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New M5

Environmental Impact Statement

Technical working paper: Surface water

Appendix N

November 2015

WestConnex

WestConnex The New M5

Technical Working Paper - Surface Water

Client: Roads and Maritime Services

ABN: 76 236 371 088

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Glossary of terms and acronyms

Term	Meaning
Acid Sulfate Soils (ASS)	Naturally acid clays, mud and other sediments usually found in swamps and estuaries. They may become acidic when drained and exposed to oxygen and may produce acidic leachate run-off that can pollute waters and liberate toxins.
AEP	Annual exceedance probability. The probability of a rainfall or flood event exceeding a nominated level in a year. For example, a one per cent AEP is the probability of an event exceeding a nominated level in 100 years.
Afflux	An increase in water level resulting from obstacles in the flow path.
AHD	Australian Height Datum. The standard reference level used to express the relative height of various features. A height given in metres AHD is the height above sea level. Mean sea level is set as zero metres elevation.
Alluvial	Relating to, consisting of, or formed by sediment deposited by flowing water.
Alluvial material (alluvium)	Relatively recent deposits of sedimentary material within river / creek beds, floodplains, lakes or at the base of mountain slopes.
ANZECC	Australian and New Zealand Environment and Conservation Council.
Aquatic ecology	Flora and fauna that live in or on water for all or a substantial part of the life span (generally restricted to fresh / inland waters).
Aquifer	Underground layer of water-bearing permeable rock or unconsolidated material (such as gravel, sand, or silt) from which groundwater can be usefully extracted.
AR&R	Australian Rainfall & Runoff.
ARI	Average Recurrence Interval. Used to describe the frequency or probability of flood occurring. (eg a 100 year ARI flood is a flood that occurs or is exceeded on average once every 100 years (100:1)).
As	Arsenic
Batter	The constructed side slope of road embankments and cuttings usually expressed as a ratio of horizontal distance to a vertical height value of one e.g. 2H: 1V. A fill batter is where the road is above the existing surface on a filled embankment and refers to the sloping sides of the embankment. A cut batter is where the road is below the existing surface.
BBWQIP	Botany Bay Water Quality Improvement Program.
Bedrock	Rock of a substantial thickness and extent underlying a relatively soft and variable surface.
Biota	All organisms in a given area (including flora and fauna), considered as a unit.
BOD	Biological Oxygen Demand.
BoM	Bureau of Meteorology.
Box culvert	A culvert of rectangular cross section.
Bund	A small embankment designed to retain water.
Cd	Cadmium.
CEMP	Construction environmental management plan.
Chl-a	Chlorophyll-a.
CMA	Catchment Management Authority.
Confluence	A point at which streams combine.
Construction footprint	The area required to construct the project, including underground components, above ground components and temporary ancillary construction facilities.
Cr	Chromium.

Term	Meaning
CRSMP	Cooks River Stormwater Management Plan.
Cu	Copper.
Culvert	An enclosed channel for conveying water below a road.
Cumulative impacts	Impacts that, when considered together, have different and / or more substantial impacts than a single impact considered alone.
D&C	Design and Construction
DAF	Dissolved Air Floatation.
DEC	(NSW) Department of Environment and Conservation (now OEH and the EPA).
DECC	(NSW) Department of Environment and Climate Change (now OEH and EPA).
DECCW	(NSW) Department of Environment, Climate Change and Water (now OEH and the EPA).
Detailed design	The phase of the project following concept design where the design is refined, and plans, specifications and estimates are produced. These typically include two dimensional and three dimensional models.
Dewatering	The removal of water from solid material or soil by wet classification, centrifugation, filtration or similar solid-liquid separation processes.
Discharge	The volumetric rate of water flow.
DLWC	(NSW) Department of Land and Water Conservation (now part of DPI).
DO	Dissolved Oxygen.
DoP	(NSW) Department of Planning (now Department of Planning and Environment).
DP&E	(NSW) Department of Planning and Environment.
DP&I	(NSW) Department of Planning and Infrastructure (now Department of Planning and Environment).
DPI	(NSW) Department of Primary Industries.
DPI (Water)	(NSW) Department of Primary Industries (Water), formerly the NSW Office of Water
DPWS	(NSW) Department of Public Works and Services
Drainage	Natural or artificial means for the interception and removal of surface or subsurface water.
DRAINS	A stormwater drainage system design and analysis program for estimating water flows. It is a successor to the ILSAX program which has been widely used for urban stormwater system design and analysis.
Earthworks	All operations involved in loosening, excavating, placing, shaping and compacting soil or rock.
Eastern Portal	Land around the eastern end of the project, where the main alignment tunnels and on and off ramps connect with the surface, generally bounded by the Princes Highway, Campbell Road, Burrows Road and Canal Road with the actual location also to be determined during the design phase.
EC	Electrical Conductivity.
Ecosystem	A functional unit of energy transfer and nutrient cycling in a given place. It includes all relationships within the biotic community and between the biotic components of the system.
EIS	Environmental Impact Statement.
Embankment	An earthen structure where the road (or other infrastructure) subgrade level is above the natural surface.
Environmental assessment (process)	A specialised part of the decision-making process, where the environmental impact of a development or proposal or activity is considered in detail, together with other aspects of the development.

Term	Meaning
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW).
EP&A Regulation	Environmental Planning and Assessment Regulation 2000 (NSW).
EPA	(NSW) Environment Protection Authority.
EPBC Act	(Commonwealth) Environment Protection and Biodiversity Conservation Act 1999.
Ephemeral creek	A creek that only exists for a short duration of time following rainfall.
EPL	Environment Protection Licence under the (NSW) Protection of the Environment Operations Act 1997.
Erosion	A natural process where wind or water detaches a soil particle and provides energy to move the particle.
ESCP	Erosion and Sedimentation Control Plan.
Fill	The material placed in an embankment.
Flood Immunity	Relates to the level at which a particular structure would be clear of a certain flood event.
FM Act	(NSW) Fisheries Management Act 1994.
Footprint	The extent of direct impact that a development makes on the land.
FRP	Filterable Reactive Phosphorus.
Geomorphology	The study of shaping of the landscape by water, wind and other processes. Commonly used to describe the condition of streams as they are shaped by erosion and / or accretion of sediments.
GIS	Geographical Information System.
GPT	Gross pollutant trap.
Grade	Rate of longitudinal rise (or fall) with respect to the horizontal expressed as a percentage or ratio.
Groundwater	Water that is held in the rocks and soil beneath the earth's surface.
GWTP	Groundwater treatment plant.
ha	Hectare(s).
Habitat	The place where a species, population or ecological community lives (whether permanently, periodically or occasionally). Habitats are measurable and can be described by their flora and physical components.
HEC-RAS	A computer program that models the hydraulics of water flow through natural rivers and other channels. The program is one-dimensional, meaning that there is no direct modelling of the hydraulic effect of cross section shape changes, bends, and other two- and three-dimensional aspects of flow.
Hydrology	The study of rainfall and surface water runoff processes.
ID	Insufficient Data.
IFD	Intensity-Frequency-Duration.
IPCC	Intergovernmental Panel on Climate Change.
LGA	Local Government Area.
LiDAR	Light Detection and Ranging.
LLS	Local Land Services.
MHL	Manly Hydraulics Laboratory.
MUSIC	Model for Urban Stormwater Improvement Conceptualisation – predicts the performance of stormwater quality management systems. It is intended to help organisations plan and

Term	Meaning
	design (at a conceptual level) appropriate urban stormwater management systems for their catchment.
Ni	Nickel.
NOW	NSW Office of Water, now DPI (Water).
NOx	Oxides of nitrogen.
NSW	New South Wales.
OEH	(NSW) Office of Environment and Heritage.
Operation footprint	The area required to accommodate the permanent features of the project, including underground components, above ground components and ancillary facilities associated with motorway operations.
Pavement	The portion of a carriageway placed above the subgrade for the support of, and to form a running surface for vehicular traffic.
Pb	Lead.
pH	A measure of acidity or alkalinity of a solution, numerically equal to 7 for neutral solution, increasing with increasing alkalinity and decreasing with increasing acidity.
PMF	Probable Maximum Flood.
Pollutant	Any measured concentration of solid or liquid matter that is not naturally present in the environment.
Portal	Where a tunnel emerges to the surface, being the entrance or exit of the main alignment tunnels, off-ramps or on-ramps.
PPK	PPK Environment and Infrastructure Services.
(The) project	The WestConnex New M5 project.
Project corridor	Forms the basis for the assessment within this document.
Proprietary stormwater treatment device	Pre-fabricated device designed for removal of pollutants from stormwater. These are usually installed underground and connected to the pipe drainage network.
RCBC	Reinforced concrete box culvert.
RCC	Rockdale City Council.
Remnant native vegetation	Small patches of native vegetation that remain after land use changes to the surrounding area.
RESA	Runway End Safety Area.
Revegetation	To revegetate an area by direct seeding with non-native species or cover crops and / or native species using manual or mechanical means such as hydromulching, straw mulching and tractor seeding.
Riffle	A rocky or shallow part of a waterway where the water flows brokenly.
Riparian	The part of the landscape adjoining rivers and streams that has a direct influence on the water and aquatic ecosystems within them.
Runoff	The part of the rainfall on a catchment which flows as surface discharge past a specified point.
Scour	The erosion of material by the action of flowing water.
SEARs	Secretary's Environmental Assessment Requirements. Requirements and specifications for an environmental assessment prepared by the Secretary for the Department of Planning and Environment under section 75F of the *Environmental Planning and Assessment Act 1979*.

Term	Meaning
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.
Sedimentation	Deposition of sediment usually by water.
Sedimentation basins	A stormwater detention system that promotes the settling of sediments trough the reduction of flow velocities and temporary detention. Key elements include purpose designed inlet and outlet structures, settling pond and high flow, overflow structures.
Shotcrete	Concrete applied to a surface through a pressure hose.
SMCMA	Sydney Metropolitan Catchment Management Authority.
SMP	Spoil Management Plan
St Peters interchange	Would initially provide road connections from the new tunnels to Campbell Road and Euston Road, St Peters and Gardeners Road, Mascot
Stockpile	Temporarily stored materials such as soil, sand, gravel and spoil / waste.
Strahler stream ordering process	A stream classification system where waterways are given an 'order' according to the number of additional tributaries associated with each waterway. This is used as a measure of system complexity and therefore the potential for fish habitat to be present. Flow paths at the top of a catchment are assigned the number one.
Stratum	A layer of rock in the ground.
Surface road widening works	Located between the M5 East Motorway, east of King Georges Road and the new tunnel portals.
Surface water	Water flowing or held in streams, rivers and other wetlands in the Landscape.
Swale	A shallow, grass-lined drainage channel.
SWMP	Stormwater Management Plan.
SWSOOS	South Western Suburbs Ocean Outfall System.
Terrestrial	Living or growing on land (i.e. terrestrial flora or fauna).
Thalweg	The lowest point along the length of a stream bed.
Threatened	As defined under the *Threatened Species Conservation Act 1994*, a species, population or ecological community that is likely to become extinct or is in immediate danger of extinction.
TKN	Total Kjeldahl Nitrogen.
TN	Total Nitrogen.
Training walls	Artificial embankments or walls used to direct the course of a waterway.
TP	Total Phosphorus.
Transverse Drainage	Existing drainage lines (typically) that cross linear infrastructure such as roads. Synonym: cross drainage
Tributary	A river or stream flowing into a larger river or lake.
TSS	Total Suspended Solids.
TUFLOW	A 1D / 2D finite difference numerical model that simulates hydrodynamic behaviour in rivers, floodplain and urban drainage environments.
TURB	Turbidity.
Turbidity	A measure of light penetration through a water column containing particles of matter in suspension.
UoQ	University of Queensland.
Urban design	The process and product of designing human settlements, and their supporting infrastructure, in urban and rural environments.

Term	Meaning
Waterway	Any flowing stream of water, whether natural or artificially regulated (not necessarily permanent).
WBNM	A flood hydrograph model that calculates flood runoff from rainfall hyetographs.
WDA	WestConnex Delivery Authority. On 1 October 2015, the transfer of the project delivery functions of WDA to Sydney Motorway Corporation (SMC) was finalised, forming a single decision-making entity to finance and deliver the WestConnex program of works.
Western Portal	Land around the western end of the project, where the main alignment tunnels and on and off ramps connect with the surface. Located east of King Georges Road and west of Bexley Road.
Wetland	Wetlands are areas of land that are wet by surface water or groundwater, or both, for long enough periods that the plants and animals in them are adapted to, and depend on, moist conditions for at least part of their lifecycle. They include areas that are inundated cyclically, intermittently or permanently with fresh, brackish or saline water, which is generally still or slow moving except in distributary channels such as tidal creeks which may have higher peak flows. Wetlands may be constructed for the purposes of removing pollutants from runoff.
WQIP	Water Quality Improvement Plan.
WSUD	Water sensitive urban design.
WTP	Water treatment plant.
XP-RAFTS	A runoff routing model that is used for hydrologic and hydraulic analysis of stormwater drainage and conveyance systems.
Zn	Zinc.
µS/cm	Microsiemens per centimetre (a measure of electrical conductivity).

Executive summary

NSW Roads and Maritime Services (Roads and Maritime) is seeking approval to construct and operate the New M5 (the project), which would comprise a new, tolled multi-lane road link between the existing M5 East Motorway, east of King Georges Road, and St Peters. The project would also include an interchange at St Peters and connections to the existing road network.

This technical working paper presents the assessment of the potential impacts of the project during construction and operation on surface water, including localised flooding and drainage, water quality and geomorphology. This technical working paper also assesses mainstream flooding impacts during construction. An assessment of mainstream flooding impacts during operation is presented in Technical Working Paper: Flooding (Lyall and Associates, 2015).

The project is located within the Cooks River catchment and the sub-catchments of Alexandra Canal, Wolli Creek, Eastern Channel, all of which are located within the greater Botany Bay catchment. The catchments are highly urbanised and extensively altered. The water quality in the three main watercourses (Wolli Creek, Cooks River and Alexandra Canal) has been found to representative of the water quality expected in highly urbanised catchments.

Construction

During construction, the potential impacts on surface water would be associated with:

- Erosion of soils, sedimentation of waterways and exposure of contaminated soils and Acid sulfate soils (ASS)
- Accidental leaks or spills of chemicals, fuels and oils from construction plant
- Direct disturbance of waterway beds and riparian areas, or increase scour due to increased discharge flows and volumes
- Discharge of treated water to waterways during construction, which could have an impact on water quality and/or geomorphology of receiving waterways.

The potential impacts on surface water quality during construction of the project are considered minor and manageable with the application of standard mitigation measures. The Construction Environmental Management Plan (CEMP) would control potential surface water quality impacts during construction. Construction water treatment plants would be established during the construction phase to treat water to a quality that would comply with ANZECC Water Quality Guidelines (ANZECC, 2000) – trigger values derived from a local reference data set.

Discharges of treated construction water would not have an impact the geomorphology of those waterways for due to the location of discharge and the relatively low level of discharges compared to existing flows. Specific localised mitigation measures are proposed where outlet scour protection and energy dissipation is required prior to releasing water into local creeks / waterways.

A qualitative construction phase flooding impact assessment was made based on proposed locations of surface works and activities. Potential mainstream flooding impacts are generally minor in nature and readily mitigated by adjusting specific aspects of the compound designs and site planning to better suit identified flooding conditions and avoid the potential for off-site flooding impacts.

All construction works would also have the potential to impact local overland flows and existing minor drainage paths. These would require consideration during future detailed design and construction planning, along with mitigation measures.

Operation

Operation of the project has the potential to impact surface water quality due to increased runoff and associated pollutant loads from roads. This could be caused by increases in impervious surfaces, spills or leaks of fuels and / or oils from vehicle accidents, or from operational plant and equipment, discharges of treated groundwater and other waste waters (such as tunnel wash or deluge system water).

Operational water treatment would be designed with consideration to the pollutant reduction targets of the Botany Bay and Catchment Water Quality Improvement Plan (SMCMA, 2011). The pollutant loads associated with increases in imperviousness would be managed through a range of stormwater treatment measures such as

gross pollutant traps, constructed wetlands, bioretention systems, water quality basins and proprietary treatment devices. These would designed with consideration to the pollutant reduction targets of the Botany Bay and Catchment Water Quality Improvement Plan (SMCMA, 2011).

Current provisions are sufficient to meet the treatment targets for most catchments, and stormwater treatment in some catchments exceeds the treatment requirements, such that the project overall would result in less pollutants being delivered to Botany Bay. The final design would be would be confirmed during detailed design.

New stormwater outlets would be built to discharge into Alexandra Canal. These have the potential to scour the in-situ contaminated sediments, leading to poor water quality. Stormwater drainage discharge at the canal would be designed with sufficient energy dissipation or scour protection to minimise the potential for scour and suspension of sediments.

A water treatment plant would be permanently established at the Arncliffe motorway operations complex to treat groundwater inflows into the tunnels as well as discharges collected via the tunnel drainage system and sump. Treated water would be discharged at a rate of up to 20 litres per second into the Cooks River downstream from Marsh Street Bridge. The requirements for quality of the water produced by the treatment plant would be the same as for the construction phase, which would ensure that the project would not have an impact on existing water quality. Discharge volumes would also result in an insignificant increase in baseflows and as such, impacts to geomorphology are unlikely.

Conclusion

Construction and operation of the project has the potential to impact on surface water features (waterways, drainage channels and Botany Bay) as a result of altered hydrology and soil management within the catchment, as well as the discharge of treated groundwater. The implementation of mitigation measures would reduce or address these impacts to a level such that conditions are no worse than the existing situation.

1.0 Introduction

NSW Roads and Maritime Services (Roads and Maritime) is seeking approval to construct and operate the New M5 (the project), which would comprise a new, tolled multi-lane road link between the existing M5 East Motorway, east of King Georges Road, and St Peters. The project would also include an interchange at St Peters and connections to the existing road network. The project is shown in Figure 1.

Approval is being sought under Part 5.1 of the Environmental Planning and Assessment Act 1979 (EP&A Act). The project is declared to be State significant infrastructure (SSI) under section 115U(2) of the EP&A Act by reason of the operation of clause 14 and Schedule 3 of the *State Environmental Planning Policy (State and Regional Development) 2011*. Accordingly, the project is subject to assessment under Part 5.1 of the EP&A Act and requires the approval of the Minister for Planning. An environmental impact statement (EIS) is therefore also required.

Roads and Maritime is seeking the project to be declared by the Minister for Planning as State significant infrastructure and critical State significant infrastructure under sections 115U(4) and 115V of the EP&A Act.

On 11 August 2015, the Commonwealth Minister for the Environment determined that the project has the potential to significantly impact on a matter of national environmental significance and is therefore a 'controlled action'. This means that approval of the project will be required from the Commonwealth Minister for the Environment in addition to environmental and planning approvals required under State legislation.

Under the Bilateral Agreement relating to environmental assessment (February 2015) between the Commonwealth Government and the NSW Government, this EIS has been adopted for the purpose of meeting the assessment requirements of both the Commonwealth EPBC Act and the NSW EP&A Act.

This technical working paper provides a surface water impact assessment of the project, specifically in relation to impacts during construction and operation on localised flooding and drainage, water quality and geomorphology.

This report also assesses mainstream flooding impacts during construction. The assessment of mainstream flooding impacts during operation is presented in the Technical Working Paper: Flooding (Lyall and Associates, 2015).

1.1 Overview of WestConnex

WestConnex is a 33 kilometre motorway that is intended to link Sydney's west with the airport and the Port Botany precinct. The component projects of the WestConnex program of works are:

- M4 Widening – Pitt Street, Parramatta to Homebush Bay Drive, Homebush (planning approval granted on 21 December 2014 and under construction)
- M4 East – Homebush Bay Drive, Homebush to Parramatta Road and City West Link (Wattle Street) at Haberfield (planning application lodged and subject to planning approval)
- New M5 – (the subject of this EIS)
- King Georges Road Interchange Upgrade (planning approval granted on 3 March 2015 and under construction)
- M4-M5 Link – Haberfield to St Peters (undergoing concept development and subject to planning approval)
- Sydney Gateway (is the subject of further investigations by the NSW Government and would be subject to separate planning approval).

Separate planning applications have or will be lodged for each component project. Each project will be assessed separately, but the impact of each project will also be considered in the context of the wider WestConnex program of works.

A proposed Southern extension from Arncliffe to Kogarah is currently being investigated by the NSW Government, and would connect the New M5 to the southern and bayside suburbs of Sydney, and the proposed F6 motorway.

The WestConnex Delivery Authority (WDA) was established by the NSW Government to manage the delivery of the WestConnex series of projects for Roads and Maritime on behalf of the State. The WDA was a public subsidiary corporation of the Roads and Maritime. Following the achievement of early milestones for the

WestConnex program of works, the NSW Government took the opportunity to evolve this early governance model.

On 1 October 2015 the transfer of the project delivery functions of WDA to Sydney Motorway Corporation (SMC) was finalised, forming a single decision-making entity to finance and deliver the WestConnex program of works. SMC is a private corporation, the shareholders of which are the Minister for Roads, Maritime and Freight and the Treasurer, with a majority independent board of nine directors.

Roads and Maritime is the Government client agency for the WestConnex program of works. In that capacity Roads and Maritime will enter into contractual arrangements with SMC subsidiary entities which will design, build, own and operate the motorway on behalf of Roads and Maritime. Roads and Maritime and SMC are working together to manage the planning approval process for the project. However, for the purpose of the planning application for the project, Roads and Maritime is the proponent.

1.2 Overview of the project

Key components of the project would include:

- Twin motorway tunnels between the existing M5 East Motorway (between King Georges Road and Bexley Road) and St Peters. The western portals along the M5 East Motorway would be located east of King Georges Road, and the eastern portals at St Peters would be located in the vicinity of the Princes Highway and Canal Road. Each tunnel would be about nine kilometres in length and would be configured as follows:
    - Between the western portals and Arncliffe, the tunnels would be built to be three lanes but marked for two lanes as part of the project. Any change from two lanes to three lanes would be subject to future environmental assessment and approval
    - Between the Arncliffe and St Peters, the tunnels would be built to be five lanes but marked for two lanes as part of the project. Any change from two lanes to any of three, four or five lanes would be subject to future environmental assessment and approval
- The western portals along the M5 East Motorway would be located east of King Georges Road, and the eastern portals at St Peters would be located in the vicinity of the Princes Highway and Canal Road
- Tunnel stubs to allow for a potential future connection to the future M4-M5 Link and a potential future connection to southern Sydney
- Surface road widening works along the M5 East Motorway between east of King Georges Road and the new tunnel portals
- A new road interchange at St Peters, which would initially provide road connections from the main alignment tunnels to Campbell Road and Euston Road, St Peters
- Two new road bridges across Alexandra Canal which would connect St Peters interchange with Gardeners Road and Bourke Road, Mascot
- Closure and remediation of the Alexandria Landfill site, to enable the construction and operation of the new St Peters interchange
- Works to enhance and upgrade local roads near the St Peters interchange
- Ancillary infrastructure and operational facilities for electronic tolling, signage (including electronic signage), ventilation structures and systems, fire and life safety systems, and emergency evacuation and smoke extraction infrastructure
- A motorway control centre that would include operation and maintenance facilities
- New service utilities and modifications to existing service utilities
- Temporary construction facilities and temporary works to facilitate the construction of the project
- Infrastructure to introduce tolling on the existing M5 East Motorway
- Surface road upgrade works within the corridor of the M5 East Motorway.

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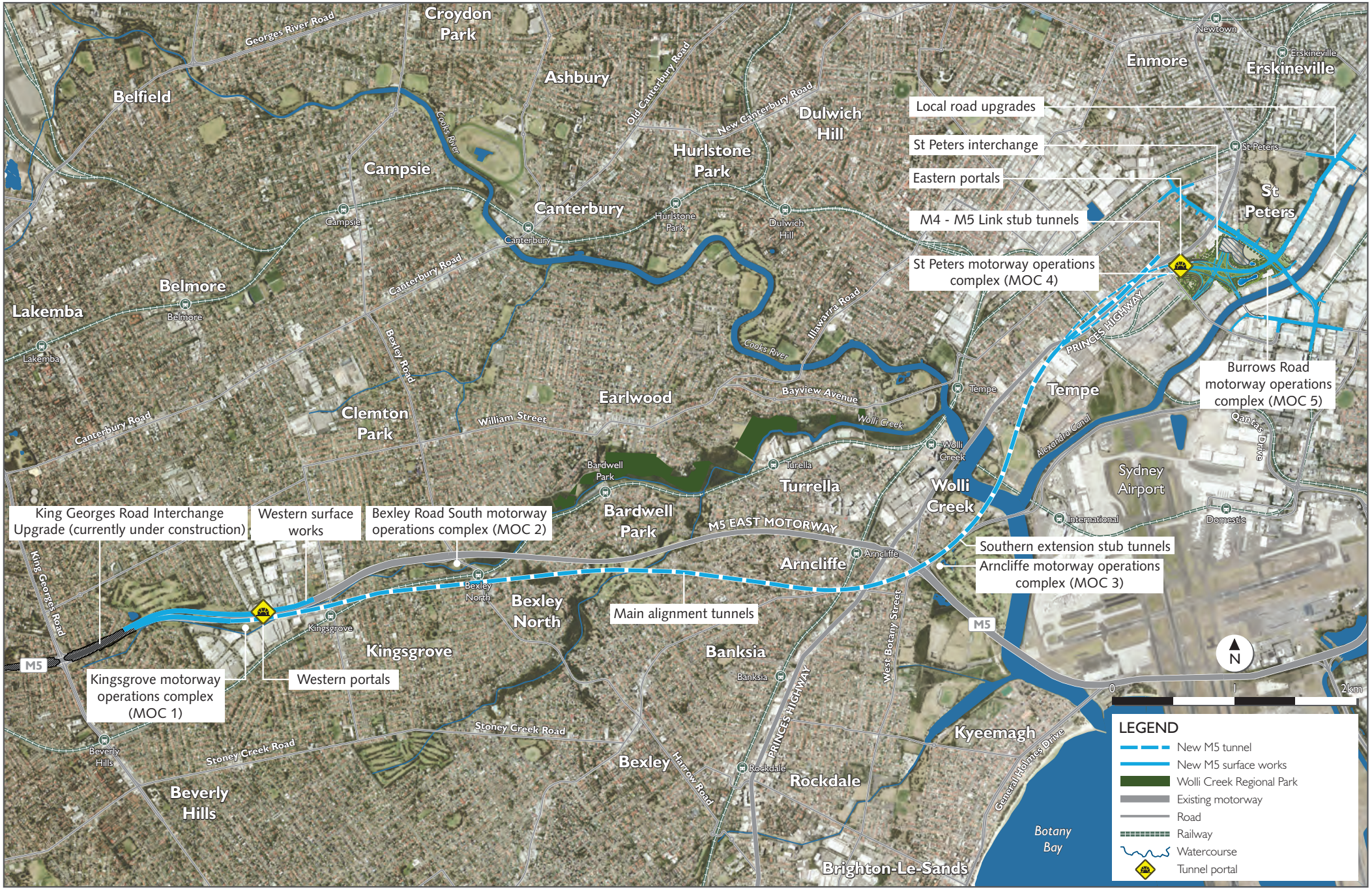

Figure 1 The project

Construction activities associated with the project would generally include:

- Commencement of enabling and temporary works, including construction power, water supply, ancillary site establishment, demolition works, property and utility adjustments and public transport modifications (if required)
- Construction of the road tunnels, interchanges, intersections and roadside infrastructure
- Haulage of spoil generated during tunnelling and excavation activities
- Fitout of the road tunnels and support infrastructure, including ventilation and emergency response systems
- Construction and fitout of the motorway control centre and ancillary operations buildings
- Upgrades to surface roads and construction of bridges
- Implementation of environmental management and pollution control facilities for the project.

Subject to the project obtaining environmental planning approval, construction of the project is anticipated to commence around mid-2016 and is expected to take around three years to complete.

The M5 Motorway corridor (the M5 East Motorway and the M5 South West Motorway) is the main passenger, commercial and freight corridor between Port Botany, Sydney Airport and south-west Sydney. Traffic demands on the M5 East Motorway currently exceed the design capacity of the roadway, and as a result, present a significant bottleneck to the M5 Motorway corridor with motorists experiencing heavy congestion and unreliable journey times. The project is needed to provide additional capacity along the M5 Motorway corridor, and would allow for a more robust and reliable transport network

1.3 Project location

The project would be located within the Canterbury, Hurstville, Rockdale, Marrickville, Sydney and Botany Bay local government areas. The project corridor is located from about five to twenty kilometres to the south and south-west of the central business district of Sydney. The project would traverse the suburbs of Beverly Hills, Kingsgrove, Bexley North, Earlwood, Bardwell Park, Bardwell Valley, Arncliffe, Wolli Creek, Tempe, Sydenham, St Peters, Alexandria and Mascot.

1.4 Secretary's Environmental Assessment Requirements (SEARs)

In preparing this Technical Working Paper: Surface water, the Secretary's Environmental Assessment Requirements (SEARs) issued for the New M5 Project on 5 March 2015, and re-issued on 26 August 2015 have been addressed. The key matters raised by the Secretary for consideration in the Technical Working Paper: Surface Water and where this report addresses the SEARs are outlined in Table 1.

Table 1 SEARs applicable to the Technical Report: Surface Water

Secretary's Environmental Assessment Requirements		Section addressed
Direct requirements		
Soil, water and hydrology	An assessment of construction and operational erosion and sediment and water quality discharge impacts, taking into account impacts from treated discharge, accidents and runoff (i.e. acute and chronic impacts), having consideration to impacts to surface water runoff, soil erosion and sediment transport, mass movement, salinity and iron levels. The assessment must include identification and estimation of the quality and quantity of pollutants that may be introduced into any waterways by source and discharge point;	For construction, refer to Section 6.2.2 For operational impacts refer to Section 7.2.2
	An assessment of water quality impacts on receiving waterways likely to be affected by the proposal (including Wolli, Cup and Saucer Creeks, Cooks River and Alexandra Canal). The assessment must include existing water quality, geomorphology, riparian vegetation and rehabilitation of riparian land, and have reference to the NSW Water Quality Objectives and relevant public health and environmental water quality trigger values and criteria, including those specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000), any applicable regional, local or site-specific guidelines and any licensing requirements.	For construction, refer to Section 6.2.2 For operation, refer to Section 7.2.2
	An assessment of groundwater impacts (including ancillary facilities such as the tunnel control centre and any deluge systems), considering local impacts along the length of the tunnels and impacts on local and regional hydrology including consideration of any Water Sharing Plan and impacts on groundwater flow. The assessment must consider: extent of drawdown; impacts to groundwater quality; volume of groundwater that will be taken (including inflows); discharge requirements; location and details of groundwater management and implications for groundwater-dependent surface flows, groundwater-dependent ecological communities, and groundwater users. The assessment must include details of proposed surface and groundwater monitoring and be prepared having consideration to the requirements of the NSW Aquifer Interference Policy;	For construction, refer to Section 6.2.2 and 6.4 For operation, refer to Section 6.4 and Section 7.4 For groundwater impacts, refer to Technical Working Paper: Groundwater (AECOM, 2015)
	Identification of potential impacts of the proposal on existing flood regimes, consistent with the Floodplain Development Manual (NSW Government, 2005), including impacts to existing receivers and infrastructure and the future flood mitigation options for and development potential of affected land, demonstrating consideration of the changes to rainfall frequency and / or intensity as a result of climate change on the proposal. The assessment must demonstrate due consideration of flood risks during construction and in the proposal design.	For construction, refer to Section 6.2 For operation, refer to Technical Working Paper: Flooding (Lyall and Associates, 2015)
	Identifying potential impacts of the development on acid sulfate soils in accordance with the relevant guidelines and a description of the mitigation measures proposed to minimise potential impacts.	Technical Working Paper: Contamination (AECOM, 2015)
Links with requirements directly dealt elsewhere within the EIS		
Biodiversity	An assessment of the potential ecological impacts of the proposal, with specific reference to vegetation and habitat clearing, connectivity, edge effects, weed dispersal, riparian and aquatic habitat impacts, soil and water quality impacts and operational impacts.	Technical Working Paper : Biodiversity (Eco Logical Australia, 2015)

Secretary's Environmental Assessment Requirements		Section addressed
	Where there are potential impacts to the OEH estate reserved under the *National Parks and Wildlife Act 1974* or where the proposal is located upstream of OEH estate, an assessment of the matters to be considered outlined in the *Guidelines for Developments Adjoining Land and Water Managed by DECCW* (DECCW, 2010).	Technical Working Paper : Biodiversity (Eco Logical Australia, 2015) Chapter 13 (Land Use and property) of the EIS
Land use, social and economic	Potential impacts on utilities (including communications, electricity, gas, and water and sewerage) and the relocation of these utilities.	Chapter 13 (Land Use and property) of the EIS
Contaminated sites	An assessment of the potential disturbance of contaminated bed sediments in the Alexandra Canal, and interception of contaminated water from the Botany Sand Beds aquifer.	Technical Working Paper: Contamination (AECOM, 2015) and Technical Working Paper: Groundwater (AECOM, 2015)

This technical working paper describes the physical environment within the study area in relation to surface water, including details of the existing catchments, watercourses, sensitive receiving environments, drainage, and flooding. It identifies and assesses the potential surface water impacts related to the construction and operation of the project, including impacts to hydrology, water quality and geomorphology. This technical working paper also details the extent of impacts on surface water features associated with the discharge of treated groundwater to waterways.

Guided by the SEARs, the key objectives of the surface water assessment were to:

- Identify potential impacts on flooding (during construction), surface water flows, water quality, geomorphology, riparian vegetation and rehabilitation of riparian land associated with construction and operation of the project, with reference to relevant guidelines *NSW Water Quality and River Flow Objectives* (DECCW, 2006).
- Identify environmental management measures that would be required to manage the identified impacts.
- Inform the future detailed design of the project with respect to surface water flows and quality.

1.5 Study area

The interaction of the project with the surface water environment would include use, treatment and discharge of water (including increased runoff from road surfaces and the discharge of groundwater inflows) and activities within various catchments and subcatchments.

All project activities, including surface water discharges, would lie within the Cooks River catchment. Tributary catchments (known as sub-catchments) of the Cooks River within the surface water study area include Wolli Creek, Alexandra Canal and Eastern Channel catchments as shown on Figure 3 and Figure 4.

The study area was determined based on the location of the surface construction and operational footprints for the project as well as areas where potential impacts could occur as a result of construction or operation of the project. The following catchments and subcatchments are identified across the project area:

- Wolli Creek – from upstream of the project boundary, near King Georges Road, to its confluence with the Cooks River. The parts of the project within this catchment is the western portals, widened and connecting roads between the portals and King Georges Road Interchange, and supporting ventilation facilities
- Cooks River – from the Bayview Avenue Bridge, Tempe to Botany Bay. This bridge is around 1.5 kilometres upstream of the Arncliffe surface works (within Kogarah Golf Course) and there would be no impact on the water quality, geomorphology or hydrology upstream of this point. The entire project lies within this catchment
- Alexandra Canal – The parts of the project within this catchment include a portion of the Local Road Upgrades and the St Peters interchange
- Eastern Channel – The parts of the project within this catchment include a portion of the Local Road Upgrade.

The SEARs included a requirement to assess the potential impacts on Cup and Saucer Creek, which is within the Cooks River catchment. The study area excludes Cup and Saucer Creek as the project would not discharge to Cup and Saucer Creek and would not have any impacts on its hydrology, water quality or geomorphology.

1.6 Report structure

This technical working paper is structured as follows:

- **Chapter 1** – Introduction. This chapter outlines the project and presents the purpose of this report.
- **Chapter 2** – Statutory and policy context. This chapter lists the various governing publication that guide surface water impact for the project.
- **Chapter 3** – Methodology. This chapter describes the methodology employed for the Technical Working Paper – Surface water impact assessment.
- **Chapter 4** – Existing environment. This chapter describes the surface water study area and its existing surface water conditions.
- **Chapter 5** – The project. This chapter provides a summary of potential impacts the project could have on the surface water environment.
- **Chapter 6** – Impact assessment (construction). This chapter describes the potential impacts to surface water resulting from the project.
- **Chapter 7** – Impact assessment (operation). This chapter describes the potential impacts to surface water resulting from the project.
- **Chapter 8** – Mitigation and management. This chapter provides a summary of environmental mitigation, management and monitoring responsibilities in relation surface water management for the project.
- **Chapter 9** – Conclusion.
- **Chapter 10** – References.
- **Appendix A** – Water quality reference criteria.
- **Appendix B** – Water quality monitoring program.

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2.0 Statutory and policy context

This chapter details the key policies and guidelines applicable to surface water management in NSW which have been considered in this assessment.

2.1 Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARNCANZ, 2000)

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARNCANZ, 2000), (commonly referred to as the 'ANZECC Water Quality Guidelines') form part of the National Water Quality Management Strategy and list a range of environmental values for water bodies. Different water quality criteria are set for the water bodies based on environmental values assigned to that water body. These values include consideration as to whether the water is to be used for drinking, recreation or according to ecological values. The ANZECC Water Quality Guidelines provide water quality criteria (scientifically-based benchmark values) for a wide range of parameters for each of these values. The ANZECC Water Quality Guidelines state that "*The Guidelines are not intended to be used as mandatory standards because there is significant uncertainty associated with the derivation and application of water quality guidelines*" (Chapter 1: Introduction). However the guidelines provide a useful measure of risks to aquatic ecosystem health.

The ANZECC Water Quality Guidelines are ambient water quality guidelines, appropriate for the assessment of the existing water quality of watercourses in proximity to the project as discussed in Section 7.2.3. The ANZECC Water Quality Guidelines criteria would also be used in future monitoring of ambient conditions (baseflow) of the downstream waterways to identify appropriate criteria for the ongoing compliance.

2.2 NSW Water Quality and River Flow Objectives

The *NSW Water Quality and River Flow Objectives* (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).

The *NSW Water Quality and River Flow Objectives* have been developed for the Cooks River catchment. The water quality and river flow objectives that were determined are shown in Table 2.

Table 2 NSW water quality and river flow objectives

Objective	Where covered in this paper
Water quality objectives	
Protect aquatic ecosystems	Technical Working Paper : Biodiversity (Ecological Australia, 2015)
Protect visual amenity	Section 7.3
Protect irrigation water supply	n/a – no agriculture in surface water study area
River flow objectives	
Maintain natural flow variability	Section 7.2
Maintain natural rates of change in water levels	Section 7.2
Minimise effects of weirs and other structures	Section 7.2

2.3 Managing Urban Stormwater – Soils and Construction

The Managing Urban Stormwater (MUS) – 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 MUS 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) (commonly known as The Blue Book 1) and Volume 2D, Main Road Construction (DECC, 2008) (commonly known as The Blue Book 2).

2.4 Managing Urban Stormwater – Environmental Targets

Stormwater pollution control targets have been set by the NSW Government in the draft document *Managing Urban Stormwater: Environmental Targets* (Consultation Draft, 2007). These targets are applicable to the operational phase of the project. They were developed to support the protection of waterways through the NSW Water Quality and River Flow Objectives, and are recommended to be adopted by consent authorities such as councils for medium-large scale developments.

This document acknowledges that "*cost-effective stormwater treatment*" is usually insufficient to prevent impacts to the environment, but recommends that the following targets are the minimum requirements for developments to minimise impacts on the environmental values of water. These targets require pollutant reductions for Total Suspended Solids – 85 per cent, Total Phosphorus – 65 per cent, and Total Nitrogen – 45 per cent (Managing Urban Stormwater: Environmental Targets (DECC, 2007)).

2.5 Botany Bay and Catchment Water Quality Improvement Plan

Sydney Metropolitan Catchment Management Authority's (SMCMA) *Botany Bay and Catchment Water Quality Improvement Plan* (SMCMA, 2011) is a contemporary plan designed specifically for 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 study area.

The main objective of the Botany Bay and Catchment Water Quality Improvement Plan was 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 Botany Bay Water Quality Improvement Program (BBWQIP) to provide direction for future land use and water quality management decisions in the Botany Bay catchment.

The plan was aimed at Local, State and Federal Government agencies. A primary objective of the *Botany Bay and Catchment Water Quality Improvement Plan* (SMCMA, 2011) is to establish stormwater pollution reduction targets for all new development and re-development within the Botany Bay catchment to protect the condition of the bay, its estuaries and waterways. These pollutant reduction targets are shown in Table 3. The targets for large redevelopments have been applied to the project.

Table 3 Stormwater reduction targets recommended for urban development in the Botany Bay catchments

Stormwater pollutant	Reduction target	
	Greenfield developments large re-developments	Multi-unit dwellings, commercial developments, industrial developments and small re-developments
Gross pollutants	90%	90%
Total suspended solids (TSS)	85%	80%
Total phosphorus (TP)	60%	55%
Total Nitrogen (TN)	45%	40%

2.6 Floodplain Development Manual

The Floodplain Development Manual (NSW Government, 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 and to reduce public and private losses resulting from floods, whilst also recognising the benefits of use, occupation and development of flood prone land.

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, and promotes strategic consideration of key issues including safety to people, management of potential damage to property and infrastructure, and management of cumulative impacts of development. 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.

2.7 Floodplain Risk Management Guideline – Practical Considerations of Climate Change

Climate change is expected to impact sea levels and rainfall intensities, both of which may have significant influence on flood behaviour at specific locations. IPCC 2007 trends indicate that average global sea level rise (not including ice flow melt) may be between 0.18 to 0.59 metres by between 2090 and 2100. Adding to this the ice flow melt uncertainty of up to 0.2 metres gives an adjusted global range of 0.18 to 0.79 metres. IPCC 2007 and recent CSIRO modelling (see for example McInnes et al 2007) indicate that mean sea levels along the NSW coast are expected to rise by more than the global mean.

Combining the relevant global and local information indicates that sea level rise on the NSW coast is expected to be in the range of 0.18 to 0.91 metres by between 2090 and 2100. In addition, climate change impacts on flood producing rainfall events show a trend towards more intense storms, at least for larger scale events (DECC, 2007).

The Cooks River, Alexandra Canal, the Eastern Channel and Wolli Creek are all tidal. Therefore, for these areas climate change in terms of potential sea level rise is a relevant consideration. DECC (2007) recommended sensitivity analyses be undertaken to assess the potential impact of sea level rise in the range 0.18 to 0.91 metres, dependent on the relevant project time horizon. These recommendations are still widely applied in NSW for urban and infrastructure planning purposes in the absence of any formal state-wide sea level rise planning benchmarks. They have been considered as part of technical investigations that have informed development of the project.

2.8 Other policies and guidelines

Other polices and guidelines that apply to the project include:

- *Water Act 1912*
- *NSW Water Management Act 2000*
- *Fisheries Management Act 1994*
- *NSW Protection of the Environment Operations Act 1997*
- *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* (EPA, 1981)
- *Australian Rainfall and Runoff* (Institute of Engineers Australia, 1987; AR&R).

Relevant policies and guidelines of Roads and Maritime that also apply to the project include:

- *Water Policy* (RTA, 1997)
- *Code of Practice for Water Management - Road Development and Management* (RTA, 1999)
- *Stockpile Site Management Procedures* (RTA, 2001)
- *Erosion and Sediment Management Procedure* (RMS, 2008)
- *Technical Guideline: Temporary Stormwater Drainage for Road Construction* (RMS, 2011)
- *Procedures for Selecting Treatment Strategies to Control Road Runoff* (RTA, 2003).

Relevant Austroads guidelines that apply to the project include:

- *AP-R180 Road Runoff and Drainage: Environmental Impacts and Management Options* (Austroads, 2011)
- *AP-R232 Guidelines for Treatment of Stormwater Runoff from the Road Infrastructure* (Austroads, 2003)
- *Guide to Road Design, Part 5: Drainage Design* (Austroads, 2013).

3.0 Methodology

This chapter details the methodology applied in this assessment, which involved:

- Characterisation of the existing environment and potential surface water issues through review and analysis of existing information (desktop analysis)
- A field inspection to confirm the outcomes of the desktop analysis, and further refine the scope or relevant issues to be considered in the surface water impact assessment
- Assessment of specific surface water issues, including flooding (construction only), surface water quality and geomorphology impacts during construction and operation, having regard to applicable policies and guidelines.

3.1 Desktop analysis

The existing surface water environment across the study area has been characterised, and potential impacts have been identified through an initial desktop analysis of available information. The desktop analysis has included consideration of:

- Review of information and previous studies conducted within the surface water study area, including those for the existing M5 East Motorway and other developments along Alexandra Canal (refer Section 3.1.2). This included flooding, geomorphological and water quality studies, used to inform the EIS for this project
- Other Technical Working Papers included in the EIS, including those relating to groundwater, contamination, biodiversity and flooding.

3.1.1 Compilation of relevant information

Information concerning the existing environmental conditions within the study area has been obtained from the following sources:

- The local councils of Marrickville, Sydney, Botany, Canterbury, Rockdale and Hurstville
- The Cooks River Alliance – a partnership of eight Councils
- NSW government agencies: Roads and Maritime, WDA, Local Land Services (LLS), the Office of Environment and Heritage (OEH), NSW Public Works and Sydney Water Corporation
- Local community groups, including Streamwatch.

3.1.2 Review of previous studies

A number of previous studies have been made into various aspects of surface water in the study area. These have been in relation to similar works, including the M5 East Motorway and for environmental management purposes, as presented in Table 4.

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Table 4 Previous studies relating to surface water in the study area

Catchment	Report title	Author(s)	Year	Summary
Flooding				
Wolli Creek	King Georges Road Interchange Upgrade – Flooding and Drainage Investigation. Prepared for Roads and Maritime.	Lyall and Associates	2014	Assessment of flooding and drainage upgrades for King Georges Road Interchange Upgrade
	M5 East Upgrade – King Georges Road to Bexley Road – Review of pavement drainage issues. Prepared for Roads and Maritime.	Lyall and Associates	2011	Assessment of pavement drainage upgrades for the M5 East Motorway
	Cooks River Flood Study. Prepared for Sydney Water.	PB MWH	2009	Regional flood study
	Update of Wolli Creek Pipe Drainage & Overland Flow Study	WMA Water	2008	Localised flooding and drainage study
	M5 East Project – Report on Flood Risk Management	Hyder	2000	Assessment of flood risk attributed to previous M5 East works.
Cooks River	Technical Note No.1. Impacts of Proposed Airport Drive Option on Flooding Patterns M5 East Upgrade – March Street To Sydney Park Road. Prepared for Roads and Maritime.	Lyall and Associates	2012	Assessment of flooding and drainage upgrades for early motorway options
	Technical Note No. 2. M5 East Upgrade – March Street to Sydney Park Road Potential Impacts of Airport Orbital North-west over Alexandra Canal Solution on Flooding Behaviour. Prepared for Roads and Maritime.	Lyall and Associates	2012	Assessment of flooding and drainage upgrades for early motorway options
	Cooks River Flood Study. Prepared for Sydney Water.	PB MWH	2009	Regional flood study
Alexandra Canal	Proposed Bridge over Alexandra Canal – Preliminary Flood Impact Assessment. Prepared for WDA.	Lyall and Associates	2015	Preliminary assessment to inform design of the project
	Alexandra Canal Flood Study. Prepared for City of Sydney.	Cardno	2014	Municipal / catchment flood study
	Technical Note No.1. Impacts of Proposed Airport Drive Option on Flooding Patterns M5 East Upgrade – March Street To Sydney Park Road. Prepared for Roads and Maritime.	Lyall and Associates	2012	Assessment of flooding and drainage upgrades for early motorway options

Catchment	Report title	Author(s)	Year	Summary
	Technical Note No. 2. M5 East Upgrade – March Street to Sydney Park Road Potential Impacts of Airport Orbital North-west over Alexandra Canal Solution on Flooding Behaviour. Prepared for Roads and Maritime.	Lyall and Associates	2012	Assessment of flooding and drainage upgrades for early motorway options
	Cooks River Flood Study. Prepared for Sydney Water.	PB MWH	2009	Regional flood study
Eastern Channel	Marrickville Valley Flood Study – Draft Report. Prepared for Marrickville Council and Sydney Water.	WMA Water	2011	Municipal flood study
	EC East Sub-catchment Management Plan Volume 2- Flood Study. Prepared for Marrickville Council.	Golder Associates	2010	Municipal flooding and drainage study
	Cooks River Flood Study. Prepared for Sydney Water.	PB MWH	2009	Regional flood study
Water Quality				
	Botany Bay & Catchment Water Quality Improvement Plan. Sydney: Botany Bay Water Quality Improvement Program	SMCMA	2011	Catchment management strategy for water quality management
	Cooks River Stormwater Management Plan (CRSMP). Prepared for the Cooks River Catchment Association of Councils.	PPK-WMA	2009	Catchment management strategy for water quality management
	Alexandra Canal, 61 Huntley Street, Stormwater Asset Renewal Program. Review of Environmental Factors. Prepared for Sydney Water.	GHD	2014	Environmental impact assessment
	Sediment Water Quality Interactions. Prepared for Sydney Water Corporation.	UoQ	2002	Environmental study
Geomorphology				
	Sydney Metropolitan CMA Waterways Health Strategy. Prepared for Sydney Metropolitan Catchment Management Authority (CMA).	EarthTech	2007	Catchment management strategy for stream management
	Alexandra Canal Conservation Management Plan (NSW DPW, 2004).	DPWS	2004	Management plan

3.1.3 Review of baseline data

A number of sources provided data for the purpose of the study. These include:

- Details of pit and pipe drainage provided by City of Sydney, Botany Bay, Rockdale, Marrickville, Canterbury and Hurstville. Data included locations of pits and pipes
- Details of trunk drainage assets operated by Sydney Water
- Light Detection and Ranging (LIDAR) topographic surveys
- Water quality monitoring data provided by Rockdale City Council, Streamwatch and Sydney Water.

3.2 Field assessment

The objective of field inspections was to assess the current state of surface water features within the surface water study area. A judgement of their resilience was made so as to determine if the surface water environment is likely to be impacted by the project. Field assessment included inspection of features that could be impacted by changes to surface water flooding, hydrology or water quality.

Field inspections were made on three separate occasions, as shown in Table 5.

Table 5 Field inspections

Date	Watercourses Visited	Antecedent Conditions	Outcomes
16 April 2015	Alexandra Canal, Eastern Channel, Lower Cooks River.	Dry conditions in days leading up to inspections.	Inspection of geomorphology and waterways
17 April 2015	Wolli Creek and wetlands around Cooks River	Dry conditions in days leading up to inspections.	Inspection of geomorphology and waterways as well as existing water quality improvement devices
23 April 2015	Alexandra Canal, Sheas Creek, Botany Road / Doody Street stormwater channel, Eastern Channel, Sydenham storage pit, and Upper Wolli Creek	Heavy rainfall prior to inspection (over 200 millimetres in previous 48 hours), which resulted in localised flooding.	Inspection of drainage infrastructure. Assessment of waterway capacity following heavy rainfall.

3.3 Assessment of potential flooding and drainage impacts

3.3.1 Overview

A Technical Working Paper: Flooding (Lyall and Associates, 2015) was prepared for the project to define mainstream flooding behaviour across the study area under present day conditions, as well as to assess the potential impacts on mainstream flooding that are associated with the operational phase of the project. This investigation involved two dimensional hydraulic modelling of the major study watercourses, including Wolli Creek, Alexandra Canal and the lower Cooks River. Refer to the Technical Working Paper: Flooding (Lyall and Associates, 2015) for a detailed description of the methodology that was adopted for this study.

3.3.2 Flooding during construction

A qualitative construction phase flooding impact assessment was made based on indicative areas and activities as provided in the concept design. Locations of surface works, construction compounds and other structures such as temporary noise barriers were mapped against the existing 20 year ARI, 100 year ARI and Probable Maximum Flood (PMF) indicative flood extents as outlined in the Technical Working Paper: Flooding (Lyall and Associates, 2015). This provided an understanding of the likelihood that flooding would occur in the vicinity of construction activities.

An assessment was made on the potential for mainstream flooding to affect the construction process and the potential for construction activities to impact flooding behaviour and any nearby properties. Treatment was also given to the potential for localised overland flooding occurring at construction locations.

3.3.3 Flooding during operation

The Technical Working Paper: Flooding (Lyall and Associates, 2015) was prepared to assess the potential impacts on mainstream flooding associated with operation of the project in upper Wolli Creek, lower Cooks River and Alexandra Canal. Flooding of the Eastern Channel has been assessed within this report. The project would include measures (for example the upgrade of Camdenville Park Basin) to ensure that flooding downstream of the works would not be exacerbated.

The impacts of the project on localised flooding and drainage during operation of the project are addressed in this paper. The assessment was made with reference to the proposed connection of new and upgraded drainage systems to existing local drainage networks. Details of the existing networks were sought from the various authorities that own and maintain these networks, typically local Councils and Sydney Water. Historical information about existing localised flooding issues was also gathered.

3.4 Assessment of potential water quality impacts

3.4.1 Water quality during construction

The quality of surface water runoff during the construction phase is largely determined by sediment and erosion control measures, this requires:

- Assessment of the erosion hazard of the site soils
- Bunding in place for spills.

These controls are guided by 'The Blue Book' (Landcom, 2004) and CEMP requirements.

The assessment of surface water quality impacts during proposed works has involved:

- Assessment of potential construction activities that could mobilise sediments into the surface water environment, in particular contaminated sediments
- Review of existing policies and guidelines applicable to the management of water quality during construction
- Assessment of the quality of proposed discharges of treated construction water with reference to water quality reference criteria (Appendix A).

The water quality reference criteria were developed in accordance with guidelines from the Australian and New Zealand Environment Conservation Council (ANZECC, 2000). For highly disturbed receiving environments such as those that could be impacted by the project, ANZECC (2000) recommends that suitable guidelines for water quality trigger values can be trigger values derived from a local reference data set for nutrients, dissolved oxygen and pH where the quality of discharge should not exceed the 80th and/or 20th percentile values. The water quality reference criteria were developed from available water quality data from the receiving environments in the vicinity of the project. For toxicants (such as heavy metals or organic chemical compounds) the water quality requirements should be consistent with the 80 percent protection level for freshwater ecosystems (see Table 3.4.1 in ANZECC 2000).

3.4.2 Water quality during operation

The assessment of surface water quality impacts from proposed works has involved:

- Collation and review of available data on stream condition, water quality and soils to define the existing environment within the catchments and watercourses
- Review of existing policies and guidelines applicable to the management of water quality
- Assessment of proposed activities for impacts on the water quality of receiving environments. The assessment of the project impacts on surface water runoff incorporates an assessment of the mitigation measures provided in the design
- Identification of required mitigation measures, including type of controls and design criteria required to manage potential impacts.

Pollutant loads generated by the project were assessed to determine if mitigation would be sufficient to meet the stormwater pollution reduction targets from the *Botany Bay and Catchment Water Quality Improvement Plan*. This plan establishes stormwater pollution reduction targets (in terms of gross pollutants, total suspended solids, total phosphorus and total nitrogen) for all new development and re-development within the Botany Bay catchment. These pollutant reduction targets are presented in Table 6. The targets recommended by SMCMA for large redevelopment are applicable to the project.

Table 6 Pollution reduction targets applicable to the project

Stormwater pollutant	Pollution reduction target
Gross Pollutants	90%
Total Suspended Solids	85%
Total Phosphorus	60%
Total Nitrogen	45%

Note: Gross Pollutant removal is not reported since if the treatment target for Total Suspended Solids is met, the target for Gross Pollutants is typically also met.

Designs are assessed against the SMCMA targets for the upgrade of the roads i.e. the increase in pollutant loads above the existing condition that are attributable to the project. A treatment train approach was adopted to improve water quality of runoff from new impervious areas of the project. The aim is to achieve the stormwater targets where practical.

In order to assess the pollutant loads of the pavement runoff, assessments incorporating MUSIC modelling were undertaken. The MUSIC model was developed by the Cooperative Research Centre for Catchment Hydrology (now eWater CRC) as a decision support system for the design of stormwater treatment devices, and is now considered the standard method for determining compliance with water quality targets within the stormwater industry. The MUSIC model used was based on the NSW MUSIC modelling guidelines for the meteorological template and pollutant generation parameters. The pollutant load reduction targets that would be required to achieve the treatment targets were calculated as follows:

1) An estimate was made of the extent of the proposed impervious area associated with the project catchment after development. The imperviousness of the existing catchment was then calculated by subtracting the increase in impervious area that would result from the project.
2) Pollutant loads were modelled for each project catchment area before development (the existing condition).
3) Pollutant loads were modelled for each project catchment area after development.
4) The increase in pollutants in stormwater runoff resulting from the project was calculated from the above [(3) – (2) = increase in pollutants].
5) The targeted pollutant reduction loads were calculated based on pollution reduction targets, for example Total Suspended Solids 85 per cent removal, Total Phosphorus 60 per cent removal, Total Nitrogen 45 per cent removal. The required pollutant load reduction was calculated by multiplying the increase in pollutants for each catchment (i.e. (4) above)) by the pollutant load reduction required (i.e. Total Suspended Solids 85 per cent removal etc.).

The performance of the treatment devices proposed for stormwater quality treatment has been modelled and the results are presented in Section 7.3.The type and design of specific stormwater treatment measures across the project would be further refined as part of detailed design. Due to the conceptual nature of design to date, the modelling undertaken for this assessment has required assumptions to be made regarding the size of catchments and the size and design of stormwater quality improvement devices. Therefore the results of the modelling should be considered estimates of the likely treatment performance that can be expected. Modelling will need to be revised during detailed design, and this would be accompanied by a description of the treatment devices and any accompanying calculations, including the assumptions.

Discharge from the groundwater treatment plant was assessed for potential impacts from the quality of water discharged. Discharged water quality would meet water quality reference criteria developed for the project in accordance with guidelines from the Australian and New Zealand Environment Conservation Council (ANZECC, 2000) (refer to Appendix A).

3.5 Assessment of potential geomorphology impacts

The surface water impacts on geomorphology of relevant watercourses were assessed for the construction and operation phases of the project has involved:

- Collation and review of available data on stream condition to define the existing environment within the catchments and watercourses.
- Visual inspection of the receiving watercourses at a number of locations to verify the current condition.
- Review of historical stabilisation works along the watercourses.
- Review of existing policies and guidelines applicable to the management of erosion and sedimentation.
- Review of the proposed groundwater discharge rates and comparison with estimates of watercourse flow rates derived from the Cooks River Flood Study (WMA, 2009). The most frequent return interval flows from the flood study (the 2-year ARI) were used to derive an extrapolated approximation for the 1 year ARI flow and used for comparison to predicted discharge of treated groundwater. This comparison allows a relative assessment of whether the groundwater discharges are likely to create flow conditions that are rare or common for the streams being assessed. Coupled with the flow comparison, the channel type and condition in the vicinity of the discharge location, and cumulative impacts, was considered to understand potential impacts from the proposed groundwater discharge rates.
- Assessment of proposed activities for impacts on the water quality of receiving environments.
- Identification of required mitigation measures, including type of controls and design criteria required to manage potential impacts.
- Review of the dominant soil landscapes found in the study area.

As a basis of understanding the types of watercourses that exist in the project corridor, a geomorphic categorisation framework called River Styles (Brierley and Fryirs, 2005) was used to classify watercourses based on morphology and behaviour (character). This is the method adopted by DPI (Water) to define the physical form of rivers to measure and report on progress towards the Governments 'river health' targets. The River Styles classification for morphology and behaviour provides the basis for determining the vulnerability of each watercourse to geomorphic impacts. Fieldwork was undertaken on 16 and 17 April 2015 to inform this assessment, confirming that the mapping is accurate for the reaches of watercourses that have the potential to be affected by the project.

Desktop assessment of the current morphology and behaviour of the receiving watercourses was completed using a modified River Styles® geomorphic assessment technique, employed for the Sydney Metropolitan Waterways Health Strategy (EarthTech, 2007), to understand the potential for geomorphic impacts (Table 7). All of the watercourses within the surface water study area are likely to have been anthropogenically modified to some degree within the last 100 years.

Table 7 Categories of RiverStyles® used in categorising the existing physical form of rivers for this assessment

GIS label	Map descriptors	Channel continuity	Channel controls
Confined 2	Occasional pockets	Continuous channel	Bedrock controlled, channel abuts valley margin >90per cent of reach length. Alternating discontinuous floodplain pockets and opportunistic deposits at areas of localised valley widening.
Partly Confined 1	Bedrock controlled, discontinuous floodplain	Continuous channel	Channel abuts valley margin 50-90 per cent of stream length. Plan form aligned with valley alignment. Common vertical bedrock controls. Alternating, discontinuous pockets of floodplain deposits.
Partly Confined 3	Meandering, planform controlled, alternating discontinuous floodplain	Continuous channel	Channel abuts valley margin 10-50 per cent of stream length. Meanders independently of valley alignment. Common vertical bedrock controls.
Anthropogenic 1	Shaped channel	Continuous channel	Channels that have a modified morphology but may not have been entirely stabilised. May be partially concreted or rock-lined but there is limited potential for lateral adjustment.
Anthropogenic 2	Piped channel	Continuous channel	No potential for lateral or vertical adjustment. No open channel.
Anthropogenic 3	Concrete channel	Continuous channel	No potential for lateral or vertical adjustment.
Anthropogenic 4	Rock-lined channel	Continuous channel	Open channel. The potential for lateral and vertical adjustment limited by the stability of channel bed and walls.
Anthropogenic 5	Underground concrete channel	Continuous channel	No potential for lateral or vertical adjustment. No open channel.

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