Appendix G - Part 1

Surface Water and Flooding Impact Assessment

WESTLINK M7 WIDENING

SURFACE WATER AND FLOODING IMPACT ASSESSMENT

July 2022

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NOTE ON FLOOD FREQUENCY TERMINOLOGY

The frequency of flood events is generally referred to in terms of their Annual Exceedance Probability (AEP) or Average Recurrence Interval (ARI). For example, for a flood magnitude having five per cent AEP, there is a five per cent probability (or 1 in 20 chance) that there would be floods of greater magnitude each year. As another example, for a flood having a 20 year ARI, there would be floods of equal or greater magnitude once in twenty years on average. The approximate correspondence between these two systems is:

Annual Exceedance Probability (AEP) per cent	**Average Recurrence Interval (ARI) years**
0.2	500
0.5	200
1	100
5	20
10	10
20	5
50	2

In this report the frequency of flood events generated by runoff from the catchments within the study area (i.e. catchment flooding) is referred to in terms of their AEP, for example a 1% AEP flood.

The report also refers to the Probable Maximum Flood (PMF). This flood occurs as a result of the probable maximum precipitation (PMP) on the catchments within the study area. The PMP is the result of the optimum combination of the available moisture in the atmosphere and the efficiency of the storm mechanism as regards rainfall production. The PMP is used to estimate PMF discharges using a catchment hydrologic model that simulates the conversion of rainfall to runoff. The PMF is defined as the upper limiting value of floods that could reasonably be expected to occur and defines the extent of flood prone land (i.e. the floodplain).

GLOSSARY OF TERMS AND ABBREVIATIONS

Term	Meaning
AEP	Annual exceedance probability. The chance of a rainfall or a flood event exceeding a nominated level in any one year, usually expressed as a percentage. For example, if a peak flood level has an AEP of five per cent, it means that there is a five per cent chance (that is one-in-20 chance) of being exceeded in any one year. The frequency of floods is generally referred to in terms of their AEP or ARI. In this report the frequency of floods generated by runoff from the study catchments is referred to in terms of their AEP, for example a 1% AEP flood.
Afflux	Increase/decrease in water level resulting from a change in conditions. The change may relate to the watercourse, floodplain, flow rate, tailwater level, etc.
AHD	Australian height datum. A common national surface level datum approximately corresponding to mean sea level.
Approved project	The Westlink M7 (previously referred to as Western Sydney Orbital) is an existing 39-kilometre-long toll road connecting the M5 Motorway at Prestons, the Hills M2 Motorway at Baulkham Hills and the M4 Motorway at Eastern Creek.
ARI	Average recurrence interval. An indicator used to describe the frequency of a rainfall or a flood event, expressed as an average interval in years between events of a given magnitude. For example, over a long period of say 200 years, a flood equivalent to or greater than a 20 year ARI event would occur 10 times. A 20 year ARI flood has a one-in-5 chance of occurrence in any one year. See also AEP.
ARR 1987	Australian Rainfall and Runoff (Institute of Engineers Australia (IEAust) 1987).
ARR 2019	Australian Rainfall and Runoff (Geosciences Australia (GA) 2019).
BoM	Bureau of Meteorology.
Box culvert	A culvert of rectangular cross section.
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
Climate change	A change in the state of the climate that can be identified (for example by statistical tests) by changes in the mean and/or variability of its properties, and that persists for an extended period of time, typically decades or longer (IPCC 2007).
Climate projection	A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which in turn is based on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realised (IPCC 2007).
Conditions of Approval (CoA)	These are the current conditions that apply to the approved project. Found here: https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SSI-663-MOD-5%2120190718T013836.398%20GMT

Term	Meaning
Construction ancillary facilities	Temporary facilities during construction that include, but are not limited to, construction work areas, sediment basins, material stockpile and laydown areas, parking, maintenance workshops and offices, and construction compounds.
Construction footprint	The area required for construction of the proposed modification.
CEMP	Construction Environmental Management Plan. A site specific plan developed for the construction phase to ensure that all contractors and sub-contractors comply with the environmental conditions of approval and that the environmental risks are properly managed.
DCP	Development control plan.
DECC	Department of Environment and Climate Change (now DPE EES).
DECCW	Department of Environment, Climate Change and Water (now DPE EES).
Detailed design	The stage of design where project elements are designed in detail, suitable for construction.
DIPNR	Department of Infrastructure, Planning and Natural Resources (now DPE EES).
Discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (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]).
DPE	Department of Planning and Environment (formerly DPIE).
DPIE	Department of Planning, Industry and Environment (now DPE).
DPE EES	Department of Planning and Environment – Environment Energy and Science.
Drainage	Natural or artificial means for the interception and removal of surface or subsurface water.
DRAINS	A computer simulation program which converts rainfall patterns to stormwater runoff and generates discharge hydrographs. These hydrographs can then be routed through networks of piped drainage systems, culverts, storages and open channels using the DRAINS software to calculate hydraulic grade lines and analyse the magnitude of overflows. Alternatively, discharge hydrographs generated by DRAINS can be used as inflows to alternative hydraulic models (such as the TUFLOW two-dimensional hydraulic modelling software) to calculate water surface levels and flooding patterns.
Earthworks	All operations involving the loosening, excavating, placing, shaping and compacting of soil or rock.
EIS	Environmental Impact Statement
Emergency management	A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
Embankment	An earthen structure where the road (or other infrastructure) is located above the natural surface.
EMS	Environmental management system
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW). Provides the legislative framework for land use planning and development assessment in NSW

Term	Meaning
EP&A Regulation	*Environmental Planning and Assessment Regulation 2021* (NSW)
EPA	NSW Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
EPL	Environment protection licence
FDM	*Floodplain Development Manual* (Department of Planning, Infrastructure and Natural Resources (DIPNR) 2005).
Fill	The material placed in an embankment.
Flash flooding	Flooding which is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. Often defined as flooding which peaks within six hours of the causative rain.
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 tsunamis.
Flood affectation	The extent to which a property or area of land is affected by flooding.
Flood fringe area	The remaining area of flood prone land after floodway and flood storage areas have been defined.
Flood immunity	Relates to the level at which a particular structure would be clear of a certain flood event.
Flood prone land	Land susceptible to flooding by the Probable Maximum Flood. Note that the flood prone land is synonymous with flood liable land.
Flood storage area	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
Floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event (i.e. flood prone land).
Floodplain Risk Management Plan	A management plan developed in accordance with the principles and guidelines in the *Floodplain Development Manual* (FDM), (DIPNR 2005). Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
Floodway area	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
Flow velocity	A measure of how fast water is moving, for example, metres per second (m/s).
FPA	Flood Planning Area. The area of land below the Flood Planning Level and thus subject to flood planning controls.

Term	Meaning
FPLs	Flood Planning Levels. The combination of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans.
Freeboard	A factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. It is usually expressed as the difference in height between the adopted Flood Planning Level and the peak height of the flood used to determine the Flood Planning Level. Freeboard provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain, such as wave action, localised hydraulic behaviour and impacts that are specific event related, such as levee and embankment settlement, and other effects such as "greenhouse" and climate change. Freeboard is included in the Flood Planning Level.
GSDM	Generalised Short Duration Method. A method prescribed by BoM for estimating the Probable Maximum Precipitation for catchments up to 1,000 square kilometres in area.
Hazard	A source of potential harm or a situation with a potential to cause loss. In relation to the *NSW Floodplain Development Manual* (FDM), (DIPNR 2005) the hazard is flooding which has the potential to cause damage to the community.
Hydraulics	The term given to the study of water flow in waterways, in particular the evaluation of flow parameters such as water level and velocity.
Hydrograph	A graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.
Hydrology	The term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of discharge hydrographs for a range of floods.
Hyetograph	A graph which shows how rainfall intensities or depths vary with time during a storm burst. A design hyetograph shows the distribution of rainfall over a design storm burst.
IFD	Intensity-Frequency-Duration.
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
In-bank area	The area of a creek or watercourse below its top of bank levels.
Inundation	The spreading of a flood over an area.
IPCC	Intergovernmental Panel on Climate Change.
LEP	Local Environmental Plan
LGA	Local government area
LiDAR	Light detection and ranging. A form of aerial survey used to measure ground elevations.
Local drainage	Smaller scale drainage systems in urban areas. Commonly defined as areas where the depth of inundation along overland flow paths is less than 150 millimetres during a 1% AEP storm.
m	Metres. Used to define a length.

Term	Meaning
m AHD	Metres above Australian Height Datum. Used to define an elevation above Australian Height Datum.
m/s	Metres per second. Used to define velocity.
m^2	Square metres. Used to define an area.
m^3	Cubic metres. Used to define a volume.
m^3/s	Cubic metres per second. Used to quantify a flowrate.
Main stream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
Major overland flow	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam. Also referred to as overland flooding.
Mathematical/ computer models	The mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.
Merits based approach	The merits based approach weighs social, economic and environmental impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well-being of the State's rivers and floodplains.
MHWLS	Mean high water level spring
Modification	Proposed changes to be made to the conditions of approval for the approved project.
Operational footprint	The area required for operation of the proposed modification.
Overland flooding	Refer major overland flow.
Peak discharge	The maximum discharge occurring during a flood event.
Peak flood level	The maximum water level occurring during a flood event.
PMF	Probable maximum flood. The flood that occurs as a result of the Probable Maximum Precipitation (PMP) on a study catchment. The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically feasible to provide complete protection against this event. The PMF defines the extent of flood prone land (i.e. the floodplain).
PMP	Probable maximum precipitation. The PMP is the result of the optimum combination of the available moisture in the atmosphere and the efficiency of the storm mechanism as regards rainfall production. The PMP is used to estimate PMF discharges using a catchment hydrologic model which simulates the conversion of rainfall to runoff.

Term	Meaning
Proposed modification	The addition of a trafficable lane in both directions within the existing median of the Westlink M7, from about 140 metres south of the Kurrajong Road overhead bridge at Prestons (southern end) to the Westlink M7 Bridge at Richmond Road in Oakhurst/Glendenning (northern end), excluding at the M4/M7 Motorway Light Horse Interchange.
PRM	Probabilistic rational method.
Probability	A statistical measure of the expected chance of flooding (see annual exceedance probability).
RCBC	Reinforced Concrete Box Culvert.
RCP	Reinforced Concrete Pipe.
Representative Concentration Pathway	A greenhouse gas concentration trajectory adopted by the Intergovernmental Panel on Climate Change.
REF	Review of Environmental Factors
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the *NSW Floodplain Development Manual* (DIPNR 2005) it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
RL	Reduced level. The reduced level is the vertical distance between an elevation and an adopted datum plane such as the Australian Height Datum (AHD).
Runoff	The amount of rainfall which actually ends up as stream flow, also known as rainfall excess.
Scour	The erosion of material by the action of flowing water.
SES	NSW State Emergency Services.
Spoil	Surplus excavated material.
Stage	Equivalent to water level (measured with reference to a specified datum).
Stockpile	Temporarily stored materials such as soil, sand, gravel and spoil/waste.
Surcharge	Overflow from a creek, waterbody, overland flow or drainage system.
Surface water	Water flowing or held in streams, rivers and other water bodies in the landscape.
Transport	Transport for NSW. The proponent seeking approval for the modification.
Westlink M7	M7 Motorway or formerly known as Western Sydney Orbital.
WSO Co	WSO Co Pty Ltd.

ES1 EXECUTIVE SUMMARY

This report documents the findings of an investigation which was undertaken to assess the surface water and flooding related issues associated with the construction and operation of the proposed modification of the project planning approval for the Western Sydney Orbital (now referred to as Westlink M7) to permit the addition of a trafficable lane in both directions within the existing median between Prestons and Oakhurst (the proposed modification).

This report has been prepared to support the Modification Report for the proposed modification. Section 1 to Section 4 provide details of the background to the assessment, as well as a description of the proposed works that have the potential to influence surface water conditions and flood behaviour in the catchments through which the proposed modification is located. A more detailed description of the proposed modification is contained in Chapter 4 of the Modification Report.

Existing environment

The proposed modification is located within the catchments of Cabramatta Creek, Ropes Creek and Eastern Creek. Cabramatta Creek forms part of the larger Georges River catchment, while Ropes Creek and Eastern Creek are located within the Hawkesbury-Nepean River catchment.

Surface water

The quality of water in the watercourses that receive runoff from the section of the Westlink M7 within the footprint of the proposed modification has been heavily impacted due to changing land uses within the catchments, as well as works within their inbank area. The area surrounding the proposed modification contains significant portions of residential, industrial and commercial development, with existing water quality generally indicative of a highly urbanised catchment.

Available water quality monitoring data in the downstream watercourses was reviewed against the guideline values presented in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC Water Quality Guidelines) (Australian and New Zealand and Conservation Council 2000) for the environmental values and water quality indicators that are relevant to the proposed modification that are set out in:

- *NSW Water Quality Objectives* (Department of Environment, Climate Change and Water 2006) for the Cabramatta Creek catchment
- *Healthy Rivers Commission Inquir*y (NSW Government 1995) for the Ropes Creek and Eastern Creek catchments

The set of environmental values, water quality indicators and guideline values that have been established for the proposed modification are collectively referred to in this report as the ‘water quality objectives’.

The review of available water quality monitoring data found that nutrient levels and dissolved oxygen concentrations in the receiving watercourses do not currently meet the guideline values, whereas levels of total suspended solids and turbidity were found to be typically within the range of guideline values set out in the water quality objectives.

Flooding

The investigation found that the drainage systems within the broader catchments within which the proposed modification is located are of limited capacity in some areas. As a result, the areas surrounding the proposed modification are presently impacted by both mainstream flooding and major overland flow during periods of heavy rainfall.

The investigation also found that the main carriageways of the existing Westlink M7 within the extent of the proposed modification is not impacted by mainstream flooding or major overland flow during a 1% (1 in 100) Annual Exceedance Probability (AEP) design storm event, which is consistent with the level of flood immunity adopted in the original design of the motorway.

Impacts during construction

Surface water related impacts

The potential for impacts on surface water quality during the construction of the proposed modification would primarily be as a result of:

- the erosion and mobilisation of sediments and associated nutrients, heavy metals and toxicants into waterways due to:
    - the clearing of vegetation and topsoil to construct additional areas of road pavement, widening of bridges over waterways, adjustments to the stormwater drainage system and utilities, as well as the installation of temporary construction ancillary facilities
    - earthworks associated with the construction of the additional areas of road pavement; the reshaping of waterways and embankments to accommodate the bridge works; and trenching for new or realigned stormwater drainage and utilities
    - the temporary stockpiling of excavated spoil prior to its reuse on site, or of imported material for the construction of the additional areas of road pavement
    - inadequate revegetation of disturbed areas following construction, which can be exacerbated by the presence of saline soils
- the release of petroleum hydrocarbons, oil and grease, heavy metals or chemicals into waterways as a result of accidental spills or leaks from plant and machinery
- contaminants in wash down water from plant and concrete slurries.

An assessment of erosion potential from disturbed areas during construction of the proposed modification was carried out using the procedures set out in *Managing Urban Stormwater – Soils and Construction – Volume 1* (Blue Book) (Landcom 2004). The assessment found that the estimated volumes of soil loss from disturbed areas would be sufficiently low such that effective erosion and sediment management could be achieved through a series of local controls and measures, as opposed to the need for large scale sediment retention basins.

The potential impacts of the construction of the proposed modification on surface water are typical of road widening projects. With the application of appropriate controls and measures in accordance with the Blue Book, the potential impacts are considered to be minor and manageable.

Flood related impacts

An assessment was carried out into the flood related impacts associated with the construction activities that are proposed within each of the:

- bridge and median widening construction ancillary facilities
- construction zone support zone ancillary facilities
- bridge construction work areas
- median widening work areas.

Table 6.2 in Section 6.2.1 of this report lists each ancillary facility and work area, as well as their level of flood affectation and potential impacts on existing flood behaviour. Figure 6.1 (8 sheets) shows the extent to which floods of varying magnitude affect each ancillary facility and construction work area.

The key findings of the assessment of flood related impacts during construction can be summarised as follows:

i. While there is a low risk of flooding associated with the construction ancillary facilities that would be located within the central median of the main carriageways, the following ancillary facilities associated with bridge construction and construction zone support are subject to flooding conditions that would be considered hazardous during storms as frequent as 20% (1 in 5) AEP:

   a. ancillary facility C2@B9817, which is proposed to support the widening of the bridge over Maxwells Creek

   b. Zone A-1 ancillary facility.

   Ancillary facilities located in areas of high hazard pose a safety risk to construction personnel and plant. It is therefore recommended that the location and layout of the above ancillary facility sites be reviewed to confirm how flood risks will be managed, or if alternative locations need to be considered.

ii. Site facilities, stored materials and perimeter fencing associated with a number of the ancillary facilities have the potential to obstruct the conveyance of floodwater or displace floodplain storage. The ancillary facilities where there is the greatest potential for impacts correspond to those where high hazard flooding conditions are identified under item i. The potential for the ancillary facilities to impact on flood behaviour in existing development will therefore need to also be taken into consideration when reviewing the suitability of the location and layout of the two ancillary facilities identified in item i.

iii. Temporary access roads and working platforms that would be required to undertake the widening of the existing bridges over creeks all have the potential to obstruct the conveyance of flow, which in turn may impact on the extent and depth of inundation and flow velocities in the creeks and their overbank areas.

   Further flood modelling and assessment would need to be carried out during detailed design and construction planning to assess the extent of potential impacts and therefore the scope of mitigation measures that may be required. This further flood assessment would guide the sizing and level of temporary access roads, working platforms and waterway crossings, and help inform the staging of construction and the identification of flood emergency response procedures.

Impacts during operation

Surface water related impacts

The proposed modification has the potential to increase the generation of the following contaminants that could impact on the quality of surface water runoff discharging from the Westlink M7 corridor:

- total suspended solids that build up on paved surfaces
- toxicants and heavy metals attached to particulates from paved surfaces
- hydrocarbons, oils and grease from spills or leaks
- gross pollutants from the Westlink M7 corridor
- nutrients from organic material and any potential spills during transportation.

The types of contaminants are the same as those generated by the approved project. However, the proposed modification has the potential to lead to an increase in the quantity of contaminants due to an increase in paved area and increase in vehicle movements.

The approved project incorporates measures for treating runoff from the carriageways of the Westlink M7 that typically comprise water quality basins, but also include gross pollutant traps where there was insufficient space along the Westlink M7 corridor for a basin. While the water quality basins are primarily designed to treat total suspended solids and associated contaminants, they also provide a level of treatment of nutrients such as total phosphorus and total nitrogen. The design documentation for the Westlink M7 indicates that the water quality basins were sized to accommodate additional paved area within the central median associated with future widening of the roadway.

An assessment of the existing stormwater quality controls that are located along the Westlink M7 was carried out to assess their performance under pre- and post-proposed modification conditions and to compare the modelled concentrations of pollutants discharging from the Westlink M7 corridor against the water quality objectives that are relevant to the proposed modification. The assessment found the following:

i. There are negligible differences between the median pollutant concentrations discharging from the stormwater quality controls under pre- and post-proposed modification conditions, indicating that there is negligible difference in the ability of the stormwater quality controls to meet the water quality objectives between pre- and post-proposed modification conditions.

ii. The median concentrations of total suspended solids and levels of turbidity discharging from the stormwater quality controls under both pre- and post-proposed modification condition achieve the water quality objectives related to these two indicators.

iii. As existing levels of nutrients (such as total phosphorus and total nitrogen) exceed the guideline values set out in the water quality objectives, the objective of the proposed modification would be to improve existing water quality. In this regard, the median concentrations of total phosphorus and total nitrogen discharging from the stormwater quality controls under pre- and post-proposed modification conditions:

    a) meet the objective of improving existing water quality in regard to total discharge into the major creek systems of Cabramatta Creek, Ropes Creek and Eastern Creek, as well as local discharges into Bells Creek and Angus Creek,

b) do not meet the objective of maintaining or improving existing water quality in regards to local discharges into Maxwells Creek, Cabramatta Creek, Hinchinbrook Creek and Eskdale Creek.

Measures aimed at improving existing water quality in regard to local discharges into Maxwells Creek, Cabramatta Creek, Hinchinbrook Creek and Eskdale Creek will be investigated during detailed design in accordance with the proposed management measures set out in Section 9 of this report.

Flood related impacts

Potential impacts of flooding on the proposed modification

While inundation of the proposed modification by floodwater during its operation has the potential to cause damage to infrastructure and impact on the safe operation of the motorway, given the nature of the works associated with the proposed modification, the potential for this inundation to occur is similar to that of the existing motorway. As noted in the preceding section, the existing carriageways of the Westlink M7 have been designed to provide a 1% AEP level of flood immunity which would be maintained under post-proposed modification conditions.

Potential impacts of the proposed modification on flood behaviour

The proposed modification has the potential to exacerbate flooding conditions in adjacent development, which would be primarily due to:

- an increase in the rate and volume of runoff from the widened road pavement, which has the potential to impact on flooding patterns in the receiving drainage lines downstream of the Westlink M7 corridor
- the obstruction that is caused by the additional piers that are proposed to support the widened bridges, which has the potential to impact on flooding patterns in the drainage lines that they cross.

An assessment was carried out of the impact that the above changes associated with the proposed modification would have on flood behaviour, the findings of which are presented in Section 7.2 of this report.

The assessment found that once constructed, the proposed modification would generally have only a minor impact on the depth of inundation in adjacent properties for storms with AEP's up to 1% in intensity. While it would be necessary to carry out further design development during detailed design which is aimed at further reducing the residual impacts of the proposed modification on flood behaviour, the nature of the changes in flooding patterns attributable to the proposed modification would not have an impact on the hazardous nature of flooding, or the future development potential of land outside the Westlink M7 corridor.

While the assessment also found that increases in the depths of inundation during a Probable Maximum Flood (PMF) would generally be minor in nature, modelling indicates that PMF levels would be increased by a maximum of 0.015 metres over an area to the west (upstream) of the bridge over Angus Creek (denoted bridge waterway structure BR9898/99 on Figure 7.7, sheet 7). Increases in PMF levels upstream of the bridge over Angus Creek would extend to a recently constructed aged care facility that is located between the Main Western Railway and Mavis Street in Rooty Hill.

During detailed design, a scope of works would be developed to design out this potential increase in flood level. Alternatively, floor level survey of the buildings that comprise the aged care facility would be undertaken in order to confirm the potential for above-floor inundation to occur and therefore the impact of the proposed modification on the affected buildings. Table 9.1 in Section 9.2 of this report includes potential measures that could be investigated during detailed design should it be identified that the proposed modification would lead to an increase in above-floor inundation in the affected buildings of the aged care facility.

The assessment found that while the proposed modification would have only a minor impact on flow velocities and hence scour potential in the drainage lines that are located downstream of the Westlink M7 corridor, there is the potential for a localised increase in scour potential due to:

- localised increases in flow velocities at the outlet to drainage structures within the Westlink M7 corridor that would control runoff from the widened road formation
- localised increases in flow velocities due to the obstruction caused by the additional piers that are proposed to support the widened bridges.

During detailed design, scour protection and energy dissipation measures would be incorporated into the design of the drainage outlets and around bridge piers where it is required to manage localised increases in flow velocity.

The assessment found that given the relatively minor increases in the depths of inundation there would also be minor changes in the extent of inundation for all events up to the PMF. It was also found that the proposed modification would have only a minor impact on the duration of flooding in the drainage lines downstream of the Westlink M7 corridor.

Impact of future climate change on flood behaviour

Projected changes in the intensity of flood-producing rainfall has the potential to impact on the characteristics of flooding in the vicinity of the proposed modification. The potential impacts of future climate change on flooding were assessed in accordance with the recommended procedures set out in the NSW Department of Planning, Industry and Environment (Environment, Energy and Science) *Floodplain Risk Management Guideline – Practical Considerations of Climate Change* (NSW Department of Environment and Climate Change (DECC), 2007).

As set out in Section 4.2.6 of this report, the 0.5% AEP and 0.2% AEP storms were adopted as proxies to assess the impact that a 10% and 30% increase in 1% AEP rainfall intensities would have on flood behaviour in the vicinity of the proposed modification (denoted future climate change scenarios 1 and 2)**.**

The assessment found that under both future climate change conditions:

- while depths of inundation would be increased along the drainage lines that cross the Westlink M7 corridor, the main carriageways of the motorway would remain flood free
- the impact of the proposed modification on flood behaviour during a 1% AEP design storm event would be similar to those under current climatic conditions.

Impact of a partial blockage of major hydraulic structures on flood behaviour

The assessment found that while a partial blockage of the transverse drainage structures that are located along the Westlink M7 corridor would lead to an increase in the depth of ponding at their inlets, the main carriageways of the motorway would remain flood free.

Application of ARR 2019 to design flood estimation

For consistency with the flood studies undertaken for Liverpool City Council and Blacktown City Council, the present investigation has also adopted the procedures set out in the 1987 edition of *Australian Rainfall and Runoff* (Institution of Engineers, Australia, 1987) (ARR 1987) for defining flood behaviour in the Cabramatta Creek and Eastern Creek catchments.

As the procedures set out in the recently released edition of *Australian Rainfall and Runoff* (Geoscience Australia, 2019) (ARR 2019) are likely to be used by councils to carry out updates to the existing studies within the Cabramatta Creek and Eastern Creek catchments in future, a sensitivity study was carried out as part of the present investigation to assess the likely changes that would occur in predicted flood behaviour in the vicinity of the proposed modification where it runs through the Cabramatta Creek and Eastern Creek catchments.

The investigation found that the adoption of ARR 2019 procedures would lead to a reduction in the rate of runoff that would be generated in the Cabramatta Creek and Eastern Creek catchments, which in turn would lead to a reduction in design peak flood levels in the vicinity of the proposed modification when compared to those derived using the procedures set out in ARR 1987.

Based on the above findings, the adoption of the procedures set out in ARR 1987 represents a more conservative estimate of flood behaviour in the vicinity of the proposed modification during design storm events.

Cumulative impacts

The proposal has the potential for cumulative impacts on surface water quality and flood behaviour in combination with the following projects that are located in its vicinity:

- M12 Motorway
- Horsley Drive Upgrade
- Light Horse Interchange Business Hub at Eastern Creek
- Gazorp Industrial Estate at 813-913 Wallgrove Road, Horsley Park
- Horsley Park Brickworks Plant 2 Upgrade at 780 Wallgrove Road, Horsley Park

Subject to the incorporation of the mitigation measures that are identified in Section 9 of this report the proposal would have either no impact, or a minor and relatively localised impact on surface water and flood behaviour. It is therefore expected that the cumulative impacts of the proposal in combination with other projects in its vicinity would also be minor in nature.

Management of impacts

Section 9 of this report sets out the environmental management measures which will be implemented during the detailed design, construction and operation of the proposed modification.

<u>Surface water related management measures</u>

The key water quality objective would be to ensure downstream waterways are protected against potential impacts from surface runoff generated during the construction and operational phases of the proposed modification.

Construction methods would be in accordance with the Blue Book and the water quality objectives. Water quality would be monitored in accordance with the construction water quality monitoring program proposed in Section 9.2.

The ability of the existing operational stormwater quality controls that are located along the Westlink M7 corridor to control runoff from both the existing and widened carriageways will be further assessed during detailed design to confirm that for waterways that receive runoff from the proposed modification:

a) the water quality objectives continue to be met at waterways where they are currently being achieved, or

b) existing water quality is improved at waterways where the water quality objectives are not being met.

In the instance that during detailed design it cannot be demonstrated that the existing operational stormwater quality controls would be effective in mitigating potential impacts in accordance with the above requirements, then additional mitigation measures will be identified and implemented.

Flood related management measures

The key flood related objective of the proposed modification would be to ensure that it minimises adverse impacts in areas outside the Westlink M7 corridor caused by changes in flood behaviour.

While the findings of the initial assessment presented in Section 6.2 provide an indication of the potential impact construction activities would have on flood behaviour, further investigations would need to be carried out during detailed design with the benefit of more detailed site layouts and staging diagrams. Table 9.1 in Section 9.2 of this report contains a range of potential measures which would be implemented in order to reduce the impact of construction activities on flood behaviour.

Table 9.1 in Section 9.2 also sets out the specific measures which would be incorporated into the detailed design of the proposed modification in order to mitigate its minor operational related flood risks.

The design of permanent works associated with the proposed modification would be designed to minimise adverse flood related impacts on:

- surrounding development during storms up to the 1% AEP in intensity
- critical infrastructure, vulnerable development or increases in risk to life due to a significant increase in flood hazard for events up to the PMF.

The nature and extent of impacts, and therefore the scope of mitigation measures required, would be subject to further flood assessment during the detailed design phase. Subject to this further flood assessment, additional floor level survey may be required to confirm the extent to which the proposed works would increase above-floor inundation in affected properties and therefore the scope of specific measures that may be required to mitigate the proposed modification related impacts.

1 INTRODUCTION

The Westlink M7 is an existing 39-kilometre-long toll road connecting the M5 Motorway at Prestons, the Hills M2 Motorway at Baulkham Hills and the M4 Motorway at Eastern Creek ('the approved project'). Transport for NSW (Transport) is seeking a modification to the approved project to widen part of the Westlink M7 in response to current and forecast traffic growth, and to improve motorway efficiency, travel time performance and safety.

1.1 Overview of proposed modification

Transport as the proponent for the proposed modification, is requesting that the Minister for Planning and Homes modify the planning approval for the Western Sydney Orbital (now referred to as Westlink M7) under section 5.25 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act).

The original approval (DPE reference number SSI-663) was for the construction and operation of the four-traffic lane motorway. The proposed modification would provide an additional trafficable lane in both directions within the existing median of the Westlink M7. The motorway would be widened from about 140 metres south of the Kurrajong Road overhead bridge at Prestons (southern end) to Richmond Road in Oakhurst/Glendenning (northern end), excluding at the M7 Westlink/M4 Motorway (Light Horse) Interchange.

This technical assessment has been prepared to support the application for the proposed modification.

1.2 Purpose of this technical report

This technical report provides a surface water and flooding assessment of the proposed modification and has been prepared to inform the Modification Report. The aim of this report is to address the relevant Secretary's Environmental Assessment Requirements (SEARs) for the modification, provided by the NSW Department of Planning Industry and Environment (DPE) (Application number SSI 663).

1.2.1 Secretary's Environmental Assessment Requirements

The relevant surface water and flooding related SEARs are presented in Table 1.1.

Table 1.1 SEARs – Surface Water and Flooding

Desired Performance Outcome	SEAR	Where addressed within this report
Water – Quality and Hydrology		
The project is designed, constructed and operated to protect the NSW Water Quality Objectives where they are currently being achieved, and contribute	1. The Proponent must assess water quality impacts, including: a. stating the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the project, including the indicators and associated trigger values or criteria for the identified environmental	1. Sections 6.1 and 7.1 present the findings of an assessment of impacts on surface water quality. a. Section 4.1.3 sets out the environmental values set out in the NSW Water Quality Objectives that have been identified as being relevant to the proposed modification, together with their associated indicators and criteria values that have been established in accordance with the Australian & New Zealand Guidelines for Fresh & Marine Water Quality.

Desired Performance Outcome	SEAR	Where addressed within this report
towards achievement of the Water Quality Objectives over time where they are currently not being achieved, including downstream of the project to the extent of the project impact including estuarine and marine waters (if applicable).	values in accordance with the Australian & New Zealand Guidelines for Fresh & Marine Water Quality and or local objectives, criteria or targets endorsed by the NSW Government; b. identifying and estimating the quality and quantity of pollutants that may be introduced into the water cycle by source and discharge point and describe the nature and degree of impact that any discharge(s) may have on the receiving environment, including consideration of all pollutants that pose a risk of non-trivial harm to human health and the environment; c. identifying the rainfall event that the water quality protection measures will be designed to cope with; d. the significance of any identified impacts including consideration of the relevant ambient water quality outcomes; e. demonstrating how construction and operation of the project will, to the extent that the project can influence, ensure that: ▪ where the NSW WQOs for receiving waters are currently being met, they will continue to be protected; and ▪ where the NSW WQOs are not currently being met, activities will work toward their achievement over time; f. justifying, if required, why the WQOs cannot be maintained or achieved over time. g. demonstrating that all practical measures to avoid or minimise water pollution	b. Pollutants that pose a risk of non-trivial harm to human health and the environment have been considered in establishing the water quality objectives of the proposed modification that are set out in Section 4.1.3 of this report. Sections 6.1.1, 6.1.2 and 6.1.3 contain an assessment of the potential impacts that the construction of the proposed modification could have on the quality of surface water runoff, including quantification of potential sediment loads, as well as an assessment of construction discharges against the water quality objectives that have been established for the proposed modification. The corresponding assessment of impacts during the operation of the proposed modification is provided in Sections 7.1.1, 7.1.2 and 7.1.3, including quantification of pollutant loads and assessment of discharges from operational stormwater quality controls against the water quality objectives that have been established for the proposed modification. c. Section 5.5.1 describes the design (including the rainfall event capacity) of the existing stormwater quality controls along the Westlink M7 that are proposed to be utilised and upgraded or augmented where required as part of the proposed modification. Section 6.1.3 describes the approach to erosion and sediment control during the construction of the proposed modification. d. Refer Sections 5.6, 6.1 and 7.1. e. Section 6.1 and 7.1 respectively provide an assessment of the construction and operational related surface water quality impacts against the water quality objectives that have been established for the proposed modification. Section 9.2 identifies the measures that are proposed to be incorporated into the detailed design of the proposed modification to manage its impact on surface water quality. f. Section 5.6 documents the existing water quality which does not currently meet the water quality objectives based on the current ANZG 2018 and ANZECC 2000 guidelines. Further measures to meet or improve the NSW WQOs are incorporated into detailed design, which is discussed further in Section 9. g. Section 5.5.1 describes the design (including the rainfall event capacity) of the existing stormwater quality controls along the Westlink M7 that are proposed to be utilised and upgraded or augmented where required as part of the proposed modification. This is considered further in Section 6 and Section 7 which present an assessment of impacts, and

Desired Performance Outcome	SEAR	Where addressed within this report
	and protect human health and the environment from harm are investigated and implemented; h. identifying sensitive receiving environments (which may include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments; and i. identifying proposed monitoring locations, monitoring frequency and indicators of surface and groundwater quality. 2. An assessment of the impact of the development on hydrology, including: a. a detailed and consolidated site water balance, including quantity, quality and source; b. effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas; c. effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems; d. impacts to natural process and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches); e. changes to environmental water availability; f. mitigation measures for the management of stormwater and wastewater during both construction and operation (including volumes, flow rates, management methods and re-use options); and g. proposed surface and groundwater monitoring activities and methodologies.	Section 9 which presents measures to be implemented, to avoid or minimise water pollution. h. Section 5.3 identifies sensitive receiving environments, and the approach to avoid or minimise impacts on them, with further information provided in sections referenced in Section 5.3 i. Section 9 describes a monitoring plan to be implemented for the proposed modification. 2. Sections 6.1 and 7.1 respectively provide an assessment of the construction and operational related impacts of the proposed modification on surface water hydrology in terms of both quality and quantity of runoff. Chapter 7.5 of the Modification Report contains an assessment of the impact of the proposed modification on groundwater. a. Section 4.1.6 describes the methodology that was adopted to assess the impact of the proposed modification on the quantity and quality of surface water runoff from source catchments along the Westlink M7 corridor during the operation of the proposed modification. An assessment of water demand and likely sources during the construction of the proposed modification is presented in Section 6.1.5. b. Section 6.1.4 and 7.1.4 present the findings of an assessment of the impact of the proposed modification on the geomorphology of the receiving waterways downstream of the Westlink M7 corridor. Appendix H (Biodiversity Development Assessment Report) contains an assessment of the impact of the proposed modification to downstream rivers, wetlands, estuaries, marine waters and floodplain areas that are relevant to the proposed modification. c. Appendix H (Biodiversity Development Assessment Report) contains an assessment of the impact of the proposed modification to aquatic ecosystems, including groundwater dependent ecosystems. d. Sections 6.1.4 and 7.1.4 present the findings of an assessment of the impact of the proposed modification on the geomorphology of the receiving waterways downstream of the Westlink M7 corridor. Appendix H (Biodiversity Development Assessment Report) contains an assessment of the impact of the proposed modification to downstream rivers, wetlands, estuaries, marine waters and floodplain areas in terms of nutrient flow, aquatic connectivity and access to habitat for spawning and refuge. e. Sections 6.1.4 and 7.1.4 include an assessment of the impact of the proposed modification on environmental water availability,

Desired Performance Outcome	SEAR	Where addressed within this report
		f. Section 9 outlines potential measures to mitigate construction and operational related impacts of the proposed modification on stormwater runoff. Management of wastewater is dealt with Chapter 7.16 (Waste) of the Modification Report. g. Section 4.1.4 describes the surface water monitoring that has been undertaken to support the surface water assessment for the proposed modification, while Section 9 outlines the proposed monitoring of surface water quality that would be undertaken prior to, throughout and following the construction of the proposed modification.
Flooding		
The project minimises adverse impacts on existing flooding characteristics. Construction and operation of the project avoids or minimises the risk of, and adverse impacts from, infrastructure flooding, flooding hazards, or dam failure.	1. A flood impact and risk assessment (FIRA) must be undertaken by a qualified flooding engineer. As a minimum the FIRA should consider: a. existing base case scenario, including developing a hydrologic and hydraulic model that is compatible with existing flood information developed by Liverpool, Fairfield and Blacktown Councils' flood studies and floodplain risk management studies and plans; b. existing flood behaviour and flood constraints and risks on the site and its surrounding areas for the full range of events including 5% AEP, 1% AEP, PMF and 0.5% AEP or 0.2% AEP; c. changes in post development flood behaviour, impacts of flooding on existing community and on the development for the full range of events including 5% AEP, 1% AEP, PMF and 0.5% AEP or 0.2% AEP. This should address impacts on flood behaviour and on emergency response management of the site and surrounding areas;	1. Section 4 describes the methodology that was adopted to assess the flood related impacts and risks associated with the proposed modification during its construction and operation. a. Section 4.2.3 describes the approach that was adopted in establishing a set of hydrologic and hydraulic models representing existing (present day) conditions, including details of previous flood studies that were considered as part of the present investigation. b. Section 5.7 describes the existing flood behaviour in the vicinity of the proposed modification for a range of flood events that includes the 5% AEP, 1% AEP, PMF and 0.2% AEP. c. Sections 6.2 and 7.2 respectively present the findings of an assessment of the potential changes in flood behaviour attributable to the proposed modification during its construction and operation. The assessment includes consideration of flood related impacts on the proposed modification as well as development in the broader community for a range of flood events that includes the 5% AEP, 1% AEP, PMF and 0.2% AEP. Section 7.2.2 presents the findings of a review of the proposed modification in terms of its impact on the community emergency management arrangements as well as relevant council flood management plans. d. Section 7.2.3 presents the findings of an assessment of the impact that an increase in rainfall intensities under future climate change could have on flooding to the proposed modification as well as the impact that the proposed modification could have on flood behaviour compared to current climatic conditions. e. Section 6.2 present the findings of an assessment of the potential impacts risks of flooding

Desired Performance Outcome	SEAR	Where addressed within this report
	d. impacts of climate change on both existing and post development flood behaviour due to increase in rainfall intensities; and e. proposed temporary management actions to mitigate impacts of flooding during construction on the community, personnel, machinery, and construction sites. *Note: flood behaviour includes flood volume, extent, depth, level, velocity, duration, rate of rise, flood function and hazard.* 2. The assessment must include maps of all features relevant to flooding as described in the Floodplain Development Manual, including flood prone and the flood planning area.	to the construction of the proposed modification, as well as the impact it could have on flood behaviour in surrounding development. Section 9 outlines potential measures to mitigate construction related impacts of the proposed modification on flooding conditions in adjacent development as well as the risk of flooding to the construction work areas and ancillary facilities, including associated construction personnel and machinery. 2. Figure 4.4 shows the extent of flood prone land in the vicinity of the proposed modification (i.e. the extent of land that is susceptible to flooding during a Probable Maximum Flood (PMF) event). Figure D.3 in Annexure D shows the extent of land which is located below the 1% Annual Exceedance Probability (AEP) flood level plus 0.5 m (as defined in the relevant Local Environmental Plans). Figure C.1 and C.2 respectively show the preliminary hydraulic categorisation and provisional hazard classification of land based on the 1% AEP design storm event in accordance with the *Floodplain Development Manual* (Department of Infrastructure, Planning and Natural Resources (DIPNR) 2005).

1.3 Structure of this report

This technical report is structured as follows:

- **Section 1 Introduction:** This section introduces features of the proposed modification.
- **Section 2 Modification description:** This section provides a description of the proposed modification including construction and operational activities.
- **Section 3 Relevant legislation, guidelines and policy:** This section provides an overview of the Commonwealth, State and local government based legislation, guidelines and policy that is relevant to the surface water and flood assessments.
- **Section 4 Methodology:** This section outlines the methods used to assess the proposed modification as it relates to surface water and flooding. The section also contains a summary of the criteria and standards that have been adopted for the assessment based on consideration of the relevant government legislation, policies and guidelines.
- **Section 5 Existing environment:** This section describes the existing environment as it relates to surface water and flooding, including a brief description of the catchments through which the proposed modification would be located. The section provides an overview of the quality of runoff in the receiving drainage lines, their environmental values and associated water quality objectives. The section also provides a description of flood behaviour in the vicinity of the proposed modification under present day (i.e. pre-proposed modification) conditions
- **Section 6 Construction impact assessment**: This section assesses the impacts of the proposed modification during construction as it relates to surface water and flooding.
- **Section 7 Operational impact assessment**: This section assesses the impacts of the proposed modification during operation as it relates to surface water and flooding.
- **Section 8 Assessment of cumulative impacts**: This section assesses the potential cumulative impacts of the proposed modification in combination with other projects on surface water conditions and flood behaviour.
- **Section 9 Mitigation and management measures**: This section documents environmental management measures that are proposed to mitigate the identified surface water and flooding related impacts of the proposed modification (taking into account the existing Conditions of Approval for the approved project).
- **Section 10 References**: This section contains a list of references cited in this report.
- **Annexure A** contains a summary of the stormwater quality control basins along the section of the Westlink M7 within the proposed modification footprint, as well as a set of figures that show the catchment area draining to each basin under the pre- and post-proposed modification conditions.
- **Annexure B** contains a series of figures which show flooding patterns for design storms with annual exceedance probabilities (AEPs) of 20% and 0.2%. **Annexure B** also contains a series of figures that show the change in peak flow velocities under post modification conditions during a 1% AEP storm.

The scales on figures referred to in this report are applicable when printed at A3 size. The figures referred to in Sections 5, 6 and 7 are located after Section 10 of this report.

2 PROPOSED MODIFICATION

The proposed modification would permit the addition of a trafficable lane in both directions within the existing median of the Westlink M7, from about 140 metres south of the Kurrajong Road overhead bridge at Prestons (southern end) to at Richmond Road in Oakhurst/Glendenning (northern end), excluding at the M4 Motorway/Westlink M7 (Light Horse) Interchange (see Figure 2-1 to Figure 2-5 for extent).

A full description of the construction activities and operational features associated with the proposed modification are provided in detailed in Chapter 4 (Proposed modification) of the Modification Report.

The proposed modification to the approval for the Westlink M7 would include the following key operational components:

- Widening of the motorway into the existing median for a length of about 26 kilometres along the Westlink M7, from about 140 metres south of the Kurrajong Road overhead bridge at Prestons (southern end) to Richmond Road interchange in Oakhurst/Glendenning (northern end), excluding at the M4 Motorway/Westlink M7(Light Horse) Interchange
- Widening the exit from the Westlink M7 northbound onto the M4 Motorway westbound from one lane to two lanes
- Widening of 43 existing northbound and southbound bridges on the Westlink M7 at 23 locations within the centre median, and widening on the outside of the bridges on the approach to the M4 Motorway from Old Wallgrove Road
- Upgrades, additions and modifications to noise wall infrastructure
- Utility works and upgrades to drainage infrastructure
- Intelligent Transport System (ITS) installations, adjustments and relocations to cover the new lane configurations.

Existing operational features impacted by the proposed modification would include:

- Main road alignment, including median and bridge areas
- Interchanges, tie-ins and entry/exit ramps
- Fill embankments and cuttings
- Culverts and drainage structures
- Water quality control measures, including basins
- Landscaping
- Existing public art and landscaping at the M4 (Light Horse) Interchange
- Maintenance access
- Security fencing
- Noise walls
- Shared path
- Other associated elements required during operation (for example, intelligent transport systems (ITS), utilities and variable message signs (VMS)).

The following activities would be required to facilitate construction of the proposed modification:

- Multiple construction ancillary facility sites within and adjacent to Westlink M7 for stockpiling, construction support at bridge and median widening locations, project offices and compounds
- Vegetation clearing within the widening areas and construction ancillary facilities (including construction accesses)
- Demolition of existing structures and infrastructure within the construction footprint
- Provision of temporary water management infrastructure including the maintenance of stormwater drainage and establishment of waterway crossings and diversions
- Utility works within Westlink M7 and adjoining roads, particularly around existing motorway bridge substructures
- Earthworks for bridge and road widening within the existing median, and placement and compaction of fill material likely to result in a net amount of cut material
- Bridge widening works to existing structures including establishment of substructures including piles, abutments, piers and headstocks and superstructures including beams, girders, decks and barriers
- Pavement widening works within the road median
- Finishing works including asphalting the carriageway surface, line marking, signage, permanent barriers and median infill, adjustments to noise walls, installation of communications infrastructure and landscaping treatments.

Construction would likely commence in 2023 and continue through to the end of 2025. The construction program for the M12 Motorway interface has been considered in the development of this program. It is proposed to undertake the proposed modification at this interchange at the same time as the M12 Motorway project works to minimise disruption and achieve efficiencies during construction.

FIGURE 2-1: KEY FEATURES

Legend
- Proposed widening
- Operational footprint
- Watercourse
- Existing noise wall
- New noise wall (NW####)
- Transport for NSW bridge number B9#### proposed to be widened

Figure 2-1 Key features (Map 1)

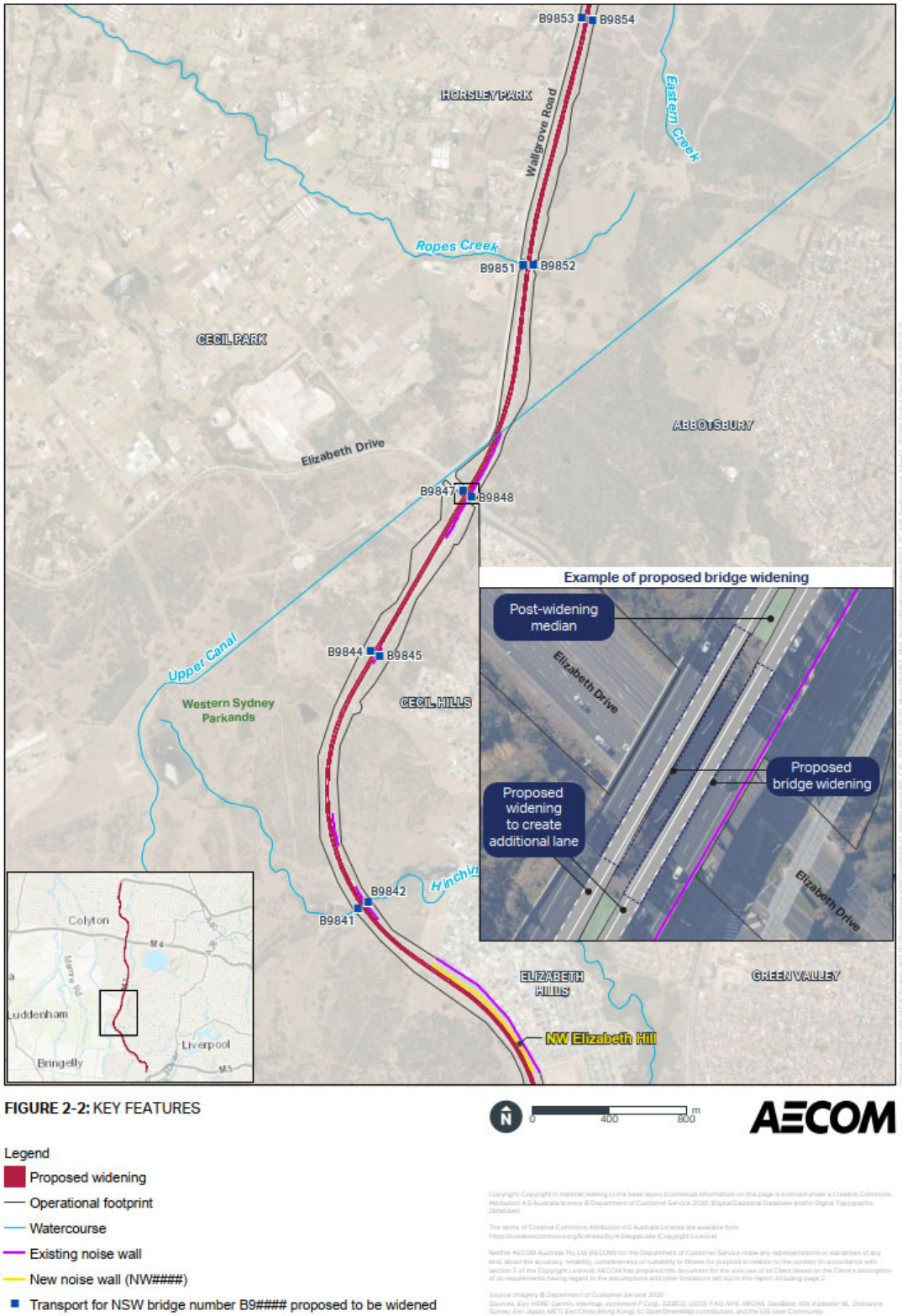


Figure 2-2 Key features (Map 2)

Figure 2-3 Key features (Map 3)

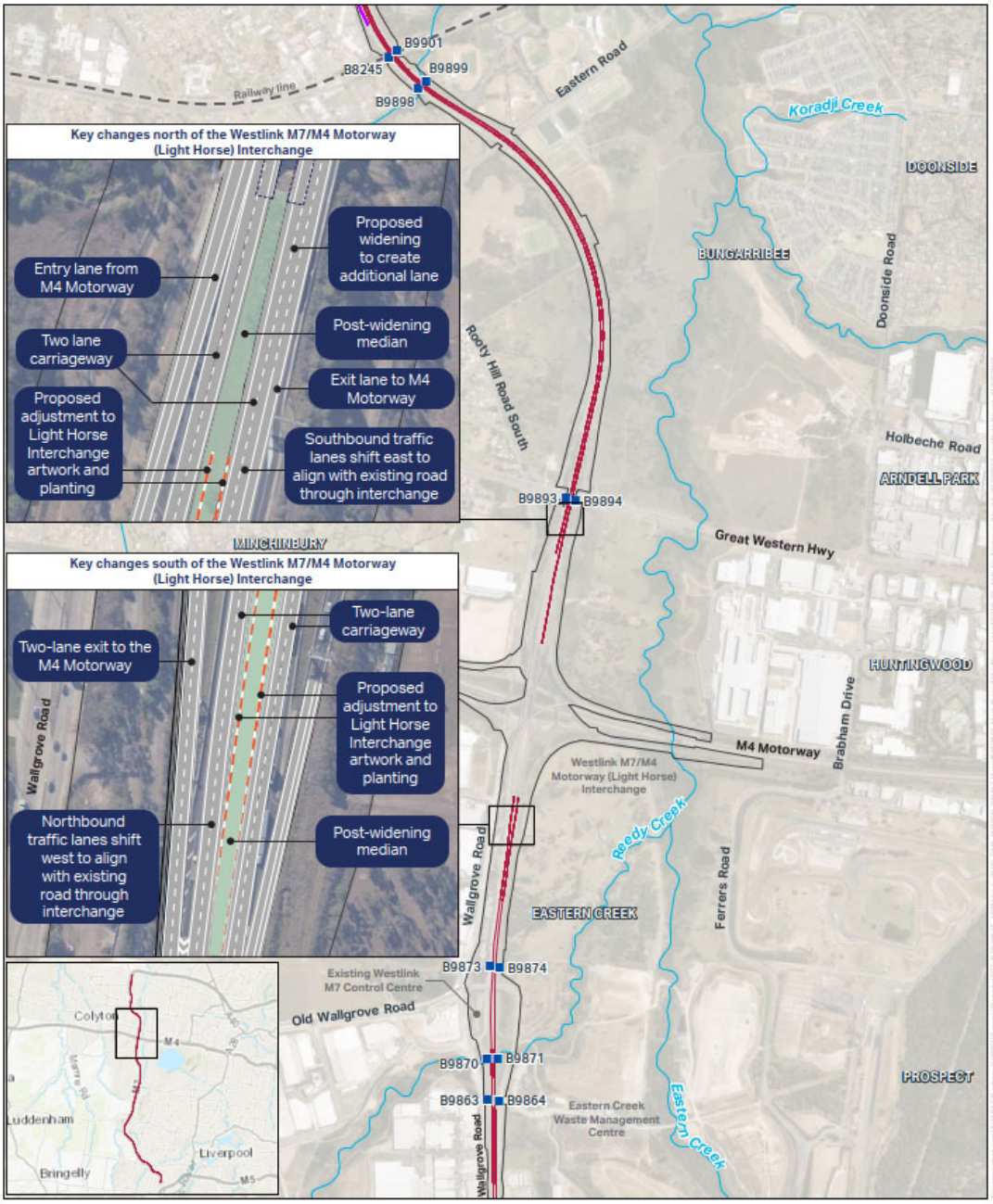


FIGURE 2-4: KEY FEATURES

Legend

- Proposed widening
- Operational footprint
- Watercourse
- Existing noise wall
- Artwork potentially impacted by proposed modification
- Transport for NSW bridge number B9#### proposed to be widened

Figure 2-4 Key features (Map 4)

FIGURE 2-5: KEY FEATURES

Figure 2-5 Key features (Map 5)

3 RELEVANT LEGISLATION, GUIDELINES AND POLICY

This section outlines the legislation, guidelines and policy that are relevant to the assessment.

3.1 Surface water

3.1.1 Commonwealth guidelines

Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC Water Quality Guidelines) (Australian and New Zealand and Conservation Council 2000) provide a framework for managing the water quality of freshwater, groundwater and marine waters. The ANZECC Water Quality Guidelines were recently updated to incorporate new guidance and updated default guideline values for certain regions (ANZG 2018) (referred to herein as the ANZG Water Quality Guidelines).

The ANZG and ANZECC Water Quality Guidelines form the central technical reference of the National Water Quality Management Strategy, which the Commonwealth and all state and territory governments have adopted for managing water quality.

The ANZECC Water Quality Guidelines provide default trigger values for physical and chemical stressors as well as toxicants for waterways across Australia. For the purpose of the surface water assessment for the proposed modification both guidelines continue to be applied as the default trigger values for aquatic ecosystems relevant to the southeast coast of Australia have not yet been updated as part of the ANZG Water Quality Guidelines.

The ANZG and ANZECC Water Quality Guidelines indicate that the default trigger values are not necessarily designed for the direct application to discharge criteria as has been applied to the present investigation. However, in the absence of a set of locally derived trigger values for the receiving watercourses, the adoption of the default trigger values from the ANZG and ANZECC Water Quality Guidelines would be protective of the desired environmental values of the receiving waters.

The default trigger values provided in the ANZG and ANZECC Water Quality Guidelines for the environmental values that have been established for the receiving waters are provided in **Section 4.1.2** of this report.

Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The EPBC Act is the Australian Government's key piece of environmental legislation. The EPBC Act applies to developments and associated activities that have the potential to significantly impact on Matters of National Environmental Significance (MNES) protected under the Act.

The impact of the proposed modification on MNES is addressed in the Appendix H (Biodiversity Development Assessment Report) of the Modification Report which identifies the presence or otherwise of nationally listed threatened species and threatened ecological communities on or near the proposed modification.

The presence of nationally listed threatened species and threatened ecological communities under the EPBC Act has been taken into consideration in the identification of sensitive receiving environments, the details of which is presented in Section 4.1.2 of this report.

3.1.2 State legislation, guidelines and policies

NSW Water Quality Objectives

The NSW Water Quality Objectives (NSW WQOs) (DECCW, 2006) set out the environmental values and long term goals for protecting and enhancing surface waters in NSW.

The environmental values that are set out in the NSW WQOs represent the community based values and uses for the rivers, creeks, estuaries and lakes within NSW, such as healthy aquatic life or water suitable for recreational activities like swimming and boating, and drinking water. For each environmental value the NSW WQOs contain a set of water quality indicators and associated guideline values that are recommended in the ANZECC Water Quality Guidelines to assess the water quality that is required to protect environmental values.

The proposed modification lies within areas of the Hawkesbury-Nepean River and Georges River catchments. In the case of the Hawkesbury-Nepean River catchment, the NSW WQOs refer to the *Healthy Rivers Commission Inquir*y (NSW Government 1995) for the relevant environmental values (HRC WQOs).

Section 4.1.2 of this report sets out the environmental values that have been for each watercourse in accordance with the NSW WQOs and HRC WQOs.

Protection of the Environment Operations Act 1997 and Protection of the Environment Administration Act 1991

The *Protection of the Environment Operations Act 1997* (POEO Act) regulates waste management, noise, air and water pollution. The POEO Act is aimed at protecting, restoring and enhancing the quality of the environment and to reduce risks to human health. It sets out obligations and responsibilities for managing activities that may cause environmental harm.

In regard to the operation of the proposed modification, under the POEO Act the operators of roads such as the approved project should ensure that any discharges into water of substances likely to cause harm to the environment must be reduced to harmless levels. The approved project contains water quality basins and tanks that provide containment in the event of a fuel or chemical spill, the operation of which would be maintained following the proposed modification.

In regard to the construction of the proposed modification, works would include road pavement widening and bridge development which are listed as road construction activities in Schedule 1 of the POEO Act as requiring an Environmental Protection Licence under the POEO Act.

The *Protection of the Environment Administration Act 1991* (POEA Act) establishes the roles and responsibilities of the Environment Protection Authority in relation to the quality of the environment, environmental audit and reports on the state of the environment.

Water Management Act 2000

The *Water Management Act 2000* (WM Act) provides guidance for the sustainable and integrated management of water sources within NSW. The WM Act is aimed at balancing the need to allocate and provide water for the environmental health of our rivers and groundwater systems, with provisioning licence holders with secure access to water.

The *Water Management (General) Regulation 2018* specifies the procedural, technical and licence requirements under the WM Act as well as the functions and powers of water supply authorities. Under Schedule 4, Part 1, Clause 2 of the *Water Management (General) Regulation 2018* road authorities are exempt from requiring to hold a licence to take water for the purposes of road construction and maintenance.

Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) provides for the conservation, development and sharing of fishery resources within NSW for the benefit of present and future generations. A key objective of the FM Act is the conservation of threatened species, populations and ecological communities of fish and their habitats.

The proposed modification of the Westlink M7 would involve the augmentation of existing bridge crossings over Maxwells Creek, Cabramatta Creek, Hinchinbrook Creek, Ropes Creek, Reedy Creek, Eskdale Creek and Angus Creek. Appendix H (Biodiversity Development Assessment Report) of the Modification Report includes mapping of the presence of and type of aquatic habitat in the vicinity of these creek crossings in accordance with the FM Act. The augmentation of these bridges would be designed and constructed in accordance with the guidelines entitled *"Why do fish need to cross the road?"* (NSW Fisheries 2003) in order to minimise their impact on existing fish habitat.

Under section 199 of the FM Act, Transport as a public authority has a duty to notify the Minister responsible under that Act, before it carries out or authorises any dredging or reclamation work. The Minister may within 21 days of receiving that notification, raise any matters concerning the proposed work. Transport must consider any matter raised by the Minister before it carries out the proposed work.

State Environmental Planning Policy (Biodiversity and Conservation) 2021

Chapter 9 (former Sydney Regional Environmental Plan No 20 – Hawkesbury-Nepean River (No 2-1997) (SREP 20))

Chapter 9 of the *State Environmental Planning Policy (Biodiversity and Conservation) 2021* applies to certain land within the Hawkesbury-Nepean River catchment that lies within local government areas in the greater metropolitan region of Sydney. Chapter 9 would apply to those sections of the proposed modification that lie within the Ropes Creek and Eastern Creek catchments, which are located in the local government areas of Fairfield and Blacktown.

The stated aim of Chapter 9 is to protect the environment of the Hawkesbury-Nepean River system by ensuring that the impacts of future land uses are considered in a regional context.

Clause 9.5(3) titled "Water quality" states the following:

"Policy: Future development must not prejudice the achievement of the goals of use of the river for primary contact recreation (being recreational activities involving direct water contact, such as swimming) and aquatic ecosystem protection in the river system. If the quality of the receiving waters does not currently allow these uses, the current water quality must be maintained, or improved, so as not to jeopardise the achievement of the goals in the future. When water quality goals are set by the Government these are to be the goals to be achieved under this policy.

Note: Aquatic ecosystems and primary contact recreation have the same meanings as in the document entitled Australian Water Quality Guidelines for Fresh and Marine Waters, published in 1992 by the Australian and New Zealand Environment and Conservation Council.

Strategies:

(a) Quantify, and assess the likely impact of, any predicted increase in pollutant loads on receiving waters.

(b) Consider the need to ensure that water quality goals for primary contact recreation and aquatic ecosystem protection are achieved and monitored.

(c) Approve development involving primary contact recreation or the withdrawal of water from the river for human contact (not involving water treatment), such as showers, only in locations where water quality is suitable (regardless of water temperature).

(d) Do not carry out development involving on-site disposal of sewage effluent if it will adversely affect the water quality of the river or groundwater. Have due regard to the nature and size of the site.

(e) Develop in accordance with the land capability of the site and do not cause land degradation.

(f) Consider the need for an Erosion and Sediment Control Plan (to be in place at the commencement of development) where the development concerned involves the disturbance of soil.

(g) Minimise or eliminate point source and diffuse source pollution by the use of best management practices.

(h) Site and orientate development appropriately to ensure bank stability. Plant appropriate native vegetation along banks of the river and tributaries of the river, but not so as to prevent or inhibit the growth of aquatic plants in the river, and consider the need for a buffer of native vegetation.

(i) Consider the impact of the removal of water from the river or from groundwater sources associated with the development concerned.

(j) Protect the habitat of native aquatic plants."

The policy objectives set out above are consistent with the environmental values that have been established for the Hawkesbury Nepean River catchment in the HRC WQOs (refer **Section 4.1.2** of this report for further details).

Chapter 11 (former Greater Metropolitan Regional Environmental Plan No 2 – Georges River Catchment (1999 EPI 52))

Chapter 11 applies to certain land within the Georges River catchment that lies within the local government areas of the greater metropolitan region of Sydney. Chapter 11 would apply to those sections of the proposed modification that lie within the Cabramatta Creek catchment, which are located in the local government areas of Liverpool and Fairfield.

A stated aim of Chapter 11 is to maintain and improve the water quality of the Georges River and its tributaries and ensure that development within the catchment is managed in a manner that is in keeping with the national, State, regional and local significance of the catchment.

Clause 11.4(2) of GMREP 2 sets out the following specific aims and objectives of the plan:

"Environmental protection and water quality and river flows

(a) to preserve and protect and to encourage the restoration or rehabilitation of regionally significant sensitive natural environments such as wetlands (including mangroves, saltmarsh and seagrass areas), bushland and open space corridors within the Catchment, by identifying environmentally sensitive areas and providing for appropriate land use planning and development controls,

(b) to preserve, enhance and protect the freshwater and estuarine ecosystems within the Catchment by providing appropriate development,

(c) to ensure that development achieves the environmental objectives for the Catchment.

Regional role and land use

(a) to identify land uses in the Catchment which have the potential to impact adversely on the water quality and river flows in the Georges River and its tributaries and to provide appropriate planning controls aimed at reducing adverse impacts on the water quality and river flows,

(b) to conserve, manage and improve the aquatic environment within the Catchment which is a significant resource base for the aquaculture industry, by providing controls aimed at reducing pollution entering the Catchment's watercourses,

(c) to protect the safety and well being of the local and regional community in accordance with standards and processes aimed at improving the water quality and river flows in the Catchment to enable recreation,

(d) to aid in the improvement of the environmental quality of Botany Bay in conjunction with other regional planning instruments."

The aims and objectives set out above are consistent with the NSW Water Quality Objectives for the Georges River catchment, the details of which are discussed further in **Section 4.1.2** of this report.

Managing Urban Stormwater – Soils and Construction series

The *Managing Urban Stormwater – Soils and Construction* series, commonly referred to as the 'Blue Book', are a set of guidelines to assist councils and industry in reducing the impact of land disturbance activities on waterways by better management of soil erosion and sediment control during the construction phase of urban development.

The volumes of the Blue Book that are relevant to the construction of the proposed modification are:

- Volume 1 (Landcom 2004)
- Volume 2D – Main Roads (Department of Environment and Climate Change (DECC) 2008)

Section 6.1 of this report provides an overview of how the Blue Book would be used to develop erosion and sediment control measures to manage the impact that the construction of the proposed modification could have on water quality in the receiving drainage lines and watercourses.

3.1.3 Council guidelines

Liverpool City Council, Fairfield City Council and Blacktown City Council all have guidelines and policies relating to the assessment of water quality impacts, as well as target reductions in the annual average weight of pollutant loads for commercial, industrial and residential development in their respective local government areas.

Table 3.1 lists the target reductions in gross pollutants, total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN) for each council as well as those set out in:

- *Managing Urban Stormwater – Council Handbook* (EPA 1997)
- *Georges River Estuary Coastal Zone Management Plan* (Georges River Combined Councils Committee (GRCCC) 2013).

While not a mandatory requirement of the proposed modification under Part 5 of the EP&A Act, the targets set out in Table 3.1 provide a basis for comparing the performance of the water quality strategy for the proposed modification against the objectives set by the local councils for development in their local government areas. However, the primary objective of the surface water assessment is to demonstrate the performance of the water quality strategy for the proposed modification against the criteria set out in the NSW WQOs.

Table 3.1 Council pollutant load reduction targets

Pollutant	Liverpool City Council	Fairfield City Council[(1)]	Blacktown City Council	EPA 1997	GRCCC 2013
Gross Pollutants	90%	90%	90%	-	90%
TSS	85%	80%	85%	80%	85%
TP	45%	55%	65%	45%	60%
TN	45%	40%	45%	45%	45%

1. Only applies to development in the Fairfield City Council area that is located in the Georges River catchment.

3.2 Flooding

3.2.1 Commonwealth guidelines

Australian Rainfall and Runoff

Australian Rainfall and Runoff (ARR) is a national guideline for the estimation of design flood characteristics in Australia. The application of the procedures, inputs and parameters set out in ARR is an important component in the provision of reliable and robust estimates of design flood behaviour to ensure that projects such as the proposed modification are designed in a manner that manages the impact of flooding.

The third edition of ARR was released in 1987 (ARR 1987) (Institute of Engineers Australia (IEAust) 1987), while a fourth edition of ARR was issued in 2019 (ARR 2019) (Geoscience Australia (GA) 2019).

The hydrologic and hydraulic models (collectively referred to as 'flood models') that were relied on for the present investigation were based on models that were developed as part of the following studies:

- *Cabramatta Creek Flood Study and Basin Strategy Review* (Bewsher Consulting 2010)
- *Eastern Creek Catchment Hydrological Assessment* (WMAwater 2013)
- *Eastern Creek Hydraulic Assessment* (Catchment Simulation Solution 2014).

Bewsher Consulting 2010 was developed on behalf of Liverpool City Council, while WMAwater 2013 and Catchment Simulation Solutions 2014 were developed on behalf of Blacktown City Council. The studies are used by the respective councils to define flood behaviour in the Cabramatta Creek and Eastern Creek catchments and to assist in the application of flood planning controls.

As part of Bewsher Consulting 2010, a set of flood models were developed using the XP-RAFTS and TUFLOW modelling software to define flood behaviour across the Cabramatta Creek floodplain and its tributaries, including Maxwells Creek and Hinchinbrook Creek. The models were calibrated through comparison of modelled flood behaviour with flood behaviour that was recorded during historical flood events that occurred in August 1986 and April 1988.

WMAwater 2013 involved the development of a XP-RAFTS hydrologic model of the Eastern Creek catchment, the discharge hydrographs from which were subsequently used as inputs to a TUFLOW hydraulic model that was developed as part of Catchment Simulation Solution 2014. Both WMAwater 2013 and Catchment Simulation Solution 2014 note that insufficient historical flood data were available of a suitable nature for model calibration. As a result, the validation of the models was based on comparison with previous studies and results from alternative methods.

As all three studies listed above were prepared prior to the release of ARR 2019, they were based on the procedures set out in ARR 1987. For consistency with the studies undertaken for Liverpool City Council and Blacktown City Council, the present investigation has also adopted ARR 1987 procedures for defining flood behaviour in the Cabramatta Creek and Eastern Creek catchments. As part of the present investigation a sensitivity study was also carried out to assess the likely changes in predicted flood behaviour in the vicinity of the proposed modification based on the adoption of the ARR 2019 procedures in the Cabramatta Creek and Eastern Creek catchments. The findings of this sensitivity study are presented in Section 7.2.5.

In the absence of existing flood studies for the portion of the Ropes Creek catchment that is in the vicinity of the proposed modification, new hydrologic and hydraulic models have been developed using the latest procedures that are set out in ARR 2019 for the derivation of design rainfalls, temporal patterns and rainfall losses.

Section 4.2.3 of this report provides further details of the approach that has been adopted to define flood behaviour in the vicinity of the proposed modification within the Cabramatta Creek, Ropes Creek and Eastern Creek catchments.

3.2.2 State legislation, guidelines and policies

Floodplain development manual

The *Floodplain Development Manual* (FDM) (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 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 FDM 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 FDM promotes the concept that proposed developments be treated on their merit rather than through the imposition of rigid and prescriptive criteria.

Flood and floodplain risk management studies undertaken by local councils as part of the NSW Government's Floodplain Management Program are carried out in accordance with the merits based approach promoted by the FDM. A similar merits based approach has been adopted in the assessment of the impacts that the proposed modification would have on existing flood behaviour and also in the development of a range of potential measures which would be aimed at mitigating the impact of the proposed modification on the existing environment. In accordance with the FDM, the hydraulic and hazard categorisation of the floodplain was also considered when assessing the impact of the proposed modification on existing flood behaviour as well as the impact of flooding to the proposed modification and its users.

Guideline on development controls on low risk flood areas

In July 2021 the NSW Government issued Planning Circular PS 21-006 *Considering flooding in land use planning: guidance and statutory requirements*. The circular provides advice on a package of changes regarding how land use planning considers flooding and flood-related constraints. The package includes:

- an amendment to clause 7A of Schedule 4 to the *Environmental Planning and Assessment Regulation 2000* (the Regulation)
- a revised local planning direction regarding flooding issued under section 9.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act)
- two local environmental plan clauses which introduce flood related development controls
- a new guideline: *Considering Flooding in Land Use Planning (2021)* (the guideline)
- revoking the *Guideline on Development Controls on Low Flood Risk Areas (2007)*.

While Planning Circular PS 21-006 specifically relates to planning proposals under Part 3 of the EP&A Act, it is relevant to the proposed modification under Part 5 of the EP&A Act in that it sets out the approach to establishing flood planning controls for surrounding development and is therefore an important consideration in assessing the impact of the proposed modification on existing flood risk as well as the future development potential of land outside the proposed modification footprint.

Planning proposals are required to be consistent with directions issued under section 9.1 of the EP&A Act. *Local Planning Direction 4.3—Flooding* requires, among other matters, a planning proposal to be consistent with the principles of the FDM. The direction has been revised to remove the need to obtain exceptional circumstances to apply flood-related residential development controls above the 1% Annual Exceedance Probability (AEP) flood event. It also ensures planning proposals consider the flood risks and do not permit residential accommodation in high hazard areas and other land uses on flood prone land where the development cannot effectively evacuate.

The direction also makes provision for special flood considerations where councils have chosen to adopt the optional *Special flood considerations* clause in an LEP. The revised direction will apply to planning proposals that have not been issued with a gateway determination under section 3.34(2) of EP&A Act.

The guideline supports the principles of the FDM and provides advice to councils on land use planning on flood-prone land. It provides councils with greater flexibility in defining the areas to which flood-related development controls apply, with consideration of defined flood events, freeboards, low-probability/high-consequence flooding and emergency management considerations. The FDM states that a defined flood event (DFE) of 1% AEP, or a historic flood of similar scale, plus a freeboard should generally be used as the minimum level for setting residential flood planning levels (FPL). Choosing different DFEs and freeboards requires justification based on a merit assessment that is consistent with the floodplain risk management process and principles of the FDM. Special flood considerations apply to sensitive and hazardous development in areas between the flood planning area (FPA) and the PMF and to land that may cause a particular risk to life and other safety considerations that require additional controls. These controls relate to the management of risk to life and the risk of hazardous industry/hazardous storage establishments to the community and the environment in the event of a flood.

A similar merits based approach to that described in the guideline has been adopted in the assessment of the impacts that the proposed modification would have on existing flood behaviour and also in the development of a range of potential measures which would be aimed at mitigating the impact of the proposed modification on the existing environment. Consistent with the guideline the assessment that is presented in this report has taken into consideration floods larger than the 1% AEP event, up to the PMF.

Environmental Planning and Assessment Act 1979

The EP&A Act and associated regulations set out the system of environmental planning and assessment for the state of New South Wales.

In July 2009 the NSW Minister for Planning issued a list of directions to local councils under section 117(2) of the EP&A Act. These directions were later amended on 14 July 2021 as part of the NSW Government's update of its Flood Prone Land package. *Direction 4.3 - Flood Prone Land* (Direction 4.3) applies to all councils that contain flood prone land within their LGA and requires that:

> *A planning proposal must include provisions that give effect to and are consistent with:*
>
> *(a) the NSW Flood Prone Land Policy,*
>
> *(b) the principles of the Floodplain Development Manual 2005,*
>
> *(c) the Considering flooding in land use planning guideline 2021, and*
>
> *(d) any adopted flood study and/or floodplain risk management plan prepared in accordance with the principles of the Floodplain Development Manual 2005 and adopted by the relevant council.*
>
> *A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Environmental Protection Zones to a Residential, Business, Industrial or Special Purpose Zones.*
>
> *A planning proposal must not contain provisions that apply to the flood planning area which:*
>
> *(a) permit development in floodway areas,*

(b) permit development that will result in significant flood impacts to other properties,

(c) permit development for the purposes of residential accommodation in high hazard areas,

(d) permit a significant increase in the development and/or dwelling density of that land,

(e) permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,

(f) permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require development consent,

(g) are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or

(h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.

A planning proposal must not contain provisions that apply to areas between the flood planning area and probable maximum flood to which Special Flood Considerations apply which:

(a) permit development in floodway areas,

(b) permit development that will result in significant flood impacts to other properties,

(c) permit a significant increase in the dwelling density of that land,

(d) permit the development of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,

(e) are likely to affect the safe occupation of and efficient evacuation of the lot, or

(f) are likely to result in a significantly increased requirement for government spending on emergency management services, and flood mitigation and emergency response measures, which can include but not limited to road infrastructure, flood mitigation infrastructure and utilities.

For the purposes of preparing a planning proposal, the flood planning area must be consistent with the principles of the Floodplain Development Manual 2005 or as otherwise determined by a Floodplain Risk Management Study or Plan adopted by the relevant council.

Direction 4.3 also states that a planning proposal may be inconsistent with the terms of this direction only if the planning proposal authority can satisfy the Secretary of the Department of Planning and Environment (or their nominee) that:

(a) the planning proposal is in accordance with a floodplain risk management study or plan adopted by the relevant Council in accordance with the principles and guidelines of the Floodplain Development Manual 2005, or

(b) where there is no council adopted floodplain risk management study or plan, the planning proposal is consistent with the flood study adopted by the council prepared in accordance with the principles of the Floodplain Development Manual 2005 or

(c) the planning proposal is supported by a flood and risk impact assessment accepted by the relevant planning authority and is prepared in accordance with the principles of the Floodplain Development Manual 2005 and consistent with the relevant planning authorities' requirements, or

(d) the provisions of the planning proposal that are inconsistent are of minor significance as determined by the relevant planning authority.

As with Planning Circular PS 21-006, Direction 4.3 specifically relates to planning proposals under Part 3 of the EP&A Act. However, it is relevant to the proposed modification under Part 5 of the EP&A Act in that it sets out the approach to establishing flood planning controls for surrounding development and is therefore an important consideration in assessing the impact of the proposed modification on existing flood risk as well as the future development potential for land outside the proposed modification footprint.

Floodplain risk management guidelines on climate change

Scientific evidence shows that climate change is expected to lead to an increase in flood producing rainfall intensities and sea levels. The significance of these effects on flood behaviour would vary depending on geographic location and local topographic conditions. Given the location and elevation of the Westlink M7 and the watercourses that it crosses, future sea level rise would not impact on flood behaviour in its vicinity. Consideration of flood behaviour under future climate change has therefore focused on potential increases in rainfall intensities. Current guidance on the impact of future climate change on increased rainfall intensities and how this have been taken into consideration in the flood assessment for the proposed modification is outlined below.

The NSW Government's *Floodplain Risk Management Guideline: Practical Considerations of Climate Change* (DECC 2007) recommends that until more work is completed in relation to the climate change impacts on rainfall intensities, sensitivity analyses should be undertaken based on increases in rainfall intensities of between 10 and 30 per cent. Under current climatic conditions, increasing the 1% AEP design rainfall intensities by 10 per cent would produce about a 0.5% AEP flood; and increasing those rainfalls by 30 per cent would produce about a 0.2% AEP flood. On current projections the increase in rainfalls within the design life of the proposed modification is likely to be around 10 per cent, with the higher value of 30 per cent representing an upper limit.

Based on the recommendations set out in DECC 2007, the 0.5% AEP and 0.2% AEP design storms were adopted as being analogous to an increase in 1% AEP design rainfall intensities of 10 and 30 per cent respectively. This range of potential increases also encompasses the values given in ARR 2019, which suggests a potential increase in rainfall intensities of between 9.5% and 19.7% by 2090 for Representative Concentration Pathways (RCPs) of between 4.5 and 8.5. RCPs are a greenhouse gas concentration trajectory adopted by the Intergovernmental Panel on Climate Change, with a value of 8.5 considered to represent a 'worse case' greenhouse gas emission scenario.

3.2.3 Council policies and guidelines

Flood related planning controls

The proposed modification is located in the Liverpool City Council, Fairfield City Council and Blacktown City Council local government areas. The *Liverpool Local Environmental Plan 2008, Fairfield Local Environmental Plan 2013* and *Blacktown Local Environmental Plan 2015* each contain flood planning clauses that apply to the determination of a Part 4 development application by a consent authority under the EP&A Act. While not a mandatory requirement of the proposed modification under Part 5 of the EP&A Act, the flood planning clauses in the respective Local Environmental Plans (LEPs) have been taken into consideration in establishing the approach to assessing the impact of the proposed modification on flood behaviour.

Clause 5.21 of all three council LEPs titled 'Flood planning" state the following:

"(1) The objectives of this clause are as follows -

(a) to minimise the flood risk to life and property associated with the use of land,

(b) to allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change,

(c) to avoid adverse or cumulative impacts on flood behaviour and the environment,

(d) to enable the safe occupation and efficient evacuation of people in the event of a flood.

(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development -

(a) is compatible with the flood function and behaviour on the land, and

(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and

(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and

(d) incorporates appropriate measures to manage risk to life in the event of a flood, and

(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.

(3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters -

(a) the impact of the development on projected changes to flood behaviour as a result of climate change,

(b) the intended design and scale of buildings resulting from the development,

(c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,

(d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.

(4) A word or expression used in this clause has the same meaning as it has in the Considering Flooding in Land Use Planning Guideline unless it is otherwise defined in this clause.

(5) In this clause -

***Considering Flooding in Land Use Planning Guideline** means the Considering Flooding in Land Use Planning Guideline published on the Department's website on 14 July 2021.*

***flood planning area** has the same meaning as it has in the Floodplain Development Manual.*

***Floodplain Development Manual** means the Floodplain Development Manual (ISBN 0 7347 5476 0) published by the NSW Government in April 2005."*

In May 2021 the NSW Government issued the Standard Instrument (Local Environmental Plans) Amendment (Flood Planning) Order 2021 that sets out changes to the flood planning clauses of the Local Environmental Plans of the respective councils that took effect on 14 July 2021. The updates to the above flood planning clauses under the Standard Instrument (Local Environmental Plans) Amendment (Flood Planning) Order 2021 are aimed at supporting better management of flood risk and building greater resilience in communities located on floodplains during floods greater than 1% AEP up to the PMF. The assessment that is presented in this report has taken into consideration floods larger than the 1% AEP event, up to the PMF and is therefore considered to be consistent with the updates to clause 5.21.

Liverpool City Council, Fairfield City Council and Blacktown City Council have all prepared Development Control Plans (DCPs) to guide development in accordance with their respective Local Environmental Plans. As with the flood planning clauses of the LEPs for each council, the requirements set out in respective DCPs are not strictly binding on the proposed modification under Part 5 of the EP&A Act. However, the flood related requirements of the respective DCPs have been taken into consideration in establishing the approach to assessing the impact of the proposed modification on existing flood behaviour

The DCPs for Liverpool City Council, Fairfield City Council and Blacktown City Council each contain a set of flood related development controls that have been developed based on the merits-based approach that is set out in the FDM to manage the impact of flooding on development, as well as the impact that development would have on flood behaviour. Each DCP also contains requirements for the provision of on-site detention in order to mitigate an increase in the quantity of runoff discharging into the respective council's receiving drainage systems. Notwithstanding these council requirements there would be a general requirement of the proposed modification to manage any adverse changes to existing flood behaviour. The assessment of flooding patterns under the pre- and post-proposed modification conditions is presented in Sections 5.7 and 6.2 of this report, respectively.

4 METHODOLOGY

This section describes the methodology used to undertake the surface water and flooding assessments.

4.1 Surface water

4.1.1 Key tasks

The key tasks comprising the surface water assessment were broadly as follows:

- Review of available information on the catchments within which the proposed modification would be located, including existing catchment studies and plans of management, available water quality sampling data, rainfall data, soil conditions, as well as details of the existing surface water controls that are located along the Westlink M7
- Field assessment and surface water quality monitoring to supplement the available water quality sampling data and provide a general understanding of the drainage related features along the Westlink M7 within the proposed modification footprint
- Identification of sensitive receiving environments and environmental values that are relevant to the proposed modification
- Establish the water quality objectives and criteria that are relevant to the receiving waterways into which runoff from the Westlink M7 discharges
- Assessment of existing water quality in the receiving waterways based on available water quality monitoring data and comparison against the criteria set out the in the water quality objectives
- Assessment of the potential impacts to surface water during the construction of the proposed modification
- Development of a set of rainfall runoff models using the MUSIC software to assess the volume and quality of surface water runoff that is discharged from the Westlink M7 under pre-proposed modification conditions
- Update of the MUSIC model to reflect proposed modification conditions to assess the potential impact it would have on the volume and quality of surface water runoff during its operation
- Assessment of the impact of the proposed modification on surface water quality with reference to the relevant Water Quality Objectives
- Assessment of potential measures which aim to mitigate the impact of the proposed modification on surface water conditions during its construction and operation.

The followings sections of this report set out the methodology which was adopted in the assessment of surface water conditions under existing (i.e. pre-proposed modification) conditions and during both the construction and operational phases of the proposed modification.

4.1.2 Identification of sensitive receiving environments

Sensitive receiving environments were identified based on consideration of:

- aquatic habitat that has been assessed as part of the *Aquatic Ecology Report* that is contained in Annexure A of Appendix H (Biodiversity Development Assessment Report) of the Modification Report based on:

- mapping of key fish habitat
- classification of waterways for fish passage
- presence of coastal wetlands mapped under the State Environmental Planning Policy (Coastal Management) 2018
- presence of aquatic threatened species, populations or communities under the EPBC Act.

- whether the proposed modification falls within a drinking water catchment
- areas that contribute to aquaculture or commercial fishing.

The identification of sensitive receiving environments based on mapping of key fish habitat, classification of waterways for fish passage and presence of coastal wetlands is provided in **Section 5.3** of this report. In regard to the other considerations listed above it is noted that:

- the *Aquatic Ecology Report* in Annexure A of Appendix H (Biodiversity Development Assessment Report) of the Modification Report found that there were no aquatic threatened species, populations or communities under the EPBC Act that are considered to have a moderate to high likelihood of occurrence within, or up and downstream of, the waterways present within the construction footprint.
- The proposed modification has not been identified as falling within a drinking water catchment.
- The proposed modification has not been identified as being located in an area that contributes to aquaculture or commercial fishing.

4.1.3 Water quality objectives

As outlined in **Section 3.1** of this report, the NSW WQOs and the HRC WQOs were respectively used to establish the environmental values within the Georges River and Hawkesbury-Nepean River catchments. For each environmental value a range of water quality indictors and associated guideline values have been identified from the ANZG and ANZECC Water Quality Guidelines.

Table 4.1 lists the environmental values that apply to the watercourses that receive runoff from the proposed modification. The following section of the report provides a brief description of each environmental value and sets out the key water quality indicators and guideline values relevant to each.

Table 4.1 Environmental values of receiving watercourses

Catchment	Environmental value				
Catchment	**Aquatic ecosystem**	**Visual amenity**	**Primary and secondary contact recreation**	**Irrigation water supply**	**Homestead water supply**
Georges River	x	x	x		
Hawkesbury-Nepean River	x	x	x	x	x

Protection of aquatic ecosystems

Water quality parameters that affect the health of aquatic ecosystems can be divided into those that have a direct toxic effect on organisms and animals (toxicants) and those that indirectly affect ecosystems causing a problem for a specific environmental value (stressors). Toxicants which are relevant to this assessment are primarily heavy metals, while the stressors include nutrients, such as total nitrogen (TN), ammonia, oxidised nitrogen, phosphorus (TP) and filterable reactive phosphorus (FRP), as well as turbidity, total suspended solids (TSS), salinity and pH.

The MUSIC modelling that has been carried out to assess the impact of the proposed modification on surface water quality is able to quantify three of the primary stressors comprising TSS, TP and TN. While toxicants are not directly quantified, pollutants such as heavy metals, hydrocarbons and other toxicants in particulate form are usually attached to fine sediments and so can be indirectly measured through quantification of TSS loads and concentrations (*Australian Runoff Quality: A Guide to Water Sensitive Urban Design* Engineers Australia, 2006).

Visual amenity

To maintain the visual amenity of a waterbody the ANZG and ANZECC Water Quality Guidelines recommend that it should be free from obvious pollution including debris, oil, scum and other matter, including substances that produce objectionable colour, odour, taste or turbidity.

As noted in the NSW WQOs, indicators for visual amenity are linked to those aimed at protecting aquatic ecosystems and stormwater management. Visual amenity also needs to be protected to maintain water quality for primary and secondary contact recreation.

Recreational water quality

Measures for recreational water quality can be divided into bacteria and toxicants. Bacteria levels are not directly relevant to this assessment given the typical types of pollutants in road runoff. The guideline values for toxicants that are provided in the ANZECC Water Quality Guidelines for primary and secondary recreation are higher (i.e. less conservative) than those recommended for the protection of aquatic ecosystems. As a result, the guideline values for toxicants that have been adopted for this assessment are based on the protection of aquatic ecosystems.

Irrigation water supply

This relates to the protection of waters that are applied to crops and pasture. The ANZG and ANZECC Water Quality Guidelines indicate that for the protection of irrigation water supply, several biological, pesticide and toxicant parameters need to be controlled. The guideline values for toxicants that are provided in the ANZECC Water Quality Guidelines for irrigation water supply are higher (i.e. less conservative) than those recommended for the protection of aquatic ecosystems. As a result, the guideline values for toxicants that have been adopted for this assessment are based on the protection of aquatic ecosystems.

Homestead water supply

This relates to the protection of waters that are used for domestic application in homesteads, including drinking, cooking and bathing. For the protection of human consumers, the ANZG and ANZECC Water Quality Guidelines indicates that toxicants, bacteria and chemical contaminants are of primary concern.

Homestead water supply would no longer be relevant in the portion of the Eastern Creek catchment that is relevant to the proposed modification as reticulated supply is available.

Water quality indicators and relevant guideline values

Table 4.2 sets out the key water quality indicators and associated guideline values that have been established for each environmental value using the ANZG and ANZECC Water Quality Guidelines.

For indicators relevant to the proposed modification, the guideline values for the protection of aquatic ecosystems provides the most conservative water quality criteria of the nominated environmental values and have therefore been adopted in the assessment of the surface water quality in the receiving watercourses, as well as the discharges from the proposed modification. A comparison of the guideline values for the protection of aquatic ecosystems against existing water quality in the receiving waterways is presented in Section 5.6, while a comparison against the modelled quality of runoff discharging from the Westlink M7 under approved project and proposed modification conditions is presented in **Section 7.1.2** of this report.

Table 4.2 Water quality objectives relevant to the proposed modification

Environmental value	Indicator	Guideline value
Aquatic ecosystems[(1)] Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term	Total phosphorus	0.025mg/L
	Total nitrogen	0.35mg/L
	Chlorophyll-a	0.003mg/L
	Turbidity	6-50 Nephelometric Turbidity Unit (NTU)[(2)]
	Total suspended solids	< 50 mg/L
	Salinity (electrical conductivity)	200-300µS/cm
	Dissolved oxygen	85-110% saturation
	pH	6.5-8.5
	Chemical contaminants or toxicants such as [(4)]:	Based on Table 3.4.1 of the ANZECC Water Quality Guidelines:
	Arsenic	0.013 mg/L
	Cadmium	0.0002 mg/L
	Chromium (VI)	0.0001 mg/L
	Copper	0.0014 mg/L
	Nickel	0.011 mg/L
	Lead	0.0034 mg/L
	Mercury	0.00006 mg/L
	Zinc	0.008 mg/L
	Benzene	0.95 mg/L
	Ethylbenzene	0.08 mg/L
	Toluene	0.18 mg/L

Environmental value	Indicator	Guideline value
Visual amenity Aesthetic qualities of waters	Visual clarity and colour	Natural visual clarity should not be reduced by more than 20%. Natural hue of water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%.
	Surface films and debris	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter.
	Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts
Secondary contact recreation Maintaining or improving water quality of activities such as boating and wading, where there is a low probability of water being swallowed	Faecal coliforms	Median bacterial content in fresh and marine waters of < 1000 faecal coliforms per 100 mL, with 4 out of 5 samples < 4000/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month).
	Enterococci	Median bacterial content in fresh and marine waters of < 230 enterococci per 100 mL (maximum number in any one sample: 450-700 organisms/100 mL).
	Algae and blue-green algae	< 15 000 cells/mL
	Nuisance organisms	Use visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable.
	Chemical contaminants	Toxic substances should not exceed values in Tables 5.2.3 and 5.2.4 of the ANZECC Water Quality Guidelines.
	Visual clarity and colour	As per the guideline values for visual amenity.
	Surface films	As per the guideline values for visual amenity.
Primary contact recreation Maintaining or improving water quality for activities such as swimming where there is a high probability of water being swallowed	Visual clarity and colour	As per the guideline values for visual amenity.
	Faecal coliforms	Median over bathing season of < 150 faecal coliforms per 100 mL, with 4 out of 5 samples < 600/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month).
	Enterococci	Median over bathing season of < 35 organisms per 100 mL (maximum number in any one sample 60-100 organisms per 100 mL).
	Protozoans	Pathogenic free-living protozoans should be absent from bodies of fresh water. (Analysis only required if temperature is greater than 24 degrees Celsius).
	Algae & blue-green algae	< 15 000 cells/mL
	Nuisance organisms	As per the guideline values for visual amenity. Large numbers of midges and aquatic worms are undesirable.
	pH	5.0-9.0

Environmental value	Indicator	Guideline value
	Temperature	15°-35°C
	Chemical contaminants	Toxic substances should not exceed the concentrations provided in tables 5.2.3 and 5.2.4 of the ANZECC Water Quality Guidelines.
	Visual clarity and colour	Use visual amenity guidelines
	Surface films	Use visual amenity guidelines
Irrigation water supply Protecting the quality of waters applied to crops and pastures	Algae & blue-green algae	Should not be visible. No more than low algal levels are desired to protect irrigation equipment.
	Salinity (electrical conductivity)	To assess the salinity and sodicity of water for irrigation use, a number of interactive factors must be considered including irrigation water quality, soil properties, plant salt tolerance, climate, landscape and water and soil management. For more information, refer to Chapter 4.2.4 of ANZECC 2000 Guidelines.
	Thermotolerant coliforms (faecal coliforms)	Trigger values for thermotolerant coliforms in irrigation water used for food and non-food crops are provided in Table 4.2.2 of the ANZECC Guidelines
	Heavy metals and metalloids	Long-term trigger values (LTV) and short-term trigger values (STV) for heavy metals and metalloids in irrigation water are presented in Table 4.2.10 of the ANZECC 2000 Guidelines.
Homestead water supply Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing	Blue-green algae	Recommend twice weekly inspections during danger periods for storages with history of algal blooms. No guideline values are set for cyanobacteria in drinking water. In water storages, counts of < 1000 algal cells/mL are of no concern. >500 algal cells/mL - increase monitoring. >2000 algal cells/mL - immediate action indicated; seek expert advice. >6500 algal cells/mL - seek advice from health authority
	Turbidity[(5)]	5 NTU; <1 NTU desirable for effective disinfection; >1 NTU may shield some micro-organisms from disinfection.
	Total dissolved solids	< 500 mg/L is regarded as good quality drinking water based on taste. 500-1000 mg/L is acceptable based on taste. >1000 mg/L may be associated with excessive scaling, corrosion and unsatisfactory taste.
	Faecal coliforms	Zero faecal coliforms per 100 mL (0/100 mL). If micro-organisms are detected in water, advice should be sought from the relevant health authority. See also the Guidelines for Microbiological Quality in relation to Monitoring, Monitoring Frequency and Assessing Performance in the Australian Drinking Water Guidelines (NHMRC & ARMCANZ 2004).
	pH[(5)]	6.5 – 8.5

Environmental value	Indicator	Guideline value
	Chemical contaminants	See Guidelines for Inorganic Chemicals in the *Australian Drinking Water Guidelines* (NHMRC & NRMMC 2004).

1. Based on default guideline values for lowland rivers and protection of aquatic ecosystems for slightly to moderately disturbed ecosystems as set out in the ANZG and ANZECC Water Quality Guidelines.
2. In accordance with Table 3.3.3 of the ANZECC Water Quality Guidelines, a value at the low end of the range would apply to waterways flowing through well vegetated catchments during low flows while a values at the high end of the range would apply to waterways draining slightly disturbed catchments and other waterways at high flows. The values at the high end are considered to be applicable to the proposed modification given the disturbed nature of the catchments within which it is located.
3. The ANZECC Water Quality Guidelines advises that the trigger levels for TSS would be similar to those reported for turbidity. By limiting TSS to less than 50 milligrams per litre the project would generally meet the recommended trigger value for protection of aquatic ecosystems.
4. Default guideline values for slightly to moderately disturbed ecosystems and 95% level of species protection have been adopted except for cases where there is potential bioaccumulation (such as mercury) in which the 99% level of species protection has been applied.
5. Turbidity and pH in ambient waters are likely to vary outside the criteria above. Treatment at the point of use is likely to be necessary to achieve criteria above. It is advisable to maintain pH within this range to protect plumbing and fittings from corrosion and scale.

4.1.4 Surface water quality monitoring

Table 4.3 lists the ten locations within the study area where samples were collected to assess the existing water quality in the watercourses that receive runoff from the proposed modification. The ten locations where water quality samples were collected are shown on Figure 5.1 and comprise creek crossings of the proposed modification as well as locations on Eastern Creek and Bells Creek downstream of points of discharge from the footprint of the proposed modification. Figure 5.1 also shows the location of existing water quality monitoring data that has been collected by the Georges Riverkeeper, Bankstown City Council and the NSW Office of Environment and Heritage (OEH) (now the NSW Department of Planning and Environment).

[Note: Sampling commenced in September 2021 and is planned to be undertaken on a monthly basis. The water quality sampling results are to be progressively updated and it is expected results will be based on at least four samples at each location on finalisation of the report.]

Water quality sampling has been carried out in accordance with *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (DECC 2008) and included field measurements of electrical conductivity, total dissolved solids, pH, dissolved oxygen, redox potential, temperature, as well as observations on odour, colour, turbidity and presence of anthropogenic material and organic matter. Samples were also collected to undertake laboratory testing for oil and grease, total Kjeldahl nitrogen, TN, TP, dissolved oxygen, turbidity, redox potential, salinity, pH electrical conductivity, total dissolved solids and TSS.

Section 5.6 provides a comparison of the water quality sampling results against the water quality objectives that are relevant to the study area.

Table 4.3 Water quality sampling locations

Water Quality Sampling Identifier[(1)]	Catchment	Watercourse	Number of samples collected	Period of sampling
CC01	Cabramatta Creek	Maxwells Creek	7	September 2021 – March 2022
CC02		Cabramatta Creek	7	September 2021 – March 2022
CC03		Lower Hinchinbrook Creek	7	September 2021 – March 2022
CC04		Upper Hinchinbrook Creek	7	September 2021 – March 2022
RC01	Ropes Creek	Ropes Creek	7	September 2021 – March 2022
EC01	Eastern Creek	Reedy Creek	7	September 2021 – March 2022
EC02		Eskdale Creek	7	September 2021 – March 2022
EC03		Eastern Creek	7	September 2021 – March 2022
EC04		Angus Creek	7	September 2021 – March 2022
EC05		Bells Creek	7	September 2021 – March 2022

1. Refer Figure 5.1 for locations of water quality sample identifiers.

4.1.5 Assessment of construction related impacts

The assessment of potential surface water related impacts during construction involved:

- Identification of the types of risks to surface water quality from construction activities
- Assessment of the erosion potential during construction using the procedures in the Blue Book
- Assessment of the types of measures that would be implemented during construction to minimise erosion and manage the discharge of runoff into the downstream watercourses
- The identification of the process that would be adopted to manage the discharge of captured runoff in accordance with the procedures set out in the Blue Book and the water quality objectives.

4.1.6 Assessment of operational related impacts

The assessment of potential surface water related impacts during operation involved:

- The identification of the types of risks to surface water quality during the operation of the proposed modification.

- Assessment of the quality of runoff discharging from the Westlink M7 under pre- and post-proposed modification conditions. The MUSIC model was used for this task. The first step in the process involved the development of a MUSIC model to reflect the contributing areas of the road corridor discharging to the receiving drainage lines under pre-proposed modification conditions (pre-proposed modification MUSIC model). Figure A1 in Annexure A shows the layout of the sub-catchments that comprise the pre-proposed modification MUSIC model.

  Rainfall records from the Liverpool (Whitlam Centre) rainfall station (Station Number 67035) for the period 1967 to 1976 were selected for use in the pre-proposed modification MUSIC model. The recorder is located approximately 5 km to the east of the Westlink M7 and is the rainfall data recommended in a publication entitled *WSUD Developer Handbook – MUSIC Modelling and Design Guide* (Blacktown City Council (BCC) 2020). Rainfall losses, as well as base and stormwater flow pollutant concentrations were also based on values recommended in BCC 2020.

  The pre-proposed modification MUSIC model was then adjusted to reflect post-proposed modification conditions in order to assess the impact of the proposed modification on the weight and concentration of pollutants entering the receiving drainage lines (post-proposed modification MUSIC model). This was done by adjusting sub-catchment boundaries, drainage paths and per cent imperviousness based on the concept road and drainage designs.

  For comparative purposes only, and in recognition of the fact that the existing stormwater quality controls along the Westlink M7 were sized to accommodate the future widening of the motorway, the model was also updated to reflect indicative pre-Westlink M7 conditions based on an agricultural land use type along the motorway corridor. Existing stormwater quality controls are described in **Section 5.4.1** of this report.

- Comparison of the quality of runoff discharging from the road corridor under pre- and post-proposed modification conditions based on the MUSIC modelling outlined above against the available surface water quality monitoring results in the receiving watercourses and the water quality objectives that are relevant to the study area.

4.2 Flooding

4.2.1 Key tasks

The key tasks comprising the flood assessment were broadly as follows:

- Review of available data and existing flood studies of the catchments within which the proposed modification is located
- Development of a set of hydrologic and hydraulic models (collectively referred to as 'flood models') of the catchments that are located within the study area
- Flood modelling and preparation of figures showing flood behaviour under existing (i.e. pre-proposed modification) conditions for design floods with AEPs of 20% (1 in 5), 5% (1 in 20), 1% (1 in 100) and 0.2% (1 in 500), as well as the PMF
- Assessment of the potential impact the proposed modification (both during its construction and operation) would have on flood behaviour for the aforementioned design flood events
- Assessment of the impact future climate change would have on flood behaviour under operational conditions

- Assessment of the impact a partial blockage of major hydraulic structures would have on flood behaviour under operational conditions
- Assessment of potential measures which aim to mitigate the risk of flooding to the proposed modification and its impact on existing flood behaviour.

The followings sections of this report set out the methodology that was adopted in the assessment of flood behaviour under pre-proposed modification conditions and during both the construction and operational phases of the proposed modification.

4.2.2 Summary of adopted assessment criteria and standards

Table 4.4 sets out the flood related assessment criteria and standards that have been established for the proposed modification with due consideration of the policies and guidelines outlined in the preceding sections of this report.

In accordance with the FDM, the hydrologic standards adopted are based on matching the level of protection to the likelihood and consequence of flooding. A merits-based approach has been adopted in the assessment of the impacts the proposed modification would have on existing flood behaviour and also in the development of a range of potential measures which are aimed at mitigating its impact on the existing environment.

Table 4.4 Summary of adopted flood assessment criteria and standards

Aspect	Requirement
Flood risks to the proposed modification	
Impact of flooding on proposed construction activities	➢ Construction related flood risks need to be evaluated in the context of the construction period in order to set requirements that are commensurate to the period of time that the risk exposure occurs. To this end, this report identifies the risks associated with each construction activity such that informed decisions can be made on the flood criteria that are set as part of the Construction Environmental Management Plan (CEMP) for the proposed modification.
Upgrade of the existing road	➢ As a minimum, the proposed modification is to ensure the existing level of flood immunity (i.e. the magnitude of flood that does not cause inundation to the travel lanes) is not reduced. In this regard it is noted that the pre-proposed modification was designed for a 1% AEP level of flood immunity.
Impact of future climate change on flooding to the proposed modification	➢ The assessment of the potential impact future climate change could have on flood behaviour in the vicinity of the proposed modification was based on increases in 1% AEP design rainfall intensities ranging between 10 and 30 per cent in accordance with the NSW Government's *Floodplain Risk Management Guideline: Practical Considerations of Climate Change* (DECC 2007).[1] ➢ Due to the elevation of the land on which the proposed modification is located, the rise in sea level due to future climate change is not relevant to the flood assessment.
Impact of the proposed modification on flood behaviour	
Impact of construction	➢ Construction related flood impacts are to be evaluated in the context of the construction period in order to set requirements that are commensurate to the period of time that the exposure to the potential impacts occurs. To this end, this report identifies the potential impacts associated with the proposed modification

Aspect	Requirement
activities on flood behaviour	such that informed decisions can be made on the flood criteria that are set as part of the CEMP.
Impact of proposed modification on flood behaviour in existing development	➢ Floods up to 1% AEP in magnitude are to be considered in the assessment of measures that are required to mitigate any adverse impacts on flood behaviour attributable to the proposed modification. ➢ Changes in flood behaviour under larger floods up to the PMF event are also to be assessed in order to identify impacts on critical infrastructure (such as hospitals) and vulnerable development (such as aged care facilities and schools), as well as to identify potentially significant changes in flood hazard as a result of the proposed modification.
Impact of the proposed modification on flood behaviour under future climate change conditions	➢ The assessment of the impact the proposed modification would have on flood behaviour under future climate change conditions was based on assessing the effect of the proposed modification on existing (pre-proposed modification) flood behaviour during a 0.5 % and 0.2 % AEP event.[1]

1. For the purpose of this assessment the 0.5% and 0.2% AEP events were adopted as being analogous to increases in 1% AEP design rainfall intensities of 10 and 20 per cent, respectively.

4.2.3 Definition of flood behaviour under pre-proposed modification conditions

In order to define the nature of flooding in the vicinity of the proposed modification it was necessary to develop a set of computer-based flood models. Separate flood models were developed to define flood behaviour in the vicinity of the proposed modification as a result of mainstream flooding and major overland flow within the catchments of:

- Cabramatta Creek (referred to in this report as ‘Cabramatta Creek catchment flooding’)
- Ropes Creek (referred to in this report as ‘Ropes Creek catchment flooding’)
- Eastern Creek (referred to in this report as ‘Eastern Creek catchment flooding’).

The development of the flood models within these three catchments is described below. The flood models were used to define flood behaviour in the vicinity of the proposed modification for a range of events with AEPs of between 20% and 0.2%, as well as the PMF. Figures were prepared for each event showing the indicative extent and depth of inundation, as well as the direction and relative velocity of flow. Figures were also prepared showing the hydraulic and hazard categorisation during a 1% AEP event, which were defined using the procedures set out in the *Floodplain Development Manual* (DIPNR 2005) as well as the more recent flood hazard vulnerability curves set out in ARR 2019.

A description of flood behaviour in the vicinity of the Westlink M7 under pre-proposed modification conditions is presented in **Section 5.7**, which also includes a summary of the figures that show flood behaviour under pre-proposed modification conditions.

Cabramatta Creek catchment flooding

The definition of Cabramatta Creek catchment flooding was based on a flood model that was originally developed as part of Bewsher Consulting 2010 (denoted in this report as the 'Cabramatta Creek flood model').

As part of Bewsher Consulting 2010, a set of flood models were developed using the XP-RAFTS and TUFLOW modelling software in order to define flood behaviour across the Cabramatta Creek floodplain and its tributaries, including Maxwells Creek and Hinchinbrook Creek (respectively referred to in this report as the 'Cabramatta Creek RAFTS and TUFLOW models'). The models were calibrated through comparison of modelled flood behaviour with flood behaviour that was recorded during historical flood events that occurred in August 1986 and April 1988.

The flood models that were developed as part of Bewsher Consulting 2010 were updated for the purpose of the present investigation in order to more accurately define flood behaviour in the vicinity of the proposed modification. The location, level and dimensions of drainage pits, pipes and box culverts in the vicinity of the proposed modification were updated or added to the flood models using work-as-executed drawings of the Westlink M7 that were obtained from WSO Co. as well as GIS based pit and pipe data that was obtained from Liverpool City Council. The definition of ground levels over select areas in the vicinity of the proposed modification were updated using aerial survey data that was flown in 2019 to account for changes in the floodplain that had occurred subsequent to the preparation of Bewsher Consulting 2010. This included recent development within Len Waters Estate, Cecil Hills and Prestons.

The sub-catchment delineation within the XP-RAFTS model was refined in order to more accurately define runoff behaviour along the section of the Westlink M7 corridor within the proposed modification footprint. Sub-catchments along the Westlink M7 corridor were converted to a ILSAX hydrologic modelling approach using the DRAINS software as it is better suited to modelling runoff behaviour from road pavements (referred to in this report as the 'Cabramatta Creek DRAINS model').

Ropes Creek catchment flooding

New hydrologic and hydraulic models were developed of the portion of the Ropes Creek catchment that is located in the vicinity of the proposed modification. The hydrologic model was used to convert rainfall patterns to runoff and generate design discharge hydrographs which were applied as inflow boundaries to the hydraulic model, which was then used to define flooding patterns in terms of the depth and velocity of flow along overland flow paths and within watercourses. Hydrologic modelling was undertaken using the IL-CL and RAFTS sub-models within the DRAINS software, while hydraulic modelling was based on the TUFLOW two-dimensional (in plan) modelling software (denoted herein as the 'Ropes Creek DRAINS and TUFLOW models').

<u>Hydrologic modelling</u>

Figure B.1 in Annexure B shows the layout of the Ropes Creek DRAINS model. Sub-catchment boundaries were digitised based on contour information derived from the available detailed and LIDAR survey data. Sub-catchment slopes used as input to the IL-CL and RAFTS sub-models were derived using the average sub-catchment slope and vector averaged slope approaches, respectively.

As noted in Section 3.2.1, the procedures set out in ARR 2019 were used to derive the design rainfall intensities, temporal patterns and losses that were used in the Ropes Creek DRAINS model.

Estimates of Probable Maximum Precipitation (PMP) were derived using the Generalised Short Duration Method (GSDM) as described in *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method* (BoM, 2003). This method is recommended in ARR 2019 for the estimation of extreme rainfall depths for catchments up to 1,000 square kilometres in area and storm durations up to six hours.

The peak flows from the Ropes Creek DRAINS model were compared against peak flow estimates that were derived using the Probabilistic Rational Method (PRM) that is set out in ARR 1987. While consideration was given to comparing peak flow estimates from the Ropes Creek DRAINS Model with those derived using the Regional Flood Frequency Estimation Model (RFFEM) that is set out in ARR 2019, it is only suitable for catchments larger than 50 hectares and is therefore not suitable for deriving a peak flow estimate at the proposed transverse drainage structures. Initial calculations using the RFFEM also found that it produced peak flow estimates that were orders of magnitude different to both the Ropes Creek DRAINS model and the PRM estimate.

On-site detention basins that are located along the Westlink M7 corridor within the Ropes Creek catchment were incorporated into the DRAINS model in order to reflect their attenuating effect on discharges from the motorway.

Hydraulic modelling

The layout of the Ropes Creek TUFLOW model is shown on Figure B.2 in Annexure B. The Ropes Creek TUFLOW model extends downstream of the Westlink M7 corridor a distance of about 1 km along the main arm of Ropes Creek.

Grid elevations in the Ropes Creek TUFLOW model were based on detailed ground survey that had been collected by Transport as part of the M12 Motorway project, which was supplemented with LIDAR survey data across the remainder of the two-dimensional model domain that was captured in 2012.

The quad-tree mesh refinement function within the TUFLOW software was used to enable the grid resolution to be varied across the three TUFLOW models and thus balance model run time with the level of definition that was required to properly define hydraulic features that influence flood behaviour in the vicinity of the proposed modification. The following three levels of grid spacing were adopted for modelling purposes:

- a 2 metre grid spacing (denoted “Quadtree Level 3 Mesh Refinement” on Figure B.2) which was used to define hydraulic features in the immediate vicinity of the Westlink M7 corridor
- a 4 metre grid spacing (denoted “Quadtree Level 2 Mesh Refinement” on Figure B.2) which was used to define inbank reaches of creek extending to the downstream boundary of the model
- a base grid spacing of 8 metres across the remaining areas of the model, which comprised overbank areas downstream of the Westlink M7 corridor.

The footprints of individual buildings located in close proximity to the Westlink M7 corridor were digitised and assigned a relatively high hydraulic roughness value that accounted for their blocking effect on flow while maintaining storage in the model.

Discharge hydrographs that were generated by the Ropes Creek DRAINS model were applied at the inflow boundaries of the TUFLOW model. These comprised both inflows applied at the external TUFLOW model boundary and internal point source and region inflows[1] as shown on Figure B.2.

The downstream boundaries of the Ropes Creek TUFLOW model comprised a normal depth calculation. The model extent was selected to ensure the boundary was located a sufficient distance downstream to prevent any influence on flood behaviour within the vicinity of the Westlink M7 corridor.

The main physical parameter represented in TUFLOW is hydraulic roughness, which is required for each of the various types of surfaces comprising the overland flow paths in the two-dimensional model domain, as well as for the culverts and pipes that were incorporated in the model as one-dimensional elements. In addition to the energy lost by bed friction, obstructions to flow also dissipate energy by forcing water to change direction and velocity, and by forming eddies. Hydraulic modelling traditionally represents all of these effects via the surface roughness parameter known as “Mannings n”.

Hydraulic roughness values adopted for design purposes were selected based on site inspection, past experience and values contained in the engineering literature (refer Table 4.5).

Table 4.5 “Best estimate” of hydraulic roughness values adopted for TUFLOW modelling

Surface Treatment	Manning’s n Value
Reinforced concrete pipes and box culverts	0.015
Roads	0.02
Remnant cleared pasture land	0.045
South Creek channel bed	0.05
Macrophytes	0.06
Light vegetation	0.07
Trees and shrubs	0.09
Allotments	0.1
Dense vegetation	0.12
Buildings	10

[1] In parts of the model area, inflow hydrographs were applied over individual regions called “Rain Boundaries”. The Rain Boundaries act to “inject” flow into the one and two-dimensional domains of the TUFLOW model, firstly at a point which has the lowest elevation, and then progressively over the extent of the Rain Boundary as the grid in the two-dimensional model domain becomes wet as a result of overland flow.

Eastern Creek catchment flooding

The definition of Eastern Creek catchment flooding was based on a set of flood models that were originally developed as part of WMAwater 2013 and Catchment Simulation Solution 2014 (denoted in this report as the 'Eastern Creek flood model').

WMAwater 2013 involved the development of a XP-RAFTS hydrologic model of the Eastern Creek catchment, the discharge hydrographs from which were subsequently used as inputs to a TUFLOW hydraulic model that was developed as part of Catchment Simulation Solution 2014 (respectively referred to in this report as the 'Eastern Creek RAFTS and TUFLOW models'). Both WMAwater 2013 and Catchment Simulation Solution 2014 note that insufficient historical flood data were available of a suitable nature for model calibration. As a result, the validation of the models was based on comparison with previous studies and results from alternative methods.

The flood models that were developed as part of WMAwater 2013 and CSS 2014 were updated for the purpose of the present investigation to more accurately define flood behaviour in the vicinity of the proposed modification. The location, level and dimensions of drainage pits, pipes and box culverts in the vicinity of the proposed modification were updated or added to the flood models using work-as-executed drawings of the Westlink M7 that were obtained from WSO Co. as well as GIS based pit and pipe data that was obtained from Blacktown City Council.

The sub-catchment delineation within the XP-RAFTS model was refined to more accurately define runoff behaviour along the section of the Westlink M7 corridor within the footprint of the proposed modification. Sub-catchments along the Westlink M7 corridor were converted to a ILSAX hydrologic modelling approach using the DRAINS software as it is better suited to modelling runoff behaviour from road pavements (referred to in this report as the 'Eastern Creek DRAINS model').

On-site detention basins that are located along the Westlink M7 corridor within the Eastern Creek catchment were incorporated into the DRAINS model in order to reflect their attenuating effect on discharges from the motorway.

Flood behaviour in the vicinity of the proposed modification was defined for a range of events with AEPs of between 20% and 0.2%, as well as the PMF. Figures were prepared for each event showing the indicative extent and depth of inundation, as well as the direction and relative velocity of flow. Figures were also prepared showing the hydraulic and hazard categorisation during a 1% AEP event, which were defined using the procedures set out in the *Floodplain Development Manual* (DIPNR 2005) as well as the more recent flood hazard vulnerability curves set out in ARR 2019.

A description of flood behaviour in the vicinity of the Westlink M7 under pre-proposed modification conditions is presented in **Section 5.7**, which also includes a summary of the figures that show flood behaviour under pre-proposed modification conditions.

4.2.4 Assessment of construction related impacts

A qualitative assessment was made of the construction related issues associated with flooding along the construction footprint based on indicative construction areas and activities as provided in the current design. The locations of surface works, construction ancillary sites and working platforms for bridge construction were overlaid onto the indicative flood extents for events with AEPs of 20%, 10%, 5% and 1%, as well as the PMF. This provided an understanding of the likelihood that flooding could occur in the vicinity of construction activities.

The potential flood risk to construction activities, as well as their impact on existing flood behaviour were assessed based on an understanding of flood behaviour under approved widening conditions during a 1% AEP event.[2] Consideration was also given to the potential for localised overland flooding to occur in construction areas.

Section 6.2 of this report assesses the impact that flooding could have on construction activities. It also includes an assessment of the impact that construction activities could have on flood behaviour external to the construction footprint.

4.2.5 Assessment of operational related impacts

The structure of the DRAINS and TUFLOW models that were originally developed to define flood behaviour under pre-proposed modification conditions were adjusted to incorporate details of the proposed modification under operational conditions. The results of modelling a range of events with AEPs of between 20% and 0.2%, as well as the PMF were used to prepare a series of figures showing flooding patterns under operational conditions and afflux diagrams[3] showing the impact the proposed modification would have on flood behaviour.

Section 7.2.1 provides a summary of key features of the proposed modification that were incorporated into the hydraulic models used to define flood behaviour in its vicinity, as well as a discussion on the impacts that the proposed modification would have on flood behaviour during its operation.

4.2.6 Impact of future climate change on flood behaviour

The following sections describe the approach that was adopted to assess the potential impact of future climate change on flooding to the proposed modification, as well as the impact that the proposed modification may have on flood behaviour under future climate change conditions. The findings of this assessment are contained in Section 7.2.3 of this report.

Impact of future climate change on flooding to the proposed modification

Based on the adopted assessment criteria set out in Table 4.4, the following scenarios were adopted as being representative of the likely lower and upper estimates of future climate change related impacts over the design life of the proposed modification:

- Scenario 1 – based on an assumed 10 per cent increase in currently adopted design rainfall intensities
- Scenario 2 – based on an assumed 30 per cent increase in currently adopted design rainfall intensities.

[2] While the 1% AEP event has been adopted for the purpose of the preliminary assessment, as per the design criteria set out in **Table 3.1**, the management of flood impacts during the construction of the proposed modification will need to consider the period of risk exposure in establishing an appropriate flood standard. In this regard, the adoption of the 1% AEP event for the purpose of the preliminary assessment is considered to be conservative given the likelihood of such an event occurring over the period of construction, which is expected to be about 3 to 4 years.

[3] Afflux is an increase in peak flood levels caused by a change in floodplain or catchment conditions. A positive afflux represents an increase and conversely a negative afflux represents a decrease in peak flood levels when compared to pre-proposed modification conditions.

Impact of the proposed modification on flood behaviour under future climate change conditions

The predicted impact that the proposed modification could have on flood behaviour under potential future climate change conditions was based on assessing its effect on pre-proposed modification conditions flood behaviour during a 0.5% and 0.2% AEP event as proxies for assessing the sensitivity to an increase in rainfall intensity on the 1% AEP event due to future climate change.

4.2.7 Impact of a partial blockage of major hydraulic structures on flood behaviour

The assessment of the impact that a partial blockage of major hydraulic structures may have on flood behaviour was based on guidance provided in ARR 2019, as well as *AR&R Revision Projects – Project 11 – Blockage of Hydraulic Structures* (IEAust 2013).

In regards culvert structures, IEAust 2013 recommends the adoption of a 20 per cent blockage factor where the height of a culvert is less than three metres or its width is less than five metres, while ARR 2019 recommends that the adopted blockage factor be based on the size of the largest 10 per cent of debris relative to the size of the waterway opening; the availability, mobility and transportability of the debris; and the magnitude of the flood event.

With due consideration to these guidelines, the structure of the hydraulic model was adjusted to include a 50 per cent blockage factor which was applied to all transverse drainage culvert structures along the proposed modification (i.e. culvert structures that convey runoff from the catchments upstream of the proposed modification).

The findings of the blockage related impact assessment are contained in Section 7.2.4.

5 EXISTING ENVIRONMENT

5.1 Study area

The proposed modification is located within the following three catchments:

- Cabramatta Creek
- Ropes Creek
- Eastern Creek.

Each of the above catchments is mapped and described in Section 5.2. Cabramatta Creek forms part of the larger Georges River catchment, while Ropes Creek and Eastern Creek are located within the Hawkesbury-Nepean River catchment.

Section 5.4 provides an overview of the rainfall and soil conditions that exist within the study area. Section 5.5 describes the existing drainage infrastructure along the section of the Westlink M7 within the footprint of the proposed modification, including the measures that have been implemented to manage the quantity and quality of runoff from the motorway, as well as flooding to the motorway and upstream areas. Section 5.5 describes the surface water quality of the waterways that receive runoff from the section of the Westlink M7 within the footprint of the proposed modification. Section 5.7 provides an overview of main stream flooding and major overland flow behaviour in the vicinity of the proposed modification under existing (i.e. pre-proposed modification) conditions. Main-stream flooding and major overland flow have collectively been termed ‘flooding’ within this report.

5.2 Catchment description

5.2.1 Cabramatta Creek

Cabramatta Creek is a major tributary of the Georges River. The size of the catchment draining to the creek increases from about 37 square kilometres at the location where it crosses the Westlink M7, to about 74 square kilometres at its confluence with the Georges River.

Figure 5.1 shows the extent of the catchment which drains to Cabramatta Creek upstream of its confluence with the Georges River, as well as its main tributaries which comprise Hinchinbrook Creek, Maxwells Creek and Brickmakers Creek.

The majority of the Cabramatta Creek catchment is located within the Liverpool City Council local government area. A small portion of the catchment is located within the Fairfield City Council local government area, including a tributary of Hinchinbrook Creek within the Western Sydney Parklands to the north of Elizabeth Drive and an area on the northern side of Cabramatta Creek downstream (east) of Elizabeth Drive. A small portion of the Cabramatta Creek catchment in its south is also located within the Campbelltown City Council local government area.

Land use within the catchment comprises medium density residential, industrial and commercial development. Significant areas of industrial development are located in the suburb of Prestons, to the north and south of the Westlink M7 and in Len Waters Estate between the Westlink M7 and Hinchinbrook Creek. More significant areas of open space include the Western Sydney Parklands that runs north-south along the western edge of the catchment. A series of parks and reserves are also located along the corridors of Cabramatta Creek, Hinchinbrook Creek and Maxwells Creek.

Significant urban development has occurred within the Cabramatta Creek catchment over the past two to three decades, particularly in the Cabramatta Creek and Carnes Hill Urban Release Areas that are located in the south of the catchment, as well as Cecil Hills in the upper reach of the Hinchinbrook Creek catchment. Various flood mitigation works incorporating a number of detention basins and water quality basins have also been constructed in conjunction with these developments (Bewsher Consulting, 2004).

Figure 5.1 shows that the section of the Westlink M7 to the south of Elizabeth Drive is located within the Cabramatta Creek catchment. Along this section of the Westlink M7 bridge waterway crossings support the motorway where it crosses the major watercourses of Maxwells Creek and Cabramatta Creek, as well as two crossings of Hinchinbrook Creek in its upper and lower reaches. A bridge waterway crossing also supports the Westlink M7 where it crosses an unnamed tributary of Hinchinbrook Creek to the north of Aviation Road.

In addition to the bridge waterway crossings, there are also a series of transverse drainage structures that control runoff from the local catchments draining to the Westlink M7. Figure 5.2, sheets 2, 3 and 4 show the location of each transverse drainage structure, as well as the extent of the local catchment that they drain.

Maxwells Creek is a second order stream[4] where it is crossed by the Westlink M7 to the north of Kurrajong Road. While the section of the creek in the immediate vicinity of the Westlink M7 is largely in its natural state, sections upstream and downstream of the motorway have been modified by urbanisation. Upstream of the Westlink M7 the creek has been realigned as a vegetated trapezoidal channel where it runs along the western side of a regional detention basin that was constructed as part of the Westlink M7 (denoted Basin 18 on Figure 5.2, sheet 2). The creek also comprises a vegetated trapezoidal channel where it runs through the Preston industrial area and the residential suburb of Lurnea where it joins Cabramatta Creek.

Cabramatta Creek is a fourth order stream where it is crossed by the Westlink M7 immediately downstream of its confluence with Hinchinbrook Creek. The creek is largely in its natural state for a significant portion of its length both upstream and downstream of the Westlink M7.

Hinchinbrook Creek is crossed by the Westlink M7 at two locations:

- In its lower reach to the north of Hoxton Park Road and about one kilometre upstream of its confluence with Cabramatta Creek where it is a third order stream
- In its upper reach within the Western Sydney Parklands to the west of the residential suburb of Cecil Hills where it is a first order stream.

A vegetated trapezoidal shaped flood mitigation channel has been constructed on the northern bank of Hinchinbrook Creek where it runs between Cowpasture Road and the Westlink M7 to augment the capacity of the creek along this reach and reduce the impact of flooding to residential areas to the north. On the opposite side of this flood mitigation channel a regional detention basin has been constructed as part of the Westlink M7 (denoted Government Road Basin on Figure 5.2, sheet 3). A second regional detention basin was also constructed as part of the Westlink M7 on the northern bank of Hinchinbrook Creek just upstream of its confluence with Cabramatta Creek (denoted Basin 22 on Figure 5.2, sheet 2).

[4] Based on the Strahler stream classification system.

A series of on-line ponds have been constructed along the section of Hinchinbrook Creek where it runs through the residential suburb of Cecil Hills downstream (east) of the Westlink M7 and Western Sydney Parklands.

The unnamed tributary of Hinchinbrook Creek to the north of Aviation Road comprises a vegetated trapezoidal channel where it runs under the Westlink M7 and continues along the base of a rectangular shaped detention basin that has been constructed immediately downstream (east) of the motorway. The detention basin is drained by a pipe culvert that is about 220 metres in length and discharges to Hinchinbrook Creek on its western bank.

5.2.2 Ropes Creek

Ropes Creek is a major tributary of South Creek, which itself is a tributary of the Hawkesbury Nepean River.

The Westlink M7 crosses Ropes Creek about 800 metres downstream of its source where it is classified as a first order stream. The total length of the creek is about 22 kilometres from its source to its confluence with South Creek.

The catchment of Ropes Creek upstream of the Westlink M7 has largely been cleared for agricultural purposes. A series of farm dams have been constructed along the creek over this section while some remnant vegetation still exists along sections of the creek between individual farm dams. Significant clearing for agricultural purposes has also occurred along the section of Ropes Creek that is located downstream (west) of the Westlink M7.

The Westlink M7 crosses Ropes Creek in a bridge structure that spans the creek as well as local roads that are located on both its northern and southern banks. The connectivity of the riparian corridor along the creek is interrupted immediately west of the motorway where the creek passes under Wallgrove Road via a 3 metres wide by 2.4 metres high box culvert.

5.2.3 Eastern Creek

Eastern Creek is a major tributary of South Creek, which itself is a tributary of the Hawkesbury-Nepean River. The size of the catchment draining to Eastern Creek increases from about 56 square kilometres at the location where it crosses the Westlink M7, to about 128 square kilometres at its confluence with South Creek.

Figure 5.1 shows the extent of the catchment which drains to Eastern Creek upstream of the Westlink M7 as well as its main tributaries, which comprise Reedy Creek, Eskdale Creek, Angus Creek, Bells Creek and Breakfast Creek. Eastern Creek joins South Creek approximately 14 kilometres to the north of the Westlink M7.

The majority of the Eastern Creek catchment upstream of the Westlink M7 is located within the Blacktown City Council local government area. A small portion of the catchment to the south of the Warragamba to Prospect Water Supply Pipeline is located within the Fairfield City Council local government area.

Land use within the portion of the catchment upstream of the Westlink M7 comprises medium density residential, industrial and commercial development. Significant areas of industrial development are located in the suburb of Eastern Creek, Huntingwood, Arndell Park, Blacktown and Kings Park. More significant areas of open space include the Western Sydney Parklands and

Nurragingy Reserve that run north-south along the corridor of Eastern Creek. A series of parks and reserves are also located along the corridors of Reedy Creek, Angus Creek, Bells Creek and Breakfast Creek.

Areas of the catchment downstream (north) of the Westlink M7 have undergone extensive urbanisation as part of the North West Growth Centres and Western Sydney Employment Area.

Figure 5.1 shows that the northern portion of the proposed modification is located in the Eastern Creek catchment, extending south to a location two kilometres south of The Horsley Drive. Along this section of the Westlink M7 bridge waterway crossings support the motorway where it crosses the watercourses of Reedy Creek, Eskdale Creek and Angus Creek.

In addition to the bridge waterway crossings there are also a series of transverse drainage structures that are located along the Westlink M7 that control runoff from adjacent upslope areas. Figure 5.2, sheets 5, 6, 7 and 8 show the location of each transverse drainage structure as well as the extent of the local catchment that they drain.

Reedy Creek is a second order stream where it is crossed by the Westlink M7 to the north of the Warragamba to Prospect Water Supply Pipeline. While the riparian corridor of the creek in the immediate vicinity of the Westlink M7 is largely in its natural state, sections of the creek upstream of the motorway have been modified by urbanisation. Extensive industrial development is located upstream of the Westlink M7 on both the northern and southern overbanks of the creek. Downstream of the Westlink M7 Reedy Creek runs through the Western Sydney Parklands where it joins Eastern Creek.

Eskdale Creek is a first order stream where it is crossed by the Westlink M7 to the north of Old Wallgrove Road. The section of the creek that is located upstream of the Westlink M7 has been extensively modified by urbanisation with limited remnant vegetation present along its banks. Downstream of the Westlink M7 Eskdale Creek runs through the Western Sydney Parklands where it joins Eastern Creek immediately downstream (north) of Reedy Creek

Angus Creek is a first order stream where it is crossed by the Westlink M7 to the south of the Main Western Rail Line. Significant lengths of the creek upstream (west) of the Westlink M7 have been modified by urbanisation and comprise a grass lined trapezoidal shaped channel. The riparian corridor of the creek from the Westlink M7 to its confluence with Eastern Creek within the Nurragingy Reserve is largely in its natural state.

5.3 Sensitive receiving environments

Table 5.1 lists the sensitive receiving environments that have been identified as part of Appendix H (Biodiversity Development Assessment Report) of the Modification Report based on the considerations set out in Section 4.1.2 of this report.

Niche 2022 notes that there are also three small coastal wetlands that are mapped in the southern portion of the proposed modification, immediately upstream of where the Westlink M7 crosses the Lower Hinchinbrook Creek and Cabramatta Creek (refer locations SR3 and SR2 in Table 5.1, respectively).

While the list of sensitive receiving environments in Table 5.1 is based on watercourses that are crossed by the proposed modification, it is also noted that Eastern Creek is mapped as a key fish habitat on the Fisheries NSW Spatial Data Portal where it runs in a northerly direction to the east

(downstream) of the proposed modification (refer sensitive receiving environment SR6 on Figure 5.1).

Table 5.1 Sensitive receiving environments[1]

Location Identifier[2]	Watercourse	Stream Order	Key Fish Habitat and Sensitivity Classification	Classification of waterway for fish passage
SR1	Maxwells Creek	3	Sydney Metro – Type 1 (high sensitivity)	Class 3 – Minimal Key Fish Habitat
SR2	Cabramatta Creek	5	Sydney Metro – Type 1 (high sensitivity)	Class 3 – Minimal Key Fish Habitat
SR3	Lower Hinchinbrook Creek	4	Sydney Metro – Type 1(high sensitivity)	Class 3 – Minimal Key Fish Habitat
SR4	Upper Hinchinbrook Creek	3	Sydney Metro – Type 1(high sensitivity)	Class 3 – Minimal Key Fish Habitat
SR5	Reedy Creek	3	Hawkesbury-Nepean – Type 3 (minimally sensitive)	Class 3 – Minimal Key Fish Habitat

1. Source: Table 5 of Annexure 1 Appendix H (Biodiversity Development Assessment Report) of the Modification Report
2. Refer **Figure 5.1** for Location Identifiers.

Notwithstanding the sensitive receiving environments identified above, it is noted that the existing water quality controls along the Westlink M7 are aimed at treating runoff and controlling spills from the motorway at all points of discharge (i.e. not just those discharging to a sensitive receiving environment). The same approach would be adopted in managing the quality of runoff from the proposed modification by utilising the existing water quality measures and upgrading or augmenting them where required to maintain their existing function. Further details of the existing water quality measures are provided in Section 5.5.1 of this report, while an assessment of the impact that the proposed modification would have on the function of the existing water quality measures is provided in Section 7.1.2.

5.4 Climate and soils

Rainfall and soil conditions can affect erosion potential, particularly of soils that are disturbed during construction. This section provides an overview of the rainfall and soil conditions that have been taken into consideration in the assessment of erosion and sediment control requirements during the construction of the proposed modification.

5.4.1 Rainfall

Table 5.2 over the page contains a summary of monthly rainfall statistics for the Bureau of Meteorology (BoM) operated weather station at Prospect (station number 067019). While the monthly rainfall summary in Table 5.2 shows a trend towards higher rainfall total and number of rainfall days in the summer months, it is possible for significant rainfall to occur at any time of year. The risk of high rainfall is therefore considered to be an important consideration for the control of erosion during the construction of the proposed modification, irrespective of the time of year.

Table 5.2 Rainfall statistics for Prospect Reservoir (Bureau of Meteorology Station 067019)(1)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean rainfall (mm)	94.8	99.2	100.6	75.1	68.9	76.5	56.0	50.4	46.2	59.2	72.4	75.8	876.8
Mean no. of days with rain > 1 mm	8.1	8.2	8.5	7.0	6.3	7.0	5.6	5.6	6.0	6.9	7.3	7.6	84.1

1. Values in red denote the highest mean rainfall or mean number of days with more than 1 mm of rainfall across all months, while conversely values in blue denote the lowest mean rainfall or mean number of days with more than 1 mm of rainfall across all months

5.4.1 Soil Landscapes and erosion potential

A review of the *Soil landscape mapping for the Penrith 1:100,000 map* (Bannerman and Hazelton 1990) shows that section of the Westlink M7 within the footprint of the proposed modification is located within the following soil landscapes:

- Picton (colluvial)
- Luddenham (erosional)
- South Creek (fluvial)
- Blacktown (residual)
- Berkshire Park (alluvial)

Addition to the soil landscapes listed above there is a relatively localised section of the Westlink M7 to the south of Jedda Road that is identified as disturbed terrain.

Picton (colluvial), Luddenham (erosional), South Creek (fluvial) and Blacktown (residual) are defined in the Blue Book as Type D. Type D soils contain a significant proportion of fine (< 0.005 mm) dispersible materials that will not settle unless a flocculant is added to the sediment laden runoff. Berkshire Park (alluvial) is defined in the Blue Book as a Type F soil, which contains a significant portion of fine grained soils that require a longer residence time to settle in a sediment retention basin.

As noted in Section 5.2 the footprint of the proposed modification intersects a number of creeks. South Creek soils is the dominant soil landscape along these creek lines. They are actively and frequently being reworked by fluvial processes.

Overall, the potential for erosion along the footprint of the proposed modification is generally moderate to high, with higher potential for erosion typically occurring in areas close to creeks and watercourses.

5.4.2 Acid sulphate soils

Acid sulphate soil is a name given to soils or sediments containing iron sulphides. The presence of acid sulphate soils is an important consideration in construction planning as the disturbance of these types of soils can generate sulfuric acid, iron, aluminium and sometimes heavy metals that

can have adverse impacts on the surrounding environment unless appropriate controls are implemented.

NSW Office of Environment and Heritage (OEH, 2012) acid sulphate soils risk maps show areas of acid sulphate soils risk. The acid sulphate soils classification is assigned based on the probability and depth of occurrence of acid sulphate soils, ranging from Class 1 (high risk) to Class 5 (low risk).

The acid sulphate soils risk class within the study area is Class 5 (indicating no risk of intercepting acid sulphate soils for activities which do not lower the water table by more than one metre).

5.4.3 Salinity

Salinity in urban areas occurs where salt in the landscape is mobilised and redistributed closer to the soil surface or into waterways and is typically caused by changes in groundwater conditions due to urban development. Salinity affects vegetation growth which can increase the vulnerability of soils to erosion (Podmore 2009).

Review of the *Map of Salinity Potential in Western Sydney 2002* (DLWC, 2002) shows that while there is no known presence of saline soils, high salinity potential has been identified along the following watercourses where they are crossed by the footprint of the proposed modification:

- Maxwells Creek
- Cabramatta Creek
- Hinchinbrook Creek
- Reedy Creek
- Eskdale Creek.

5.5 Existing drainage infrastructure along the Westlink M7

This section provides an overview of the existing drainage that is located along the section of the Westlink M7 within the footprint of the proposed modification. **Figure 5.2** (8 sheets) shows the following elements of the Westlink M7 drainage infrastructure and should be referred to when reading the following discussion:

- The extent of the pit and pipe stormwater drainage network that controls runoff from the carriageways of the Westlink M7 and discharges it to either a stormwater basin or pollutant control device
- The locations and types of stormwater basins and pollutant control devices that receive runoff from the Westlink M7 and discharge into the receiving watercourses
- The locations of bridge and culvert crossings of the Westlink M7 over creeks and other watercourses.

5.5.1 Stormwater quantity and quality controls

Table 5.3 lists the number of each type of stormwater control basins that are located along the section of the Westlink M7 within the footprint of the proposed modification, while further details of each basin is provided in Table A1 in Annexure A.

The treatment of runoff from the main carriageways, access ramps and several local road upgrades[5] is typically provided by water quality basins that also incorporate measures for the control of spills. Gross pollutant traps and spill containment basins are provided where site constraints precluded the provision of a water quality basin.

Runoff from the section of the Westlink M7 within the Ropes Creek and Elizbeth Drive catchments is controlled by a series of on-site detention basins that are typically provided in combination with water quality basins. Within the Cabramatta Creek catchment, the impact of the motorway on stormwater quantity was addressed by three regional detention basins which are denoted Basin 18, Basin 22 and Government Road Basin on Figure 5.2.

Table 5.3 Summary of stormwater controls along the Westlink M7 (1)

Control Type	Number
Water quality basins	56
On-site detention basins	4
Spill containment basins	4
Combined water quality and on-site detention basins	37
Pollutant control devices	5
Total	**106**

1. Basin summary does not include regional or compensatory detention basins along the Westlink M7 corridor.

The design documentation for the Westlink M7 shows that on-site and regional detention basins were designed to contain the 1% AEP design storm and to mitigate impacts on the natural hydrology of the catchment for all storms up to 1% AEP in magnitude.

The following summary provides an overview of the key features and functionality of the water quality basins along the Westlink M7:

- The water quality basins comprise a shallow pond that is planted with emergent macrophytes in an arrangement that is referred to as a “constructed wetland”. The emergent macrophytes act to filter suspended sediments and associated contaminants out of the stormwater. The pollutants in stormwater, including nutrients, are taken up by various physical, chemical and biological processes that take place in the wetland.
- The water quality basins are designed to capture and treat the ‘first flush’ volume of runoff based on the initial 13 mm of rainfall. The design documentation for the Westlink M7 shows a 20% allowance was also made for the temporary storage of captured sediment.
- The design documentation for the Westlink M7 shows that the water quality basins were designed to accommodate the additional paved area due to potential future road widening.
- Low flow outlets from the water quality basins are designed to slowly release captured runoff over a 24 to 48 hour period. Under this arrangement, the basins would be expected to be empty during dry weather periods to facilitate the removal of sediment.

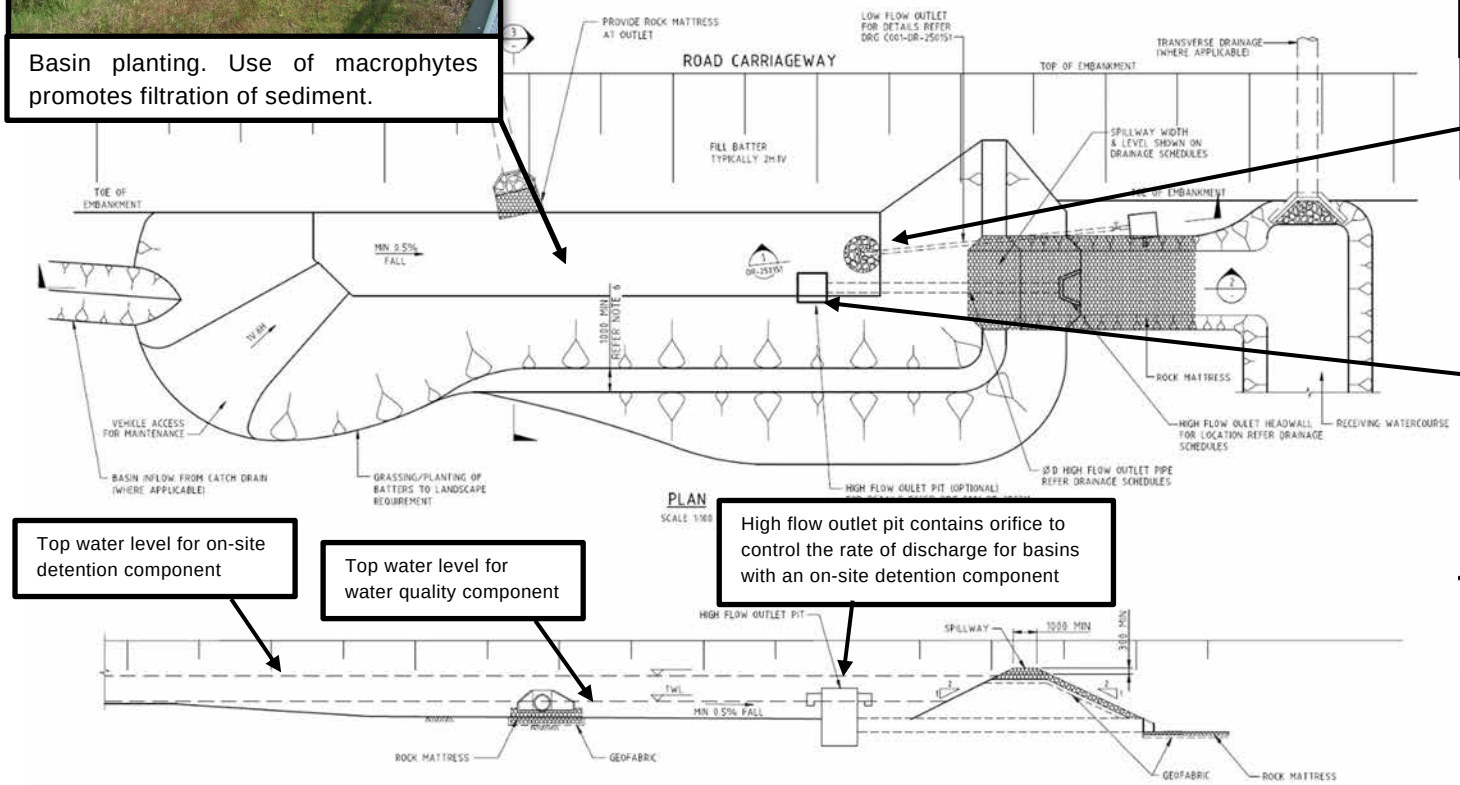
[5] The design documentation for the Westlink M7 shows that water quality measures were provided to treat stormwater runoff from local road upgrades that were predicted to experience an increase in traffic volumes.

- High flow pits are typically used to control runoff that exceeds the storage volume in the water quality basin. The high flow pit includes a baffle arrangement to control the release of spills that have a specific density less than that of water when the level of water in the basin is at or near the level of the inlet to the high flow pit.
- Combined water quality and on-site detention basins comprise a lower water quality zone which is overlain by an on-site detention zone.
- In combined water quality and on-site detention basins the high flow pit contains the outlet control structure and orifice that limits the rate of discharge from the on-site detention component of the basin.

Plate 5.1 over the page shows the typical layout of a water quality basin incorporating on-site detention storage where relevant, including photographs showing examples of some of the key features.

Basin planting. Use of macrophytes promotes filtration of sediment.

Low flow outlet. Rock surrounding slotted riser pipe allows the slow release of runoff.



Top water level for on-site detention component

Top water level for water quality component

High flow outlet pit contains orifice to control the rate of discharge for basins with an on-site detention component

High flow outlet pit. The downturned intake pipes around the pit provide a baffle to contain oil type spills within the basin.

Plate 5.1 Typical layout of a water quality basin (with or without on-site detention)

5.5.2 Transverse drainage and flood mitigation measures

Table 5.4 lists the bridge waterway and transverse drainage structure that control runoff from the catchments that drain to the Westlink M7 corridor. Figure 5.2 (8 sheets) shows the location of each bridge waterway and transverse drainage structure, together with the extent of their contributing catchment. The design documentation for the Westlink M7 shows that the bridge waterway and transverse drainage structures were designed to:

- provide a 1% AEP level of flood immunity to the main carriageways of the motorway
- manage increases in peak 1% AEP flood levels in development that was located upslope of the Westlink M7 corridor.

Furthermore, transverse drainage structures were designed to provide a minimum clearance of 0.3 metres between the peak 1% AEP flood level and the edge of the carriageway of the motorway, while bridge waterway structures were designed to provide a minimum clearance of 0.3 metres between the peak 1% AEP flood level and the underside of the bridge structure.

Table 5.4 Details of existing Westlink M7 bridge waterway and transverse drainage structures

Catchment	Structure Identifier[(1)]	Structure Type	Dimensions	Catchment Area (hectares)
Maxwells Creek	C01.25	Culvert	1 off 2700 mm x 1200 mm box culvert	55.3
	B9817	Bridge	7 spans 200 m total length	1,174
	C01.80	Culvert	1 off 900mm diameter pipe	29.1
	B9821	Bridge	3 spans 55 m total length	77.5
	C02.35	Culvert	1 off 900 mm Diameter pipe	1.8
Cabramatta Creek	B9826/27	Bridge	8 spans 225 m total length	2,021
Hinchinbrook Creek	B9829/30	Bridge	21 spans 650 m total length	1,098
	C04.75	Culvert	2 off 1200mm x 900 mm box culvert	6.8
	C04.95	Culvert	1 off 1050 mm Diameter pipe	4.1
	C05.20	Culvert	2 off 2700 mm x 1800 mm box culvert	120.0
	C05.55	Culvert	5 off 3000 mm x 1200 mm box culvert	106.6
	C05.95	Culvert	2 off 1200 mm x 600 mm box culvert	8.5
	B9839/40	Bridge	5 spans 75 m total length	137.8
	B9841/42	Bridge	4 spans 70 m total length	236.5
	C08.75	Culvert	1 off 675 mm diameter pipe	5.3
	C08.95	Culvert	1 off 1050 mm diameter pipe	13.5
Hinchinbrook Creek	C09.40	Culvert	1 off 600 mm diameter pipe	2.8
	C09.60	Culvert	3 off 900 mm diameter pipes	21.2
Hinchinbrook Creek	C09.80	Culvert	2 off 1200 mm diameter pipes	17.9

Catchment	Structure Identifier(1)	Structure Type	Dimensions	Catchment Area (hectares)
Ropes Creek	C10.40	Culvert	1 off 900 mm diameter pipes	4.1
	B9851/52	Bridge	3 spans 120 m total length	71.2
	C12.80	Culvert	1 off 1050 mm diameter pipe	10.0
Eastern Creek	C14.20	Culvert	1 off 750 mm diameter pipe	4.4
	C14.72	Culvert	1 off 600 mm diameter pipe	1.85
	C14.80	Culvert	2 off 1200 mm x600 mm box culvert	12.52
	B9858/59	Bridge	2 spans 50 m total length	21.3
	C15.30	Culvert	2 off 600 mm diameter pipe	8.7
	C16.60	Culvert	1 off 1800 mm x 1500 mm box culvert	73.8
	C16.65	Culvert	3 off 1800 mm x 1200 mm box culvert	13.8
	C16.98	Culvert	1 off 525 mm diameter pipe	5.9
Reedy Creek	C17.55	Culvert	1 off 600 mm diameter pipe	18.9
	C17.60	Culvert	1 off 1200 mm diameter pipe	13.8
	B9870/71	Bridge	5 spans 80 m total length	963
Eskdale Creek	B9873/74	Bridge	2 spans 35 m total length	182
	C18.79	Culvert	1 off 2400 mm x 600 mm box culvert	9.8
	C19.20	Culvert	1 off 450 mm diameter pipe	24.1
Eastern Creek	C20.01	Culvert	2 off 1050 mm diameter pipe	15.8
	B9893/94	Bridge	2 spans 90 m total length	156.9
	C21.12	Culvert	2 off 1800 mm x 900 mm box culvert	108.0
Angus Creek	B9898/99	Bridge	3 spans 75 m total length	514.3
	C23.10	Culvert	1 off 1200 mm diameter pipe	50.8
	C23.65	Culvert	1 off 1200 mm diameter pipe	37.5
Eastern Creek	C24.40	Culvert	1 off 1050 mm diameter pipe	37.4
	C24.50	Culvert	1 off 1050 mm diameter pipe	18.0
	C25.40	Culvert	2 off 1200 mm x 900 mm box culvert	15.4
Bells Creek	C26.80	Culvert	1 off 525 mm diameter pipe	2.2
	C26.82	Culvert	1 off 525 mm diameter pipe	1.3

(1) Refer Figure 5.2 for location of structure identifier.

5.6 Existing surface water quality

The quality of water in the watercourses that receive runoff from the section of the Westlink M7 within the footprint of the proposed modification has been heavily impacted due to changing land uses within the catchments, as well as works within their in-bank area.

Early settlement within the area within which the Westlink M7 is located was followed by land clearing and agriculture that caused an increase in sediment loads and nutrients in the waterways. Additional impacts to water quality have occurred as a result of the transition from a rural to urban land use (GRCCC 2013).

Table 5.5**,** Table 5.6 and Table 5.7 respectively contain a summary of water quality data in the receiving watercourses located downstream of the Westlink M7 within the catchments of Cabramatta Creek, Ropes Creek and Eastern Creek, together with the guideline values set out in the water quality objectives. The water quality data that are presented in Table 5.5**,** Table 5.6 and Table 5.7 are based on monitoring that has been undertaken as part of the proposed modification, as well as longer term monitoring that has been carried out by the Georges Riverkeeper, Blacktown City Council and the NSW Office of Environment and Heritage.

It is noted that the monitoring that has been undertaken as part of the proposed modification is based on seven samples and should therefore be supplemented with additional monitoring data to provide a better representation of the quality of surface water in the receiving watercourses under a range of flow conditions.

The following observations can be made based on a comparison of the existing surface water quality in the receiving watercourses against the water quality objectives:

- The concentrations of TP and TN exceed the recommended limits in the water quality objectives at all locations.
- The level of turbidity and concentrations of total suspended solids are within the range recommended in the water quality objectives at all locations except at:
    - Lower Maxwells Creek (refer water quality sampling location CC01 on Figure 5.1)
    - Upper Hinchinbrook Creek (refer water quality sampling location CC04 on Figure 5.1)
    - Upper Ropes Creek (refer water quality sampling location RC01 on Figure 5.1)
- Levels of dissolved oxygen are below the levels recommended in the water quality objectives at all locations.
- Data on concentrations of heavy metals in the Cabramatta Creek catchment that have been collected by the Georges Riverkeeper at three locations (denoted GRK01, GRK02 and GRK03 in Table 5.5) shows levels of:
    - lead and nickel are below the limits set out in the water quality objectives at all three locations
    - zinc is above the limits set out in the water quality objectives at all three locations
    - copper is below the limits in the water quality objectives at GRK01 and GRK03 and above the limit in the water quality objectives at GRK02.

Table 5.5 Cabramatta Creek catchment water quality data summary

Parameter	Lower Maxwells Creek at Westlink M7 CC01[1,3]	Upper Cabramatta Creek at Westlink M7 CC02[1,3]	Lower Hinchinbrook Creek at Westlink M7 CC03[1,3]	Upper Hinchinbrook Creek at Westlink M7 CC04[1,3]	Middle Hinchinbrook Creek at Aviation Road GRK01[2,3]	Middle Cabramatta Creek 2 km east of Westlink M7 GRK02[2,3]	Lower Cabramatta Creek 8 km east of Westlink M7 GRK03[2,3]	Water Quality Objectives Guideline Value
TP (mg/L)	0.3	0.1	0.1	0.2	0.04	0.18	0.06	0.025
TN (mg/L)	1.0	0.9	0.9	1.6	0.62	1.22	0.55	0.35
Chlorophyll-a (µgL)	-	-	-	-	-	-	-	3
Turbidity (NTU)	70.6	17.1	28.1	57.6	21.4	11.5	10.4	< 50
Electrical Conductivity (µs/cm)	718	685	613	354	718	1,087	843	200-300
Dissolved Oxygen (% Saturation)	Tbc	tbc	tbc	tbc	34	17	62	85 – 110
pH	7.3	7.2	7.5	6.9	7.1	7.2	7.4	6.5 – 8.5
TSS (mg/L)	62.0	14.0	31.0	33	48	9	15	< 50
Copper (mg/L)	-	-	-	-	<0.001	0.002	<0.001	0.0014
Lead (mg/L)	-	-	-	-	<0.001	0.002	<0.001	0.0034
Nickel (mg/L)	-	-	-	-	<0.001	<0.001	<0.001	0.011
Zinc (mg/L)	-	-	-	-	0.02	0.02	0.01	0.008

1. Refer **Figure 5.1** for location of water data sampling identifier. Data is based on sampling undertaken for the proposed modification during 2021-2022.
2. Refer **Figure 5.1** for location of water data sampling identifier. Data is based on sampling undertaken by the Georges Riverkeeper for the period 2009 – 2020.
3. Cells shaded orange represent values that do not meet the WQO guideline value, while conversely cells shaded blue represent values that do meet the WQO guideline value.

Table 5.6 Ropes Creek catchment water quality data summary

Parameter	Upper Ropes Creek at Westlink M7 RC01[1,3]	Water Quality Objectives Guideline Value
TP (mg/L)	1.6	0.025
TN (mg/L)	7.6	0.35
Chlorophyll-a (µgL)	-	3
Turbidity (NTU)	411	< 50
Electrical Conductivity (µs/cm)	825	200 - 300
Dissolved Oxygen (% Saturation)	tbc	85 – 110
pH	7.5	6.5 – 8.5
TSS (mg/L)	1,080	< 50
Copper (mg/L)	-	0.0014
Lead (mg/L)	-	0.0034
Nickel (mg/L)	-	0.011
Zinc (mg/L)	-	0.008

1. Refer **Figure 5.1** for location of water quality data identifier. Data is based on sampling undertaken for the proposed modification in 2021-2022.
2. Cells shaded orange represent values that do not meet the WQO guideline value, while conversely cells shaded blue represent values that do meet the WQO guideline value.

Table 5.7 Eastern Creek catchment water quality data summary

Parameter	Lower Reedy Creek at Westlink M7 EC01[1,4]	Lower Eskdale Creek at Westlink M7 EC02[1,4]	Middle Eastern Creek at M4 Motorway EC03[1,4]	Middle Angus Creek at Westlink M7 EC04[1,4]	Middle Bells Creek at Richmond Road EC05[1,4]	Middle Eastern Creek at the Great Western Highway OEH01[2,4]	Lower Eastern Creek at Richmond Road OEH02[2,4]	Water Quality Objectives Guideline Value
TP (mg/L)	0.7	0.1	0.3	0.1	0.3	0.068	0.066	0.025
TN (mg/L)	2.6	0.7	1.6	1.3	1.9	0.95	0.82	0.35
Chlorophyll-a (µgL)	-	-	-	-	-	13.8	3.9	3
Turbidity (NTU)	18.5	42.8	44.6	5.4	21.5	8.5	5.7	< 50
Electrical Conductivity (µs/cm)	584	914	704	486	471	1,783	1,450	200 - 300
Dissolved Oxygen (% Saturation)	Tbc	Tbc	Tbc	tbc	tbc	37	68	85 – 110
pH	7.6	7.6	7.6	7.6	7.3	7.4	7.7	6.5 – 8.5
TSS (mg/L)	14.0	12.0	37.0	10.0	15.0	-	-	< 50
Copper (mg/L)	-	-	-	-	-	-	-	0.0014
Lead (mg/L)	-	-	-	-	-	-	-	0.0034
Nickel (mg/L)	-	-	-	-	-	-	-	0.011
Zinc (mg/L)	-	-	-	-	-	-	-	0.008

Refer footnotes over page.

Continued over page

Table 5.5 Eastern Creek catchment water quality data summary (cont'd)

Parameter	Lower Angus Creek 1 km east of Westlink M7 BCC01[3,4]	Upper Eastern Creek at Warragamba to Prospect Water Supply Pipeline BCC02[3,4]	Middle Bells Creek at Richmond Road BCC03[3,4]	Water Quality Objectives Guideline Value
TP (mg/L)	0.08	0.34	0.14	0.025
TN (mg/L)	0.9	1.4	1.5	0.35
Chlorophyll-a (µgL)	-	-	-	3
Turbidity (NTU)	8.7	13.5	8.7	< 50
Electrical Conductivity (µs/cm)	827	1,572	861	200 - 300
Dissolved Oxygen (% Saturation)	47	38	38	85 – 110
pH	7.6	7.3	7.4	6.5 – 8.5
TSS (mg/L)	-	-	-	< 50
Copper (mg/L)	-	-	-	0.0014
Lead (mg/L)	-	-	-	0.0034
Nickel (mg/L)	-	-	-	0.011
Zinc (mg/L)	-	-	-	0.008

1. Refer **Figure 5.1** for location of water quality data identifier. Data is based on sampling undertaken for the proposed modification in 2021-2022.
2. Refer **Figure 5.1** for location of water quality data identifier. Data is based on sampling by the NSW OEH (now DPIE) in 2017.
3. Refer **Figure 5.1** for location of water quality data identifier. Data is based on sampling by Blacktown City Council for the period 2014 – 2021, except for BCC03 which is for the period 2018 - 2021.
4. Cells shaded orange represent values that do not meet the WQO guideline value, while conversely cells shaded blue represent values that do meet the WQO guideline value.

5.7 Existing flood behaviour

The following sections of the report provide a brief description of patterns of flooding within the catchments of Cabramatta Creek, Ropes Creek and Eastern Creek under existing (i.e. pre-proposed modification) conditions.

Figures 5.3, 5.4 and 5.5 (8 sheets each) show the indicative extent and depth of inundation of mainstream flooding and major overland flow during design storms with AEPs of 5% and 1% AEP event, as well as the PMF event, respectively. Annexure C contains a series of figures that show corresponding results for design storms with AEPs of 50%, 20%, 10% and 0.2% AEP, as well as maximum flow velocities and durations of inundation during a 1% AEP design storm event. Annexure D contains a series of figures that show the preliminary hydraulic and provisional flood hazard categorisation of land for a 1% AEP flood event, as well as the extent of land which is located below the peak 1% AEP flood level plus 0.5 metres (defined in the *Liverpool Local Environmental Plan 2008* and *Fairfield Local Environmental Plan 2013* as the Flood Planning Area).

5.7.1 Cabramatta Creek flooding

Up to 1% AEP

Flow in Maxwells Creek surcharges its main channel and inundates areas of its overbank where it crosses the Westlink M7 corridor during storms more frequent than 5% AEP. During a 1% AEP event, floodwater surcharges the western bank of Maxwells Creek to the south (upstream) of the Westlink M7 where it contributes to flow in a drainage line that crosses the motorway via a bridge waterway crossing that is located about 420 metres to the west of Maxwells Creek (denoted bridge BR9821/22 on Figure 5.2, sheet 2). Depths of inundation in industrial development that is located on the western overbank of Maxwells Creek to the north (downstream) of the Westlink M7 are up to 1 metre at several locations, resulting in hazardous flooding conditions to persons and property.

While the main carriageways of the Westlink M7 are more than 2 metres above the peak 1% AEP flood level where its crosses Maxwells Creek, a section of the shared path that runs along the northern side of the motorway on the western overbank of Maxwells Creek would be inundated to depths that exceed 1 metre, which could be hazardous to pedestrians and cyclists.

Flooding along the section of Cabramatta Creek where it crosses the Westlink M7 corridor is mainly confined to the inbank area of its main channel (i.e. the area of the creek below its top of bank level) and adjoining low-lying areas of undeveloped land for floods with AEPs up to 20% AEP. During a 1% AEP event, flooding along Cabramatta Creek will encroach into areas of residential and industrial development that is located both upstream and downstream of the Westlink M7 corridor to depths that are typically less than 0.5 m.

The main carriageways of the Westlink M7 are more than two metres above the peak 1% AEP flood level where its crosses Cabramatta Creek in an elevated bridge structure (denoted bridge BR9826/27 on Figure 5.2, sheet 2). The section of shared path that runs under bridge BR9826/27 along the north overbank of Cabramatta Creek will be inundated to a depth of 1 metre during a 1% AEP event, which could be hazardous to pedestrians and cyclists.

Floodwater that originates in Hinchinbrook Creek will inundate the section of Hoxton Park Road where it runs under the main carriageways of the Westlink M7 over a length of 850 metres and to depths that are typically less than 0.5 metres.

Flooding along the section of Hinchinbrook Creek where it crosses the Westlink M7 corridor to the north of Hoxton Park Road is mainly confined to the inbank area of its main channel, as well as a flood mitigation channel that has been constructed along its eastern bank for floods with AEPs up to 20% in magnitude. While floodwater will surcharge the banks of both the main and flood mitigation channels of the creek during a 1% AEP event, it would be mainly confined to areas of public reserve.

The main carriageways of the Westlink M7 are more than three metres above the peak 1% AEP flood level where its crosses Hinchinbrook Creek and Hoxton Park Road in an elevated bridge structure (denoted bridge BR9829/30 on Figure 5.2, sheet 2). The section of shared path that runs under bridge BR9829/30 will be inundated to depths that are typically less than 0.5 metres during a 1% AEP event.

Flooding along an unnamed tributary of Hinchinbrook Creek occurs over a width of 40 to 60 metres and to a maximum depth of 1.2 metres where it runs under the bridge waterway crossing of the Westlink M7 to the north of Middleton Drive (denoted bridge BR9839/40 on Figure 5.2, sheet 3). While the main carriageways of the Westlink M7 are more than 4 metres above the peak 1% AEP flood level in the unnamed tributary of Hinchinbrook Creek, the section of shared path that runs under bridge BR9839/40 will be inundated during a 1% AEP event, albeit to relatively shallow depths of 0.3 metres or less.

Flooding along the upper reach of Hinchinbrook Creek occurs over a width of 40 to 50 metres and to a maximum depth of 2 metres where it runs under the bridge waterway crossings of the main carriageways and shared path of the Westlink M7 to the north of Dobroyd Drive. Both the main carriageways and the shared path of the Westlink M7 are more than 3 metres above the peak 1% AEP flood level in Hinchinbrook Creek.

PMF

While widespread flooding occurs in areas upstream and downstream of where the Westlink M7 crosses Maxwells Creek, Cabramatta Creek and Hinchinbrook Creek the main carriageways of the motorway would remain flood free during the PMF.

The main carriageways along the remainder of the Westlink M7 within the Cabramatta Creek catchment is not affected by either mainstream flooding or major overland flow, with the exception of the section to the north of the bridge B9844/45 which is inundated by overland flow that originates in the Ropes Creek catchment.

5.7.2 Ropes Creek flooding

Up to 1% AEP

Flooding along Ropes Creek occurs over a width of 50 metres and to a depth of two to three metres where it runs under the bridge waterway crossings of the main carriageways and shared path of the Westlink M7 immediately east of Wallgrove Road (denoted bridge BR9851/52 on **Figure 5.2**, sheet 5). Flood levels along this section of the creek are controlled by the capacity of the 3 metres wide by 2.4 metres high box culvert that crosses Wallgrove Road. It is noted that the peak 1% AEP flood level at the inlet to the box culvert that runs under Wallgrove Road is about two metres below the adjacent level of the road.

PMF

Flow that surcharges the inlet to transverse drainage structure C10.40 during the PMF discharges onto the Westlink M7 to the south of its interchange with Elizabeth Drive where it is conveyed in a southerly direction along the northbound carriageway of the motorway toward bridge B9844/45.

While the main carriageways of the Westlink M7 are not affected by mainstream flooding from Ropes Creek, a section of the southbound carriageway to the south of the creek is subject to relatively shallow overland flow during storms which result in surcharge of the existing stormwater drainage system. The section of Wallgrove Road to the west of the Westlink M7 is impacted by Ropes Creek flooding to a maximum depth of 1.1 m, which would be hazardous to motorists.

5.7.3 Eastern Creek flooding

Up to 1% AEP

Between Villiers Road and Chandos Road the Westlink M7 generally follows a ridge of higher ground between the floodplains of Reedy Creek to the west, and Eastern Creek to the east. A series of transverse drainage culverts control local catchment runoff along this section of the Westlink M7, the largest of which is located to the north of Horsley Drive (denoted transverse drainage structure C14.80 on Figure 5.2, sheet 5), which conveys a peak 1% AEP flow of 5.4 m^3/s. Flow discharging from transverse drainage structure C14.80 travels overland across rural residential land where depths of inundation are typically less than 0.3 metres before it joins the main arm of Eastern Creek.

A tributary of Reedy Creek crosses the Westlink M7 and Wallgrove Road to the south of the Sydney Water Supply Pipeline corridor (refer transverse drainage structure C16.60 and C16.65 on Figure 5.2, sheet 5). While the main carriageways of the Westlink M7 are more than five metres above the peak 1% AEP flood level in the tributary of Reedy Creek, Wallgrove Road will be inundated over a width of about 120 metres. Depths of inundation along Wallgrove Road occur to a maximum of 0.3 metres which is the limit at which flooding becomes unsafe for small vehicles.

Flooding along the section of Reedy Creek to the west (upstream) of the Westlink M7 is mainly confined to the drainage reserve through which its main channel runs during floods up to 1% AEP in magnitude. However, backwater flooding from the creek will inundate a section of Wallgrove Road at its intersection with the access road to the Eastern Creek Water Management Facility to a maximum depth of 0.7 metres, which would be hazardous to motorists and pedestrians. The main carriageways of the Westlink M7 are more than 4 metres above the peak 1% AEP flood level, while the shared path is about two metres above the peak 1% AEP flood level where they cross Reedy Creek.

During a 1% AEP event, flooding along the section of Eskdale Creek to the west (upstream) of where it crosses the Westlink M7 and Wallgrove Road is mainly confined to the drainage reserve through which its main channel runs. However, backwater flooding from the creek will inundate a section of Old Wallgrove Road to the west of its intersection with Wallgrove Road, albeit to relatively shallow depths of 0.2 metres or less.

Flooding along the section of Angus Creek both immediately upstream and downstream of where it crosses the Westlink M7 is mainly confined to the inbank area of its main channel for floods with AEPs up to 20%. While floodwater will surcharge the banks of the creek during a 1% AEP event it would be mainly confined to areas of open space along its riparian corridor.

The main carriageways and the shared path of the Westlink M7 are more than five metres above the peak 1% AEP flood level where its crosses Angus Creek in an elevated bridge structure (denoted bridge BR9898 on Figure 5.2, sheet 7).

PMF

While the Eastern Creek flood model does not include flood mapping of the local catchments that cross the Westlink M7 to the south of The Horsley Drive, based on culvert hydraulic calculations using the peak flow estimates derived from the Eastern Creek DRAINS model it is noted that the following sections of main carriageway would be subject to overland flow:

- to the south of Saxony Road due to flow that surcharges the inlet of transverse drainage structure C12.80
- to the south of The Horsley Drive due to flow that surcharges the inlet of transverse drainage structure C14.20.

The main carriageways of the Westlink M7 are elevated above the PMF where they cross the floodplains of Reedy Creek, Eskdale Creek and Angus Creek.

While a 1.7 kilometre length of the Westlink M7 corridor in the vicinity of its intersection with the Great Western Highway is located on the floodplain of Eastern Creek, the main carriageways would not be inundated by mainstream flooding during the PMF.

6 CONSTRUCTION IMPACT ASSESSMENT

This chapter of the report provides an assessment of the surface water and flood related impacts of the proposed modification during its construction. The findings of the assessment into surface water related impacts are presented in Section 6.1, while the findings of the assessment into flood related impacts are presented in Section 6.2.

6.1 Surface water related impacts

This section provides an assessment of the impact that the proposed modification could have on surface water conditions during its construction. An assessment is made of the risks to surface water quality and quantity, as well as the measures and procedures that would be implemented to control the discharge of surface water runoff during construction. An assessment is also provided of the likely water demand during construction, including opportunities to reuse water on site to reduce such demands on the potable water supply.

6.1.1 Potential impacts on surface water quality

The primary potential for impacts on surface water quality during the construction of the proposed modification is through the erosion and mobilisation of sediments and associated nutrients, heavy metals and toxicants into waterways due to:

- the clearing of vegetation and topsoil to construct:
  - additional areas of road pavement
  - piers and associated reshaping of waterways and embankments associated with bridge works
  - adjustments to the stormwater drainage system and utilities along the Westlink M7
  - temporary construction ancillary facilities.
- earthworks associated with the construction of the additional areas of road pavement; the reshaping of waterways and embankments to accommodate the bridge works; and trenching for new or realigned stormwater drainage and utilities
- the temporary stockpiling of excavated spoil prior to its reuse on site, or of imported material for the construction of the additional areas of road pavement
- inadequate revegetation of disturbed areas following construction, which can be exacerbated by the presence of saline soils.

Other potential impacts to surface water quality during the construction of the proposed modification would include:

- the release of petroleum hydrocarbons, oil and grease, heavy metals or chemicals into waterways as a result of accidental spills or leaks from plant and machinery
- contaminants in wash down water from plant and concrete slurries.

An assessment of erosion potential from disturbed areas of the proposed modification is provided below, including an initial assessment of the scale and type of erosion and sediment controls that would be required. Further details of the measures that would be implemented to manage the impact of the construction of the proposed modification on surface water quality are provided in Section 9.2 of this report.

6.1.2 Assessment of erosion potential

An assessment of the erosion potential from areas that will be disturbed during the construction of the proposed modification was carried using the procedure set out in Blue Book. The procedure involves the estimation of the soil loss from disturbed areas using the Revised Universal Soil Loss Equation (**RUSLE**), the formula for which is as follows:

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

where,
- A = computed soil loss (tonnes/ha/year)
- R = rainfall erosivity factor
- K = soil erodibility factor
- LS = slope length / gradient factor
- P = erosion control practice factor
- C = ground cover and management factor

Table 6.1 contains a summary of the adopted values for the RUSLE calculations together with an estimate of the area of disturbance that would trigger the need for the installation of a sediment basin in accordance with the recommendations set out in the Blue Book.[6] For the purpose of the assessment, the higher of each parameter value across the extent of the construction footprint was adopted in the calculations in order to determine an upper bound estimate of soil loss.

The assessment of erosion potential found that the estimated soil loss based on the RUSLE correlates to Soil Loss Class 2 and a Low Erosion Hazard as per the classifications set out in Table 4.2 of the Blue Book. Based on an initial assessment of areas of disturbance associated with the proposed modification it is estimated that the average annual soil loss from each area would not exceed the threshold value of 150 m^3 (i.e. the largest catchment area is not expected to exceed the 1.3 hectare limit identified in Table 6.1 as triggering the need for a sediment retention basin). The implementation of effective local erosion and sediment control measures aimed at minimising the volume of sediment that is transported from disturbed areas would therefore be key to the control of sediment from the proposed modification in the absence of any large-scale sediment retention basins.

Plate 6.1 contains some examples of the types of local erosion and sediment control measures that would be implemented along the median to control runoff from the disturbed areas associated with the construction of the widened road pavement. Geotextile filter or other local controls would be installed around stormwater inlet pits to filter runoff discharging to the pit. Local sediment controls would also be installed upstream of stormwater inlet pits, which may comprise check dams or an excavated area to retain runoff and allow sediment to settle out. Where the widened road pavement grades slopes from the central median, local controls would need to be implemented along the downslope edge, which may involve the placement of sandbags (or similar) to create local check dams.

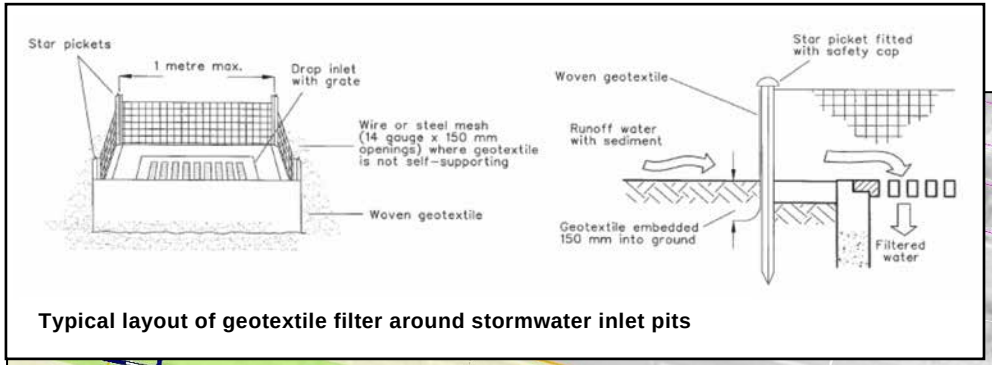
Erosion and sediment control measures would also be implemented during the establishment of construction ancillary facilities, as well as temporary access tracks and working areas to support the construction of the bridge widening works. Further details of the erosion and sediment control

[6] The Blue Book recommends that sediment retention basins be installed to control erosion and sedimentation where the average annual soil loss from a disturbed area, as derived by application of the RUSLE, is greater than or equal to 150 m^3 per year.

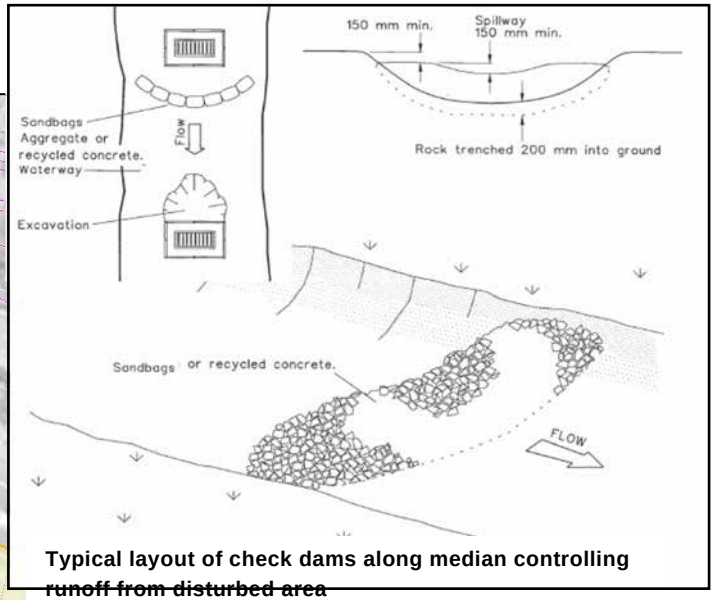
measures that would be implemented during construction of the proposed modification are outlined in Section 9.2 of this report.

Table 6.1 RUSLE input parameters and estimation of annual soil loss

Parameter	Value	Comment
R (rainfall erosivity factor)	3,000	A rainfall erosivity factor of 2,370 was derived using the 2 year Average Recurrence Interval, 6 hour design storm intensity that was obtained from the Bureau of Meteorology website, compared with a value of 3,000 based on Map 10 in Appendix B of the Blue Book. The higher value has been adopted in the RUSLE calculations.
K (soil erodibility factor)	0.05	The mapping contained in the *Soil Landscapes of the Penrith 1:100,000* (Bannerman & Hazelton, 2010) shows that the proposed modification is located on land that is mapped as Blacktown, Luddenham, Picton, South Creek, Berkshire Park soil landscapes as well as a relatively localised area that is identified as disturbed terrain. The recommended K value for these soil landscapes ranges between 0.034 and 0.050, with the latter corresponding to South Creek. In the absence of soil characteristics for disturbed terrain, the higher K value of other five soil landscapes has been adopted for the purpose of this assessment.
LS (slope length / gradient factor)	0.83	Based on a slope of 8% and length of 20 m, which is the upper values of slope and length that are expected across the proposed areas of disturbance associated with the pavement widening.
P (erosion control practice factor)	1.3	Assumed maximum value based on compacted and smooth surface conditions.
C (ground cover management factor)	1.0	Assumed maximum value based on worst case scenario with zero ground cover.
A (total calculated soil loss)	162 tonnes / ha / year	Representative soil loss associated with the proposed modification.
Erosion Hazard	Low (Soil Loss Class 2)	Based on Table 4.2 of the Blue Book.
Minimum catchment area requiring a sediment basin	1.3 Ha	Based on a threshold of 150 m^3 and a typical density of saturated sediment of 1.3 tonnes / m^3.



Typical layout of geotextile filter around stormwater inlet pits



Typical layout of check dams along median controlling runoff from disturbed area

Plate 6.1 Examples of typical local erosion and sediment control measures associated with the construction of the widened road pavement

6.1.3 Construction discharges against the water quality objectives

Erosion and sediment control measures would be implemented and maintained during the construction of the proposed modification with the aim of ensuring that the WQOs continue to be met at waterways where they are currently being achieved, or alternatively, maintaining or improving existing water quality where they are not being met.

As noted in the preceding section, erosion and sediment control measures would be designed and implemented during the construction of the proposed modification in accordance with the procedures set out in the Blue Book. The Blue Book requires that treated runoff discharging from a construction site contain TSS concentrations of no greater than 50 mg/L and have a pH of between 6.5 and 8.5.

Further water quality assessment would be undertaken during detailed design to determine whether additional site-specific discharge criteria are required to meet the objective of maintaining or improving existing water quality in the receiving watercourses. This further assessment would be based on the results of water quality monitoring in the receiving watercourses, the initial results of which are presented in Section 5.6 of this report. Further details of the water quality monitoring that would be undertaken during construction are set out in Section 9.2.

Subject to the outcomes of the further water quality assessment during detailed design, enhanced erosion and sediment control measures may be required to meet additional site-specific discharge criteria that may be identified. These enhanced erosion and sediment control measures will need to be incorporated into the Soil and Water Management Plan (SWMP). The SWMP would include consideration of the following:

- staging the proposed modification works to ensure that clean water diversion drains and/or diversion banks upslope of the proposed modification are implemented during the initial stages of construction to control the runoff which presently discharges onto the footprint
- staging the construction of drainage culverts and channels to control runoff through the site
- preparing and implementing progressive erosion and sediment controls applicable to each stage of construction
- locating site accesses, and use of shaker grids and surface treatments to control the risk of sediment being tracked onto surrounding roads
- locating stockpiled material that is erodible away from drainage paths and flood prone areas and stabilising stockpiles to minimise the risk of erosion
- conservation of existing topsoil for later site rehabilitation, including appropriate amelioration and fertilisation where required
- managing the extent of exposed surfaces based on their flood potential and the duration that the areas would be left exposed
- scour protection along drainage lines through the site
- separation of clean and dirty water wherever possible
- monitoring of forecast rainfall and developing wet weather procedures to protect or stabilise areas of construction susceptible to erosion
- implementing procedures for the routine inspection and maintenance of erosion and sediment controls measures, and following rainfall events

- progressive site rehabilitation and monitoring of the condition of permanent drainage measures to ensure that temporary erosion controls are only removed once permanent measures have been established.

During detailed construction planning a dewatering management plan (DMP) would be prepared that sets out the procedures for the discharge of surface water runoff that is retained in sediment controls and exposed excavations. The DMP would be prepared in accordance with the *"Technical Guideline – Environmental Management of Construction Site Dewatering"* (Transport 2011) based on the process set out in Diagram 6.1 over the page and would include consideration of the following:

- identification of water quality criteria for the discharge of on-site water and the treatment techniques required to meet these criteria
- methods for achieving water quality objectives for any site discharge through best practice erosion and sediment control measures and/or treatment of water through flocculation prior to discharge from sediment retention sumps
- reuse of stormwater where feasible within the scope of construction activities for:
    - dust suppression
    - earthworks compaction
    - irrigation for vegetation establishment
    - plant wash down
- selection of suitable locations for the discharge of captured runoff utilising existing drainage paths where it cannot be reused on site
- procedures for monitoring and maintenance of sediment controls taking into consideration forecast rainfall events
- water sampling and testing requirements to ensure the water quality objectives are met
- procedures for the rectification of sediment controls or site practices should the monitoring identify exceedances to the water quality parameters.

6.1.4 Potential impacts on surface water quantity, geomorphology and environmental water availability and flows

An increase in the quantity (i.e. the rate and volume) of surface water runoff discharging from the construction footprint has the potential to increase scour and exacerbate flooding along the receiving watercourses that are located downstream of the Westlink M7. An increase in scour can in turn impact on water quality due to an increase in sedimentation, as well as lead to an increase in the rate of bank erosion that can impact on the geomorphology of the creeks and watercourses downstream of the Westlink M7.

Impacts on the rate and volume of surface water runoff during the construction of the proposed modification would be similar to those under operational conditions on the basis that:

- increases in the rate and volume of runoff from exposed excavations during construction would in part be offset by the provision of erosion and sediment control measures that retain runoff to allow sediment to settle out
- the erosion and sediment control measures associated with the construction of the widened road pavement would discharge to the existing stormwater controls that are located along the Westlink M7 and are expected to remain fully operational during the construction of the widened road works.

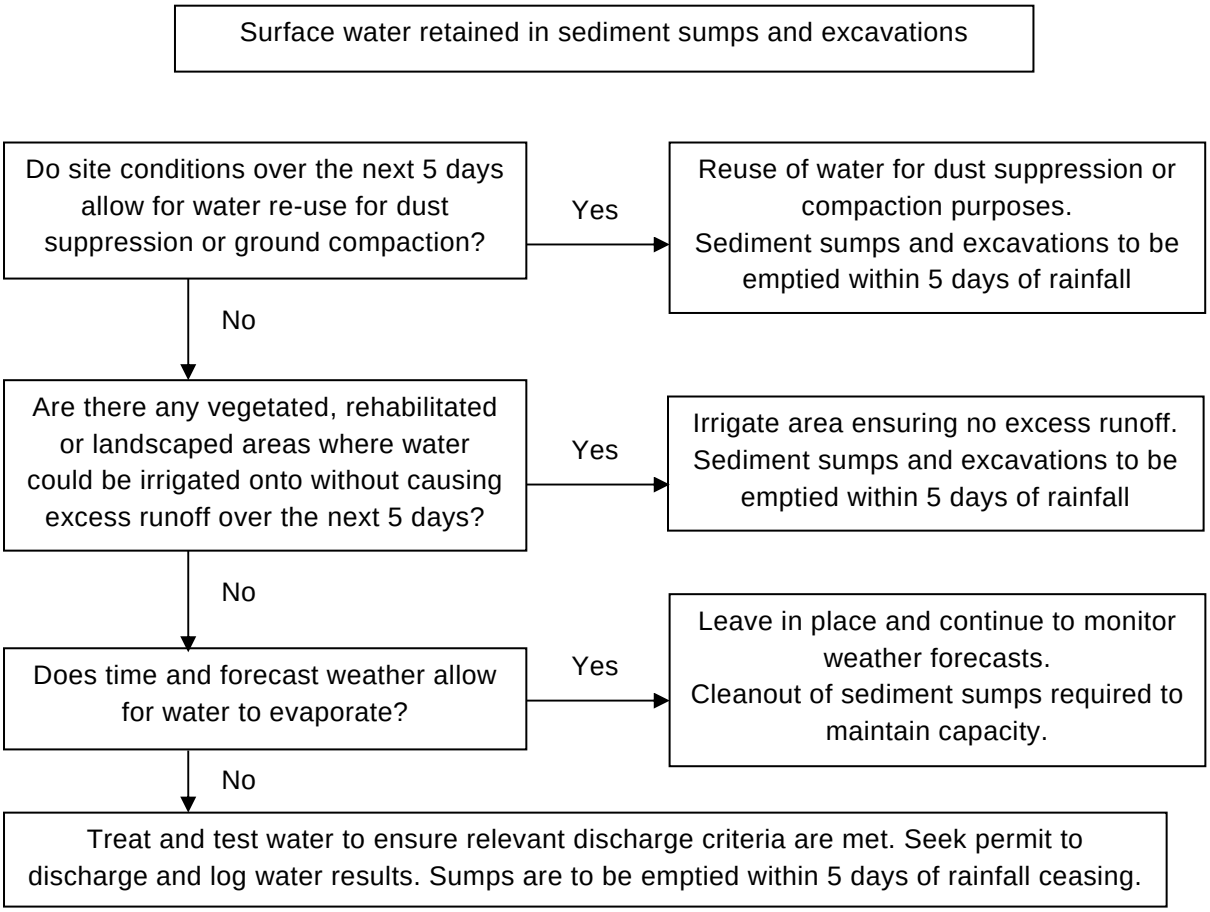


Diagram 6.1 Flow chart showing the process for managing the discharge of runoff from sediment sumps and excavations

The geomorphology of creeks that cross the construction footprint can also be adversely impacted by works within their in-bank area should they obstruct and redirect flows leading to an increase in velocities and bank erosion. As part of the construction of the proposed modification temporary creek crossings and working platforms would be installed within the in-bank area of the creeks to construct the bridge widening works. Potential impacts of the construction of the bridge widening works on flow velocities in the creeks are discussed further in Section 6.2 of this report, while measures that are proposed to manage these impacts are discussed in Section 9.2.

The construction of the proposed modification is not expected to result in a material impact on environmental water availability and flows. No damming or permanent blockage of watercourses is proposed. While a portion of the water capture in erosion and sediment controls during construction may be used for construction activities such as dust suppression or ground compaction, this is not expected to adversely impact on existing water availability and flows.

6.1.5 Potential impacts on water demand

Water use during construction would be largely associated with dust suppression and the construction of the widened road pavement (e.g. compaction). Water would also be used during construction for a range of purposes including but not limited to wheel washing, machinery, curing structures and operation of ancillary construction facility amenities (toilets, sinks, showers, and drinking).

Over the construction period, it is estimated that about 280 million litres of water would be used to construct the proposed modification, which equals around 93 million litres per annum. The actual water requirement would vary, depending on material sources and methodologies applied by the construction contractor, as well as prevailing weather conditions.

Construction water sources would be confirmed during detailed design but are likely to include a combination of potable mains supply and recycled (or non-potable) water, drawn from sources internal and external to the construction footprint. As outlined in Section 6.1.3, non-potable water would be sourced from construction sediment sumps where it is feasible to reuse this water prior to its discharge.

6.2 Flood related impacts

This section provides an assessment of the flood risk associated with the construction of the proposed modification, as well as an overview of the potential impacts that the proposed construction activities could have on flood behaviour. For the purpose of this assessment, the construction footprint has been split into the following areas:

- Areas for bridge construction works associated with the widening of the existing bridges to accommodate the additional travel lanes of the proposed modification (denoted bridge work areas on Figure 6.1 (8 sheets)). The nomenclature adopted for bridge construction work areas in this report is the same as the bridge names that are presented in Chapter 4 of the Modification Report.
- Areas along the central median of the motorway carriageways for construction of pavement widening and associated median earthworks, as well as the construction of abutments for the widening of existing bridges (denoted median work areas MWA01 to MWA25 on Figure 6.1 (8 sheets)).
- Construction ancillary facilities to support the construction of the proposed modification, which would include site construction ancillary facilities within each pavement and bridge construction area, as well as zone construction ancillary facilities to provide centralised facilities and construction management offices for site-based personnel (denoted construction ancillary facilities on Figure 6.1 (8 sheets)). The nomenclature adopted for construction ancillary facilities in this report is the same as that presented in Chapter 4 of the Modification Report.

6.2.1 Potential flood risks at construction work areas and ancillary facilities

Without the implementation of appropriate management measures, the inundation of the construction work areas and ancillary facilities by floodwater has the potential to:

- cause damage to the proposed modification works and delays in construction programming
- pose a safety risk to construction workers
- detrimentally impact the downstream waterways through the transport of sediments and construction materials by floodwater
- obstruct the passage of floodwater and overland flow, which in turn could exacerbate flooding conditions in existing development located outside the construction footprint.

Table 6.2 at the end of this section provides a summary of the proposed activities, as well as the assessed flood risk at each construction work area and ancillary facility. Figure 6.1 (8 sheets) shows the extent to which floods of varying magnitude affect each construction work area and ancillary facility. Further details of each construction work area and ancillary facility, and their associated activities are provided in Chapter 4 of the Modification Report.

Construction ancillary facilities

A number of construction ancillary facilities have been identified to support the construction of the proposed modification. The construction ancillary facilities would include offices, workshops, staff amenities, parking, as well as areas to store plant, equipment and materials. Secure perimeter fencing would be provided around each construction ancillary facility, including visual screening where necessary. Table 6.2 lists the construction ancillary facilities within each work area and construction zone together with a summary of their potential flood affectation.

The assessment found that while there is a low risk of flooding associated with the construction ancillary facilities that would be located within the central median of the main carriageways, the following ancillary facilities associated with bridge construction and construction zone support are subject to flooding conditions that would be considered hazardous based on the flood hazard vulnerability classification presented in ARR 2019:

- during a 20% AEP event at:
    - ancillary facility C2@B9817
    - Zone A-1 ancillary facility
- during a 1% AEP event at
    - ancillary facilities C2@B9826/27 and C4@B9826/27 at the Cabramatta Creek bridge
    - ancillary facilities C2@B9829/30, C3@ B9829/30 and C4@ B9829/30 at the Lower Hinchinbrook Creek bridge
    - a portion of the Zone B-1 and Zone D-2 ancillary facilities where they are crossed by a major overland flow path.

Ancillary facilities located on the floodplain, particularly in areas of high hazard[7], pose a safety risk to construction personnel and plant. A broad outline of potential mitigation measures aimed at managing the risk of flooding to ancillary facilities is provided in Section 9.2.

A number of the construction ancillary facilities associated with bridge construction and zone support include land that would be inundated during a 5% AEP flood. In accordance with standard Transport procedures, contingency planning would be required should site facilities be located in these areas.

[7] High hazard flooding is defined in the *Floodplain Development Manual* (Department of Planning, Infrastructure and Natural Resources (DIPNR) 2005) as flooding that is a possible danger to personal safety, where evacuation by trucks and able-bodied adults would be difficult and where there is potential for significant structural damage to buildings. High hazard flooding is initially categorised based on the depth and velocity of flooding but can be revised through the provision of effective flood emergency planning and response procedures to reduce the consequences of flooding if there is sufficient warning time. High hazard flooding under DIPNR 2005 generally corresponds to a hazard vulnerability classification of H4 to H6 under the flood hazard vulnerability classifications presented in ARR 2019.

Spoil management and stockpile areas

The construction of the proposed modification would generate spoil, some of which would need to be temporarily stored in stockpile areas for reuse on site or disposed of according to the procedures set out in Chapter 4 of the Modification Report. It would also be necessary to temporarily store imported material such as road base that would be used to construct the pavement widening.

Stockpiles located on the floodplain have the potential to obstruct floodwater and alter flooding patterns. Inundation of stockpile areas by floodwater can also lead to significant quantities of material being washed into the receiving drainage lines and waterways.

The locations within each construction work area and ancillary facility where materials would be stored would be subject to detailed design and construction planning.

Earthworks

Earthworks would be required across all the construction work areas to construct the proposed modification, which would include:

- the installation of construction ancillary facilities, as well as temporary access roads and working platforms at bridge construction areas
- the widening of the road pavement and associated earthworks within the median work areas
- the reshaping of ground to accommodate the new abutments and piers within the bridge construction areas.

While the assessment found that there is a low potential for flooding to the median work areas, a number of bridge construction areas and ancillary facilities are located in areas that would be frequently inundated by floodwater. The inundation of the earthworks by floodwater has the potential to cause scour of disturbed surfaces and the transport of sediment and construction materials into the receiving drainage lines and waterways.

It would therefore be necessary to plan, implement and maintain measures that are aimed at managing the diversion of floodwater either through or around the construction areas. A broad outline of potential mitigation measures is provided in Section 9.2.

Bridge construction

A total of forty three (43) bridges at twenty three (23) locations would require widening as part of the proposed modification. The widening of each bridge would typically involve the construction of abutments and piers followed by the installation of bridge beams, girders, decks and barriers.

Temporary access roads would be required to move machinery and material to each bridge construction area, while working platforms would be required to support piling rigs and cranes. At bridge crossings over creeks the temporary access roads and working platforms may need to cross part of the main creek channel in areas that would be frequently inundated by flow. It would therefore be necessary to design and construct the temporary access roads and working platforms to manage the potential for scour and transport of material into the watercourses, whilst also maintaining a passage for the conveyance of floodwater through the construction site. Section 9 provides a summary of potential measures to manage these impacts.

6.2.2 Potential impacts of construction activities on flood behaviour

Construction activities have the potential to exacerbate flooding conditions when compared to both existing and operational conditions. This is because construction activities typically impose a larger footprint on the floodplain due to the need to provide temporary structures, such as ancillary sites, outside the operational footprint which would be removed following the completion of construction activities.

A qualitative assessment was carried out of the potential impacts that construction activities could have on flood behaviour, the key findings of which are summarised in Table 6.2.

The assessment found that:

i. the construction activities within the median work areas would have a minimal impact on flood behaviour
ii. temporary access roads and working platforms that would be required to construct the widening of the existing bridges over creeks all have the potential to obstruct the conveyance of flow, which in turn may impact on the extent and depth of inundation and flow velocities in the creeks and their overbank areas
iii. site facilities, stored materials and perimeter fencing associated with a number of the ancillary facilities have the potential to obstruct the conveyance of floodwater or displace floodplain storage. The ancillary facilities where there is the greatest potential for impacts correspond to those where high hazard flooding conditions are identified in Section 6.2.1.

While the findings of the assessment provide an indication of the potential impacts of construction activities on flood behaviour, further investigation would need to be undertaken during detailed design, as layouts and staging diagrams are further developed. Consideration would also need to be given to setting an appropriate hydrologic standard for mitigating the impacts of construction activities on flood behaviour, taking into account their temporary nature and therefore the likelihood of a flood of a given AEP occurring during the construction period.

Without mitigation, the construction of the proposed modification has the potential to result in changes in flood behaviour that may have social and economic costs to the community by causing disruption and exacerbating the impact of flooding to property and infrastructure. Prior to construction, measures aimed at mitigating the impacts of construction activities on flood behaviour would be investigated. Section 9.2 outlines a range of measures which will be implemented to mitigate the potential construction related impacts of the proposed modification.

Table 6.2 Summary of assessed flood risks and potential impacts at proposed construction work areas

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
Kurrajong Road median work area (MWA01)	Ancillary facility C1@B9817	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 2. • The median work area would be subject to shallow inundation during extreme storm events.	• Activities within the Kurrajong Road median work area (MWA01) would have a minimal effect on flood behaviour.
	Other areas within MWA01	Less frequent than 0.2% AEP	x	x	✓	x	x		
Maxwells Creek bridge construction area (BCA9817)	Ancillary facility C2@B9817	More frequent than 20% AEP	✓	✓	x	✓	x	• Refer to Figure 6.1, sheet 2. • During a 20% AEP flood the entire extent of ancillary facility C2@B9817 and a significant proportion of the remainder of the bridge construction area would be inundated to depths that exceed 1.5 m.	• The depth and velocity of flow through the bridge construction area during a 20% AEP event would be hazardous to construction personnel, plant and material. • Site facilities, stored materials and perimeter fencing associated with ancillary facility C2@B9817 have the potential to obstruct the conveyance of flow in Maxwells Creek during events more frequent than 20% AEP. This in turn could impact on the extent and depth of inundation, as well as flow velocities in Maxwells Creek. • Similarly, the temporary access roads and working platforms for the widening of the Maxwells Creek bridge also have the potential to obstruct the conveyance of flow in
	Other areas within BCA9817	More frequent than 20% AEP	x	x	✓	✓	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
									Maxwells Creek during events more frequent than 20% AEP, which in turn could impact on the extent and depth of inundation, as well as flow velocities in the creek.
Maxwells Creek median work area (MWA02)	Ancillary facility C3@B9817	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 2. • The median work area would be subject to shallow inundation during extreme storm events.	• Activities within the Maxwells Creek median work area (MWA02) would have a minimal effect on flood behaviour.
	Ancillary facility C1@B9821	Not flooded	✓	✓	x	x	✓		
	Other areas within MWA02	Less frequent than 0.2% AEP	x	x	✓	x	x		
Maxwells Creek tributary bridge construction area (BCA9821)	Ancillary facility C2@B9821	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 2. • While ancillary facility C2@B9821 is not impacted by flooding during events up to 0.2% AEP in magnitude, it would be subject to relatively shallow overland flow due to runoff from the motorway carriageways. • A large proportion of the remainder of the bridge construction area would be inundated during a 20% AEP event to depths that exceed 1.5 m.	• The depth and velocity of flow through the bridge construction area during a 20% AEP event would be hazardous to construction personnel, plant and material. • Activities within ancillary facility C2@B9821 would not have an impact on flood behaviour in adjacent development. • The temporary access roads and working platforms for the widening of the Maxwells Creek tributary bridge have the potential to obstruct the conveyance of flow in the
	Other areas within BCA9821	More frequent than 20% AEP	x	x	✓	✓	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
									tributary of Maxwells Creek during events more frequent than 20% AEP, which in turn could impact on the extent and depth of inundation, as well as flow velocities in the watercourse.
Bernera Road south median work area (MWA03)	Ancillary facility C1@B9825	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 2. • The median work area would be subject to shallow inundation during extreme storm events.	• Activities within the Bernera Road south median work area (MWA03) would have a minimal effect on flood behaviour.
	Other areas within MWA03	Less frequent than 0.2% AEP	x	x	✓	x	x		
Bernera Road bridge construction area (BCA9825)	Ancillary facility C2@B9825	Between 5% and 1% AEP	✓	✓	x	✓	x	• Refer to Figure 6.1, sheet 2. • Overland flow that is conveyed in a northerly direction along Bernera Road during a 1% AEP event would inundate the northern portion of ancillary facility C2@9825, albeit over a relatively localised area and to depths that are 0.1 m or less. • The southern portion of ancillary facility C3@9825 would also be inundated by overland flow during a 1% AEP event to depths that are 0.2 m or less.	• Due to the relatively shallow nature of flow, the impacts of the activities within the Bernera Road bridge construction area (BCA9825) on flood behaviour would be localised and of a minor nature.
	Ancillary facility C3@B9825	Between 10% and 5% AEP	✓	✓	x	✓	x		
	Other areas within BCA9825	Not flooded	x	x	✓	✓	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
Bernera Road north median work area (MWA04)	Ancillary facility C4@B9825	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 2. • While the median work area is not impacted by flooding, it would be subject to relatively shallow overland flow due to runoff from the motorway carriageways.	• Refer to Figure 6.1, sheet 2. • Activities within the Bernera Road north median work area (MWA04) would have a minimal effect on flood behaviour
	Ancillary facility C1@B9826/27	Not flooded	✓	✓	x	✓	✓		
	Other areas within MWA04	Not flooded	x	x	✓	x	x		
Cabramatta Creek bridge construction area (BCA9826/27)	Ancillary facility C2@B9826/27	More frequent than 20% AEP	✓	✓	x	✓	x	• Refer to Figure 6.1, sheet 2. • Ancillary facilities C2@B9826/27 and C4@B9826/27 would be inundated during a 20% AEP event over a relatively localised area and to depths that are 0.1 m or less, while during a 1% AEP event a significant portion of both ancillary facility sites would be inundated to a maximum depth of 0.8 m. • A large proportion of the remainder of bridge construction area would be inundated during a 20% AEP event to depths that exceed 1 m, increasing to more than 1.5 m during a 1% AEP event.	• The depth and velocity of flow through the bridge construction area during a 1% AEP event would be hazardous to construction personnel, plant and material. • While site facilities and stored materials located within ancillary facilities C2@B9826/27 and C4@B9826/27 have the potential to displace floodwater that backs up from Cabramatta Creek, impacts on flood behaviour for events up to 1% AEP are likely to be minor given the extent of flooding relative to the extent of the ancillary facilities. • The temporary working platforms for the widening of the Cabramatta Creek bridge have the potential to obstruct the conveyance of flow in
	Ancillary facility C4@B9826/27	More frequent than 20% AEP	✓	✓	x	✓	x		
	Other areas within BCA9826/27	More frequent than 20% AEP	x	x	✓	✓	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
									Cabramatta Creek during events more frequent than 20% AEP, which in turn could impact on the extent and depth of inundation, as well as flow velocities in the creek.
Hoxton Park Road median work area (MWA05)	Ancillary facility C3@B9826/27	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 2. • While the median work area is not impacted by flooding, it would be subject to relatively shallow overland flow due to runoff from the motorway carriageways.	• Activities within the Hoxton Park Road median work area (MWA05) would have a minimal effect on flood behaviour
	Ancillary facility C1@B9829/30	Not flooded	✓	✓	x	x	✓		
	Other areas within MWA05	Not flooded	x	x	✓	x	x		
Lower Hinchinbrook Creek bridge construction area (BCA9829/30)	Ancillary facility C2@B9829/30	More frequent than 20% AEP	✓	✓	x	✓	x	• Refer to Figure 6.1, sheets 2 & 3. • Ancillary facilities C2@B9829/30, C3@ B9829/30 and C4@ B9829/30 would be inundated during a 20% AEP event over a relatively localised area and to depths that are typically 0.1 m or less, while during a 1% AEP event a significant portion of all three ancillary facilities would be inundated to a maximum depth of 0.8 m. • While ancillary facility C5@ B9829/30 is not impacted by floods up to 0.2% AEP in magnitude, it	• Refer to Figure 6.1, sheet 2. • The depth and velocity of flow through the bridge construction area during a 1% AEP event would be hazardous to construction personnel, plant and material. • While site facilities and stored materials located within ancillary facility C2@B9829/30 have the potential to displace floodwater that backs up from Hinchinbrook Creek, impacts on flood behaviour for events up to 1% AEP are likely to be minor given the extent of
	Ancillary facility C3@B9829/30	More frequent than 20% AEP	✓	✓	x	✓	X		
	Ancillary facility C4@B9829/30	More frequent than 20% AEP	✓	✓	x	✓	X		
	Ancillary facility C5@B9829/30	Less frequent than 0.2% AEP	✓	✓	x	✓	✓		
	Other areas within BCA9829/30	More frequent than 20% AEP	x	x	✓	✓	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
								would be subject to relatively shallow overland flow due to runoff from the motorway carriageways. • A large proportion of the remainder of the bridge construction area would be inundated during a 1% AEP event to depths up to 0.5 m in overbank areas and 3 m within the inbank area of Hinchinbrook Creek and its flood mitigation channels.	flooding relative to the extent of the ancillary facilities. • Site facilities and stored materials located within ancillary facilities C3@B9829/30 and C4@B9829/30, as well as the temporary working platforms for the bridge widening, all have the potential to obstruct the conveyance of flow in Hinchinbrook Creek during events more frequent than 20% AEP. This in turn could impact on the extent and depth of inundation and flow velocities in the creek. • Activities within ancillary facility C5@B9829/30 would not have an impact on flood behaviour in adjacent development.
Cowpasture Road south median work area (MWA06)	Ancillary facility C1@B9835/36	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheets 2 & 3. • While the median work area is not impacted by flooding, it would be subject to relatively shallow overland flow due to runoff from the motorway carriageways.	• Activities within the Cowpasture Road south median work area (MWA06) would have a minimal effect on flood behaviour
	Other areas within MWA06	Not flooded	x	x	✓	x	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
Cowpasture Road bridge construction area (BCA9835/36)	Ancillary facility C2@B9835/36	Less frequent than 0.2% AEP	✓	✓	x	✓	x	• Refer to Figure 6.1, sheet 3. • The bridge construction area would be subject to shallow inundation during extreme storm events.	• Refer to Figure 6.1, sheet 2. • Activities within the Cowpasture Road bridge construction area (BCA9835/36) would have a minimal effect on flood behaviour.
	Ancillary facility C3@B9835/36	Less frequent than 0.2% AEP	✓	✓	x	✓	x		
	Other areas within BCA9835/36	Less frequent than 0.2% AEP	x	x	x	✓	x		
Cowpasture Road north median work area (MWA07)	Ancillary facility C4@B9835/36	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 3. • While the median work area is not impacted by flooding, it would be subject to relatively shallow overland flow due to runoff from the motorway carriageways.	• Activities within the Cowpasture Road north median work area (MWA07) would have a minimal effect on flood behaviour.
	Ancillary facility C1@B9839/40	Not flooded	✓	✓	x	x	✓		
	Other areas within MWA07	Not flooded	X	x	✓	x	x		
Aviation Road bridge construction area (BCA9839/40)	Ancillary facility C2@B9839/40	More frequent than 20% AEP	✓	✓	x	✓	x	• Refer to Figure 6.1, sheet 3. • During a 20% AEP event the western portion of ancillary facility C2@B9839/40 would be inundated by floodwater that originate from the tributary of Hinchinbrook Creek that crosses the Westlink M7 at Aviation Road. Depths of inundation would occur to a maximum of 0.3 m during a 20% AEP event, increasing to 0.5 m during a 1% AEP event.	• Site facilities and stored materials located within ancillary facility C2@B9839/40, as well as the temporary working platforms for the bridge widening, all have the potential to obstruct the conveyance of flow in the tributary of Hinchinbrook Creek that crosses the Westlink M7 at Aviation Road during events more frequent than 20% AEP. This in turn could impact on the extent and depth of
	Other areas within BCA9839/40	More frequent than 20% AEP	x	x	x	✓	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
								• A significant portion of the remainder of the bridge construction area would be inundated during a 20% AEP event to a maximum depth of 0.8 m, increasing to 1.1 m during a 1% AEP event.	inundation, as well as flow velocities in the creek.
Hinchinbrook Creek south median work area (MWA08)	Ancillary facility C3@B9839/40	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 3. • While the median work area is not impacted by flooding, it would be subject to relatively shallow overland flow due to runoff from the motorway carriageways.	• Activities within the Hinchinbrook Creek south median work area (MWA08) would have a minimal effect on flood behaviour
	Ancillary facility C1@B9841/42	Not flooded	✓	✓	x	x	✓		
	Other areas within MWA08	Not flooded	x	x	✓	x	x		
Upper Hinchinbrook Creek bridge construction area (BCA9841/42)	Ancillary facility C2@B9841/42	Between 10% and 5% AEP	✓	✓	x	✓	x	• Refer to Figure 6.1, sheet 3. • Ancillary facility C2@B9841/42 would be inundated along its eastern edge by backwater flooding from Hinchinbrook Creek during a 5% AEP event. Depths of inundation would occur to a maximum of 0.4 m during a 5% AEP event, increasing to 0.6 m during a 1% AEP event. • A significant portion of the remainder of the bridge	• While site facilities and stored materials located within ancillary facility C2@B9841/42 have the potential to displace floodwater that backs up from Hinchinbrook Creek, impacts on flood behaviour for events up to 1% AEP are likely to be minor given the extent of flooding relative to the extent of the ancillary facilities. • Temporary access roads and working platforms for the bridge
	Other areas within BCA9841/42	More frequent than 20% AEP	x	x	✓	✓	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
								construction area would be inundated during a 20% AEP event to a maximum depth of 1.2 m, increasing to 1.7 m during a 1% AEP event.	widening have the potential to obstruct the conveyance of flow in Hinchinbrook Creek during events more frequent than 20% AEP. This in turn could impact on the extent and depth of inundation, as well as flow velocities in the creek.
Hinchinbrook Creek north median work area (MWA09)	Ancillary facility C3@B9841/42	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheets 3 & 4. • While the median work area is not impacted by flooding, it would be subject to relatively shallow overland flow due to runoff from the motorway carriageways.	• Activities within the Hinchinbrook Creek north median work area (MWA09) would have a minimal effect on flood behaviour.
	Ancillary facility C1@B9844/45	Not flooded	✓	✓	x	x	✓		
	Other areas within MWA08	Not flooded	x	x	✓	x	x		
Western Sydney Parklands bridge construction area (BCA9844/45)	Ancillary facility C2@B9844/45	Less frequent than 0.2% AEP	✓	✓	x	✓	x	• Refer to Figure 6.1, sheet 4. • While the bridge construction area is not impacted by flooding during events up to 0.2% AEP in magnitude, it would be subject to relatively shallow overland flow due to runoff from the localised area that slopes toward the bridge.	• Activities within the Western Sydney Parklands bridge construction area (BCA9844/45) would have a minimal effect on flood behaviour.
	Other areas within BCA9839/40	Less frequent than 0.2% AEP	x	x	✓	✓	X		
Elizabeth Drive south median work area (MWA10)	Ancillary facility C3@B9844/45	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 4. • While the median work area is not impacted by flooding, it would be subject to relatively shallow	• Activities within the Elizabeth Drive south median work area (MWA10) would have a minimal effect on flood behaviour.
	Ancillary facility C1@B9847/48	Not flooded	✓	✓	x	✓	✓		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
	Other areas within MWA10	Not flooded	x	x	✓	x	x	overland flow due to local catchment runoff from the central median.	
Elizabeth Drive bridge construction area (BCA9847/48)	Ancillary facility C2@B9847/48	Not flooded	✓	✓	x	✓	✓	• Refer to Figure 6.1, sheet 4. • While the median work area is not impacted by flooding during events up to 0.2% AEP in magnitude, it would be subject to relatively shallow overland flow due to flow that surcharges the drainage system along Elizabeth Drive.	• Activities within the Elizabeth Drive bridge construction area (BCA9847/48) would have a minimal effect on flood behaviour.
	Other areas within BCA9847/48	Less frequent than 0.2% AEP	x	x	✓	✓	x		
Elizabeth Drive north median work area (MWA11)	Ancillary facility C1@B9851/52	Less frequent than 0.2% AEP	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 4. • The median work area would be subject to shallow inundation during extreme storm events.	• Activities within the Elizabeth Drive north median work area (MWA11) would have a minimal effect on flood behaviour.
	Other areas within MWA11	Less frequent than 0.2% AEP	x	x	✓	x	x		
Villiers Road bridge construction area (BCA9851/52)	Ancillary facility C2@B9851/52	Not flooded	✓	✓	x	✓	✓	• Refer to Figure 6.1, sheet 4. • While ancillary facility C2@B9851/52 is not impacted by mainstream flooding from Ropes Creek, it would be subject to relatively shallow overland flow due to runoff from the central median. • During a 20% AEP event, a large proportion of the bridge construction area would be	• The depth and velocity of flow through the bridge construction area during a 1% AEP event would be hazardous to construction personnel, plant and material. • Activities within ancillary facility C2@B9851/52 would not have an impact on flood behaviour in adjacent development.
	Other areas within BCA9851/52	More frequent than 20% AEP	x	x	✓	✓	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
								inundated by flooding from Ropes Creek to a maximum depth of 1.3 m within the inbank area of the creek, and 0.6 m on the overbank areas. During a 1% AEP event, depths of inundation would occur to a maximum of 2.3 m within the inbank area of the creek, and 1.6 m on the overbank areas.	• The temporary access roads and working platforms for the widening of the Villiers Road bridge have the potential to obstruct the conveyance of flow in Ropes Creek during events more frequent than 20% AEP, which in turn could impact on the extent and depth of inundation, as well as flow velocities in the watercourse.
Saxony Road median work area (MWA12)	Ancillary facility C1@B9853/54	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheets 4 & 5. • While ancillary facility C1@B9853/54 is not impacted by flooding, it would be subject to relatively shallow overland flow due to local catchment runoff from the central median.	• Activities within the Saxony Road median work area (MWA12) would have a minimal effect on flood behaviour.
	Other areas within MWA12	Not flooded	x	x	✓	x	X		
Saxony Road bridge construction area (BCA9853/54)	Ancillary facility C2@B9853/54	Not flooded	✓	✓	x	✓	✓	• Refer to Figure 6.1, sheet 5. • While the bridge construction area is not impacted by mainstream flooding or major overland flow, it would be subject to inundation due to local catchment runoff that collects at the low point in Saxony Road that is located below the Saxony Road bridge.	• Activities within the Saxony Road bridge construction area (BCA9853/54) would have a minimal effect on flood behaviour.
	Other areas within BCA9853/54	Not flooded	x	x	✓	✓	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
The Horsley Drive median work area (MWA13)	Ancillary facility C1@B9858/59	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 5. • While ancillary facility C1@B9858/59 is not impacted by flooding, it would be subject to relatively shallow overland flow due to local catchment runoff from the central median. • The median work area would be subject to inundation due to flow that surcharges transverse drainage structure C14.20 during storms greater than 1% AEP in magnitude.	• Activities within The Horsley Drive median work area (MWA13) would have a minimal effect on flood behaviour.
	Other areas within MWA12	1% AEP	x	x	✓	x	X		
Redmayne Road bridge construction area (BCA9858/59)	Ancillary facility C2@B9858/59	More frequent than 20% AEP	✓	✓	x	✓	x	• Refer to Figure 6.1, sheet 5. • The eastern portion of ancillary facility C2@B9858/59 and the adjoining bridge construction area extend over an existing concrete lined channel that runs along the southern side of Redmayne Road where it crosses under the Redmayne Road bridge. The channel has less than a 20% AEP capacity.	• Site facilities and stored materials located within ancillary facility C2@B9858/59, as well as the temporary working platforms for the bridge widening, all have the potential to obstruct the conveyance of flow in the concrete lined channel that runs along the southern side of Redmayne Road. This in turn could impact on the extent and depth of inundation in the channel and adjoining areas.
	Other areas within BCA9858/59	More frequent than 20% AEP	x	x	✓	✓	x		
	Ancillary facility C3@B9858/59	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheets 5 & 6.	• Activities within the Chandos Road median work area (MWA14) would

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
Chandos Road median work area (MWA14)	Ancillary facility C1@B9861/62	Not flooded	✓	✓	x	✓	x	• While ancillary facilities C3@B9858/59 and C1@B9861/62 are not impacted by flooding, they would be subject to relatively shallow overland flow due to local catchment runoff from the central median.	have a minimal effect on flood behaviour.
	Other areas within MWA14	Not flooded	x	x	✓	x	x		
Austral Bricks Access bridge construction area (BCA9861/62)	Ancillary facility C2@B9861/62	Not flooded	✓	✓	x	✓	x	• Refer to Figure 6.1, sheet 6. • While the bridge construction area is not impacted by mainstream flooding or major overland flow, it would be subject to relatively shallow overland flow due to runoff from the localised area that slopes toward the bridge.	• Activities within the Austral Brick Access bridge construction area (BCA9861/62) would have a minimal effect on flood behaviour.
	Other areas within BCA9861/62	Not flooded	x	x	✓	✓	x		
Rousell Road median work area (MWA15)	Ancillary facility C3@B9861/62	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 6. • While ancillary facility C3@B9861/62 is not impacted by flooding, it would be subject to relatively shallow overland flow due to local catchment runoff from the central median.	• Activities within the Rousell Road median work area (MWA15) would have a minimal effect on flood behaviour.
	Other areas within MWA15	Not flooded	x	x	✓	x	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
Waste Management Access bridge construction area (BCA9863/64)	Ancillary facility C1@B9863/64	Not flooded	✓	✓	x	✓	✓	• Refer to Figure 6.1, sheet 6. • While ancillary facilities C1@B9863/64 and C2@B9863/64 are not impacted by mainstream flooding or major overland flow, they would be subject to relatively shallow overland flow due to local catchment runoff from the central median. • The bridge construction area would be impacted by backwater flooding from Reedy Creek that surcharges onto Wallgrove Road at its intersection with the Waste Management Access.	• While temporary works to undertake the bridge widening have the potential to displace floodwater that backs up from Reedy Creek across the Waste Management Access, impacts on flood behaviour in adjacent development during a 1% AEP event are likely to be minor given the extent of flooding relative to the extent of the temporary works.
	Ancillary facility C2@B9863/64	Not flooded	✓	✓	x	✓	✓		
	Other areas within BCA9863/64	Between 5% and 1% AEP	x	x	✓	✓	x		
Reedy Creek South median work area (MWA16)	Ancillary facility C1@B9870/71	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 6. • While ancillary facility C1@B9870/71 is not impacted by flooding, it would be subject to relatively shallow overland flow due to local catchment runoff from the central median.	• Activities within the Reedy Creek South median work area (MWA16) would have a minimal effect on flood behaviour.
	Other areas within MWA16	Not flooded	x	x	✓	x	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
Reedy Creek bridge construction area (BCA9870/71)	Ancillary facility C2@B9870/71	Less frequent than 1% AEP	✓	✓	x	✓	x	• Refer to Figure 6.1, sheet 6. • Ancillary facility C2@B9870/71 would be subject to relatively shallow inundation during extreme storm events as a result of backwater flooding from Reedy Creek. • A significant portion of the remainder of the bridge construction area would be inundated during a 20% AEP event to depths that exceed 1 m.	• The depth and velocity of flow through the bridge construction area during a 20% AEP event would be hazardous to construction personnel, plant and material. • While site facilities and stored materials located within ancillary facility C2@B9870/71 have the potential to displace floodwater that backs up from Reedy Creek, impacts on flood behaviour would only occur during storms less frequent than 1% AEP and even then are likely to be minor given the extent of flooding relative to the extent of the ancillary facilities. • The temporary access road and working platforms for the widening of the Reedy Creek bridge have the potential to obstruct the conveyance of flow in Reedy Creek during events more frequent than 20% AEP, which in turn could impact on the extent and depth of inundation, as well as flow velocities in the creek.
	Other areas within BCA9870/71	More frequent than 20% AEP	x	x	✓	✓	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
Reedy Creek North median work area (MWA17)	Ancillary facility C3@B9870/71	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 6. • While ancillary facilities C3@B9870/71 and C1@B9873/74 are not impacted by flooding, they would be subject to relatively shallow overland flow due to local catchment runoff from the central median.	• Activities within the Reedy Creek North median work area (MWA17) would have a minimal effect on flood behaviour.
	Ancillary facility C1@B9873/74	Not flooded	✓	✓	x	x	✓		
	Other areas within MWA17	Not flooded	x	x	✓	x	x		
Eskdale Creek bridge construction area (BCA9873/74)	Ancillary facility C2@B9873/74	Not flooded	✓	✓	x	✓	x	• Refer to Figure 6.1, sheet 6. • While ancillary facility C2@B9873/74 would not be inundated by flooding from Eskdale Creek, it extends over a water quality basin and vegetated channel that would be frequently inundated by flow that discharges from Wallgrove Road. • A significant proportion of the remainder of the bridge construction area would be inundated during a 20% AEP event to a maximum depth of 1.2 m, increasing to 1.3 m during a 1% AEP event.	• Activities within ancillary facility C2@B9873/74 would have a minor impact on flood behaviour providing that its layout is configured to prevent any temporary works that encroach onto the basin and channel that control runoff from Wallgrove Road. • Temporary working platforms for the bridge widening have the potential to obstruct the conveyance of flow in Eskdale Creek during events more frequent than 20% AEP. This in turn could impact on the extent and depth of inundation and flow velocities in the creek.
	Other areas within BCA9873/74		x	x	✓	✓	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
Eskdale Creek median work area (MWA18)	Ancillary facility C3@B9873/74	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 6. • While ancillary facility C3@B9873/74 is not impacted by flooding, it would be subject to relatively shallow overland flow due to local catchment runoff from the central median.	• Activities within the Eskdale Creek median work area (MWA18) would have a minimal effect on flood behaviour.
	Other areas within MWA18	Not flooded	x	x	✓	x	x		
Great Western Highway South median work area (MWA19)	Ancillary facility C1@B9893/94	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 7. • While ancillary facility C1@B9893/94 is not impacted by flooding, it would be subject to relatively shallow overland flow due to local catchment runoff from the central median.	• Activities within the Great Western Highway South median work area (MWA19) would have a minimal effect on flood behaviour.
	Other areas within MWA19	Not flooded	x	x	✓	x	x		
Great Western Highway bridge construction area (BCA9893/94)	Ancillary facility C2@B9893/94	More frequent than 20% AEP	✓	✓	x	✓	x	• Refer to Figure 6.1, sheet 7. • Ancillary facility C2@B9893/94 is subject to relatively shallow overland flow that surcharges the drainage system along the section of shared path to its east. • Flooding during events up to 1% AEP across the remainder of the bridge construction area would be confined to the inbank area of the channel that discharges to	• Activities within Great Western Highway bridge construction area (BCA9893/94) would have a minor impact on flood behaviour providing that the layout of ancillary facility C2@B9893/94 is configured to prevent any temporary works that encroach onto the channel that discharges to transverse drainage structure C20.59.
	Other areas within BCA9893/94	More frequent than 20% AEP	x	x	✓	✓	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
								transverse drainage structure C20.59.	
Great Western Highway North median work area (MWA20)	Ancillary facility C3@B9893/94	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 7. • While ancillary facility C3@B9893/94 is not impacted by flooding, it would be subject to relatively shallow overland flow due to local catchment runoff from the central median.	• Activities within the Great Western Highway North median work area (MWA20) would have a minimal effect on flood behaviour.
	Other areas within MWA20	Not flooded	x	x	✓	x	x		
Angus Creek bridge construction area (BCA9898/99)	Ancillary facility C1@B9898/99	Not flooded	✓	✓	x	✓	✓	• Refer to Figure 6.1, sheet 7. • While the temporary access roads to the bridge construction area are predominantly located outside the 1% AEP flood extent, the working platform for the construction of the bridge widening are located in areas that would be subject to flooding from Angus Creek during events more frequent than 20% AEP at depths that are greater than 1 m.	• The depth and velocity of flow through the bridge construction area during a 20% AEP event would be hazardous to construction personnel, plant and material. • The temporary working platforms for the widening of the Angus Creek bridge have the potential to obstruct the conveyance of flow in Angus Creek during events more frequent than 20% AEP, which in turn could impact on the extent and depth of inundation, as well as flow velocities in the creek.
	Other areas within BCA9893/94	More frequent than 20% AEP	x	x	✓	✓	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
Main Western Railway South median work area (MWA21)	Ancillary facility C2@B9898/99	Not flooded	✓	✓	x	✓	✓	• Refer to Figure 6.1, sheet 7. • While ancillary facility C2@B9897/99 is not impacted by flooding, it would be subject to relatively shallow overland flow due to local catchment runoff from the central median.	• Activities within the Main Western Railway South median work area (MWA21) would have a minimal effect on flood behaviour.
	Other areas within MWA21	Not flooded	x	x	✓	x	x		
Main Western Railway bridge construction area (BCA8245/9901)	Ancillary facility C1@B8245/9901	Not flooded	✓	✓	x	✓	✓	• Refer to Figure 6.1, sheet 7. • The portion of the bridge construction area to the north of the Main Western Railway would be subject to inundation due to flow that surcharges the stormwater drainage system.	• Activities within the Main Western Railway bridge construction area (BCA8245/9901) would have a minimal effect on flood behaviour.
	Other areas within BCA8245/9901	Less frequent than 0.2% AEP	x	x	✓	✓	x		
Main Western Railway North median work area (MWA22)	Ancillary facility C2@B8245/9901	Not flooded	✓	✓	x	✓	✓	• Refer to Figure 6.1, sheets 7 & 8. • While ancillary facilities C2@B8245/9901 and C1@9902/03 are not impacted by flooding, they would be subject to relatively shallow overland flow due to local catchment runoff from the central median.	• Activities within the Main Western Railway North median work area (MWA22) would have a minimal effect on flood behaviour.
	Ancillary facility C1@9902/03	Not flooded	✓	✓	x	x	✓		
	Other areas within MWA22	Not flooded	x	x	✓	x	x		
Woodstock Avenue bridge	Ancillary facility C2@B9902/03	More frequent than 20% AEP	✓	✓	x	✓	x	• Refer to Figure 6.1, sheet 8.	• Site facilities and stored materials located within ancillary facility

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
construction area (BCA9902/03)	Ancillary facility C3@B9902/03	Between 10% and 5% AEP	✓	✓	x	✓	x	• During a 20% AEP event, ancillary facility C2@B9902/03 would be subject to inundation to a maximum depth of 0.7 m due to flow that surcharges the stormwater drainage system, increasing to 1 m during a 1% AEP event. • During a 1% AEP event, ancillary facilities C3@B9902/03 and C4@B9902/03 would be subject to relatively shallow depths of inundation due to flow that surcharges the drainage system in Woodstock Avenue.	C2@B9902/03 have the potential to obstruct the conveyance of overland flow that discharges across Woodstock Avenue during storms more frequent than 20% AEP. This in turn could impact on the extent and depth of inundation in adjoining areas. • While site facilities and stored materials located within ancillary facilities C3@B9902/03 and C4@B9902/03 have the potential to displace floodwater that surcharges the drainage system in Woodstock Avenue, impacts on flood behaviour are likely to be minor given the extent of flooding relative to the extent of the ancillary facilities.
	Ancillary facility C4@B9902/03	Between 20% and 10% AEP	✓	✓	x	✓	x		
	Other areas within BCA9902/03	More frequent than 20% AEP	x	x	✓	✓	x		
Woodstock Avenue median work area (MWA23)	Ancillary facility C5@B9902/03	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 8. • While ancillary facility C5@B9902/03 is not impacted by flooding, it would be subject to relatively shallow overland flow due to local catchment runoff from the central median.	• Activities within the Woodstock Avenue median work area (MWA23) would have a minimal effect on flood behaviour.
	Other areas within MWA23	Not flooded	x	x	✓	x	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
Florence Street bridge construction area (BCA9908/09)	Ancillary facility C1@B9908/09	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 8. • While ancillary facility C5@B9902/03 is not impacted by flooding, it would be subject to relatively shallow overland flow due to local catchment runoff from the central median. • Inundation across the remainder of the bridge construction area is confined to the shared path that runs under the Florence Street bridge where depths of inundation occur to a maximum of 0.2 m during a 1% AEP event.	• Activities within the Florence Street bridge construction area (BCA9908/09) would have a minor impact on flood behaviour providing that the layout of the bridge construction area is configured to prevent any temporary works that obstruct overland flow along the shared path that runs under the bridge.
	Other areas within BCA9908/09	More frequent than 20% AEP	x	x	✓	✓	x		
Florence Street median work area (MWA24)	Ancillary facility C2@B9908/09	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 8. • While ancillary facility C2@B9908/09 is not impacted by flooding, it would be subject to relatively shallow overland flow due to local catchment runoff from the central median.	• Activities within the Florence Street median work area (MWA24) would have a minimal effect on flood behaviour.
	Other areas within MWA24	Not flooded	x	x	✓	x	x		
Simms Road bridge	Ancillary facility C1@B9910/11	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 8.	• Activities within the Florence Street bridge construction area

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
construction area (BCA9910/11)	Other areas within BCA9910/11	More frequent than 20% AEP	x	x	✓	✓	x	• While ancillary facility C5@B9902/03 is not impacted by flooding, it would be subject to relatively shallow overland flow due to local catchment runoff from the central median. • Inundation across the remainder of the bridge construction area during is confined to the shared path that runs under the Florence Street bridge where depths of inundation would be less than 0.1 m during a 1% AEP event.	(BCA9908/09) would have a minor impact on flood behaviour providing that the layout of bridge construction area is configured to prevent any temporary works that obstruct overland flow along the shared path that runs under the bridge.
Richmond Road median work area (MWA25)	Ancillary facility C2@B9910/11	Not flooded	✓	✓	x	x	✓	• Refer to Figure 6.1, sheet 8. • While ancillary facility C2@B9910/11 is not impacted by flooding, it would be subject to relatively shallow overland flow due to local catchment runoff from the central median.	• Activities within the Richmond Road median work area (MWA25) would have a minimal effect on flood behaviour.
	Other areas within MWA25	Not flooded	x	x	✓	x	x		
Zone A construction ancillary facilities	Zone A-1 Ancillary facility	More frequent than 20% AEP.	✓	✓	x	x	x	• Refer to Figure 6.1, sheets 2 & 3. • The full extent of the Zone A-1 ancillary facility is subject to inundation from Hinchinbrook Creek	• Site facilities and stored materials located within the Zone A-1 ancillary facility also have the potential to obstruct overland flow
	Zone A-2 ancillary facility	Not flooded	✓	✓	x	x	x		

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
	Zone A-3 ancillary facility	Less frequent than 1% AEP	✓	✓	x	x	x	flooding during a 20% AEP event to a maximum depth of 0.8 m. • The Zone A-2 ancillary facility is not impacted by mainstream flooding or major overland flow. • The Zone A-3 ancillary facility would be subject to inundation during extreme storm events due to flow that surcharges the detention basin to its north.	that is conveyed along the northern overbank of Hinchinbrook Creek during storms more frequent than 20% AEP. This in turn could impact on the extent and depth of inundation in adjoining areas. • Activities within the Zone A-2 and A-3 ancillary facilities would have a minimal effect on flood behaviour.
Zone B construction ancillary facilities	Zone B-1 ancillary facility	More frequent than 20% AEP	✓	✓	x	x	x	• Refer to Figure 6.1, sheet 4. • A major overland flow path runs through the central portion of Zone B-1 ancillary facility, where depths of inundation up to 1 m occur during a 1% AEP event.	• The depth and velocity of flow along the overland flow path that runs through the central portion of Zone B-1 ancillary facility would be hazardous to construction personnel, plant and material. • Activities within the Zone B-1 ancillary facility would have a minor impact on flood behaviour providing that the layout of the facility is configured to prevent any temporary works that obstruct the overland flow path that runs through the central portion of the site.

Construction work area	Construction ancillary facilities / other areas	Threshold of flooding[1]	Proposed construction activities[2]					Description of existing flood behaviour	Potential impacts of construction activities on flood behaviour
			Site facilities[3]	Material storage and stockpiling[4]	Earthworks[5]	Bridge construction[6]	Bridge abutment[7]		
Zone C construction ancillary facilities	Zone C-3 ancillary facility	Not flooded	✓	✓	x	x	x	• Refer to Figure 6.1, sheet 6. • Zone C-3 ancillary facility is not impacted by mainstream flooding or major overland flow.	• Activities within the Zone C-3 ancillary facility would have a minimal effect on flood behaviour.
Zone D construction ancillary facilities	Zone D-2 ancillary facility	More frequent than 20% AEP	✓	✓	x	x	x	• Refer to Figure 6.1, sheet 2. • A major overland flow path runs through the southern portion of Zone D-2 ancillary facility, where depths of inundation up to 1 m occur during a 1% AEP event.	• The depth and velocity of flow along the overland flow path that runs through the southern portion of Zone D-2 ancillary facility would be hazardous to construction personnel, plant and material. • Activities within the Zone D-2 ancillary facility would have a minor impact on flood behaviour providing that the layout of the facility is configured to prevent any temporary works that obstruct the overland flow path that runs through the southern portion of the site.

1 The assessed threshold of flooding is based on pre-proposed modification conditions. Refer Figure 6.1 (8 sheets) for flood extent mapping under pre-proposed modification conditions.

2 Refer to Section 6.2.1 for a description of flood risks associated with each construction activity.

3 Site facilities include site offices, staff amenities, stores and laydown, workshops and parking.

4 Spoil management includes stockpiling and treatment of excavated material.

5 Earthworks includes construction of road and drainage works.

6 Bridges include working pads for support cranes to install various bridge components.

7 OPERATIONAL IMPACT ASSESSMENT

This chapter of the report provides an assessment of the surface water and flood related impacts of the proposed modification during its operation. The findings of the assessment into surface water related impacts are presented in Section 7.1, while the findings of the assessment into flood related impacts are presented in Section 7.2.

7.1 Surface water related impacts

This section provides an assessment of the impact that the proposed modification could have on surface water conditions during its operation. An overview is provided of the types of contaminants that are likely to be generated from the proposed modification, as well as the stormwater controls along the Westlink M7 that are aimed at managing the impact of these contaminants on the quality of surface water in the receiving watercourses under both pre- and post-proposed modification conditions. The quality of surface water runoff discharging from the Westlink M7 under pre- and post-proposed modification conditions is assessed and compared against the water quality objectives. An assessment of the impact of the proposed modification on the quantity of surface water runoff is also presented in this section.

7.1.1 Potential impacts on surface water quality

The proposed modification has the potential to increase the generation of the following contaminants that have the potential to impact on the quality of surface water runoff discharging from the Westlink M7 corridor:

- TSS that build up on paved surfaces
- toxicants and heavy metals attached to particulates from paved surfaces
- hydrocarbons, oils and grease from spills or leaks
- gross pollutants from the Westlink M7 corridor
- nutrients from organic material and any potential spills during transportation (such as TP and TN).

The above contaminants would be primarily generated by vehicular traffic, tyre and pavement wear, as well as the atmospheric deposition of particles. The types of contaminants are the same as those generated by the approved project. However, the proposed modification has the potential to lead to an increase in the quantity of contaminants due to an increase in paved area in combination with an increase in vehicle movements.

As a significant proportion of contaminants from road runoff are related to particulates (such as TSS and particulate bound toxicants and heavy metals) the *Road Runoff and Drainage: Environmental Impacts and Management Options* (Austroads 2001) recommends that the treatment of road runoff be primarily aimed at the removal of suspended solids.

The above recommendation in Austroads 2001 is consistent with the approach that was adopted in the design of the stormwater quality controls along the Westlink M7. As noted in Section 5.5.1, the treatment of runoff from the existing Westlink M7 is typically provided by water quality basins that primarily treat TSS and associated contaminants, while planting in the basins also provides a level of treatment for total phosphorus and total nitrogen. As noted in Section 5.5.1, the design

documentation for the approved project indicates that the water quality basins were sized to accommodate the additional paved area due to the future widening of the motorway.

Other contaminants such as hydrocarbons, oils and grease from spills are addressed through existing spill control measures that are located along the Westlink M7, that would also serve to control spills from the additional lanes.

In light of the above, it is proposed to utilise the existing stormwater quality controls along the Westlink M7 corridor. While the design documentation for the approved project shows that the water quality basins were sized to capture the 'first flush' based on a nominal of 13 mm of rainfall, for the purpose of the modification assessment the performance of the water quality basins has been assessed in terms of their pollutant retention efficiency and pollutant concentrations against the water quality objectives that have been established in accordance with the SEARs. Further details of the approach adopted in the design of the existing water quality basins for the approved project is provided in Section 5.5.1 of this report, while the methodology that has been adopted in assessing the performance of the water quality basins against the water quality objectives is provided in Section 4.1.6 of this report.

The following sections of this report provide a comparison of the performance of the stormwater quality controls under pre- and post-proposed modification conditions against the water quality objectives that are relevant to the proposed modification.

7.1.2 Performance of the Westlink M7 stormwater quality controls

To demonstrate the performance of the Westlink M7 stormwater quality controls to treat runoff from the motorway under pre- and post-widening conditions, an assessment was carried out using the MUSIC modelling software. Background to the development of the MUSIC models is provided in Section 4.1.6, while a summary of the modelling results is presented below.

Table 7.1 shows the total annual weight of pollutants discharging from the Westlink M7 corridor via the various stormwater quality controls, as well as their pollutant retention efficiencies[8] under pre- and post-proposed modification conditions. For comparative purposes, Table 7.1 also shows the total annual weight of pollutants discharging from the Westlink M7 corridor under pre-Westlink M7 conditions based on an agricultural land use type, as well as the range of Council based reduction targets set out in
Table 3.1.

[8] The reduction targets are also referred to as the pollutant retention efficiency and are measured in terms of the percentage of the incoming pollutant load that is retained by the water quality control.

Table 7.1 Average annual pollutants loads discharging from the Westlink M7 stormwater quality controls

Parameter	Pre-Westlink M7 conditions[1]	Pre-proposed modification conditions		Post-proposed modification conditions		Council reduction targets from Table 3.1[3]
		Entering stormwater quality controls	Leaving stormwater quality controls[2]	Entering stormwater quality controls	Leaving stormwater quality controls[2]	
Cabramatta Creek catchment						
Flow (ML)	188	347	315 *[9%]*	379	347 *[8%]*	
Gross pollutants (kg)	2,550	7,160	0 *[100%]*	8,310	0 *[100%]*	90% (LCC)
Total Suspended Solids (kg)	16,200	78,400	13,600 *[83%]*	89,500	16,900 *[81%]*	85% (LCC)
Total phosphorus (kg)	69.7	151	42.5 *[72%]*	171	50.8 *[70%]*	45% (LCC)
Total nitrogen (kg)	405	713	454 *[36%]*	790	513 *[35%]*	45% (LCC)
Ropes Creek catchment						
Flow (ML)	32.1	57.3	53.8 *[6%]*	71.1	66.7 *[6%]*	
Gross pollutants (kg)	435	1,160	0 *[100%]*	1,580	0 *[100%]*	90% (FCC)
Total Suspended Solids (kg)	2,770	12,700	2,700 *[79%]*	16,900	3,870 *[77%]*	80% (FCC)
Total phosphorus (kg)	11.9	24.6	7.8 *[68%]*	32.2	10.7 *[67%]*	55% (FCC)
Total nitrogen (kg)	69.0	117	79.1 *[32%]*	149	102 *[32%]*	40% (FCC)

Refer footnotes over page.

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Table 7.1 Average annual pollutants loads discharging from the Westlink M7 stormwater quality controls (cont'd)

Scenario	Pre-Westlink M7 conditions[1]	Pre-proposed modification conditions		Post-proposed modification conditions		Council reduction targets from Table 3.1[3]
		Entering stormwater quality controls	Leaving stormwater quality controls[2]	Entering stormwater quality controls	Leaving stormwater quality controls[2]	
Eastern Creek catchment						
Flow (ML)	373	644	561 *[13%]*	686	603 *[12%]*	
Gross pollutants (kg)	5,060	12,600	26.1 *[100%]*	14,200	32.7 *[100%]*	90% (FCC & BCC)
Total Suspended Solids (kg)	32,200	140,000	25,600 *[82%]*	156,000	29,900 *[81%]*	80% (FCC) 85% (BCC)
Total phosphorus (kg)	138	272	82.7 *[70%]*	299	95.0 *[68%]*	55% (FCC) 65% (BCC)
Total nitrogen (kg)	802	1,310	840 *[36%]*	1,410	923 *[35%]*	40% (FCC) 45% (BCC)
Total of all catchments						
Flow (ML)	593	1,048	930 *[11%]*	1,136	1,017 *[11%]*	
Gross pollutants (kg)	8,045	20,920	26.1 *[100%]*	24,090	32.7 *[100%]*	90% (LCC, FCC & BCC)
Total Suspended Solids (kg)	51,170	231,100	41,900 *[82%]*	262,400	50,670 *[81%]*	80% (FCC) 85% (LCC & BCC)
Total phosphorus (kg)	220	448	133 *[70%]*	502	157 *[69%]*	45% (LCC), 55% (FCC) 65% (BCC)
Total nitrogen (kg)	1,276	2,140	1,370 *[36%]*	2,349	1,538 *[35%]*	40% (FCC) 45% (LCC & BCC)

1. Based on a representative pre-Westlink M7 catchment of agricultural land use.
2. Values in brackets represent the percentage of the incoming flow or pollutant loads that is retained by the water quality controls, i.e. the pollutant retention efficiency.
3. LCC = Liverpool City Council FCC = Fairfield City Council BCC = Blacktown City Council

The following observations can be made based on the comparison of pollutant loads presented in Table 7.1:

i. The pollutant retention efficiencies of the stormwater quality controls under post-proposed modification conditions are within 1 to 2 percentage points of the pollutant retention efficiencies under pre-proposed modification conditions.

ii. In comparison to an agricultural land use type that was indicative of pre-Westlink M7 conditions, the total annual weight of pollutants discharging from the stormwater quality controls under both pre- and post-proposed modification conditions is lower for total suspended solids and total phosphorus, but higher for total nitrogen.

In comparison to the Council based reduction targets in

i. Table 3.1, the retention efficiencies of the stormwater quality control basins under both pre- and post-proposed modification conditions:

    a) exceed the target value for gross pollutants

    b) are within the range of target values for total suspended solids

    c) exceed the range of target values for total phosphorus

    d) are less than the range of target values for total nitrogen.

7.1.3 Performance against the water quality objectives

Table 7.2 provides a comparison of the modelled pollutant concentrations discharging from the stormwater quality controls within the Cabramatta Creek catchment under pre- and post-proposed modification conditions against the guideline values set out in the water quality objectives, as well as the existing water quality in the receiving watercourses. Table 7.3 and Table 7.4 provide a corresponding comparison of pollutant concentrations within the Ropes Creek and Eastern Creek catchments respectively.

The following observations can be made based on the comparison of pollutant concentrations presented in Table 7.2, Table 7.3 and Table 7.4:

i. There are negligible differences between the median pollutant concentrations under pre- and post-proposed modification conditions. In some cases the median pollutant concentrations under post-proposed modification conditions are slightly lower than those under pre-proposed modification conditions. This indicates that the increase in pollutant loads under proposed modification conditions is offset by the additional volume of runoff which serves to dilute the concentration of pollutants. On this basis, it can be concluded that there is negligible difference in the ability or otherwise of the stormwater quality controls to meet the water quality objectives between pre- and post-proposed modification conditions.

ii. Under both pre- and post-proposed modification conditions, the median concentrations of total suspended solids and levels of turbidity are below the guideline values set out in the water quality objectives, and are typically less than or similar to the levels recorded in the receiving watercourses. On this basis it can be concluded that the stormwater quality controls achieve the water quality objectives related to these two indicators.

iii. Under both pre- and post-proposed modification conditions, the median concentrations of total phosphorus and total nitrogen are:

a) above the guideline values set out in the water quality objectives

b) within the range of concentration levels for total discharge into the major creek systems of Cabramatta Creek, Ropes Creek and Eastern Creek

c) below the concentration levels that have been measured in Upper Hinchinbrook Creek, Bells Creek and Angus Creek as part of the sampling that has been undertaken for the proposed modification

d) below the concentration levels of total phosphorus that have been measured in Maxwells Creek, Cabramatta Creek, Lower Hinchinbrook Creek and Eskdale Creek as part of the sampling that has been undertaken for the modification, but higher than the corresponding concentration levels of total nitrogen.

The ability of the existing operational stormwater quality controls that are located along the Westlink M7 corridor to control runoff from both the existing and widened carriageways will be further assessed during detailed design to confirm that for waterways that receive runoff from the proposed modification:

a) the water quality objectives continue to be met at waterways where they are currently being achieved, or

b) existing water quality is improved at waterways where the water quality objectives are not being met.

In the instance that during detailed design it cannot be demonstrated that the existing operational stormwater quality controls would be effective in mitigating potential impacts in accordance with the above requirements, then additional mitigation measures would be identified and implemented. Such measures may include the provision of additional pollutant control devices upstream of the existing controls, for example, or the conversion of a small number of existing water quality basins to a bioretention type arrangement that is highly effective in the retention of total phosphorus and total nitrogen.

Table 7.2 Comparison of pollutant concentrations against the water quality objectives – Cabramatta Creek catchment

Discharge Location and Identifier [1]	Water Quality Objective [2]		Existing water quality in receiving watercourse [3]	Median pollutant concentrations discharging from the Westlink M7 stormwater quality controls [4,5]	
	Indicator	Guideline Value		Pre-proposed modification conditions	Post-proposed modification conditions
Maxwells Creek (CC01)	Total Suspended Solids (mg/L)	< 50	62.0	6.0	6.0
	Total phosphorus (mg/L)	0.025	0.3	0.06	0.06
	Total nitrogen (mg/L)	0.35	1.0	1.02	1.02
	Turbidity (NTU)	6 – 50	70.6	6.0	6.0
Cabramatta Creek (CC02)	Total Suspended Solids (mg/L)	< 50	14.0	6.0	6.0
	Total phosphorus (mg/L)	0.025	0.1	0.060	0.060
	Total nitrogen (mg/L)	0.35	0.9	1.02	1.03
	Turbidity (NTU)	6 – 50	17.1	6.0	6.0
Lower Hinchinbrook Creek (CC03)	Total Suspended Solids (mg/L)	< 50	31.0	7.0	6.6
	Total phosphorus (mg/L)	0.025	0.1	0.068	0.065
	Total nitrogen (mg/L)	0.35	0.9	1.18	1.18
	Turbidity (NTU)	6 – 50	28.1	7.0	6.6
Upper Hinchinbrook Creek (CC04)	Total Suspended Solids (mg/L)	< 50	33.0	6.0	6.0
	Total phosphorus (mg/L)	0.025	0.11	0.060	0.060
	Total nitrogen (mg/L)	0.35	1.1	1.01	1.06
	Turbidity (NTU)	6 – 50	58.0	6.0	6.0

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Table 7.2 Comparison of pollutant concentrations against the water quality objectives – Cabramatta Creek catchment

Discharge Location and Identifier [1]	Water Quality Objective [2]		Existing water quality in receiving watercourse [3]	Median pollutant concentrations discharging from the Westlink M7 water quality controls [4,5]	
	Indicator	Guideline Value		Pre-proposed modification conditions	Post-proposed modification conditions
Total for all water quality controls discharging to Cabramatta Creek	Total Suspended Solids (mg/L)	< 50	9 – 15	6.5	6.3
	Total phosphorus (mg/L)	0.025	0.06 – 0.18	0.064	0.062
	Total nitrogen (mg/L)	0.35	0.55 – 1.22	1.12	1.11
	Turbidity (NTU)	< 50	10.4 – 11.5	6.5	6.3

1. Refer Figure 7.1 (8 sheets)for location of identifiers.
2. Refer Section 4.1.2 for background to the establishment of the water quality objectives for the proposed modification.
3. Based on the median value of available water sampling data in the receiving watercourses as summarised in Section 5.5.
4. Based on the median pollutant concentration from a flow based sub-sampling of results from the MUSIC modelling to exclude samples of zero flow.
5. Coloured shading of cells is based on the following:

Meets the guideline value of the water quality objectives
Exceeds the guideline value of the water quality objectives but is less than the measured pollutant concentration in the receiving watercourse.
Exceeds the guideline value of the water quality objectives and is more than the measured pollutant concentration in the receiving watercourse.

Table 7.3 Comparison of pollutant concentrations against the water quality objectives – Ropes Creek catchment

Discharge Location and Identifier (1)	Water Quality Objective (2)		Existing water quality in receiving watercourse (3)	Median pollutant concentrations discharging from the Westlink M7 water quality controls (4,5)	
	Indicator	Guideline Value		Pre-proposed modification conditions	Post-proposed modification conditions
Ropes Creek (RC01)	Total Suspended Solids (mg/L)	< 50	1,080	6.03	6.05
	Total phosphorus (mg/L)	0.025	1.6	0.060	0.061
	Total nitrogen (mg/L)	0.35	7.6	1.13	1.22
	Turbidity (NTU)	6 – 50	411	6.03	6.05
Total for all water quality controls discharging to Ropes Creek	Total Suspended Solids (mg/L)	< 50	1,080	6.02	6.04
	Total phosphorus (mg/L)	0.025	1.6	0.060	0.061
	Total nitrogen (mg/L)	0.35	7.6	1.13	1.15
	Turbidity (NTU)	6 – 50	411	6.02	6.04

1. Refer Figure 7.1 (8 sheets) for location of identifiers.
2. Refer Section 4.1.2 for background to the establishment of the water quality objectives for the proposed modification.
3. Based on the median value of available water sampling data in the receiving watercourses as summarised in Section 5.5.
4. Based on the median pollutant concentration from a flow based sub-sampling of results from the MUSIC modelling to exclude samples of zero flow.
5. Coloured shading of cells is based on the following:

Meets the guideline value of the water quality objectives
Exceeds the guideline value of the water quality objectives but is less than the measured pollutant concentration in the receiving watercourse.
Exceeds the guideline value of the water quality objectives and is more than the measured pollutant concentration in the receiving watercourse.

Table 7.4 Comparison of pollutant concentrations against the water quality objectives – Eastern Creek catchment

Discharge Location and Identifier [1]	Water Quality Objective [2]		Existing water quality in receiving watercourse [3]	Median pollutant concentrations discharging from the Westlink M7 water quality controls [4,5]	
	Indicator	Guideline Value		Pre-proposed modification conditions	Post-proposed modification conditions
Reedy Creek (EC01)	Total Suspended Solids (mg/L)	< 50	14.0	6.0	6.0
	Total phosphorus (mg/L)	0.025	0.7	0.060	0.060
	Total nitrogen (mg/L)	0.35	2.6	1.05	1.03
	Turbidity (NTU)	6 – 50	18.5	6.0	6.0
Eskdale Creek (EC02)	Total Suspended Solids (mg/L)	< 50	12.0	6.0	6.0
	Total phosphorus (mg/L)	0.025	0.1	0.060	0.060
	Total nitrogen (mg/L)	0.35	0.7	1.01	1.01
	Turbidity (NTU)	6 – 50	42.8	6.0	6.0
Eastern Creek (EC03)	Total Suspended Solids (mg/L)	< 50	37.0	6.0	6.0
	Total phosphorus (mg/L)	0.025	0.3	0.060	0.060
	Total nitrogen (mg/L)	0.35	1.6	1.04	1.04
	Turbidity (NTU)	6 – 50	44.6	6.0	6.0
Angus Creek (EC04)	Total Suspended Solids (mg/L)	< 50	10.0	6.9	7.0
	Total phosphorus (mg/L)	0.025	0.1	0.068	0.069
	Total nitrogen (mg/L)	0.35	1.3	1.11	1.13
	Turbidity (NTU)	6 – 50	5.4	6.9	7.0

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Table 7.4 Comparison of pollutant concentrations against the water quality objectives

Discharge Location and Identifier [1]	Water Quality Objective [2]		Existing water quality in receiving watercourse [3]	Median pollutant concentrations discharging from the Westlink M7 water quality controls [4,5]	
	Indicator	Guideline Value		Pre-proposed modification conditions	Post-proposed modification conditions
Bells Creek (EC05)	Total Suspended Solids (mg/L)	< 50	15.0	6.0	6.0
	Total phosphorus (mg/L)	0.025	0.3	0.060	0.060
	Total nitrogen (mg/L)	0.35	1.9	1.02	1.03
	Turbidity (NTU)	6 – 50	21.5	6.0	6.0
Total for all water quality controls discharging to Eastern Creek	Total Suspended Solids (mg/L)	< 50	5.7 – 13.5[5]	6.0	6.0
	Total phosphorus (mg/L)	0.025	0.066 - 0.340	0.069	0.068
	Total nitrogen (mg/L)	0.35	0.82 – 1.4	1.14	1.15
	Turbidity (NTU)	6 – 50	5.7 – 13.5	6.0	6.0

1. Refer Figure 7.1 (8 sheets) for location of identifiers.
2. Refer Section 4.1.2 for background to the establishment of the water quality objectives for the proposed modification.
3. Based on the median value of available water sampling data in the receiving watercourses as summarised in Section 5.5.
4. Based on the median pollutant concentration from a flow based sub-sampling of results from the MUSIC modelling to exclude samples of zero flow.
5. Coloured shading of cells is based on the following:

Meets the guideline value of the water quality objectives
Exceeds the guideline value of the water quality objectives but is less than the measured pollutant concentration in the receiving watercourse.
Exceeds the guideline value of the water quality objectives and is more than the measured pollutant concentration in the receiving watercourse.

7.1.4 Potential impacts on surface water quantity, geomorphology and environmental water availability and flows

The proposed modification has the potential to impact on the quantity of stormwater runoff discharging from the Westlink M7 corridor due to an increase in the rate and volume of runoff from the widened road pavement. This in turn could impact on:

- the performance of the on-site detention basins that control the rate of runoff from the section of the Westlink M7 corridor within the Ropes Creek and Eastern Creek catchments
- the depth and velocity of flow in the receiving drainage lines downstream of the Westlink M7 corridor
- the geomorphology of the receiving drainage lines if changes in flow velocities are significant enough to result in an increase in stream bank erosion
- the volume of surface water runoff discharging from the Westlink M7 corridor and contributing to flows in the receiving drainage lines.

The following section of this report provides a comparison of the performance of the on-site detention basins under pre- and post-proposed modification conditions as well as an assessment of potential impacts of the proposed modification on flow behaviour in the receiving drainage lines, including impacts on the geomorphology and environmental water availability and flows in these receiving drainage lines.

Impact on the performance of the Westlink M7 on-site detention basins

An assessment was carried out into the impact that the pavement widening associated with the proposed modification would have on the performance of the forty (40) on-site detention basins that control runoff from the section of the Westlink M7 corridor between Elizabeth Drive and Richmond Road within the Ropes Creek and Eastern Creek catchments.

Table 7.5 at the end of this section shows the performance of the on-site detention basins under pre- and post-proposed modification conditions during a 1% AEP design storm event in terms of the available freeboard between the peak water level and the basin crest level as well as the peak discharge from the basin.

The following observations can be made based on the comparison of basin performance presented in Table 7.5:

i. In regard to the impact of the proposed modification on the available freeboard:
    a) There would either be no change or a slight reduction in peak water level (and therefore increase in available freeboard) at twenty four (24) of the on-site detention basins.
    b) While the peak water level would be increased at sixteen (16) of the on-site detention basins, the resulting reduction in available freeboard would have a negligible impact on the potential for the basin embankment to be overtopped during a 1% AEP event on the basis that:
        i) at fifteen (15) of the basins the resulting freeboard would still be more than 0.3 m, and
        ii) at the remaining basin (B15.04) the available freeboard would be marginally reduced from 0.25 metres (pre-proposed modification conditions) to 0.24 metres (post-proposed modification conditions).

ii. In regard to the impact of the proposed modification on peak discharges:

a) There would be either no change or a slight reduction in peak discharge at twenty nine (29) of the on-site detention basins.

b) Of the remaining eleven (11) on-site detention basins the increase in peak discharge would be less than 10 percent with the exception of:

i) basin B10.55 where the peak discharge would be increased by 28 per cent to 0.23 m3/s

ii) basin B12.84 where the peak discharge would be increased by 29 per cent to 0.18 m3/s

iii) basin B15.04 where the peak discharge would be increased by 14 per cent to 0.16 m3/s

iv) basin B21.70 where the peak discharge would be increased by 19 per cent to 0.25 m3/s

v) basin B22.10 where the peak discharge would be increased by 20 per cent to 0.59 m3/s.

An assessment of the impacts associated with changes in peak discharge from the Westlink M7 corridor, including the on-site detention basins, is provided below.

Impact on flow behaviour and geomorphology in receiving watercourses

In order to assess the impact that changes in peak discharges from the Westlink M7 corridor would have on flow behaviour in the receiving drainage lines the flood models representing present day conditions were updated to incorporate inflow hydrographs reflecting runoff behaviour under post-proposed modification conditions. Details of this assessment are presented in Section 7.2.1.

The assessment presented in Section 7.2.1 shows that changes in peak discharges from the Westlink M7 corridor would have only a minor impact on both the depth and velocity of flow in the receiving drainage lines downstream of the Westlink M7 corridor.

As the Eastern Creek flood model does not cover the upper reaches of Eastern Creek and Reedy Creek to the south of The Horsely Drive, the impact of the proposed modification on flow behaviour over this part of the catchment was assessed based on a comparison of peak flows under pre- and post-proposed modification conditions. Table 7.6 provides a comparison of peak 1% AEP flows in the receiving drainage lines downstream of the stormwater quality control basins that discharge from the Westlink M7 with the portion of the Eastern Creek catchment to the south of The Horsley Drive. The comparison in Table 7.6 shows that changes in peak flows would be less than one percent, which would have only a minor impact on the depth and velocity of flow in the receiving drainage lines.

Given the minor nature of changes in peak flows and velocities downstream of the Westlink M7 it can also be concluded that the proposed modification would also have a minor impact on the geomorphology of the receiving watercourses.

There is also the potential for the proposed modification to impact on the geomorphology of the creeks that cross the Westlink M7 due to localised increases in velocities and therefore scour potential around the piers that would be required to support the widened bridges. During detailed design scour protection measures would be incorporated into the design using standard Transport procedures to manage localised increases in velocities and scour potential around new bridge piers.

Impact on environmental water availability and flows in receiving watercourses

The proposed modification is not expected to result in a material impact on environmental water availability and flows. The proposed modification would maintain the existing locations for the discharge of runoff from the Westlink M7 corridor, while no damming or permanent blockage of watercourses is proposed.

Table 7.7 shows the total annual volume of surface water runoff discharging from the Westlink M7 corridor via the various stormwater quality controls under pre- and post-proposed modification conditions based on the results of the MUSIC modelling that are presented in Section 7.1.2 of this report. While the comparison presented in Table 7.7 shows that the volume of surface water runoff discharging to the watercourses within the catchments of Cabramatta Creek, Ropes Creek and Eastern Creek will be increased by between seven and 24 per cent, this is not expected to adversely impact on environmental water availability and flows.

Table 7.5 Performance of the Westlink M7 on-site detention basins during a 1% AEP event

On-site detention basin identifier[1]	Pre-proposed modification conditions		Post-proposed modification conditions	
	Available freeboard[2] (m)	Peak discharge (m^3/s)	Available freeboard[2,3]	Peak discharge[4]
B10.55	0.56	0.18	0.54 *[-0.02]*	0.23 *[28%]*
B12.84	0.42	0.14	0.40 *[-0.02]*	0.18 *[29%]*
B13.25	0.30	0.11	0.30 *[0.00]*	0.11 *[0%]*
B14.00	0.48	0.41	0.40 *[-0.08]*	0.42 *[2%]*
B14.16	0.20	0.59	0.20 *[0.00]*	0.63 *[7%]*
B14.56	0.46	0.07	0.46 *[0.00]*	0.07 *[0%]*
B14.70	0.66	0.33	0.66 *[0.00]*	0.33 *[0%]*
B14.75	0.56	1.38	0.53 *[-0.03]*	1.41 *[2%]*
B14.87	0.33	0.08	0.33 *[0.00]*	0.08 *[0%]*
B15.04	0.25	0.14	0.24 *[-0.01]*	0.16 *[14%]*
B15.23	0.87	0.13	0.84 *[-0.03]*	0.13 *[0%]*
B17.92	0.72	0.14	0.69 *[-0.03]*	0.14 *[0%]*

Refer over for footnotes.

On-site detention basin identifier[1]	Pre-proposed modification conditions		Post-proposed modification conditions	
	Available freeboard[2] (m)	Peak discharge (m^3/s)	Available freeboard[2,3]	Peak discharge[4]
B18.01	0.39	0.10	0.39 *[0.00]*	0.1 *[0%]*
B18.60	0.37	0.18	0.35 *[-0.02]*	0.18 *[0%]*
B18.85	0.71	0.19	0.69 *[-0.02]*	0.19 *[0%]*
B19.22	0.36	0.10	0.36 *[0.00]*	0.1 *[0%]*
B19.25	0.26	0.21	0.26 *[0.00]*	0.21 *[0%]*
B19.26	1.18	1.09	1.18 *[0.00]*	1.09 *[0%]*
B19.27	0.26	0.09	0.26 *[0.00]*	0.09 *[0%]*
B19.61	0.73	0.17	0.73 *[0.00]*	0.17 *[0%]*
B19.62	0.29	0.01	0.29 *[0.00]*	0.01 *[0%]*
B19.63	0.58	0.17	0.58 *[0.00]*	0.17 *[0%]*
B19.64	0.41	0.049	0.41 *[0.00]*	0.049 *[0%]*
B19.65	0.29	0.24	0.29 *[0.00]*	0.24 *[0%]*

Refer over for footnotes.

On-site detention basin identifier[1]	Pre-proposed modification conditions		Post-proposed modification conditions	
	Available freeboard[2] (m)	Peak discharge (m^3/s)	Available freeboard[2,3]	Peak discharge[4]
B19.68	0.32	0.09	0.32 *[0.00]*	0.09 *[0%]*
B19.69	0.62	0.57	0.62 *[0.00]*	0.57 *[0%]*
B19.71	0.27	0.10	0.27 *[0.00]*	0.1 *[0%]*
B20.01	0.64	0.09	0.64 *[0.00]*	0.09 *[0%]*
B20.15	0.27	0.12	0.27 *[0.00]*	0.12 *[0%]*
B20.40	0.23	0.48	0.27 *[0.04]*	0.47 *[-2%]*
B20.50	0.47	0.45	0.43 *[-0.04]*	0.46 *[2%]*
B20.75	0.41	0.02	0.41 *[0.00]*	0.02 *[0%]*
B20.85	0.78	0.51	0.74 *[-0.04]*	0.51 *[0%]*
B21.30	0.29	0.11	0.32 *[0.03]*	0.1 *[-9%]*
B21.35	0.35	0.34	0.34 *[-0.01]*	0.34 *[0%]*
B21.70	0.37	0.21	0.35 *[-0.02]*	0.25 *[19%]*

Refer over for footnotes.

On-site detention basin identifier[1]	Pre-proposed modification conditions		Post-proposed modification conditions	
	Available freeboard[2] (m)	Peak discharge (m^3/s)	Available freeboard[2,3]	Peak discharge[4]
B21.90	0.47	0.35	0.47 *[0.00]*	0.35 *[0%]*
B22.10	0.42	0.49	0.41 *[-0.01]*	0.59 *[20%]*
B22.70	0.43	0.18	0.4 *[-0.03]*	0.19 *[6%]*
B24.40	1.65	2.02	1.64 *[-0.01]*	2.09 *[3%]*

(1) Refer Figure 7.1 for location of on-site detention basin identifiers.

(2) Available freeboard is the height between the peak water level and the top of the basin embankment.

(3) Value in brackets represents the change in available freeboard compared to pre-proposed modification conditions. A negative value represents a reduction in available freeboard due to an increase in peak water level. Conversely, a positive value represents an increase in available freeboard due to a reduction in peak water level. Coloured shading of cells is based on the following:

There is either no change or an increase in available freeboard compared to pre-proposed modification conditions.
There is a reduction in available freeboard but the resulting value under post-proposed modification conditions is greater than the 0.3 m.
There is a reduction in available freeboard and the resulting value under post-proposed modification conditions is less than the 0.3 m.

(4) Value in brackets represents the change in peak discharge compared to pre-proposed modification conditions. A positive value represents an increase, while conversely a negative value represents a decrease when compared to pre-proposed modification conditions.

Table 7.6 Peak 1% AEP flows in the upper reaches of Eastern Creek and Reedy Creek

Stormwater control basin identifier(1)	Peak flow location identifier(1)	Pre-proposed modification conditions(2) (m^3/s)	Post-proposed modification conditions(2,3) (m^3/s)
B12.84	PF12.84a	2.86	2.87 [<1%]
	PF12.84b	9.01	9.01 [0%]
B13.10	PF13.10	0.66	0.65 [-2%]
B13.25	PF13.25a	0.11	0.11 [0%]
	PF13.25b	0.69	0.69 [0%]
B14.00	PF14.00	1.05	1.05 [0%]
B14.16	PF14.16	2.98	2.99 [<1%]

(1) Refer Figures 5.4 and 7.3 for location of on-site detention basin identifiers.

(2) Values are quoted to two decimal places for comparative purposes only.

(3) Value in brackets represents the change in peak discharge compared to pre-proposed modification conditions. A positive value represents an increase, while conversely a negative value represents a decrease when compared to pre-proposed modification conditions.

Table 7.7 Average annual volume of surface water runoff discharging from the Westlink M7 stormwater quality controls

Catchment	Pre-proposed modification conditions (ML)	Post-proposed modification conditions(1) (ML)
Cabramatta Creek	315	347 *[10%]*
Ropes Creek	53.8	66.7 *[24%]*
Eastern Creek	561	603 *[7%]*
Total of all catchments	930	1,017 *[9%]*

(1) Value in brackets represents the change in peak discharge compared to pre-proposed modification conditions. A positive value represents an increase, while conversely a negative value represents a decrease when compared to pre-proposed modification conditions.

7.2 Flood related impacts

This section provides an assessment of the flood risk to the proposed modification and the impact it would have on flood behaviour during operation. The findings of an assessment into the potential impact of future climate change and impacts of a partial blockage of the local stormwater drainage system on flood behaviour under operational conditions are also presented.

Figure 7.1 (8 sheets) shows the general design arrangement of the proposed modification, including the following features that formed the basis of the flood assessment:

- Widening the road pavement of the Westlink M7 into its central median for a length of about 26 kilometres, from about 140 metres south of the Kurrajong Road at Prestons (southern end) to Richmond Road in Oakhurst/Glendenning (northern end) to accommodate an additional trafficable lane in each direction
- Widening the exit ramp from the Westlink M7 northbound to the M4 Motorway westbound from one to two lanes
- Widening of the existing Westlink M7 bridges at 23 locations within the median alignment (centre of bridges) and outside of the bridges on the approach to the M4 Motorway from Old Wallgrove Road to accommodate the additional trafficable lanes
- Upgrades and extensions to existing drainage infrastructure that controls runoff from the motorway in order to accommodate the proposed widening of its road pavement.

The assessed design would be subject to further development during the detailed design stage.

7.2.1 Flood behaviour under post-proposed modification conditions

The proposed modification has the potential to impact on flooding patterns due to:

- an increase in the rate and volume of runoff from the widened road pavement, which has the potential to impact on flooding patterns in the receiving drainage lines downstream of the Westlink M7 corridor
- the obstruction that is caused by the additional piers that are proposed to support the widened bridges, which has the potential to impact on flooding patterns in the drainage lines that they cross.

In order to assess the impact of the proposed modification on flood behaviour, the flood models representing pre-proposed modification conditions were adjusted to incorporate details of the proposed works, including changes in flow behaviour from the widened road pavement and the increase in obstruction caused by the additional piers that are proposed to support the widened bridges.

The following figures showing flooding patterns and impacts under operational conditions should be referred to when reading the following discussion:

- Figures 7.2, 7.3 and 7.4 (8 sheets each) show the indicative extent and depth of inundation of mainstream flooding and major overland flow under proposed modification conditions for design storms with AEPs of 5% and 1% AEP event, as well as the PMF event, respectively. Figures C.8, C.9 and C.10 (8 sheets each) in Annexure C respectively show corresponding results for design storms with AEPs of 20%, 0.5% and 0.2% AEP.

- Figures 7.5, 7.6 and 7.7 (8 sheets each) show the impact that the proposed modification would have on flood behaviour in terms of changes in peak flood levels for design storms with AEPs of 5% and 1%, as well as the PMF event, respectively.[9] Figures C.15, C.16 and C.17 (8 sheets each) in Annexure C contains a series of figures that show corresponding results for design storms with AEPs of 50%, 20%, 10% and 0.2% AEP.
- Figures C.11 and C.12 (8 sheets each) in Annexure C show maximum flow velocities under post-proposed modification conditions during storms with AEPs of 5% and 1%, while Figures C.18 and C.19 (8 sheets each) in Annexure C show the impact that the proposed modification would have in terms of changes in maximum flow velocities for the same design storm events.
- Figures C.13 and C.14 (8 sheets each) in Annexure C show the duration of inundation under post-proposed modification conditions during storms with AEPs of 5% and 1%, while Figures C.20 and C.21 (8 sheets each) in Annexure C show the impact that the proposed modification would have in terms of changes in the duration of inundation for the same design storm events.

The key findings of the assessment of flood behaviour under operational conditions are summarised below.

Impact of flooding on the proposed modification

The level of flood immunity to the Westlink M7 would be maintained under post-proposed modification conditions. As noted in Section 5.5.2 of this report, the bridge waterway and transverse drainage structures along the existing Westlink M7 were designed to provide a 1% AEP level of flood immunity to its carriageways. The flood modelling that has been carried out as part of the present investigation has demonstrated that this level of flood immunity is achieved under both pre- and post-proposed modification conditions.

Impact of the proposed modification on flood behaviour

Changes in peak flood levels and depths of inundation

The following increases in peak flood levels and depths of inundation outside the Westlink M7 corridor are noted:

- During a 20% AEP design storm event, the depth of ponding in a detention basin that is located immediately to the east (downstream) of bridge waterway structure BR9873/74 (refer Figure B.15, sheet 3) would be increased by 0.02 metres, which is considered minor relative to the existing depth of inundation of more than 2 metres. Similar increases would also occur during storms with AEPs of 10% and 5%. There would be no increase in peak 1% AEP flood levels within the detention basin or the frequency with which the basin would surcharge its spillway.
- During a 5% and 1% AEP design storm event, depths of flow at the outlet of the Government Road Basin (refer Figure 7.5, sheet 3) would be increased by 0.06 metres, which is considered minor relative to the existing depth of inundation of more than 3 metres.

[9] Changes in peak flood levels are denoted on the figure as “afflux”. An afflux of plus or minus 0.01 metres is considered to be within the order of accuracy of the hydraulic model. The figure also shows changes in the extent of inundation that would be caused by the construction of the proposed modification. A reduction in the extent of inundation is denoted “Land rendered flood free”, while an increase in the extent of inundation is denoted “Additional area of land flooded” as a result of the proposed modification.

- There would be a localised increase in peak 5% AEP flood levels by a maximum of 0.10 metres in an area of the Western Sydney Parklands to the east (downstream) of transverse drainage structure C16.60 (refer Figure 7.5, sheet 6). The increase in peak flood levels in this area are considered minor relative to the existing depths of inundation of about one metre and given the nature of the affected land (i.e. open space).
- While peak 1% AEP flood levels immediately upstream of the bridge over Eskdale Creek (denoted bridge waterway structure BR9873/74 on Figure 7.6, sheet 6) would be increased by a maximum of 0.06 metres on existing depths of inundation of more than 1 m, impacts would be confined to the inbank area of the creek where it runs between the Westlink M7 and Wallgrove Road. Similar impacts are observed to occur during a PMF on existing depths of more than two metres.
- There would be a localised increase in peak 1% AEP flood levels along the southern side of the Main Western Railway to the west (upstream) of the Westlink M7 corridor at transverse drainage structure C23.10 by a maximum of 0.014 m, which is considered minor relative to the existing depth of inundation of about 0.5 metres.
- PMF levels in industrial land to the east and west of the Westlink M7 at transverse drainage structure C02.35 (refer Figure 7.7, sheet 6) would be increased by a maximum of 0.03 metres on existing depths of between 0.3 to one metres. The relative increase in the depth of inundation is not considered to have a significant impact on the hazardous nature of flooding or risk to life during an event of this magnitude.
- While PMF levels in an area of open space to the west (upstream) of the Westlink M7 at transverse drainage structure C02.35 (refer Figure 7.7, sheet 6) would be increased by a maximum of 0.014 metres on existing depths of about one metre. The relative increase in the depth of inundation is not considered to have a significant impact on the hazardous nature of flooding and risk to life.
- PMF levels would be increased by a maximum of 0.015 metres over an area to the west (upstream) of the bridge over Angus Creek (denoted bridge waterway structure BR9898/99 on Figure 7.7, sheet 7). While this is generally considered to be a relatively minor increase, impacts extend to a recently constructed aged care facility that is located between the Main Western Railway and Mavis Street in Rooty Hill.

  Floor level survey would be required in order to confirm the potential for above-floor inundation to occur and therefore the impact of the proposed modification on the affected buildings. The survey would also assist in developing the scope of works that may be required to mitigate the impact of the proposed modification on the affected buildings.

  Should it be identified that the proposed modification would lead to an increase in above-floor inundation in the affected buildings, then one such measure to mitigate this impact would be to locally reshape the overbank areas of the creek where it runs under the Westlink M7 to offset the obstruction caused by the additional piers that are required to support the widened bridge.

While Figure 7.7 (8 sheets) also shows a number of minor increases at a number of locations that are remote from the proposed works, these impacts are considered to be an artefact of the flood model and are deemed not to be a result of the proposed modification.

Changes in flow velocities

From inspection of Figures C.18 and C.19 (8 sheets each), the proposed modification would have only a minor impact on maximum flow velocities for storms with AEPs of 5% and 1%. Increases in maximum flow velocities in the drainage lines downstream of the Westlink M7 corridor would be typically less than 10% and where it is greater than this maximum velocity under post-proposed conditions would be less than one metre per second. As a result, the proposed modification is expected to have only a minor impact on the scour potential in the receiving drainage lines.

The proposed modification has the potential to increase scour potential due to localised increased in flow velocities at the outlet of the drainage structures within the Westlink M7 corridor that would control runoff from the widened road formation. During detailed design, appropriate scour protection and energy dissipation measures would be incorporated into the design of the drainage outlets where it is required to manage localised increases in flow velocity.

The proposed modification also has the potential to result in localised increases in flow velocities due to the obstruction caused by the additional piers that are proposed to support the widened bridges. These impacts are discussed in Section 7.1.4 of this report.

Changes in the extent and duration of flooding

Given the relatively minor increases in peak flood levels and the depth of inundation that are attributable to the proposed modification, there would also be only minor changes in the extent of inundation for all events up to the PMF.

From inspection of Figures C.20 and C.21 (8 sheets each), the proposed modification would have only a minor impact (less than one hour) on the duration of flooding in the drainage lines downstream of the Westlink M7 corridor for storms with AEPs of 20% and 1%.

While Figure C.21 (8 sheets) also shows a number of increases in the duration of inundation in some areas upstream and remote of the proposed works, these impacts are considered to be an artefact of the flood model and are deemed not to be a result of the proposed modification.

Changes in flood hazard and the hydraulic function of floodways and flood storage areas

Flood hazard is measured in terms of the potential danger to personal safety and damage to property based on the depth and velocity of floodwater. Given the minor nature of the changes in the depth of inundation and velocity of flow that are attributable to the proposed modification it is also expected to have a minor impact on the hazardous nature of flooding.

As the carriageways of the Westlink M7 within the extent of the proposed modification are located outside areas that are impacted by flooding during a 1% AEP design storm event, the only works associated with the proposed modification that lie within areas that would be classified as floodway or flood storage areas is the additional piers that are associated with the widened bridges. The footprint of these piers is minor relative to the overall flood extent and it has been demonstrated that they would have only a minor impact on flood behaviour due to their obstruction to flow in floodways and displacement of floodwater in flood storage areas.

Changes in flood volume and the rate of rise of floodwaters

Changes in the volume of runoff from the widened road pavement have been incorporated into the flood models representing post-proposed modification conditions and therefore the impact that this would have on the volume of floodwaters passing through the floodplain during a flood event has been accounted for when assessing the changes in the various aspects of flood behaviour that are described in the preceding sections of this report.

While changes in the rate of rise of floodwaters in areas of the floodplain in the vicinity of the proposed modification have not been quantitatively assessed, given the nature of the works associated with the proposed modification and the minor nature of its impact on the aspects of flood behaviour described in the preceding sections of this report, it is reasonable to conclude that changes in the rate of rise would also be minor in nature.

7.2.2 Consistency with council and state government flood related plans

In accordance with the SEARs, a flood planning area has been defined by the current assessment through mapping the extent of land which lies below the peak 1% AEP flood level plus 0.5 metres under pre-proposed modification conditions. The flood planning area shown on Figure D.3 (8 sheets) in Annexure D is based on mainstream flooding along the major creeks and tributaries that are crossed by the proposed modification, as well as the main paths associated with major overland flow. It should be noted that the flood modelling carried out for the assessment was developed for the specific purpose of assessing the flood risks and impacts associated with the proposed modification and therefore should be taken as preliminary only in terms of defining the flood planning area across the broader extent of flood prone land within the catchments that are crossed by the proposed modification.

The findings of the assessment presented in Section 7.2.1 of this report show that the proposed modification would have only a minor impact on peak flood levels during a 1% AEP design storm event as well as the PMF. As a result, the proposed modification would have no significant impact on the extent of the flood planning area and therefore the area of land to which clause 5.21 of *Liverpool Local Environmental Plan 2008* and the *Fairfield Local Environmental Plan 2013* would apply[10]. While the *Blacktown Local Environmental Plan 2015* does not contain a definition of the flood planning level, the proposed modification would have no significant impact on the extent of the flood planning area were the council to adopt the same definition as set out in clause 5.21 of the *Liverpool Local Environmental Plan 2008* and the *Fairfield Local Environmental Plan 2013*.

While a floodplain risk management study and plan has only been prepared for the Cabramatta Creek catchment, the findings of the assessment presented in Section 7.2.1 of this report show that the proposed modification would have only a minor impact on peak flood levels external to the Westlink M7 corridor.

Given the minor changes in both peak flood levels and flow velocities that are attributable to the proposed modification, it can be concluded that it would not increase the flood hazard in existing

[10] The *Liverpool Local Environmental Plan 2008* defines the flood planning level as either the 1% AEP peak flood level plus 0.5 metres or as defined in any floodplain risk management plan adopted by council. In this regard the definition set out in the *Cabramatta Creek Floodplain Risk Management Study and Plan* (Bewsher, 2004) would apply, which prescribes a range of flood planning levels for various uses on land below the PMF. Section 6.4 of the *Fairfield Local Environmental Plan 2013 defines the* flood planning level as the 1% AEP peak flood level plus 0.5 metres.

development for all storms up to 1% AEP in intensity. It would also not have an adverse impact on NSW State Emergency Service's emergency response arrangements.

7.2.3 Impact of future climate change on flood behaviour

As previously mentioned, the 0.5% AEP and 0.2% AEP storms have been used as proxies to assess the impact that a 10% and 30% increase in 1% AEP rainfall intensities would have on flood behaviour in the vicinity of the proposed modification (denoted future climate change scenarios 1 and 2). Annexure C of this report contains a series of figures that show flood behaviour under pre- and post-proposed modification conditions for design storms with AEPs of 0.5% and 0.2% AEP. Also included are a series of figures that show the impact that the proposed modification would have on flood behaviour during design storm events with AEPs of 0.5% and 0.2%. Comparison of these results against those for a 1% AEP design storm event provides an indication of the impact that future climate change could have on flooding to the proposed modification, as well as the impact that the proposed modification could have on flood behaviour under future climate change conditions.

The findings of the assessment of potential impacts on flood behaviour associated with an increase in rainfall intensities under future climate change are summarised below.

Impact of future climate change on flooding to the proposed modification

The assessment found that while depths of inundation would be increased along the drainage lines that cross the Westlink M7 corridor, the main carriageways of the motorway would remain flood free under both climate change scenarios 1 and 2.

Impact of the proposed modification on flood behaviour under future climate change conditions

While the proposed modification would generally have a similar impact on flood behaviour to that described above for a 1% AEP design storm event, it has the potential to increase peak post-climate change 1% AEP flood levels in the following areas:

- Along the southern side of the Main Western Railway to the west (upstream) of the Westlink M7 corridor at transverse drainage structure C23.10 where the increase in peak 1% AEP flood levels under future climate change conditions would be similar, but would occur over a slightly larger area, when compared to the impact that would occur under current climatic conditions.
- Along a section of Eskdale Creek to the west (upstream) of the Westlink M7 corridor where peak 1% AEP flood levels could be increased by 0.02 metres over an area that is largely confined to the riparian corridor of the creek, whereas under current climatic conditions the proposed modification is not predicted to result in an increase in peak 1% AEP flood levels over this area.

7.2.4 Impact of a partial blockage of major hydraulic structures on flood behaviour

The impact that a partial blockage of the transverse drainage structures that are located along the Westlink M7 corridor would have on peak 1% AEP flood levels is shown on Figure E.1 (8 sheets).

The assessment found that while the depth of ponding would be increased should a partial blockage occur to the inlet of transverse drainage structures that are located along the Westlink M7 corridor, the main carriageways of the motorway would remain flood free.

7.2.5 Application of ARR 2019 to design flood estimation

As noted in Section 3.2.1, for consistency with the studies undertaken for Liverpool City Council and Blacktown City Council, the present investigation has also adopted ARR 1987 procedures for defining flood behaviour in the Cabramatta Creek and Eastern Creek catchments.

As the procedures set out in ARR 2019 are likely to be used by councils to carry out updates to the existing studies within the Cabramatta Creek and Eastern Creek catchments, a sensitivity study was carried out as part of the present investigation to assess the likely changes that would occur in predicted flood behaviour in the vicinity of the proposed modification where it runs through the Cabramatta Creek and Eastern Creek catchments.

The procedures set out in ARR 2019 were applied to the hydrologic models that relate to the Eastern Creek and Cabramatta Creek catchments in order to generate a set of inflow hydrographs that were then applied to the respective hydraulic models. Based on ARR 1987, the storm that was critical for maximising peak flood levels in the vicinity of the proposed modification was found to be typically between two and nine hours.

For the purpose of the comparison, the two and nine hour storms were also adopted in the ARR 2019 assessment. For these two storm durations, the design rainfall intensities derived using the ARR 2019 procedures were found to be between four and 26 per cent lower than the corresponding values based on ARR 1987 procedures.

While ARR 1987 prescribes a single temporal pattern for each storm duration, ARR 2019 requires an analysis of ten temporal patterns for each storm duration. A representative set of water surface elevations and depths were then developed based on the median values which were derived by running the ten temporal patterns for each storm duration.

The investigation found that the adoption of ARR 2019 procedures would lead to a reduction in the rate of runoff that would be generated by the Cabramatta Creek and Eastern Creek catchments, which in turn would lead to a reduction in design peak flood levels in the vicinity of the proposed modification when compared to those derived using the procedures set out in ARR 1987.

Based on the above findings, the adoption of the procedures set out in ARR 1987 represents a more conservative estimate of flood behaviour in the vicinity of the proposed modification during design storm events.

8 ASSESSMENT OF CUMULATIVE IMPACTS

This section presents the findings of an assessment of the potential impacts the proposed modification could have on surface water and flood behaviour in combination with a number of major projects that are located in its vicinity.

A screening of other projects was undertaken for the proposed modification and is presented in Section 7.18 (Cumulative impacts) of the Modification Report. Table 8.1 lists the relevant projects which formed the basis of the cumulative surface water and flooding impact assessment together with a brief description of each project, and the identification of the catchments that are common to each project and the proposed modification.

Table 8.1 List of projects that formed the basis of the cumulative impact assessment

Other project	Project description	Common catchment/s with the proposed modification
M12 Motorway	The approved M12 Motorway would involve the construction of a new motorway that would connect The Northern Road in the west with the Westlink M7 at Elizabeth Drive in the east and would also provide direct access to the Western Sydney International Airport at Badgerys Creek.	Ropes Creek and Hinchinbrook Creek
Horsley Drive upgrade	Transport is planning for the future upgrade of Horsley Drive between the Westlink M7 and Cowpasture Road to a four lane divided road with an option for six lanes in the future. The Horsley Drive crosses Eastern Creek to the east of the Westlink M7 along the section of road that is proposed to be upgraded.	Eastern Creek
Light Horse Interchange Business Hub	The approved Light Horse Interchange Business Hub is located on the western overbank of Eastern Creek, to the east of the Westlink M7 and south of the Western Motorway. The project would involve the development of an industrial business hub in the Light Horse Interchange Precinct of the Western Sydney Parklands.	Eastern Creek
Gazorp Industrial Estate at 813-913 Wallgrove Road, Horsley Park	The approved Gazorp Industrial Estate is located within the catchments of Eastern Creek and Reedy Creek, to the west of the Westlink M7 and south of the Sydney Water Pipeline Corridor. The project, which is currently under construction, involves the development of warehouse facilities.	Eastern Creek and Reedy Creek
Horsley Park Brickworks Plant 2 Upgrade at 780 Wallgrove Road, Horsley Park	The approved Horsley Park Brickworks Plant 2 Upgrade is located on the eastern overbank of Eastern Creek, about 1.2 kilometres to the west of the Westlink M7and immediately south of the Sydney Water Pipeline Corridor. The project involves the upgrade of an existing plant facility within the brickworks site.	Eastern Creek

8.1 Potential cumulative impacts during construction

Based on currently available information on the timing of the other major projects listed above, the construction of the proposed modification is likely to coincide with that of the M12 Motorway and the Light Horse Interchange Business Hub, which are approved projects under Section 5.19 and 4.38 of the *Environmental Planning and Assessment Act 1979*, respectively. The conditions of approval/development consents for these two projects include requirements to manage the impact of each project on the quality and quantity of stormwater runoff discharging to receiving drainage lines during construction.

Subject to the incorporation of the management measures that are identified in Section 9.2 of this report, the impact of the construction of the proposed modification on surface water and flooding is expected to be minor. Given that similar measures would be required under the conditions of approval/development consent controls for the M12 Motorway and the Light Horse Interchange Business Hub, then it is expected that the cumulative impacts of the proposed modification and these projects on surface water and flooding during construction would also be minor.

8.2 Potential cumulative impacts during operation

Subject to the incorporation of the mitigation measures that are identified in Section 9.2 of this report then the impact of the operation of the proposed modification on surface water and flood behaviour in the catchments that are identified in Table 8.1 are expected to be minor in nature. It can therefore be concluded that the contribution of the proposed modification to cumulative impacts on surface water and flood behaviour in combination with the other major projects listed in Table 8.1 would also be minor in nature.

9 MITIGATION AND MANAGEMENT MEASURES

This section describes the key performance outcomes, as well as the mitigation and management measures associated with potential surface water and flooding related impacts from the proposed modification.

9.1 Performance outcomes

The proposed modification would be designed, constructed and operated with the aim of achieving the performance outcomes outlined below.

9.1.1 Surface water

In regard to surface water, the key performance outcome for the proposed modification is to ensure that downstream waterways are protected against potential impacts during its construction and operation. The proposed modification would be designed, constructed and operated with the aim of achieving this performance outcome.

9.1.1 Flooding

In regard to flooding, the key performance outcome for the proposed modification is to manage adverse impacts in areas outside the Westlink M7 corridor caused by changes in flood behaviour.

9.2 Mitigation and management measures

The current Conditions of Approval (**CoA**) that apply to the approved project require mitigation and management measures to be implemented (either directly in the conditions or through reference to environmental management plans).

The mitigation and management measures described in Table 9.1 have been identified to address the impacts that have been identified as a direct result of the current assessment, the findings of which are set out in this report. These measures would be incorporated into existing environmental management plans where they have not been accounted for already. Proposed amendments to the CoA for the proposed modification are described in Chapter 8 of the Modification Report.

Table 9.1 Surface water and flooding related mitigation and management measures

New ID	Mitigation and management measure	Applicable area
Construction – surface water		
SW01	A Soil and Water Management Plan (**SWMP**) will be prepared as part of the proposed modification. The plan will outline measures to manage soil and water impacts associated with the construction works, including contaminated land. The SWMP will provide: ➢ Measures to minimise/manage erosion and sediment transport both within the construction footprint and offsite, including requirements for the preparation of erosion and sediment control plans (**ESCPs**) for all progressive stages of construction ➢ Measures to manage runoff from spoil and waste storage areas	All construction work sites

New ID	Mitigation and management measure	Applicable area
	➢ Procedures to manage unexpected or previously unidentified contaminants including asbestos ➢ Measures to manage stockpiles, including locations, separation of waste types, sediment controls and stabilisation ➢ Groundwater management measures to limit the risk of exposure to contaminated groundwater ➢ Controls to manage the risk posed to workers from exposure to contaminated groundwater (if encountered) ➢ Processes for dewatering of water that has accumulated on site and from sediment basins, including relevant discharge criteria ➢ Measures to manage potential tannin leachate ➢ Measures to manage accidental spills, including the requirement to maintain materials such as spill kits ➢ Measures to manage potential saline soils ➢ Details of surface water and groundwater quality monitoring to be undertaken prior to, throughout, and following construction ➢ Erosion and sediment control measures will be implemented and maintained at all work sites in accordance with the principles and requirements in *Managing Urban Stormwater – Soils and Construction, Volume 1* (Landcom 2004) and *Volume 2D* (DECCW 2008), commonly referred to as the "Blue Book", as well as relevant Transport Guidelines.	
SW02	A soil conservation specialist will be engaged throughout construction of the proposed modification to provide advice on the planning and implementation of erosion and sediment control measures, including review of ESCPs.	All construction work sites
SW03	A water reuse strategy will be developed for the construction of the proposed modification to reduce reliance on potable water. This strategy will be prepared during the detailed design stage and will outline the construction water requirements and potential water sources to supply the water demand in consultation with Sydney Water. Alternative water supply options to potable water will also be investigated, with the aim of reusing water using recycled water where feasible.	All construction work sites
SW04	Stockpiles will be managed to minimise the potential for mobilisation and transport of dust and sediment in runoff in accordance with *Stockpile Site Management Guideline* (Roads and Maritime 2015). This will include: ➢ Minimising the number of stockpiles, the area used for stockpiles and the time that they are left exposed ➢ Locating stockpiles away from drainage lines, waterways and areas where they may be susceptible to wind erosion	Construction ancillary sites

New ID	Mitigation and management measure	Applicable area
	➢ Stabilising stockpiles, establishing appropriate sediment controls and suppressing dust as required.	
SW05	A construction water quality monitoring program will be developed and included in the SWMP for the proposed modification to establish baseline conditions, observe any changes in surface water and groundwater during construction, and inform appropriate management responses. Baseline monitoring will be undertaken monthly for a minimum of 12 months prior to the commencement of construction, inclusive of the monitoring that is presented in Section 5.6 of this report. As a minimum, this will include three wet weather sampling events over six months where feasible. Sampling locations and monitoring methodology to be undertaken during construction will be further developed in detailed design in accordance with the *Guidelines for Construction Water Quality Monitoring* (RTA 2003) and the 'ANZECC water quality guidelines' (ANZECC/ARMCANZ (2000)). The monitoring will include collection of samples for analysis from sedimentation control discharge points, visual monitoring of other points of release of construction waters and monitoring of downstream waterways. The frequency of monitoring will be confirmed during detailed design and will be a minimum of once every month at all sites, as well as additional monitoring following wet weather events. Should the results of monitoring identify that the water quality management measures are not effective in adequately mitigating water quality impacts, additional mitigation measures will be identified and implemented as required.	All construction work sites
SW06	Further water quality assessment will be undertaken during detailed design to inform site specific discharge criteria to meet the objective of maintaining existing water quality in the receiving watercourses during construction.	All construction works sites
SW07	A dewatering management plan (DMP) will be prepared and included in the SWMP that sets out the procedures for the discharge of surface water runoff that is retained in sediment controls and exposed excavations. The DMP will be prepared in accordance with the *"Technical Guideline – Environmental Management of Construction Site Dewatering"* (Transport 2011) and would include consideration of the following: ➢ identification of water quality criteria for the discharge of on-site water and the treatment techniques required to meet these criteria ➢ methods for achieving the water quality objectives for any site discharge through best practice erosion and sediment control measures and/or treatment of water through flocculation prior to discharge from sediment retention sumps ➢ reuse of stormwater where feasible within the scope of construction activities	All construction works sites

New ID	Mitigation and management measure	Applicable area
	➢ selection of suitable locations for the discharge of captured runoff utilising existing drainage paths where it cannot be reused on site ➢ procedures for the rectification of sediment controls or site practices should the monitoring set out under Item SW05 identify exceedances to the water quality parameters.	
SW08	The following measures will be undertaken to manage activities within watercourses: ➢ Minimising disturbance of banks and extent of vegetation removal ➢ Implementing bank stabilisation, channel reshaping and scour protection where required to mitigate the impact of additional bridge piers on scour and stability of the bed and banks of watercourses ➢ Maintaining minimum flows to assist in maintaining the viability of aquatic communities and preventing barriers to fish passage ➢ Constructing temporary creek crossings during low flows and design so that drainage of crossings doesn't contribute sediment load to the stream ➢ Taking into consideration the former NSW Office of Water's *Guidelines for controlled activities on waterfront land* in the design and construction of works within watercourses.	Widening of bridges over Maxwells Creek, Cabramatta Creek, Hinchinbrook Creek, Ropes Creek, Reedy Creek, Eskdale Creek and Angus Creek
Operation – surface water		
SW09	The performance of the stormwater quality controls that are set out in the Modification Report (comprising the existing stormwater quality control basins and gross pollutant traps along the Westlink M7 corridor) will be verified at detailed design stage to ensure that for waterways that receive runoff from the proposed modification, and to the extent that the proposed modification can influence: ➢ the water quality objectives continue to be met at waterways where they are currently being achieved, or ➢ existing water quality is improved at waterways where the water quality objectives are not being met. In the instance that during detailed design that it cannot be demonstrated that the water quality controls would be effective in mitigating potential impacts in accordance with the above requirements, a review of measures will be undertaken to improve water quality outputs from the Westlink M7 over time, including an assessment of the potential benefits and feasibility or reasonableness of converting a select number of existing water quality control basins to bioretention basins, in consultation with NSW EPA.	All
SW10	The adequacy of the existing spill containment measures along the Westlink M7 corridor, will be verified during the detailed design of the proposed modification to ensure that they are suitable for the capture of spills from the widened road pavement.	All

New ID	Mitigation and management measure	Applicable area
	In the instance that during detailed design that it cannot be demonstrated that spill control from the widened road pavement cannot be achieved with existing spill containment measures, then additional spill containment mitigation measures would be identified and implemented, and incorporated into existing maintenance procedures.	
Construction – flooding		
FL01	A flood management plan will be prepared as part of the CEMP for the proposed modification that will detail the processes for flood preparedness, materials management, weather monitoring, site management and flood incident management. The flood management plan will set out measures that are proposed to manage adverse impacts that the construction of the proposed modification could have on flood behaviour in existing development where practicable. The flood management plan will be developed in accordance with relevant guidelines.	All construction work sites
FL02	Activities that may affect existing drainage systems during construction will be carried out so that the existing hydraulic capacity of these systems is maintained where practicable.	All construction work sites
FL03	It is recommended that spoil stockpiles be located in areas which are not subject to frequent inundation by floodwater, ideally outside the 10% AEP flood extent. The exact level of flood risk accepted at stockpile sites will depend on the duration of stockpiling operations, the type of material stored, the nature of the receiving drainage lines and also the extent to which it would impact flooding conditions in adjacent development.	All
FL04	Construction ancillary facilities should be located outside high flood hazard areas based on a 1% AEP flood.	All
FL05	Flood emergency management measures for construction of the proposed modification should be prepared and incorporated into relevant environmental and/or safety management documentation in consultation with NSW SES and relevant local councils.	All
Operation – flooding		
FL06	The impact of the proposed modification on flood behaviour should be confirmed during detailed design. This should include consideration of future climate change and a partial blockage of the stormwater drainage system.	All construction work sites
FL07	The proposed modification is to be designed and further refinements made (as required) to avoid adverse impacts on: ➢ surrounding development for storms up to 1% AEP in intensity ➢ critical infrastructure, vulnerable development or increases in risk to life due to a significant increase in flood hazard for floods up to the PMF. Where the above cannot be achieved then alternative mitigation measures may be agreed to with the affected landowners.	All

New ID	Mitigation and management measure	Applicable area
FL08	Localised increases in flow velocities at drainage outlets that would control runoff from the proposed modification should be mitigated through the provision of scour protection and energy dissipation measures.	All
FL09	The function of the Westlink M7 and the proposed modification in flood emergency management measures shall be prepared in consultation with NSW SES and relevant local councils.	All

10 REFERENCES

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FIGURES

ANNEXURE A
TABLE SUMMARY OF WATER QUALITY CONTROL BASINS AND FIGURE SHOWING LAYOUT OF MUSIC MODEL

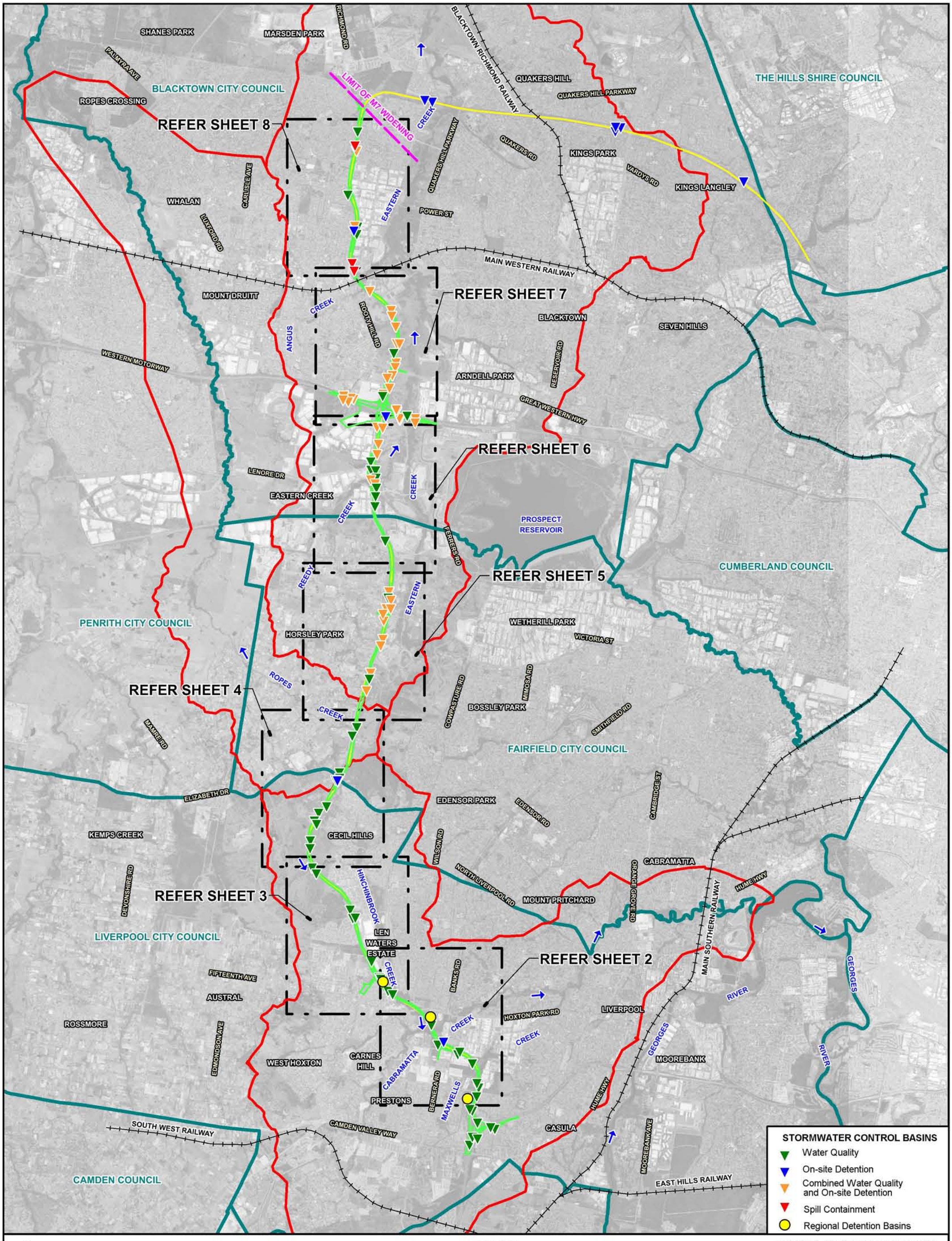
TABLE A.1
SUMMARY OF WESTLINK M7 WATER QUALITY BASINS
WITHIN FOOTPRINT OF PROPOSED MODIFICATION

Basin Identifier[1]	Type[2]	Area (m^2)	Volume (m^3)
B00.05	WQ	2059	508
B00.20	WQ	576	802
B00.27	WQ	592	174
B00.38	WQ	819	320
B00.46	WQ	1279	453
B00.60	WQ	790	607
B00.90	WQ	867	979
B00.91	WQ	516	260
B01.20	WQ	289	92
B01.44	WQ	184	139
B01.55	WQ	718	398
B02.07	WQ	540	343
B02.42	WQ	420	204
B02.48	WQ	1123	847
B03.00	WQ	961	544
B03.45	WQ	974	530
B04.60	WQ	1391	529
B04.80	WQ	639	500
B05.19	WQ	362	610
B05.20	WQ	189	417
B05.60	WQ	1692	1016
B06.74	WQ	223	143
B06.75	WQ	240	107
B06.95	WQ	849	1293
B08.16	WQ	198	88
B08.30	WQ	494	341
B08.79	WQ	183	178
B08.95	WQ	157	340
B09.40	WQ	115	79
B09.50	WQ	269	126
B09.67	WQ	251	332
B09.90	WQ	387	488
B10.54	WQ	77	93
B10.56	WQ	208	107
B10.65	WQ	395	321
B10.74	WQ	102	67
B11.74	WQ	1255	1185
B11.93	WQ	193	870
B12.84	COMB	682	203
B13.10	WQ	169	153
B13.25	COMB	772	78
B14.00	COMB	642	344

Basin Identifier[1]	Type[2]	Area (m^2)	Volume (m^3)
B14.13	COMB	191	180
B14.56	COMB	232	57
B14.70	COMB	165	147
B14.75	COMB	774	584
B14.87	COMB	132	59
B15.04	COMB	335	66
B15.09	WQ	48	82
B15.25	COMB	148	218
B16.48	WQ	750	1072
B17.30	WQ	547	663
B17.68	WQ	478	166
B17.80	WQ	478	227
B17.92	COMB	950	230
B18.01	COMB	314	111
B18.05	WQ	96	111
B18.24	WQ	462	255
B18.43	WQ	186	152
B18.60	COMB	4048	598
B18.85	COMB	1561	332
B19.22	COMB	393	137
B19.25	COMB	441	138
B19.26	COMB	2723	658
B19.27	COMB	846	163
B19.61	COMB	358	118
B19.62	COMB	247	50
B19.63	COMB	1040	179
B19.64	COMB	361	142
B19.65	COMB	474	150
B19.68	COMB	767	157
B19.69	WQ	2125	3726
B19.69A	COMB	4379	1197
B19.70	WQ	254	280
B19.71	COMB	453	172
B20.00	WQ	157	172
B20.01	COMB	470	123
B20.15	COMB	212	111
B20.40	COMB	761	261
B20.50	COMB	1978	507
B20.75	COMB	215	48
B20.85	COMB	577	295
B21.00	WQ	607	244
B21.30	COMB	2452	214
B21.35	COMB	2397	222
B21.70	COMB	1802	284
B21.90	COMB	662	192

Basin Identifier[1]	Type[2]	Area (m^2)	Volume (m^3)
B22.10	COMB	1695	447
B22.70	COMB	725	198
B23.40	SCB	571	185
B23.60	SCB	138	52
B24.30	WQ	341	260
B24.45	WQ	1073	371
B24.50	COMB	1840	747
B25.25	WQ	89	52
B26.30	COMB	651	116
B26.45	SCB	137	103
B26.70	WQ	96	85
B27.40	SCB	117	80

1. Refer **Figure 5.2** (8 sheets) for location of water quality control basins and identifier.
2. WQ = Water quality basin
   COMB = Combined water quality and on-site detention basin
   SCB = Spill containment basin


SHANES PARK
MARSDEN PARK
RICHMOND RD
BLACKTOWN RICHMOND RAILWAY
PALMYRA AVE
BLACKTOWN CITY COUNCIL
ROPES CROSSING
QUAKERS HILL
QUAKERS HILL PARKWAY
THE HILLS SHIRE COUNCIL
LIMIT OF M7 WIDENING
REFER SHEET 8
CREEK
QUAKERS HILL PARKWAY
QUAKERS RD
KINGS PARK
VARDYS RD
KINGS LANGLEY
CARLISLE AVE
WHALAN
LUXFORD RD
EASTERN
POWER ST
MAIN WESTERN RAILWAY
REFER SHEET 7
MOUNT DRUITT
CREEK
ROONYHILL RD
BLACKTOWN
SEVEN HILLS
ANGUS
WESTERN MOTORWAY
ARNDELL PARK
RESERVOIR RD
GREAT WESTERN HWY
REFER SHEET 6
LENORE DR
EASTERN CREEK
CREEK
CREEK
PROSPECT RESERVOIR
FERRERS RD
REFER SHEET 5
CUMBERLAND COUNCIL
REEDY
EASTERN
PENRITH CITY COUNCIL
HORSLEY PARK
WETHERILL PARK
VICTORIA ST
ROPES
CREEK
REFER SHEET 4
COWPASTURE RD
MIMOSA RD
BOSSLEY PARK
SMITHFIELD RD
MAMRE RD
FAIRFIELD CITY COUNCIL
ELIZABETH DR
EDENSOR PARK
EDENSOR RD
CAMBRIDGE ST
KEMPS CREEK
CECIL HILLS
WILSON RD
CABRAMATTA
NORTH LIVERPOOL RD
ORANGE GROVE RD
HUME HWY
DEVONSHIRE RD
REFER SHEET 3
HINCHINBROOK
MOUNT PRITCHARD
SOUTHERN RAILWAY
LIVERPOOL CITY COUNCIL
LEN WATERS ESTATE
REFER SHEET 2
MAIN SOUTH
CREEK
BANKS RD
FIFTEENTH AVE
AUSTRAL
ROSSMORE
HOXTON PARK RD
LIVERPOOL
GEORGES RIVER
CREEK
CREEK
EDMONDSON AVE
WEST HOXTON
CARNES HILL
CABRAMATTA
MOOREBANK
BERNERA RD
MAXWELLS
PRESTONS
HUME HWY
SOUTH WEST RAILWAY
CAMDEN VALLEY WAY
CASULA
MOOREBANK AVE
EAST HILLS RAILWAY
CAMDEN COUNCIL
STORMWATER CONTROL BASINS
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
Regional Detention Basins
N
800 0 800 1600 2400 m
Scale: 1:80,000
LEGEND
Extent of Major Catchments
LGA Boundary
M7 Motorway
Extent of MUSIC Sub-Catchment
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure A.1
(Sheet 1 of 8)
Lyall & Associates
EXTENT OF SUB-CATCHMENT COMPRISING PRE-PROSED MODIFICATION MUSIC MODEL


HINCHINBROOK DR
FLINDERS CRES
HAYMAN AVE
PARTRIDGE AVE
WILSON RD
CABRAMATTA CREEK CATCHMENT
GOVERNMENT ROAD BASIN
C04.95
ROSSINI DR
BALDINI PL
FRIGATE BIRD AVE
B04.80
C04.75
B04.60
TOPNOT AVE
CORVUS RD
BANKS RD
MILLER
BR9829/30
REFER SHEET 3
SPIRE CT
BASIN 22
HOXTON PARK RD
DORRIGO AVE
TWENTIETH AVE
PACIFIC PALMS CCT
ASTON CLOSE
B03.45
CREEK
CABRAMATTA
BR9826/27
JOADJA RD
WEIDST
WHYALLA PL
ASH RD
CARNES HILL
COFFS HARBOUR AVE
B02.96
B03.00
JEDDA RD
B02.42
B02.48
C02.35
CREEK
BR9821
B02.07
YARRUNGA ST
C01.80
BR9817
LYN PDE
PRESTONS
B01.55
MAXWELLS
B01.44
C01.25
B01.20
KURRAJONG RD
TOSCANA ST
SAN MARINO DR
ULLADULLA ST
BRAIDWOOD DR
MICHELAGO CCT
BERNERA RD
VENEZIA ST
BASIN 18
SKIPTON LANE
PRESTONS
STORMWATER CONTROL BASINS
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
Regional Detention Basins
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851
Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25
Existing Transverse Drainage Structure and Identifier
Existing Stormwater Control Basins
Existing of MUSIC Sub-Catchment
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure A.1
(Sheet 2 of 8)
EXTENT OF SUB-CATCHMENT COMPRISING PRE-PROSED MODIFICATION MUSIC MODEL
Lyall & Associates


REFER SHEET 4
REFER SHEET 2
HINCHINBROOK CREEK
FREDERICK RD
VIDAL AVE
NEWGATE BOULEVARD
SPENCER RD
REGENTVILLE DR
JENKINSON DR
DOBROYD DR
ROSEBANK AVE
ELIZABETH HILLS
CAPRICORN BOULEVARD
GREEN VALLEY RD
GREEN VALLEY
AUKANE ST
CLARENCE DR
B08.30
BR9841/42
B08.16
B06.95
BR9839/40
B06.75
HINCHINBROOK
AVIATION RD
LORD HOWE DR
BLACKBIRD CLOSE
AIRFIELD DR
COWPASTURE RD
ROTTNEST AVE
KEPPEL CCT
BRINSMEAD AVE
MCINTYRE CCT
CHARLIE ST
HEMSWORTH AVE
LENS WATERS ESTATE
C05.95
BIRD WALTON AVE
CABRAMATTA CREEK CATCHMENT
B05.60
C05.55
SOUTHERN CROSS AVE
B05.20
C05.20
B05.19
GOVERNMENT ROAD BASIN
HALL CCT
BRYANT AVE
MCGUINESS AVE
C04.95
B04.80
C04.75
B04.60
ROSSINI DR
FIFTEENTH AVE
COLLAREENE RD
CARMICHAEL DR
HOXTON PARK
PACIFIC PALMS CCT
HAYMAN AVE
HINCHINBROOK DR
STORMWATER CONTROL BASINS
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
Regional Detention Basins
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851 Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25 Existing Transverse Drainage Structure and Identifier
Existing Stormwater Control Basins
Existing of MUSIC Sub-Catchment
Lyall & Associates
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure A.1
(Sheet 3 of 8)
EXTENT OF SUB-CATCHMENT COMPRISING PRE-PROSED MODIFICATION MUSIC MODEL

REFER SHEET 5

CECIL PARK

CECIL PARK

WASHINGTON WAY

CECIL RD

M7 MOTORWAY

VILLIERS RD

B11.93

BR9851/52

B11.74

ABBOTSBURY

B10.74

WALLGROVE RD

B10.65

B10.55

C10.40

WESTERN SYDNEY PARKLANDS

ELIZABETH DR

ROPES CREEK CATCHMENT

ELIZABETH DR

MORTIMER CLOSE

CECIL HILLS

CABRAMATTA CREEK CATCHMENT

B09.90

C09.80

B09.67

BR9844/45

C09.60

B09.50

C09.40

B09.40

RICHARD CRES

SNOWDEN CLOSE

LANCASTER AVE

ANGELAST

CLEMENTINA CCT

B08.95

C08.95

FEODORE DR

DOUJON LAKE

B08.79

C08.75

ST GEORGES CRES

TUDOR CRES

SANDRINGHAM DR

HELENARD

REFER SHEET 3

FREDERICK RD

HINCHINBROOK

CREEK

STORMWATER CONTROL BASINS

- Water Quality
- On-site Detention
- Combined Water Quality and On-site Detention
- Spill Containment
- Regional Detention Basins

N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

- Extent of Major Catchments
- BR9851 — Existing Bridge Waterway Crossing and Identifier
- Existing M7 Motorway Pit and Pipe Drainage Network
- C01.25 — Existing Transverse Drainage Structure and Identifier
- Existing Stormwater Control Basins
- Existing of MUSIC Sub-Catchment

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WESTLINK M7 WIDENING

SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure A.1
(Sheet 4 of 8)

EXTENT OF SUB-CATCHMENT COMPRISING PRE-PROSED MODIFICATION MUSIC MODEL

REFER SHEET 6

ARUNDEL RD
CHANDOS RD
WALLGROVE RD
REDMAYNE RD
WALWORTH RD
HORSLEY PARK
CREEK
THE HORSLEY DR
EASTERN
HORSLEY RD
COBHAM ST
EASTERN CREEK CATCHMENT
CALMSLEY PL
CECIL PARK
ROPES CREEK CATCHMENT
ABBOTSBURY DR
KOALA WAY
SAXONY RD
SOUTHDOWN RD
BORDER RD
WESTERN SYDNEY REGIONAL PARK
COTSWOLD RD
M7 MOTORWAY
VILLIERS RD

C15.30
B15.23
B15.09
BR9858/59
B15.04
B14.87
B14.75
C14.80
C14.72
B14.70
B14.56
C14.20
B14.16
B14.13
B14.00
B13.25
B13.10
B12.84
C12.80

REFER SHEET 4

STORMWATER CONTROL BASINS

- Water Quality
- On-site Detention
- Combined Water Quality and On-site Detention
- Spill Containment
- Regional Detention Basins

N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

- Extent of Major Catchments
- BR9851 — Existing Bridge Waterway Crossing and Identifier
- Existing M7 Motorway Pit and Pipe Drainage Network
- C01.25 — Existing Transverse Drainage Structure and Identifier
- Existing Stormwater Control Basins
- Existing of MUSIC Sub-Catchment

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WESTLINK M7 WIDENING

SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure A.1
(Sheet 5 of 8)

EXTENT OF SUB-CATCHMENT COMPRISING PRE-PROSED MODIFICATION MUSIC MODEL

REFER SHEET 7

B19.68
B19.25
B19.22
C19.20
INTERCHANGE DR
WONDERLAND DR
FERRERS RD
B18.85
C18.79
B18.60
B18.43
ESKDALE
CREEK
WALLGROVE RD
BR9873/74
B18.30
B18.24
CREEK
B18.05
B18.01
BR9870/71
B17.92
EASTERN
SOUTHRIDGE ST
CAPICURE DR
CREEK
B17.80
FERRERS RD
B17.68
C17.60
C17.55
REEDY
SHALE PL
B17.30
SYDNEY
WATER
PIPELINE
CORRIDOR
C16.98
C16.65
C16.60
B16.48
BURLEY RD
ARUNDEL RD
CHANDOS RD
REFER SHEET 5

STORMWATER CONTROL BASINS

- Water Quality
- On-site Detention
- Combined Water Quality and On-site Detention
- Spill Containment
- Regional Detention Basins

N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

- Extent of Major Catchments
- BR9851 — Existing Bridge Waterway Crossing and Identifier
- Existing M7 Motorway Pit and Pipe Drainage Network
- C01.25 — Existing Transverse Drainage Structure and Identifier
- Existing Stormwater Control Basins
- Existing of MUSIC Sub-Catchment

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WESTLINK M7 WIDENING

SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure A.1
(Sheet 6 of 8)

EXTENT OF SUB-CATCHMENT COMPRISING PRE-PROSED MODIFICATION MUSIC MODEL

REFER SHEET 8

ROOTY HILL

MAIN WESTERN RAILWAY

B23.40

C23.10

BR9898/99

B22.70

CREEK

DUNSMORE ST

EASTERN RD

ANGUS

DEVON ST

WILLIS ST

FRANCIS RD

LABRADOR ST

B22.10

B21.90

CREEK

B21.70

CHURCH ST

EASTERN

BUNGARRIBEE

BEGGS RD

MINCHINBURY ST

B21.35

C21.12

B21.00

PENFOLD ST

CAWARRA ST

GREAT WESTERN HIGHWAY

WESTERN SYDNEY PARKLANDS

B20.85

B20.75

ESKDALE ST

BR9893/94

FLEURS ST

MINCHINBURY

B20.50

B20.40

B20.01

PIKES LANE

B20.15

C20.01

B20.00

B19.63

B19.65

B19.61

B19.62

WESTERN MOTORWAY

B19.69A

B19.69

B19.70

B19.67

B19.71

B19.27

B19.68

REFER SHEET 6

STORMWATER CONTROL BASINS

- Water Quality
- On-site Detention
- Combined Water Quality and On-site Detention
- Spill Containment
- Regional Detention Basins

N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

- Extent of Major Catchments
- BR9851 — Existing Bridge Waterway Crossing and Identifier
- Existing M7 Motorway Pit and Pipe Drainage Network
- C01.25 — Existing Transverse Drainage Structure and Identifier
- Existing Stormwater Control Basins
- Existing of MUSIC Sub-Catchment

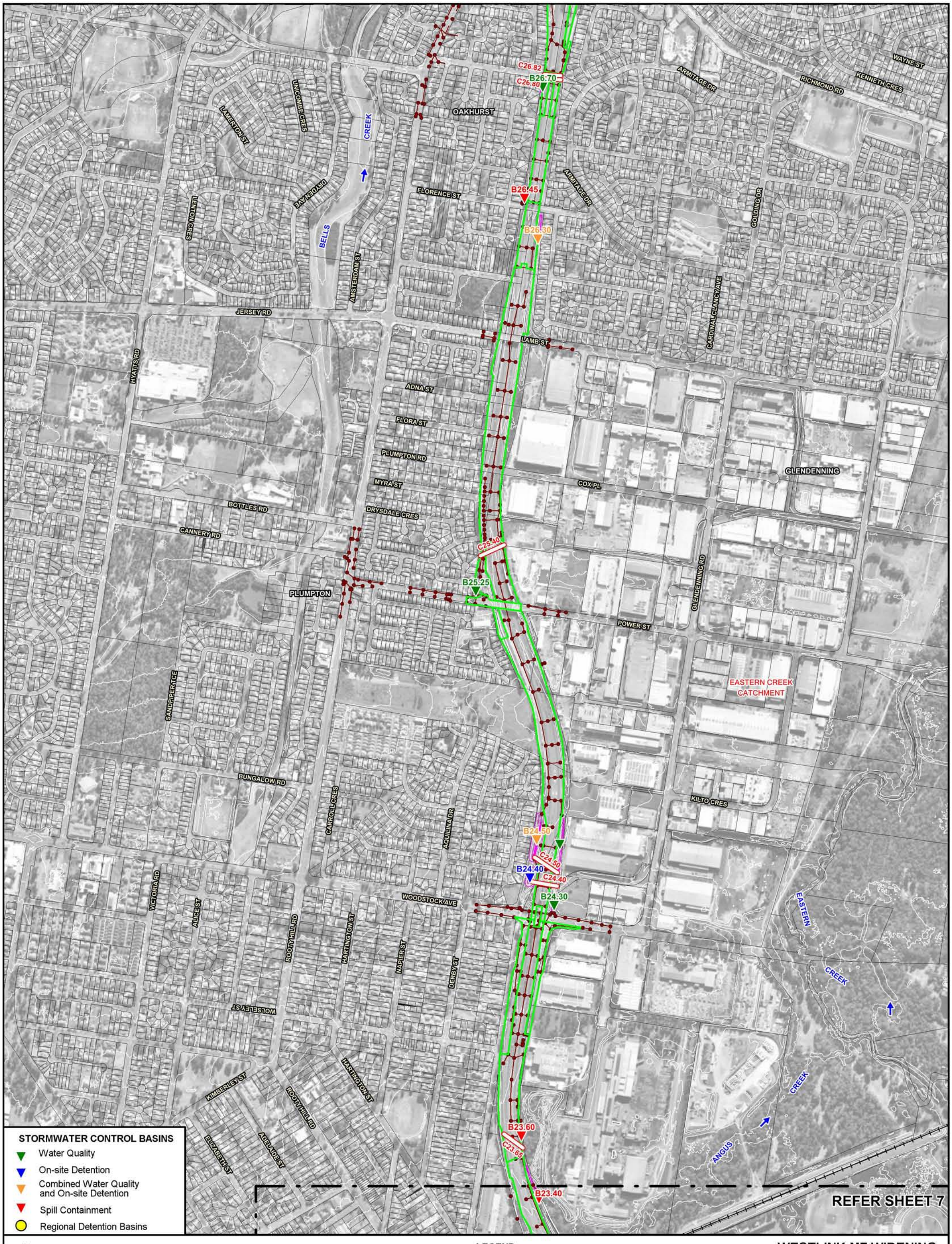
Lyall & Associates

WESTLINK M7 WIDENING

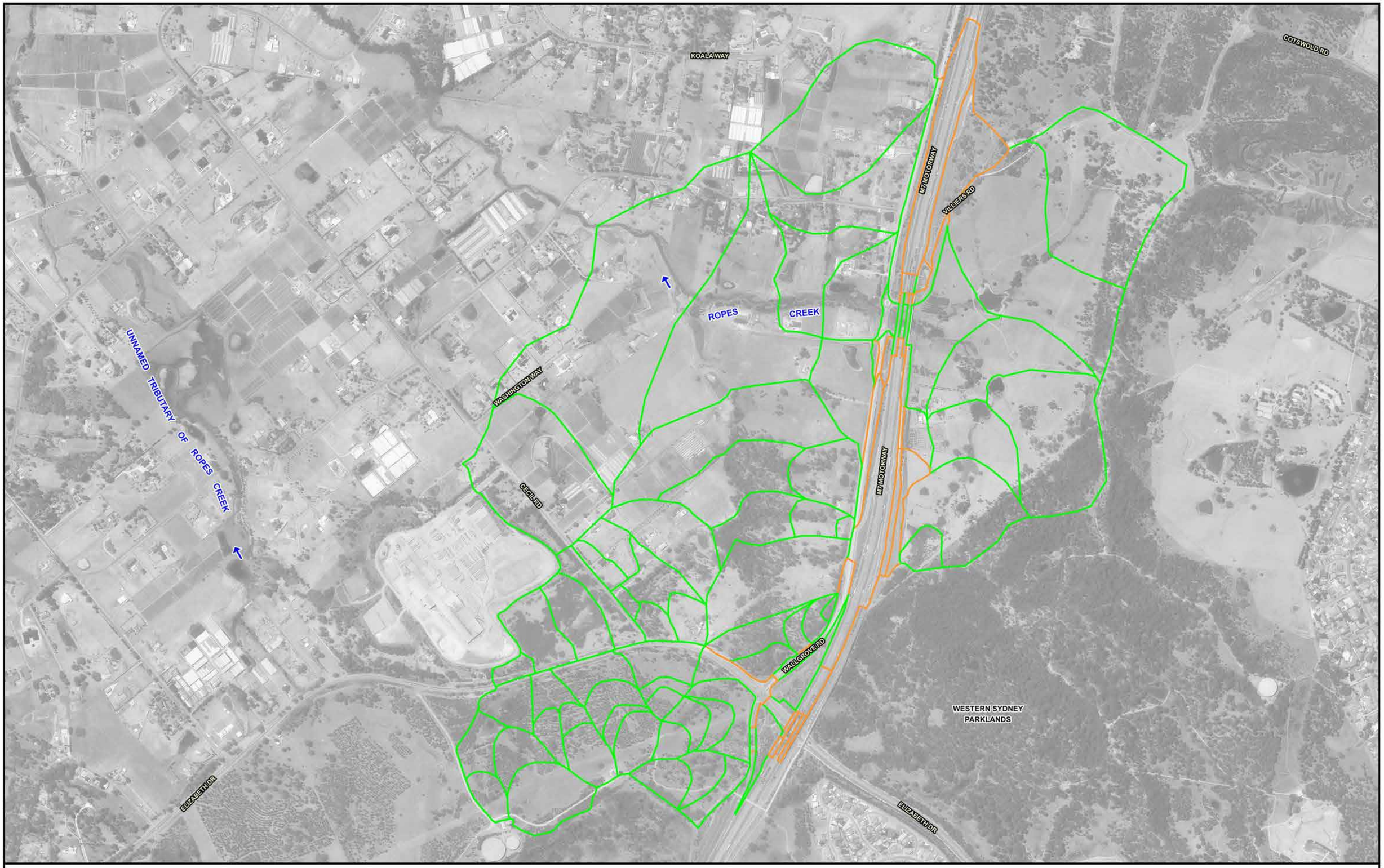
SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure A.1
(Sheet 7 of 8)

EXTENT OF SUB-CATCHMENT COMPRISING PRE-PROSED MODIFICATION MUSIC MODEL


C26.82
B26.70
C26.80
OAKHURST
UNICOMBE CRES
LAMERTON ST
CREEK
ARMITAGE DR
RICHMOND RD
KENNETH CRES
WAYNE ST
DARDEN AVE
FLORENCE ST
B26.45
B26.30
LENTON CRES
BELLS
AMSTERDAM ST
GOLDING DR
CARDINAL CLANCY AVE
JERSEY RD
LAMB ST
HYATTS RD
ADNA ST
FLORA ST
PLUMPTON RD
MYRA ST
COX PL
GLENDENNING
BOTTLES RD
DRYSDALE CRES
CANNERY RD
C25.40
B25.25
PLUMPTON
GLENDENNING RD
POWER ST
SANDPIPER TCE
EASTERN CREEK CATCHMENT
BUNGALOW RD
CARROLL CRES
AQUILINA DR
KILTO CRES
B24.50
C24.50
B24.40
C24.40
B24.30
VICTORIA RD
ALICE ST
ROONEY HILL RD
HARTINGTON ST
NAPIER ST
DERBY ST
WOODSTOCK AVE
EASTERN
CREEK
WOLSELEY ST
KIMBERLEY ST
ELIZABETH ST
ADELAIDE ST
B23.60
C23.65
B23.40
ANGUS
CREEK
REFER SHEET 7
STORMWATER CONTROL BASINS
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
Regional Detention Basins
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851
Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25
Existing Transverse Drainage Structure and Identifier
Existing Stormwater Control Basins
Existing of MUSIC Sub-Catchment
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure A.1
(Sheet 8 of 8)
EXTENT OF SUB-CATCHMENT COMPRISING PRE-PROSED MODIFICATION MUSIC MODEL
Lyall & Associates

ANNEXURE B
FIGURES SHOWING THE LAYOUT OF THE ROPES CREEK DRAINS AND TUFLOW MODELS



N

100 0 100 200 300 m

Scale: 1:10,000

Lyall & Associates

LEGEND

Sub-Catchment Modelled in RAFTS

Sub-Catchment Modelled in ILSAX

WESTLINK M7 WIDENING
SURFACE WATER AND FLOOD IMPACT ASSESSMENT

Figure B.1

ROPES CREEK DRAINS MODEL

TUFLOW ONE-DIMENSIONAL ELEMENT

- Inlet Pit
- Headwall
- Pipe

TUFLOW BOUNDARY CONDITIONS

- Inflow - Rain Boundary
- Inflow Boundary
- Outlet - Normal Depth
- Two-Dimensional Model Boundary
- Quadtree Level 3 Mesh Refinement (2 m grid)

KOALA WAY
COTSWOLD RD
M7 MOTORWAY
VILLIERS RD
ROPES CREEK
UNNAMED TRIBUTARY OF ROPES CREEK
WASHINGTON WAY
CECIL RD
WALLGROVE RD
WESTERN SYDNEY PARKLANDS
ELIZABETH DR

N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

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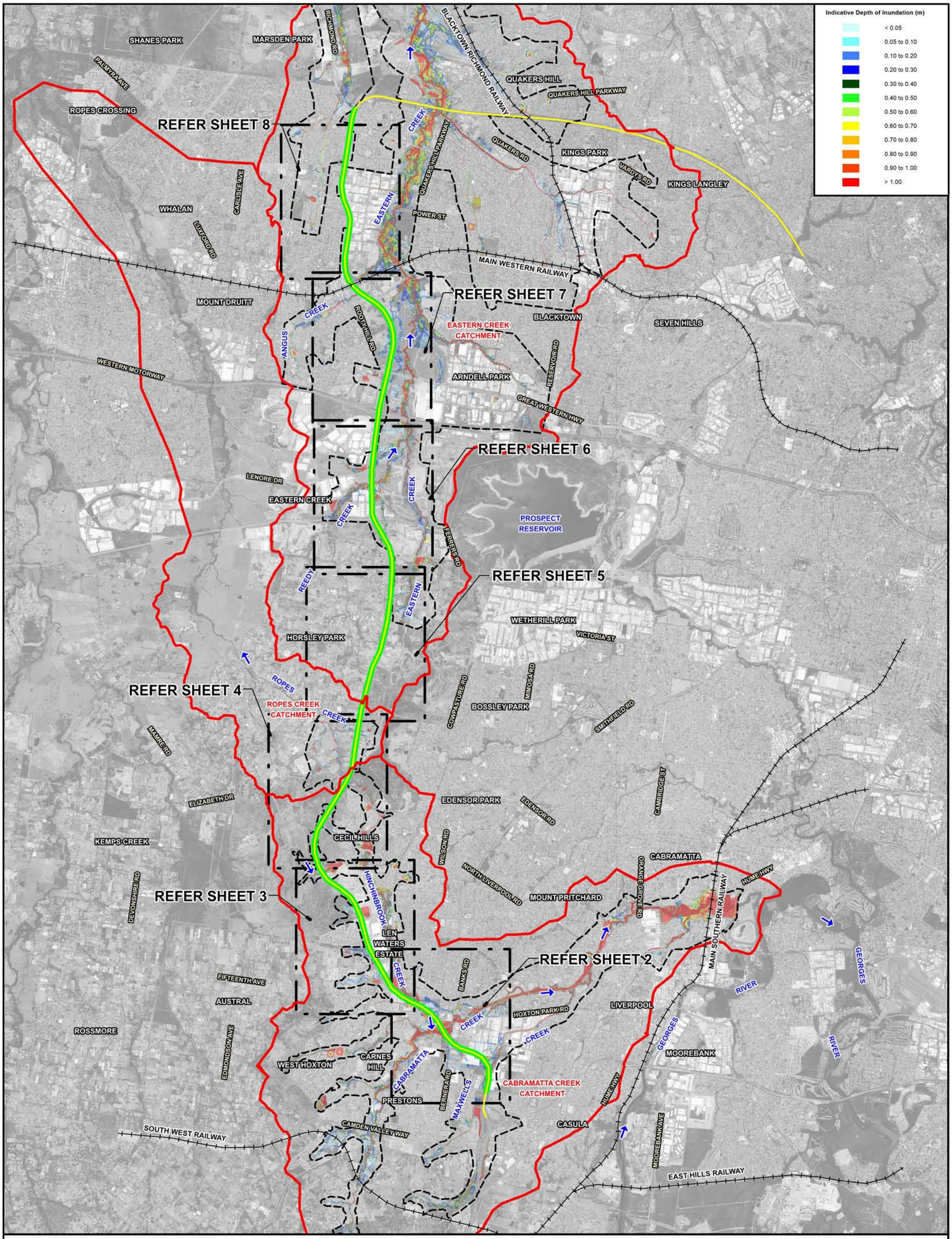
SURFACE WATER AND FLOOD IMPACT ASSESSMENT

Figure B.2

ROPES CREEK TUFLOW MODEL LAYOUT

ANNEXURE C
ADDITIONAL FIGURES SHOWING FLOOD MODEL RESULTS



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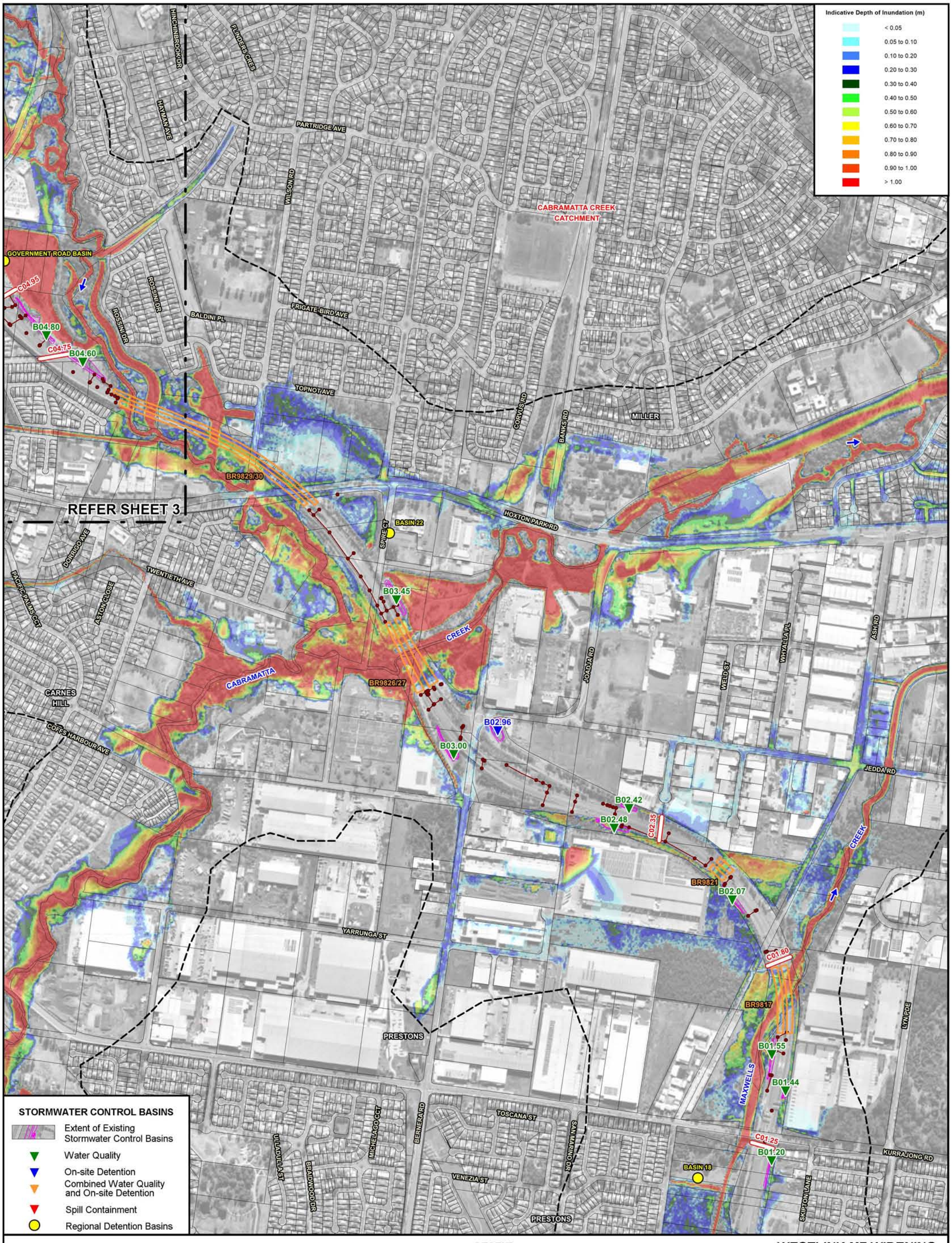
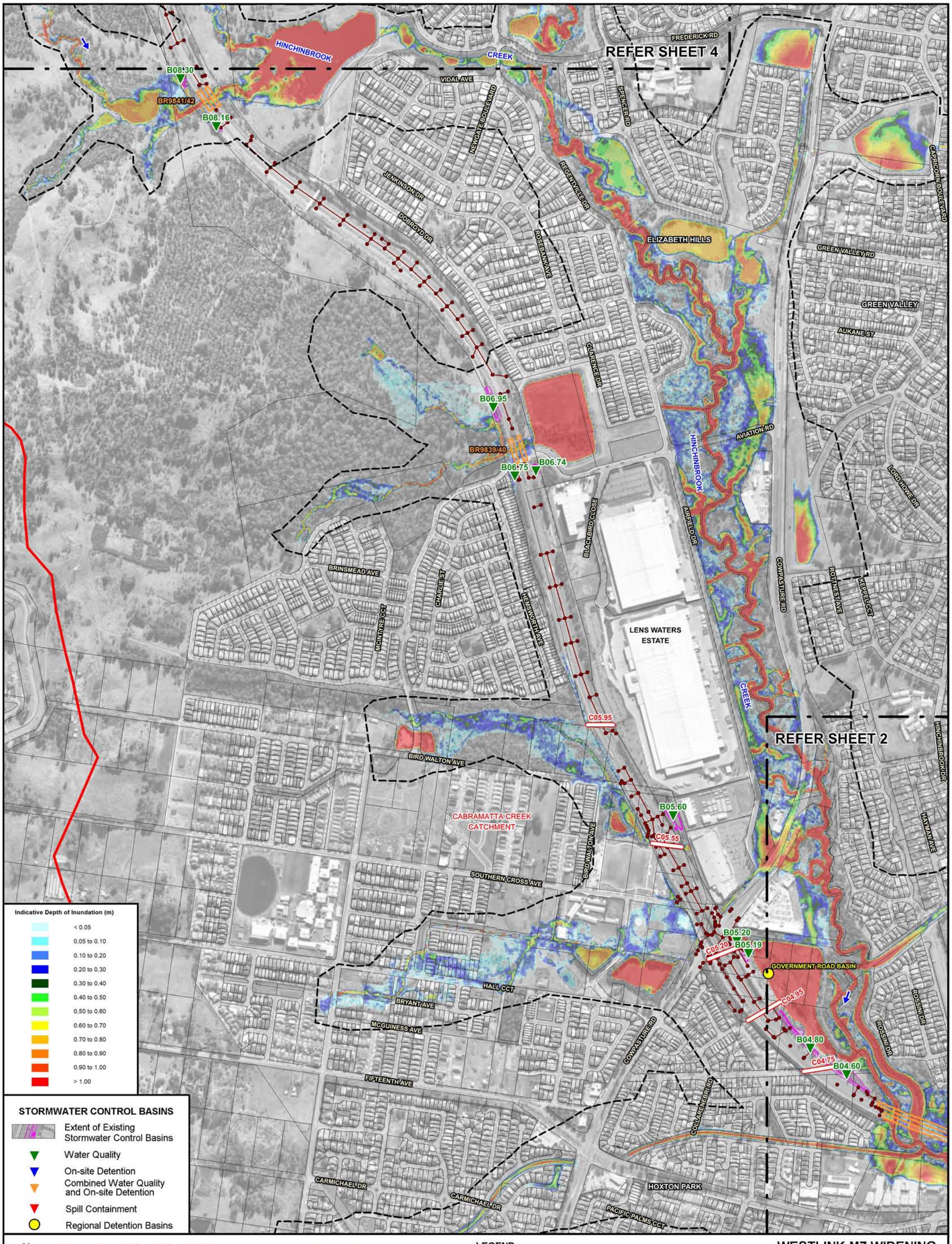
WESTLINK M7 WIDENING

SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.1
(Sheet 1 of 8)

PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 20% AEP


Indicative Depth of Inundation (m)
< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00
CABRAMATTA CREEK CATCHMENT
GOVERNMENT ROAD BASIN
HINCHINBROOK DR
FLINDERS CRES
HAYMAN AVE
PARTRIDGE AVE
WILSON RD
ROSSINI DR
BALDINI PL
FRIGATE BIRD AVE
TOPNOT AVE
CORVUS RD
BANKS RD
MILLER
C04.95
B04.80
C04.75
B04.60
REFER SHEET 3
BR9829/30
SPIRE CT
BASIN 22
HOXTON PARK RD
DORRIGO AVE
PACIFIC PALMS CCT
ASTON CLOSE
TWENTIETH AVE
B03.45
CREEK
CABRAMATTA
BR9826/27
CARNES HILL
COFFS HARBOUR AVE
B02.96
B03.00
JOADJA RD
WELD ST
WHYALLA PL
ASH RD
JEDDA RD
B02.42
B02.48
C02.35
BR9821
B02.07
CREEK
YARRUNGA ST
C01.80
BR9817
LYN PDE
B01.55
B01.44
MAXWELLS
C01.25
B01.20
KURRAJONG RD
BASIN 18
SKIPTON LANE
PRESTONS
TOSCANA ST
SAN MARINO DR
VENEZIA ST
BERNERA RD
MICHELAGO CCT
ULLADULLA ST
BRADWOOD DR
PRESTONS
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
Regional Detention Basins
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851
Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25
Existing Transverse Drainage Structure and Identifier
Extent of Two-Dimensional Hydraulic Model Boundary
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.1
(Sheet 2 of 8)
PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 20% AEP
Lyall & Associates



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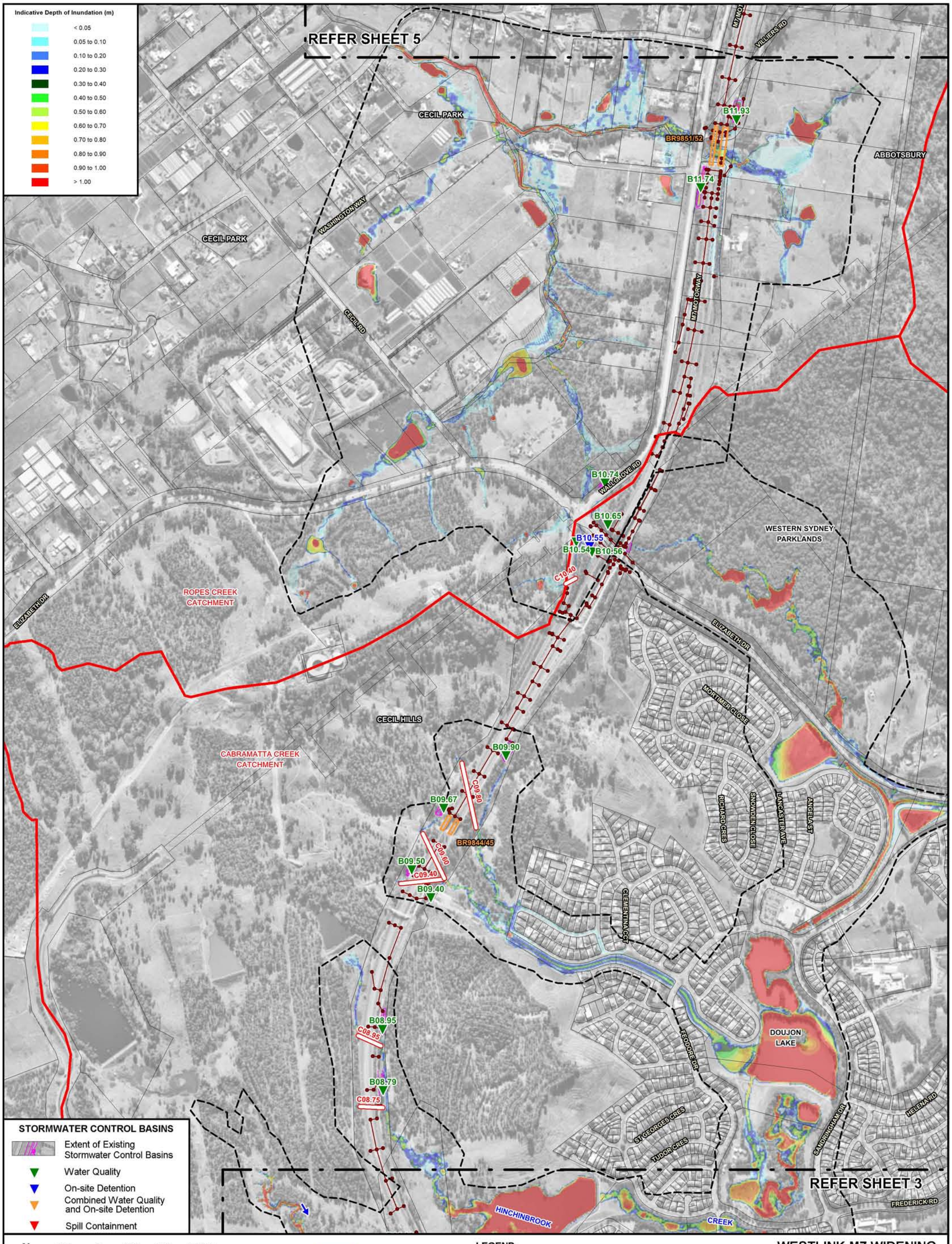
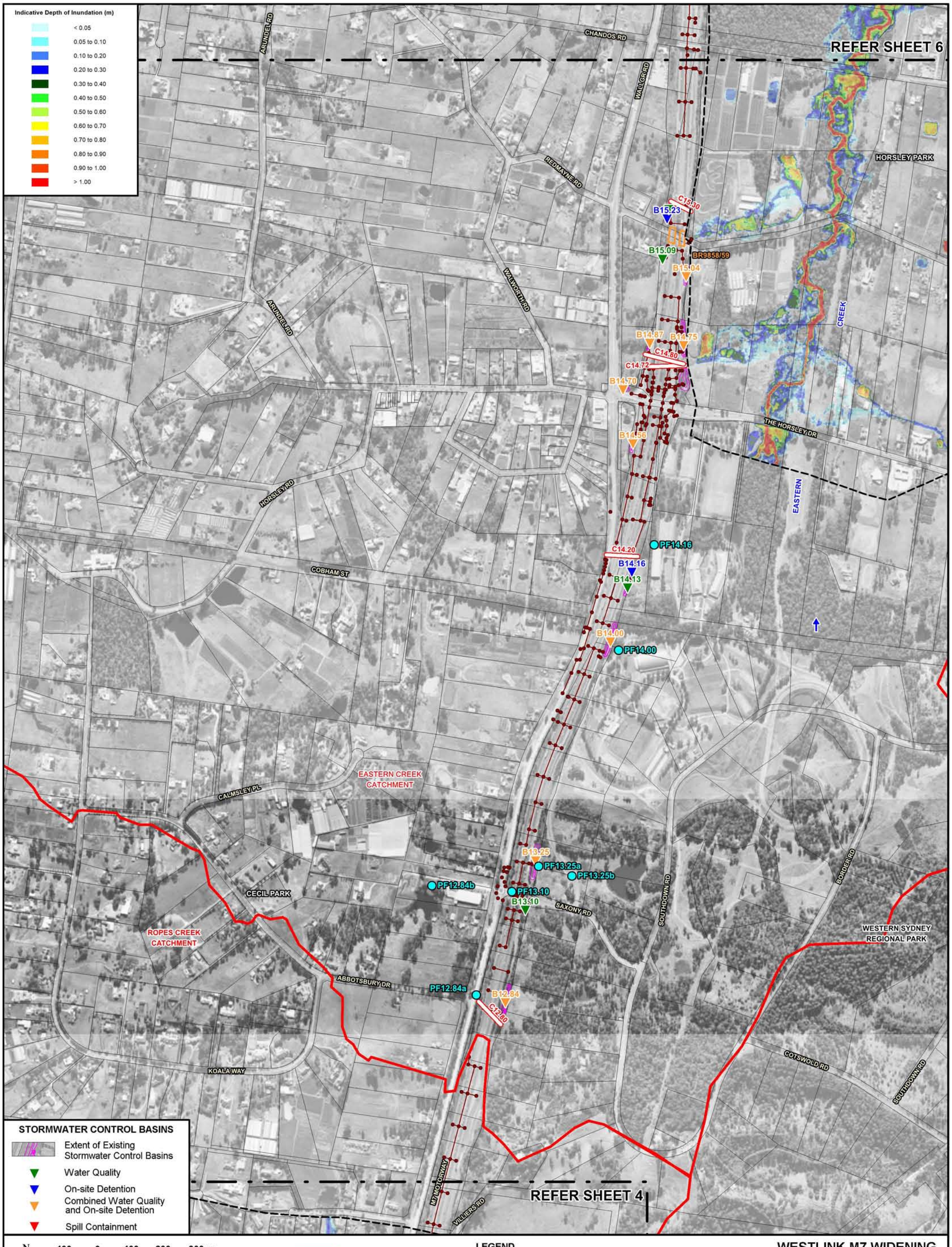
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.1
(Sheet 3 of 8)

PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 20% AEP


Indicative Depth of Inundation (m)
< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00
REFER SHEET 5
M7 MOT
VILLIERS RD
CECIL PARK
CECIL PARK
WASHINGTON WAY
CECIL RD
B11.93
BR9851/52
ABBOTSBURY
B11.74
M7 MOTORWAY
B10.74
WALLGROVE RD
B10.65
B10.55
B10.54
B10.56
C10.40
WESTERN SYDNEY PARKLANDS
ROPES CREEK CATCHMENT
ELIZABETH DR
ELIZABETH DR
MORTIMER CLOSE
CECIL HILLS
CABRAMATTA CREEK CATCHMENT
B09.90
C09.80
B09.67
BR9844/45
C09.60
B09.50
C09.40
B09.40
CLEMENTINA CCT
RICHARD CRES
SNOWDEN CLOSE
LANCASTER AVE
ANGELAST
B08.95
C08.95
FEODORE DR
DOUJON LAKE
B08.79
C08.75
ST GEORGES CRES
TUDOR CRES
SANDRINGHAM DR
HELENA RD
REFER SHEET 3
FREDERICK RD
HINCHINBROOK
CREEK
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851
Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25
Existing Transverse Drainage Structure and Identifier
Extent of Two-Dimensional Hydraulic Model Boundary
Lyall & Associates
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.1
(Sheet 4 of 8)
PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 20% AEP


Indicative Depth of Inundation (m)
< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00
REFER SHEET 6
ARUNDEL RD
CHANDOS RD
WALLGROVE RD
REDMAYNE RD
HORSLEY PARK
C15.30
B15.23
B15.09
BR9858/59
B15.04
WALWORTH RD
ARUNDEL RD
CREEK
B14.87
B14.75
C14.80
C14.72
B14.70
THE HORSLEY DR
B14.56
HORSLEY RD
EASTERN
C14.20
PF14.16
B14.16
B14.13
COBHAM ST
B14.00
PF14.00
EASTERN CREEK CATCHMENT
CALMSLEY PL
B13.25
PF13.25a
PF13.25b
PF12.84b
PF13.10
B13.10
CECIL PARK
SAXONY RD
SOUTHDOWN RD
BORDER RD
ROPES CREEK CATCHMENT
WESTERN SYDNEY REGIONAL PARK
ABBOTSBURY DR
PF12.84a
B12.84
C12.80
KOALA WAY
COTSWOLD RD
SOUTHDOWN RD
M7 MOTORWAY
VILLIERS RD
REFER SHEET 4
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851
Existing Bridge Waterway Crossing and Identifier
C01.25
Existing Transverse Drainage Structure and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
Extent of Two-Dimensional Hydraulic Model Boundary
PF13.25a
Peak Flow Location and Identifier
Lyall & Associates
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.1
(Sheet 5 of 8)
PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 20% AEP

REFER SHEET 7

B19.68
B19.25
B19.22
C19.20
EASTERN CREEK
INTERCHANGE DR
WONDERLAND DR
FERRERS RD
B18.85
C18.79
B18.60
B18.43
ESKDALE
CREEK
WALLGR RD
BR9873/74
B18.30
B18.24
CREEK
B18.05
B18.01
BR9870/71
B17.92
SOUTHRIDGE ST
CAPICURE DR
CREEK
EASTERN
B17.80
FERRERS RD
B17.68
C17.60
C17.55
REEDY
SHALE PL
B17.30
SYDNEY
WATER
PIPELINE
CORRIDOR
C16.98
C16.65
C16.60
B16.48
BURLEY RD
ARUNDEL RD
CHANDOS RD
REFER SHEET 5

Indicative Depth of Inundation (m)

- < 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.30
- 0.30 to 0.40
- 0.40 to 0.50
- 0.50 to 0.60
- 0.60 to 0.70
- 0.70 to 0.80
- 0.80 to 0.90
- 0.90 to 1.00
- > 1.00

STORMWATER CONTROL BASINS

- Extent of Existing Stormwater Control Basins
- Water Quality
- On-site Detention
- Combined Water Quality and On-site Detention
- Spill Containment

N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

- Extent of Major Catchments
- BR9851 — Existing Bridge Waterway Crossing and Identifier
- Existing M7 Motorway Pit and Pipe Drainage Network
- C01.25 — Existing Transverse Drainage Structure and Identifier
- Extent of Two-Dimensional Hydraulic Model Boundary

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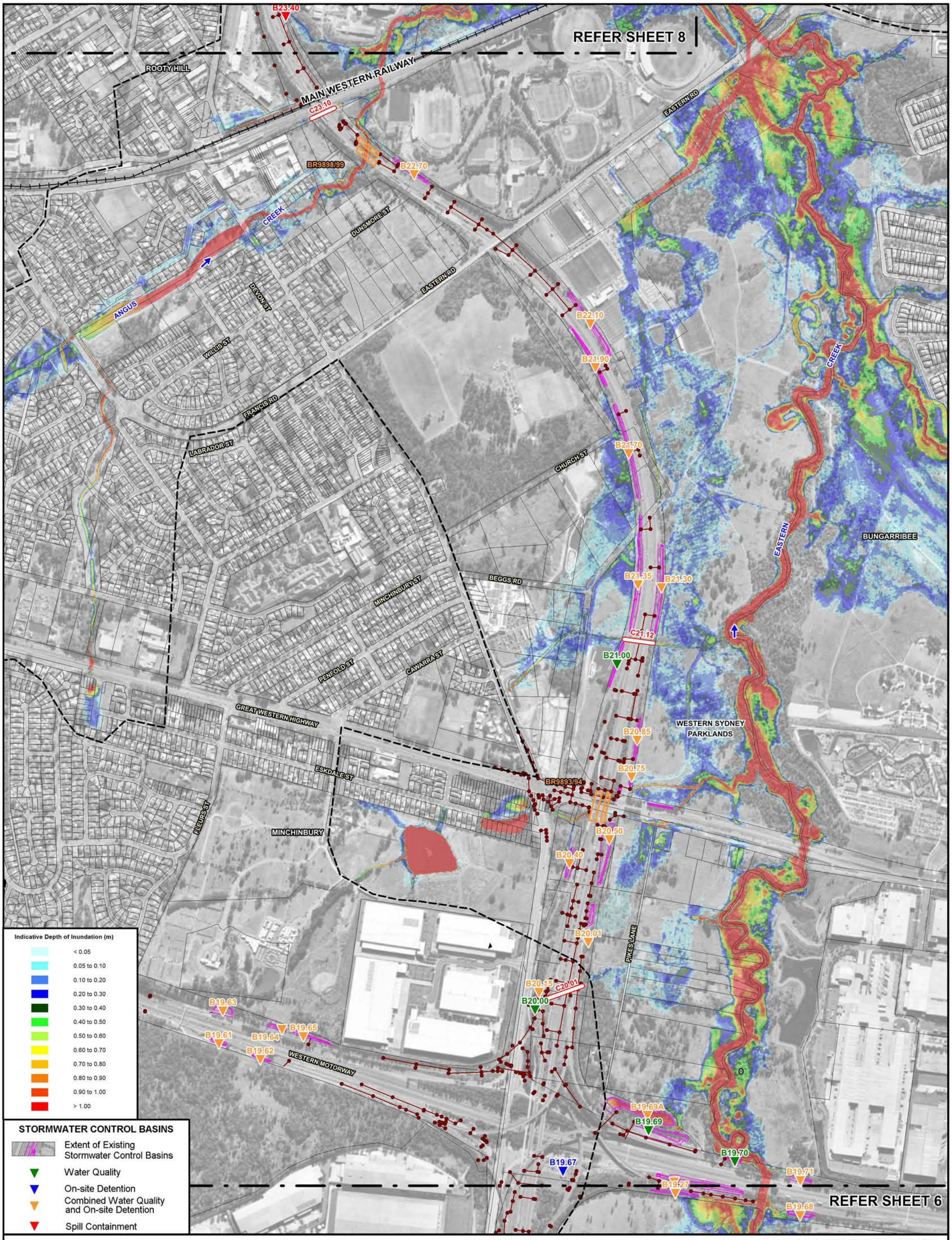
WESTLINK M7 WIDENING

SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.1
(Sheet 6 of 8)

PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 20% AEP



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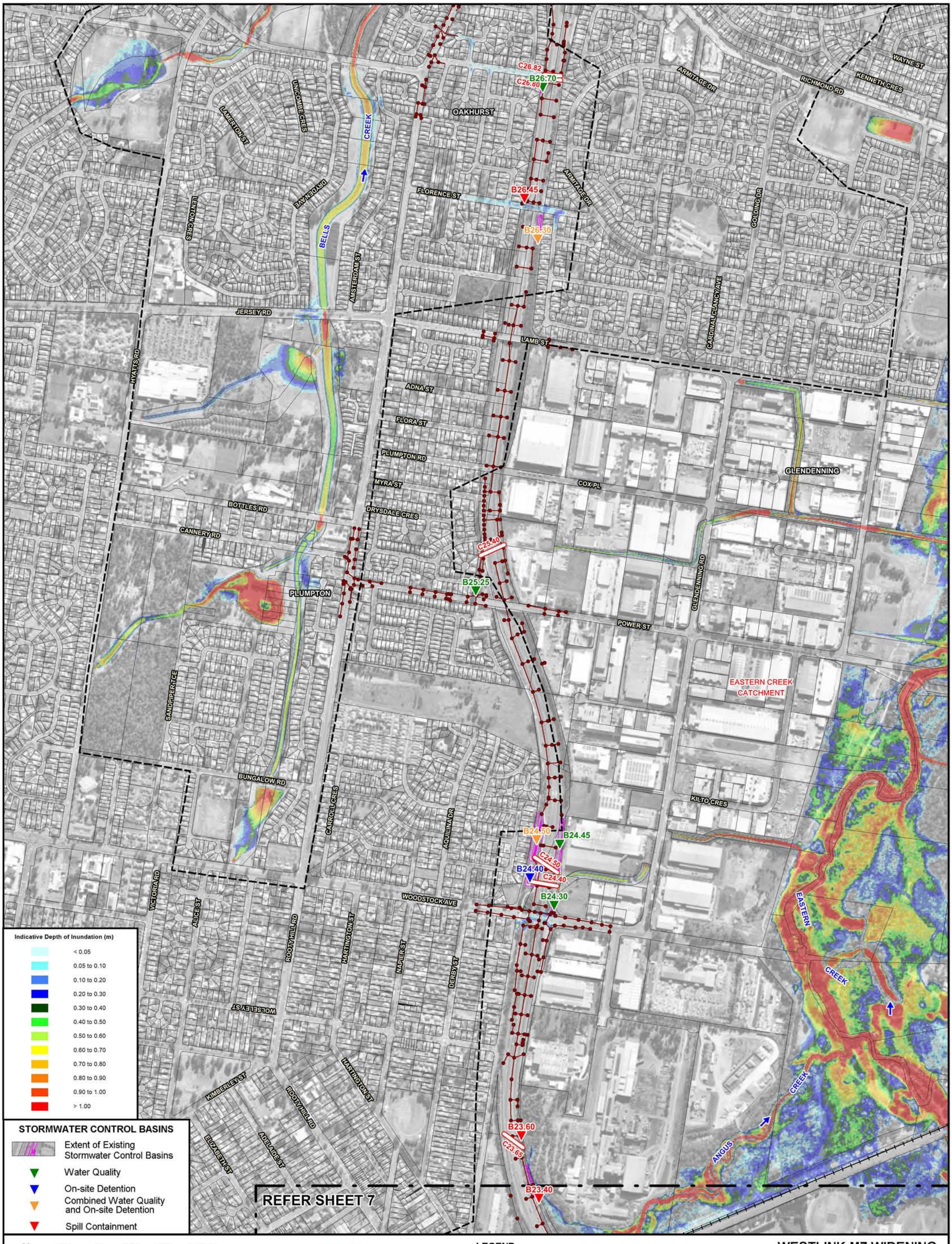
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.1
(Sheet 7 of 8)

PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 20% AEP


C26.82
B26.70
C26.80
OAKHURST
ARMITAGE DR
RICHMOND RD
KENNETH CRES
WAYNE ST
UNICOMBE CRES
LAMERTON ST
BELLS
CREEK
DRYDEN AVE
LENTON CRES
FLORENCE ST
B26.45
B26.30
ARMITAGE DR
GOLDING DR
AMSTERDAM ST
JERSEY RD
CARDINAL CLANCY AVE
LAMB ST
HYATTS RD
ADNA ST
FLORA ST
PLUMPTON RD
MYRA ST
COX PL
GLENDENNING
BOTTLES RD
DRYSDALE CRES
CANNERY RD
C25.40
B25.25
PLUMPTON
GLENDENNING RD
POWER ST
SANDPIPER ICE
EASTERN CREEK
CATCHMENT
BUNGALOW RD
CARROLL CRES
AQUILINA DR
KILTO CRES
B24.50
B24.45
C24.50
B24.40
C24.40
B24.30
VICTORIA RD
ALICE ST
WOODSTOCK AVE
EASTERN
ROOTY HILL RD
HARTINGTON ST
NAPIER ST
DERBY ST
CREEK
WOLSELEY ST
KIMBERLEY ST
ADELAIDE ST
ELIZABETH ST
B23.60
C23.65
ANGUS
CREEK
B23.40
REFER SHEET 7
Indicative Depth of Inundation (m)
< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851
Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25
Existing Transverse Drainage Structure and Identifier
Extent of Two-Dimensional Hydraulic Model Boundary
Lyall & Associates
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.1
(Sheet 8 of 8)
PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 20% AEP

Indicative Depth of Inundation (m)

< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00

REFER SHEET 8
REFER SHEET 7
REFER SHEET 6
REFER SHEET 5
REFER SHEET 4
REFER SHEET 3
REFER SHEET 2

SHANES PARK
MARSDEN PARK
PALMYRA AVE
ROPES CROSSING
RICHMOND RD
BLACKTOWN RICHMOND RAILWAY
QUAKERS HILL
QUAKERS HILL PARKWAY
CREEK
QUAKERS HILL PARKWAY
QUAKERS RD
KINGS PARK
VARDYS RD
KINGS LANGLEY
CARLISLE AVE
WHALAN
LUXFORD RD
EASTERN
POWER ST
MAIN WESTERN RAILWAY
MOUNT DRUITT
CREEK
ANGUS
ROOTY HILL RD
BLACKTOWN
EASTERN CREEK CATCHMENT
SEVEN HILLS
RESERVOIR RD
WESTERN MOTORWAY
ARNDELL PARK
GREAT WESTERN HWY
LENORE DR
EASTERN CREEK
CREEK
CREEK
PROSPECT RESERVOIR
FERRERS RD
REEDY
EASTERN
WETHERILL PARK
VICTORIA ST
HORSLEY PARK
ROPES
ROPES CREEK CATCHMENT
CREEK
COWPASTURE RD
MIMOSA RD
BOSSLEY PARK
SMITHFIELD RD
MAMRE RD
ELIZABETH DR
EDENSOR PARK
EDENSOR RD
CAMBRIDGE ST
KEMPS CREEK
CECIL HILLS
WILSON RD
CABRAMATTA
NORTH LIVERPOOL RD
ORANGE GROVE RD
MOUNT PRITCHARD
HUME HWY
MAIN SOUTHERN RAILWAY
DEVONSHIRE RD
HINCHINBROOK
LEN WATERS ESTATE
CREEK
BANKS RD
FIFTEENTH AVE
AUSTRAL
ROSSMORE
EDMONDSON AVE
HOXTON PARK RD
CREEK
CREEK
LIVERPOOL
GEORGES RIVER
GEORGES RIVER
MOOREBANK
WEST HOXTON
CARNES HILL
CABRAMATTA CREEK
BERNERA RD
MAXWELLS
PRESTONS
CABRAMATTA CREEK CATCHMENT
HUME HWY
CASULA
MOOREBANK AVE
SOUTH WEST RAILWAY
CAMDEN VALLEY WAY
EAST HILLS RAILWAY

N
800 0 800 1600 2400 m
Scale: 1:80,000

LEGEND

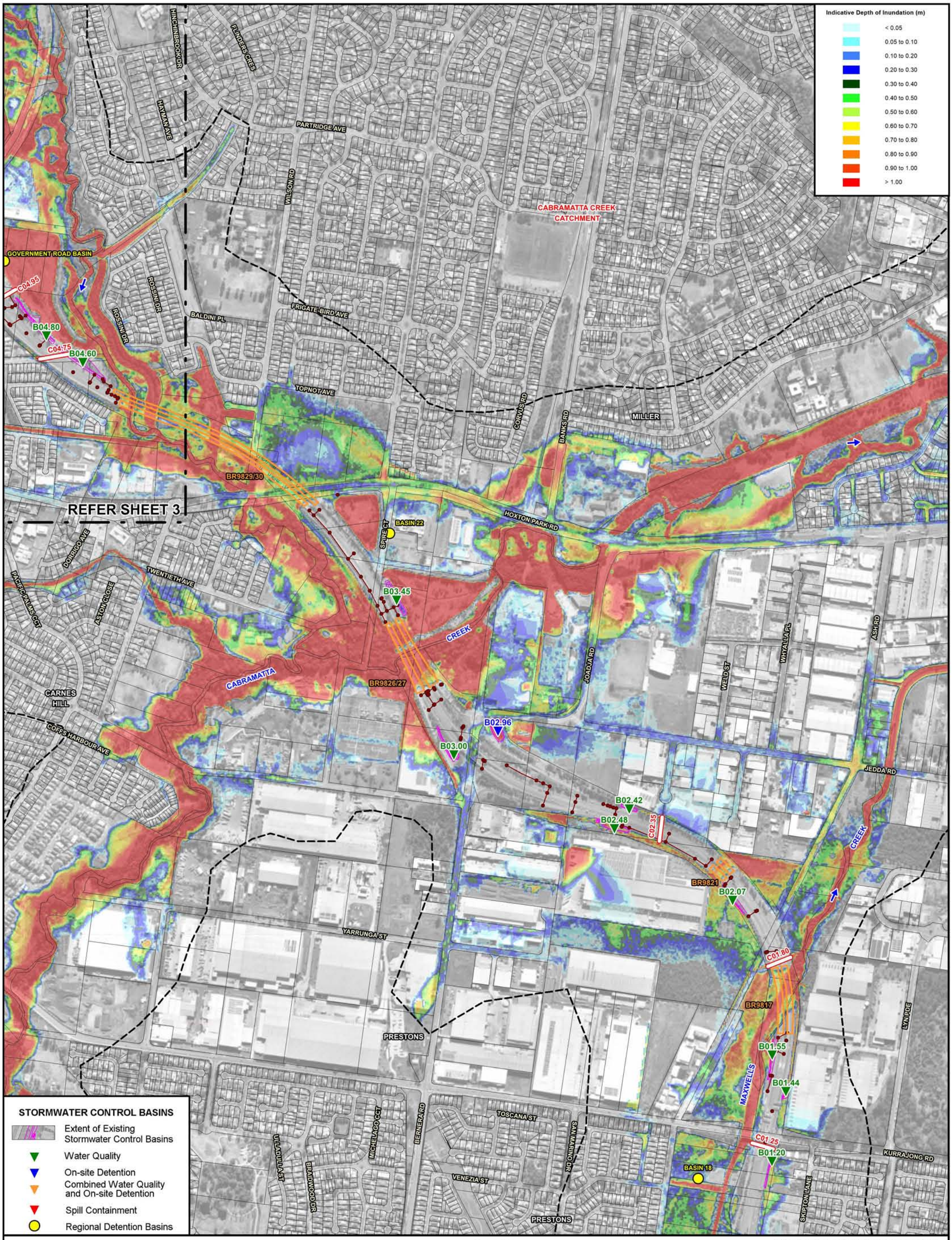
Extent of Major Catchments
Extent of Two-Dimensional Hydraulic Model Boundary
Extent of M7 Motorway Widening
M7 Motorway

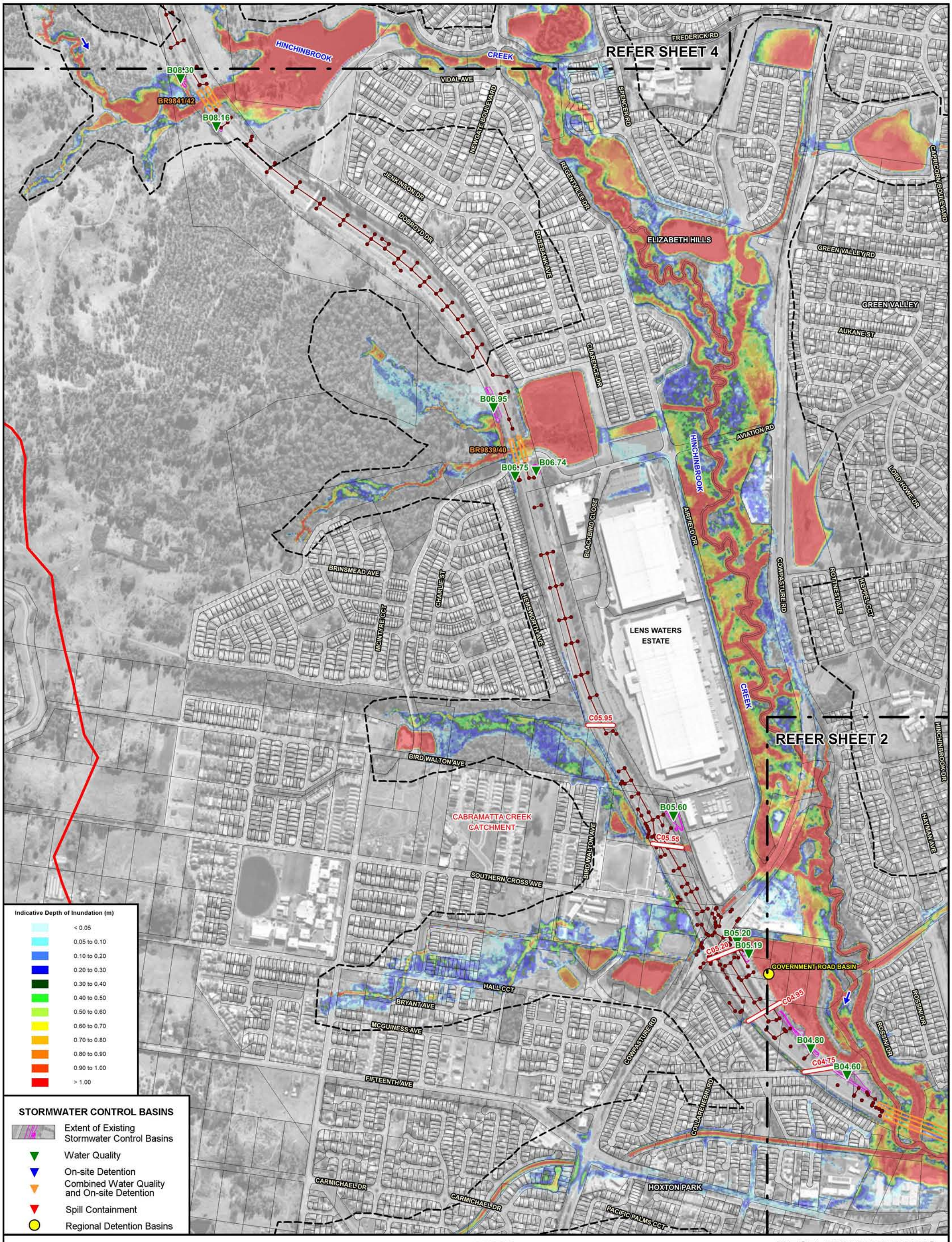
Lyall & Associates

WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.2
(Sheet 1 of 8)

PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.5% AEP


Indicative Depth of Inundation (m)
< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00
CABRAMATTA CREEK CATCHMENT
REFER SHEET 3
GOVERNMENT ROAD BASIN
HINCHINBROOK DR
FLINDERS CRES
HAYMAN AVE
PARTRIDGE AVE
WILSON RD
ROSSINI DR
BALDINI PL
FRIGATE BIRD AVE
TOPNOT AVE
CORVUS RD
BANKS RD
MILLER
BASIN 22
SPIRE CT
HOXTON PARK RD
DORRIGO AVE
PACIFIC PALMS CCT
ASTON CLOSE
TWENTIETH AVE
CARNES HILL
COFFS HARBOUR AVE
CABRAMATTA CREEK
JOADJA RD
WELD ST
WHYALLA PL
ASH RD
JEDDA RD
YARRUNGA ST
PRESTONS
MAXWELLS CREEK
LYN PDE
TOSCANA ST
SAN MARINO DR
BERNERA RD
MICHELAGO CCT
ULLADULLA ST
BRAIDWOOD DR
VENEZIA ST
BASIN 18
SKIPTON LANE
KURRAJONG RD
C04.95
B04.80
C04.75
B04.60
BR9829/30
BR9826/27
B03.45
B03.00
B02.96
B02.42
B02.48
C02.35
BR9821
B02.07
C01.80
BR9817
B01.55
B01.44
C01.25
B01.20
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
Regional Detention Basins
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851
Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25
Existing Transverse Drainage Structure and Identifier
Extent of Two-Dimensional Hydraulic Model Boundary
Lyall & Associates
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.2
(Sheet 2 of 8)
PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.5% AEP


HINCHINBROOK CREEK
REFER SHEET 4
FREDERICK RD
VIDAL AVE
NEWGATE BOULEVARD
SPENCER RD
REGENTVILLE DR
CAPRICORN BOULEVARD
JENKINSON DR
DOBROYD DR
ROSEBANK AVE
ELIZABETH HILLS
GREEN VALLEY RD
GREEN VALLEY
AUKANE ST
CLARENCE DR
AVIATION RD
HINCHINBROOK
LORD HOWE DR
B08.30
BR9841/42
B08.16
B06.95
BR9839/40
B06.75
B06.74
BLACKBIRD CLOSE
AIRFIELD DR
GOWPASTURE RD
ROTHNEST AVE
KEPPEL CCT
BRINSMEAD AVE
MCINTYRE CCT
CHARLIE ST
NEMSWORTH AVE
LENS WATERS ESTATE
CREEK
C05.95
REFER SHEET 2
HINCHINBROOK DR
BIRD WALTON AVE
CABRAMATTA CREEK CATCHMENT
B05.60
C05.55
HAYMAN AVE
SOUTHERN CROSS AVE
B05.20
C05.20
B05.19
GOVERNMENT ROAD BASIN
HALL CCT
BRYANT AVE
MCGUINESS AVE
C04.95
ROSSINI DR
COMPASTURE RD
B04.80
C04.75
B04.60
FIFTEENTH AVE
COLLAREENE RD
CARMICHAEL DR
HOXTON PARK
PACIFIC PALMS CCT
Indicative Depth of Inundation (m)
< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
Regional Detention Basins
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851 Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25 Existing Transverse Drainage Structure and Identifier
Extent of Two-Dimensional Hydraulic Model Boundary
Lyall & Associates
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.2
(Sheet 3 of 8)
PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.5% AEP

Indicative Depth of Inundation (m)

- < 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.30
- 0.30 to 0.40
- 0.40 to 0.50
- 0.50 to 0.60
- 0.60 to 0.70
- 0.70 to 0.80
- 0.80 to 0.90
- 0.90 to 1.00
- > 1.00

REFER SHEET 5

CECIL PARK

CECIL PARK

WASHINGTON WAY

CECIL RD

M7 MOTORWAY

VILLIERS RD

ABBOTSBURY

B11.93

BR9851/52

B11.74

ROPES CREEK CATCHMENT

ELIZABETH DR

CABRAMATTA CREEK CATCHMENT

CECIL HILLS

B10.74

WALLGROVE RD

B10.65

B10.55

B10.54

B10.56

C10.40

WESTERN SYDNEY PARKLANDS

ELIZABETH DR

MORTIMER CLOSE

B09.90

C09.80

B09.67

BR9844/45

C09.60

B09.50

C09.40

B09.40

RICHARD CRES

SNOWDEN CLOSE

LANCASTER AVE

ANGELA ST

CLEMENTINA CCT

B08.95

C08.95

FEODORE DR

DOUJON LAKE

B08.79

C08.75

ST GEORGES CRES

TUDOR CRES

SANDRINGHAM DR

HELENA RD

REFER SHEET 3

FREDERICK RD

HINCHINBROOK

CREEK

STORMWATER CONTROL BASINS

- Extent of Existing Stormwater Control Basins
- Water Quality
- On-site Detention
- Combined Water Quality and On-site Detention
- Spill Containment

N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

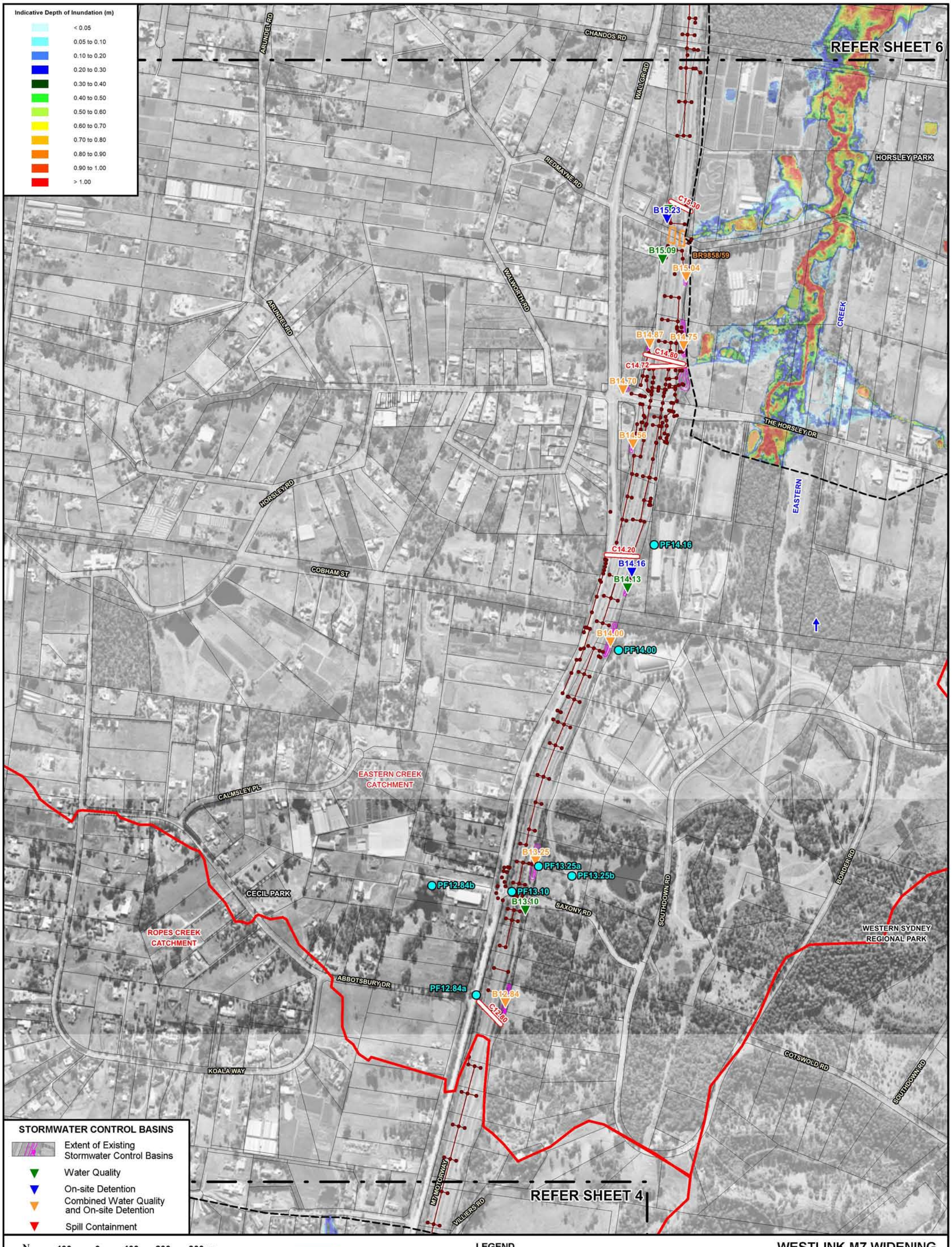
- Extent of Major Catchments
- BR9851 — Existing Bridge Waterway Crossing and Identifier
- Existing M7 Motorway Pit and Pipe Drainage Network
- C01.25 — Existing Transverse Drainage Structure and Identifier
- Extent of Two-Dimensional Hydraulic Model Boundary

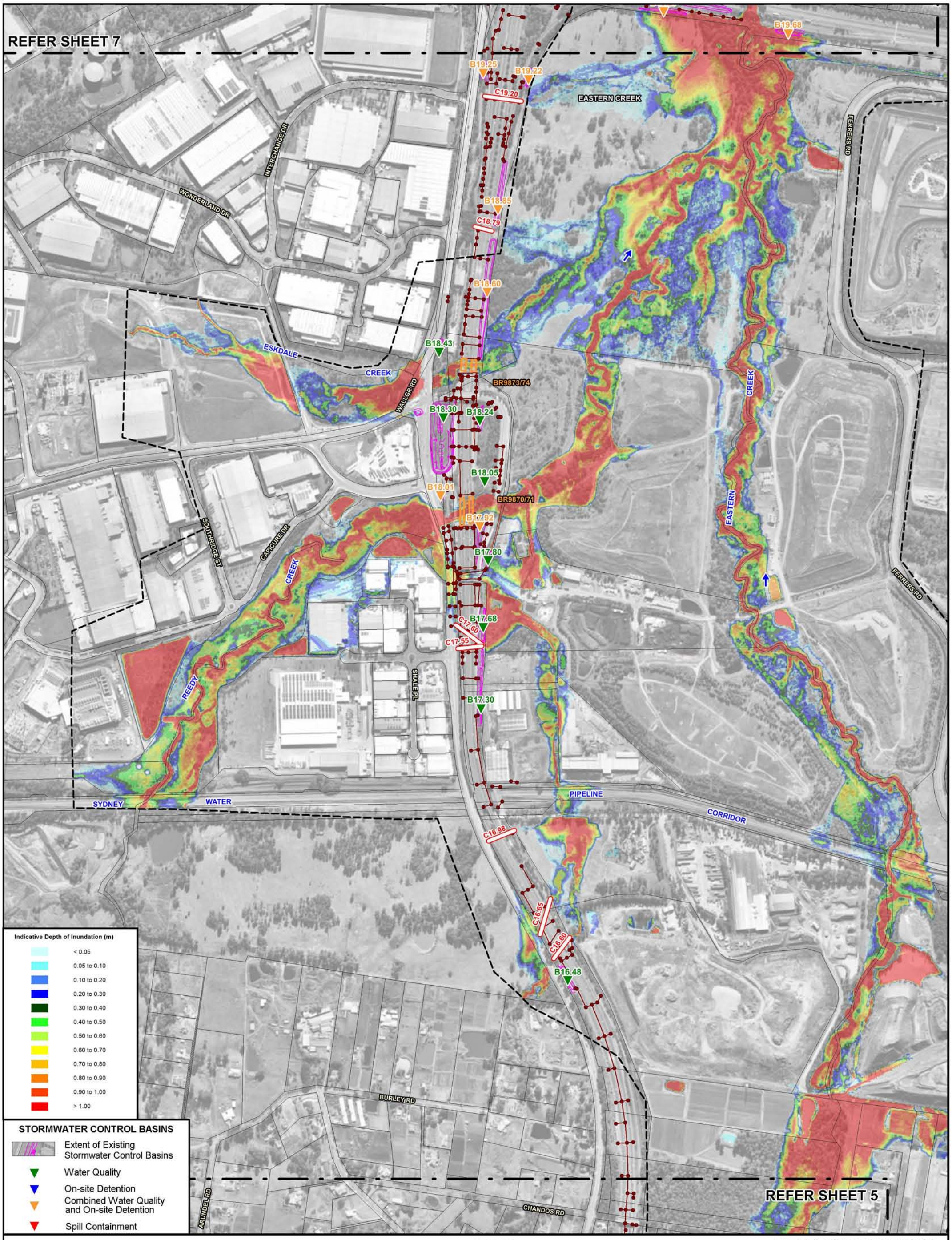
Lyall & Associates

WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.2
(Sheet 4 of 8)

PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.5% AEP


Indicative Depth of Inundation (m)
< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00
REFER SHEET 6
ARUNDEL RD
CHANDOS RD
WALLGROVE RD
REDMAYNE RD
WALWORTH RD
HORSLEY PARK
CREEK
EASTERN
THE HORSLEY DR
HORSLEY RD
COBHAM ST
CALMSLEY PL
EASTERN CREEK CATCHMENT
CECIL PARK
ROPES CREEK CATCHMENT
ABBOTSBURY DR
KOALA WAY
SAXONY RD
SOUTHDOWN RD
BORDER RD
COTSWOLD RD
WESTERN SYDNEY REGIONAL PARK
M7 MOTORWAY
VILLIERS RD
REFER SHEET 4
C15.30
B15.23
B15.09
BR9858/59
B15.04
B14.87
B14.75
C14.80
C14.72
B14.70
B14.56
C14.20
PF14.16
B14.16
B14.13
B14.00
PF14.00
B13.25
PF13.25a
PF13.25b
PF12.84b
PF13.10
B13.10
PF12.84a
B12.84
C12.80
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851
Existing Bridge Waterway Crossing and Identifier
C01.25
Existing Transverse Drainage Structure and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
Extent of Two-Dimensional Hydraulic Model Boundary
PF13.25a
Peak Flow Location and Identifier
Lyall & Associates
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.2
(Sheet 5 of 8)
PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.5% AEP


REFER SHEET 7
B19.68
B19.25
B19.22
C19.20
EASTERN CREEK
FERRERS RD
INTERCHANGE DR
WONDERLAND DR
B18.85
C18.79
B18.60
B18.43
ESKDALE
CREEK
WALLGR RD
BR9873/74
B18.30
B18.24
CREEK
B18.05
B18.01
BR9870/71
B17.92
EASTERN
B17.80
SOUTHRIDGE ST
CARICURE DR
CREEK
FERRERS RD
B17.68
C17.60
C17.55
REEDY
SHALE PL
B17.30
SYDNEY
WATER
PIPELINE
CORRIDOR
C16.98
C16.65
C16.60
B16.48
BURLEY RD
ARUNDEL RD
CHANDOS RD
REFER SHEET 5
Indicative Depth of Inundation (m)
< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851
Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25
Existing Transverse Drainage Structure and Identifier
Extent of Two-Dimensional Hydraulic Model Boundary
Lyall & Associates
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.2
(Sheet 6 of 8)
PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.5% AEP

REFER SHEET 8

ROOTY HILL

MAIN WESTERN RAILWAY

EASTERN RD

CREEK

DUNSMORE ST

ANGUS

DEVON ST

WILLIS ST

FRANCIS RD

LABRADOR ST

CHURCH ST

BEGGS RD

MINCHINBURY ST

PENFOLD ST

CAWARRA ST

GREAT WESTERN HIGHWAY

ESKDALE ST

FLEURS ST

MINCHINBURY

BUNGARRIBEE

WESTERN SYDNEY PARKLANDS

PIKES LANE

WESTERN MOTORWAY

B23.40
C23.10
BR9898/99
B22.70
B22.10
B21.90
B21.70
B21.35
B21.30
C21.12
B21.00
B20.85
B20.75
BR9893/94
B20.50
B20.40
B20.01
B20.15
C20.01
B20.00
B19.63
B19.65
B19.61
B19.64
B19.62
B19.69A
B19.69
B19.70
B19.71
B19.67
B19.27
B19.68

REFER SHEET 6

Indicative Depth of Inundation (m)

< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00

STORMWATER CONTROL BASINS

- Extent of Existing Stormwater Control Basins
- Water Quality
- On-site Detention
- Combined Water Quality and On-site Detention
- Spill Containment

N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

- Extent of Major Catchments
- BR9851 — Existing Bridge Waterway Crossing and Identifier
- Existing M7 Motorway Pit and Pipe Drainage Network
- C01.25 — Existing Transverse Drainage Structure and Identifier
- Extent of Two-Dimensional Hydraulic Model Boundary

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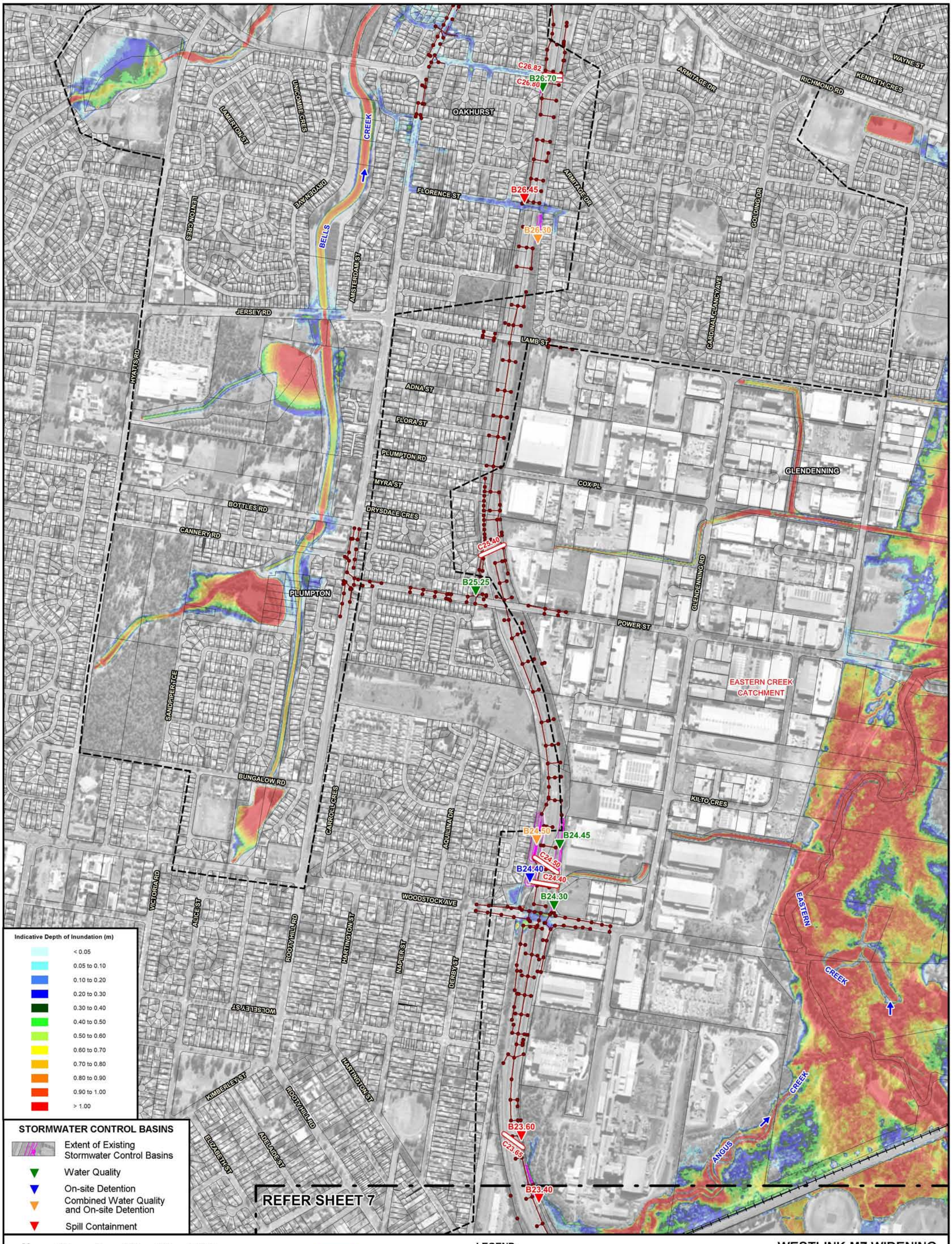
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.2
(Sheet 7 of 8)

PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.5% AEP



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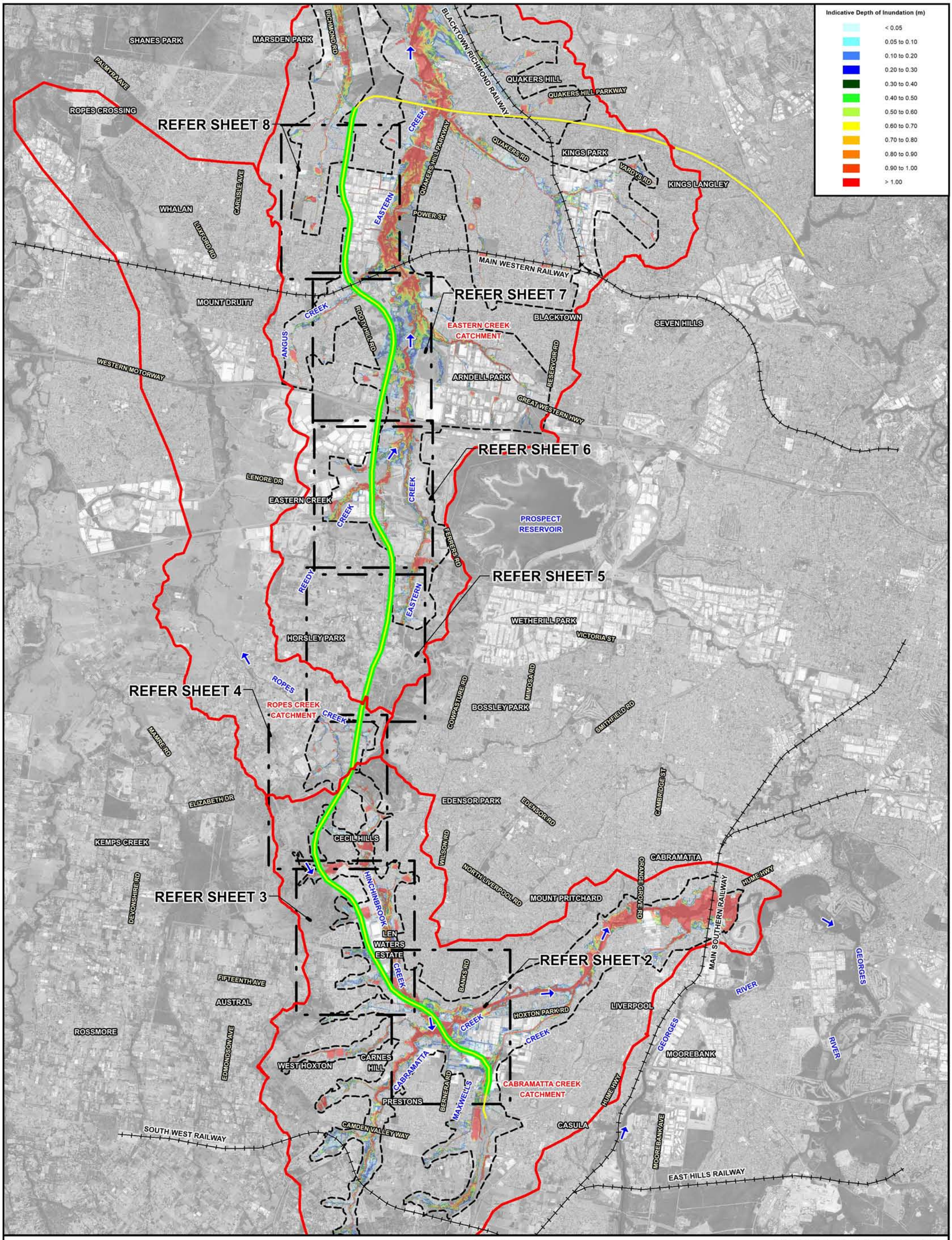
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.2
(Sheet 8 of 8)

PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.5% AEP



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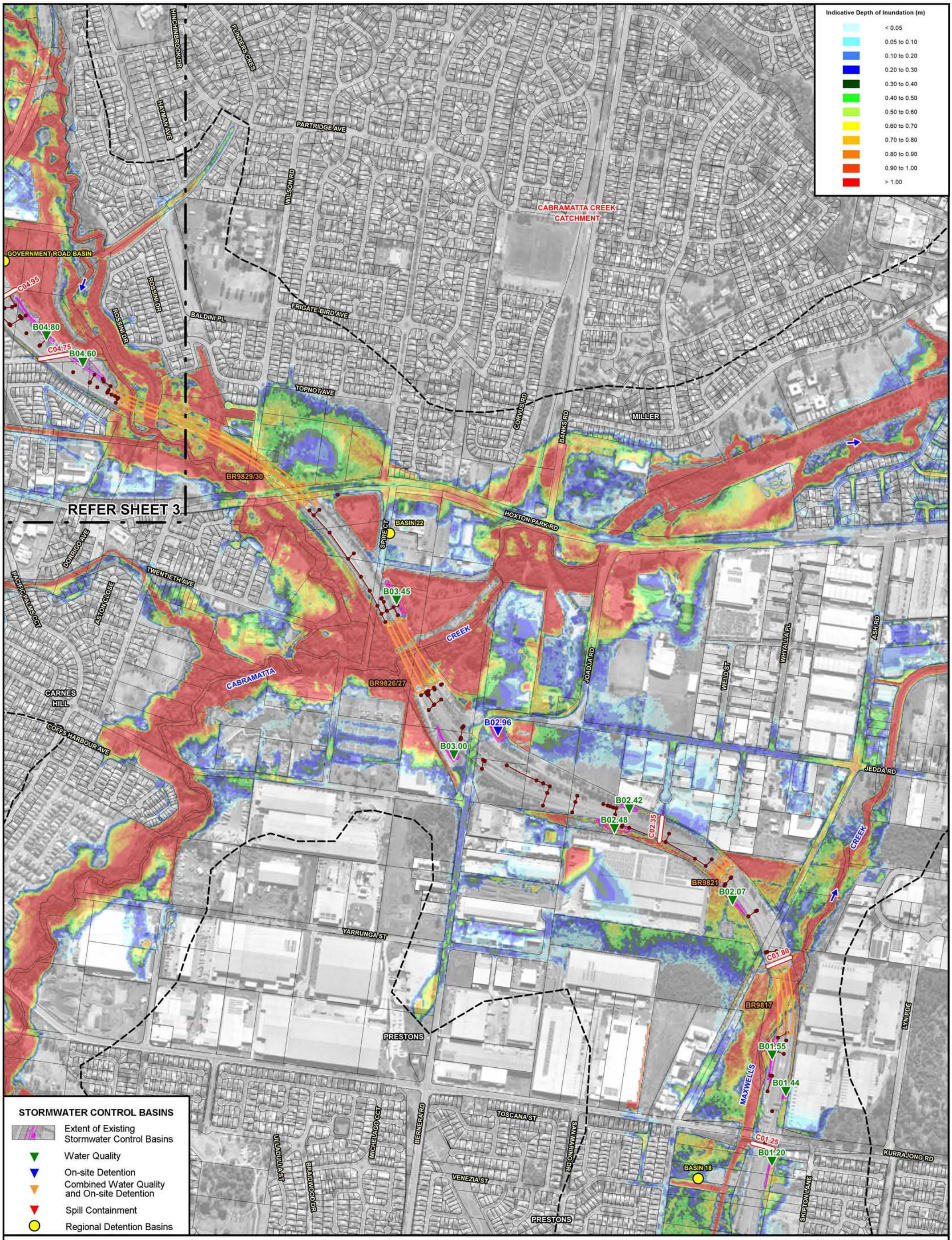
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.3
(Sheet 1 of 8)

PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.2% AEP



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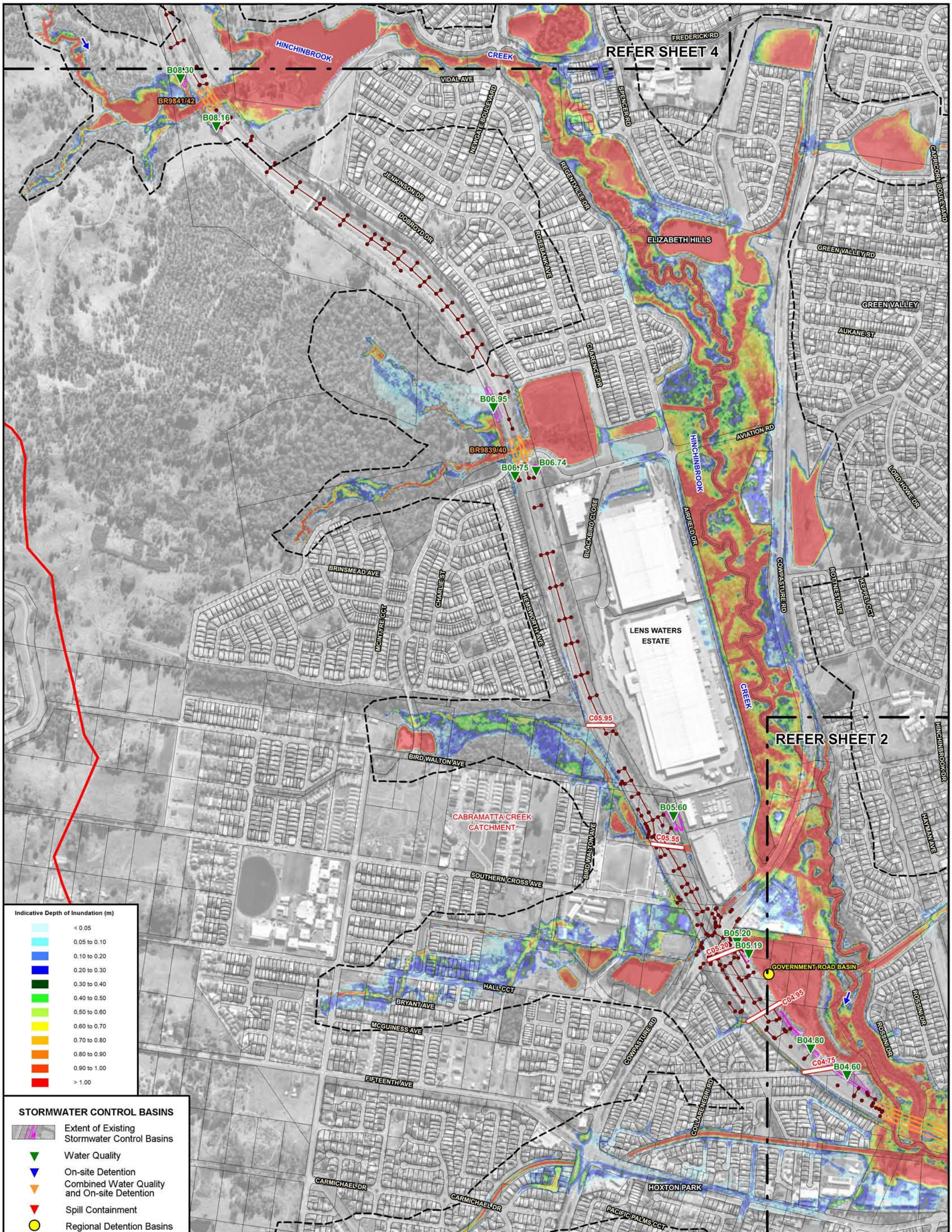
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.3
(Sheet 2 of 8)

PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.2% AEP



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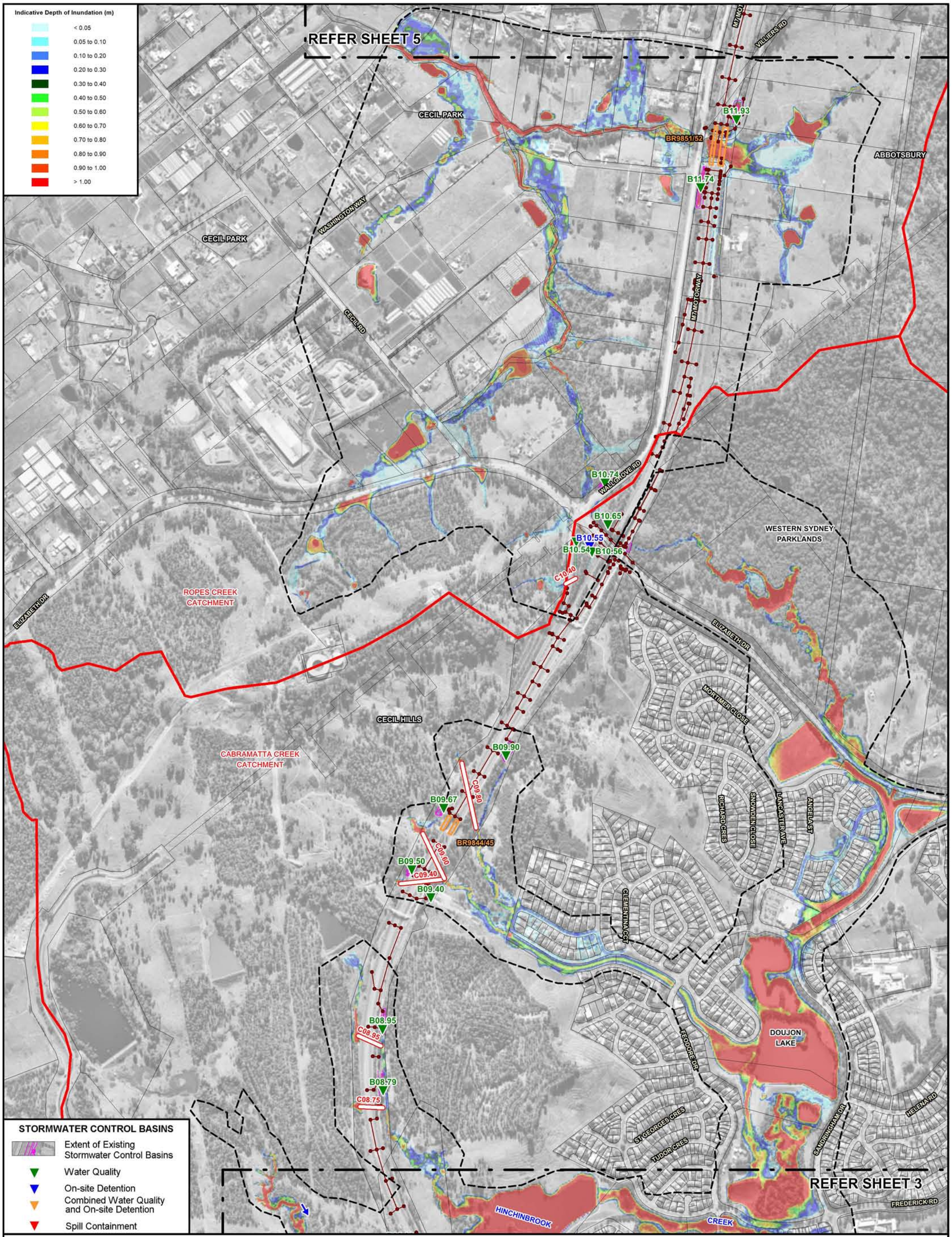
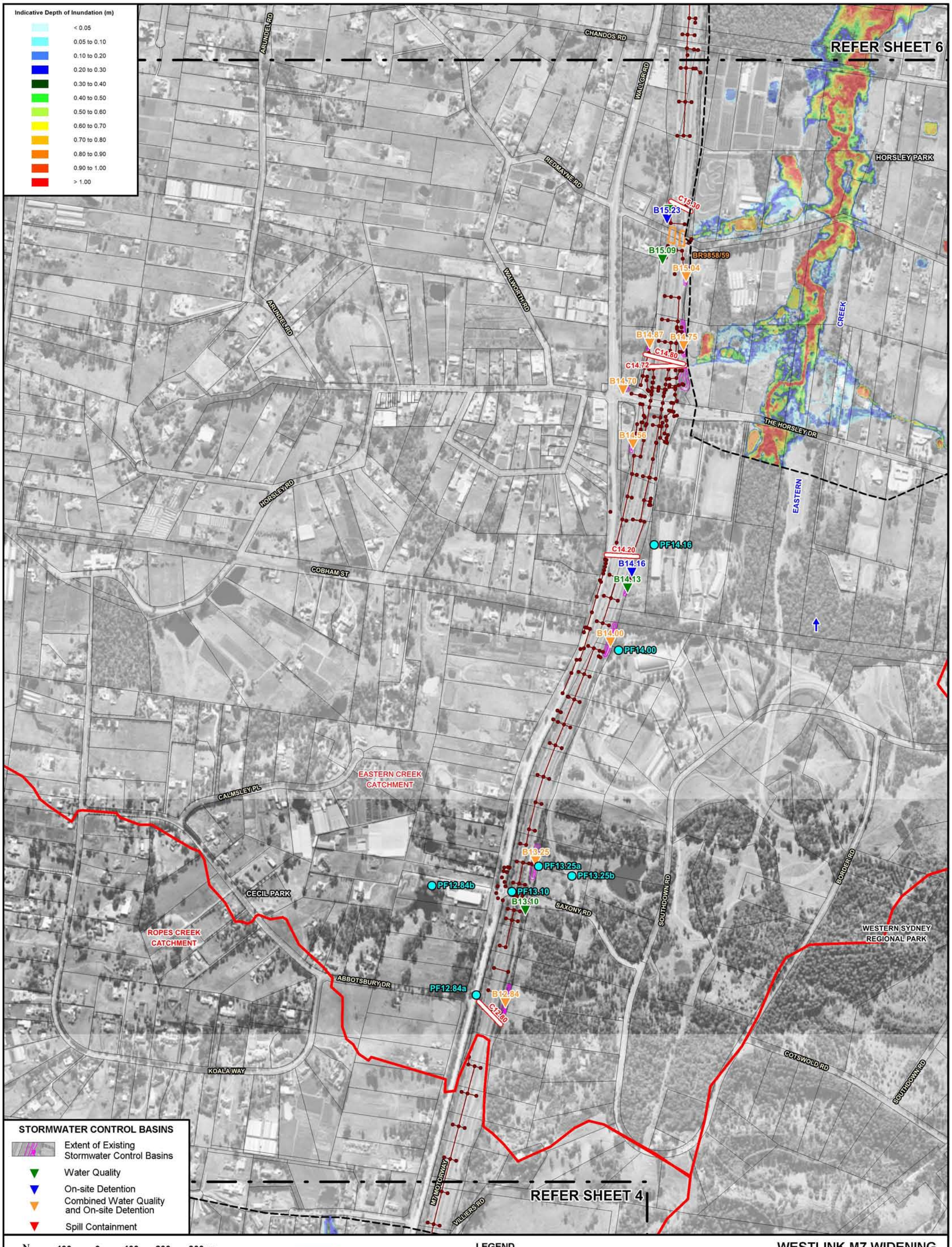
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.3
(Sheet 3 of 8)

PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.2% AEP


Indicative Depth of Inundation (m)
< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00
REFER SHEET 5
M7 MOT
VILLIERS RD
CECIL PARK
B11.93
BR9851/52
ABBOTSBURY
B11.74
WASHINGTON WAY
CECIL PARK
CECIL RD
M7 MOTORWAY
B10.74
WALLGROVE RD
B10.65
WESTERN SYDNEY PARKLANDS
B10.55
B10.54
B10.56
C10.40
ELIZABETH DR
ROPES CREEK CATCHMENT
ELIZABETH DR
MORTIMER CLOSE
CECIL HILLS
B09.90
CABRAMATTA CREEK CATCHMENT
C09.80
B09.67
BR9844/45
RICHARD CRES
SNOWDEN CLOSE
LANCASTER AVE
ANGELA ST
C09.60
B09.50
C09.40
B09.40
CLEMENTINA CCT
B08.95
C08.95
FEODORE DR
DOUJON LAKE
B08.79
C08.75
ST GEORGES CRES
TUDOR CRES
SANDRINGHAM DR
HELENA RD
REFER SHEET 3
FREDERICK RD
HINCHINBROOK
CREEK
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851
Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25
Existing Transverse Drainage Structure and Identifier
Extent of Two-Dimensional Hydraulic Model Boundary
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.3
(Sheet 4 of 8)
PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.2% AEP
Lyall & Associates


Indicative Depth of Inundation (m)
< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00
REFER SHEET 6
ARUNDEL RD
CHANDOS RD
WALLGROVE RD
REDMAYNE RD
WALWORTH RD
HORSLEY PARK
CREEK
EASTERN
THE HORSLEY DR
HORSLEY RD
COBHAM ST
CALMSLEY PL
EASTERN CREEK CATCHMENT
CECIL PARK
ROPES CREEK CATCHMENT
ABBOTSBURY DR
KOALA WAY
SAXONY RD
SOUTHDOWN RD
BORDER RD
COTSWOLD RD
WESTERN SYDNEY REGIONAL PARK
M7 MOTORWAY
VILLIERS RD
REFER SHEET 4
C15.30
B15.23
B15.09
BR9858/59
B15.04
B14.87
B14.75
C14.80
C14.72
B14.70
B14.56
C14.20
PF14.16
B14.16
B14.13
B14.00
PF14.00
B13.25
PF13.25a
PF13.25b
PF12.84b
PF13.10
B13.10
PF12.84a
B12.84
C12.80
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851
Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
PF13.25a
Peak Flow Location and Identifier
C01.25
Existing Transverse Drainage Structure and Identifier
Extent of Two-Dimensional Hydraulic Model Boundary
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.3
(Sheet 5 of 8)
PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.2% AEP
Lyall & Associates

REFER SHEET 7

B19.68
B19.25
B19.22
C19.20
EASTERN CREEK
FERRERS RD
INTERCHANGE DR
WONDERLAND DR
B18.85
C18.79
B18.60
ESKDALE
CREEK
B18.43
WALLGR RD
BR9873/74
B18.30
B18.24
CREEK
B18.05
B18.01
BR9870/71
SOUTHRIDGE ST
CARICURE DR
B17.92
EASTERN
B17.80
CREEK
FERRERS RD
B17.68
C17.60
C17.55
REEDY
SHALE PL
B17.30
SYDNEY
WATER
PIPELINE
CORRIDOR
C16.98
C16.65
C16.60
B16.48
BURLEY RD
ARUNDEL RD
CHANDOS RD
REFER SHEET 5

Indicative Depth of Inundation (m)

- < 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.30
- 0.30 to 0.40
- 0.40 to 0.50
- 0.50 to 0.60
- 0.60 to 0.70
- 0.70 to 0.80
- 0.80 to 0.90
- 0.90 to 1.00
- > 1.00

STORMWATER CONTROL BASINS

- Extent of Existing Stormwater Control Basins
- Water Quality
- On-site Detention
- Combined Water Quality and On-site Detention
- Spill Containment

N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

- Extent of Major Catchments
- BR9851 — Existing Bridge Waterway Crossing and Identifier
- Existing M7 Motorway Pit and Pipe Drainage Network
- C01.25 — Existing Transverse Drainage Structure and Identifier
- Extent of Two-Dimensional Hydraulic Model Boundary

Lyall & Associates

WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.3
(Sheet 6 of 8)

PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.2% AEP

REFER SHEET 8

ROOTY HILL

MAIN WESTERN RAILWAY

EASTERN RD

B23.40

C23.10

BR9898/99

B22.70

CREEK

DUNSMORE ST

ANGUS

DEVON ST

EASTERN RD

B22.10

B21.90

WILLIS ST

FRANCIS RD

CREEK

B21.70

LABRADOR ST

CHURCH ST

EASTERN

BUNGARRIBEE

B21.35

B21.30

BEGGS RD

MINCHINBURY ST

C21.12

B21.00

PENFOLD ST

CAWARRA ST

GREAT WESTERN HIGHWAY

WESTERN SYDNEY PARKLANDS

B20.85

B20.75

ESKDALE ST

BR9893/94

FLEURS ST

MINCHINBURY

B20.50

B20.40

B20.01

PIKES LANE

B20.15

C20.01

B20.00

B19.63

B19.65

B19.61

B19.64

B19.62

WESTERN MOTORWAY

B19.69A

B19.69

B19.70

B19.67

B19.71

B19.27

B19.68

REFER SHEET 6

Indicative Depth of Inundation (m)

< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00

STORMWATER CONTROL BASINS

- Extent of Existing Stormwater Control Basins
- Water Quality
- On-site Detention
- Combined Water Quality and On-site Detention
- Spill Containment

N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

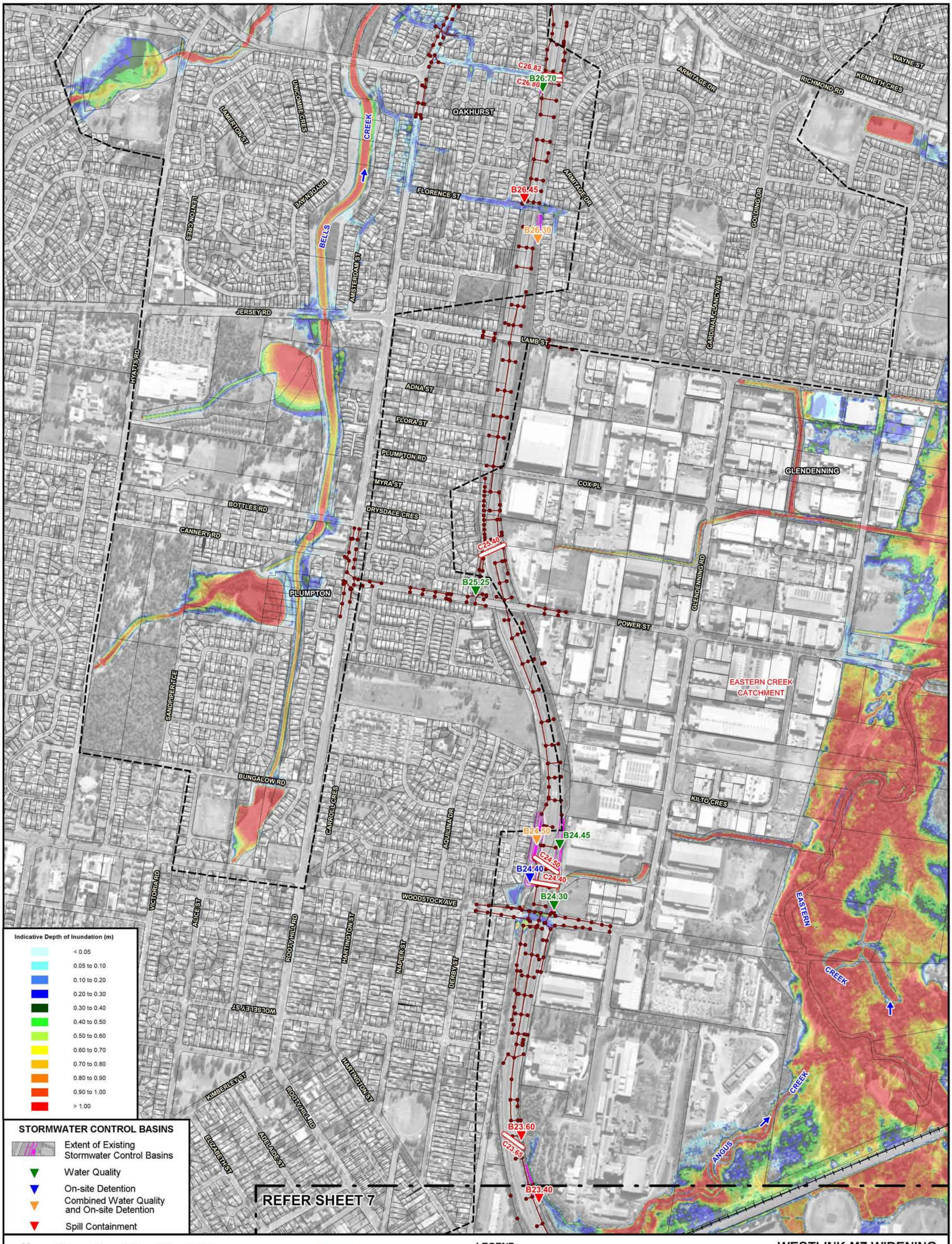
- Extent of Major Catchments
- BR9851 — Existing Bridge Waterway Crossing and Identifier
- Existing M7 Motorway Pit and Pipe Drainage Network
- C01.25 — Existing Transverse Drainage Structure and Identifier
- Extent of Two-Dimensional Hydraulic Model Boundary

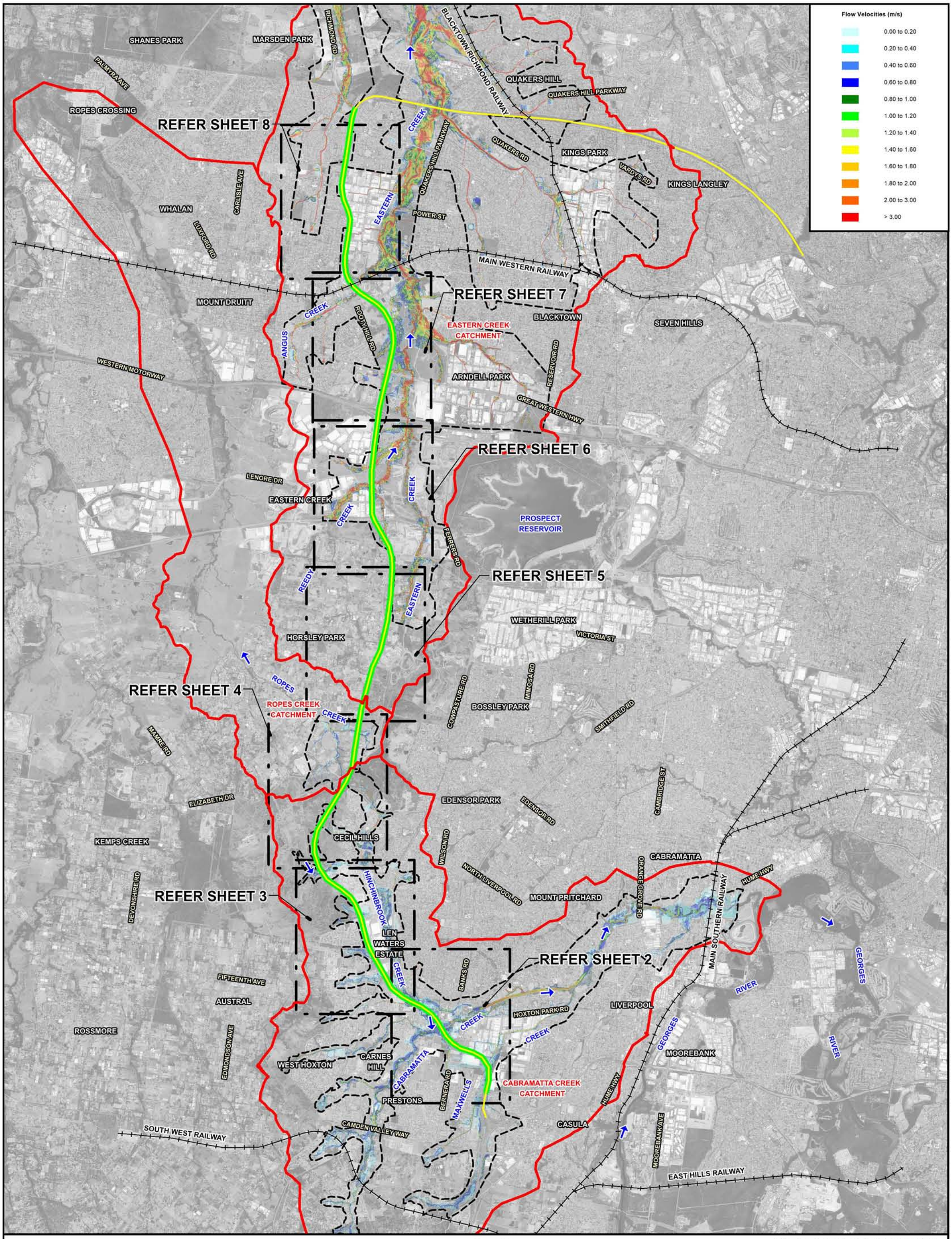
Lyall & Associates

WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.3
(Sheet 7 of 8)

PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.2% AEP


C26.82
B26.70
C26.80
OAKHURST
ARMITAGE DR
RICHMOND RD
KENNETH CRES
WAYNE ST
UNICOMBE CRES
LAMERTON ST
CREEK
BELLS
DRYDEN AVE
LENTON CRES
FLORENCE ST
B26.45
B26.30
AMSTERDAM ST
GOLDING DR
CARDINAL CLANCY AVE
JERSEY RD
LAMB ST
HYATTS RD
ADNA ST
FLORA ST
PLUMPTON RD
GLENDENNING
MYRA ST
COX PL
BOTTLES RD
DRYSDALE CRES
CANNERY RD
C25.40
B25.25
PLUMPTON
GLENDENNING RD
POWER ST
SANDPIPER TCE
EASTERN CREEK
CATCHMENT
BUNGALOW RD
CARROLL CRES
AQUILINA DR
KILTO CRES
B24.50
B24.45
C24.50
B24.40
C24.40
B24.30
VICTORIA RD
ALICE ST
WOODSTOCK AVE
ROOTY HILL RD
HARTINGTON ST
NAPIER ST
DERBY ST
EASTERN
CREEK
WOLSELEY ST
KIMBERLEY ST
ADELAIDE ST
ELIZABETH ST
B23.60
C23.65
ANGUS
CREEK
B23.40
REFER SHEET 7
Indicative Depth of Inundation (m)
< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851
Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25
Existing Transverse Drainage Structure and Identifier
Extent of Two-Dimensional Hydraulic Model Boundary
Lyall & Associates
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.3
(Sheet 8 of 8)
PATTERNS OF MAINSTREAM FLOODING AND MAJOR OVERLAND FLOW
PRE-PROPOSED MODIFICATION CONDITIONS - 0.2% AEP



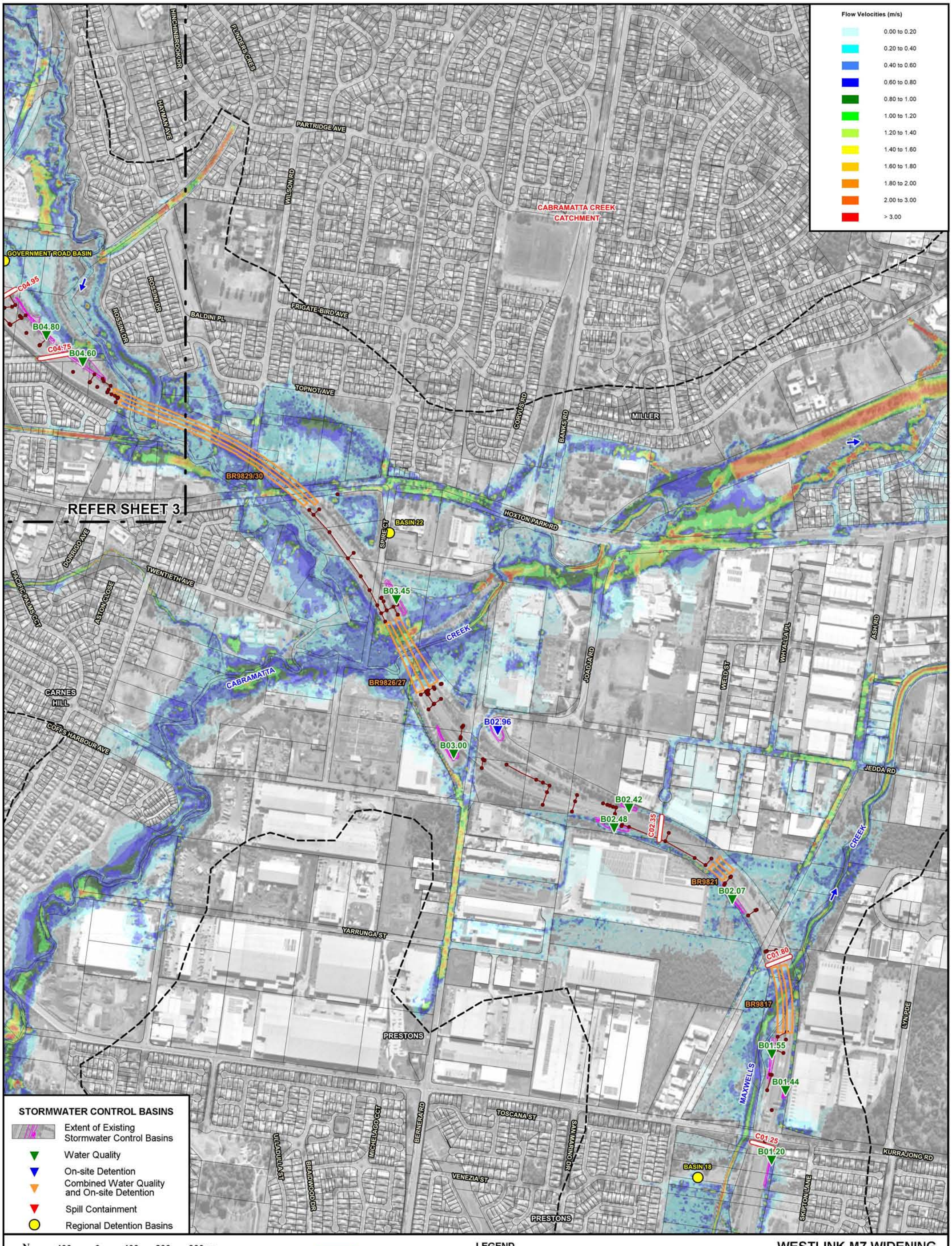
Lyall & Associates

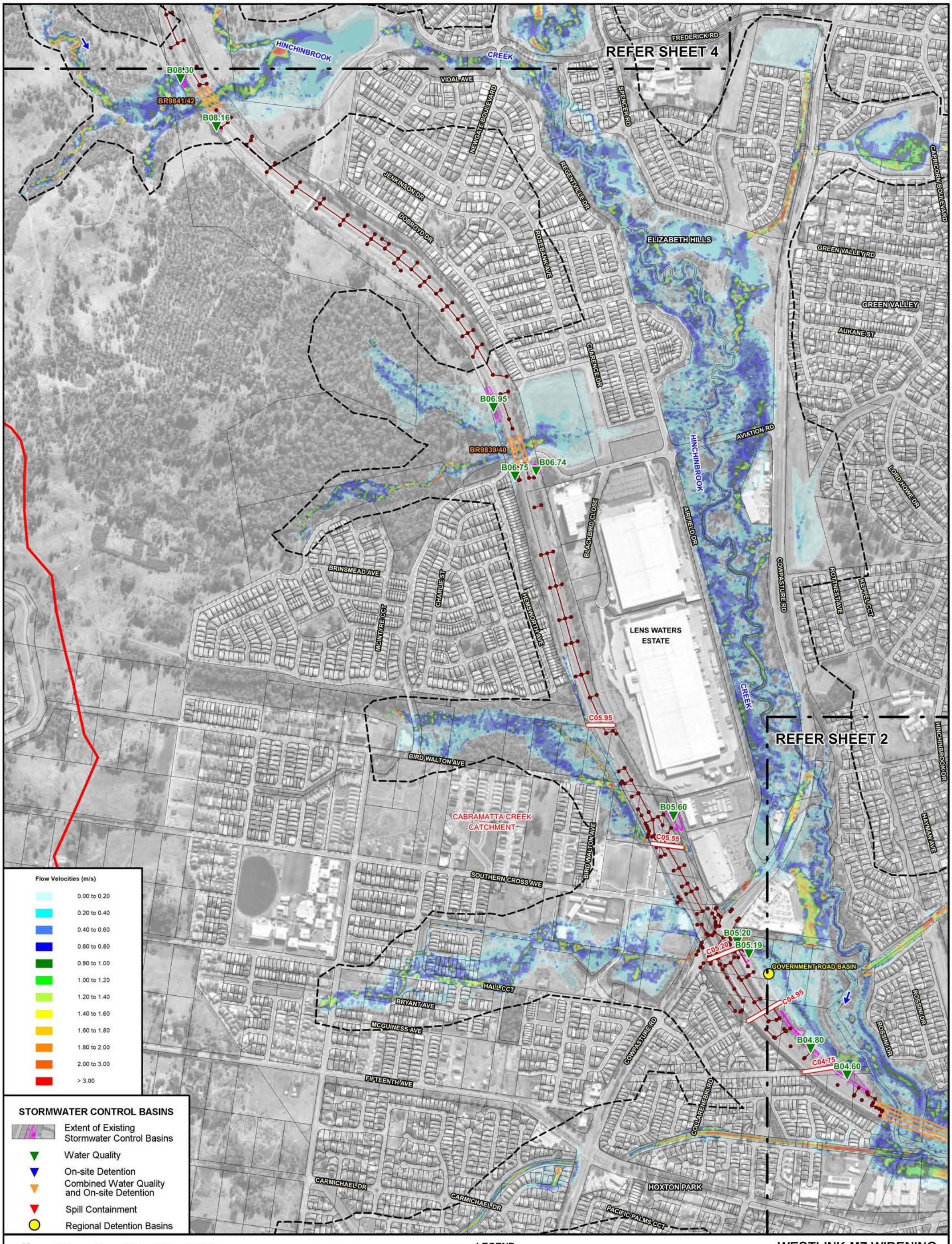
WESTLINK M7 WIDENING

SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.4
(Sheet 1 of 8)

MAXIMUM FLOW VELOCITIES - PRE-PROPOSED MODIFICATION CONDITIONS
5% AEP


Flow Velocities (m/s)
0.00 to 0.20
0.20 to 0.40
0.40 to 0.60
0.60 to 0.80
0.80 to 1.00
1.00 to 1.20
1.20 to 1.40
1.40 to 1.60
1.60 to 1.80
1.80 to 2.00
2.00 to 3.00
> 3.00
CABRAMATTA CREEK CATCHMENT
REFER SHEET 3
GOVERNMENT ROAD BASIN
HINCHINBROOK DR
FLINDERS CRES
HAYMAN AVE
PARTRIDGE AVE
WILSON RD
ROSSINI DR
BALDINI PL
FRIGATE BIRD AVE
TOPNOT AVE
CORVUS RD
BANKS RD
MILLER
HOXTON PARK RD
SPIRE CT
BASIN 22
DORRIGO AVE
PACIFIC PALMS CCT
ASTON CLOSE
TWENTIETH AVE
CREEK
CABRAMATTA
CARNES HILL
COFFS HARBOUR AVE
JOADJA RD
WELD ST
WHYALLA PL
ASH RD
JEDDA RD
YARRUNGA ST
PRESTONS
TOSCANA ST
SAN MARINO DR
VENEZIA ST
BASIN 18
KURRAJONG RD
SKIPTON LANE
LYN PDE
MAXWELLS
ULLADULLA ST
BRADWOOD DR
MICHELAGO CCT
BERNERA RD
C04.95
B04.80
C04.75
B04.60
BR9829/30
B03.45
BR9826/27
B03.00
B02.96
B02.42
B02.48
C02.35
BR9821
B02.07
C01.80
BR9817
B01.55
B01.44
C01.25
B01.20
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
Regional Detention Basins
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851
Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25
Existing Transverse Drainage Structure and Identifier
Extent of Two-Dimensional Hydraulic Model Boundary
Lyall & Associates
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.4
(Sheet 2 of 8)
MAXIMUM FLOW VELOCITIES - PRE-PROPOSED MODIFICATION CONDITIONS
5% AEP


REFER SHEET 4
REFER SHEET 2
HINCHINBROOK CREEK
FREDERICK RD
VIDAL AVE
NEWGATE BOULEVARD
SPENCER RD
REGENTVILLE DR
JENKINSON DR
DOBROYD DR
ROSEBANK AVE
CLARENCE DR
ELIZABETH HILLS
GREEN VALLEY RD
GREEN VALLEY
AUKANE ST
CAPRICORN BOULEVARD
AVIATION RD
HINCHINBROOK
BLACKBIRD CLOSE
AIRFIELD DR
COWPASTURE RD
LORD HOWE DR
ROTHNEST AVE
KEPPEL CCT
HINCHINBROOK DR
HAYMAN AVE
LENS WATERS ESTATE
BRINSMEAD AVE
MCINTYRE CCT
CHARLIE ST
HEMSWORTH AVE
BIRD WALTON AVE
SOUTHERN CROSS AVE
HALL CCT
BRYANT AVE
MCGUINESS AVE
FIFTEENTH AVE
CARMICHAEL DR
HOXTON PARK
PACIFIC PALMS CCT
COLLARENEBRI RD
ROSSINI DR
GOVERNMENT ROAD BASIN
CABRAMATTA CREEK CATCHMENT
B08.30
BR9841/42
B08.16
B06.95
BR9839/40
B06.75
B06.74
B05.60
C05.55
C05.95
B05.20
B05.19
C05.20
C04.95
B04.80
C04.75
B04.60
Flow Velocities (m/s)
0.00 to 0.20
0.20 to 0.40
0.40 to 0.60
0.60 to 0.80
0.80 to 1.00
1.00 to 1.20
1.20 to 1.40
1.40 to 1.60
1.60 to 1.80
1.80 to 2.00
2.00 to 3.00
> 3.00
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
Regional Detention Basins
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851 Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25 Existing Transverse Drainage Structure and Identifier
Extent of Two-Dimensional Hydraulic Model Boundary
Lyall & Associates
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.4
(Sheet 3 of 8)
MAXIMUM FLOW VELOCITIES - PRE-PROPOSED MODIFICATION CONDITIONS
5% AEP

Flow Velocities (m/s)

- 0.00 to 0.20
- 0.20 to 0.40
- 0.40 to 0.60
- 0.60 to 0.80
- 0.80 to 1.00
- 1.00 to 1.20
- 1.20 to 1.40
- 1.40 to 1.60
- 1.60 to 1.80
- 1.80 to 2.00
- 2.00 to 3.00
- > 3.00

REFER SHEET 5

CECIL PARK

CECIL PARK

WASHINGTON WAY

CECIL RD

M7 MOTORWAY

VILLIERS RD

ABBOTSBURY

B11.93

BR9851/52

B11.74

WALLGROVE RD

B10.74

B10.65

B10.55

B10.54

B10.56

C10.40

WESTERN SYDNEY PARKLANDS

ELIZABETH DR

ROPES CREEK CATCHMENT

CECIL HILLS

CABRAMATTA CREEK CATCHMENT

B09.90

C09.80

B09.67

BR9844/45

C09.60

B09.50

C09.40

B09.40

CLEMENTINA CCT

MORTIMER CLOSE

RICHARD CRES

SNOWDEN CLOSE

LANCASTER AVE

ANGELA ST

B08.95

C08.95

B08.79

C08.75

FEODORE DR

DOUJON LAKE

ST GEORGES CRES

TUDOR CRES

SANDRINGHAM DR

HELENA RD

REFER SHEET 3

FREDERICK RD

HINCHINBROOK CREEK

STORMWATER CONTROL BASINS

- Extent of Existing Stormwater Control Basins
- Water Quality
- On-site Detention
- Combined Water Quality and On-site Detention
- Spill Containment

N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

- Extent of Major Catchments
- BR9851 — Existing Bridge Waterway Crossing and Identifier
- C01.25 — Existing Transverse Drainage Structure and Identifier
- Existing M7 Motorway Pit and Pipe Drainage Network
- Extent of Two-Dimensional Hydraulic Model Boundary

Lyall & Associates

WESTLINK M7 WIDENING

SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.4
(Sheet 4 of 8)

MAXIMUM FLOW VELOCITIES - PRE-PROPOSED MODIFICATION CONDITIONS
5% AEP

Flow Velocities (m/s)

- 0.00 to 0.20
- 0.20 to 0.40
- 0.40 to 0.60
- 0.60 to 0.80
- 0.80 to 1.00
- 1.00 to 1.20
- 1.20 to 1.40
- 1.40 to 1.60
- 1.60 to 1.80
- 1.80 to 2.00
- 2.00 to 3.00
- > 3.00

REFER SHEET 6

ARUNDEL RD
CHANDOS RD
WALLGR RD
REDMAYNE RD
WALWORTH RD
HORSLEY PARK
CREEK
EASTERN
THE HORSLEY DR
HORSLEY RD
COBHAM ST
EASTERN CREEK CATCHMENT
CALMSLEY PL
CECIL PARK
ROPES CREEK CATCHMENT
ABBOTSBURY DR
KOALA WAY
SAXONY RD
SOUTHDOWN RD
BORDER RD
WESTERN SYDNEY REGIONAL PARK
COTSWOLD RD
M7 MOTORWAY
VILLIERS RD

C15.30
B15.23
B15.09
BR9858/59
B15.04
B14.87
B14.75
C14.80
C14.72
B14.70
B14.56
C14.20
PF14.16
B14.16
B14.13
B14.00
PF14.00
B13.25
PF13.25a
PF13.25b
PF12.84b
PF13.10
B13.10
PF12.84a
B12.84
C12.80

REFER SHEET 4

STORMWATER CONTROL BASINS

- Extent of Existing Stormwater Control Basins
- Water Quality
- On-site Detention
- Combined Water Quality and On-site Detention
- Spill Containment

N

100 0 100 200 300 m

Scale: 1:10,000

Lyall & Associates

LEGEND

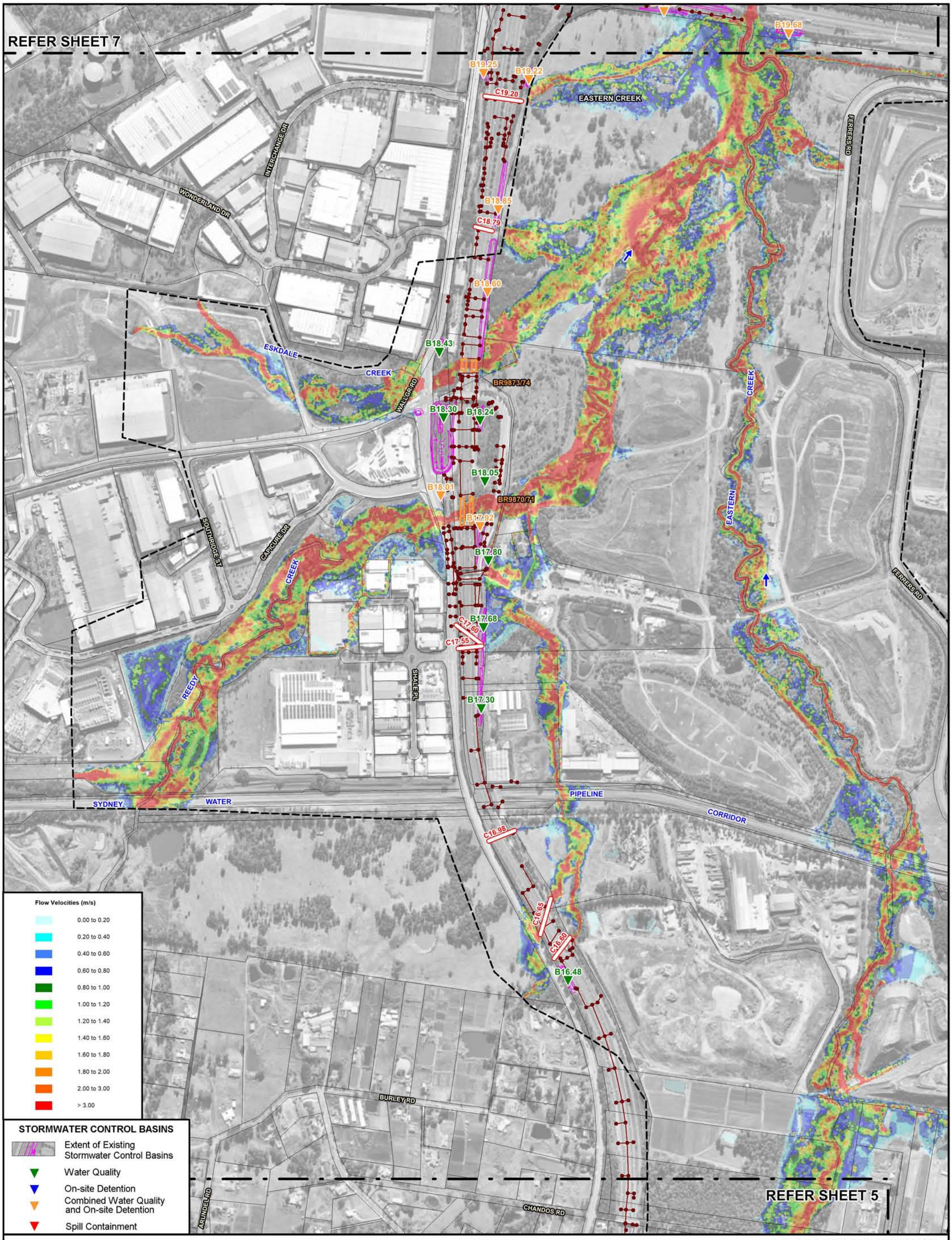
- Extent of Major Catchments
- BR9851 — Existing Bridge Waterway Crossing and Identifier
- Existing M7 Motorway Pit and Pipe Drainage Network
- PF13.25a — Peak Flow Location and Identifier
- C01.25 — Existing Transverse Drainage Structure and Identifier
- Extent of Two-Dimensional Hydraulic Model Boundary

WESTLINK M7 WIDENING

SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.4
(Sheet 5 of 8)

MAXIMUM FLOW VELOCITIES - PRE-PROPOSED MODIFICATION CONDITIONS
5% AEP


REFER SHEET 7
B19.68
B19.25
B19.22
C19.20
EASTERN CREEK
FERRERS RD
INTERCHANGE DR
WONDERLAND DR
B18.85
C18.79
B18.60
B18.43
ESKDALE
CREEK
WALLGR RD
BR9873/74
B18.30
B18.24
CREEK
B18.05
B18.01
BR9870/71
B17.92
SOUTHRIDGE ST
CAPICURE DR
CREEK
B17.80
EASTERN
FERRERS RD
B17.68
C17.60
C17.55
REEDY
CREEK
SHALE PL
B17.30
SYDNEY
WATER
PIPELINE
CORRIDOR
C16.98
C16.65
C16.60
B16.48
BURLEY RD
ARUNDEL RD
CHANDOS RD
REFER SHEET 5
Flow Velocities (m/s)
0.00 to 0.20
0.20 to 0.40
0.40 to 0.60
0.60 to 0.80
0.80 to 1.00
1.00 to 1.20
1.20 to 1.40
1.40 to 1.60
1.60 to 1.80
1.80 to 2.00
2.00 to 3.00
> 3.00
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851
Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25
Existing Transverse Drainage Structure and Identifier
Extent of Two-Dimensional Hydraulic Model Boundary
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.4
(Sheet 6 of 8)
MAXIMUM FLOW VELOCITIES - PRE-PROPOSED MODIFICATION CONDITIONS
5% AEP
Lyall & Associates

REFER SHEET 8

ROOTY HILL

MAIN WESTERN RAILWAY

B23.40

C23.10

BR9898/99

B22.70

CREEK

DUNSMORE ST

EASTERN RD

ANGUS

DEVON ST

WILLIS ST

FRANCIS RD

LABRADOR ST

B22.10

B21.90

B21.70

CHURCH ST

CREEK

EASTERN

BUNGARRIBEE

BEGGS RD

MINCHINBURY ST

B21.35

B21.30

C21.12

B21.00

PENFOLD ST

CAWARRA ST

GREAT WESTERN HIGHWAY

WESTERN SYDNEY PARKLANDS

B20.85

B20.75

ESKDALE ST

BR9893/94

FLEURS ST

MINCHINBURY

B20.50

B20.40

B20.01

PIKES LANE

B20.15

C20.01

B20.00

B19.63

B19.65

B19.61

B19.64

B19.62

WESTERN MOTORWAY

0

B19.69A

B19.69

B19.70

B19.71

B19.67

B19.27

B19.68

REFER SHEET 6

Flow Velocities (m/s)

- 0.00 to 0.20
- 0.20 to 0.40
- 0.40 to 0.60
- 0.60 to 0.80
- 0.80 to 1.00
- 1.00 to 1.20
- 1.20 to 1.40
- 1.40 to 1.60
- 1.60 to 1.80
- 1.80 to 2.00
- 2.00 to 3.00
- > 3.00

STORMWATER CONTROL BASINS

- Extent of Existing Stormwater Control Basins
- Water Quality
- On-site Detention
- Combined Water Quality and On-site Detention
- Spill Containment

N

100 0 100 200 300 m

Scale: 1:10,000

LEGEND

- Extent of Major Catchments
- BR9851 — Existing Bridge Waterway Crossing and Identifier
- Existing M7 Motorway Pit and Pipe Drainage Network
- C01.25 — Existing Transverse Drainage Structure and Identifier
- Extent of Two-Dimensional Hydraulic Model Boundary

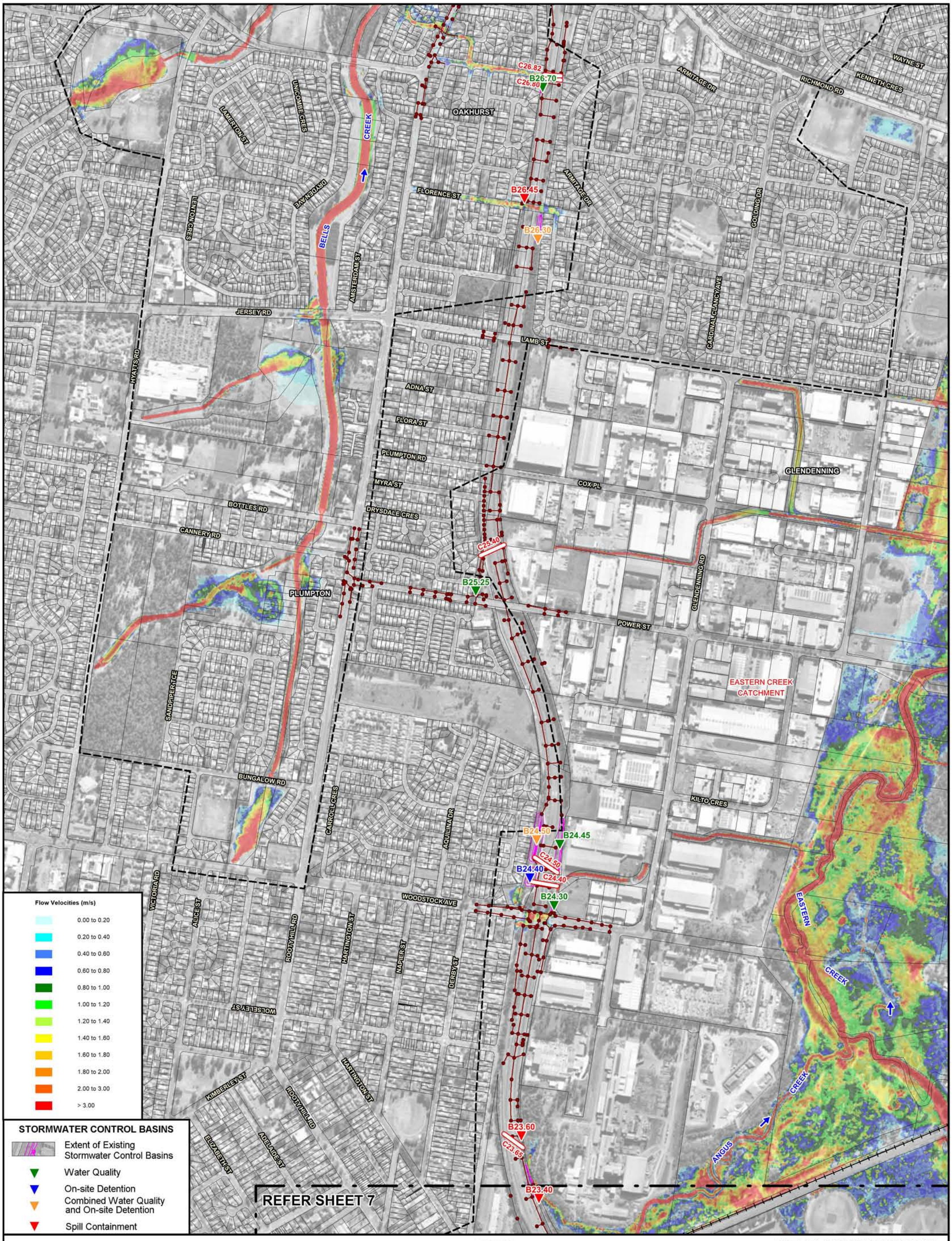
Lyall & Associates

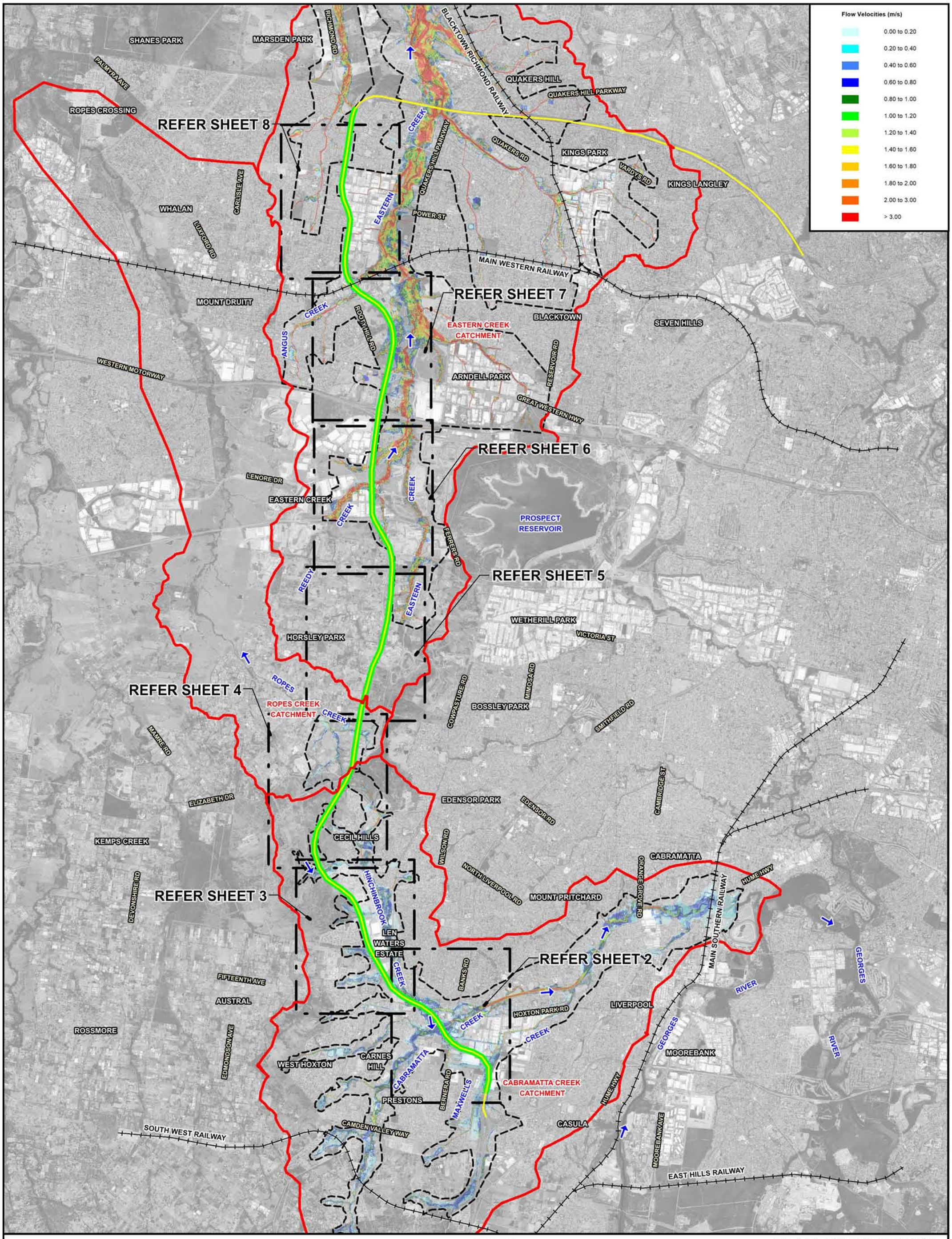
WESTLINK M7 WIDENING

SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.4
(Sheet 7 of 8)

MAXIMUM FLOW VELOCITIES - PRE-PROPOSED MODIFICATION CONDITIONS
5% AEP


C26.82
B26.70
C26.80
OAKHURST
ARMITAGE DR
RICHMOND RD
KENNETH CRES
WAYNE ST
UNICOMBE CRES
LAMERTON ST
CREEK
BELLS
DRYDEN AVE
LENTON CRES
FLORENCE ST
B26.45
B26.30
GOLDING DR
CARDINAL CLANCY AVE
AMSTERDAM ST
JERSEY RD
HYATTS RD
LAMB ST
ADNA ST
FLORA ST
PLUMPTON RD
MYRA ST
DRYSDALE CRES
COX PL
GLENDENNING
BOTTLES RD
CANNERY RD
C25.40
B25.25
PLUMPTON
GLENDENNING RD
POWER ST
SANDPIPER TCE
EASTERN CREEK CATCHMENT
BUNGALOW RD
CARROLL CRES
AQUILINA DR
KILTO CRES
B24.50
B24.45
C24.50
B24.40
C24.40
B24.30
VICTORIA RD
ALICE ST
ROOTY HILL RD
HARTINGTON ST
NAPIER ST
DERBY ST
WOODSTOCK AVE
EASTERN CREEK
WOLSELEY ST
KIMBERLEY ST
ELIZABETH ST
ADELAIDE ST
B23.60
C23.65
B23.40
ANGUS
REFER SHEET 7
Flow Velocities (m/s)
0.00 to 0.20
0.20 to 0.40
0.40 to 0.60
0.60 to 0.80
0.80 to 1.00
1.00 to 1.20
1.20 to 1.40
1.40 to 1.60
1.60 to 1.80
1.80 to 2.00
2.00 to 3.00
> 3.00
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851
Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25
Existing Transverse Drainage Structure and Identifier
Extent of Two-Dimensional Hydraulic Model Boundary
Lyall & Associates
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.4
(Sheet 8 of 8)
MAXIMUM FLOW VELOCITIES - PRE-PROPOSED MODIFICATION CONDITIONS
5% AEP



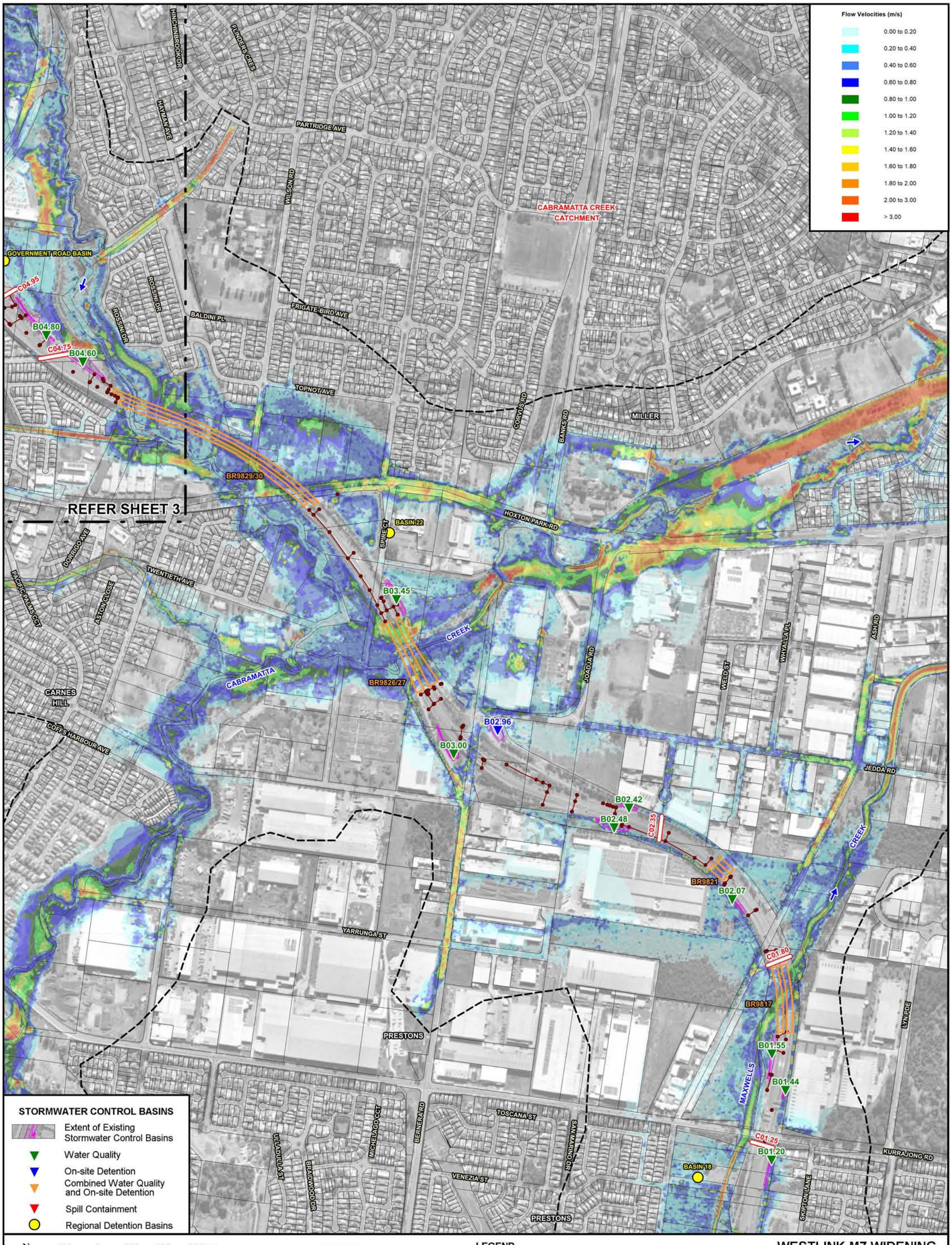
Lyall & Associates

WESTLINK M7 WIDENING

SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.5
(Sheet 1 of 8)

MAXIMUM FLOW VELOCITIES - PRE-PROPOSED MODIFICATION CONDITIONS
1% AEP

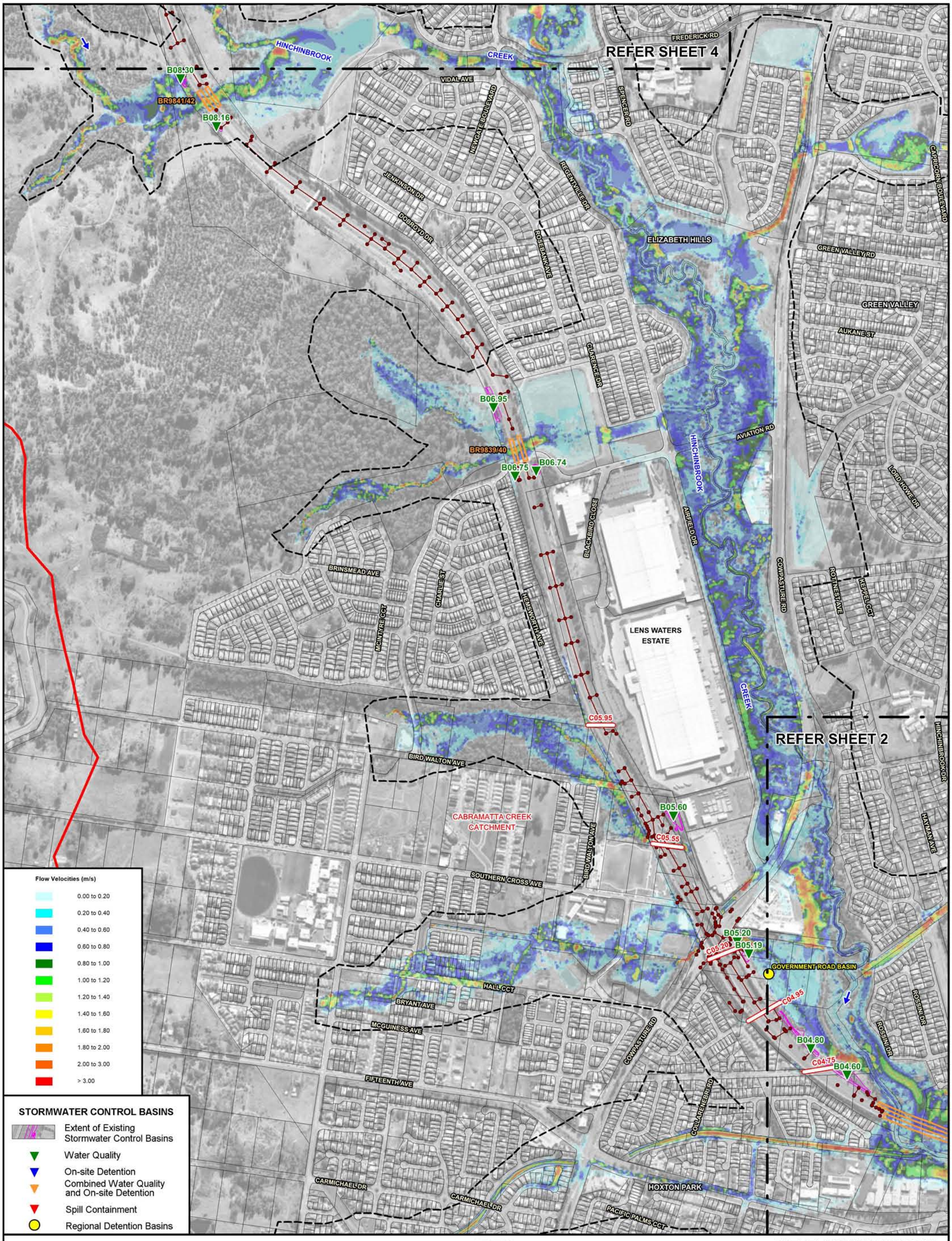


Lyall & Associates

WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT

Figure C.5
(Sheet 2 of 8)

MAXIMUM FLOW VELOCITIES - PRE-PROPOSED MODIFICATION CONDITIONS
1% AEP


REFER SHEET 4
REFER SHEET 2
HINCHINBROOK CREEK
FREDERICK RD
VIDAL AVE
NEWGATE BOULEVARD
SPENCER RD
REGENTVILLE DR
JENKINSON DR
DOBROYD DR
ROSEBANK AVE
CLARENCE DR
ELIZABETH HILLS
CAPRICORN BOULEVARD
GREEN VALLEY RD
GREEN VALLEY
AUKANE ST
AVIATION RD
HINCHINBROOK CREEK
AIRFIELD DR
BLACKBIRD CLOSE
LORD HOWE DR
COWPASTURE RD
ROTHNEST AVE
KEPPEL CCT
LENS WATERS ESTATE
BRINSMEAD AVE
MCINTYRE CCT
CHARLIE ST
HEMSWORTH AVE
BIRD WALTON AVE
HINCHINBROOK DR
HAYMAN AVE
CABRAMATTA CREEK CATCHMENT
SOUTHERN CROSS AVE
GOVERNMENT ROAD BASIN
ROSSINI DR
HALL CCT
BRYANT AVE
MCGUINESS AVE
FIFTEENTH AVE
COLLAREENE RD
CARMICHAEL DR
HOXTON PARK
PACIFIC PALMS CCT
B08.30
BR9841/42
B08.16
B06.95
BR9839/40
B06.75
B06.74
C05.95
B05.60
C05.55
B05.20
C05.20
B05.19
C04.95
B04.80
C04.75
B04.60
Flow Velocities (m/s)
0.00 to 0.20
0.20 to 0.40
0.40 to 0.60
0.60 to 0.80
0.80 to 1.00
1.00 to 1.20
1.20 to 1.40
1.40 to 1.60
1.60 to 1.80
1.80 to 2.00
2.00 to 3.00
> 3.00
STORMWATER CONTROL BASINS
Extent of Existing Stormwater Control Basins
Water Quality
On-site Detention
Combined Water Quality and On-site Detention
Spill Containment
Regional Detention Basins
N
100 0 100 200 300 m
Scale: 1:10,000
LEGEND
Extent of Major Catchments
BR9851 Existing Bridge Waterway Crossing and Identifier
Existing M7 Motorway Pit and Pipe Drainage Network
C01.25 Existing Transverse Drainage Structure and Identifier
Extent of Two-Dimensional Hydraulic Model Boundary
Lyall & Associates
WESTLINK M7 WIDENING
SURFACE WATER AND FLOODING IMPACT ASSESSMENT
Figure C.5
(Sheet 3 of 8)
MAXIMUM FLOW VELOCITIES - PRE-PROPOSED MODIFICATION CONDITIONS
1% AEP