

10. Other environmental issues

10.1 Operational surface water management

An *Environmental Assessment – Surface water assessment* report was prepared by AECOM, dated February 2010 and this section presents a summary of that assessment.

The assessment includes the identification of potential impacts and mitigation measures pertaining to flooding, stormwater and water quality, and implications for watercourses.

The objectives of this assessment included:

- Define the existing environment with respect to surface water aspects such as
 - The interaction of the M2 Motorway and its transverse culvert drainage structures on flooding for surrounding areas.
 - The quality of surface water runoff from the M2 Motorway and the receiving water environment from operation.
- Quantify the nature and extent of potential impacts on the above elements due the operational phases of the project.
- Identify appropriate mitigation measures to address and ameliorate impacts.

The following key issues were considered and addressed as part of the environmental assessment. These address the stormwater and watercourse implications component of the DGRs listed above:

- Description of the stormwater treatment and outlet works.
- Measures to minimise the potential erosion impacts on watercourses
- Identification of sources of polluted water at project sites on surface roads and in tunnels during operation.

10.1.1 Existing environment

The existing soils, aquatic and water quality environments are described in Section 9.8.1 and in Technical Paper 6.

Flooding

The original design of the existing M2 Motorway was undertaken in 1995-96 with construction completed and the M2 Motorway opened to traffic in May 1997. Detailed information relating to the assumptions and basis for the original Motorway design of drainage elements are limited. Copies of the design drawings and some work as executed information have been obtained but the supporting design calculations, reports or technical models were not available for review. The investigations undertaken for this current assessment have therefore relied upon the limited details that were already available along with some new information specifically gathered while developing the upgrade concept.

The following survey information was initially available for the purposes developing the design concept and associated investigations:

- Two metre topographical mapping contours for the surrounding region.
- Photogrammetric survey within the corridor, excluding the pavement area, obtained from Ausimage (SKM).
- Detailed survey of the M2 Motorway surface between the existing barriers and from previous studies.
- Additional surveys obtained by surveyors for the project team in January 2009 to specifically assist with the hydraulic investigations and the detail design process in general.

To quantify the existing general flood conditions and to establish the relative impacts of the proposed upgrade works, hydrologic and hydraulic analyses were undertaken. To accommodate for increased variability in rainfall that may result from climate change, the performance of the affected structures was conservatively assessed. A 20 percent increase in flows was allowed for, to accommodate significant issues or risks should the future situation be different to existing or the assumed designed conditions as a result of climate change.

The analyses and results are considered suitable for the intended purposes of quantifying the existing situation and the potential impacts attributable to the widening works.

To quantify if the proposed upgrade works would impact on flood levels and flow velocities, local surface water catchments draining to and across/through the M2 Motorway were hydrologically modelled to determine peak flow estimates applicable for design and hydraulic modelling. The hydrologic modelling of the urbanised catchments has been based on the XP-Rafts runoff-routing software. Hydrologic models were established for the Devlins Creek, University and Shrimptons Creek catchments.

Hydraulic modelling has involved a combination of headwater calculations for the smaller culvert structures which primarily operate under inlet control, while detailed HEC-RAS modelling has been undertaken for the larger waterways where structures are more influenced by hydraulic gradients or potential downstream tailwater conditions. The waterways modelled hydraulically include Devlins Creek, University Creek and Shrimptons Creek.

For the purposes of this study, existing flood conditions in the 1 in 100 year ARI design event have been estimated for the seven transverse culvert structures which are to be extended due to the widening works. A long reach of Devlins Creek extending from Beecroft Road to just upstream of Kirkham Street and the upper M2 Motorway crossing (Culvert 23), effectively runs parallel to the M2 Motorway and incorporates or influences a number of culvert structures. Additionally, sections of the M2 Motorway adjacent to the creek are to be widened. Consequently this entire reach was modelled using HEC-RAS. The structures and adjoining reaches immediately upstream and downstream of the M2 Motorway at University (Culvert 35) and Shrimptons Creeks (Culvert 36) were modelled separately also using HEC-RAS. Culverts 13, 18, 26 and 30 were analysed using HY-8 culvert analysis software.

The estimated 1 in 100 year ARI flood extent for the upper and lower reaches of Devlins Creek under existing conditions is presented in Figures 13 and 14 of Technical Paper 6. Along the entire length of the reach modelled, the flood extent is typically contained within the riparian bush zone which is bounded by the M2 Motorway embankment on one side and residential development on the other. Large precast concrete arch culvert structures are used for the main M2 Motorway crossings of Devlins Creek (Culverts 23, 24, 27 and 28) with only Culvert 23 to be extended by 4.9 metres due to the widening works.

The existing flood behaviour for University Creek in the vicinity of the M2 Motorway (refer Figure 15 of the Technical Paper 6) appears to be influenced by a number of manmade features. Flows from the

upper catchment are initially controlled by a large diameter pipe and inlet structure immediately upstream south of Talavera Road. The pipe flows are conveyed under the road and the building on the property located upstream of the M2 Motorway to discharge into an open channel near the inlet of the existing Motorway culvert (Culvert 35). Excess flows that surcharge across Talavera Road, drop over a concrete weir (wall) where they are then directed overland through the property car park into another drop inlet structure and large box culvert which discharges into an overgrown gabion and rock mattress lined channel running eastwards alongside the westbound (southern) side of the M2 Motorway. The channel drops one metre into the M2 Motorway culvert inlet. Whilst this culvert was designed to convey a 1 in 100 year ARI design flood during original construction, preliminary results of the hydraulic analyses conducted as part of this assessment have indicated that the 1 in 100 year ARI flood levels in this area may be higher than the adjoining motorway, which may then be overtopped in the existing situation.

Further modelling would be required to confirm the existing hydraulic conditions at this location, which are outside the scope of this assessment. The current assessment is considered adequate for the purpose of predicting relative changes in culvert performance due to the proposed upgrade works.

At Shrimptons Creek, the hydraulic profile and results summarised in the Technical Paper 6 indicates that the existing property access bridge, located just upstream of the M2 Motorway boundary, is constricting the waterway and appears to be controlling flood levels in this area. Downstream of the bridge as the channel drops quickly through the large arch culvert structure (nearly three metres in elevation difference from the bridge to the arch outlet), the steep nature causes flow in the reach to the inlet of the arch to become super-critical (below the normal water level based on the geometric properties of the waterway area). The 20 x 6 metre arch itself has sufficient capacity to convey the 1 in 100 year ARI design flow.

10.1.2 Impact assessment

Proposed upgrade works

A brief description of the proposed upgrade works pertaining to surface water drainage elements structures within each of the precincts is in Section 9.8.2. A full description is provided in Section 6.3.9 and Technical Paper 6.

Flooding

The flooding impacts of the proposed upgrade works for the project have been assessed. The varying nature and extent of the proposed widening along the route means that only seven of the 26 existing transverse culvert drainage structures are affected by the widening to such an extent that they require extension. The lengths of these extensions vary from a minimum of 2.4 metres to a maximum of 17.1 metres (both for the same Culvert 35) with the remainder generally falling in the range of 4.9 metres to 8.5 metres.

Each of the affected structures has been modelled to establish 1 in 100 year ARI flood levels for both the existing and proposed conditions. A summary of the flood level and velocity results is presented in Table 102.

Table 102 Hydraulic impacts – 1 in 100 year ARI event

Culvert		Analysis	Design Flow (m ³ /s)	Upstream Flood Level (mAHD)		Relative Impact (metres)	Outlet Velocity (metres/s)		Relative Impact (metres/s)
ID	Chainage			Existing	Proposed		Existing	Proposed	
13	5250	HY8	4.5	78.84	78.84	0.00	6.36	6.44	0.08
18	7560	HY8	5.3	73.05	73.05	0.00	6.66	6.66	0.00
23	10550	Hecras HY8	110	85.56	85.56	0.00	1.34	1.34	0.00
				86.11	86.12	0.01	2.93	2.93	0.00
26	11640	HY8	14.8	78.81	78.83	0.02	2.58	2.58	0.00
30	13500	HY8	19.3	48.02	48.02	0.00	3.91	3.96	0.05
35	16220	Hecras	41	41.51	41.41	-0.10	2.96	4.49	1.53
36	16450	Hecras	190	32.91	32.91	0.00	3.68	3.68	0.00

There are no significant increases in flood levels that would potentially impact on upstream or adjoining properties (results documented in Table 102). Culvert 26 (refer Figure 9 of Technical Paper 6), is the only location where a potential impact has been identified and this is limited to maximum increase is only 0.02 metres, which should not adversely affect surrounding properties. At University Creek (Culvert 35), the proposed channel works (refer Section 2.7 of Technical Paper 6), would reduce flood levels at the culvert by 0.1 metre and in the upstream reach by between 1.0 to 1.5 metres thereby improving the existing situation and reducing the risk of the M2 Motorway being overtopped.

It is not proposed to alter the waterway area (cross sectional dimensions) of the existing culvert structures and as such the changes in outlet velocity are typically less than 0.1 metres per second. Such small changes are considered to be negligible relative to the velocities already prevailing at the existing outlets and in the adjoining downstream creek sections. The only exception is for University Creek/Culvert 35, where increasing the length of the relatively steep existing culvert grade with improvements to the channel upstream has increased the outlet velocity. An energy dissipater at the relocated outlet together with other possible detail design measures (channel and inlet configurations, grade changes, increased culvert roughness or downstream dimensions) would be provided to address this increase.

In addition to the individual transverse culvert crossings, the M2 Motorway is to be widened along the reach running parallel to Devlins Creek. For the reach between Chainage 10580 to 11100 (refer Figure 8 of Technical Paper 6) the proposed design concept is to construct the carriageway supported on piers and as a structurally cantilevered section to overhang the creek. This concept has been modelled in HEC-RAS and found to have minimal impact (<0.01 metres) on flood levels.

Water quality of stormwater runoff

During the operational phase, the potential water quality impacts attributable to the widening works would be an increase in pollutants associated with changes in the contributing catchment characteristics (increase in percentage of imperviousness or the overall total surface area resulting in larger volumes of runoff to be treated).

The pollutant types associated with the operation of the M2 Motorway contained in this runoff include:

- Gross pollutants (such as litter).
- Sediments and suspended solids.
- Nutrients.
- Heavy metals.
- Organics, oils and surfactants.
- Accidents/chemical spills.

Minimising the transportation and discharge of sediments, suspended solids, heavy metals and PAHs from the M2 Motorway is the key objective for the operational phase.

In order to assess the potential impacts associated with the M2 Motorway widening, preliminary computer modelling using the MUSIC software (Version 3, 2005) has been undertaken for a selection of the existing basins affected by the works. MUSIC is a quantitative model used to determine the impacts of catchment change on the water quality of runoff. Nine basins were selected to provide a representative sample of the range of changes in contributing catchment areas including those with the largest percentage increases. For the 22 others they are either not affected by the widening works or the increase in area is less than 10 percent.

Models defining the existing catchment characteristics were initially set up for each of the selected basins to establish a baseline performance representative of current Motorway conditions. The models were then modified to reflect changes in percentage imperviousness or increase in catchment area and thus quantify what potential impacts may be created by the widening works alone.

The pollutant loads estimated from the MUSIC model for the current and proposed widened Motorway conditions are summarised in Table 103. The base parameters adopted for purposes of the MUSIC modelling along with more detailed results are presented in Technical Paper 6.

Table 103 Estimated catchment pollutant loads pre and post M2 Upgrade project

Basin	Chainage	Change in total Area percent	Existing Catchments			Proposed Widened Catchments		
			TSS	TP	TN	TSS	TP	TN
8b	3580	51.5	5610	9.67	34.7	9600	16.2	56.1
12b	4770	10.4	8840	14.9	52	9760	16.6	57.5
13b	5360	12.9	10100	17.2	60.8	11000	18.5	66.7
23b	10510	5.8	9490	16	54.7	10100	16.9	57.6
25b	11310	5.9	8990	15.2	51.5	9690	16.3	55.3
30b	13470	38.3	7190	12.1	41.8	9930	16.7	57.2
33b	14860	17.6	4720	7.92	27.4	5630	9.48	32.6
35c	16285	43.3	3120	5.28	18.1	4660	7.84	26.9
36b	16500	58.8	5150	8.69	30.1	8040	13.6	47.4

Note: TSS = Total Suspended Solids, TP = Total Phosphorus, TN = Total Nitrogen; pollutant loads expressed in kg/year.

Further model changes were then introduced to demonstrate the resultant treatment effectiveness (reduction in potential pollutant load impacts) following implementation of proposed basin modification works. The proposed works primarily involve changes to the inlet and outlet details in order to better utilise the existing storage volume available. All of the basins currently have a one metre freeboard above the top water level (TWL – the normal operating level for capturing and treating the low flow events) and at least 0.5 metres freeboard above the maximum water level (MWL – the highest water level reached in the basin before excess overflows are discharged directly from the basin itself).

Initial modelling results suggest that increasing the ponded (extended) depth by approximately 0.2 metres to 0.3 metres would generally cater for treating the increase in runoff volumes generated by the changes in catchment area. Given that a majority of basins are situated below the M2 Motorway level in downstream bushland areas, it should be feasible to accommodate such relatively small increases in depth without adversely affecting the hydraulic performance of the upstream drainage systems whilst still maintaining some freeboard of 0.2 metres to 0.3 metres.

A comparison of the treatment effectiveness results (percentage reduction of pollutant loads discharged) is included in Table 104 with more details available in Technical Paper 6 have not been included as the current and proposed basin arrangements provide 100 percent capture.

Table 104 Water quality treatment train effectiveness

Basin	Percentage Reduction						Relative Difference (percent)		
	Existing Basin			Proposed Basin					
	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN
8b	85.4	68.8	20	85.4	68.9	18.7	0	0.1	-1.3
12b	80.3	64.5	16.1	80.9	64.6	16.4	0.6	0.1	0.3
13b	71.3	56.1	14.2	72.3	57	14.9	1.0	0.9	0.7
23b	77.2	61.8	15.9	77.6	62.1	16.2	0.4	0.3	0.3
25b	81.5	65.8	17.1	81.3	65.9	17	-0.2	0.1	-0.1
30b	84.8	68.6	17.6	84.8	68.8	17.4	0	0.2	-0.2
33b	85	69.1	21.1	84.9	69.1	20.6	-0.1	0	-0.5
35c	81.8	65.9	17.1	81.5	65.6	16.8	-0.3	-0.3	-0.3
36b	87.9	72.1	23.8	87.7	71.7	23.3	-0.2	-0.4	-0.5

Note: TSS = Total Suspended Solids, TP = Total Phosphorus, TN = Total Nitrogen. Negative values indicate that treatment train effectiveness is reduced after the upgrade.

The modelling results in Table 104 indicate that the existing basins are performing well and except for TN appear to be achieving treatment efficiency levels (or percentage pollutant reductions) which are generally greater than or in accordance with the stormwater treatment objectives for NSW, which are also outlined in Australian Runoff Quality (ARQ Table 1.2) being:

- TSS reduction of 80 percent.
- TP reduction of 45 percent.
- TN reduction of 45 percent.
- Gross Pollutants 100 percent.

The City of Ryde has also set out pollutant reduction objectives in the March 2009 Development Control Plan for Water Sensitive Urban Design which targets 85 percent for TSS, 60 percent for TP, 45

percent for TN and 90 percent for gross pollutants. These objectives are greater than those required by ARQ but the modelling results suggest that with the exception of TN these values are also mostly being achieved under existing conditions. Following the proposed widening of the M2 Motorway, the modelling results suggest that the existing basins would still have sufficient capacity/performance to be able to satisfy the treatment objectives of ARQ without substantial modification.

There are some situations where a large reduction in Total Nitrogen is not practical to achieve due to the size of basin which would be required. Nitrogen loads are often due to atmospheric fall-out rather than being sourced from M2 Motorway activities and typically large water surface areas (such as wetlands) are required for treatment purposes. In this instance, the potential size or footprint of basins are more often constrained by the prevailing topography and limited corridor area available whilst trying to minimise disturbance of the surrounding environment and established vegetation. A reduction in TN in the order of 15 – 25 percent has been found to be generally achievable given the prevailing constraints and this is also consistent with the existing level of treatment efficiencies (the current situation is not exacerbated).

Overall, the various analyses undertaken using MUSIC modelling indicate that the pollutant loads are proportionally related to the changes in catchment area. The results also show that these impacts are manageable through modifications to the existing basins and it is possible to achieve the treatment efficiency objectives required by ARQ for TSS and TP. Additionally, the treatment performance levels achieved would be similar to the existing situation including TN.

10.1.3 Mitigation measures

Flooding

The options for managing potential increases in upstream flood levels are largely constrained by the existing size and location of the previously constructed transverse culvert structures. The typical presence of retaining walls and a narrow corridor width is also a limiting factor. The concept design therefore generally proposes to construct new, or modify existing, retaining walls over inlets/outlets affected by the widening works to minimise the need for extending the culvert structure. This approach would ensure there would be minimal additional upstream impacts (increase in flood levels) created and the need for disturbance of the surrounding environment is also reduced.

For the few culvert structures that are to be extended and may cause flood level impacts, the proposed mitigation measures include modifying the inlet details to ensure hydraulic efficiencies are optimised and therefore losses and upstream impacts are minimised, thereby keeping the length of required extensions to an absolute minimum.

Energy dissipaters and scour protection measures downstream of the culvert outlets would be modified and/or reconstructed to suit. Depending on the extent or nature of modification to the existing outlet structures, these scour protection works would largely reproduce the existing measures which generally comprise either concrete dissipaters, rock mattress and/or dumped rock rip rap.

Just downstream of Kirkham Street, between Chainage 10580 to 11100 (refer Figure 13 of Technical Paper 6) the M2 Motorway is to be widened on the westbound (southern) side where it would potentially impose on Devlins Creek and its floodplain, which runs in parallel along the M2 corridor. In order to minimise impacts on the waterway area of the creek and floodplain, the concept design proposes to construct a concrete deck carriageway structure supported on piers (10880 to 11100) and as a cantilevered section (10580 to 10880) overhanging the floodplain area. Consequently, there would be little to no change in flood behaviour along this reach.

At University Creek (Culvert 35), the property immediately upstream of the M2 Motorway is currently affected by overland flooding from upstream and in a 1 in 100 year ARI event and the M2 Motorway may be overtopped.

The proposed works include replacing the existing overgrown gabion and rock mattress lined channel, which runs along the upstream (westbound) side of the M2 Motorway, with a concrete lined channel. The new channel would provide greater flow capacity than is currently available which would be sufficient to mitigate the impacts of the proposed widening as well as improve the existing flood situation. An open traffic barrier, such as wire rope or guard rail, would be utilised along this reach to allow for potential overtopping of the M2 Motorway in the larger flood events. Special attention would be afforded to transitioning the channel into the culvert inlet in order to ensure hydraulic losses are minimised and the potential culvert performance is optimised. Increased velocities within the channel and at the culvert outlet would require additional consideration, such as energy dissipation, during detail design to reduce the hazard and prevent scouring of the downstream reaches.

Where piers are required for widening of the main bridges (Darling Mills, Devlins or Terrys Creeks) these are generally located out of the main creek waterway and unlikely to create additional hydraulic impacts and wherever possible the new piers would be aligned with the existing to minimise the potential to interfere with stream flows. Appropriate scour protection in the form of dumped rock rip rap would be provided where required.

Water quality of stormwater runoff

As a general guiding principle for both design and construction, water quality mitigation and management measures would be implemented in accordance with the requirements of:

- Water Policy and Code of Practice for Water Management (RTA 1999).
- *Managing Urban Stormwater - Soils and Construction* Volumes 1 and 2 (often referred to as The Blue Book – Landcom 2004 and 2008).

A summary of measures likely to be implemented for the operational phase is provided below.

The existing water quality basins would be modified as required to account for material changes in contributing catchment area or to meet the target pollutant reduction criteria. Due to the constrained project corridor, and in an effort to minimise further disturbance of the established vegetation, wherever practical it is proposed to modify the inlet/outlet details of the existing basins to better utilise the storage volume already available by increasing the ponded (extended) depth. The majority of existing basins appear to have been designed with up to one metre of freeboard above the top water level (TWL) and 0.5 metres above the maximum water level (MWL). The required increases in depth are typically directly proportional to the percentage increase in catchment area.

The change in contributing area is less than 15 percent for more than half of the existing basins and storage depths are in the order of one to two metres, so the required increase in depth would mostly be in the range of 0.15 metres to 0.3 metres, which should not present major problems or issues to achieve. In a number of instances however, it would be necessary to enlarge the basin to cater for the additional volume of runoff requiring treatment. In some instances the solution would involve a combination of increasing area and depth so as to minimise the actual disturbance footprint for the basin. The final solution would ultimately be determined during the detailed design phase once the additional survey information has been obtained and further modelling/investigations are undertaken.

The basins would be used to treat the low flow runoff 'first flush' from the M2 Motorway pavement surfaces. Basin 30b which is located just to the east of the Norfolk Tunnel would additionally be modified to incorporate measures for dealing with tunnel wash down water from maintenance activities.

The spill containment capability afforded within the existing basins would be retained and upgraded or enhanced as appropriate to minimise the risk of accidental spills or contaminants discharging freely to the downstream environment. Operational procedures would be reviewed to ensure the relevant incident response plans are updated to address changes or issues attributable to the upgrade works. Maintenance plans and schedules would also be reviewed and updated as appropriate.

Protection of watercourses

Watercourses would be protected from changes to the hydrology of their catchments through the appropriate design of culverts and the re-design of the water quality basins. Appropriate energy dissipation and scour protection measures would be provided at bridge waterways and culvert inlets/outlets as necessary. Permanent scour protection requirements particularly at culvert outlets would be implemented as soon as practical. Surface areas disturbed by the construction works would be re-established with landscaping.

The re-design of the water quality basins would ensure that water of an appropriate quality is delivered downstream to the watercourses.

10.2 Groundwater management

An *Assessment of Groundwater Impacts – M2 Upgrade project* report was prepared by Coffey Geotechnics, dated December 2009 and a summary is presented below.

This assessment included the identification of potential impacts to groundwater due to both the construction and operational phases of the proposed upgrade. Potential impacts were assessed at key locations where the groundwater table could be intercepted or affected by activities associated with the project. Potential impacts were based on the activities proposed at each of the following key locations:

- Norfolk Tunnel.
- Long cuts of mostly Hawkesbury Sandstone at four reaches along the M2 Motorway.
- Darling Mills Creek Bridge.
- Barclay Road Bridge.
- Devlins Creek Bridge.
- Kirkham Street Overbridge.
- Beecroft Road Overbridge.
- Terrys Creek Bridge.
- Christie Road Overbridge.
- Khartoum Road Underbridge.
- Somerset Street Bridge.
- Windsor Road Bridge.
- Certain detention basins.

As the project involves the upgrade of an existing M2 Motorway with no known groundwater issues, a qualitative analysis only has been conducted to identify and assess potential impacts associated with the current scope of works.

10.2.1 Existing environment

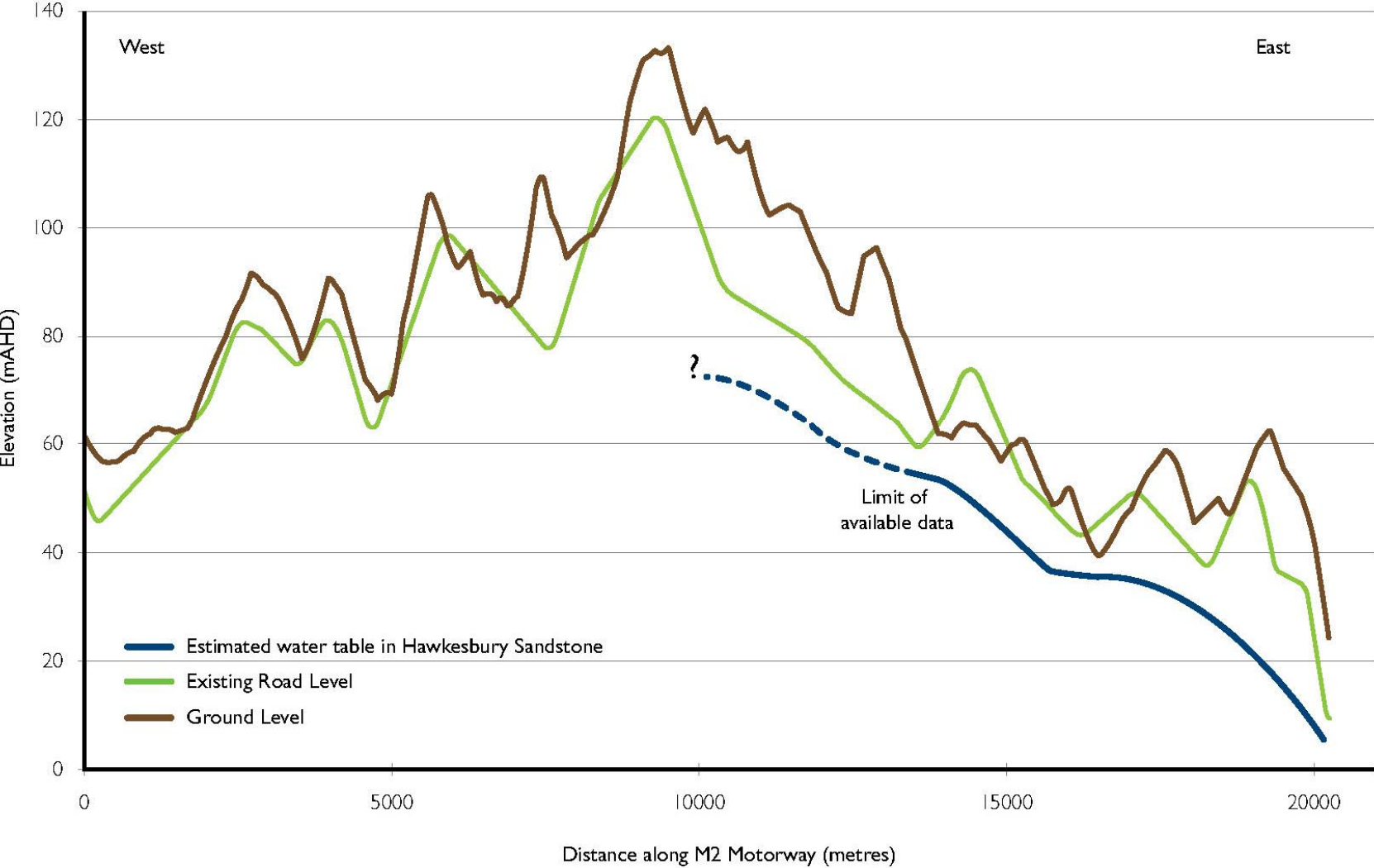
The M2 Motorway alignment crosses ground comprising mostly Hawkesbury Sandstone, overlain by varying thickness of alluvium at creeks or residual soils on higher ground. Ashfield Shale of the Wianamatta Group is present in some elevated areas. The major aquifers comprise:

- Hawkesbury Sandstone.
- Limited parts of alluvium associated with the main drainage channels.

The M2 Motorway is located entirely within the Parramatta River / Sydney Harbour catchment. The most important subcatchments are Darling Mills Creek, Devlins Creek, and Terrys Creek.

Figure 38 displays a long section along the existing M2 Motorway which shows the height of the groundwater table where known from other infrastructure projects. Water level data for the western part of the alignment is not yet available and is expected to be collected during geotechnical drilling prior to commencement of construction.

Figure 38 Long section of groundwater depth along M2 Motorway



Source: Coffey Geotechnics Pty Ltd, 2010

Groundwater levels in the vicinity of the M2 Motorway (2 kilometres either side) vary between sea level at Lane Cove River to around 70 metres Australian Height Datum (AHD) further west (where known). Typically groundwater slopes downwards around 30 metres per kilometre towards the Lane Cove River. However the groundwater level is uneven due to the variable topography created by the Hawkesbury Sandstone landforms. The shallowest groundwater levels occur at or near the surface at creek systems such as Terrys Creek and Shrimptons Creek. The deepest groundwater levels are expected to occur around the centre of the M2 Motorway in the vicinity of Pennant Hills Road where the ground surface is highest.

Groundwater flow direction in the upper Hawkesbury Sandstone is generally towards the Lane Cove River (to the northeast) in the eastern region of the M2 Motorway. The Ashfield Shale is likely to be unsaturated in the vicinity of the M2 Motorway, except where it may reach an appreciable thickness and thereby be more likely to maintain some saturation at the base.

The presence of seepage faces at existing cuts and in the Norfolk Tunnel is not apparent from visual inspection, nor is their presence expected, based on available information on groundwater levels in the area.

Groundwater quality within the Hawkesbury Sandstone is generally good. Electrical conductivity, which is an indicator for salinity, is generally low in comparison with groundwater in shale-based parts of the Sydney Basin. The pH is slightly acidic or close to neutral which generally indicates good water quality. The sandstone tends to have naturally elevated iron concentrations.

There are no known groundwater dependent ecosystems in the vicinity of the M2 Motorway (refer to Section 9.5).

10.2.2 Impact assessment

It is not anticipated that the groundwater table would be encountered for the majority of works associated with the project. The situations in which groundwater may be encountered include excavations in close proximity to the major watercourses in the study area (for example, bridge footings) or where substantial subsurface works are proposed well below the existing ground surface levels (for example, tunnel widening). Groundwater impacts may also occur at locations where surface water is intercepted and collected, such as the sediment basins along the road alignment. Potential impacts to groundwater are discussed in the following sections.

Potential excavation into the groundwater table

Given the known groundwater levels in the fractured rock aquifer and its low permeability, groundwater seepage to each excavation during installation is likely to be minimal.

Where the groundwater level is above the base of a pile or footing, the impact of the piles and footings on the groundwater regime in the long term is expected to be negligible given:

- The size of each pile or footing compared to the available subsurface cross-sectional flow area (meaning that they would not provide significant barriers to groundwater flow).
- The relatively inert material (concrete).

Groundwater recharge

Runoff from the M2 Motorway is diverted to 31 detention basins whose primary function is management of runoff water quality. The widening works would increase the amount of paved area of the M2 Motorway by approximately 20 percent (based on calculations of changes to the areas of micro-

catchments associated with the detention basins). This area of paved M2 Motorway represents less than two percent of the catchment areas of the local waterways thus the catchment area for the local waterways is reduced by less than two percent. Overall, groundwater recharge from infiltration from the basins is not expected to change significantly from current conditions.

The increased area of the M2 Motorway would decrease the rainfall recharge to the catchments of the local waterways by a negligible amount. Stormflows of local waterways (accepting water from the detention basins) would increase slightly. The increased stormflow may increase recharge near the waterways by a very small amount. Recharge to the groundwater system from current detention basins is considered to be very small and is not expected to change from enlargement of some of the basins. Groundwater quality of the Hawkesbury Sandstone is therefore not expected to be impacted by the development beyond the current impact of the detention basins.

Groundwater flow

Additional cutting in the Norfolk Tunnel is not expected to significantly change the geometry of the seepage face at the tunnel wall, given the small change relative to the size of the sandstone hill.

No groundwater extraction is expected to be undertaken during construction or operation, and no waste water would be disposed to groundwater systems.

Due to the method and relative extent of pile / footing installation, and the small magnitude of widening of the tunnel and existing cuts (being relatively small in comparison to potential recharge galleries for the seepage faces where they may be present), existing groundwater levels and flow are not expected to be impacted by the upgrade either during construction or operation.

Groundwater quality

M2 Motorway runoff that is diverted to the detention basins would eventually evaporate (with only minor infiltration from some basins) or continue flowing downstream during subsequent storm events after mixing with additional runoff. Existing surface water quality control measures (including monitoring) would be sufficient to ensure that the impact to groundwater would be low.

Existing groundwater users

A review of existing groundwater bores in the vicinity of the M2 Motorway was conducted by referencing the NSW State Government Groundwater Works website, where records of individual bores can be obtained. Some registered bores were identified in the vicinity of the M2 Motorway. Most of these bores are screened in the sandstone. The closest bore (GW105547) is located just over 200 metres from the M2 Motorway, which is 306 metres deep and is cased to two metres depth, its water supply is from sandstone.

Since the bridge footings would mostly penetrate sediments only, the upgrade is unlikely to impact groundwater levels and quality above impacts already sustained from the existing M2 Motorway, therefore it is expected that there would be negligible impact on groundwater users.

10.2.3 Mitigation measures

Impacts to groundwater from the M2 Upgrade project are likely to be limited to widening of existing cuts and the Norfolk Tunnel. However, the presence of seepage faces is not apparent from inspections undertaken, nor is their presence expected.

Groundwater systems most at risk would be perennially saturated high permeability sediments, with shallow groundwater levels, associated with drainage channels, however previous work for the Chatswood to Epping Rail Link indicated no such systems to the east. As such groundwater monitoring bores are not planned.

Table 105 identifies mitigation and management measures that would be implemented for the management of potential groundwater issues. Provided they are managed appropriately these measures would be sufficient to ensure that the impact of the project on groundwater is negligible.

Table 105 Groundwater mitigation and management measures

Potential impact	Mitigation and management measure
Instability of excavation walls and higher groundwater inflow, particularly where higher permeability sediments are encountered.	Temporary casing is installed to limit groundwater inflow, because the pile is usually installed in a hole without water. Where required, applications would be made and licences obtained, prior to groundwater being pumped from footing excavations.
Inflows to the footing /pile excavation occurring in the fractured rock aquifer.	Temporary casing would be installed to seal off the hole. Where required, applications would be made and licences obtained, prior to groundwater being pumped from footing excavations.
Damage to the local environment from inappropriate disposal of groundwater.	Where necessary, groundwater would be pumped out and, depending on disposal method, appropriately treated prior to discharge.
Infiltration to groundwater from sediment basins.	The basins are generally lined with concrete or clay, however this depends on the nature of the foundation and some basins may allow some minor infiltration, which would have a negligible effect on the groundwater aquifer.
Contamination of groundwater from sewage disposal.	Sewage from amenities blocks (during construction) would be disposed of appropriately.
Adverse impacts to groundwater including interception of the groundwater table and contamination of groundwater from construction work.	Existing surface water mitigation measures, combined with the method of installation of piles / footings, are considered adequate to manage the increase in run-off and would be sufficient for limiting the impacts of the upgrade works on the groundwater system to negligible levels above current impacts.

10.3 Contamination

A *Phase 1 Contamination Assessment* report was prepared by Coffey Environments Pty Ltd, dated December 2009 and a summary is presented in this section.

10.3.1 Existing environment

The M2 Motorway comprises areas of cut, retaining walls and fill embankments. The project would require the development of existing areas of bushland and urban areas. Whilst the majority of the activities associated with the M2 Upgrade project would not impact existing structures, several detention and sedimentation basins located along the M2 Motorway may be impacted. These basins may be redeveloped or relocated and existing retaining walls within the M2 Motorway may require reconstruction.

The '*Groundwater in New South Wales Assessment of Pollution Risk*' (1987) compiled by the Hydrogeological Unit, Department of Water Resources NSW (scale 1: 2,000,000) indicates that the subsurface of the site corridor comprises sandstone with a low to medium potential for groundwater movement. This indicates a low to medium potential for pollution risk. Groundwater salinity was indicated to be less than 1,000 milligrams per litre which is considered suitable for stock use, domestic and some irrigation purposes.

The Acid Sulfate Soil (ASS) Risk Map for the area (Prospect / Parramatta River, Sheet 90) indicates that there is no known occurrence of acid sulfate soils along the proposed route.

A review of the DECCW contaminated land register was undertaken for sites adjacent or within close proximity to the site corridor. No registered contaminated sites were identified within close proximity of the site corridor. A review of past and present aerial photography indicated that the land use surrounding the site corridor comprised mainly of bushland, farming properties and minor residential properties. The construction of the now Macquarie Park was evident and commercial development within this area has continued until present day. The review of potential contamination indicates minimal potential for widespread contamination in the assessment area.

10.3.2 Impact assessment

The *Phase 1 Contamination Assessment* indicates that there is likely to be a low potential for widespread or significant contamination to be encountered within the M2 corridor and there is not considered to be a duty to report contamination under the *Contaminated Land Management Act 1997* (CLM Act). However, construction activities undertaken may potentially encounter localised areas of contamination which may require reporting to the DECCW in accordance with the '*Duty to Report Guidelines*' (2009) under the CLM Act. If identified, these are likely to be related to point sources and / or activities.

The available data was assessed using a risk assessment process consistent with the risk matrix approach described in AS/NZS 4360:2004 which comprises:

- Hazard: Identification of the hazard.
- Consequences: Identification of consequences or impacts.
- Likelihood: Assessment of the likelihood of the consequence through a qualitative assessment of the probability of the impact and the frequency of the event.

The level of risk was assessed using the consequence and likelihood in a risk matrix. The outcome of the contamination assessment of contamination risk for the site corridor identified the main hazards associated with the project to be:

- Areas of cut and fill along the length of the M2 Motorway.
- Detention and sediment basins at various locations along the length of the M2 Motorway.
- Point sources of contamination, for example, transformer substations, spills and other contaminating incidents.

Based on available knowledge of the land use history along the M2 corridor it is considered that the potential for contamination associated with fill material sourced from cuttings undertaken during the construction period is likely to be low. Potential contaminant sources are likely to be point sources and be related to herbicides and pesticides. If contamination is present, it would be mostly confined to immediate surface soils, which are generally not geotechnically suitable for construction and often stripped and disposed of offsite.

The Porters Creek landfill site is in the vicinity of the M2 Motorway corridor east of Lane Cove Road. There is no widening proposed as part of the M2 Upgrade project east of Lane Cove Road and there are no construction compounds located within the vicinity of the landfill. There would be no impact on or from the landfill site as a result of the project.

Sediment and detention basins collect surface water run-off from the M2 Motorway. These basins provide an indication of the potential for contamination along the M2 Motorway. A water quality assessment of 30 detention basins along the M2 corridor was undertaken in 2008 and indicated that of twenty nine water samples collected, contaminant concentrations generally complied with 'ANZECC and ARMCANZ Guidelines for Fresh and Marine Water Quality' (ANZECC and ARMCANZ, 2000). Overall, it is considered that the results of the monitoring are generally consistent with water quality in developed urban environments and are not considered indicative of significant widespread contamination. Appropriate testing and classification of sediments would be undertaken prior to works being carried out on the basins. The potential for significant widespread contamination of surface water or sediments within detention and sedimentation basins is considered to be low.

Current information available indicates that there are currently seven electrical switch boards located within the M2 Motorway. As the M2 Motorway was constructed between 1993 and 1997 it is considered unlikely that older transformer units would contain polychlorinated biphenyls (PCBs). The potential for significant contamination associated with electrical switch boards and transformer units is considered to be low.

10.3.3 Mitigation measures

The results of the *Phase 1 Contamination assessment* indicate that there is a low potential for widespread contamination. The following mitigation measures are proposed to address the issues discussed in this assessment:

- Undertake a visual assessment for evidence of contamination along the site corridor and in the boreholes during the geotechnical investigations. Evidence of contamination encountered should be noted and its significance and implications assessed.
- Development of risk management measures to address potential contamination conditions along the site corridor during construction activities.
- Collection and testing / classification of sediments in sediment basins and development of appropriate management strategies prior to works in sediment basins to mitigate potential adverse risks to the environment.

It is considered that the development and implementation of an *Unexpected Finds Protocol* and *Activity Specific Procedures* would be appropriate tools for the management of the risks identified above. The *Unexpected Finds Protocol* is a protocol which describes the actions to be undertaken should conditions or materials be found that are different to those described (unexpected materials). An unexpected finds protocol means that as soon as anything not expected is encountered the protocol can be immediately implemented and the unexpected conditions can be managed appropriately and efficiently. *Activity Specific Procedures* are developed on the basis of the risk posed by the activities within an area where a higher level of risk has been assessed. These management measures would be best undertaken prior to commencing and during construction activities.

10.4 Socio-economic impact assessment

A *Socio-economic Impact Assessment* report was prepared by AECOM dated February 2010 and a summary is presented below. This section should be read in conjunction with the assessment of land use and property impacts provided in Section 10.5.

10.4.1 Existing environment

Areas peripheral to the M2 Motorway are characterised by residential, commercial and retail land uses and areas of bushland reserves. In surrounding areas, Hornsby and Baulkham Hills, located to the north of the M2 Motorway, are characterised predominantly by residential development and urban bushland reserve areas. Blacktown (west), Ryde (north) and Parramatta (south) are also principally residential but also hold substantial commercial, industrial and institutional areas, notably the Macquarie Centre, Ryde and the North Ryde industrial area.

Hornsby, Baulkham Hills and Ryde residents tend to be comparatively more affluent than residents in the rest of the study area and Sydney as a whole. They have a larger proportion of people with higher incomes, more professionals and managers, higher levels of employment, higher education attainment and tend to live in larger houses. In contrast, Blacktown and Parramatta are more disadvantaged than Sydney as a whole and the other areas surrounding the M2 Motorway.

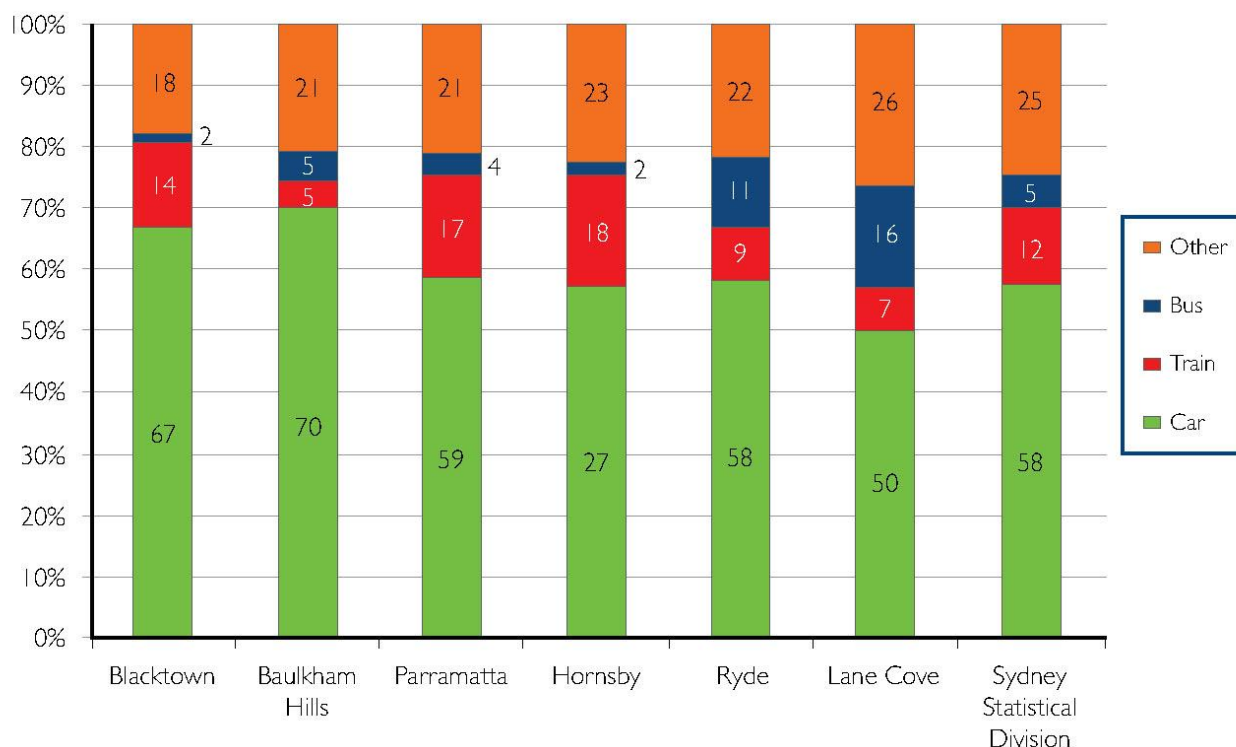
The eastern end of the M2 Motorway is included within the North Sydney to Macquarie Park Strategic corridor and is part of the large 'Global Arc' reaching from Macquarie Park to Sydney Airport. The strategy for the M2 corridor is to 'protect and strengthen' its role as a focus for commercial activity. The focus is on further employment related development (and restricting residential development) and making jobs and services within the M2 corridor more accessible to people in the metropolitan area.

Macquarie University and Macquarie Shopping Centre are key regional land uses that depend on access to the M2 Motorway. Macquarie Business Park is designated as a nationally significant research and employment centre that includes Macquarie University as well as businesses specialising in high technological enterprises, pharmaceuticals, medical and services and communications.

With a comparative lack of rail infrastructure within much of the M2 Motorway study area, bus services are often the primary public transport alternative for most people within surrounding areas. As illustrated in Figure 39 the 2006 Census data shows travel to work by car is the same or more than the Sydney Statistical Region, with Blacktown and Baulkham Hills having a substantially higher proportion of people travelling to work by car at 67 percent and 70 percent respectively compared to 58 percent for the Sydney region. These statistics reflect the low availability of public transport and the distance from employment hubs, such as Norwest and Macquarie Park.

Bus services are an important public transport service for many people within the study area. Towards the eastern end of the M2 Motorway study area, residents have access to Government operated buses and train services, which provide relatively frequent access to major destinations such as Macquarie Park, Sydney CBD and Ryde. Towards the western end of the M2 Motorway study area, apart from M2 Motorway buses and a T-Way, public transport is provided by private bus operators that typically provide bus connections to train services. Without these connecting bus services, much of the western end of the M2 Motorway study area is not within convenient reach of existing rail infrastructure.

Figure 39 Travel to work in the M2 Motorway study area



Source: Australian Bureau of Statistics, Census of Population and Housing, 2006

Note: 'Other' includes travel by tram, ferry, taxi, truck, motorbike, on foot, and those who did not work or worked at home.

10.4.2 Impact assessment

The assessment of the M2 Upgrade project considers potential socio-economic impacts and suitable mitigation measures both during construction and operation and within the following categories:

- Community impacts, such as: property acquisition (also refer to Section 10.5), land use (also refer to Section 10.5), employment, connectivity and severance, and access.
- Amenity impacts, such as: traffic and transport, noise and vibration, visual, landscape and urban design, and air quality.
- Direct employment and business impacts, such as, job opportunities.
- Wider Economic Impacts not captured in the Road User Cost Benefit Analysis (RUCBA) (Transurban, 2009. Refer to Appendix E).

As the M2 Motorway is an existing major road transport corridor, many of the socio-economic impacts that would typically be expected from construction of a major road, such as changes to the social profile, and impacts on local businesses, accessibility and severance, have already occurred. In this regard, this assessment considers only the socio-economic potential impacts generated by the proposed upgrade works. Therefore, this study aggregates additional impacts identified in other specialist studies undertaken as part of the environmental assessment in the context that a concentration of minor impacts has the potential to create more substantive impacts on a community or individuals. The most noteworthy economic impact associated with the project relates to the value of large travel time savings for road users and is covered under the RUCBA (Transurban, 2009).

Road User Cost Benefit Analysis

Based on a Road User Cost Benefit Analysis (RUCBA) undertaken for the M2 Upgrade project, the economic worth of the project case relative to the base case has been estimated to be:

- \$1.2 billion in net present value terms; and
- A benefit cost ratio value of 3.4.

On both measures, it would be considered economically worthwhile to proceed with the project case. A series of sensitivity tests to the above results was carried out by varying the discount rate, construction costs, benefits and diminishing travel time savings. Under these conditions, the Benefit Cost Ratio ranges between 2.3 and 4.9 and the Net Present Value between \$629 million and \$2.1 billion.

The provision of additional capacity on an existing and congested road provides large economic benefits from reduced travel time in return for low additional travel costs. Capital costs are relatively low in comparison to construction of a new link, which results in a high benefit cost ratio.

Although the value of the travel time experienced by the road users would be reduced by the cost of increased or new tolls, this cost transfers as a benefit to the road operator. Therefore, the RUCBA includes zero net effect for toll charges

Construction

Potential socio economic impacts during construction may include impacts on community, amenity and local employment and business and are summarised in Table 106.

The M2 Upgrade project is not expected to generate significant community impacts during construction as there would not be additional severance or access impacts arising. The primary community impact is likely to be stress due to uncertainty during the construction process.

Residents in the vicinity of the M2 Upgrade project may experience minor disruption due to loss of amenity during temporary and short term construction impacts such as noise, visual amenity, air quality (dust) and light spill. Five properties in the vicinity of the Windsor Road ramps would experience a concentration of amenity impacts.

It is expected road capacity and average vehicle speed would decrease on the M2 Motorway during construction due to temporary closure or diversion of lanes; this would result in increased travel times for users. The disruption would also have other impacts, such as:

- Potential to cause disruption to emergency service access.
- Potential delays to public transport (bus) services.
- Increased congestion on surrounding arterial road network due to diversion of existing users and additional construction site traffic.
- Additional heavy vehicles on surrounding arterial road network.
- Restrictions and disruptions to cycle access.

While some traffic and transport impacts may affect road users, some, such as the increased congestion on local arterial roads, would particularly impact local communities during their daily travel activities.

Although there may be some benefit to the local economy from expenditure by construction workers and from job opportunities, local residents may experience undesirable impacts during construction of the project for the benefit of the M2 Motorway users. Mitigation measures seek to address the undesirable construction phase impacts without reducing wider benefits to M2 Motorway users.

Operation

Potential socio-economic impacts during operation may include community and amenity impacts as well as Wider Economic Benefits. The potential impacts that are expected to result from the operation of the M2 Motorway are summarised in Table 107.

Community impacts as a result of operation of the M2 Upgrade project are unlikely to include changes to land use, access and connectivity and would be limited to property acquisitions. There is expected to be partial land acquisition from five properties on Windsor Road due to the new access ramps. Two properties at Talavera Road would also be impacted by land acquisition.

Negative impacts may be experienced by local residents through increased noise from additional traffic on the M2 Motorway and approach routes (refer to Section 9.3 for assessment of operational noise and vibration impacts). Reduced visual amenity for residents may arise as a result of changes to the scale and location of existing noise walls and due to new access ramps. Seven properties adjacent to the new Windsor Road, Herring Road and Christie Road ramps would be subject to partial land acquisition.

The M2 Upgrade project would result in reduced congestion and a corresponding reduction in journey time for users of the M2 corridor. In addition, crash rates on the M2 Motorway may decrease as capacity increases, congestion decreases and emergency shoulders are reinstated. It is expected that there would be less congestion on the surrounding arterial road network as vehicles transfer from alternative routes, although some users on the local network in the vicinity of the new access ramps at Windsor Road, Christie Road and Herring Road may experience increased congestion. The M2 Upgrade project would provide also better access to the employment market and businesses for local residents and users of the M2 corridor. The provision of a new transit lane eastbound between Terrys Creek and Lane Cove Road may result in increased public transport use along the M2 corridor and the replacement of the alternative westbound cycle route between Lane Cove Road and Beecroft Road with access to the M2 Motorway shoulder would result in a faster, more amenable trip for cycle commuters.

In addition to the economic effects identified in the RUCBA (refer to Section 10.5.2), Wider Economic Benefits (WEBs) are improvements in economic welfare that are acknowledged but which have not been typically captured in traditional cost benefit analyses. In this regard, WEBs generally refer to four specific additional benefits, which are:

- Improved agglomeration economies.
- Increased competition.
- Increased output under imperfect competition.
- Improved labour supply.

Given the M2 Motorway already exists as a major road transport corridor, it is likely that most of the WEBs have been realised and the widening would not generate significantly more benefits. Some WEBs may result from agglomeration and improved labour supply. Over the longer term it is expected that the reduced travel time may encourage agglomeration benefits within the 'Global Arc' from North Sydney to Macquarie Park. In addition, job opportunities along the M2 corridor may become more accessible as a result of reduced travel costs inducing more people into the workforce or to move to more productive jobs.

As indicated in Table 107 the majority of the impacts of the M2 Upgrade project during operation are positive, but positive and negative impacts generated by the M2 Upgrade project may not be equally distributed between the project stakeholders. Overall, the M2 Upgrade project is expected to provide benefits for the M2 Motorway users and the adjacent communities through reducing congestion on the M2 Motorway and arterial roads, improving access to markets, improving public transport usage, and reinstating amenities for cyclists. Local residents would also benefit from reduced travel times on arterial roads.

10.4.3 Mitigation measures

Mitigation measures are proposed to seek to reduce the impact on local residents. Table 106 and Table 107 summarise the impacts and recommended mitigation measures, which are consistent with the measures recommended within other specialist reports.

Table 106 Summary of construction impacts and mitigation measures

Category	Impact	Mitigation
Community	<ul style="list-style-type: none"> Uncertainty surrounding the project and impacts on property. Stress due to anticipated or real prospect of land acquisition. 	<ul style="list-style-type: none"> Provide regular and transparent information and updates to potentially affected residents in accordance with the adopted communications strategy.
Amenity	<ul style="list-style-type: none"> The construction of the project is likely to cause a loss in amenity due to the following impacts: 	
	<ul style="list-style-type: none"> Potential noise, visual amenity (construction lighting, vegetation clearance and temporary noise walls), air quality and traffic impacts to properties surrounding construction compound sites. 	<ul style="list-style-type: none"> Implement mitigation measures discussed through Chapter 9 and Chapter 10 at construction compound sites, particularly the Windsor Road, Beecroft Road (old bus ramp), Beecroft Road (tunnel) and existing TIDC compound sites.
	<ul style="list-style-type: none"> Impact on local resident amenity through increased noise and vibrations during construction (traffic and equipment). The combined amenity impacts are particularly disruptive to five properties located adjacent to the new Windsor Road ramps. 	<ul style="list-style-type: none"> Minimise adverse noise and vibration impacts during construction by adopting mitigation measures recommended by this environmental assessment (refer to Section 9.2).
	<ul style="list-style-type: none"> Potential visual impacts on adjacent properties. 	<ul style="list-style-type: none"> Provide temporary screening to minimise visual intrusion (refer to Section 9.6.3).
	<ul style="list-style-type: none"> Potential for dust generation during excavation works and movement of construction vehicles/equipment. 	<ul style="list-style-type: none"> Use management measures to minimise dust (refer to Section 10.6.3).
	<ul style="list-style-type: none"> Increased lighting during night time as construction occurs. 	<ul style="list-style-type: none"> Minimise lighting impact by selecting appropriate design and work practices (refer to Section 10.7.3).
	<ul style="list-style-type: none"> Potentially reduced road capacity and or operating speed due to temporary closure/diversion of lanes resulting in increased travel times. 	<ul style="list-style-type: none"> Plan construction around off peak times to minimise impact on journey times (refer to Section 9.2.3).
	<ul style="list-style-type: none"> Disruption to emergency service access. 	<ul style="list-style-type: none"> Consultation with emergency services.
	<ul style="list-style-type: none"> Restrictions and or disruption to cyclist access to the M2 Motorway during construction. 	<ul style="list-style-type: none"> Plan temporary route to optimise amenity for cyclists within the topographical constraints of the corridor (refer to Section 9.2.3).
	<ul style="list-style-type: none"> Localised pedestrian route diversions. 	<ul style="list-style-type: none"> Provide safe temporary pedestrian crossings and routes (refer to Section 9.2.3).
	<ul style="list-style-type: none"> Disruption to some local trips brought about by the need to extend Barclay Road and Murray Farm/Kirkham Street bridges, requiring the closure of these links across the M2 Motorway. 	<ul style="list-style-type: none"> Sign posting and pamphlets to advise local residents of closures (refer to Chapter 5).
	<ul style="list-style-type: none"> Possible delays to public transport (bus) services during construction. More congestion on surrounding arterial road network due to construction vehicles and slower trips on M2 Motorway. 	<ul style="list-style-type: none"> Manage movement of construction vehicles to avoid peak periods and provide access to compounds and work sites via Motorway (refer to Section 9.2.3).

Category	Impact	Mitigation
Direct employment and business impact	<ul style="list-style-type: none"> • Direct construction job creation. • Construction expenditure may have flow on effects to other businesses in the area. 	<ul style="list-style-type: none"> • To maximise these benefits, products and services would be sourced as locally as possible, and construction job opportunities advertised in the local area.

Table 107 summarises operation impacts and mitigation measures.

Table 107 Summary of operation impacts and mitigation measures

Category	Impact	Mitigation
Community	<ul style="list-style-type: none"> • Negative impact on wellbeing due to property loss through acquisition. • Access to new job and business opportunities along the M2 corridor. 	<ul style="list-style-type: none"> • Explain the land acquisition process through the consultation program (refer to Chapter 4). • Compensation to landowner in accordance with the RTA Land Acquisition Policy and the Land Acquisition (Just Terms Compensation) Act 1991.
Amenity	<ul style="list-style-type: none"> • The project is expected to create both positive and negative amenity impacts as follows: 	<ul style="list-style-type: none"> •
	<ul style="list-style-type: none"> • Impact on adjacent residents through increased noise from increased traffic volume and the widening changing the noise attenuation provided by existing noise walls. 	<ul style="list-style-type: none"> • Change noise attenuation to meet the project's noise objectives based on the <i>Environmental Criteria for Road Traffic Noise</i> (DECCW, 1999) (refer to Section 9.3.3).
	<ul style="list-style-type: none"> • Potentially reduced amenity impacting adjacent properties where noise walls may be closer to the boundary. • Potential changes in scale or design of relocated/new noise walls may affect visual amenity. • Removal of existing vegetation or construction/altering of infrastructure may change character of surrounding streetscape increasing visual impact on local roads. • Relocated/ noise walls and new access ramps at Windsor Road may affect solar access. 	<ul style="list-style-type: none"> • Provide screening of noise walls and new ramps to minimise visual intrusion (refer to Section 9.6.3). • Use materials that reduce the visual intrusion of new infrastructure (refer to Section 9.6.3).
	<ul style="list-style-type: none"> • Increased lighting on M2 Motorway and additional access points. 	<ul style="list-style-type: none"> • Design and locate new lighting to minimise light spill in direction of homes.
	<ul style="list-style-type: none"> • Construction and operational noise and visual amenity impacts to schools and institutes surrounding the M2 corridor. 	<ul style="list-style-type: none"> • Minimise impacts to sensitive receivers such as schools by implementing mitigation measures recommended in this environmental assessment (refer to Section 9.3.3 and Section 9.6.3). Management of impacts is of particular importance at Epping Heights Public School, the Royal Institute for the Deaf and Blind, Our Lady of Lourdes School and Macquarie University.
	<ul style="list-style-type: none"> • Impact of increased traffic on pedestrians at Our Lady of Lourdes School on Windsor Road. 	<ul style="list-style-type: none"> • Proposed pedestrian arrangements at the Windsor Road crossings would be subject to detailed design and assessment by RTA Road Safety Group.
	<ul style="list-style-type: none"> • Reduced air pollution from alleviation of 'stop and start' effect. • Increased accessibility to Sydney orbital Motorway 	<ul style="list-style-type: none"> • M2 Upgrade project would be an improvement to the existing condition.

Category	Impact	Mitigation
	<p>network, Macquarie Centre, Regional city centres, commercial centres.</p> <ul style="list-style-type: none"> • Reduced congestion on the M2 Motorway and some arterial routes. • Reduced journey time on the M2 Motorway and some arterial routes. • Increased journey time reliability on the M2 Motorway and some arterial routes. • Improved access for emergency services (for M2 Motorway and surrounding roads). • Replacement of the interim cyclist detour for westbound cyclists between Lane Cove Road and Beecroft Road with access to the breakdown lane on the M2 Motorway, resulting in a faster trip. • Increased public transport use along M2 Motorway through provision of a new transit lane eastbound between Terrys Creek and Lane Cove Road. 	
	<ul style="list-style-type: none"> • Less congestion on surrounding arterial road network (currently traffic seeks alternative, less congested routes). 	<ul style="list-style-type: none"> • Modify intersections and approaches to increase capacity for critical movements (refer to Chapter 6).
Direct employment and business impact	<ul style="list-style-type: none"> • No additional jobs or direct business effects are expected to be created by operation of the M2 Motorway. 	<ul style="list-style-type: none"> • No mitigation measure required.
Wider Economic Benefits (WEBs)	<ul style="list-style-type: none"> • The majority of WEBs are already realised following construction of the M2 Motorway but the project is expected to bring: <ul style="list-style-type: none"> – agglomeration effects within the Global Arc from North Sydney to Macquarie. – improved labour supply as job opportunities become more accessible. 	

10.5 Land use and property

An assessment of the land use and property impacts associated with the project has been undertaken and is presented below.

10.5.1 Existing environment

The existing land uses along the M2 Motorway, in the vicinity of the proposed upgrade, include a combination of residential, commercial and industrial developments, bushland, recreational areas, schools and universities. The perimeter of the M2 corridor is also referred to the M2 lease boundary for the purpose of this assessment.

The M2 Motorway provides an important connection to Sydney's north west which houses a rapidly growing business park and large tracts of new residential development. The M2 Motorway also provides an important connection to Norwest Business Park, Macquarie Park and Macquarie University. Norwest Business Park, located north of the M2 Motorway at Old Windsor Road, and Macquarie Park, located adjacent to the M2 Motorway at its eastern extent, are prominent commercial and industrial precincts.

Dominant features of the natural landscape along the M2 Motorway include Darling Mills State Forest in the west and Lane Cove National Park in the east. The M2 Motorway ends at its eastern extent approximately 200 metres from the Lane Cove River before the western entrance to the Lane Cove Tunnel.

The land uses within each precinct are described in the following sections.

Precinct 1 – Abbott Road to Windsor Road

South of the M2 Motorway between Old Windsor and Junction Road there is a large industrial area. To the north of the M2 Motorway the land use predominantly comprises of residential development interspersed with recreational areas and sporting fields. Travelling east towards Windsor Road there is a residential belt (north and south of the M2 Motorway), which is characterised by low density suburban development and detached dwellings.

Model Farms High School is located to the north of the M2 Motorway near Langdon Road. Winston Heights and Winston Hills Public Schools are located to the south of the M2 Motorway along Junction Road. Other community facilities in Precinct 1 include sporting facilities such as Gooden Reserve and Yattenden Park.

Precinct 2 – Windsor Road to Pennant Hills Road

The dominant feature of Precinct 2 comprises large tracts of vegetation that form part of Bidjigal Reserve and Darling Mills State Forest. These tracts are interspersed with pockets of low density residential development. East of Windsor Road to Darling Mills Creek is an area of low density suburban residential development characterised by detached dwellings consistent with the land use west of Windsor Road. Adjacent to the north eastern corner of Windsor Road and the M2 Motorway is Our Lady of Lourdes School and its associated church. The block adjacent to the south eastern corner of Windsor Road and the M2 Motorway is under development as medium density housing and was cleared in late 2009.

Ted Horwood Reserve is a large recreational facility located west of Darling Mills Creek on Renown Road which contains sporting fields and netball courts.

East of Darling Mills Creek is Bidjigal Reserve where a band of native vegetation surrounds the creek line to the north and south of the M2 Motorway. Bidjigal Reserve joins with Darling Mills State Forest to the east, on the northern side of the M2 Motorway. The two reserve areas are split by a cluster of detached residential dwellings. The area east of Darling Mills Creek to the south of the M2 Motorway is characterised by low density residential development which surrounds Muirfield Golf Course, Muirfield High School and the Royal Institute for Deaf and Blind Children.

Residential and education developments through this section are shielded from the M2 Motorway through the use of screening vegetation. This screening vegetation is typical of the section between Barclay Road and Pennant Hills Road where predominantly residential developments are interspersed with parkland and bushland areas to the north and south of the M2 Motorway.

Recreational facilities in this area include Murray Farm Park, which contains sporting fields, and West Pennant Hills Reserve, an area of open space with a playground utilised by the local community, both of which are located to the south of the M2 Motorway.

Precinct 3 – Pennant Hills Road to Beecroft Road

Devlins Creek is a dominant feature of the landscape in Precinct 3. It runs to the north of the M2 Motorway from Pennant Hills Golf Course until it crosses to the southern side at Kirkham Street. East of Kirkham Street, Devlins Creek crosses from the north to the south of the M2 Motorway numerous times before crossing permanently to the northern side of the M2 Motorway at Beecroft Road.

North of the M2 Motorway the land use is dominated by recreational facilities and open space or bushland areas. The Pennant Hills Golf Course is between Pennant Hills Road and Burns Road. Chilworth Recreation Reserve is east of Burns Road. Beecroft Park and Cheltenham Oval are located between Burns Road and Kent Street. Residential development between Pennant Hills Golf Course and Beecroft Road is characterised by low density detached dwellings, which are separated from the M2 Motorway by Chilworth Recreation Reserve and Cheltenham Oval.

South of the M2 Motorway, residential development runs adjacent to the M2 Motorway for the majority of Precinct 3. The residential development is low density and characterised by detached dwellings. Generally, the residential development is screened from the M2 Motorway by Chilworth Recreation Reserve, riparian vegetation surrounding Devlins Creek and the presence of other vegetation. Epping Heights Public School is located south of the M2 Motorway, just east of the Kent Street footbridge.

Precinct 4 – Beecroft Road to Terrys Creek

The Northern Rail Line crosses over the M2 Motorway between Beecroft Road and the western tunnel portal approximately 300 metres east of the Beecroft Road interchange.

The western end of the land above the tunnel comprises detached residential dwellings. Epping Park, which includes two sporting fields, and Poplars Private Hospital are located above the central portion of the tunnel. Above the eastern end of the tunnel is a new residential development with detached dwellings and a new private road, Sunden Way.

From the eastern tunnel portal to Terrys Creek the dominant land use is low to medium density residential development north and south of the M2 Motorway. The development to the north is shielded from the M2 Motorway by a pocket of vegetation that runs adjacent to the M2 Motorway. Berriwerrie Reserve and Lucknow Park are located to the east of this cluster of houses to the north and south of the M2 Motorway respectively. Terrys Creek runs through both of these reserves, with connectivity between them provided by Terrys Creek bridge.

Precinct 5 – Terrys Creek to Lane Cove Tunnel

The primary land uses within Precinct 5 are notably different from Precincts 1 to 4. Precinct 5 is dominated by commercial and educational land uses, with Macquarie Business Park and Macquarie University being key features of the landscape.

North of the M2 Motorway is a large tract of vegetation and open space which extends from Terrys Creek to Khartoum Road. The land is a relatively flat area of fill created during the construction of the M2 Motorway with a slope leading down to an area of moderately disturbed native forest. The Great North Walk, which is a walking track that links Sydney and Newcastle, runs roughly parallel to the M2 Motorway through this bushland.

Macquarie University sporting fields located off Culloden Road, and Christie Park located off Christie Road are situated on the filled area, adjacent to the M2 Motorway. There is a small pocket of medium density residential housing situated at Culloden Road, west of the Macquarie University sporting fields. The M2 Control Centre is located between the M2 Motorway and the Macquarie University sporting fields.

There is a pocket of medium density residential development north of the M2 Motorway between Khartoum Road and Lane Cove Road, north of the M2 Motorway. There are two recreation areas, Fontenoy Park and Tuckwell Park located within this pocket of houses. Between Lane Cove Road and Delhi Road the primary land use is the Macquarie Park Cemetery.

South of the M2 Motorway, from Terrys Creek to Culloden Road is a section of low to medium density residential housing, which includes Macquarie University Village student accommodation along Waterloo Road. Macquarie University is located between Culloden Road and Herring Road.

Macquarie Centre is a large commercial complex which is located on the corner of Herring Road and Talavera Road. Macquarie Park is a growing commercial and industrial precinct which has become a hub for specialised technology firms. It spans the area bordered by Herring Road, Epping Road, Delhi Road and the M2 Motorway.

10.5.2 Impact assessment

The M2 Upgrade project would support surrounding land uses and encourage future growth and development. Given that the M2 Motorway is existing infrastructure, impacts to surrounding land uses are expected to be minimal. There would be no long-term adverse impacts on land use when upgrade works occur within the existing M2 corridor. Where the proposed footprint extends outside the existing corridor, there are individual properties which would experience partial acquisition and would therefore experience some negative impact. Construction impacts would be temporary.

The following section discusses the impact the upgrade would have on the broader land uses within the M2 Motorway region and the specific impacts on individual properties. These impacts would be mitigated as described in this section and in the Statement of Commitments (Section 11). It should be noted that many of the land uses described in Section 10.6.1 would not be impacted by the M2 Upgrade project.

Land use impacts

The M2 Upgrade project would increase accessibility between Sydney's north west and the Sydney Orbital network, improving access to new regional growth centres for people, goods and services. Increased accessibility supports the future development of land use within regions such as the north west and Macquarie Park. Growing land uses surrounding the M2 Motorway include commercial, industrial, residential and educational activities.

Commercial land use

Once it is operational, the M2 Upgrade project is expected to have a positive impact on the commercial land uses in the immediate vicinity of the M2 Motorway and further afield, within the M2 Motorway's larger catchment area. The key commercial and industrial developments surrounding the M2 Motorway are the Norwest Business Park and Macquarie Business Park.

There would be temporary positive impacts associated with the construction of the M2 Upgrade project on surrounding commercial land uses. The influx of construction workers and their expenditure throughout the two year construction period may be profitable to local businesses. This would, to some degree, compensate for loss of business that may be experienced as a result of decreased accessibility during construction, although construction would be managed to minimise impacts to vehicular access.

Following the completion of the project, access to commercial precincts such as Norwest Business Park and Macquarie Park would be improved benefiting those precincts and improving the movement of people and goods to and from the north west. Decreased congestion and reduced travel times would give workers in their existing locations easier and quicker access to their place of employment. Improved public transport and accessibility would make these regions more attractive for firms looking to relocate which, in turn, would increase job opportunities within the region. These opportunities would be more accessible for employees and would provide employers with access to larger labour markets. Further information regarding the labour supply can be found in Section 10.4.

The M2 Upgrade project would provide benefits to commercial enterprises by improving the efficiency of freight transport and accessibility which, in turn, would allow them to access more markets and improve their overall competitiveness. The project would increase the catchment area of individual businesses as well as the business parks as a whole. The full impact of the M2 Upgrade project on commercial enterprises is described in Section 10.4.

The new on and off-ramps at Herring and Christie Roads are of particular importance to the continued development of Macquarie Park as a commercial precinct. These ramps would facilitate increased movement between Sydney's north west, Macquarie Park and Sydney CBD. However, a number of commercial properties (listed in Table 108) would be directly affected by the upgrade to Herring Road, Christie Road and Talavera Road. Details of these disturbances are described below.

Residential land use

Some residential development surrounding the M2 Motorway would be impacted during the construction and operation of the M2 Upgrade project.

Temporary amenity impacts such as noise, air quality and visual impacts would occur during construction of the M2 Upgrade project as described in Section 10.4. These impacts would not affect residential land use or the value of residential properties surrounding the M2 corridor. There are no residential properties located at the proposed sites for the construction compounds, therefore no leases of residential properties would be required.

Impacts on residential development that would continue following completion of construction include:

- Permanent property acquisitions.
- Amenity issues including visual impacts and improvements to traffic noise and air quality.

Amenity impacts on residential properties would not affect land use or property value and are discussed in Section 10.4.

Residential property acquisition for the project would be minimal with only partial acquisition of properties required and no need for demolition of residential dwellings. Details of the required acquisitions are described further below, summarised in Table 108.

Educational land use

There are a number of schools and educational facilities that would experience amenity impacts during and following construction of the M2 Upgrade project such as increased noise levels, loss of visual amenity and pedestrian and traffic impacts. These amenity impacts are discussed in Section 10.4. There is no need, however, for permanent acquisition or temporary leasing of land from within their property boundaries.

Natural resources and recreational land use

Open space and bushland constitute a large portion of the land use setting along the M2 corridor. Through the concept design process, bushland and reserve areas have been preserved as much as is feasibly possible by minimising the construction footprint (refer to Section 9.5). The greatest impact on recreational land use would occur during construction. Temporary construction compounds and access to these compounds would require use of some of this open space as well as removal of some vegetation. Figure 5 illustrates the required permanent and temporary vegetation removal. Impacts to flora and fauna are discussed in Section 9.5.

Property impacts

The majority of the widening of the M2 Motorway would occur within the existing M2 lease boundary. A small amount of partial property acquisition would be required. This permanent partial acquisition of property would be needed to accommodate the new ramps at Windsor Road, Christie Road and Herring Road as well as the widening of Talavera Road. Permanent substratum acquisition would also be required in areas where works below the ground surface would be necessary. Temporary lease of land would be required for construction compound sites that lie outside of the M2 lease boundary.

There would also be indirect impacts to properties along the M2 Motorway due to changes to existing noise walls. While these noise walls would not require property acquisition, as they would be located within the M2 lease boundary, the movement or modification of the noise walls may impact on the visual amenity of surrounding properties. This amenity impact would not affect land use or property value and is discussed further in Section 10.4.

Permanent land acquisition

There are seven privately owned properties that would require permanent partial land acquisition. These are illustrated in Table 108. Five of these properties are located on Windsor Road and are associated with the new west facing on ramp. Two of these properties are located on Talavera Road and are associated with the new Christie Road on ramp, Herring Road off ramp and widening of Talavera Road. The locations of these properties are shown in Figure 40.

Table 108 Permanent partial land acquisition requirements

Address	Land use	Required adjustment
Baulkham Hills 2153		
266 Windsor Road	Residential	Driveway and fence adjustment
264 Windsor Road	Residential	Driveway adjustment only (strip of land already acquired by RTA)
262 Windsor Road	Residential	Driveway and fence adjustment and new gate
260 Windsor Road	Residential	Driveway location and grade subject to survey confirmation
258 Windsor Road	Residential	As above – shared driveway with 260 Windsor Road and batter adjustment
256 Windsor Road	Residential	As above – shared driveway with 260 Windsor Road and batter adjustment
Macquarie Park 2113		
112 Talavera Road	Commercial	Approximately three driveway adjustments subject to negotiation with owner
84-92 Talavera Road	Commercial	Minor boundary adjustment – to be confirmed by survey

The impacted properties would require partial acquisition only and buildings on these properties would be retained during the M2 Upgrade project. Adjustments to property boundaries would generally be limited to modifications of driveways, fence lines and front gardens.

The impacted land of particular concern would be the residential property at 266 Windsor Road and the commercial property at 112 Talavera Road. 266 Windsor Road is listed as a heritage item on the *Parramatta Local Environmental Plan 1996*. Further information regarding the impact to this property is contained in Section 9.9. The owner of 112 Talavera Road has proposed a major development for this property at its western end. The development would involve construction of a new six storey commercial office building which has been approved by the City of Ryde's Planning and Environment Committee (City of Ryde, 2009).

There are also a number of properties, currently utilised as open space, owned by public authorities that would need to be acquired permanently. These areas include land owned by Hornsby Shire Council near Devlins Creek and land owned by the RTA at Windsor Road and Talavera Road.

Permanent land acquisition would also be required at the eastern end of Somerset Street which would be narrowed at the point opposite Gloucester Road to allow for the widening of the M2 Motorway. Somerset Street, which is a residential street, is currently owned by the RTA. No private land would need to be acquired to accommodate the works in this area.

Lease of land

A number of properties would be leased during the construction of the M2 Upgrade project where the construction compounds are located outside of the M2 lease boundary. This land would not be acquired but would be leased for part or all of the construction period. Table 109 lists the construction compounds that currently lie outside the M2 lease boundary. The final location of these compound sites is subject to further assessment as well as consultation with landowners and would be determined during the detailed design phase.

Table 109 Leases required at this time

Compound name / location	Compound size (square metres)	Ownership details
Windsor Road north	5,800	NSW RTA
Devlins Creek	16,000	Hornsby Shire Council
Sutherland Road (Tunnel)	3,800	Partially owned by NSW RTA Partially privately owned
Vimiera Road	8,200	Privately owned
Busaco Road	1,300	City of Ryde
Christie Road	7,000	Department of Planning
Existing TIDC	35,000	Transport Infrastructure Development Corporation (TIDC)
North Ryde Station	11,500	TIDC

Substratum acquisition

Permanent acquisition would be required in the substratum of a number of properties to allow for the insertion of subsurface rock anchors. The acquisitions would occur:

- South of the M2 Motorway just west of the Pennant Hills Road west facing on ramp.
- To the south of Devlins Creek bridge just west of Kirkham Street.
- At the eastern and western portals to Norfolk Tunnel, north and south of the M2 Motorway.

These acquisitions would not impact the ownership of the properties and would require no change to the dwellings situated on those properties. Figure 41 provides the locations of the required substratum property acquisitions. The construction vibration impacts that may be associated with substratum property acquisitions are discussed in Section 9.4.

10.5.3 Mitigation measures

Where possible, works have been contained within the M2 lease boundary. Where land acquisition is required, it would be negotiated in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991 (NSW)* and the RTA's Land Acquisition Policy. Consultation with affected stakeholders would continue to be carried out in accordance with DoP *Guidelines for Major Project Community Consultation* through the detailed design phase. Property access would be maintained for the duration of the two year construction period. Impacts from both the construction and operation of the M2 Upgrade project on the different land uses surrounding the M2 Motorway would be minimised through the implementation of reasonable and feasible mitigation measures for each of the individual areas. Mitigation measures to minimise negative changes in land use or property value would include:

- Noise and vibration.
- Visual amenity.
- Traffic and transport.
- Construction lighting.
- Air quality.

Where land use is temporarily modified during the construction period (particularly at construction compound sites), the land would be rehabilitated to similar or better condition to enable the land use to be reinstated after construction. These mitigation measures are described throughout this report and in the Statement of Commitments (Chapter 11).



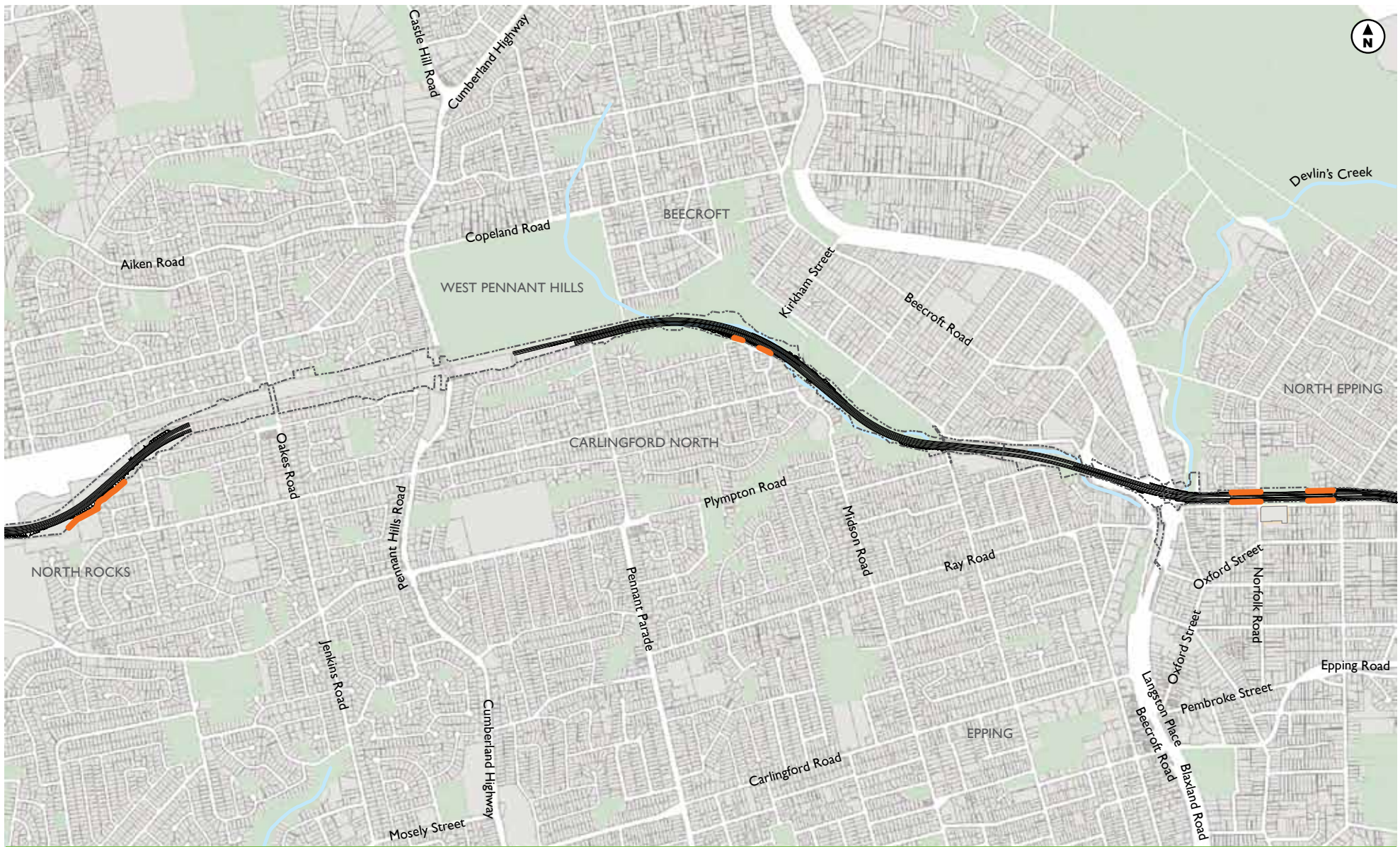
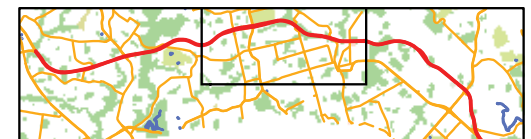


Figure 41 - Location of substratum property acquisition

- M2 Motorway Corridor (Lease Boundary)
- █ Extent of Proposed Upgrade
- ▬ Cadastral Boundaries
- █ Substratum Acquisition



Source: MapData, 2010