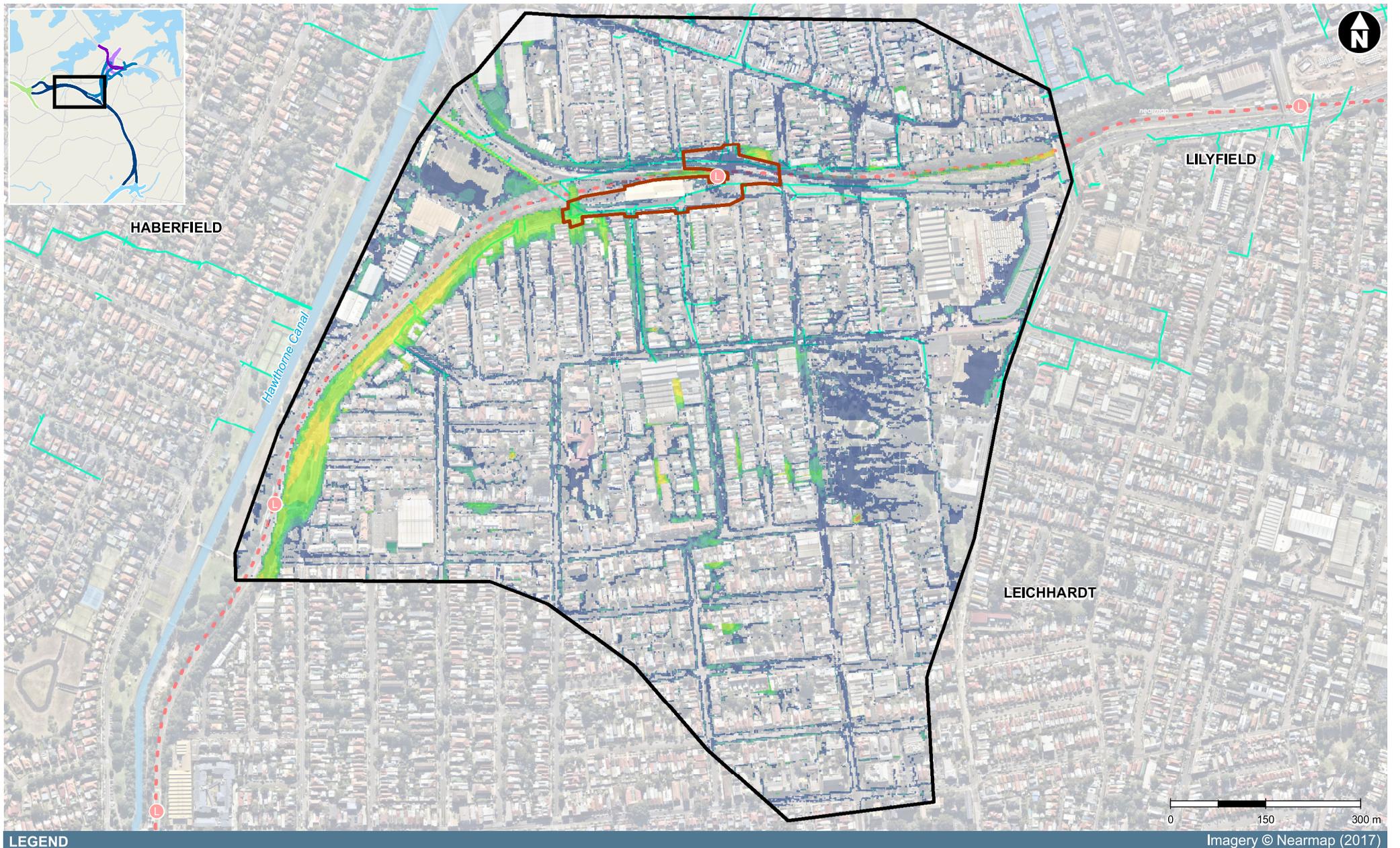


Imagery © Nearmap (2017)

Existing features		M4-M5 Link		M4-M5 Link surface works		Ancillary facilities		Project features	
Waterway	Existing drainage system	Mainline tunnel	Land subject to UDLP	Water treatment facility	Subcatchment boundary	Light rail	Tunnel	Project footprint	
Light rail stop		Rozelle interchange				1m Contours			

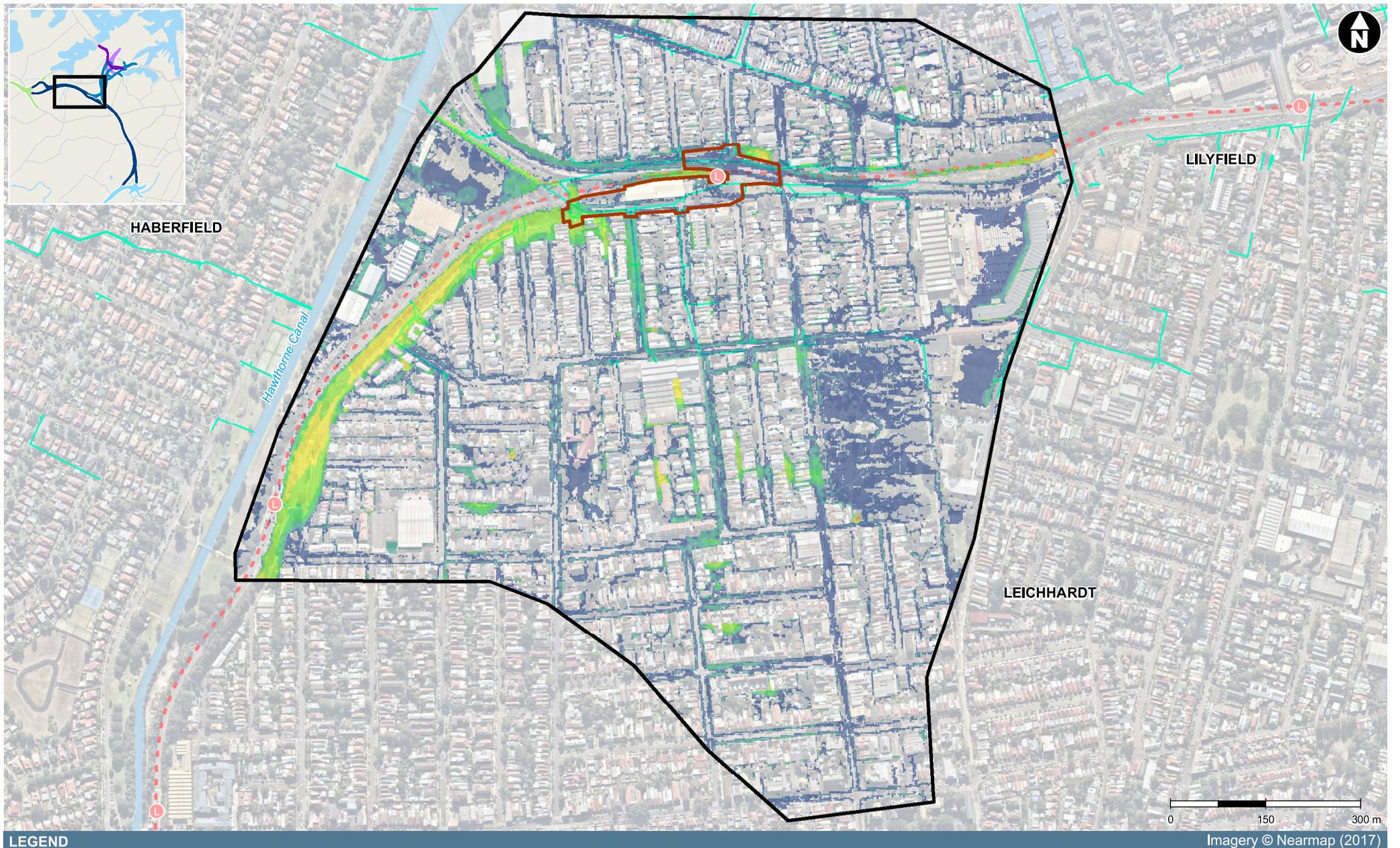
Figure 4-15 Subcatchment draining to Darley Road civil and tunnel site



LEGEND

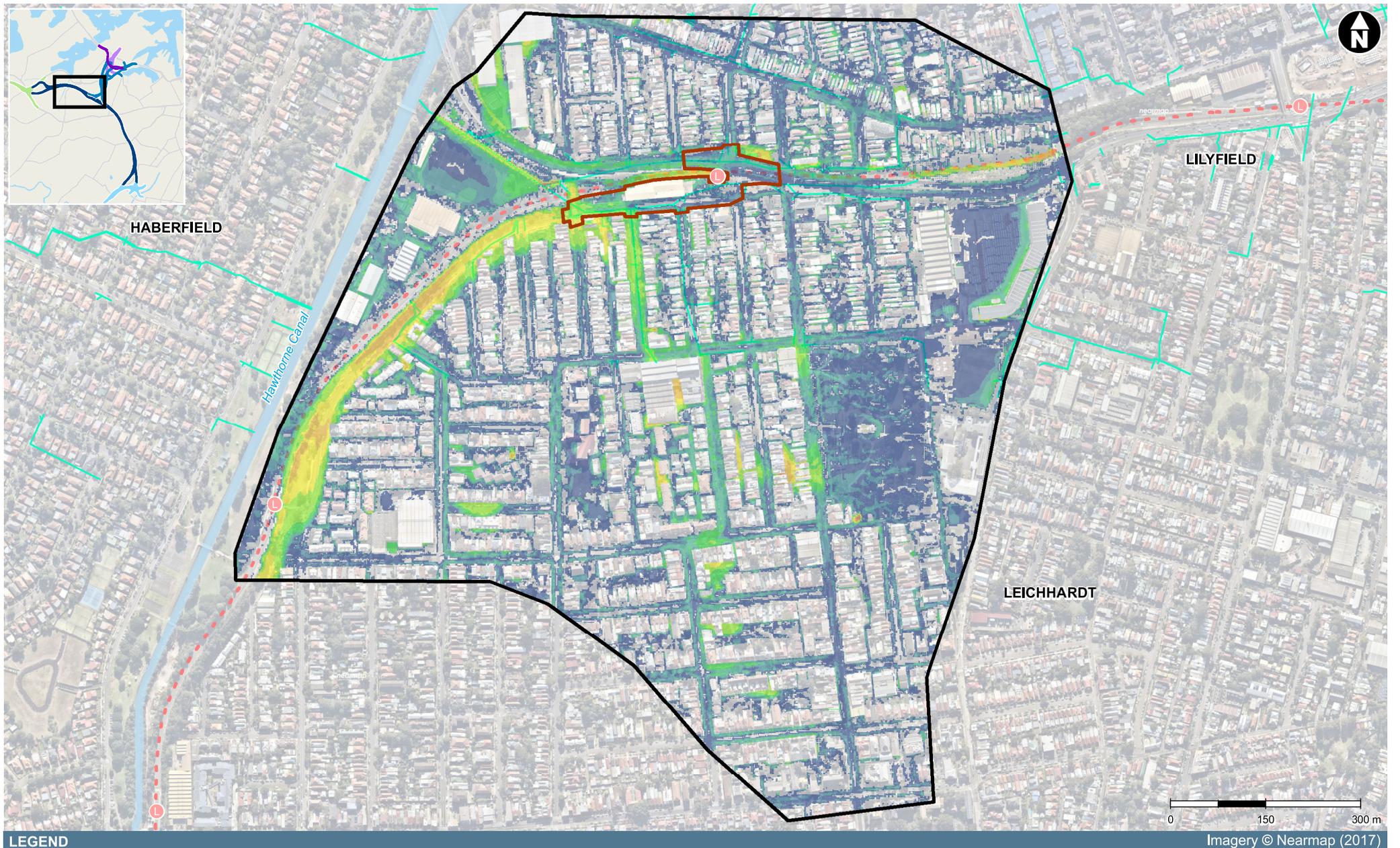
Existing features	Stormwater	M4-M5 Link	Peak flood depths (m)
Waterway	Existing drainage system	Project footprint	<0.05
Light rail		Model extent	0.05 to 0.1
Light rail stop			0.1 to 0.25
			0.25 to 0.5
			0.5 to 1
			1.0 to 1.5
			1.5 to 2
			2.0 to 2.5
			>2.5

Figure 4-16 Present day flood behaviour – Darley Road - 10 year ARI maximum depths



Existing features		Stormwater	M4-M5 Link		Peak flood depths (m)					
	Waterway			Project footprint		<0.05		0.25 to 0.5		1.5 to 2
	Light rail			Model extent		0.05 to 0.1		0.5 to 1		2.0 to 2.5
	Light rail stop					0.1 to 0.25		1.0 to 1.5		>2.5

Figure 4-17 Present day flood behaviour – Darley Road - 100 year ARI maximum depths



Existing features		M4-M5 Link		Peak flood depths (m)		
Waterway	Existing drainage system	Project footprint	Model extent	<0.05	0.25 to 0.5	1.5 to 2
Light rail				0.05 to 0.1	0.5 to 1	2.0 to 2.5
Light rail stop				0.1 to 0.25	1.0 to 1.5	>2.5

Figure 4-18 Present day flood behaviour – Darley Road - peak flood depths (PMF)

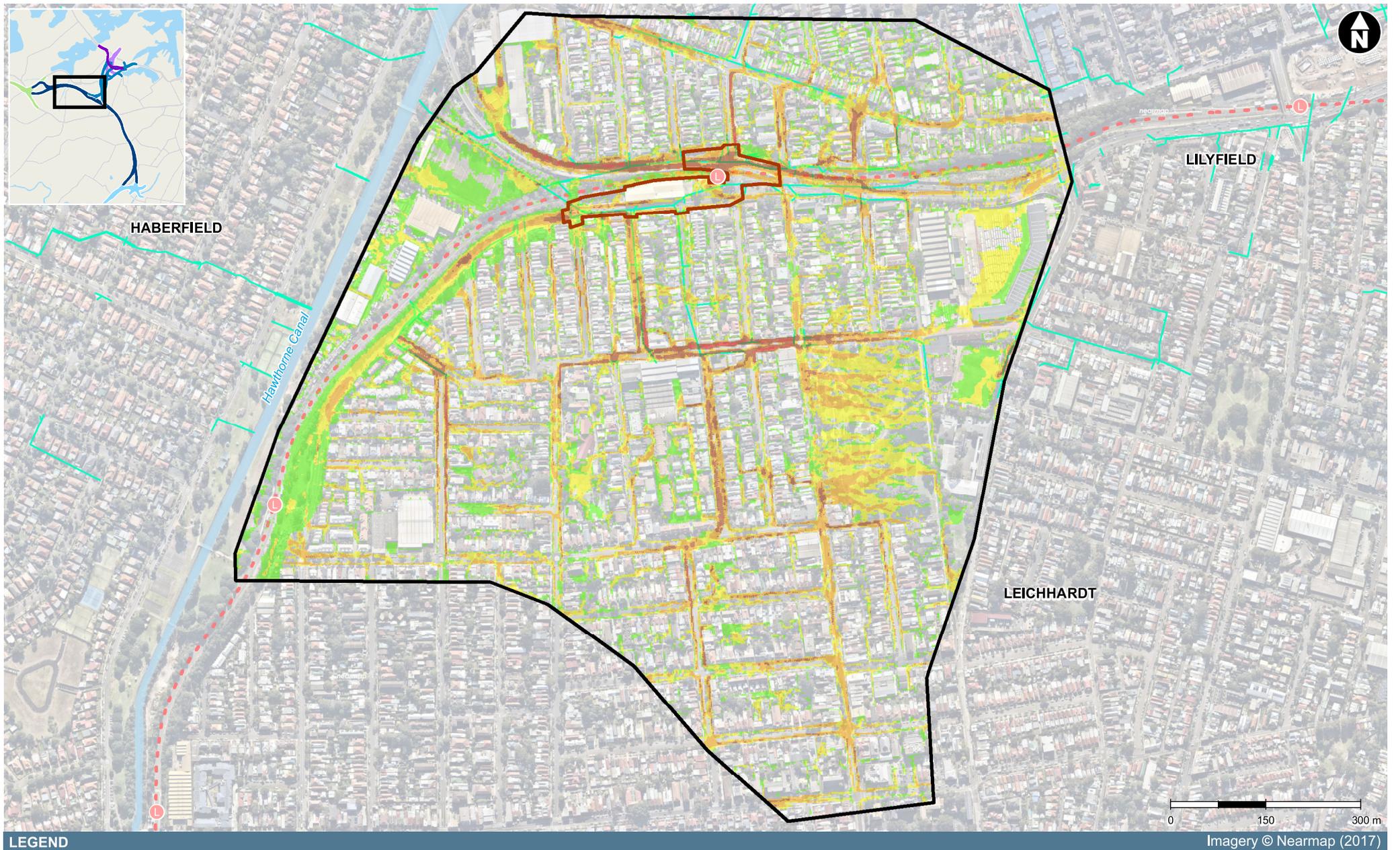
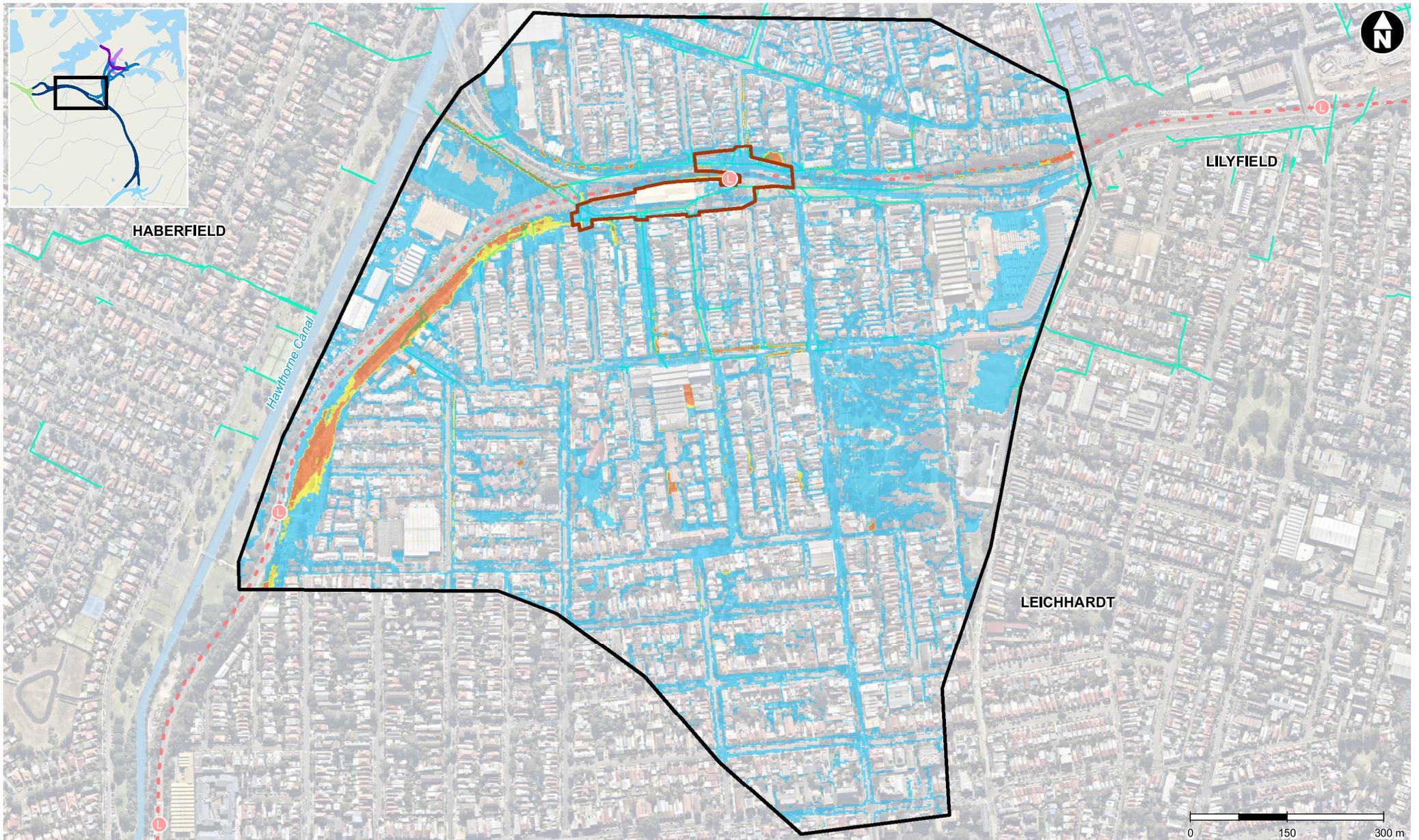


Figure 4-19 Present day flood behaviour – Darley Road - peak flow velocities (100 year ARI)



LEGEND

Existing features	Stormwater	M4-M5 Link	Provisional flood hazard
— Waterway	— Existing drainage system	— Project footprint	— High
- - Light rail		— Model extent	— Medium
● Light rail stop			— Low

0 150 300 m
Imagery © Nearmap (2017)

Figure 4-20 Present day flood behaviour – Darley Road - provisional flood hazard (100 year ARI)

4.5 Surface water quality

Surface water quality within the receiving urban waterways and bays are currently affected by a range of point and diffuse sources of pollutants which has led to contamination of sediments. Key existing water quality issues include:

- Primary contemporary sources of pollution to the waters and sediments of Sydney Harbour are stormwater, sewage overflows and leachate from contaminated reclaimed land (Montoya 2015)
- The urbanisation of the catchments and subsequent reduction in pervious area reduces the likelihood of pollutants and sediments, transported in stormwater runoff to settle or deposit out before entry into the estuary or contributing waterways
- The artificial channelisation and hard (typically concrete) lining of waterways mitigates against erosive processes in the channels, reducing the ability for sediments to be deposited from upstream catchments prior to discharge to the estuary
- Stormwater discharged via large canals with extensive catchments is a major point source of contaminants to Parramatta River estuary and Sydney Harbour (Birch and Taylor 1999)
- Stormwater discharged from highly urbanised catchments on the southern shore of the Parramatta River estuary and Sydney Harbour has been identified as the primary source of contaminants responsible for ecological degradation and reduction in recreational value of these waters (Beck and Birch 2010)
- A study conducted by Beck and Birch (2010) in Johnstons Creek, Whites Creek and Hawthorne Canal found that the majority (>90 per cent) of metal (copper, lead and zinc) and total suspended solid annual loads were contributed during high flow conditions (>50 mm rainfall day), whereas ≤55 per cent of total nitrogen and ≤21 per cent of total phosphorus were contributed to annual loading by dry weather base flow conditions by the three catchments
- Contaminants associated with illegal dumping or sewage overflows may also be important in contamination of Parramatta River estuary and Sydney Harbour (Beck and Birch 2010)
- Harbour sediments contain a variety of contaminants including dioxins, heavy metals and organochlorine pesticides with Iron Cove, Rozelle Bay and Blackwattle Bay some of the worst affected
- The NSW EPA declared the bed sediments of Alexandra Canal between Huntley Street, Alexandria and the junction of Alexandra Canal with the Cooks River at Mascot as a remediation site in August 2000 under Section 23 of the *Contaminated Land Management Act 1997* (NSW). The bed sediments have been found to be contaminated with chlorinated hydrocarbons including organochlorine pesticides, polychlorinated biphenyls and metals. Contamination levels are considered by the NSW EPA to present a significant risk of harm to human health and the environment
- Nutrients and heavy metals supplied by stormwater canals draining highly urbanised catchments have accumulated in bottom sediments in concentrations up to 50 times greater than pre-anthropogenic levels (Birch and Taylor 1999). Estuarine sediments adjacent to these canals contain the highest concentrations of heavy metals. Atmospheric contributions may also be an important diffuse source of heavy metals to the estuary but sewage overflows and stormwater drains with small catchments are not considered to be important point sources of heavy metals (Birch and Taylor, 1999)
- Typically, the Parramatta River estuary is well-mixed and contaminants associated with base-flow stormwater runoff deposit close to discharge points becoming permanently trapped in estuary embayments. Catchment runoff increases rapidly during high precipitation events (rainfall >50 millimetres per day) and upon reaching the waterbody forms a buoyant layer above saline estuarine waters. Under these conditions, contaminants associated with stormwater runoff may migrate beyond off-channel embayments and depending on the intensity of the storm, the plume may reach the main estuary channel even exiting the Parramatta River estuary mouth into Sydney Harbour (Lee, Birch and Lemckert 2010). A study conducted in the Parramatta River estuary on freshwater plume behaviour following high-precipitation events (Lee, Birch and Lemckert 2010) found that the fresh-water plume broke down within the estuary, therefore

contaminants associated with stormwater runoff due to high-precipitation events were retained within the system for a longer period than was previously recognised

- Elevated levels of heavy metals, pH, turbidity and nutrients were frequently recorded during water quality sampling conducted in the waterways within the study area. The monitoring results were representative of waterways within a highly urbanised catchment.

It is noted that disturbance of contaminated sediments can cause impacts on surface water quality.

A baseline surface water monitoring program was undertaken as part of the M4-M5 Link project to:

- Evaluate the existing surface water quality at predetermined locations located within the vicinity of the project
- Inform the EIS
- Monitor and assess the surface water quality over a 12 month monitoring program and form a baseline of environmental conditions against which compliance can be measured during the construction and operation of the project.

The monitoring program includes a minimum of 12 months of baseline monitoring conducted at tidal and non-tidal locations with samples collected up to twice monthly including one monthly dry weather sampling event in the same week of each month and one wet weather sampling event following rainfall events (> 15 millimetres over a 24 hour period) when they occur.

A review of available M4-M5 Link project water quality monitoring data and other known water quality monitoring data carried out by others was undertaken to establish water quality conditions within the waterways in the study area. A summary of the results is presented in **Annexure B**. The monitoring results were compared with relevant ANZECC (2000) guideline trigger values (ie estuarine / marine trigger values). Existing water quality conditions within the key receiving waterways and bays potentially affected by the project are discussed in the following sections. The monitoring locations are shown in **Figure 4-21**.

4.5.1 Dobroyd Canal

A review of known water quality data was undertaken to gain an appreciation of water quality conditions within the canal including:

- Samples collected by AECOM at two tidally influenced locations (SW8 and SW9), the pedestrian bridge at Reg Coady Reserve and west of Ramsey Street bridge between July 2016 and May 2017, as part of the M4-M5 Link baseline surface water sampling
- Samples collected by GHD at one non-tidal (DB01) location from a footbridge connecting Gregory and Hedge Avenues and one tidally influenced (DB02) location from a footbridge connecting Timbrell Park and Reg Coady Reserve between June 2015 and May 2016, as part of the M4 East project.

Elevated levels of heavy metals (copper, chromium, lead, nickel and zinc) and nutrients (phosphorus, nitrogen and nitrate) were recorded in tidal and non-tidal zones. The pH was also outside guideline levels and the turbidity exceeded guideline levels on some occasions. High electrical conductivity indicated brackish conditions on occasion in the assumed non-tidal sampling location, indicating this location may be tidally influenced. Total recoverable hydrocarbons were also detected.

4.5.2 Hawthorne Canal

A review of known water quality data was undertaken to gain an appreciation of water quality conditions within the canal including:

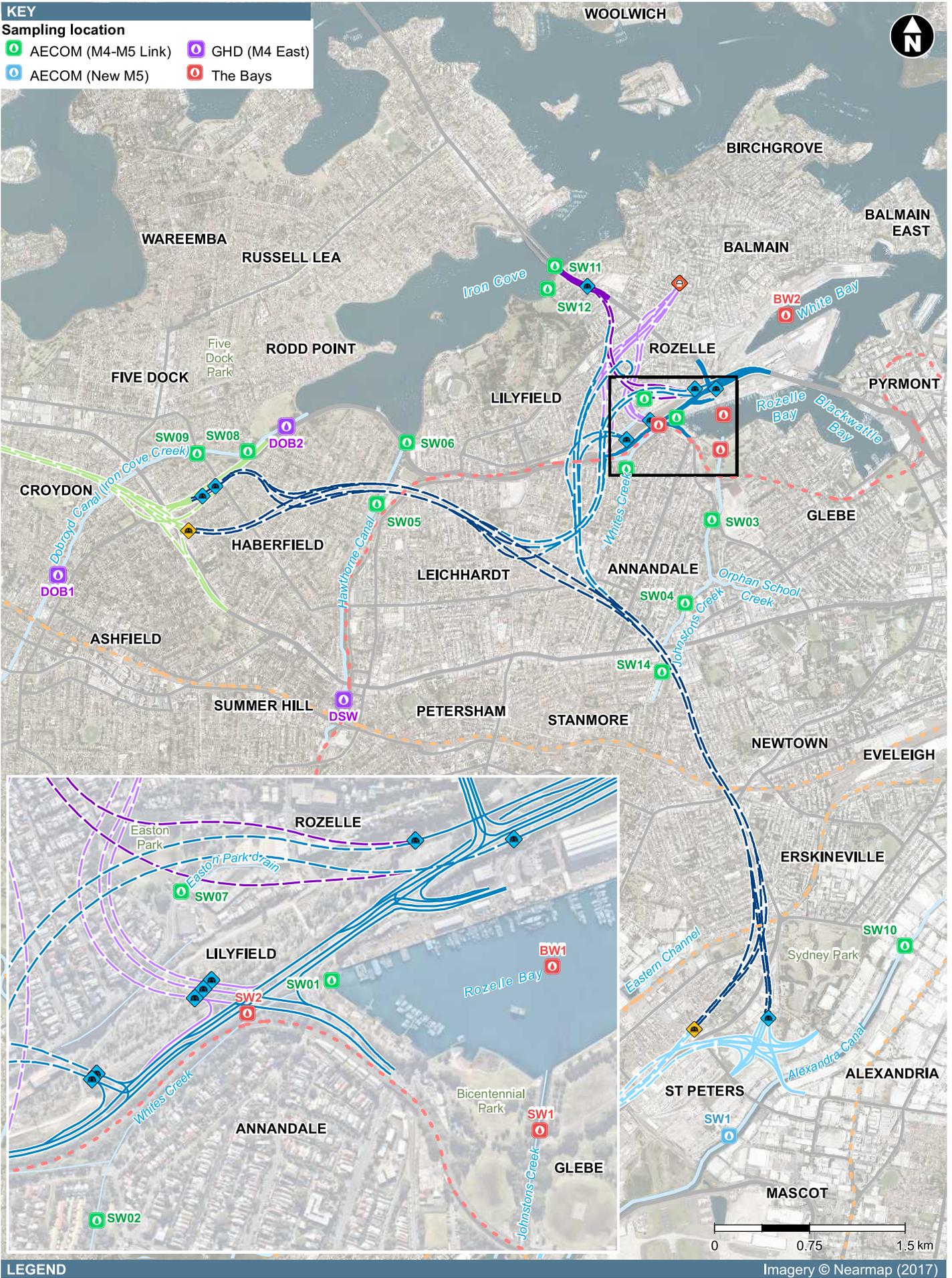
- Samples collected by AECOM at two tidally influenced locations in Hawthorne Canal (SW5 and SW6) at Hawthorne Canal Reserve kiosk (tidal) and its discharge point to Iron Cove (tidal) between July 2016 and May 2017, as part of the M4-M5 Link baseline surface water sampling
- Samples collected by GHD at a tidally influenced location (DSW) from a footbridge connecting Hawthorne Parade and Lords Road between June 2015 and May 2016, as part of the M4 East project.

Elevated levels of heavy metals (chromium, copper, lead and zinc) and nutrients (phosphorus, nitrogen and nitrate) were recorded. On some occasions the pH was also outside guideline levels and the turbidity exceeded guideline levels.

4.5.3 Whites Creek

A review of known water quality data was undertaken to gain an appreciation of water quality conditions within Whites Creek including samples collected by AECOM at a tidally influenced location in Whites Creek (SW2) at Whites Creek Valley Park between July 2016 and May 2017, as part of the M4-M5 Link baseline surface water sampling, and samples collected by Sydney University on behalf of UrbanGrowth NSW within a tidally influenced location (SW2) as part of The Bays project between June and September 2016.

Elevated levels of heavy metals (chromium, copper, lead and zinc), phosphorus, nitrogen, nitrate, oxides of nitrogen and were recorded. On some occasions the pH was also outside guideline levels and the turbidity exceeded guideline levels.



Existing features		Project features		M4 East		M4-M5 Link		Rozelle interchange		Iron Cove Link		Proposed future WHTBL connections (civil construction only)	
	Waterway		Tunnel portal		Surface road		Mainline Surface road		Surface road		Surface road		Surface road
	Railway		Tunnel extent		Tunnel		Tunnel		Tunnel		Tunnel		Tunnel
	Light rail		Tunnel connection		Surface road		Tunnel		Tunnel		Tunnel		Tunnel
	Arterial road				Tunnel								
	Subarterial road												

Figure 4-21 Locations of water quality data

4.5.4 Easton Park drain

A review of known water quality data was undertaken to gain an appreciation of water quality conditions within Johnstons Creek including samples collected by AECOM at a tidally influenced location (SW7) at Lilyfield Road opposite Easton Park during July 2016 and May 2017, as part of the M4-M5 Link baseline surface water sampling.

Elevated levels metals (copper, lead, and zinc) and nutrients (nitrogen, phosphorus and nitrate) were recorded. On some occasions the pH was also outside guideline levels and the turbidity exceeded guideline levels.

4.5.5 Johnstons Creek

A review of known water quality data was undertaken to gain an appreciation of water quality conditions within Johnstons Creek, including samples collected by AECOM at a tidally influenced (SW3) and two non-tidal locations (SW4 and SW14) at Smith Park pedestrian bridge, Chester Street and Cruikshank Street, Camperdown respectively between July 2016 and May 2017, as part of the M4-M5 baseline surface water sampling, and samples collected by the University of Sydney on behalf of UrbanGrowth NSW within a tidally influenced location (SW1) as part of The Bays project between June and September 2016.

Elevated levels of heavy metals (cadmium, copper, chromium, lead, nickel and zinc), phosphorus, nitrogen and nitrate were recorded. On some occasions the pH was also outside guideline levels and the turbidity exceeded guideline levels. The electrical conductivity indicated brackish conditions on occasion in the assumed non-tidal sampling location which indicate this location may be tidally influenced. Total recoverable hydrocarbons were also detected in the non-tidal sampling location (SW4).

4.5.6 Rozelle Bay

Rozelle Bay is historically affected by industrial activities which have led to the contamination of its sediments. Research completed at Sydney University in 2014 assessed the condition of Sydney Harbour and its sub-catchments and sub-estuaries. Each sub-catchment/sub-estuary was graded on three indicators – catchment pressures, water quality and sediment quality. These grades were combined into an overall grade. Blackwattle/Rozelle Bay has been graded as D+ with a recommendation that high priority management was required (Montoya 2015).

Rozelle Bay sediments are contaminated with heavy metals and dioxins, with research indicating that the sediments are highly toxic (Montoya 2015). Discharge points are the worst affected by dioxins and metal concentrations in surficial sediments have generally declined over the past few decades (Montoya 2015). A recent assessment of environmental conditions in Rozelle Bay by the University of New South Wales (Bugnot *et al* 2016) found evidence of severe degradation in Rozelle Bay but the degradation appeared to be fairly localised. Sediments had concentrations of copper, lead, zinc and arsenic above recommended sediment quality guideline values.

A review of known water quality data was undertaken to establish water quality conditions within the bay. This included samples collected by AECOM at one location (SW1) within Rozelle Bay at the Whites Creek outlet between July 2016 and May 2017 as part of the M4-M5 Link baseline surface water sampling and one location within the centre of the bay (BW1) collected by Sydney University on behalf of UrbanGrowth NSW as part of The Bays project between July and September 2016. Elevated levels of heavy metals (copper, chromium, lead and zinc), nitrogen, phosphorus, nitrate, oxides of nitrogen, ammonia and chlorophyll a were recorded. On some occasions the pH was also outside guideline levels and the turbidity exceeded guideline levels. Enterococci was recorded on occasions.

4.5.7 Iron Cove

Iron Cove is historically affected by industrial activities which have led to the contamination of its sediments. Iron Cove sediments are contaminated with heavy metals and dioxins, with research indicating the sediments to be moderately toxic (Montoya 2015). However, metal concentrations in surficial sediments have generally declined over the past few decades (Montoya 2015).

Sydney University assessed Iron Cove to be graded C with a recommendation that high priority management was required (Montoya 2015). Montoya (2015) reported that water quality samples

collected from Iron Cove exceeded ANZECC (2000) guideline criteria for nitrogen phosphorus, chlorophyll-a and enterococci.

A review of known water quality data was undertaken to establish water quality conditions within the bay. This included samples collected by AECOM at two locations (SW11 and SW12) within Iron Cove as part of the M4-M5 Link baseline surface water sampling between November 2016 and May 2017. Elevated levels of metals (chromium, copper, lead, mercury and zinc), nitrogen, nitrate and phosphorus were recorded. The turbidity also exceeded guideline levels and the pH was outside guideline levels on occasions.

4.5.8 White Bay

White Bay is historically affected by waterfront industry including abattoirs on Glebe Island which discharged polluted effluent into the surrounding waters until the abattoirs were moved to Homebush in 1916 (Montoya 2015).

A review of known water quality data was undertaken to establish water quality conditions within the bay. This included samples collected on behalf of UrbanGrowth NSW within the centre of the bay (BW2) as part of The Bays Precinct project between July and September 2016.

Elevated levels of metals (copper and zinc), nitrogen, nitrate and phosphorus, were recorded. The turbidity also exceeded guideline levels on occasions.

4.5.9 Alexandra Canal

A review of known water quality data was undertaken to gain an appreciation of water quality conditions within Alexandra Canal, including samples collected by AECOM at a non-tidally influenced location (SW10) on the canal's upstream tributary, Sheas Creek, at the south side of Huntley Street Bridge between July and May 2017, as part of the M4-M5 Link baseline surface water sampling. Samples were also taken at a tidally influenced location (SW1) on Alexandra Canal at Coward Street as part of the New M5 project surface water sampling conducted between June 2015 and November 2015.

Elevated levels of metals (copper, lead, chromium (III+VI), nickel, manganese and zinc) and nutrients (nitrogen, nitrate and phosphorus) and turbidity were recorded. The pH was also outside guideline levels on occasions.

4.6 Sensitive receiving environments

The project has the potential to interact with a number of sensitive receiving environments, namely:

- Protected wetlands in Iron Cove
- Iron Cove (classified as a water recreation zone)
- Johnstons Creek constructed wetland in Federal Park
- Whites Creek constructed wetland in Whites Creek Valley Park
- Mapped Key Fish Habitat in Rozelle Bay, Iron Cove, White Bay, Alexandra Canal and downstream portions of Dobroyd Canal and Hawthorne Canal
- The Cooks River
- Seagrass in Botany Bay.

4.7 Aquatic habitat and groundwater dependant ecosystems

An assessment of groundwater dependent ecosystems (GDE) and other sites of ecological significance are provided in **Appendix S** (Technical working paper: Biodiversity) and **Appendix T** (Technical working paper: Groundwater) of the EIS.

Appendix S (Technical working paper: Biodiversity) of the EIS states that waterways in or adjacent to the proposed works are not suitable habitat for threatened fish species and there are no SEPP 14 wetlands in the study area. It is also unlikely that there is valuable or specific aquatic habitat for threatened aquatic/estuarine species, populations or communities listed under the FM Act,

Threatened Species Conservation Act 1995 (NSW) or *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) present within the project footprint. It is possible some species may opportunistically pass through the estuarine bays within the study area (Whites Bay, Rozelle Bay and Iron Cove) given the connectivity to the broader harbour and coastal habitats, but the species are unlikely to depend on the habitat within the study area (**Appendix S** of the EIS (Technical working paper: Biodiversity)).

A search of the GDE Atlas (BoM, accessed 27 September 2016) and review of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* for high priority GDEs was undertaken as part of the Biodiversity Assessment (**Appendix S** of the EIS). The search indicated that there are no ecosystems within the study area that are likely to be dependent on groundwater. Although not mapped as being groundwater dependent, Johnstons Creek and Whites Creek are associated with palaeochannels. In low lying areas such as these, the project is not expected to change availability of water for plants due to the low permeability of the clayey soils in combination with frequent rainfall events and higher recharge than elevated sites.

4.8 Existing water quality treatment measures

Water quality improvement devices have been incorporated into the existing stormwater system at a number of locations within the study area. Known water quality treatment measures within the Johnstons Creek, Hawthorne Canal and Whites Creek catchments, as obtained from Beck 2010, are listed in **Table 4-2**.

Table 4-2 Known existing water quality improvement devices

Catchment	Device type	Location
Johnstons Creek	Gross Pollutant Trap (GPT)	Federal Park
	Wetland	Federal Park
	GPT Rocla basket trap	Creek Street and Wigram Road
	GPT	Gadigal Avenue, Victoria Park
	GPT	Larkin Street Road
	GPT Rocla Continuous Deflection Separation (CDS) Unit	Larkin Street Park
	GPT	Corner of Australia Square, Enmore and King Street, Newtown
	Biofiltration	Corner of Federal and Church Street
Hawthorne Canal	Litter Boom	Canal Mouth
	GPT	Francis Street
	GPT	Dept. of Defence, Hawthorne Parade
Whites Creek	CDS GPT	Thorby Avenue
	GPT Rocla basket trap	North Avenue and White Creek Lane
	Wetland	Wisdom Street
	Infiltration Basin	Gillies Street

The constructed wetland (owned by Inner West Council) located within Whites Creek Valley Park adjacent to Wisdom Street, Annandale receives low flows from Whites Creek. It is understood that a sewage overflow in 2009 caused the death of most of the fauna in the Whites Creek wetland (Leichhardt Council 2010). A constructed wetland receiving low flows from Johnstons Creek is also located in Federal Park, Annandale.

Sydney Park has four wetland areas which are an important part of the parks ecosystem as well as providing a flood mitigation role. A City of Sydney Council water reuse project at Sydney Park was

completed in October 2015. Stormwater is diverted from the stormwater channel near the corner of Euston and Sydney Park Roads for treatment within a series of bioretention beds prior to being reused to top up the wetlands, irrigate the park and supply the neighbouring Council depot. The stormwater harvesting system is the largest water harvesting system in Sydney (City of Sydney Council 2016).

4.9 Riparian corridors

EIS **Appendix S** (Technical working paper: Biodiversity) indicates that the riparian buffer of Whites Creek and Rozelle Bay are located within the construction footprint at Rozelle and a small portion of the riparian buffer of Iron Cove touches the western edge of the construction footprint at Iron Cove. No other construction sites or operational areas of the project are within riparian corridors.

4.10 Contamination and acid sulfate soils

Potential contamination within the project footprint and its associated management has been assessed in **Appendix R** (Technical working paper: Contamination) of the EIS. Contaminants of potential concern within the project footprint as identified within **Appendix R** (Technical working paper: Contamination) of the EIS are provided in **Table 4-3**. These include contaminants which could potentially be present within soil, sediments and groundwater, based on a desktop review of relevant historical reports, land titles, council and government documentation and records, historical photographs, historical land use and activities, existing soil, sediment and groundwater data and site inspections.

Based on the NSW Department of Planning and Environment (DP&E) acid sulfate soil risk maps (Acid Sulfate Data Source Accessed 03/06/2015: NSW Crown Copyright - Planning and Environment Creative Commons 3.0 Commonwealth of Australia), acid sulfate soil classes were mapped as shown in **Table 4-3** for each of the construction sites. The classification scheme for acid sulfate soils is provided in **Table 4-4**.

Table 4-3 Contaminants of Potential Concern and acid sulfate soil class

Construction Site	Contaminants of Potential Concern (CoPC)	Acid sulfate soil classes
C1a Wattle Street civil and tunnel site	Lead, asbestos, metals, Polycyclic Aromatic Hydrocarbons (PAHs), and hydrocarbons	Class 5
C2a Haberfield civil and tunnel site	Lead, asbestos, Total Recoverable Hydrocarbons (TRH), Benzene, Toluene, Ethylbenzene, Xylenes (BTEX), PAHs, Volatile Organic Compound (VOCs), Volatile Halogenated Compounds (VHCs)	Class 5
C3a Northcote Street civil site	Lead, asbestos, TRH, BTEX, PAH, VOCs	Class 5
C1b Parramatta Road West civil and tunnel site	PAHs, metals, TRH, BTEX, PAHs, VOCs, lead, asbestos, Polychlorinated Biphenyls, PCBs, Phenols, Organochlorine Pesticides (OCPs), Organophosphorus Pesticides (OPPs)	Class 5
C2b Haberfield civil site	Lead, asbestos, Total Recoverable Hydrocarbons (TRH), Benzene, Toluene, Ethylbenzene, Xylenes (BTEX), PAHs, Volatile Organic Compound (VOCs), Volatile Halogenated Compounds (VHCs)	Class 5
C3b Parramatta Road East civil site	Metals, TRH, BTEX, PAHs, VOCs, PCBs, lead, asbestos, chlorinated hydrocarbons, OCPs, OPPs, phenols	Class 5
C4 Darley Road civil and tunnel site	Heavy metals, acid sulfate soils, PAHs, TRH, asbestos, VOCs, SVOCs	Class 2 and 5
C5 Rozelle civil and tunnel	Metals, TRH, PAHs, OCPs, asbestos, acid	Class 1, 3 and 5

Construction Site	Contaminants of Potential Concern (CoPC)	Acid sulfate soil classes
site	sulfate soils, SVOCs, VOCs, TBT	
C6 Crescent civil site	Lead, PAHs, Tributyltin, asbestos, PFAS-PFOS and PFHxS, metals, SVOCs, VOCs, TRH, BTEX Contaminants of potential concern for the sediments in Rozelle Bay include asbestos, Perfluoroalkylated Substances (PFAS): PFAS compounds Perfluorooctanesulfonic acid (PFOS) and Perfluorohexane sulfonate (PFHxS), heavy metals, PAHs and Phthalates.	Class 5 (soils) Acid sulfate soils were detected in sediment samples collected from Rozelle Bay by AECOM in 2017
C7 Victoria Road civil site	TRH, BTEXN, PAHs, lead and asbestos.	Class 5
C8 Iron Cove civil site	Metals, TRH, VOCs, SVOCs, asbestos, acid sulfate soils, BTEX, PAHs, OCPs, Polychlorinated Biphenyls (PCBs), lead. Metals, OCPs, PAHs and asbestos also CoPCs for the proposed water quality treatment facility within the car park	Class 2 and 5
C9 Pymont Bridge Road tunnel site	Metals, TRH, BTEXN, PAHs, VOCs, lead, asbestos, PCBs, cyanide, SVOCs	Class 5
C10 Campbell Road civil and tunnel site	Landfill gases (methane, hydrogen sulphide, carbon dioxide and carbon monoxide), leachate (particularly ammonia), acid sulfate soils, heavy metals, PAHs, asbestos, SVOCs, VOCs, TRH, lead, BTEXN	Class 2 and 3

Table 4-4 Classification scheme in the acid sulfate soils planning maps

Class of land	Works which present an acid sulfate soil risk
1	Any works
2	Works below natural ground surface Works by which the watertable is likely to be lowered
3	Works beyond 1 metre below natural ground surface Works by which the watertable is likely to be lowered beyond 1 metre below natural ground surface
4	Works beyond 2 metres below natural ground surface Works by which the watertable is likely to be lowered beyond 2 metres below natural ground surface
5	Works within 500 metres of adjacent Class 1, 2, 3 or 4 land which are likely to be lower the watertable below 1 metre AHD on adjacent Class 1, 2, 3 or 4 land

4.11 Groundwater quality

As groundwater seepage to the tunnels will be captured, treated and ultimately discharged to Hawthorne Canal and Rozelle Bay, a review of groundwater quality data collected to inform **Appendix T** (Technical working paper: Groundwater) was undertaken of the EIS. At the time of reporting, 58 monitoring wells had been installed, with groundwater quality monitoring data collected from 47 wells to date. Sampling is conducted on a monthly basis and commenced in June 2016 for the earliest wells.

The sampling data has the following limitations:

- Sampling data provides an indication of groundwater at the monitoring well location at the time of sampling only. The yield of groundwater which would seep into the tunnels is assumed to be

one litre per second per kilometre however the proportion of water from each aquifer zone (of varying water quality) is unknown. The respective composite quality of water seeping into the tunnel is therefore unknown

- No distinction between target lithology or depth has been made when analysing the data but samples collected from alluvium were discounted from the analysis as tunnels and cut and cover sections would be constructed as undrained through palaeochannels to prevent groundwater ingress in these areas (refer to **Appendix T** (Technical working paper: Groundwater) of the EIS)
- Sampling data relevant to the mainline tunnel included that collected from monitoring wells within the vicinity of St Peters and Haberfield and along the mainline alignment. See **Figure 4-22** for further details of the wells and well locations.
- Sampling data assumed to be relevant to the Rozelle tunnels included samples from monitoring wells at Rozelle, The Crescent, Iron Cove and Easton Park (see **Figure 4-22**).

A summary of the data is presented in **Table 4-5** and **Table 4-6** for monitoring wells relevant to the mainline tunnel and Rozelle tunnels respectively. The ANZECC (2000) marine 95 per cent protection level, freshwater 95 per cent protection level (or default trigger levels for physical and chemical stressors where appropriate) and recreational water quality guideline levels (consistent with the SHPRC water quality objectives) are shown for comparison as well as an indication of water quality within the receiving waters.

The mainline tunnel monitoring wells recorded:

- Consistently elevated concentrations of manganese and iron
- Consistently elevated concentrations of ammonia, total nitrogen and total phosphorus
- pH consistently outside the guideline levels
- Elevated concentrations of chromium, copper, lead, nickel, zinc, nitrite, nitrate and filterable reactive phosphorus on some occasions.

The Rozelle tunnel monitoring wells recorded:

- Consistently elevated concentrations of manganese and iron
- Consistently elevated concentrations of ammonia, total nitrogen and total phosphorus
- pH consistently outside the guideline levels
- Concentrations of chromium, copper, lead, nickel, zinc, nitrate, filterable reactive phosphorus on some occasions.

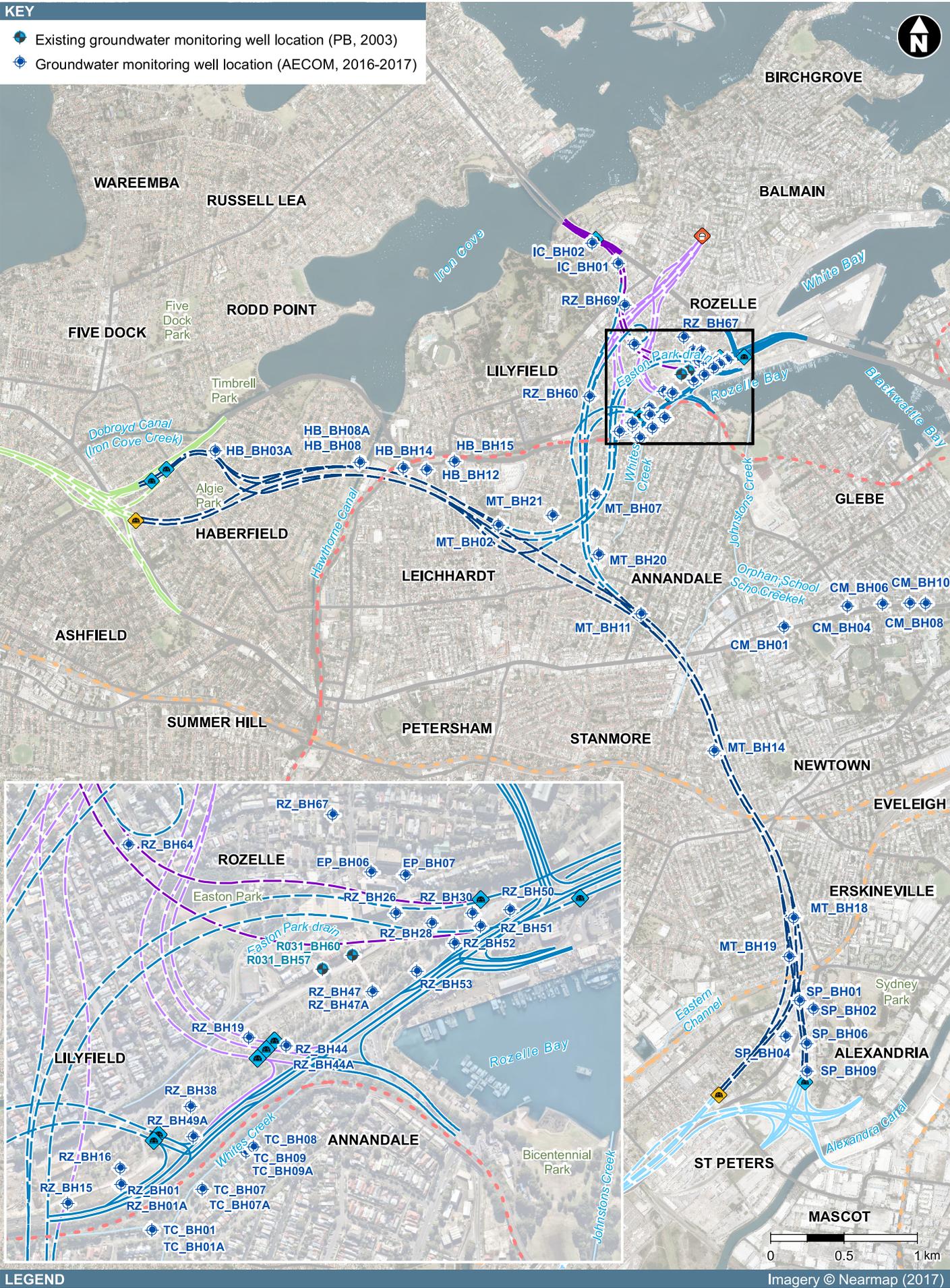


Figure 4-22 Groundwater monitoring well locations

Table 4-5 Groundwater monitoring - summary of samples relevant to mainline tunnel

Analyte	Units	95% marine protection level	95% freshwater protection level	Recreational water quality guideline level	Hawthorne Canal median ¹	Hawthorne Canal mean ¹	Number of wells data collected from	Number of Samples	Minimum	Maximum	Median	Mean ²	Percentage of samples exceeding a guideline level ³
Temperature	°C	-	-	-	21.2	24.4	15	64	17	26.1	21	21.1	-
pH	-	7- 8.5 ⁴	6.5 – 8.0 ⁴	6.5 – 8.5	7.6	7.4	15	64	5.51	12.69	7.52	8.40	72%
Conductivity	uS/cm	-	125 - 2000 ⁴	-	42334	36041	15	64	16.8	16300	2356	3139	61%
Arsenic	mg/L	-	-	0.05	<0.01	0.0042	15	64	<0.001	0.006	0.005	0.004	0%
Chromium	mg/L	-	-	0.05	<0.01	0.0034	15	64	<0.001	0.157	<0.001	0.0056	4%
Copper	mg/L	0.0013	0.0014	1	<0.01	0.0092	15	64	<0.001	0.029	<0.001	0.0013	15%
Iron	mg/L	-	-	0.3	0.34	0.77	15	64	0.05	458	10.8	41.9	97%
Lead	mg/L	0.0044	0.0034	0.05	<0.01	0.01	15	64	<0.001	0.004	<0.001	0.0005	1%
Manganese	mg/L	-	1.9	0.1	0.018	0.021	15	64	0.008	25.1	0.30	1.12	88%
Nickel	mg/L	0.07	0.011	0.1	0.004	0.0031	15	64	<0.001	0.15	0.002	0.009	19%
Zinc	mg/L	0.015	0.008	5	0.026	0.043	15	64	<0.005	0.126	<0.005	0.011	29%
Nitrite	mg/L	-	-	1	<0.01	0.01	15	66	<0.01	1.18	<0.01	0.054	1%
Nitrate	mg/L	-	0.7	10	0.09	0.36	15	66	<0.01	1.31	0.02	0.09	4%
Ammonia	mg/L	0.91	0.9	0.01	-	-	15	23	0.02	3.41	0.53	0.79	83%
Total Nitrogen	mg/L	0.3 ⁴	0.5 ⁴	-	0.25	0.82	15	24	0.3	158	1.4	2.1	90%
Filterable Reactive Phosphorus	mg/L	0.005	0.02	-	0.03	0.034	15	66	<0.01	0.13	<0.01	0.011	21%
Total Phosphorus	mg/L	0.03 ⁴	0.05 ⁴	-	0.07	0.29	15	16	0.01	236	0.15	1.16	88%
Exceeds 95% marine protection level													
Exceeds 95% freshwater protection level													
Exceeds recreational water quality guideline level													

Notes:

¹Based on M4-M5 Link surface water quality monitoring (see **Annexure B**)

²Results below the limit of reporting were assumed to be half the limit of reporting when calculating the mean

³ Trigger values for toxicants have been obtained from ANZECC (2000) and are for reference only. Adjustments in trigger level for hardness (copper, nickel, lead, zinc) or pH (ammonia) has not been undertaken for receiving environment when determining trigger level exceedances.

⁴ Default trigger values for physical and chemical stressors in south-east Australia (ANZECC, 2000)

⁵ Excludes anomalous results for TP (236mg/L) and TN (158mg/L) collected on 8/6/2016

Table 4-6 Groundwater monitoring - summary of samples relevant to Rozelle tunnels

Analyte	Units	95% Marine Protection Level	95% Freshwater Protection Level	Recreational Water Quality Guideline level	Rozelle Bay Median ¹	Rozelle Bay Mean ¹	Number of wells data collected from	Number of Samples	Minimum	Maximum	Median	Mean ²	Percentage of Samples exceeding guideline level ³
Temperature	°C	-	-	-	21.2	20.9	31	237	16.72	26.5	20.9	20.92	-
pH	-	7- 8.5 ⁴	6.5 – 8.0 ⁴	6.5 – 8.5	7.61	7.39	31	237	4.48	12.37	7.05	7.57	70%
Conductivity	uS/cm	-	125 - 2000 ⁴	-	46630	41014	31	239	159.6	13552	1261	2076	23%
Arsenic	mg/L	-	-	0.05	<0.01	0.004	31	244	<0.001	0.019	<0.001	0.0010	0%
Chromium	mg/L	-	-	0.05	<0.01	0.003	31	245	<0.001	0.064	<0.001	0.0019	0%
Copper	mg/L	0.0013	0.0014	1	<0.01	0.006	31	245	<0.001	0.056	<0.001	0.0031	24%
Iron	mg/L	-	-	0.3	0.23	0.21	31	245	0.025	237	14.9	23.2	98%
Lead	mg/L	0.0044	0.0034	0.05	<0.01	0.005	31	245	<0.001	0.035	<0.001	0.0012	6%
Manganese	mg/L	-	1.9	0.1	0.006	0.014	31	245	0.007	5.62	0.469	0.623	90%
Nickel	mg/L	0.07	0.011	0.1	<0.01	0.0032	31	245	<0.001	0.159	0.004	0.007	13%
Zinc	mg/L	0.015	0.008	5	0.042	0.1	31	245	<0.005	0.229	<0.005	0.013	29%
Nitrite	mg/L	-	-	1	<0.01	0.01	31	234	<0.01	0.92	<0.01	0.020	0%
Nitrate	mg/L	-	0.7	10	0.09	0.19	31	234	<0.01	1.47	0.03	0.13	5%
Ammonia	mg/L	0.91	0.9	0.01	0.042	0.049	31	96	0.02	2.73	0.16	0.37	70%
Total Nitrogen	mg/L	0.3 ⁴	0.5 ⁴	-	0.25	0.49	31	122	0.2	13.4	0.9	1.25	87%
Filterable Reactive Phosphorus	mg/L	0.005	0.02	-	0.02	0.023	31	235	<0.01	0.16	<0.01	0.009	15%
Total Phosphorus	mg/L	0.03 ⁴	0.05 ⁴	-	0.025	0.27	31	50	0.01	0.99	0.15	0.22	86%
Exceeds 95% marine protection level													
Exceeds 95% freshwater protection level													
Exceeds recreational water quality guideline level													

Notes:

¹Based on M4-M5 Link surface water quality monitoring (see **Annexure B**)

²Results below the limit of reporting were assumed to be half the limit of reporting when calculating the mean

³ Trigger values for toxicants have been obtained from ANZECC (2000) and are for reference only. Adjustments in trigger level for hardness (copper, nickel, lead, zinc) or pH (ammonia) has not been undertaken for receiving environment when determining trigger level exceedances.

⁴ Default trigger values for physical and chemical stressors in south-east Australia (ANZECC 2000)

5 Assessment of construction impacts

Construction of the project would involve a range of activities at sites of both permanent and temporary occupancy. Construction activities are described in **section 2.3**. A list of construction ancillary facilities is provided in **section 2.3**.

An assessment of construction impacts associated with water extraction, flooding and drainage and water quality is provided in **sections 5.1, 5.2 and 5.2.1** respectively.

5.1 Water use

As detailed in **section 2.4.1**, the project would require water for various tunnelling and surface works activities. There would be a temporary increase in potable water demand as a result of the project during the construction phase. Potable water would be obtained from the Sydney Water potable supply network, subject to agreement with Sydney Water.

The use of alternative sources for non-potable water, as detailed in **section 2.4.1**, would reduce the increased demand on the Sydney Water potable supply network. The use of non-potable water would likely be considered for construction water requirements and environmental controls on the proviso that suitable treatment and management measures are implemented.

The water usage and associated source and volume of water supplied during construction will vary depending on the proposed construction method. Indicative volumes of water use for construction are provided in **section 2.4.1**.

5.2 Flooding and drainage

Flooding during construction of the project could potentially impact areas within and near to the construction sites. The construction footprint is shown in **Figure 2-2**. Flood related impacts during construction could include:

- Inundation of excavated tunnels
- Damage to facilities, infrastructure, equipment, stockpiles and downstream sensitive areas caused by inundation from floodwaters
- Increased risk of flooding of adjacent areas due to temporary loss of floodplain storage (resulting in displacement of water) or impacts on the conveyance of floodwaters.

The likelihood of flooding and a summary of the potential impacts of construction sites and associated construction activities on flood risk is provided in **Table 5-1**. These are based on preliminary construction plans and indicative layouts, which would be refined in future as the detailed design and site construction planning is further developed.

The project proposes permanent tunnel portals at Wattle Street (C1a), Darley Road (C4), Rozelle (C5), Iron Cove (C8) and Campbell Road (C10). These are proposed to be created using cut and cover techniques. Tunnelling would also occur through temporary shafts at the Pymont Bridge Road tunnel site (C9), Parramatta Road West (C1b, if Option B is selected) and Darley Road (C4).

Ingress of floodwater into the shafts or cut and cover excavations during construction would pose significant risk to personal safety for those working in the tunnel. Where these facilities occur within the floodplain, such as at Darley Road and Rozelle, protection measures such as bunding or floodwater barriers would need to be provided to ensure floodwaters do not enter shafts or portals.

Other flood impacts during construction, such as flooding of site facilities or stockpiles and erosion of cleared areas, are expected to be generally minor in nature. These are readily mitigated by adjusting specific aspects of the construction ancillary facility designs and site planning in a way that recognises the identified flood conditions in order to minimise the potential for off-site flood impacts. The indicative layout of the construction ancillary facilities has been developed with information on existing flood risk and identifying opportunities to provide setback from high risk areas to minimise impacts on existing flowpaths, where feasible.

Typical mitigation measures that would be employed are outlined in **section 8** and a summary of locational criteria for ancillary facilities are listed below:

- Tunnels, ditches and shafts should be located outside flood affected areas. Where this is not possible, bunding or flood control barriers are required
- Stockpiles should be located outside the 20 year ARI flood extent
- Chemicals should be stored and substations located outside or above flood affected areas
- Site facilities, construction roads, and car parks should be located in low hazard areas.

As part of the works around the Rozelle interchange, the existing bridge structure over Whites Creek at The Crescent would be replaced. This is to satisfy road/geometric requirements as well as to address the durability of the existing structure, which is not considered sufficient to match that required for the project. The existing bridge over Whites Creek is a single span approximately nine metres long and 47 metres wide, and would be replaced with a new bridge. The new bridge is proposed to consist of two 16 metre spans (total length 32 metres) with an overall width of 88 metres. Along the right bank of the creek a new landscaped flow path will be constructed. The new bridge piers are proposed to be located along the flow path and outside the main channel so as to minimise flood impacts and low flow patterns.

All formwork, access tracks and other temporary works would be located outside of the existing Whites Creek channel. While there is the potential for temporary structures (used to support permanent structures, materials, plant equipment or people) to reduce the available waterway area beneath the replacement bridge, it is noted that the longer spans have been designed to likely mitigate the potential impact this would have had on flood behaviour. It is also likely that the replacement bridge would comprise pre-cast members, meaning that the waterway would not be obstructed by additional temporary structures associated with an alternative cast in situ type approach. A pre-cast approach would also result in a comparatively shorter timeframe for installation of the bridge and potential associated obstruction.

Table 5-1 Construction ancillary facilities and flooding

Construction ancillary facilities	Facilities	Existing flood risk (source, mechanisms)	Potential impacts
C1a Wattle Street civil and tunnel site (part of M4 East project footprint)	<ul style="list-style-type: none"> • Dive structure into the mainline tunnel • Buildings • Parking • Laydown area 	<ul style="list-style-type: none"> • Dobroyd Canal catchment • Western side of the site inundated by PMF overland flowpath • M4 East project has mitigated flood risk from overland flow, channelling PMF flow towards Parramatta Road junction and away from the dive structure. • M4 East EIS (2015), M4 East Detailed Design (CSJ 2016) 	None anticipated – area flooded in the PMF only used for vehicle access. No topographic changes proposed therefore negligible impacts on flood risk.
C2a Haberfield civil and tunnel site (part of M4 East project footprint)	<ul style="list-style-type: none"> • Mechanical and electrical fitout of M4 East ventilation facility (Parramatta Road ventilation facility) • Office, storage and laydown area • Substation • Parking • Stockpiling underground 	<ul style="list-style-type: none"> • Dobroyd Canal catchment • Outside of PMF flood extent for mainstream flooding and overland flowpath • M4 East EIS (2015), M4 East Detailed Design (CSJ 2016) 	None anticipated – area outside of PMF flood extent.
C3a Northcote Street civil site (part of M4 East project footprint)	<ul style="list-style-type: none"> • Parking • Laydown area 	<ul style="list-style-type: none"> • Dobroyd Canal catchment • Outside of PMF flood extent for mainstream flooding and overland flowpath • M4 East EIS (2015), M4 East Detailed Design (CSJ 2016) 	None anticipated – area outside of PMF flood extent.
C1b Parramatta Road West civil and tunnel site	<ul style="list-style-type: none"> • Acoustic shed • Laydown area • Temporary dive structure into the mainline tunnel 	<ul style="list-style-type: none"> • Dobroyd Canal catchment • Outside of 100 year ARI flood extent for mainstream flooding • Overland flowpaths along Parramatta Road, Bland Street and Alt Street 	None anticipated – area just on the fringe of PMF flood extent. No overland flow paths through the site. No topographic changes proposed for Parramatta Road, Bland Street and Alt Street, therefore overland flowpaths will be maintained.

Construction ancillary facilities	Facilities	Existing flood risk (source, mechanisms)	Potential impacts
C2b Haberfield civil site (part of M4 East project footprint)	<ul style="list-style-type: none"> Mechanical and electrical fitout of M4 East ventilation facility (Parramatta Road ventilation facility) 	<ul style="list-style-type: none"> Dobroyd Canal catchment Outside of PMF flood extent for mainstream flooding and overland flowpaths M4 East EIS (2015), M4 East Detailed Design (CSJ 2016) 	None anticipated – area outside of PMF flood extent.
C3b Parramatta Road East civil site	<ul style="list-style-type: none"> Parking Buildings and laydown area 	<ul style="list-style-type: none"> Dobroyd Canal catchment Outside of PMF flood extent for mainstream flooding 	None anticipated – area outside of PMF flood extent.
C4 Darley Road civil and tunnel site	<ul style="list-style-type: none"> Temporary access tunnel for construction Buildings and laydown area Parking Acoustic shed and spoil handling area Temporary substation 	<ul style="list-style-type: none"> Hawthorne Canal catchment Localised shallow flooding from 10 year ARI and 100 year ARI flowpath from light rail line Majority of the site may be inundated in a PMF with depths up to 0.5 metres at the western end of the site Hawthorne Canal Flood Study (2013), Leichhardt Flood Study (2014), AECOM flood modelling (2016) 	Potential displacement of water by bunding of tunnel ramps to prevent floodwater ingress, as well as presence of temporary noise walls, buildings/hoarding, acoustic shed, stockpiles and other structures.
C5 Rozelle civil and tunnel site	<ul style="list-style-type: none"> Dive structure into the mainline tunnel Buildings and laydown area Parking Acoustic shed and spoil handling areas Temporary sedimentation pond and water treatment plant Ventilation facility Temporary drainage structures 	<ul style="list-style-type: none"> Easton Park drain catchment Mainstream flooding and overland flowpaths Located within 10 year, 100 year ARI and PMF flood extent AECOM flood modelling (2016) 	Potential displacement of water by bunding of ramps to prevent floodwater ingress, as well as presence of temporary noise walls, buildings/hoardings, buildings, stockpiles and other structures.
C6 The Crescent civil site	<ul style="list-style-type: none"> Construction of Whites Creek bridge Widening and improvement works to Whites Creek Construction of culverts from Rozelle Rail Yards 	<ul style="list-style-type: none"> Whites Creek catchment On the edge of Rozelle Bay Located outside 100 year ARI flood extent but within PMF flood extent AECOM flood modelling (2016) 	Potential displacement of water by hoardings, buildings, stockpiles and other structures.

Construction ancillary facilities	Facilities	Existing flood risk (source, mechanisms)	Potential impacts
	<ul style="list-style-type: none"> Buildings and laydown area Parking 		
C7 Victoria Road civil site	<ul style="list-style-type: none"> Buildings Parking 	<ul style="list-style-type: none"> Rozelle Bay catchment Outside of PMF flood extent Leichhardt Flood Study (2014) 	None anticipated – area outside of PMF flood extent.
C8 Iron Cove civil site	<ul style="list-style-type: none"> Dive structure into Iron Cove Link tunnel Buildings Temporary water treatment plant Workshop and storage 	<ul style="list-style-type: none"> Iron Cove catchment Overland flowpaths on Victoria Road for 10 year ARI event Leichhardt Flood Study (2014), AECOM flood modelling (2016) 	Potential displacement of water by bunding of ramps to prevent floodwater ingress, as well as activities to widen the road.
C9 Pymont Bridge Road tunnel site	<ul style="list-style-type: none"> Temporary access tunnel for construction Buildings and laydown area Workshop Parking Acoustic shed and spoil handling area Temporary substation 	<ul style="list-style-type: none"> Johnsons Creek catchment Overland flow in 10 year ARI event, depths of over 1m limited to Bignell Lane Johnstons Creek Catchment Flood Study (2014), Leichhardt Flood Study (2014) 	Potential displacement of water by bunding of ramps to prevent floodwater ingress, as well as presence of temporary noise walls, buildings/hoardings, acoustic shed, offices and other structures.
C10 Campbell Road civil and tunnel site (part of New M5 project footprint).	<ul style="list-style-type: none"> Dive structure into the mainline tunnel Buildings and laydown area Parking Acoustic shed and spoil handling area 	<ul style="list-style-type: none"> Alexandra Canal Outside of 20 year ARI and PMF flood extent associated with mainstream flooding New M5 EIS (2015), AJJV Detailed Design (2016) 	The New M5 project is providing the construction site platform within the St Peters interchange, including designing to protect the construction site from flooding. No impacts anticipated on the basis that the New M5 project is assessing impacts and providing mitigation, such as a temporary stormwater drainage strategy to divert flows around and away from stockpile sites and other vulnerable infrastructure.

5.2.1 Localised flooding and drainage

All construction works would have the potential to impact local overland flow paths and existing minor drainage paths. Disruption of existing flow mechanisms, both of constructed drainage systems or those of overland flow paths, could occur as a consequence of the various construction activities and facilities. Specific causes of these impacts could include:

- Disruption of existing drainage networks during decommissioning, upgrade or replacement of drainage pits and pipes
- Interruption of overland flow paths by installation of temporary ancillary construction facilities
- Sediment entering into drainage assets and causing blockages
- Overloading the capacity of the local drainage system due to the generation of additional runoff.

These are typical impacts faced on most construction projects and can be addressed by adopting industry standard mitigation measures. Consideration of these impacts would be included during future detailed design and construction planning phases, along with consideration of the typical mitigation measures described in **section 8**.

5.2.2 Discharge volume

The discharge of treated construction water would have a minor increase in base flow rates of receiving waterways. Discharges are likely to be continuous. Daily discharge rates are provided in **section 2.4.1**. The locations of discharge points into Dobroyd Canal, Hawthorne Canal, Easton Park drain and Alexandra Canal, all artificial waterways, are reaches that are tidally influenced. As the flow variability within the study area is dominated by tides and given the urban setting and artificial nature of the waterways, it is not considered likely that project discharges during construction would significantly impact on the natural flow variability or environmental water availability at these locations.

Iron Cove and Rozelle Bay would also receive direct discharges from the project. As they are large tidal waterbodies associated with the Parramatta River Estuary and Sydney Harbour, the discharge volumes would not impact natural flow variability or environmental water availability.

Discharge from the Rozelle civil and tunnel site to Easton Park drain may initially be to the existing brick-lined open channel. During the course of the construction activities, the Easton Park drain would be re-aligned to enable construction progression through the site and construction of the ultimate alignment of the drain. It is unlikely that the treated water discharge would significantly impact on the natural flow variability or environmental water availability in the drain prior to its re-alignment.

5.3 Water quality

Sections 5.3.1 and **5.3.2** summarise potential project impacts on surface water quality during tunnelling works and surface works respectively. Further details of potential impacts and the receptors at risk are provided in **Table 5-2**.

5.3.1 Tunnelling activities

The project proposes twin tunnels and ramp tunnels which provide surface connections from the mainline tunnels to the St Peters interchange, Rozelle interchange, Iron Cove Link and the M4 East interface at Wattle Street. During construction, tunnelling works would result in large volumes of wastewater being generated from the following sources:

- Groundwater ingress
- Rainfall runoff in tunnel portals and ventilation outlets
- Heat and dust suppression water
- Wash down runoff.

A high proportion of the water generated from tunnelling would be collected from groundwater seepage. Natural groundwater quality along the alignment is variable, with the Ashfield Shale typically being more saline than the Hawkesbury Sandstone. Alluvial groundwater tends to become more saline down gradient due to increased tidal influences but in low lying areas may also be acidic due to

the presence of potential acid sulphate soils (PASS). Previous and current land-use practices may have impacted groundwater quality at some locations by the introduction of contaminants such as hydrocarbons or heavy metals from light industrial activities.

The use of chemicals in the treatment and curing process of concrete as well as the concrete dust itself could result in construction water having an increased alkalinity. During construction, the wastewater generated in the tunnel would be captured, tested and treated at a construction water treatment plant (if required) prior to reuse or discharge, or disposal offsite if required (see **section 2.4.1**).

Information and knowledge from adjoining projects (M4 East and New M5) indicates that the water treatment plants will likely be required to include pH correction as well as the ability to remove iron, manganese, suspended solids, hydrocarbons and other settleable compounds. A review of groundwater quality data collected as part of the M4-M5 Link project is provided in **section 4.11**. The results indicate that groundwater in the study area may also be impacted by elevated levels of ammonia, total nitrogen and total phosphorus compared to ANZECC (2000) guideline levels (marine, freshwater and recreational protection levels). Other metals including copper, chromium, lead, nickel and zinc were also recorded at elevated levels on a limited number of occasions.

Tunnel wastewater, if discharged untreated or poorly treated, has the potential to impact the receiving waterways by introducing increased nutrient loading and result in algal growth with increased risk to human health. There is also potential for reduction in visual amenity and impacts to aquatic species as a result of heavy metal or other toxicants.

Construction treatment and plant locations, discharge points and expected discharge volumes are described in **section 2.4.1**. The type, arrangement and performance of construction water treatment facilities will be developed and finalised during detailed design.

Provided appropriate treatment is achieved, tunnel wastewater discharges during construction would pose a negligible impact on receiving water quality. Further details of treatment requirements are provided in **section 8.2**. Impacts associated with the increased discharge volumes are discussed in **section 5.2.2**.

5.3.2 Surface activities

Surface activities would be required to support tunnelling and to construct surface infrastructure such as roadways, bridges, interchanges, tunnel portals, ventilation facilities, ancillary operations buildings and facilities. The highest risk of impacts on water quality during construction of surface works would be associated with:

- Exposure of soils during earthworks (including vegetation clearance, stripping of topsoil, removal of existing pavement, excavation, stockpiling and materials transport), may result in soil erosion and off-site movement of eroded sediments by wind and/or stormwater to receiving waterways. This could adversely impact water quality through increased turbidity, lowered dissolved oxygen levels, and increased nutrients (nitrogen, phosphorus) as well as any contaminants contained within the soils
- Demolition works, predominantly associated with the removal of buildings and residential dwellings. Sources of pollutants during demolition works that could affect water quality include asbestos and other building materials, toxic or pollutant laden soils, heavy metals, chemicals including hydrocarbons or fluids associated with demolition processes and machinery as well as dust and airborne pollutants. The typical impacts on surface water quality from the demolition in these areas would be through mobilised dust, litter and other building materials being deposited and picked up by stormwater runoff and conveyed to downstream waterways via drainage infrastructure
- Disturbance of contaminated land, which may result in soil and contaminants (see **section 4.10**) attached or mixed with the particles mobilised by stormwater runoff through the disturbed area. Soils and sediments containing contaminants transported by stormwater runoff and/or tidal influences to downstream waterways could potentially increase contaminant concentrations in the receiving environment. Refer to **Appendix R** of the EIS (Technical working paper: Contamination) for further details of the management of soil contamination during construction

- Exposure of potential acid sulfate soils (see **section 4.10**) as a result of earthworks or dewatering, which may result in generation of sulfuric acid and subsequent acidification of waterways and mobilisation of heavy metals into the environment if poorly managed. Refer to **Appendix R** (Technical working paper: Contamination) of the EIS to for further details of the management of acid sulfate soils during construction
- Rinse water from plant washing and concrete slurries may contain polluting contaminants which if discharged offsite could impact on surface water quality
- Potential spills or leaks of fuels and / or oils from maintenance or re-fuelling of construction plant and equipment or vehicle / truck incidents could potentially be conveyed to downstream waterways via drainage infrastructure
- Disturbance of Whites Creek and Rozelle Bay due to construction of the proposed new road and pedestrian bridges as part of the realigning of The Crescent and associated Whites Creek channel widening and naturalisation works. This may lead to disturbance of contaminated sediments and potentially erosion of exposed banks once the existing channel concrete lining has been removed and prior to construction of naturalised channel treatments. This could result in temporary impacts to water quality within Whites Creek and Rozelle Bay during construction. Impacts are likely to be temporary until settling occurs and would be managed in accordance with DPI guidelines
- The project includes widening and improvement works to the channel and bank at Whites Creek Annandale to manage flooding and drainage. The channel form would be naturalised with works extending back to the railway bridge, adopting a similar philosophy regarding surface treatments to integrate with Sydney Water's proposed channel naturalisation works (see **section 4.2.1**). The naturalisation works would be finalised during detailed design but are likely to incorporate features such as sandstone blocks and vegetated benches to provide ecological benefits to the channel. The proposed channel bed and bank treatments would be hard lined therefore impacts to channel form and geomorphology are unlikely to occur once the works are complete. Any vegetated zones (eg benches) would be susceptible to erosion and should be protected during the vegetation establishment period
- Upgrades to drainage infrastructure and the major diversion of Easton Park drain would involve removal and upgrade of some existing drainage infrastructure, during which time the exposed, potentially contaminated soils and sediments may be highly susceptible to erosion and flow paths may be interrupted or diverted
- Relocation of utilities would involve earthworks to remove existing services and construct new service routes, during which time exposed soils may be susceptible to erosion. Further details of the proposed utility adjustments are provided within the **Appendix F** (Utilities Management Strategy)
- Construction of new stormwater outlets to receiving bays (Rozelle and Iron Cove), which would potentially cause localised mobilisation of sediments that might be contaminated. Disturbance of sediments could temporarily impact on water quality within proximity to new stormwater discharge points until settling occurs. Where new discharge points are utilised during construction, there is potential for bed scouring and mobilisation of sediments to occur during stormwater discharges. Impacts on water quality are likely to be localised for short periods during and after storm events until settling occurs.
- Construction of the project would result in construction wastewater discharges from Campbell Road tunnel site, draining via an existing outlet to Alexandra Canal. Due to the extra sensitivity of Alexandra Canal bed sediments (see **section 4.1.9**) a quantitative assessment was undertaken to assess the impact of the additional flows. Wastewater would discharge at a flow rate of approximately 1200 kilolitres per day (13 litres per second) (see **section 2.4.1**). This is slightly higher than the estimated 7 litres per second of treated water indicated in the New M5 EIS Technical working paper: Surface water (New M5 EIS Appendix N) to be discharging at the Ricketty Street bridge for that project via the existing drainage system. Existing scour protection and/or energy dissipation measures would minimise localised disturbance of contaminated sediments near to the outlet. The 13 litres per day would contribute an increase of 0.015 per cent (0.024 per cent increase when combined with the estimated New M5 flows) to the one year ARI flow of 83.9 cubic metres per second at Alexandra Canal's confluence with the Cooks River (PB-

MWH 2009). Given the proposed wastewater discharge rate is negligible in relation to existing flows within the canal, impacts on levels and velocities in the canal would also be negligible, hence disturbance of contaminated sediments is not expected to occur.

Management and mitigation measures (see **sections 2.4.1** and **8.2.1**) would be required to reduce the potential for surface water quality impacts arising during construction of surface works. Provided appropriate measures are implemented during construction, short term impacts are expected to be manageable with no material impact on receiving water quality.

Table 5-2 Construction water quality impact summary

Location/construction component	Potentially impacting construction activities	Potential surface water quality impact	Waterways potentially affected
<p>Civil and tunnel sites (excluding Rozelle and The Crescent) inclusive of their adjacent construction footprint including:</p> <ul style="list-style-type: none"> • C1a Wattle Street • C2a Haberfield • C3a Northcote Street • C1b Parramatta Road West • C2b Haberfield • C3b Parramatta Road East • C4 Darley Road • C7 Victoria Road • C8 Iron Cove • C9 Pyrmont Bridge • C10 Campbell Road 	<ul style="list-style-type: none"> • Vegetation clearance and topsoil stripping • Demolition works • Establish construction facilities, access and utility supply • Excavations • Concrete works • Stockpiling of spoil, construction materials and demolition materials • Relocation of utilities • Access and egress of vehicles to the site and public roads • Accidental spills / material drops during transportation of building waste from demolition sites with pollutants mobilised into waterways • Chemicals / fuel stored onsite • Operation of construction water treatment plant • Activities associated with construction for permanent works 	<ul style="list-style-type: none"> • Erosion and mobilisation of exposed soils, open cuts and stockpiles by stormwater runoff and wind leading to sedimentation of waterways • Exposure of acid sulfate soils or contaminated soils which if mobilised via stormwater runoff could acidify or pollute waterways • Dust, litter and pollutants associated with building materials and demolition waste being mobilised by wind and stormwater runoff into waterways. • Leakage / spills of hydrocarbons or other chemicals from machinery with pollutants conveyed by stormwater runoff into waterways • Increased alkalinity due to transport of chemicals used in treatment and curing of concrete and concrete dust to waterways by stormwater or wind • Vehicles transferring soil to adjacent roads and stormwater runoff conveying soil and pollutants into waterways • Poorly treated water from construction water treatment plant being discharged into stormwater network 	<ul style="list-style-type: none"> • C1a, C2a, C3a and C1b, C2b and C3b drain to Dobroyd Canal • C4 drains to Hawthorne Canal • C7 drains White Bay • C8 drains to Iron Cove • C9 drains to Johnstons Creek • C10 drains to Alexandra Canal
<p>Construction works at Rozelle including the Rozelle civil and tunnel site (C5), The Crescent civil site (C6) and wider Rozelle interchange construction footprint</p>	<ul style="list-style-type: none"> • Vegetation clearance and topsoil stripping • Demolition works • Establish construction facilities, access and utility supply • Excavations • Concrete works • Stockpiling of spoil, construction materials and demolition materials • Relocation of utilities 	<ul style="list-style-type: none"> • Erosion and mobilisation of exposed soils and open cuts by stormwater runoff and wind leading to sedimentation of waterways • Scour of exposed channel bank material during Whites Creek naturalisation works and subsequent soil mobilisation and sedimentation. • Exposure of acid sulfate soils or contaminated soils which if mobilised via stormwater runoff could acidify or pollute waterways 	<ul style="list-style-type: none"> • Rozelle Bay • Easton Park drain • White Bay • Whites Creek

Location/construction component	Potentially impacting construction activities	Potential surface water quality impact	Waterways potentially affected
	<ul style="list-style-type: none"> • Access and egress of vehicles to the site and public roads • Accidental spills / material drops during transportation of building waste from demolition sites with pollutants mobilised into waterways • Chemicals / fuel stored onsite • Operation of machinery • Operation of construction water treatment plant (C6 only) • Activities associated with construction for permanent works • Bridgeworks associated with new road and pedestrian bridges across and adjacent to Whites Creek • Whites Creek naturalisation works 	<ul style="list-style-type: none"> • Dust, litter and other building materials being mobilised by wind and stormwater runoff into waterways. • Leakage / spills of hydrocarbons or other chemicals from machinery with pollutants conveyed by stormwater runoff into waterways • Increased alkalinity due to transport of chemicals used in treatment and curing of concrete and concrete dust to waterways by stormwater or wind • Vehicles transferring soil to adjacent roads and stormwater runoff conveying soil and pollutants into waterways • Poorly treated water from construction water treatment plant being discharged into stormwater network (C6 only) 	
Potential new permanent drainage outlets to Rozelle Bay, Iron Cove and Whites Creek	<ul style="list-style-type: none"> • Construction of the outlets • Discharges from the outlets during construction 	<ul style="list-style-type: none"> • Mobilisation of sediments and contaminants within the sediments at outlet locations • Scouring of sediments at outlet locations 	<ul style="list-style-type: none"> • Rozelle Bay • Iron Cove • Whites Creek
Drainage infrastructure adjustments and upgrades	<ul style="list-style-type: none"> • Earthworks during drainage upgrades • Earthworks and construction of the Easton Park drain diversion 	<ul style="list-style-type: none"> • Mobilisation of exposed soils by stormwater runoff leading to sedimentation of waterways • Exposure of acid sulfate soils or contaminated soils which if mobilised via stormwater runoff could acidify or pollute waterways • Increased alkalinity due to curing of concrete 	<ul style="list-style-type: none"> • Iron Cove • Whites Creek • Easton Park drain • Rozelle Bay
Construction of new stormwater quality treatment facilities	<ul style="list-style-type: none"> • Vegetation removal • Earthworks to facilitate construction of the devices • Access and egress of vehicles to the site and public roads • Activities associated with construction for permanent works • Operation of machinery 	<ul style="list-style-type: none"> • Erosion and mobilisation of exposed soils and open cuts by stormwater runoff and wind leading to sedimentation of waterways • Exposure of acid sulfate soils or contaminated soils which if mobilised via stormwater runoff could acidify or pollute waterways • Leakage / spills of hydrocarbons or other chemicals from machinery with pollutants 	<ul style="list-style-type: none"> • Iron Cove • Rozelle Bay

Location/construction component	Potentially impacting construction activities	Potential surface water quality impact	Waterways potentially affected
		conveyed by stormwater runoff into waterways • Vehicles transferring soil to adjacent roads and stormwater runoff conveying soil and pollutants into waterways.	

5.4 Riparian vegetation

Appendix S (Technical working paper: Biodiversity) of the EIS indicates the works may require removal of planted native and exotic riparian vegetation for the upgrade of the intersection of The Crescent and City West Link. Water temperature is unlikely to be affected by the removal of riparian vegetation due to the shading provided by the proposed road and tidal influence. As Whites Creek is a concrete channel, the removal of vegetation would not impact on bank stability. New riparian vegetation would be established during the Whites Creek naturalisation works.

No direct impacts will occur to riparian vegetation at Dobroyd Canal, Hawthorne Canal, Iron Cove, Rozelle Bay, Johnstons Creek and Alexandra Canal as the construction footprint either lies outside of the riparian buffer or is on developed land.

6 Assessment of operational impacts

6.1 Water use

Surface water would not be extracted from any waterways for operation of the project. Opportunities for the reuse of treated stormwater or tunnel water would be considered for non-potable water uses in preference to discharge to the stormwater system or receiving waterbodies. This could include irrigation of landscaped areas by others within the Rozelle interchange and opportunities outside the project footprint such as Blackmore Park, Leichhardt.

6.2 Flooding and drainage

6.2.1 Operational related flood risk

The Rozelle interchange, Iron Cove Link and Darley Road site are partially located within the PMF flood extent, which has the potential to impact on the interchange and tunnel portals. The design standard is to prevent flooding of the portals for events up to the PMF or the 100 year ARI event plus 0.5 metres freeboard (whichever is greater). Therefore an exclusion strategy is required to prevent any floodwater ingress.

A water exclusion strategy has the potential to displace floodwaters where the interchange blocks existing flow paths, or reduces available floodplain storage, and thereby could impact surrounding properties. This is particularly the case at Rozelle Rail Yards as this area currently functions as a floodway and provides a significant amount of storage of floodwater in larger events such as the 100 year ARI and PMF.

Council emergency management and response procedures have not been assessed in detail as they are still under development as part of the Inner West Council's Floodplain Risk Management Study and Plan. The Inner West Council is currently working toward formation of a Floodplain Risk Management Committee for the new Council. There are no local NSW State Emergency Service (SES) flood plans for the area. The NSW State Flood Plan, which is a sub plan of the State Emergency Management Plan, has been reviewed. The design has taken into consideration the general recommendations set out in the NSW State Flood Plan with regards to managing flooding. The flood assessment has been undertaken in accordance with the Floodplain Development Manual (NSW Government 2005) and has sought to minimise adverse flood impacts. During the detailed design stage, once the design is more formalised, all relevant flooding information would be provided to council and SES and feed into the Floodplain Risk Management process. The process would also take into consideration safe entry to and egress and evacuation routes from the tunnels during floods.

The social and economic impacts from flooding during construction and operation may include damage to property and infrastructure and changes to mobility and access. However, the design of construction ancillary facilities and permanent operational infrastructure has been developed to avoid or minimise changes to flood behaviour in and around the project footprint. Potential damage to property and critical infrastructure would be assessed further using the detailed design, and if required, further refinements would be made to the temporary or permanent designs as required to minimise impacts. The social and economic impacts associated with flooding events during construction and operation are therefore forecast to be minor, localised, and likely constrained to short-term changes to access, mobility and potential disruption to services such as power and water supply.

Rozelle interchange

The proposed Rozelle interchange would provide connections between the M4-M5 Link mainline tunnels, City West Link, Victoria Road/Anzac Bridge and the Iron Cove Link. Below ground stub tunnels and entry and exit ramps at the surface would also be built to enable connections to the proposed future Western Harbour Tunnel and Beaches Link.

Due to the high risk of flooding posed to the Rozelle interchange, the design of the proposed layout and evolution of the road design was directly influenced by flood risk and drainage considerations.

An assessment of potential flood impacts at the Rozelle interchange was undertaken by modelling the installation of bunds/walls set at or above the PMF flood level (or 100 year ARI plus 0.5 metres, whichever is the greater) around the perimeter of three different portals/ ramps associated with the interchange to prevent floodwater ingress into the tunnel. Generally at the Rozelle interchange tunnel portals the PMF flood levels are greater than the 100 year ARI plus 0.5 metres levels.

No external flows would therefore enter the tunnels, but rainfall falling over the open tunnel dives would be captured by the tunnel drainage system. The tunnel drainage system would be designed to not only provide the required level of service during the operational phase of the project, but also the safety of people both within the tunnel and at the portals during floods.

The preliminary results for the 100 year ARI event indicated that there would be a re-distribution of flows due to the proposed changes to existing overland flow paths. Around the Easton Park drain (north of the Rozelle interchange) and along Whites Creek flood levels are expected to reduce following construction of the project due to the installation of more efficient drainage channels. In the remainder of the Rozelle Rail Yards site flood levels are generally estimated to be higher than existing due to the proposed new buildings and other infrastructure that are raised above ground for flood protection.

The proposed tunnel ventilation facilities, substation and water treatment plant would be located adjacent to the new western and northern channels and would be set above PMF flood level (or 100 year ARI plus 0.5 metres whichever is the greater).

Raising surface levels along the City West Link to prevent floodwater ingress into the Rozelle interchange was shown to influence overland flows spilling from Whites Creek (upstream and around The Crescent) during the PMF. The model indicated that raising of surface levels and obstruction of the overland flow path could lead to a potential increase in flood levels of up to 0.5 metres upstream of The Crescent in the 100 year ARI event, and had the potential to impact surrounding properties, in particular along Railway Parade. In order to retain the existing function of the site as a flood storage area and to minimise impacts in the 100 year ARI event (as per the design requirements), design changes were made to manage adverse impacts to an acceptable level.

In order to mitigate the potential increase in flood risk for surrounding properties due to the proposed Rozelle interchange, a number of measures have been incorporated into the development of the design, including:

- Provision of large transverse conveyance systems for the existing Easton Park drain and the catchment to the west, passing through the interchange under City West Link and discharging into Rozelle Bay
- Increase of the waterway area for the Whites Creek bridge structure under The Crescent.

The conveyance system modelled for Easton Park drain and the western catchment includes a 'low-flow' channel to carry flows of around a 2 year ARI event, with a defined landscaped overland flow path sized to convey larger flows up to the 100 year ARI. PMF flows would then spread across the adjacent open space areas. The western channel will cross under the proposed M5 to City West Link ramps and Western Harbour Tunnel ramps (within the Rozelle Rail Yards) before combining with the northern channel to then pass under City West Link to discharge into Rozelle Bay. The channels would range in width from around two metres to six metres and the overbank flow path from approximately nine metres to 18 metres through the Rozelle interchange. A typical cross section is shown in **Annexure C**. The large open channels and allowance for floodwaters to spread out onto adjacent areas compensates for the loss of informal flood storage that the Rozelle Rail Yards provide under existing conditions.

The flood modelling suggests that this approach, combined with improved local road drainage along Lilyfield Road to convey runoff to the channel, should manage potential impacts to an acceptable level, ie no adverse flood impacts to adjoining properties for the 100 year ARI event (see **Table 6-1**). Peak flood depths for the 10 year and 100 year ARI event and PMF under proposed design conditions are shown in **Figure 6-1** to **Figure 6-3**.

The proposed interchange limits raising of road levels for City West Link and The Crescent. Road crest levels have generally been kept to within 0.3 metres of existing levels to minimise flood impacts. Flood modelling has indicated that this would maintain the flood immunity of City West Link, but would

still allow floodwaters to overtop the road in extreme events such as the PMF. Adverse flood level impacts on the north of City West Link are generally contained within the project boundary in events up to the 100 year ARI. Where flood impacts extend outside the project boundary, the increases in flood levels are minor and localised which means there is unlikely to be significant impact on surrounding properties. In the PMF, potential flood level impacts of up to 0.04 metres are estimated to the east of Victoria Road. The design of the Rozelle interchange infrastructure would take into account increases in flood levels within the site.

To the south of City West Link along Whites Creek no adverse flood impacts are estimated in events up to the 100 year ARI (see **Figure 6-4**). The Crescent would be realigned to the west from its current alignment, roughly following the light rail corridor before crossing over Whites Creek. The new bridge has been designed for a 100 year ARI flood immunity. The skewed angle of the realigned The Crescent and additional lanes result in a wider bridge structure than under existing conditions. In order to achieve increased hydraulic conveyance to compensate for the wider bridge, the length of the new bridge is proposed to be increased to two 16 metres spans (total length of 32 metres). It is proposed that the topography of the land between the new bridge and Rozelle Bay (immediately to the south of Whites Creek on the right overbank) is re-profiled to provide a landscaped overland flow path. When the capacity of the Whites Creek channel is exceeded, floodwater would spill over the southern bank and pass underneath The Crescent and discharge into Rozelle Bay. Bridge piers are proposed to be located along the overland flow path and not within the main channel, to minimise flood impacts.

In the PMF, flood impacts of up to 0.4 metres are estimated along Whites Creek (see Figure 6-4). This is a result of the larger footprint of the proposed road embankments and wider bridge structure (compared to existing). Further widening of the Whites Creek channel is constrained by the existing light rail embankment and raising the road levels on City West Link would potentially raise flood levels. These changes in flood behaviour under PMF conditions would be investigated further during detailed design to confirm potential impacts on critical infrastructure and address changes in flood hazard as a result of the project.

Peak flow velocities outside Whites Creek and the new drainage channels will generally remain below 0.5 metres per second in the 100 year ARI (see **Figure 6-5**), similar to existing conditions discussed in **section 4.4.1**. At the new bridge over Whites Creek at The Crescent, peak flow velocities entering the bay are likely to increase due to the increased conveyance capacity of the new structure. Velocities for the new overland flow path under the bridge would be up to two metres per second. Appropriate scour protection of the new overland flow path and stabilisation of all the outlets to the bay would be required, including the upgraded outlet from the rail yards. This would be undertaken to prevent scour of potentially contaminated sediments in Rozelle Bay at the upgraded outlets. Peak flow velocities in the new drainage channels through the rail yards would generally be less than 1.5 metres per second. It is expected that peak flow velocities entering Rozelle Bay from the Rozelle Rail Yards would generally be less than two metres per second.

The flood hazard for the land in the vicinity of the interchange would not change substantially from existing conditions (see **Figure 6-5**). The new drainage channels through the Rozelle Rail Yards would be high hazard areas as they are formal conveyance systems similar to the Easton Park drain and Whites Creek. The overland flow paths through the rail yards would have a low flood hazard, which is consistent with flood hazards in recreational areas that are flood prone in the vicinity, such as Easton Park to the north of the rail yards.

The proposed drainage channels and new waterway structures would maintain the flood immunity of City West Link and The Crescent by providing 100 year ARI flood immunity in the vicinity of the interchange. Flood conditions along City West Link would be improved in events greater than the 100 year ARI and up to the PMF as a result of the project. Flood depths under existing conditions at the low point on City West Link to the north of the intersection with The Crescent are up to one metre in the PMF. Under proposed conditions these could be much reduced at only 0.5 metres.

The flood modelling undertaken suggests that the mitigation measures will minimise impacts on surrounding properties for the 100 year ARI event and therefore satisfy the required design standards. Refinements to the flood model will be required to inform the detailed design of the proposed interchange.

Iron Cove Link

The proposed Iron Cove Link includes:

- Two portals providing a connection to Rozelle interchange, west of the junction of Victoria Road and Terry Street
- Widening of Victoria Road to the south, between the eastern abutment of Iron Cove Bridge and Springside Street, in order to accommodate the project entry and exit portals
- Re-grading of road surface levels and removing some of the existing intersections with local roads
- Inclusion of a ventilation outlet and building.

Peak flood depths for the 10 year ARI, 100 year ARI event and PMF under proposed design conditions are shown in **Figure 6-7** to **Figure 6-9**. Within the Iron Cove Link, floodwater on the southern (westbound) carriageway heading towards Iron Cove Bridge reaches depths of between 0.5 metres and 0.8 metres in the 10 year ARI and PMF, respectively. This is associated with a topographic depression in the proposed road levels at this location.

Increases in flood levels are predominantly limited to within the Iron Cove Link and Victoria Road for the 100 year ARI and PMF event (see **Figure 6-11**).

There would be some localised flood impacts along the northern (eastbound) carriageway heading to the city. The catchment at Iron Cove Link generally drains from the north-east towards Iron Cove Link. Changes in road levels along the main alignment, in particular at the intersections with existing local roads could lead to localised flood impacts along the northern carriageway. These impacts would be managed through limiting the raising of road levels and through upgrading the road drainage system to manage changed overland flowpaths.

There is also a risk of flood impacts on adjoining properties at the edge of Iron Cove to the east of the alignment (see **Figure 6-11**). Between Terry Street and Iron Cove Bridge the portals would reduce the number of surface traffic lanes on Victoria Road from four lanes to three lanes. As the road acts a major overland flowpath the reduced road width would also mean a reduced flow path width and more concentrated flows. This could be managed through upgrading the road drainage network to compensate for the reduced overland flowpath width.

In order to minimise the residual risk of flooding of the road and the portals, the design of the road drainage system around the tunnel portals would need to manage surface runoff in this area, particularly for the southern tunnel due to the topographic low at this location.

The drainage network under Victoria Road would be upgraded to collect local surface water runoff draining to the portals up-gradient of Crystal Street and also at Terry Street. The water would then be diverted into a new drainage network and discharged into Iron Cove (see **Figure 2-4**). Barriers or flood bunds would be set at or above the PMF flood level (or 100 year ARI plus 0.5 m whichever is the greater) to provide protection to the exposed sections of the portal from runoff from the adjacent roads. In order to minimise the potential impact on surrounding properties, the road would be graded and kerb lines used to keep runoff away from the portals but within the road reserve and directed towards a discharge point into Iron Cove. Where possible the road runoff would be directed to the proposed new bioretention facility at Manning Street, within King George Park prior to discharge to Iron Cove.

Critical infrastructure such as the Iron Cove Link motorway operations complex (MOC4) and substation are proposed to be located at the southern end of the interchange. The sites would be protected from local stormwater runoff flooding the site through the provision of bunds around these sites or raising floor levels to the PMF (or 100 year ARI plus 0.5 metres whichever is the greater). At the Iron Cove interchange the 100 year ARI level plus 0.5 metres is usually greater than the PMF level.

Peak flow velocities within the Iron Cove Link area are up to 2.2 metres per second in the 100 year ARI, similar to existing conditions described in **section 4.4.1** (see **Figure 6-13**). The flood hazard for the land in the vicinity of Iron Cove Link also does not change substantially from existing conditions (see **Figure 6-14**).

Darley Road

The proposed Darley Road operational facilities would house an operational water treatment plant, for tunnel drainage, and a substation.

An assessment of potential flood impacts at the Darley Road site for events up to the PMF event was undertaken by assuming bunds/walls around the majority of the site in order to prevent floodwater ingress to the water treatment plant and substation. Flood protection for vulnerable infrastructure, such as the Darley Road motorway operations complex (MOC1) would need to be set at PMF flood level (or 100 year ARI plus 0.5 metres whichever is the greater). At the Darley Road site there are locations where the 100 year ARI level plus 0.5 metres is greater than the PMF level.

Peak flood depths for the 10 year ARI, 100 year ARI event and PMF under proposed design conditions are shown in **Figure 6-14** to **Figure 6-17**.

It was found the water exclusion strategy for the vulnerable infrastructure on the site (water treatment plant and substation) would lead to localised increases in flood levels on Darley Road and the light rail corridor (see **Figure 6-17** and **Figure 6-19**). Surrounding properties would not be adversely impacted in the events up to the 100 year ARI. In the PMF, minor flood impacts of up to 0.3 metres are estimated to the west of the site along Darley Road and Charles Street. Impacts on the light rail corridor would need to be managed in consultation with Transport for NSW by either providing a managed flowpath through the site, whilst still protecting vulnerable infrastructure, and/or by providing additional piped drainage systems.

Peak flow velocities along Darley Road would be similar as under existing conditions at 1.5 metres per second (see **Figure 6-20**). Provisional flood hazards would also be similar to existing conditions (see **Figure 6-21**).

Table 6-1 shows peak design flood depths for selected locations at the Rozelle interchange, Iron Cove Link and Darley Road for the 100 year ARI event.

Table 6-1 Peak design flood levels at selected sites - 100 year ARI (m AHD)

Location	Pre-construction	Post-construction*
Rozelle interchange		
The Crescent bridge at Whites Creek	3.00	2.75 (-0.25)
Culvert at City West Link	3.00	2.09 (-0.91)
Western channel upstream of tunnel portal bridge	3.00	2.33 (-0.67)
Iron Cove Link		
Victoria Road near Iron Cove Bridge	17.86	17.86 (+0.0)
Victoria Road near Crystal Street	25.56	25.72 (+0.16)
Manning Street	3.62	3.61 (-0.01)
Victoria Road near Callan Street	23.51	23.72 (+0.21)
King George Park	3.16	3.15 (-0.01)
Darley Road		
SLR stop	8.11	8.20 (+0.09)
Darley Road near Charles Street	3.29	3.29 (+0.0)
Darley Road near James Street	14.59	14.59 (+0.0)

Note: *: Values in brackets indicate change in peak design flood level compared to pre-construction conditions

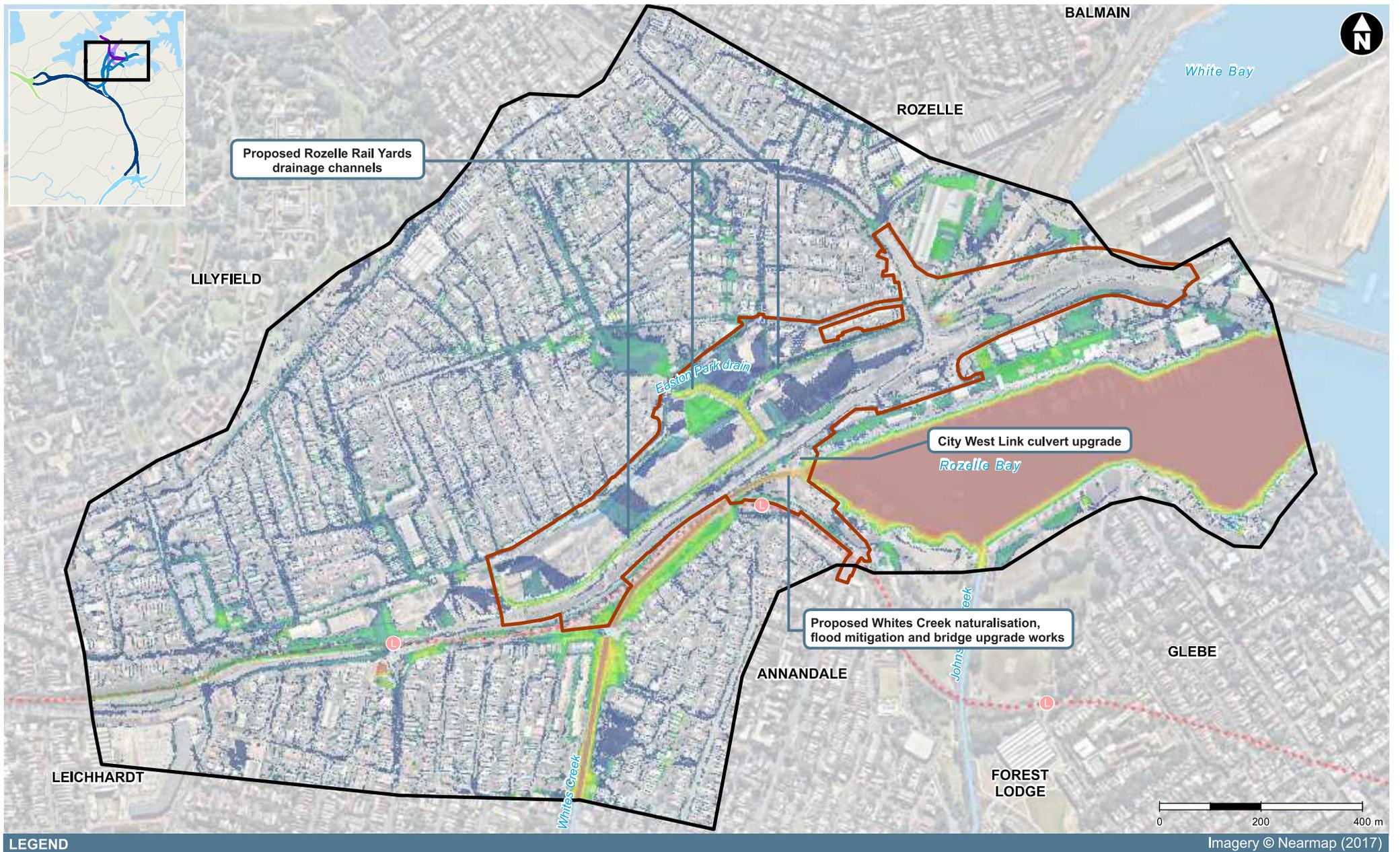


Figure 6-1 Proposed design conditions flood behaviour – Rozelle interchange - peak flood depths (10 year ARI)