMS) to manage temporary dewatering would be required. The GMS would include measures to manage localised temporary dewatering to minimise groundwater extraction and to ensure groundwater discharge works minimise potential impacts on the environment. The installation of gravel drainage blankets may be required beneath parts of the transmission cable route where bedrock is shallow and groundwater mounding could be caused by the blocking of groundwater flow paths. The strategy would be developed during the detailed design phase.

The potential increase of impermeable areas, such as construction laydown areas and joint bays, could temporarily alter or reduce groundwater recharge, by directing captured water to stormwater. The increase of impervious surfaces during construction is expected to be minor in comparison to the area from which the groundwater is recharged. As such, potential impacts related to an increase of impervious surfaces are considered minor and would not significantly reduce groundwater recharge.

5.3 Acid sulfate soils

Potential acid sulfate soils are likely to be present within natural alluvium flanking the Cooks River and possibly within the alluvium along Alexandra Canal and in other areas in Precincts 3, 4 and 5. When exposed to air, the iron sulfides (commonly pyrite) within ASS can oxidise, producing sulfuric acid. The soils may become exposed to air by either excavation or dewatering and may cause the generation of acidic runoff and/or the increased acidity of groundwater, negatively impacting on water quality and aquatic ecosystems. ASS would only be present within the natural alluvium or in areas that have been infilled with dredged alluvial materials. Therefore, where there is potential for PASS or ASS to occur, field tests would need to be completed prior to excavation taking place.

The risks associated with PASS and ASS identified for the portions of the project area in Precincts 4 and 5 would be managed in line with relevant measures detailed within the ASSMP which is a sub-plan of the CSWMP. These measures would be developed in accordance with *NSW Acid Sulfate Soils Manual* (Stone *et al* 1998). The Preliminary Site Investigation – Contamination report in **Appendix K** of the EIS provides further information on ASS.

6.0 Assessment of potential operational impacts

6.1 Overview

Operation of the project is anticipated to have limited impacts on groundwater, given the majority of infrastructure would be located above the expected groundwater elevation. Although project infrastructure would be in contact with groundwater at a number of special crossings, there would be no dewatering or significant alteration of the groundwater flow regime, therefore operational impacts would be minimal as discussed below.

Measures identified to minimise and manage any impacts are presented in **Section 7.0**.

6.2 Changes to groundwater flow and levels

Below ground infrastructure such as the transmission cable circuit has the ability to create physical barriers to groundwater flow, resulting in temporary or permanent interruptions. Temporary impacts may occur after heavy rainfall, with infiltration to the watertable 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 hydraulic boundary impacting groundwater flow patterns.

However, the limiting factor to groundwater flow is the hydraulic conductivity of the surrounding material and its ability to transmit groundwater. As previously discussed, the majority of the transmission cable route is in the low hydraulic conductivity Bringelly and Ashfield Shales. Because of the relatively small footprint of the underboring special crossings, a significant barrier to flow would not be created. Conversely, the Botany Sands aquifer in Precinct 5 generally has a relatively high hydraulic conductivity. The special crossing at Sydney Park in the Botany Sands aquifer also has a small footprint in the saturated zone and excess groundwater, if present, would flow around the infrastructure with the elevated head conditions dissipating rapidly across the aquifer because of the higher hydraulic conductivity.

In the case of the installation of the transmission cable circuit, a hydraulic barrier can be created if the conduits fully penetrate the aquifer. The below ground infrastructure is unlikely to create hydraulic barriers because the excavations are shallow and where the watertable is intersected, it is likely to only be partially intersected, allowing groundwater to flow beneath the infrastructure. In areas where it is suspected that groundwater flows may be altered, groundwater mounding could be avoided by the inclusion of drainage blankets beneath the concrete lined infrastructure.

Long term groundwater levels are unlikely to be impacted by the project other than the potential for some localised groundwater mounding. Consequently, groundwater levels in registered bores and in the wetlands in Sydney Park are not expected to be impacted by the project.

7.0 Environmental management and mitigation measures

7.1 Management objectives

The groundwater management and mitigation measures for the project seek to minimise disturbance and maintain the existing quality of groundwater.

7.2 Environmental management and mitigation measures

The measures outlined in **Table 7-1** are recommended to manage and monitor potential groundwater impacts during construction and operation of the project. These measures include the development and implementation of a range of management strategies which would inform the detailed design and the construction management plans that would be implemented during construction. These plans are shown in **Figure 7-1**.

The GMS considers aquifer interference and would inform the detailed design and subsequent construction planning for the project.

A CSWMP would be implemented during construction and would form part of the overarching CEMP for the project. The CSWMP would be developed in accordance with the principles and requirements of the Blue Book and would consider the GMS.

The measures in the CSWMP and its sub-plans would be confirmed once the detailed design has been developed sufficiently and the proposed construction staging and layouts for the transmission cable route work sites, construction laydown areas and substations are known.

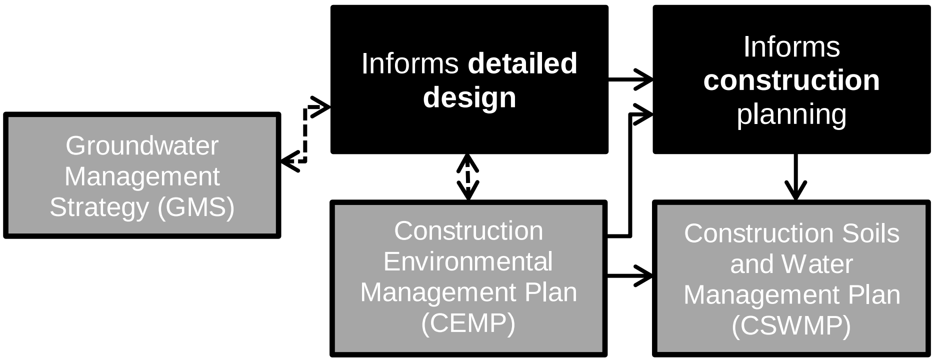

Figure 7-1 Groundwater management strategies and plans

Table 7-1 Environmental management and mitigation measures

No.	Impact/issue	Environmental management and mitigation measures	Timing
GW1	Groundwater interception	A GMS will be prepared that will outline the requirement for drilling and installation of monitoring wells for baseline groundwater level and quality monitoring. This additional information will be collected prior to or during detailed design in locations where it is likely that the watertable may be intersected (**Section 5.0**). This data will be used to confirm whether groundwater control measures or dewatering will be required. Where it is likely that groundwater will be intersected, estimates of groundwater inflows will be predicted to assess if a groundwater extraction license would be required (that is if 3 ML/year of groundwater discharge was to be exceeded). Outcomes from the GMS will inform the Construction Environmental Management Plan (CEMP). The CEMP will include, where necessary: • measures to stabilise the excavation, such as installation of temporary shoring in trenches (e.g. sheet piling); • localised temporary dewatering measures to maintain dry working conditions; and • measures to minimise groundwater drawdown to reduce any ground settlement impacts.	Detailed design
GW2	Aquifer interference	Detailed hydrogeological information (e.g. bore data) will be used to inform the most suitable underboring construction method at the special crossings that will minimise the need for dewatering. Where an aquifer is to be completely penetrated at the underboring special crossings, appropriate controls (such as drainage blankets) will be installed beneath the infrastructure to ensure groundwater flow is maintained to minimise disruption to groundwater flow paths.	Detailed design
GW3	Intersection of contaminated groundwater	If existing contaminated groundwater is identified, measures will be implemented to ensure that the backfill within the excavation does not create a more permeable pathway for migration of contamination.	Detailed design and construction
GW4	Dewatering	A CSWMP will be prepared as part of the overall CEMP to document the measures required to mitigate and manage potential impacts on groundwater during construction. The CSWMP will include the following measures: • water collected during dewatering of excavations would be discharged or disposed of in accordance with the *Protection of the Environment Operations Act 1997 and the ANZECC Water Quality Guidelines (2000) for 95% protection level for marine ecosystems; and* • contaminated groundwater captured during construction will be disposed of at an appropriately licensed facility.	Construction

8.0 Conclusion

This technical report presents an assessment of potential impacts of the project during construction and operation on groundwater systems. The assessment found that while the project has the potential to impact on the groundwater environment as a result of construction activities, the implementation of management measures would reduce or manage these impacts to an appropriate level.

During construction, the watertable is likely to be intersected during underboring of special crossings, in particular through the launch and receive pits required for the thrust boring method, during trenching and excavation along the cable route and during construction of the joint bays.

Temporary dewatering would be required to maintain dry working conditions with the exception of:

- Sydney Park; the deeper excavations for the thrust bore launch and receive pits would occur in the shale bedrock, which has a low hydraulic conductivity;
- the trench excavations, which would not be open for a significant amount of time (only a matter of a few days before being backfilled) and therefore would not require dewatering for significant periods of time; and
- joint bay excavations, which are unlikely to intersect groundwater, being typically no deeper than 2 metres. Joint bays will potentially be left open for up to three weeks during which time they would potentially require dewatering, should groundwater happen to be intersected.

Discharge from dewater would be captured and the water quality monitored prior to discharge. Depending on where the water would be discharged to, a licence or permit may be required from the relevant water infrastructure authority. In the event that dewatering is predicted to exceed 3 ML/year, a dewatering licence would be required from DI - Water under Part 5 of the *Water Act 1912*.

The risk that the proposed infrastructure would create physical barriers to the movement of groundwater has been assessed, including temporary or permanent interruptions to groundwater flow. Temporary impacts may occur after heavy rainfall, with infiltration to the watertable and lateral flow being slowed due to the barrier, creating a groundwater mound behind the infrastructure. There are potential long-term impacts through compartmentalisation of an aquifer if construction causes an hydraulic boundary which impacts groundwater flow patterns.

During operation project infrastructure may be in contact with groundwater at a number of special crossings, however there would be no dewatering or significant alteration of the groundwater flow regime because:

- the majority of the transmission cable route is in the low hydraulic conductivity Bringelly and Ashfield Shales and a significant barrier to flow would not be created due to the relatively small footprint of the project in the special crossings; and
- the two special crossings in the Botany Sands aquifer also have a small footprint in the higher hydraulic conductivity saturated zone and excess groundwater, if present, would flow around the infrastructure.

In the case of the installation of the cable trenches and joint bays, the proposed excavation is unlikely to create hydraulic barriers because the depth is shallow. Where the watertable is intersected, it is likely to only be partially intersected which would allow groundwater to flow beneath or around the trench. In cases where it is suspected that groundwater flows may be altered, groundwater mounding could be avoided by the inclusion of drainage blankets beneath the trench. With this mitigation measure, over the long term, groundwater levels are unlikely to be impacted.