Appendix L

SURFACE WATER AND FLOODING REPORT

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Powering Sydney's Future
TransGrid

Potts Hill to Alexandria transmission cable project

Surface Water and Flooding Technical Report

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Surface Water and Flooding Technical Report

Client: TransGrid

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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.
Amenity	The quality of a place, its appearance, feel and sound, and the way its community experiences the place. Amenity contributes to a community's identity and its sense of place.
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.
Average recurrence interval (ARI)	An indicator used to describe the frequency of floods. The average period in years between the occurrences of floods of a particular magnitude or greater. In a long period of say 1,000 years, a flood equivalent to or greater than a 100 year ARI event would occur 10 times. The 100 year ARI flood has a one per cent chance (i.e. a one in-100 chance) of occurrence in any one year. Floods generated by runoff from the study catchments are referred to in terms of their ARI, for example the 100 year ARI flood.
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.
Bund	A low artificial engineered ridge designed to contain any spills, leaks or prevent turbid water discharge. It can be constructed from compacted earth, sandbags, hay bales or other materials.
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.

Term	Definition
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.
Cumulative impacts	Impacts that, when considered together, have different and/or more substantial impacts than a single impact assessed on its own.
Derating	Refers to operating electrical cables at less than their optimal capacity. Usually involves converting the cables to a lower voltage.
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.
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).
Endangered ecological community (EEC)	A threatened ecological community with an 'endangered' listing status under environmental legislation.
Erosion	A natural process where wind or water detaches a soil particle and provides energy to move the particle.
Eutrophication	When a body of water becomes overly enriched with minerals or nutrients which induces an excessive growth of plants and algae.
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).

Term	Definition
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.
Geomorphology	Physical features of the earth's surface and their relation to its geological structures.
Geotechnical investigation	Below ground investigation including soil and groundwater sampling and testing.
Greater Sydney area	The area generally from Penrith in the west to the east coast and from Hornsby in the north to Campbelltown in the south.
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.
Insulation (electrical)	Material designed to prevent the flow of electric current.
Joint bay	An enlarged section of excavated trench in which cables are joined together.
Key stakeholders	Government departments/agencies, local councils, utility and service providers.
Pollutant	Any measured concentration of solid or liquid matter that is not naturally present in the environment.
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.
Probability	A statistical measure of the expected chance or likelihood of occurrence.
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 infrastructure or watercourses; • substation sites requiring upgrades (noting that all works would be contained within the existing site boundaries); and • construction laydown areas.
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.

Term	Definition
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).
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, underboring 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*
ASS	Acid sulfate soil
BBWQIP	Botany Bay and Catchment Water Quality Improvement Plan
BoM	Bureau of Meteorology
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
GPT	Gross Pollutant Trap
LEP	Local Environment Plan
LiDAR	Light Detection and Ranging
ML	Mega Litre (one million Litres)
PASS	Potential acid sulfate soils
PMF	Probable Maximum Flood
SHPR	Sydney Harbour and Parramatta River
SHWQIP	Sydney Harbour Water Quality Improvement Plan (Greater Sydney Local Land Services 2015)
SMCMA	Sydney Metropolitan Catchment Management Authority
WAL	Water Access Licence

Executive summary

TransGrid is the manager and operator of the major high-voltage electricity transmission network in NSW and the Australian Capital Territory. 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).

This Surface Water and Flooding Technical Report presents an assessment of potential impacts of the project during construction and operation on surface water receptors. This assessment considers potential impacts related to flooding, drainage, water quality, water quantity and geomorphology. It has been completed to meet the requirements of the Secretary's Environmental Assessment Requirements (SEARs) for the project. Potential groundwater impacts have been assessed separately and are reported on in the Groundwater Technical Report for the project (refer to **Appendix N** of the EIS).

The majority of the project area is located within the Cooks River Catchment, with the northern portion located within the Sydney Harbour and Parramatta River estuary catchment. The predominant waterways along the transmission cable route include the Cooks River, Coxs Creek, Hawthorne Canal, the Eastern Channel, Sydney Park wetland and the Alexandra Canal. The catchments are highly urbanised and the waterways which are crossed by the cable are all artificial and/or hard lined stormwater channels. The existing water quality in the waterways is poor and indicative of a highly urbanised catchment.

Construction of the project could potentially further degrade the receiving water quality in the Cooks River and Parramatta River estuary unless suitable mitigation measures are implemented. Construction of the project would involve activities such as site preparation, trenching and excavation and underboring, with potential to impact on various aspects of surface water.

During construction, the potential water quality, hydrology and geomorphology impacts would be associated with:

- exposure and erosion of soils resulting in sedimentation of waterways;
- exposure of contaminated soils impacting water quality;
- increased surface runoff from work sites close to waterways;
- accidental leaks or spills of chemicals, fuels and oils during construction;
- potential frac out and release of drilling fluids; and
- direct disturbance of waterway channel and riparian areas, or increased scour due to increased discharge flow rates and volumes.

Potential impacts on water quality, hydrology and geomorphology 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 water 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 soil and water management plan which would document measures to manage and monitor potential water quality impacts. The CEMP would form the overarching management document during construction and would include:

- Erosion and Sediment Control Plans (ESCPs) prepared for all construction work sites in accordance with the Blue Book (Volume 1, 4th Edition, Landcom, 2004, and Volume 2A, Installation of services, DECC, 2008). ESCPs would be implemented in advance of site disturbance and updated as required as the work progresses and the sites change;
- standard pollution control measures to be applied during the construction phase to ensure that water leaving work sites along the transmission cable route is of a suitable quality for discharge to the environment. Runoff that does not meet water quality requirement would be captured and sent for off-site disposal. These standard control measures would be broadly in line with

Managing Urban Stormwater (Landcom, 2004) and would be documented in an Erosion and Sediment Control Plan; and

- measures for the collection and disposal of trench water in accordance with the *Protection of the Environment Operations Act 1997*.

During operation, potential impacts are limited to above ground structures such as the cable bridges across watercourses where additional supports may be required in areas that may influence the existing flooding characteristics of the Cooks River or other catchments. While some general principles for the design of the bridges have been developed, the concept design of these structures is still to be prepared. As such, there is opportunity to ensure impacts are avoided and minimised through the preparation of a Flood Mitigation Strategy (FMS).

The FMS is recommended for flood prone or flood affected land within the project area as part of the detailed design and prior to construction. This strategy would be developed to demonstrate that the existing flooding characteristics within the study area would not be exacerbated as a consequence of the project. The FMS would identify specific flood risks to the project and adjoining areas as a result of the final design and proposed construction methodology. This plan would consider potential flood impacts related to the design that may arise during the operational phase of the project, as well as measures to manage potential impacts during the construction phase where these activities must take place in flood prone areas. These measures would be developed to respond to the proposed construction staging and construction methodology.

While the assessment has identified potential impacts of the project on the quality and flows of surface water 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).

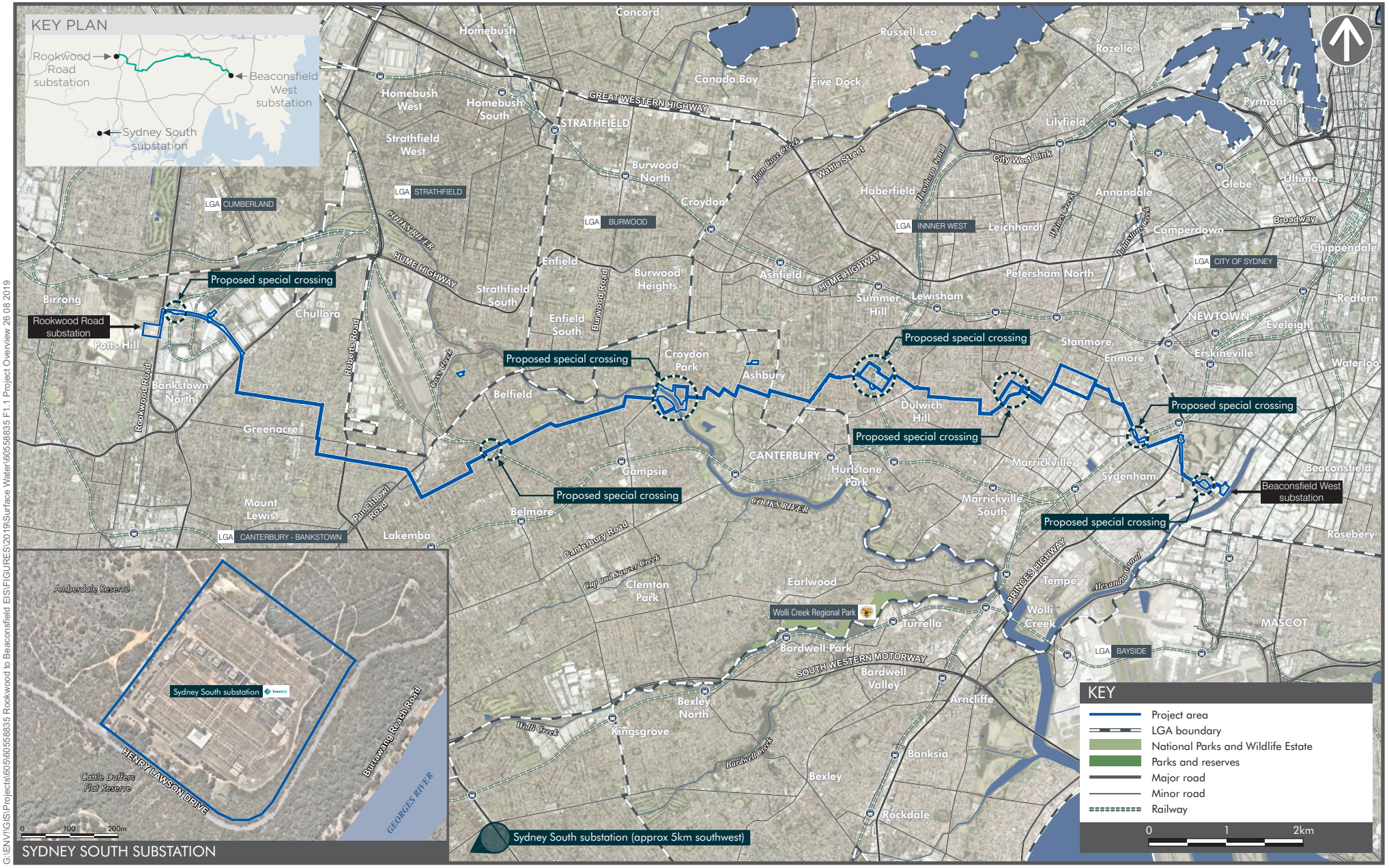
The project has been identified as a solution to address existing issues in the electricity supply network for inner Sydney, which is characterised by ageing and deteriorating electricity infrastructure and forecast increases in consumer demand.

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.

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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TransGrid

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

G:\ENVIGIS\Projects\605\60558835 Rookwood to Beaconsfield EIS\FIGURES\2019\Surface Water\60558835 F1.1 Project Overview 26 08 2019

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	• a description of water demand, a breakdown of water supplies and the measures to minimise water use;	**Section 5.7**
	• 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**. Groundwater is assessed in **Appendix N Groundwater Technical Report** of the EIS.
	• an assessment of the impacts of the project on watercourses (including the Cooks River and Coxs Creek), waterfront land, water related infrastructure and other water users, including an assessment of the use and discharge of water during construction and maintenance of the project; and	**Section 5.0** and **6.0**.
	• 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 7.0**
Soils	• an assessment of the impacts on soil and land resources (including erosion risk or hazard), with attention to soil erosion and sediment transport consistent with the practices and principles in the current guidelines; and	Erosion and sediment control is assessed in **Section 5.3**.
	• verification of the risk of acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Risk Map) along the transmission cable route and an assessment of the impacts of the project on acid sulfate soils (including impacts of acidic runoff off-site) in accordance with the current guidelines.	**Section 4.7**. Contaminated soils are assessed in detail in **Appendix K Preliminary Site Investigation** 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 line (Enfield Intermodal, 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 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 the 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, 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[1] 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

[1] Road reserve is defined as the area comprising roads, footpaths, nature strips and public transport infrastructure (including indented bus bays, bus shelters and bus stop signage).

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 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.

2.4.2 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.

2.4.3 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.

2.4.4 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 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 underbore 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 construction 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 construction 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.

2.7 Other relevant technical information

2.7.1 Waste minimisation

Approximately 115,000 cubic metres of spoil would be removed during excavation and trenching. The spoil would be characterised and, if acid sulfate soils or contaminated material is detected, managed in accordance with relevant legislation and guidelines. Excavated material would be transported to a disposal/reuse site based on its classification.

Sediment and erosion control devices would be installed and maintained to manage stormwater during the construction of the project. Standard pollution control measures would also be implemented to ensure that water leaving work sites is of a suitable quality for discharge to the environment. Runoff that does not meet the water quality requirements would be captured and sent for off-site treatment or disposal in accordance with the requirements of the *Protection of the Environment Operations Act 1997* (POEO Act).

2.7.2 Plant and equipment

The following typical plant and equipment are likely to be used during construction of the project:

- chainsaws;
- diamond saws;
- jackhammers;
- rock breakers;
- hand tools;
- hydraulic excavators;
- drill rig;
- spoil haulage trucks;
- mobile cranes and elevated working platforms;
- piling rigs;
- concrete trucks;
- winch trucks;
- low loaders;
- vacuum tankers/trucks;
- light vehicles;
- temporary generators;
- compressors;
- backhoes/front-end loaders;
- mixing plant;
- road millers;
- asphalt machine; and
- heavy rollers.

2.7.3 Site access and traffic movements

Access for heavy vehicles would be required throughout the project area. The standard of access along the transmission cable route would be sufficient to permit passage of excavators, spoil haulage trucks, concrete trucks, low loaders and mobile cranes. The estimated vehicle movements required for construction is outlined in **Table 2-5**. The vehicle numbers estimated do not include private vehicles used by the workforce to arrive at the work site, or traffic management vehicles. The vehicle numbers for the 'transmission cable route' assume four work crews operating concurrently at multiple locations within the project area. The final number of work crews, materials and vehicle movements would be determined during detailed design and construction planning.

Table 2-5 Anticipated vehicle movements

Location	Activity	Number of vehicle movements per day
Construction laydown areas	Delivery/pickup of plant and materials, spoil transfer (at relevant sites)	Vehicle movements per construction laydown area, per day: • Light: 3-4 • Heavy: 12
Transmission cable route – trenching and joint bay excavation	Delivery of plant and materials, removal of spoil, general construction	Vehicle movements for four work sites, per day: • Light: 16 • Heavy: 96
Special crossings	Delivery of plant and materials, removal of spoil, general construction	• Light: 10-12 • Heavy: 8-10
Substation upgrade – Rookwood Road	Delivery of plant and materials, removal of spoil	• Light: 3-4 • Heavy: 4
Substation upgrade – Beaconsfield West	Delivery of plant and materials, removal of spoil	• Light: 3-4 • Heavy: 4
Substation upgrade – Sydney South	Delivery of plant and materials, removal of spoil	• Light: 5-6 • Heavy: 6

Equipment and materials would be held in storage at the construction laydown areas until needed and delivered to the relevant work sites. Larger plant and cable materials may be delivered at night to avoid disrupting daytime traffic. Materials such as the cable drums may be temporarily stored near the trench and would be securely stored and barricaded.

Where the trench intersects another road or access to properties is required to enable construction works, vehicle and pedestrian passage would be restored as soon as possible after excavation has passed the intersection or access point.

3.0 Assessment methodology

3.1 Study area

This assessment has considered the surface water catchments where the project would occur, including Rookwood Road, Beaconsfield West and Sydney South substations, as well as waterways and drainage lines that cross the transmission cable route between the Rookwood Road substation and Beaconsfield West substation and the construction laydown areas. The connected waterways, such as the Cooks River, Botany Bay and Iron Cove have also been considered.

As the conversion of Cable 41 from 330 kV to 132 kV operation does not require works along the length of the cable, the catchments and waterways along the length of this route are excluded.

For the purpose of this assessment, the study area comprises portions of the following catchments as shown on **Figure 3-1**:

- Cooks River catchment;
- Parramatta River (Iron Cove) catchment; and
- Georges River catchment.

While these broader catchments have been considered in the assessment, the potential impacts are focused at a more localised level surrounding the project area. These localised impacts are discussed based on the assessment precincts presented in **Section 4.0**.

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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 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 surface water and flooding.

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.

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.

3.2.1.2 Developments on waterfront land

Developments conducted on waterfront land and along major creeks and canals, are regulated by the WM Act in accordance with the *Guidelines for riparian corridors on waterfront land* (DI-Water, 2012). These guidelines state that waterfront land includes the bed and bank of any river, lake or estuary and all land within 40 metres of the highest bank of the watercourse. The project area crosses some major waterways including Cooks River, Coxs Creek and the Beaconsfield West substation is located adjacent to the Alexandra Canal. Controlled activities on waterfront land are administered by DI-Water and include removal of vegetation, earthworks and construction of temporary detention basins. A controlled activity approval must be obtained prior to commencing the controlled activity (*Controlled activity exemptions on waterfront land*, Department of Primary Industries 2012). Under Section 5.23 of the EP&A Act, SSI projects are exempt from requiring a controlled activity approval.

3.2.1.3 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 Local Environmental Plans

The project is located in the Canterbury-Bankstown, Strathfield, Inner West and City of Sydney LGAs.

The Local Environment Plans (LEPs) for each of the councils specify Flood Planning Levels (FPLs). Their approach is consistent with the NSW Government's *Floodplain Development Manual* (DIPNR, 2005). To support land use planning and development assessment, certain councils and Sydney Water have undertaken various flood studies and floodplain risk management studies in selected areas.

3.2.3 Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005

The Sydney Regional Environment Plan (Sydney Harbour) 2005 aims to recognise, protect, enhance and maintain the catchment, foreshores, waterways and islands of Sydney Harbour for existing and future generations, and the study area includes the Hawthorne Canal catchment which drains to Sydney Harbour. Specifically, with respect to water this plan aims to:

- ensure a healthy, sustainable environment on land and water;
- achieve a high quality and ecologically sustainable urban environment;
- ensure a prosperous working harbour and an effective transport corridor; and
- ensure the protection, maintenance and rehabilitation of watercourses, wetlands, riparian lands, remnant vegetation and ecological connectivity.

3.2.4 Guidelines and policies

3.2.4.1 Floodplain Development Manual

The *Floodplain Development Manual* (DIPNR, 2005) incorporates the NSW Government's *Flood Prone Land Policy,* the primary objectives of which are to reduce the impact of flooding and flood liability on owners and occupiers of flood prone property. Additionally, it is also intended to reduce public and private losses resulting from floods, while also recognising the benefits of use, occupation and development of flood prone land. The study area crosses the Coxs Creek and Cooks River floodplains, and the project has the potential to affect flooding conditions due to the location, nature and extent of proposed works.

The *Floodplain Development Manual* forms the NSW Government's primary technical guidance for the development of sustainable strategies to support human occupation and use of the floodplain. It also promotes strategic consideration of key issues including safety to people, management of potential damage to property and infrastructure, and management of cumulative development impacts. Importantly, the *Floodplain Development Manual* promotes the concept that proposed developments be treated on their merit rather than through the imposition of rigid and prescriptive criteria. This means that each project needs to be assessed on a case by case basis and that there is no single solution or standard that should be applied to all projects. The overall benefits and impacts of a project should be taken into consideration when development is proposed in flood affected areas.

3.2.4.2 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.

3.2.4.3 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 and 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" (DECCW, 2006).

3.2.4.4 Managing Urban Stormwater – Soils and Construction

The *Managing Urban Stormwater* (commonly known as The Blue Book) – *Soils and Construction* series of handbooks are an element of the NSW Government's urban stormwater program specifically applicable to the construction phase of developments. These are aimed at providing guidance for managing soils in a manner that protects the health, ecology and amenity of urban streams, rivers estuaries and beaches through better management of stormwater quality.

The Blue Book handbooks were produced to provide guidelines, principles, and recommended minimum design standards for good management practice in erosion and sediment control during the construction of roads. Of particular relevance to the project are Volume 1, 4th Edition (Landcom, 2004) and *Volume 2A, Installation of services* (DECC, 2008). These guidelines will be used for the development of construction management measures (refer to **Section 7.0**).

3.2.4.5 Fisheries Policy and Guidelines for Fish Habitat Conservation and Management

NSW Department of Industry produced guidelines that assist with the sustainable management of natural resources, including the conservation and management of 'fish' and their habitats. The Fisheries Policy and Guidelines for Fish Habitat Conservation and Management (update 2013) (Fairfull, 2013) support the implementation of the NSW *Fisheries Management Act 1994*. The project is located within catchments that have tributaries identified as Key Fish Habitat to which this guideline applies. Potential impacts on Key Fish Habitat are discussed in the Biodiversity Development Assessment Report in Appendix H of the EIS.

3.2.4.6 Sydney Harbour Water Quality Improvement Plan

The *Sydney Harbour Water Quality Improvement Plan* (Greater Sydney Local Land Services, 2015) (SHWQIP) was developed by Greater Sydney Local Land Services, NSW OEH and local government in coordination with a range of stakeholders. The SHWQIP provides a coordinated management framework for local councils, state government agencies and federal government agencies that have a stake in improving the future health of Sydney Harbour and its catchments. This plan applies to the portion of the study area which ultimately drains to Sydney Harbour, including the Hawthorne Canal catchment.

3.2.4.7 Botany Bay and Catchment Water Quality Improvement Plan

Sydney Metropolitan Catchment Management Authority's (SMCMA) *Botany Bay and Catchment Water Quality Improvement Plan* (BBWQIP) (SMCMA, 2011) is a recent plan designed specifically to improve the runoff water quality from the catchment of Botany Bay. The Cooks River catchment is a sub-catchment of the larger Botany Bay catchment hence this plan applies to the majority of the study area.

The main objective of the BBWQIP is to set targets for pollutant load reductions (in terms of total nitrogen, total phosphorus and suspended sediment) required to protect the condition of Botany Bay, its estuaries and waterways. The plan is an agreed water quality improvement plan that builds on research and engagement undertaken as part of the BBWQIP, to provide direction for future land use and water quality management decisions in the Botany Bay catchment.

The plan is aimed at local, state and federal government agencies. A primary objective of the BBWQIP is to establish stormwater pollution reduction targets for all new development and redevelopment within the Botany Bay catchment to protect the condition of the bay, its estuaries and waterways.

3.2.4.8 Other policies and guidelines

Other polices and guidelines that may apply to the design and construction of the project and therefore should be considered include:

- *NSW State Rivers and Estuaries Policy* (NSW Water Resources Council, 1993);
- *National Water Quality Management Strategy* (ANZECC, 2000);
- *Guidelines for Design of Fish and Fauna Friendly Waterway Crossings* (Fairfull and Witheridge, 2003);
- *Fish Passage Requirements for Waterway Crossings* (Fairfull and Witheridge, 2003);
- *Controlled Activities – Guidelines for Riparian Corridors* (NSW Office of Water, 2011);
- *Controlled Activities – Guidelines for Watercourse Crossings* (NSW Office of Water, 2010);
- *Controlled Activities – Guidelines for In-stream Works* (NSW Office of Water, 2010);
- *Controlled Activities – Guidelines for Laying Pipes and Cables in Watercourses* (NSW Office of Water, 2011);
- *Controlled Activities – Guidelines for Outlet Structures* (NSW Office of Water, 2010);
- *Managing Urban Stormwater: Council Handbook, Draft* (NSW EPA, 1981);
- *Australian Rainfall and Runoff* (Institute of Engineers Australia, 2001; AR&R);
- *Australian Rainfall and Runoff* (Institute of Engineers Australia, 2016; AR&R, 2016);
- *Australian Runoff Quality* (Institute of Engineers Australia, 2006; ARQ);
- *Guideline on Development Controls on Low Flood Risk Areas* (NSW Government, 2007);
- *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short- Duration Method* (Bureau of Meteorology (BoM, 2003);
- *Derivation of the NSW Government's Sea Level Rise Planning Benchmarks.* Technical Note (DECCW, 2009);
- *Coastal Planning Guideline – Adapting to Sea Level Rise* (NSW Department of Planning, 2010);
- *Coastal Risk Management Guideline – Incorporating Sea Level Rise Benchmarks in Coastal Risk Assessments* (NSW Department of Planning, 2010);
- *Flood Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments* (DECCW, 2010); and
- *The Floodplain Risk Management Guideline – Practical Consideration of Climate Change* (DECC, 2007.

3.3 Methodology

An assessment has been undertaken to address the potential impacts on surface water and flooding that may result from the project, including from the construction of the transmission cable circuit, construction laydown areas and substation upgrades. This has included an assessment of the potential impacts on the Cooks River and Coxs Creek, as well as waterfront land and water users more broadly. Required water use during the construction process, as well as discharge of water from the project was also considered.

Due to the linear nature of the project and ability to contain the excavations to a defined area along the transmission cable route, a quantitative assessment was not deemed necessary to identify and manage any potential water quality impacts.

While general principles for the design of new cable bridges has been developed for the project (refer to **Section 2.1**), the concept design of these structures are still to be prepared. As such, a quantitative assessment of operational impacts was undertaken at a high-level.

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.

In order to determine the existing water quality within the study area, the following water quality data was reviewed:

- River Health Report Card (CRA, 2016); and
- River Health Georges River Report Card (GRCCC, 2017).

Council flood information was also reviewed, including the following flood studies:

- Alexandra Canal Flood Study (Cardno, 2014, prepared for the City of Sydney);
- Hawthorne Canal Flood Study (WMAwater, 2014, prepared for Inner West Council);
- EC East Subcatchment Management Plan: Volume 2 - Flood Study (Golder Associates, 2010, prepared for Inner West Council);
- Marrickville Valley Flood Study (WMAwater, 2013, prepared for Inner West Council);
- Cooks River and Coxs Creek Flood Study (WMAwater, 2010, prepared for Strathfield Municipal Council); and
- Cooks River Flood Study (PB MWH Joint Venture 2009, prepared for Sydney Water).

A review of GIS data of stormwater assets for the following LGAs was undertaken to identify existing stormwater assets within the study area:

- City of Sydney (Alexandra Canal);
- Inner West Council;
- Strathfield Municipal Council;
- Burwood Council; and
- Canterbury-Bankstown Council.

Additional GIS information was obtained to support the assessment. This included:

- mapping of Estuary Catchments (OEH);
- mapping of EECs and other key aquatic habitats (OEH); and
- aerial photographs and topographic maps for the transmission cable route (NSW Land and Property Information).

The desktop study also included a review of existing policies and guidelines applicable to the management of water quality during construction.

3.3.2 Assessment of potential impacts

The assessment of surface water quality impacts arising from the project involved an assessment of potential construction and operational activities that could mobilise sediments and other pollutants into the surface water environment.

For flooding, the 100 year ARI flood standard was adopted in the assessment to identify measures which are required to mitigate adverse flooding impacts attributable to the project. Changes in flood behaviour under Probable Maximum Flood (PMF) conditions were also considered in order to identify impacts on critical infrastructure or emergency response, and significant changes in flood hazard resulting from the project.

The assessment of flood impacts was undertaken by identifying where the transmission cable route would require significant changes to finished surface levels or above ground infrastructure. Potential project related changes that may result in changes to surface drainage/flooding include:

- the finished surface following trenching and installation of the conduits; and
- construction and operation of the cable bridge required to cross the Cooks River.

At the Cooks River, the potential for impacts associated with a cable bridge were assessed using a TUFLOW model of the crossing. To undertake this assessment, the existing TUFLOW model from the Cooks River Flood Study (PB MWH Joint Venture, 2009) prepared for Sydney Water was used. The geometry of the model, the hydrologic input and other boundary conditions were unmodified, although some minor modifications to accurately represent key structures were undertaken. To assess the impact of the cable bridge crossing, an additional bridge crossing was included in the model immediately adjacent to the existing pedestrian bridge at Lindsay Street. This should be considered as a high level assessment only, as the concept design of the proposed cable bridge has not been confirmed. Estimate for energy losses across the assumed bridges were benchmarked using Bradley (1978).

Flooding impacts at substations were not considered in this assessment as the project would not change the flood flow paths in the existing substations. Of the three substations, only Beaconsfield West is documented to be within the 100 ARI flood extent.

4.0 Description of the existing environment

4.1 Catchments and waterways

The transmission cable route (including Rookwood Road and Beaconsfield West substations) is located within the Cooks River catchment (which includes Coxs Creek) and the Sydney Harbour and Parramatta River catchment (SHPR catchment). The Sydney South substation is located within the Georges River catchment.

The Cooks River catchment covers an area of 100 square kilometres in southern Sydney and discharges to Botany Bay at Mascot. The SHPR catchment covers an area of around 484 square kilometres including its main tributary the Parramatta River.

Waterways within each catchment 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.

Figure 4-1 shows the estuary catchments and main waterways near the project area.

The geomorphological characteristics of the waterways are primarily categorised as having no potential for lateral or vertical adjustment as they generally consist of a concrete channel, piped channel, rock-lined channel, shaped channel or underground concrete channel. The geomorphic characteristics of the waterways reflect their urban and anthropogenic nature.

The Cooks River, Iron Cove, Alexandra Canal and downstream portions of Hawthorne Canal have been mapped as Key Fish Habitat, as defined in the *Fisheries Policy and Guidelines for Fish Habitat Conservation and Management* (update 2013) (Fairfull, 2013). Key fish habitat is mapped within the project area at two locations: the Cooks River in Precinct 3 where the project crosses the river and at Alexandra Canal in Precinct 5 (which is a tributary of the Cooks River), where the project is adjacent (at the Beaconsfield West substation). However, as both the Cooks River and Alexandra Canal are concrete lined where they intersect with the project area, they are not consistent with the definition of key fish habitat under the *Fisheries Management Act 1994*.

The project's receiving waters are marine environments which include the intertidal and subtidal ecosystem of the harbour and its estuarine tributaries.

Alexandra Canal is one of the main waterways downstream of the project area within the Cooks River catchment. Alexandra Canal is one of only two navigable canals built in NSW and is characterised by its controlled route, defined edges and sandstone embankment walls. The canal is considered to be of high historic, aesthetic and technical/research significance (Sydney Water, 2014). Historically the Alexandra Canal catchment has been the site of a number of industries, which has resulted in contaminated runoff flowing into the waterway. The NSW EPA declared the bed sediments of Alexandra Canal between Huntley Street, Alexandria and the junction of Alexandra Canal with the Cooks River at Mascot as a remediation site in August 2000 under Section 23 of the *Contaminated Land Management Act 1997*.

The water features within the study area are summarised in **Table 4-1** and **Table 4-2** and shown graphically on **Figure 4-2**, **Figure 4-3**, **Figure 4-4** and **Figure 4-5**. **Table 4-1** also outlines the water features that would be crossed by the transmission cable route or are located adjacent to construction laydown areas or substations. Water features in **Table 4-1** have been described as the following:

- channelised watercourse: a number of watercourses in Sydney are channelised, including sections of the Cooks River and Coxs Creek. A channelised watercourse is where the natural watercourse has been realigned or straightened, with the bed replaced with a concrete slab, and the sides replaced with either concrete or brick panels. In this process a regular prismatic channel cross-section is adopted which typically increases the flow velocity;
- culvert: a culvert is a structure used to convey water underneath a road, railway or other obstruction. In the Cooks River catchment, these are typically made of concrete, with the bed of the natural watercourse replaced with a concrete base slab;
- natural watercourse: a channel formed by natural processes through which water flows. The bed is formed with natural materials such as sand or mud and the sides are earth or rock. The cross-section often varies along the length. In places the bed may have been artificially stabilised, for example, by the use of rock gabions, but not sufficiently to detract from the otherwise natural characteristics, including flooding and ecological characteristics;
- urban drainage network: throughout the project area, stormwater runoff is collected by a network of stormwater pits and pipes which convey it to a downstream watercourse such as the Cooks River or Coxs Creek; and
- naturalised watercourse: a watercourse such as the Yana Badu Wetland (approximately 200 metres downstream of Muir Road), where works have been undertaken to restore or replicate some of the characteristics of a natural watercourse (such as flood or ecological characteristics) in what was previously a channelised watercourse or urban drainage network. There is the potential for these watercourses to have restored the environmental and community benefits of natural watercourses.

Riparian corridors as defined by the WM Act are associated with any natural watercourse or natural watercourse artificially improved. For the purposes of this assessment, this includes watercourses identified as natural watercourses and channelised watercourses.

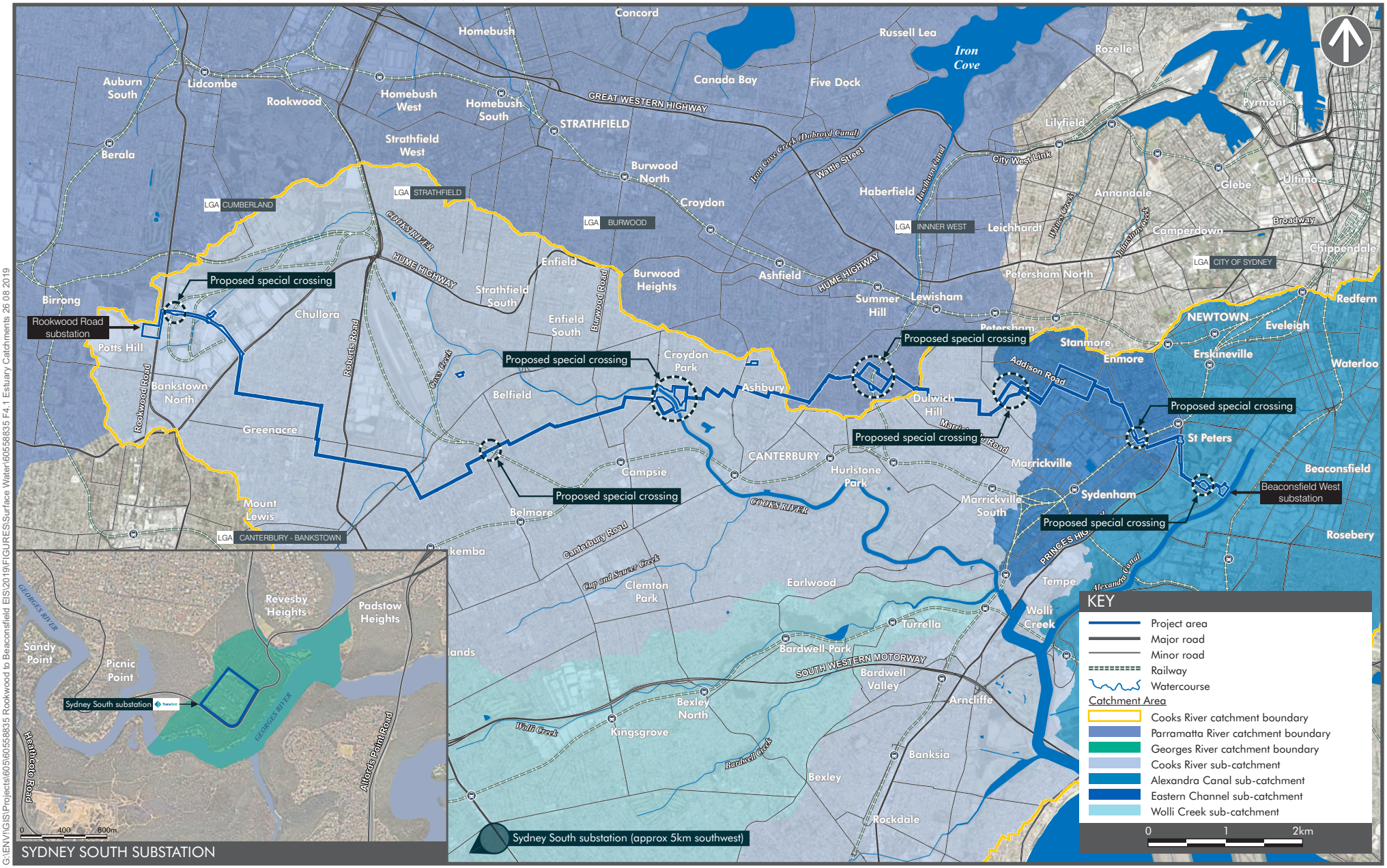
Table 4-1 Catchment descriptions and water features which intersect the transmission cable route

Precinct	Catchment description	Intersected water features	Form of water feature at intersection location	Form of proposed crossing
Precinct 1 (**Figure 4-2**)	**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 (**Figure 4-2** and **Figure 4-3**)	**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 (**Figure 4-3**, **Figure 4-4** and **Figure 4-5**)	**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	Catchment description	Intersected water features	Form of water feature at intersection location	Form of proposed crossing
Precinct 4 (**Figure 4-5**)	**Catchment:** Cooks River (Eastern Channel sub-catchment) 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.	Major urban drainage network	Stormwater pits and pipes	Measures to temporarily support or relocate the stormwater network would be required
Precinct 5 (**Figure 4-5**)	**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 north-eastern 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	Underboring

Table 4-2 Water features near substations and construction laydown areas

Substations and construction laydown areas	Water feature
12 Muir Road, Chullora	Located directly adjacent to the Cooks River culvert
Cooke Park	Adjacent to the Coxs Creek channel
Peace Park	Approximately 1 kilometre from the Cooks River
Camdenville Park	Adjacent to the Camdenville Park flood detention basin
Beaconsfield West substation	Adjacent to the Alexandra Canal
Rookwood Road substation	Approximately 150 metres from the Cooks River
Sydney South substation	Approximately 200 metres from the Georges River



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ESTUARY CATCHMENTS

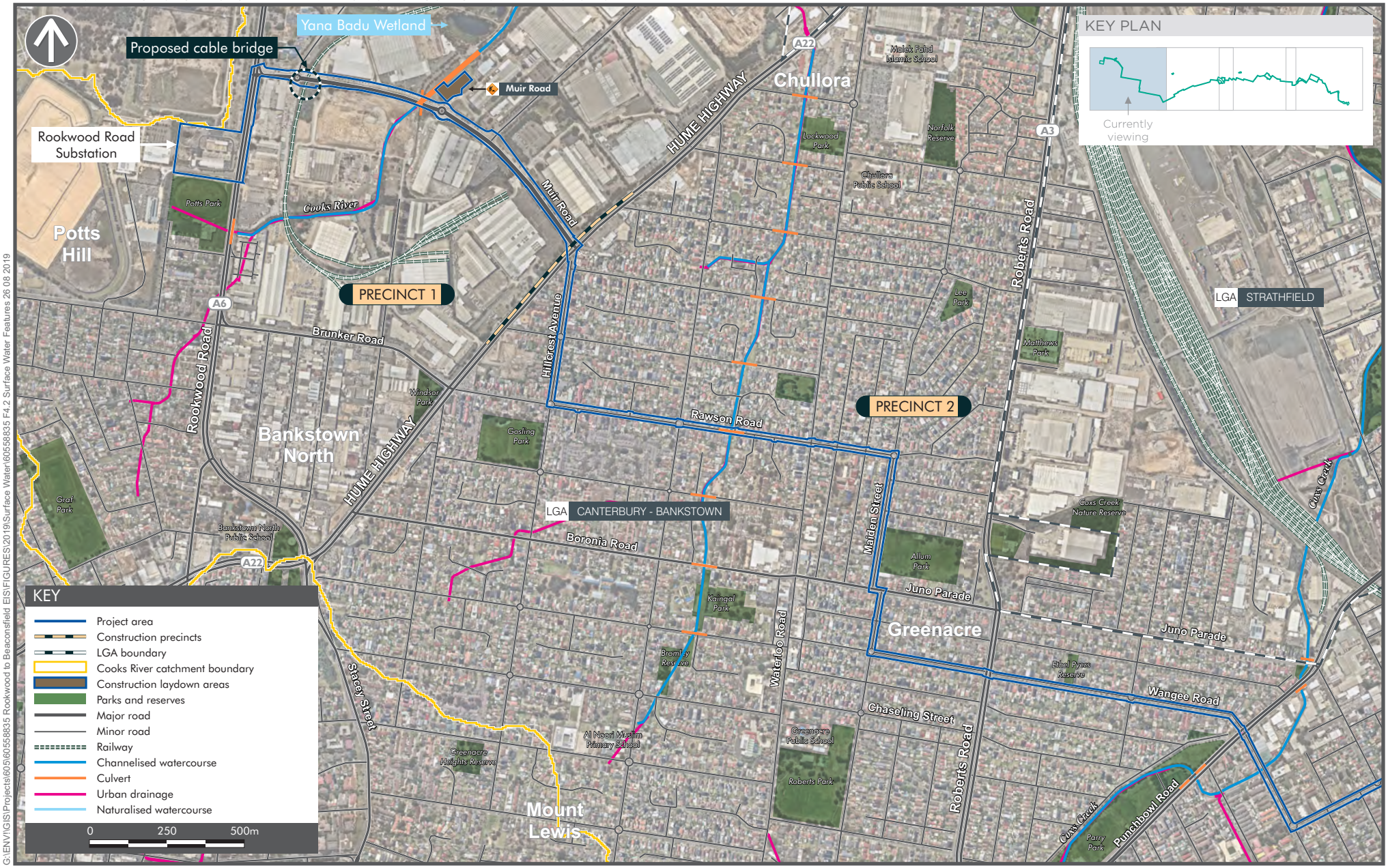
Powering Sydney's Future

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), SMCMA (2011), AECOM (2018)

FIGURE 4-1



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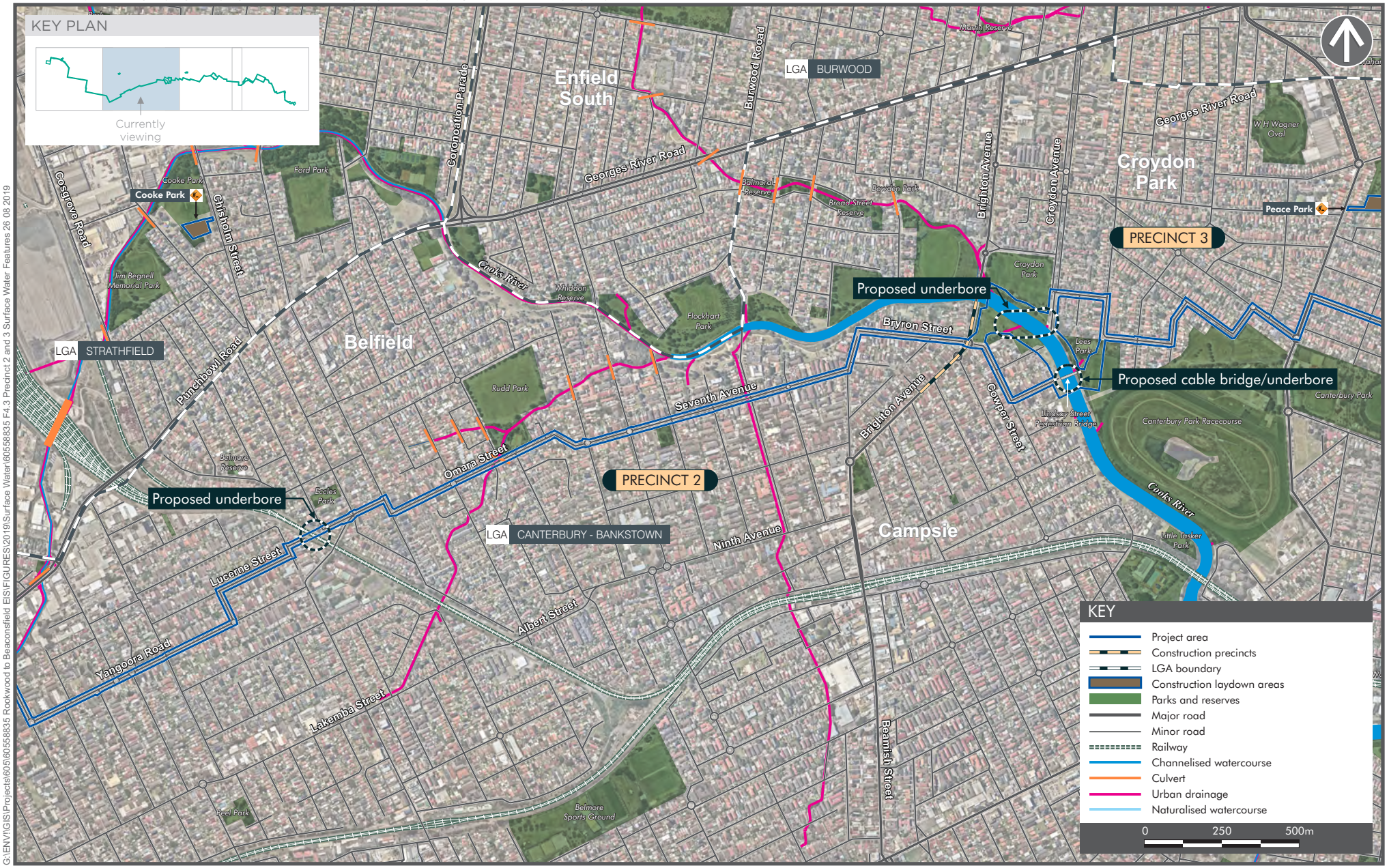
PRECINCT 1 AND 2 SURFACE WATER FEATURES

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 4-2



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PRECINCT 2 AND 3 SURFACE WATER FEATURES

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 4-3

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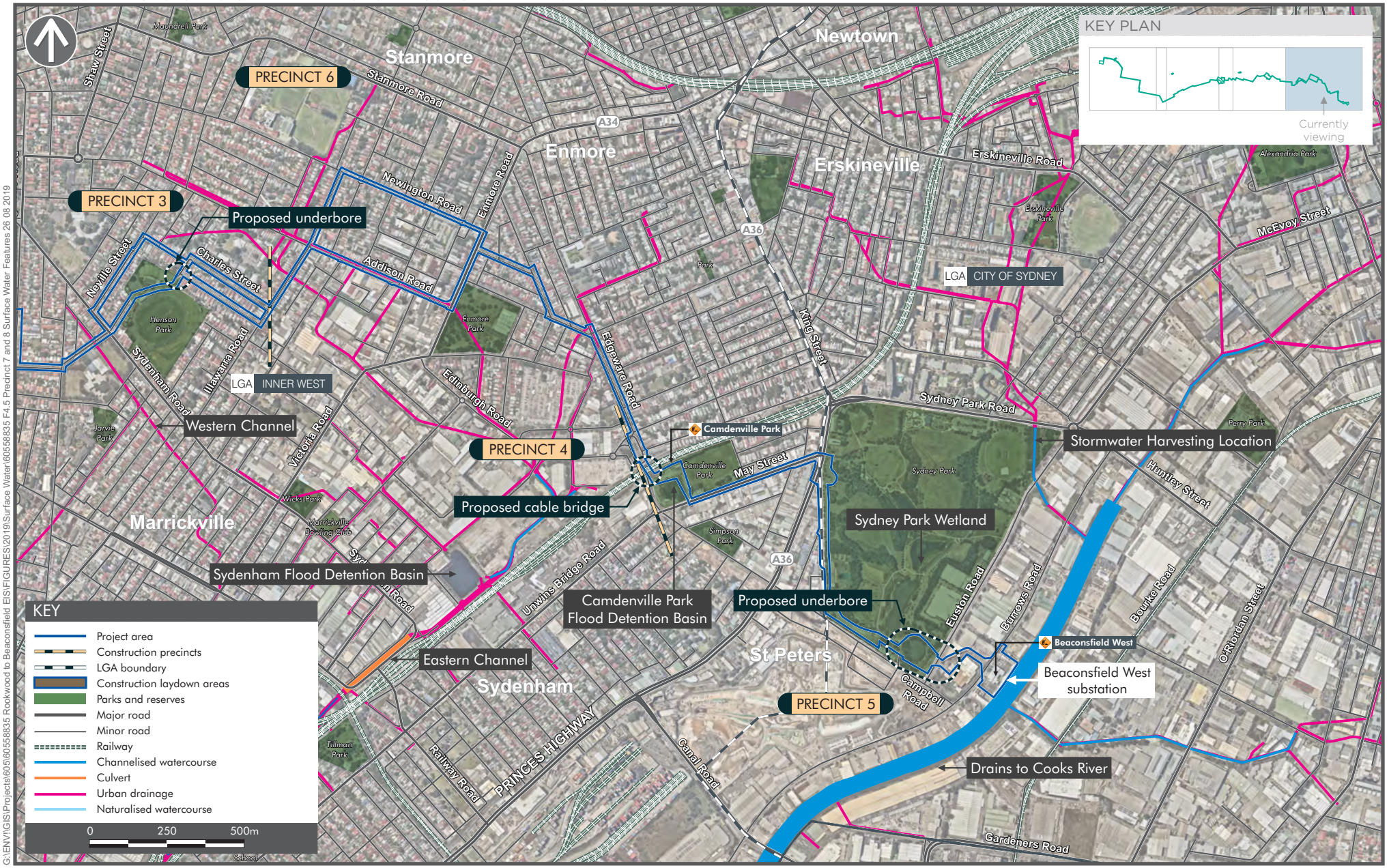
PRECINCT 3 SURFACE WATER FEATURES

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 4-4



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PRECINCT 3, 4 AND 5 SURFACE WATER FEATURES

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 4-5

4.2 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 (LiDAR) data (Department of Finance, Services and Innovation, 2013).

Topography and drainage across the study area is summarised in **Table 4-3**.

Table 4-3 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.

4.3 Water quality

The water quality issues in the receiving waters, including Coxs Creek, the Cooks River, and the Parramatta River estuary (Iron Cove) have been assessed in terms of the issues and stressors that the watercourses and their catchments are subject to. The Cooks River, Parramatta River and Georges River catchments are discussed in further detail in the following section.

Water quality of the catchments and waterways within the study area are generally highly influenced by their urban context. The following features influence the water quality of the receiving waters in the study area:

- the urbanisation of the catchments and subsequent reduction in pervious areas reduces the likelihood of the settling or depositing out of pollutants and sediments being transported in stormwater runoff to settle or deposit out before entry into the estuary or contributing waterways;
- the artificial channelisation and hard (typically concrete) lining of waterways reduces the potential for erosion in the channels, minimising the sediment load transfer from upstream catchments to the discharge location;
- elevated levels of heavy metals, pH, turbidity and nutrients. This is representative of waterways within a highly urbanised catchment; and
- to assist with managing the water quality in the receiving waters, pollution control devices including Gross Pollutant Traps (GPTs) and litter booms have been installed at a number of locations on waterways downstream of the project. These devices are typically maintained by Council.

4.3.1 Cooks River catchment

Water quality in the Cooks River catchment has been affected historically by stormwater pollution, industrial and domestic wastewater discharge, rubbish dumping and modifications of the waterway. Present levels of pollutants, including nutrients, sediments, toxicants and faecal coliforms make the Cooks River unsafe for swimming, unsuitable for many aquatic species and a health risk for commercial fishing.

River health monitoring was undertaken for the Cooks River from 2015 to 2016, and results from this monitoring (which included Coxs Creek) have been presented as a River Health Report Card (Cooks River Alliance, 2017). The report card rates river health and assigns ratings, with A+ being excellent, A–B+ being good, B–C- being fair, and D+–F- indicating poor health. The River Health Report Card from 2016 indicates that the Cooks River freshwater sites have an overall river health condition rating of 'Poor' (D), but with 'Good' to 'Fair' (A- to B-) water quality. Estuary conditions within the Cooks River were rated as 'Poor" (D–E) (CRA, 2016). This is consistent with previous studies (PPK, 1999; Woodlots, 2004), which showed that the Cooks River catchment is regarded as one of the most polluted urban river catchments in Australia. Alexandra Canal and Wolli Creek are also considered highly disturbed ecosystems (Woodlots, 2004).

4.3.2 Parramatta River catchment

Pollution to the waters and sediments in Sydney Harbour (including Iron Cove) result from stormwater, sewage overflows and leachate from contaminated reclaimed land (Montoya 2015). Stormwater discharged via large canals with extensive catchments is a major point source of contaminants to Parramatta River estuary and Sydney Harbour (Birch and Taylor, 1999). Stormwater discharged from highly urbanised catchments on the southern shore of the Parramatta River estuary and Sydney Harbour has been identified as the primary source of contaminants responsible for ecological degradation and reduction in recreational value of these waters (Beck and Birch, 2010).

Typically, the Parramatta River estuary is well-mixed and contaminants associated with base-flow stormwater runoff deposit close to discharge points and become permanently trapped in estuary embayments. Catchment runoff increases rapidly during high precipitation events (rainfall >50 millimetres per day) and upon reaching the watercourse forms a buoyant lens above saline estuarine waters. Under these conditions, contaminants associated with stormwater runoff may migrate beyond off-channel embayments, and depending on the intensity of the storm the plume may reach the main estuary channel even exiting the Parramatta River estuary mouth into Sydney Harbour (Lee, Birch and Lemckert, 2010).

A study conducted in the Parramatta River estuary on freshwater plume behaviour following high-precipitation events (Lee, Birch and Lemckert, 2010) found that the fresh-water plume broke down within the estuary, therefore contaminants associated with stormwater runoff due to high-precipitation events were retained within the system for a longer period than was previously recognised.

A study conducted by Beck and Birch (2010) in Hawthorne Canal (which discharges into Iron Cove) found that the majority (>90%) of metal (copper, lead and zinc) and total suspended solid annual loads were contributed during high flow conditions (>50 millimetres rainfall day), whereas ≤55% of total nitrogen and ≤2% of total phosphorus were contributed to annual loading by dry weather base flow conditions by the three catchments.

Nutrients and heavy metals supplied by stormwater canals draining highly urbanised catchments have accumulated in bottom sediments in concentrations up to 50 times greater than preanthropogenic levels (Birch and Taylor, 1999). Estuarine sediments adjacent to these canals contain the highest concentrations of heavy metals. Atmospheric contributions may also be an important diffuse source of heavy metals to the estuary but sewage overflows and stormwater drains with small catchments are not considered to be important point sources of heavy metals (Birch and Taylor, 1999).

4.3.3 Georges River catchment

Construction activities within the Georges River catchment are limited to work to convert the existing Cable 41 from 330 kV to 132 kV at Sydney South substation. Estuary health monitoring was undertaken for the Georges River Estuary from 2016 to 2017. Results from this monitoring have been presented in the *Georges River Health Report Card* (Georges River Combined Councils Committee, 2017). The report card rates river and estuary health, with the Georges River Estuary, giving a rating of B- (Fair). Estuary conditions are affected by the urbanisation of the tributaries. Stormwater inflows flush pollutants into the estuary, while the upper estuary where the Sydney South substation is located receives minimal tidal flushing.

4.4 Waterfront land

The transmission cable route would be required to cross waterfront land and the associated riparian corridor as defined by the WM Act. Waterfront land serves the following functions:

- providing bed and bank stability and reducing bank and channel erosion;
- water quality management by trapping sediment, nutrients and other contaminants;
- habitat diversity for terrestrial, riparian and aquatic plants (flora) and animals (fauna);
- connectivity between wildlife habitats;
- flood conveyance and controlling the direction of flood flows;
- interface or buffer between developments and waterways; and
- recreational uses.

Locations where the riparian corridor would be traversed or may be temporarily occupied during construction include:

- un-named tributary at Rawson Road (Precinct 2);
- un-named tributary at Omaha Street (Precinct 2);
- Coxs Creek at Wangee Road (Precinct 2); and
- Cooks River at Lindsay Street (Precinct 3).

At these locations the watercourse has been channelised, limiting the need for the riparian corridor to provide bank stability. Hydrologic connectivity to these watercourses is through the urban drainage network, so the water quality management functions, which might otherwise be provided by the riparian corridors, are currently provided through the urban drainage network. The riparian corridors that are connected to by the project have been disturbed, limiting their habitat diversity and connectivity. The riparian corridors have also been urbanised, with roads or pedestrian bridges crossing the corridors at the considered locations. As such, the buffer between development and these watercourses is already limited.

For all locations other than the Cooks River, the flood conveyance is controlled by other hydraulic structures. A preliminary flood assessment of the Cooks River is discussed in **Section 6.4**.

The Sydney South substation is more than 40 metres from the edge of a watercourse and does not occupy waterfront land.

4.5 Flooding

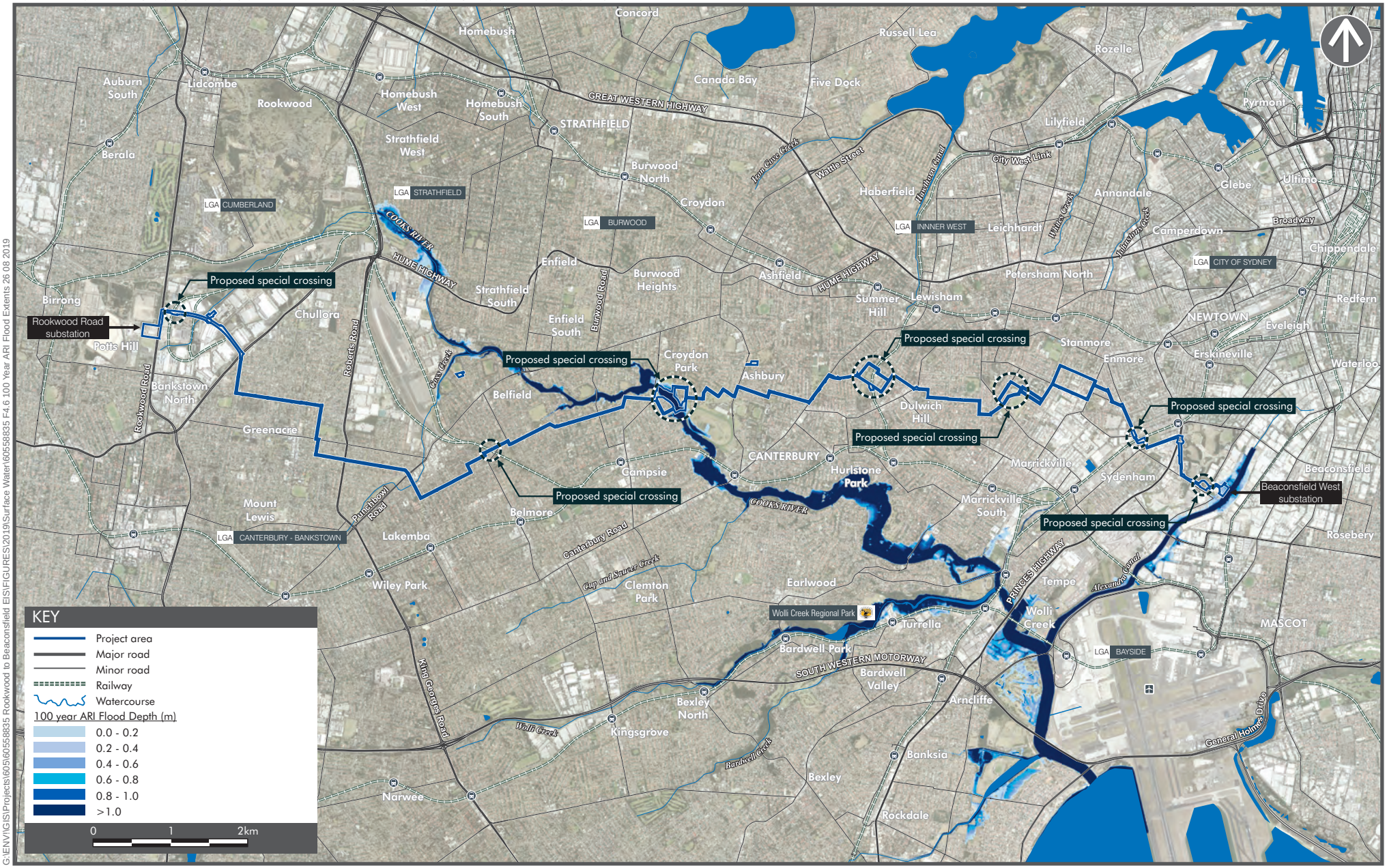
There are a number of existing flood studies and flood risk management plans that relate to the study area.

The study area is located within the Cooks River and Parramatta River estuary catchments, including the Alexandra Canal, Eastern Channel and Hawthorne Canal sub-catchments. Typically the transmission cable route is only subject to local overland (surface runoff) flows. However, there are a select number of locations where the transmission cable route must cross a watercourse and is therefore subject to mainstream flooding. These locations are:

- Cooks River at Muir Road (Precinct 1);
- un-named tributary of the Cooks River at Rawson Road (Precinct 2);
- Coxs Creek at Wangee Road (Precinct 2);
- un-named tributary of the Cooks River at Omaha Street (Precinct 2); and
- Cooks River at Lindsay Street (Precinct 3).

The Cooks River Flood Study (PB MWH Joint Venture, 2009) shows areas of key inundation during the 100 year ARI flood (refer to **Figure 4-6**). Due to the nature of the proposed cable bridge structure and the extent of flooding in the 100 year ARI event, the Cooks River at Lindsay Street in Campsie (Precinct 3) has been identified as the location, across the project area, with the greatest potential for flood impacts (refer to **Figure 4-7**). The flow breaks out of the formal channel in the 100 year ARI event and inundates part of the overbank area up to 2 metres in depth. Discussion of these potential impacts is provided in **Section 6.4**.

The Sydney South substation is sufficiently far from the Georges River estuary, and is elevated above the anticipated water surface, such that mainstream flooding is not likely to affect the substation.



G:\ENV\GIS\Projects\605\60558835 Rookwood to Beaconsfield EIS\FIGURES\2019\Surface Water\60558835 F4.6 100 Year ARI Flood Extents 26 08 2019

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100 YEAR ARI FLOOD EXTENTS (COOKS RIVER FLOOD STUDY)

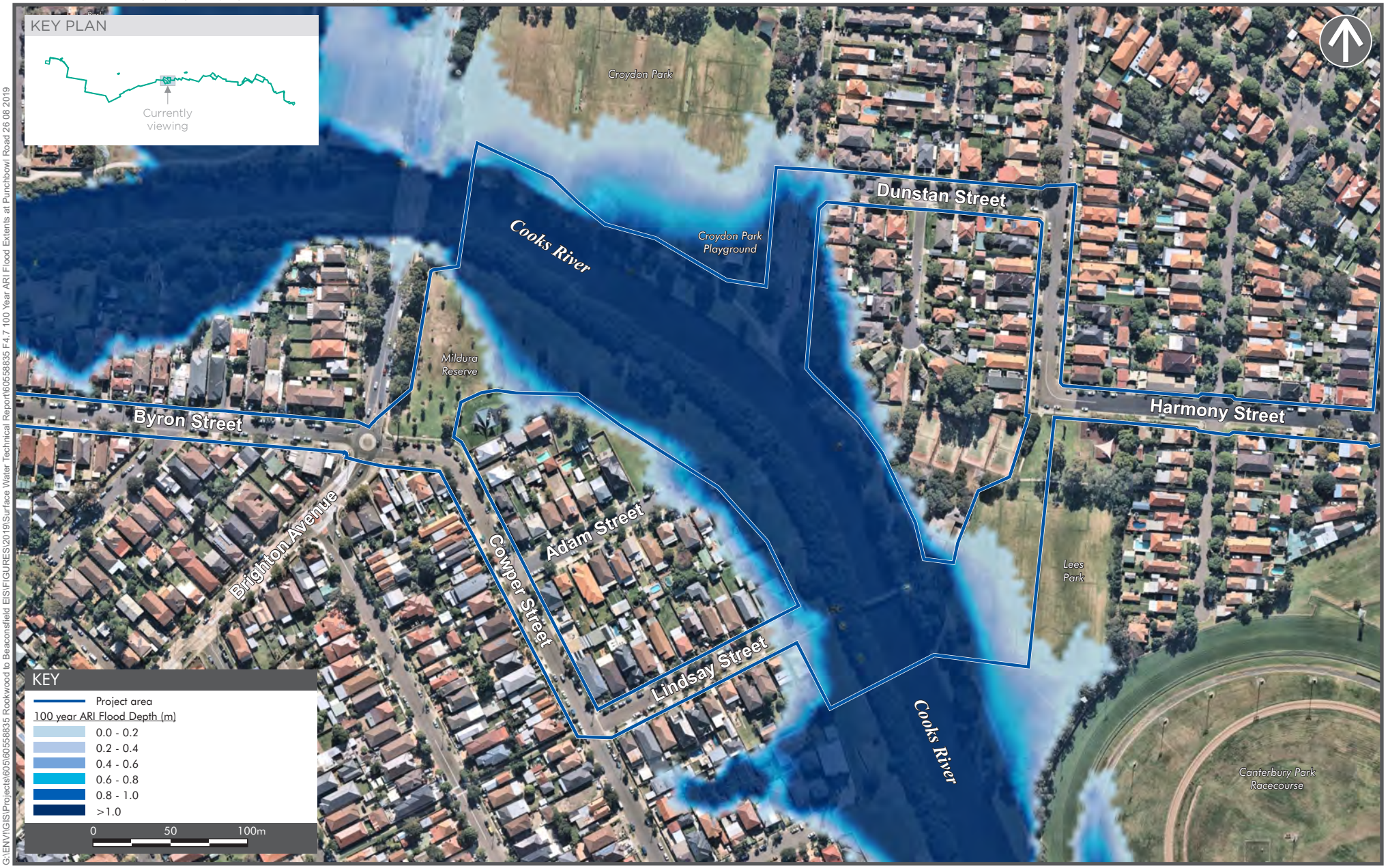
Powering Sydney's Future

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), Cooks River Flood Study (MWH+PB, 2009)

FIGURE 4-6



G:\ENV\GIS\Projects\605\60558835 Rookwood to Beaconsfield EIS\FIGURES\2019\Surface Water Technical Report\60558835 F4.7 100 Year ARI Flood Extents at Punchbowl Road 26 08 2019

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100 YEAR ARI FLOOD EXTENTS AND DEPTHS AT THE PROPOSED CABLE BRIDGE CROSSING OVER COOKS RIVER

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), Cooks River Flood Study (MWH+PB, 2009)

FIGURE 4-7

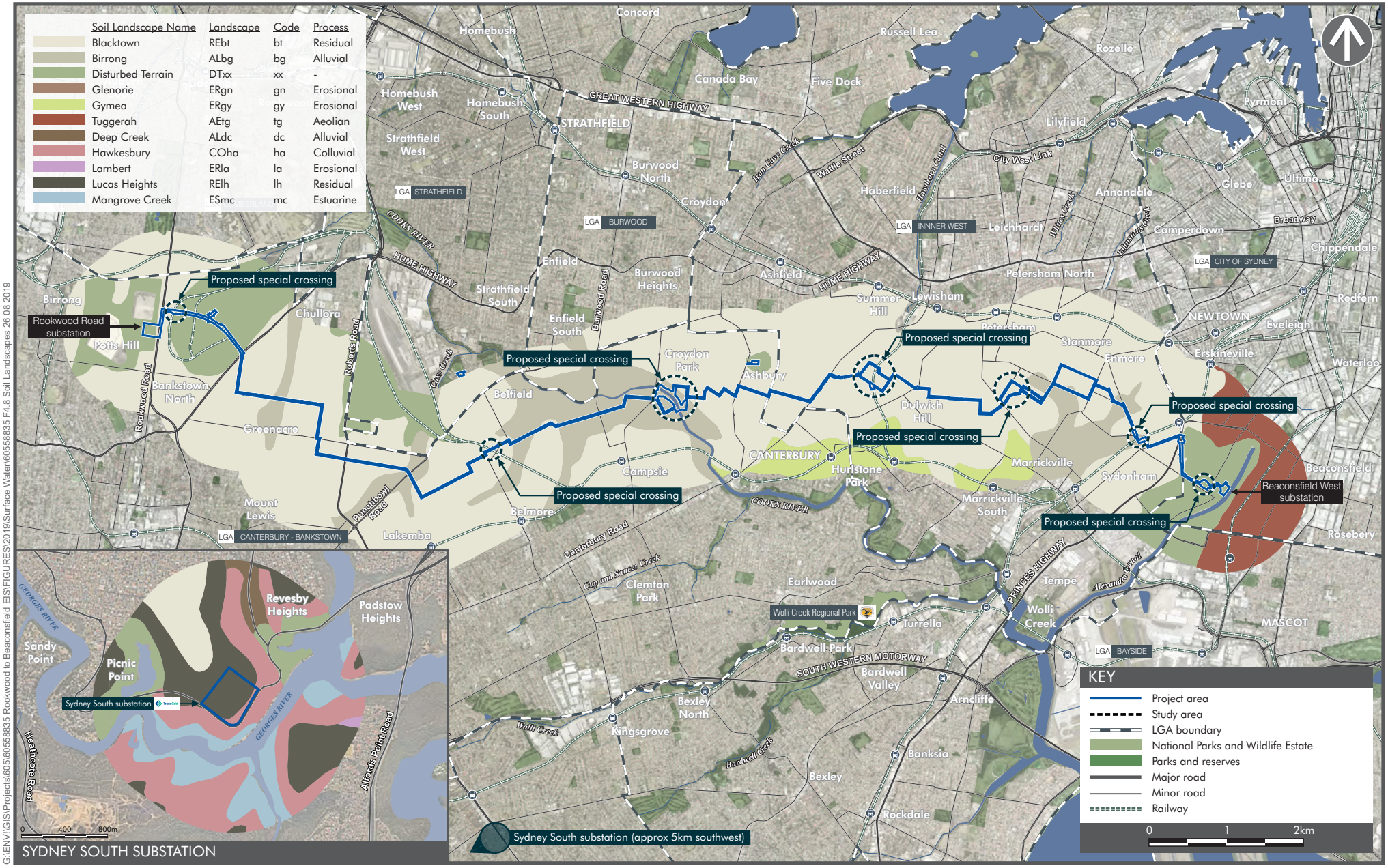
4.6 Soils

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 4-8**. 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. The 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.



G:\ENVIGIS\Projects\605\60558835 Rookwood to Beaconsfield EIS\FIGURES\2019\Surface Water\60558835 F4.8 Soil Landscapes 26 08 2019

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SOIL LANDSCAPES

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), Office of Environment and Heritage (OEH), 2008

FIGURE 4-8

4.7 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, etc.) activity has resulted in PASS to being exposed to air, resulting in releasing acidity and reaction products (iron, sulfate, calcium, magnesium, aluminium etc.).

NSW Office of Environment and Heritage (OEH, 2012) acid sulfate soil (ASS) risk maps 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:

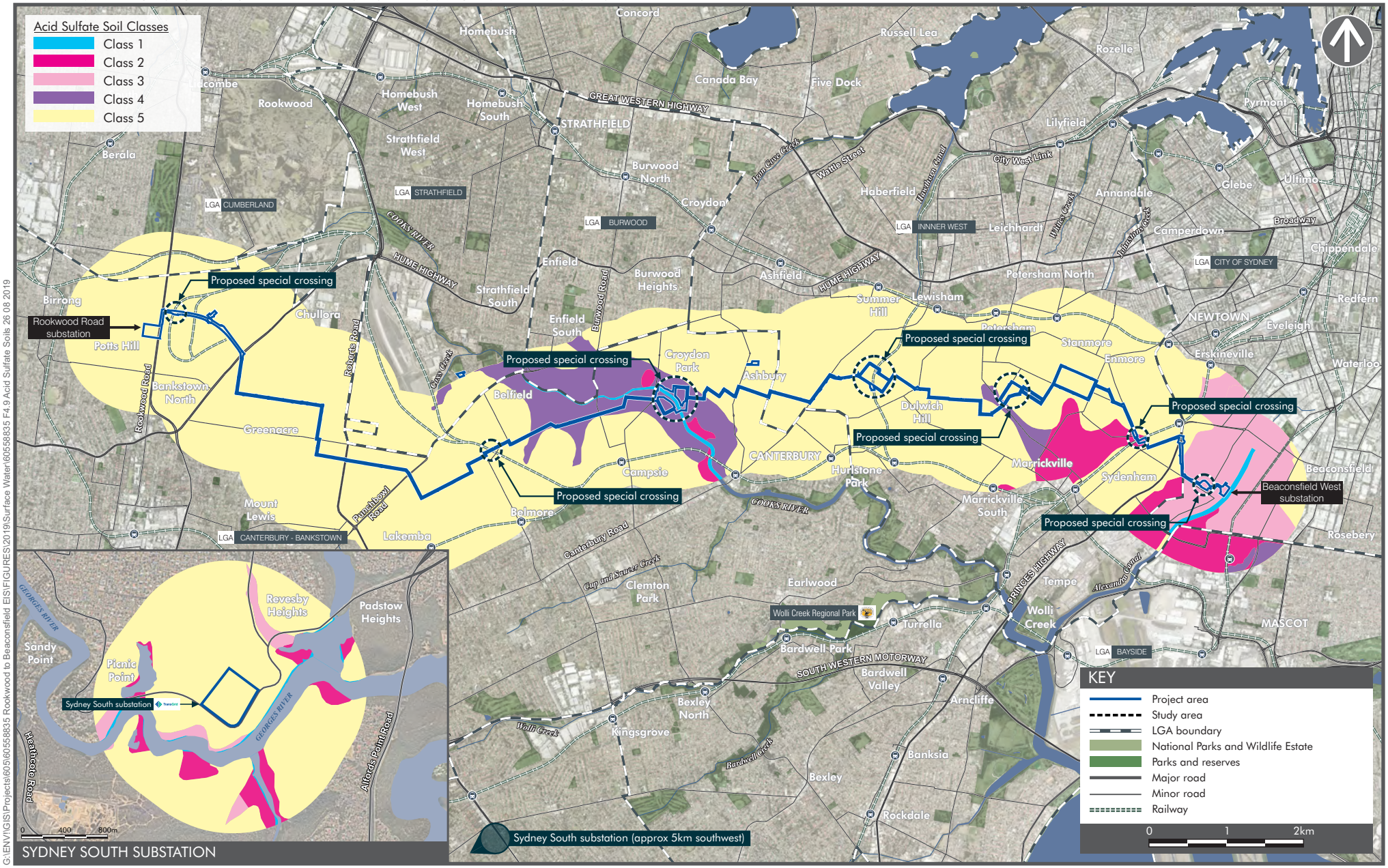
- Class 1: Any works[2] require an ASSMP;
- Class 2: Works below the natural ground surface and/or works by which the watertable is likely to be lowered require an ASSMP;
- Class 3: Works more than 1 metre below the natural ground surface and/or works by which the watertable is likely to be lowered more 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, require an ASSMP.

The ASS risk class along the transmission cable route and Sydney South substation 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 4-4**. ASS risk class in the project area is shown in **Figure 4-9**.

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

Table 4-4 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 and Cooks River crossing area)	Low	Class 2
5	Princes Highway to Alexandra Canal (1.3 km length)	Low	Class 3



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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), NSW Office of Environment and Heritage (OEH) Acid Sulfate Soil Risk Maps, 2011

FIGURE 4-9

5.0 Assessment of potential construction impacts

5.1 Overview

Construction of the project has the potential to further degrade the receiving water quality in the Cooks River, Georges River and Parramatta River estuary unless suitable management and mitigation measures are implemented. Construction of the project would involve a variety of activities with potential to impact on quality and flow of surface water. These are discussed in the following sections. Measures identified to avoid, minimise and manage potential impacts are presented in **Section 7.0**.

5.2 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 project areas in Precincts 2, 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 be completed prior to excavation taking place.

The risks associated with PASS and ASS identified for the portions of the project area in Precincts 2 and 5 would be managed in line with relevant measures detailed within the ASSMP which is a sub-plan of the Construction Soil and Water Management Plan (CSWMP). These measures would be developed in accordance with *NSW Acid Sulfate Soils Manual* (Stone *et al* 1998).

Appendix K of the EIS provides further information on ASS.

5.3 Erosion and sedimentation

5.3.1 Impacts to sensitive receiving environments

Runoff from the project area could result in the delivery of sediments and pollutants to downstream waterways such as the Cooks River. Unmitigated runoff from the project during construction would place increased pressure on the Cooks River and Parramatta River estuary. Mitigation measures would be required to avoid or reduce the potential for environmental impacts during construction. These measures are discussed in **Section 7.0**.

5.3.2 Impacts to water quality

Water quality impacts could potentially arise from:

- earthworks activities (including tracking or moving loose soil) and exposed soil (including soil stockpiles) subjected to wind or rain which may cause sediment pollution to enter surface water or the stormwater network;
- during underboring, there is a risk of drilling fluid being released either during frac out or through spills at the surface; spills of fuels, oils, chemicals or construction materials may enter surface water or infiltrate to groundwater;
- construction activities adjacent to or within waterways could introduce foreign contaminants such as oil or greases, and disturb contaminated sediments, potentially having an adverse impact on water quality;
- contaminated or ASS sediments that may be mobilised by works;
- pollutants from work sites may be carried downstream by stormwater, potentially impacting the water quality in the Cooks River, Alexandra Canal, Iron Cove Creek or Georges River;
- exposed soils being eroded by wind or rain, and the eroded soils leading to water quality issues such as sedimentation in the receiving waters downstream; and

- drainage works, such as installation of drainage diversions during construction or trenching through drainage networks, have the potential to concentrate flows, which may exacerbate erosion and result in scour or the mobilisation of pollutants.

Soils transported into surface water or stormwater networks can impact water quality through increased turbidity, lowered dissolved oxygen levels, and increased nutrients (nitrogen and phosphorus). Suspended sediments within surface water flows may settle and smother aquatic ecosystems. Increases in nutrients carried by these flows may also contribute to eutrophication[3]. Temporary drainage works implemented during construction also have the potential to concentrate flows, which may exacerbate erosion. These construction activities pose the greatest risk where they occur near waterways; on steep slopes or on land subject to surface water flows or flooding.

The key objective during construction would be to separate clean water from sediment laden water, to minimise erosion of disturbed areas, and to contain sediments on-site. Land that is considered at high risk of erosion during construction includes:

- slopes with greater than ten per cent grade; and
- areas where rainfall erosivity (as identified in *the Blue Book* (Landcom, 2004)) presents a risk of erosion for this part of Sydney.

Within the project area, the banks of the Cooks River near the cable crossing may meet these criteria.

Erosion and sediment loads would gradually diminish with completion of construction activities as the disturbed areas are progressively stabilised. The Beaconsfield West substation, which would be a stockpiling location, is exposed to flooding from both overland flows along Burrows Road and flooding of the Alexandra Canal. There is the potential for material that is stockpiled below the Probable Maximum Flood (PMF) level to be inundated and released into the environment by the flood velocity. Any contaminated material, if present within the stockpile, could therefore be released into the environment.

Spills and leaks from construction vehicles and plant have the potential to impact surface water quality where the materials enter a local watercourse. Spills and leaks would be managed by maintaining equipment and conducting activities with the potential to cause a spill in a safe manner. Refuelling and fuel storage would not be carried out within 100 metres of a water way. Appropriate spill containment measures would be implemented to reduce the potential for spills and leaks to impact off-site receivers. Accidental spills or leaks would be managed by protocols outlined in the CSWMP which could include quick spill response times and the use of spill kits to contain and capture contaminated water. Industry standard measures are proposed to manage the potential water quality impacts that may arise as a result of runoff and spills associated with the project. Many of the measures are documented in the Blue Book.

During underboring, there is the risk of frac-out i.e. where drilling fluid leaks from the bore and may reach the surface in some instances. Suitable containment measures are typically sufficient in mitigating a release of drilling fluid, fuels, oils, chemicals or other construction materials at the surface. The management of leaks and spills will be addressed in and the Construction Soil and Water Management Plan (CSWMP). The risk of frac-out is discussed in the Groundwater Technical Report for the project (refer to **Appendix N** of the EIS).

[3] Eutrophication is when a body of water becomes overly enriched with minerals or nutrients which induces an excessive growth of plants and algae.

Water that collects in the open sections of trenches would require discharge or disposal in accordance with the POEO Act. The POEO Act is the legislation that governs waterways and may trigger the need for a licence. As the project would be undertaken in accordance with the Blue Book guidelines, the risk of pollution is considered manageable and therefore no licence is likely to be required. If a licence or permit is required, such as if a reasonably foreseeable risk of water pollution arises during the course of design development or Blue Book guidelines cannot be met, this would be obtained from the relevant authority (NSW EPA) prior to the commencement of construction activities. Water that does not meet water quality requirements for discharge would be captured and transported off-site for disposal at a suitably licenced facility. Where possible, the transmission cable route would be designed to avoid intercepting groundwater. This would minimise the need for dewatering the trench.

Potential impacts on surface water quality during construction of the project would be similar to those experienced for other urban construction projects and are considered manageable with the application of standard mitigation measures (refer to **Section 7.0**). These measures would be in accordance with applicable guidelines such as the Blue Book.

5.3.3 Impacts to geomorphology

Geomorphology impacts could potentially arise from:

- construction activities adjacent to or within watercourses, which could impact channel bed and bank conditions;
- mobilisation of sediment and sediment build up in streams; and
- increased impermeable areas.

Construction activities within or adjacent to watercourses and/or riparian zones belonging to the Cooks River may involve the clearing of vegetation, including for the installation of bridge piers to support the proposed cable bridges, and therefore may result in disturbance to the channel bed and bank areas. These activities have the potential to disturb the existing floodplain and/or in-channel geomorphic units, exposing them to scour erosion or altering the trajectory of the channel planform.

Water from the work sites, derived mainly from groundwater and some surface water runoff could be discharged to the stormwater system if it is suitable quality and this would ultimately discharge into Botany Bay via Alexandra Canal or the Cooks River. It is unlikely that increased erosion or channel deepening (bed incision) would be caused by discharge of this water and increased flows, since the stormwater discharge points are concrete lined.

Project areas where soil has been exposed and/or weakened by construction activities (including excavations) and can be eroded/mobilised by wind or runoff, have the potential to deposit sediments in receiving waterways. Sediments can fill and smother in-stream geomorphic units and habitat features such as pools and riffles. Furthermore, sediments can accumulate at in-stream barriers and constrictions, which may result in localised flooding and/or channel avulsion (a new altered flow path around an in-stream barrier).

However, the receiving waterways that intersect the transmission cable route, including the Cooks River and Coxs Creek are concrete lined channels, so the potential for geomorphic changes are restricted.

Erosion and sediment loads would gradually diminish after construction as the disturbed areas are stabilised. The key objective is to minimise erosion of disturbed earthworks areas and to contain sediments on-site before they enter the riparian zone and watercourse/drainage system. This could be achieved by stabilising areas as soon as possible, minimising the amount of time areas are exposed for and avoiding working in wet weather, where feasible.

Other potential construction impacts on the geomorphology include increased impermeable areas associated with work sites and construction laydown areas (e.g. site offices and sheds) and/or altered flow paths that may result in increased over bank flows entering the waterway causing erosion.

5.4 Changes to surface water flows

Construction flooding and drainage impacts could potentially arise as a result of:

- work sites may increase runoff volumes and peak flows (e.g. maximum flow rates) following rainfall events due to an increase in impermeable surfaces;
- drainage infrastructure may become blocked (e.g. by soil, vegetation, waste) or temporarily diverted due to construction activities. Disruption to local drainage lines may result in localised flooding upstream of the project areas; and
- removal of existing pavement could divert flow away from designed drainage structures and into new receiving areas. Diverting drainage lines may also create localised areas of flooding and scour.

Construction of the transmission cable circuit would require excavating a trench in which to lay the conduits. Trenching and conduit installation would only require the opening of short sections of trench at a time (typically up to around 20 metres at any one location per day), with backfilling occurring as soon as each section of the conduits has been installed, leaving typically no more than 20 metres open at one time. During this period, there is a possibility that overland flow would enter the trench, either as sheet flow from surrounding areas or as channelised flow in the kerb and gutter system. Trenches would be temporarily covered when works are not occurring; however, there is a potential that temporary covers are not sealed and flow may enter the trench. There may also be disruption of existing drainage networks during decommissioning, upgrade or replacement of drainage pits and pipes during trenching activities.

Water may be diverted from the existing flow path into the excavated trenches, requiring it to be pumped out of the trench to a tank/basin. If large volumes of water accumulate during heavy rain, the water may spill from the trench in an uncontrolled manner.

Where cable bridges are required, the construction of the bridges and piers may have some localised impact on overland stormwater flows.

Coxs Creek at Wangee Road and the un-named tributaries of the Cooks River at both Rawson Road and Omaha Street are comprised of stormwater culverts passing under the roadways. The level of cover present above these culverts would be insufficient to construct the new transmission cable circuit above the culverts. As such, the construction process at these locations would likely involve trenching under the existing culverts, laying the transmission cable conduits and then reconstructing the culverts to match the pre-existing conditions. Depending on local site conditions, alternative construction methods, such as underboring, may also be considered by the construction contractor to minimise surface impacts.

Where underboring is carried out, launch and receive pits would be required . These excavated pits would need to be in place for around eight to 10 weeks at each location. These pits would have containment measures in place to prevent surface water flow from entering the pits. Backfilling of the pits would occur as soon as the conduits are installed.

At the Cooks River, sediment barriers or site bunds would be used to prevent sediment from entering the watercourse. Work inside watercourses would not be undertaken during or immediately following rainfall events when flows in the watercourse (e.g. Cooks River or Coxs Creek) are expected.

As substation upgrades and construction laydown area works at the Beaconsfield West substation would be contained within the existing perimeter walls of the site, it is unlikely that surface water flows would be impacted in this location.

5.5 Impacts to existing stormwater network

Where the transmission cable route crosses existing stormwater assets, these assets may require relocation, or protection during construction. There would also be a need to divert stormwater as part of construction management activities to help manage flow. Where diversion would result in additional stormwater flow being diverted into the existing stormwater network, appropriate sediment management would be required and consultation with relevant authorities, including OEH, Sydney Water and local governments undertaken. Where a water stream is identified as being contaminated, it

will not be permitted to discharge to the stormwater network. The contaminated water would be either discharged to the sewer under a trade waste licence or trucked off-site for disposal.

Impacts to the urban stormwater network are not anticipated if the alignment of the transmission cable circuit passes below the stormwater pipes, which would be supported during construction. However, there is a risk that stormwater could enter the trench if the stormwater pipes are temporarily cut and replaced during asset relocation. If pipes are required to be cut and replaced, rainfall forecasts would be monitored and works rescheduled if required, to avoid disrupting the flow of stormwater so as to minimise the risk of uncontrolled stormwater discharge.

At Camdenville Park, a flood detention basin has been constructed. Depending on the final project design and construction methodology, including transmission cable route and choice of backfill materials respectively, the construction of the transmission cable circuit could compromise the integrity of the embankment wall of the flood detention basin unless suitable measures are implemented. That is, the integrity of the flood detention basin would need to be considered during detailed design to prevent potential damage.

Stormwater is harvested from the Ashmore trunk drain to support the Sydney Park wetlands in the north-eastern corner of Sydney Park. This system captures a portion of the stormwater runoff from Sydney Park Village and the Ashmore Street precinct. The proposed transmission cable route is outside the catchment draining to the harvesting point, and as such impacts to stormwater quantity or quality available to the harvesting system are not predicted.

5.6 Impacts to waterfront land

The existing riparian corridors within the project area have undergone significant urbanisation (**Section 4.4**), therefore the potential for additional impacts to the riparian corridors are limited. However, construction works and construction laydown areas would occupy land that would otherwise be used for recreation such as Mildura Reserve and the Cooks River cycleway in Croydon Park and Lees Park reserves. Therefore there would be a temporary impact to the recreational functions provided by waterfront land.

5.7 Water use

There would be a temporary increase in potable water demand as a result of the project during the construction phase. However, construction of the project does not require any on-site processes that consume large quantities of water. For example, concrete batching is expected to be done off-site at locations with sufficient water supply. A number of other activities may require minor quantities of water. These activities include:

- on-site washrooms and amenities;
- wheel wash-down for vehicles and plant leaving the site;
- dust suppression;
- concrete cutting; and
- equipment cleaning.

Potable water would be obtained from the Sydney Water potable supply network subject to agreement with Sydney Water.

6.0 Assessment of potential operational impacts

6.1 Overview

Operation of the project is anticipated to have limited impacts, given the majority of infrastructure would be located underground and separate from the surface water environment. The substation upgrade works are not expected to have additional impacts to those already occurring in the existing substations, as the operation of the substations would generally remain unchanged. Above ground infrastructure such as cable bridges has the potential to change the existing flow paths and flood storage at key locations. These potential impacts are discussed in the following sections.

Once the transmission cable circuit has 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 cable circuit 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.

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

6.2 Water quality

Once the trenches and underboring launch and receive pits are backfilled and the surface restored, there are unlikely to be ongoing water quality impacts associated with the project.

Maintenance activities may occur from time to time, which has the potential for spills or leaks of fuels and/or oils to occur and impact on the water quality of groundwater and nearby waterways.

6.3 Impacts to waterfront land

The existing riparian corridor has undergone significant urbanisation (**Section 4.4**), therefore the potential for additional impacts to the riparian corridor during project operations are limited. There is one possible location where a cable bridge would cross the Cooks River, which may affect the following riparian corridor functions:

- conveying flood flows (**Section 6.4**);
- providing an interface between developments and waterways; and
- providing passive recreational uses.

The cable bridge would be adjacent to an existing footbridge and is expected to have a relatively small footprint. This would not impact on the function of the Croydon Park cycleway, Croydon Park playground or the Lees Park sports field. The recreational function of the land along the transmission cable route would be restored following completion of the project construction, and as such, the impacts to the functions provided by waterfront land are minimal.

6.4 Changes to surface water flows

The project may result in minor potential obstruction to flood flows as a result of new infrastructure and reductions in the flood plain area, which could have an impact on downstream flooding behaviour or on nearby existing developments.

For the majority of the transmission cable route, the surface would be restored to be similar to the existing condition, and as a result no major alterations to overland flow are anticipated. Minor alterations to overland flow routes may occur around bridge piers where cable bridges are required. However, with the appropriate design of cable bridges, these alterations are expected to be negligible as flowpaths would be maintained and the loss of storage is minor.

Coxs Creek at Wangee Road and the un-named tributaries of the Cooks River at Rawson Road and Omaha Street (in Precinct 2) are comprised of stormwater culverts passing under the roadways.

These culverts would be restored following completion of project construction therefore there would be no lasting impacts on water flows.

A cable bridge is proposed to cross the Cooks River waterway adjacent to the existing Lindsay Street footbridge (Precinct 3) (refer to **Figure 6-1**).

The existing footbridge does not sit above the current 100 year ARI floodplain and therefore would provide some obstruction to flows. The new cable bridge would be aligned immediately upstream of the existing footbridge, but would sit above the 100 year ARI event water level to minimise the potential for increase in flood impacts. In order to raise the cable bridge above the 100 year ARI event water level, the cable bridge would be built such that the lowest structural element of the bridge clears 5.1 m AHD, assuming 500 millimetres of freeboard.

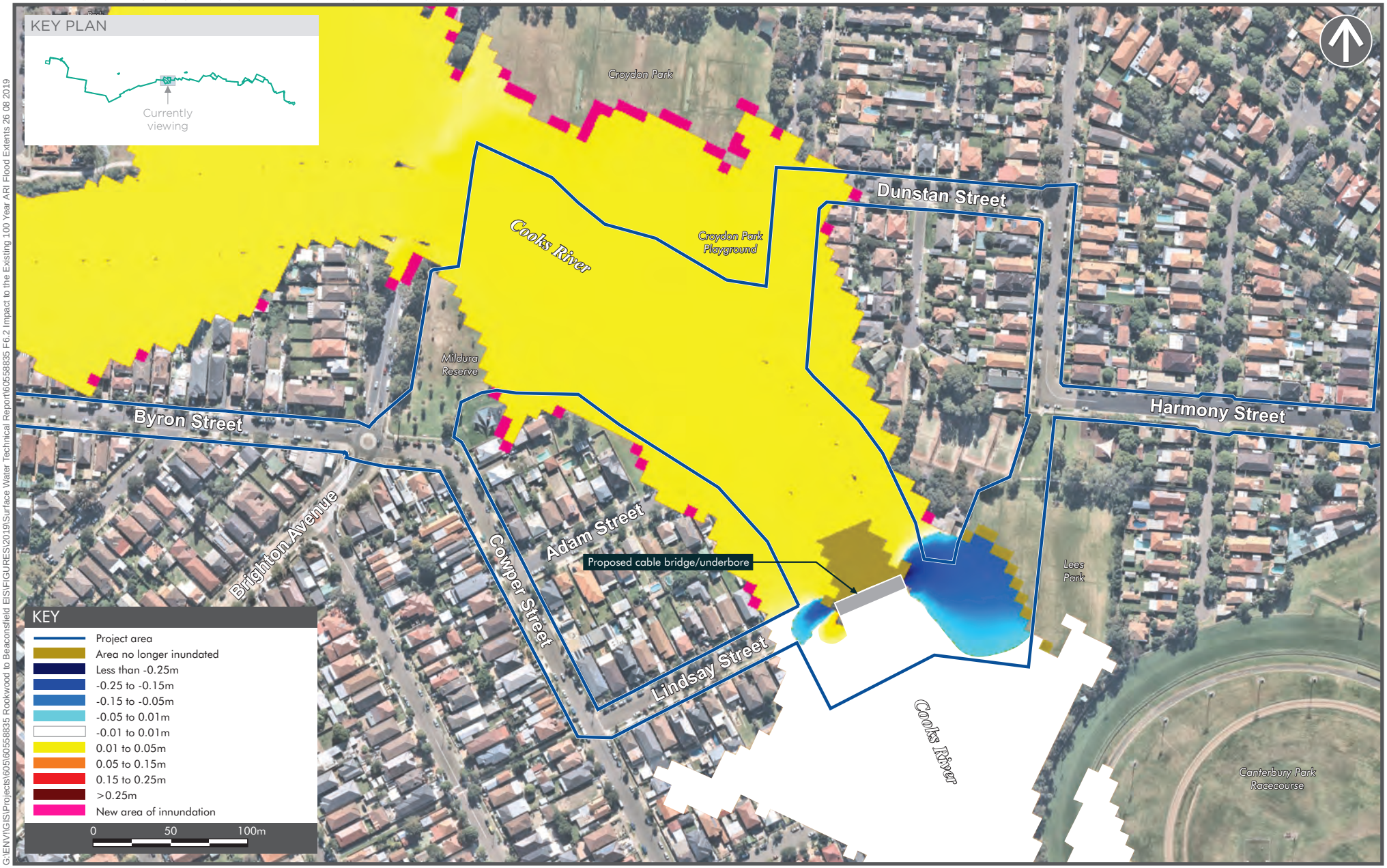
Although the deck of the cable bridge would clear the 100 year ARI water level, the bridge abutments would potentially exacerbate existing upstream flooding impacts to adjacent properties of approximately 40 millimetres with localised impacts up to 50 millimetres (refer to **Figure 6-2**).

This assessment has shown that there would be no new properties inundated as a result of the potential flood level increases of up to 50 millimetres. The severity of increased flood impacts to the properties that are already inundated is defined by the environmental management and mitigation measures outlined in **Section 7.2.** These measures require that the increase in inundation at properties where floor levels would not be exceeded in a 100 year ARI rainfall event does not exceed 50 millimetres. For these properties, the increased flood levels of up to 50 millimetres may be considered acceptable.

However, at properties where flood levels in a 100 year ARI rainfall event are above the floor level, the environmental management and mitigation measures require that the increase in inundation does not exceed 10 millimetres. There should also be no new over floor flooding during this event. Floor level survey would be required to determine if any floor levels would be affected. Where there is an increase in flood levels of up to 40 millimetres as shown by the modelling, these flood impacts may be considered unacceptable and would require further assessment and consultation with relevant stakeholders .

During extreme events such as the PMF, roads and road crossings of the Cooks River are blocked by flooding under present conditions (Sydney Water, 2009). As such, the PMF does affect the emergency response under present conditions. The potential impacts of the construction of the cable bridge would need to be investigated further to determine if emergency response would be adversely affected. Should impacts to emergency response be identified, additional modelling and design review as well as consultation with State Emergency Services and Inner West Council would be undertaken to identify measures to mitigate these impacts.

Figure 6-1 Visual simulation of the proposed cable bridge crossing over the Cooks River and cycleway adjacent to the existing Lindsay Street footbridge



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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), Cooks River Flood Study (MWH+PB, 2009)

100 YEAR ARI FLOOD IMPACTS AT LINDSAY STREET (PRECINCT 3)

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FIGURE 6-2

7.0 Environmental management and mitigation measures

7.1 Management objectives

The surface water and flooding management and mitigation measures for the project seek to meet the following objectives:

- minimise the disturbance to the movement of water in the stormwater network as well as in the Cooks River and Coxs Creek;
- preserve the downstream receiving water quality; and
- limit the potential for increases in flood levels and manage flood risk.

7.2 Environmental management and mitigation measures

The measures outlined in **Table 7-1** are recommended to manage and monitor potential surface water and flooding 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 Flood Mitigation Strategy (FMS) will identify site specific flood risks.

A CSWMP would be implemented during construction and would form part of the overarching Construction Environmental Management Plan (CEMP) for the project. The CSWMP would be developed in accordance with the principles and requirements of the Blue Book and would consider the FMS and Groundwater Management Strategy. The CSWMP would include sub-plans, including ESCPs (to manage erosion and sedimentation) and Flood Management Plans (FMPs) (to manage flood risks identified in the FMS).

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.

Measures to manage soils and contamination have been addressed in the Preliminary Site Investigation report (refer to **Appendix K** of the EIS).

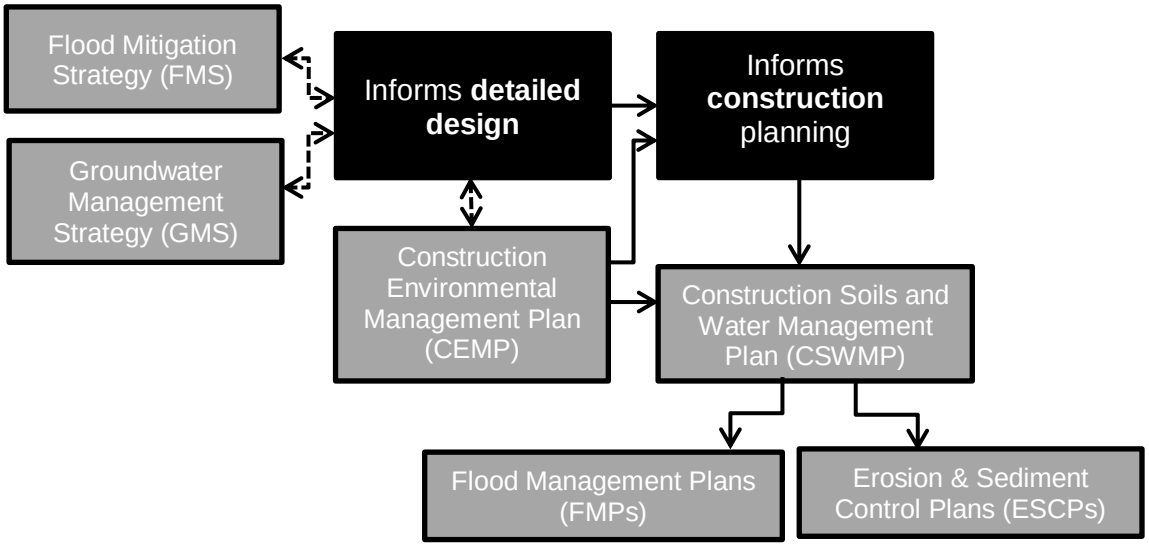

Figure 7-1 Surface water and groundwater management strategies and plans

Table 7-1 Environmental management and mitigation measures

No.	Impact/issue	Environmental management and mitigation measures	Timing
WQ1	Water quality, soil erosion and sediment control (CSWMP)	A CSWMP will be prepared as part of the overall CEMP to document the measures required to mitigate and manage potential impacts on soils and surface water during construction. The CSWMP will include the following sub-plans and measures: • ESCPs (see WQ2); • where wheel washing is required, wheel wash wastewater will be collected (e.g. through temporary containment and directing to sediment basins or tanks) and disposed of appropriately; • water collected during construction (e.g. during dewatering or surface water inflows to the trench or pits) 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.* Contaminated water captured during construction would be disposed of at an appropriately licensed facility; and • where works are within the riparian zone (40 metres from the top of the watercourse bank) the *Controlled Activities on Waterfront Land Guidelines* (DPI, 2012) would be reviewed and relevant measure included into the CSWMP where appropriate. Procedures and protocols to manage potentially contaminated fill, soil, bedrock, acid sulfate soils and extracted groundwater will be detailed in the CEMP in accordance with conditions outlined in the Preliminary Site Investigation report (refer to **Appendix K** of the EIS) and the *NSW Acid Sulfate Soils Manual* (Stone *et al,* 1998).	Construction

No.	Impact/issue	Environmental management and mitigation measures	Timing
WQ2	Water quality, soil erosion and sedimentation control (ESCP)	ESCPs will be prepared as part of the CEMP for transmission cable route work sites, substations and construction laydown areas, in accordance with the Blue Book (Landcom, 2004). ESCPs will be implemented in advance of site disturbance and updated as required as the construction progresses and the work site locations change. Measures in the ESCPs will include: • construction traffic to be restricted to access tracks, where existing roads cannot be utilised (e.g. through Sydney Park). These access tracks will be clearly delineated and maintained until construction is complete; • where possible, clean water will be prevented from entering excavations by diverting runoff away from earthworks activities; • the extent of ground disturbance and exposed soil will be minimised to the greatest extent practicable to minimise the potential for erosion; • disturbed ground and exposed soils, such as inside trenches or at construction laydown areas, will be temporarily stabilised (e.g. with geotextile) prior to extended periods of site inactivity and permanently stabilised as soon as possible to minimise the potential for erosion; • stormwater flows will be managed to avoid flow over exposed soils which may result in erosion and impacts to water quality. Inside the excavation this may require the use of trench stops; and • rainfall forecasts will be monitored daily during construction and works rescheduled if necessary and as determined by the contractor, to reduce risk of erosion and sedimentation and to minimise the impact of heavy rainfall and flood events.	Construction

No.	Impact/issue	Environmental management and mitigation measures	Timing
WQ3	Water quality – spills and leaks	The following measures will be documented in the CSWMP and implemented to mitigate and manage spills and leaks: • areas will be allocated for the storage of fuels, chemicals and other hazardous materials. These areas will be as far away as feasible and reasonable from watercourses, located where flooding during a 20 year ARI event is unlikely, and on an impervious, bunded area; • the storage and handling of dangerous goods will be in accordance with relevant guidelines and standards such as the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005); • fuel and liquid storage at construction laydown areas will be secured and stored in accordance with the NSW EPA guidelines (Department of Environment and Climate Change NSW, 2007a); • appropriate spill containment and prevention measures will be applied to fuel and liquid storage, where feasible and reasonable; • accidental spills or leaks will be managed through the use of spill containment measures including spill kits. Any contaminated material will be disposed of to an appropriately licenced facility; • re-fuelling of construction plant and equipment will be undertaken using appropriate spill containment measures to mitigate pollution risks from accidental spills or leaks; • refuelling activities will be undertaken at least 100 metres from the nearest watercourse; • a spill response kit will be available on-site at all work sites at all times; • where bulk fuel or other liquid substances are to be brought to a work site, a container specifically designed for that purpose will be used; • underboring sites will have appropriate stormwater diversions, as well as downstream pollution and sediment control measures to both prevent stormwater entering the excavation as well as to assist with containing any loss of drilling fluid; and • flows of drilling fluid will be visually monitored in accordance with the CSWMP.	Construction

No.	Impact/issue	Environmental management and mitigation measures	Timing
FF1	Flooding and water flows (FMS)	A Flood Mitigation Strategy (FMS) will be prepared in accordance with the *Floodplain Development Manual* (DIPNR, 2005) for work within flood prone or flood affected land within the project area to demonstrate that the existing flooding characteristics will not be exacerbated. The FMS will be prepared by a suitably qualified and experienced person in consultation with directly affected landowners, Department of Industry (DI) - Water, DPIE, Sydney Water and relevant councils. The FMS will be prepared during detailed design and prior to construction. The FMS will identify design and mitigation measures that will: • be considered by the contractor in the development of site-specific flood management plans including the need to protect plant, staff, materials and earthworks activities from flooding (refer to FF3); • seek to not worsen existing flood risks to adjacent properties; or • where existing flood risks are exacerbated, document consultation with stakeholders around alternative management or mitigation strategies; and • not significantly alter surface water flows during construction and operation. The FMS will limit flooding characteristics to the following levels, or else provide alternative flood mitigation solutions consistent with the intent of these limits: • a maximum increase in inundation time of one hour in a 100 year ARI rainfall event; • a maximum increase of 10 millimetres in inundation at properties where floor levels are currently exceeded in a 100 year ARI rainfall event; • a maximum increase of 50 millimetres in inundation at properties where floor levels would not be exceeded in a 100 year ARI rainfall event; and • no inundation of floor levels which are currently not inundated in a 100 year ARI rainfall event.	Detailed design

No.	Impact/issue	Environmental management and mitigation measures	Timing
FF2	Flooding and water flows at Cooks River	The FMS will outline specific measures for the construction of the proposed cable bridge over the Cooks River to minimise impacts associated with impeding surface water flows. This will include: • where possible, construction will take place outside of the floodplain; • construction will not be undertaken during flooding events; • temporary mobile plant will be used during construction that be quickly removed in the event a flood; • the crossing will be designed to be elevated above the 100 year ARI floodplain extent (as identified in the FMS), subject to consultation with Sydney Water and the relevant road authority; and • if abutments or piers are required within the floodplain and within an area with significant depth or velocity during flood events, or are likely to affect an overland flow path, then a quantitative flood impact assessment will be prepared for the crossing to meet the requirements of mitigation measure FF1. If these requirements cannot be met, design changes for this crossing may be required. These changes will be discussed with the relevant authorities, where necessary.	Detailed design and construction
FF3	Flooding and water flows during construction	Flood Management Plans (FMPs) will be developed as part of the CSWMP for works within flood prone or flood affected land within the project area. Measures to be detailed in the FMPs to manage potential flood and water flow impacts will include: • the construction of the project will be staged to limit the extent and duration of temporary works in a floodplain; • work inside ephemeral watercourses including, but not limited to the Coxs Creek and other urban drainage network assets, will not be undertaken during or immediately following runoff generating rainfall events when stormwater flows in these watercourses are expected; and • flood emergency response procedures will be documented within the FMPs to make sure construction equipment and materials are removed from floodplain areas at the completion of each work activity or in the event a weather warning is issued for impending flood producing rain.	Construction
FF4	Camdenville Park flood detention basin	Design of the transmission cable route through Camdenville Park will consider the integrity and functionality of the existing flood detention basin.	Detailed design

8.0 Conclusion

This technical report has presented an assessment of potential impacts of the project during construction and operation on surface water. The assessment found that while the project has the potential to impact on the surface water environment as a result of construction activities, the implementation of management measures would reduce or manage these impacts to an appropriate level. The assessment also identified that operational impacts are primarily limited to above ground infrastructure, specifically cable bridges over waterways and within areas of flood risk. It is considered these impacts could be managed through detailed design and the preparation of a flood mitigation strategy for the Cooks River crossing.

8.1 Surface water

8.1.1 Water quality

Potential impacts on surface water quality during construction of the project are considered minor and manageable with the application of standard mitigation measures. There is anticipated to be negligible impacts on water quality during operation of the project.

The CEMP would include measures to control potential surface water quality impacts during construction. Industry standard pollution control measures would be applied during the construction phase to ensure runoff water is at a quality suitable for discharge to the environment or otherwise capture it for off-site disposal. These measures are documented in the *Managing Urban Stormwater* (Landcom, 2004).

A CSWMP would be prepared as part of the overall CEMP to outline the specific management and mitigation measures required to mitigate potential impacts on surface water quality during construction.

These plans would be prepared once the detailed design has been developed sufficiently, and the proposed construction staging and site layouts are known. Due to the nature of the construction of the transmission cable circuit (located generally within the road reserve where space is limited), these plans would need to consider factors influencing available space within the work site for the implementation of these surface water measures (in addition to other measures such as traffic management).

In the context of the entire catchment draining to the Cooks River, Sydney Harbour and the Georges River, the project is likely to have a negligible influence on achieving the water quality objectives with these measures in place.

8.1.2 Flooding

The risk of flooding as a result of the project has been assessed, including consideration of potential impacts that the project might have on surrounding properties during the construction as well as operational phases. The risk of exacerbating flooding impacts across the study area is considered negligible for the majority of the transmission cable route, given that infrastructure would be located below ground and the surface returned to its natural level at the end of construction. Consideration of potential flooding impacts therefore focused on above ground infrastructure and in particular those within high flood risk areas.

The transmission cable route crosses the Cooks River watercourse at Lindsay Street (Precinct 3), and a new cable bridge is proposed as a special crossing option. Although the concept design of the cable bridge crossing of the Cooks River is yet to be confirmed, a high level quantitative flood impact assessment was undertaken to support the design and verify the potential impacts. From this assessment, flood level impacts of up to 50 millimetres were noted in nearby areas. These impacts will require management through the flood mitigation strategy, and at this stage may require that the design approach be revised.

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