Hurstville City Council
Office of the General Manager

22 January 2016

Director, Infrastructure Projects Planning Services
NSW Department of Planning and Environment
Application number SSI 6788
G P O Box 39
SYDNEY NSW 2001

Dear Sir / Madam,

Please find attached Hurstville City Council's submission to the Environmental Impact Statement (EIS) for the WestConnex New M5 Project. Council supports the project as it will provide additional capacity for the M5 East Motorway however, following a thorough review of the EIS by Council staff and suitably qualified consultants (Molino Stewart), Council believes that the EIS does not provide sufficient information to fully assess the impacts of the project on the local environment or community. The consultants and Council staff have highlighted a number of areas which are outlined in Council's submission where additional information is required.

In relation to the biodiversity impacts identified in the consultant's report, while many of the key areas of concern identified fall outside of the immediate Hurstville local government area, I have chosen to include them in our submission as they impact the greater Botany Bay Catchment to which our Council and neighbouring Councils belong. As many of the endangered ecological communities and some of the threatened species noted in the consultant's report are also found within the Hurstville local government area the issues raised within the report may have regional consequences and hence may impact the biodiversity of the Hurstville local government area. A copy of the consultant's report is attached for your reference.

It would be appreciated if the Department of Planning and Environment could seek responses from Westconnex and other relevant agencies to the recommendations made within Council's submission prior to any determination of the EIS.

Should you have any queries, please contact Alison Hanlon, Manager of Environmental Sustainability on (02) 9330 6222 or at ahanlon@hurstville.nsw.gov.au.

Yours sincerely,

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Our Reference: D16/2741

Hurstville City Council Submission to the Environmental Impact Statement for the Westconnex New M5 Project

1. Air quality issues

Assessment of General Construction impacts

Recommendation 1.1: That appropriate and specific Construction Phase Air Quality Management Plans (or sub-plans) are developed and implemented for individual components of the overall construction task. Council requests a copy of the Construction Management Plan and sub-plans to ensure that air quality mitigation measures are applied in accordance to relevant guidelines and levels adopted in the plans.

Assessment of Operational Impacts (In-Tunnel Air Quality)

For reasons fully detailed within the attached Molino Stewart EIS Assessment Report, it is considered that the longitudinal ventilation system currently proposed for the two New M5 tunnels may not be adequate or appropriate to ensure safe and compliant air quality at all times, especially on longer tunnels, such as the New M5 and tunnels that carry a very significant traffic load with commensurate pollution burdens.

Recommendation 1.2: That a contingency strategy based on alternative tunnel ventilation approaches and the management of in-tunnel air, such as Transverse Ventilation be fully incorporated into the project proposal and modelled in the working paper and EIS.

Assessment of Operational Impacts (Emission Stacks)

Any inadequacy in the control of air pollutant levels within the tunnels will have an impact on the quality of discharges from the associated exhaust stacks, and any assumptions made regarding surface air quality near those stacks.

Recommendation 1.3: That an alternative approach to the management of air quality in the immediate vicinity of the proposal tunnel emission stacks is included in the project proposal and modelled in the working paper and EIS, to complement the inclusion of an alternative tunnel ventilation strategy as recommended above. This should also include any air quality management limitations available through stack height and discharge velocity and the inclusion of air cleaning and filtration technologies at the emission stacks.

Recommendation 1.4: Council seeks a commitment on the continuous monthly monitoring of the air quality around the Kingsgrove area and for the report to be made available on the website.

2. Hydrology and Water Quality

Council notes that there are many potential water quality and hydrology impacts arising from the construction and operation phases of the proposed New M5 project. These include:

Potential impacts to groundwater during construction and operations:

- Groundwater inflow
- Groundwater drawdown and drying out of surface waters
- Reduced base flow to creeks and groundwater recharge
- Changes in groundwater quality due to incursion of saline soils and other contaminants
- Treatment and discharge of potentially saline or low pH groundwater.

Potential impacts to surface water during construction and operation:

- Increased stormwater discharge due to larger impermeable surface areas.
- Impacts to local water ways due to earthworks and exposed soil, followed by wind or rain mobilising sediments that could be discharged to local watercourses;
- Construction activities adjacent to or within waterways could introduce foreign contaminants such as chemicals, oil or greases, and disturb contaminated sediments, potentially having an adverse impact on water quality;
- The project would increase the impervious surfaces in the road corridor. Consequently, pollutant loads building up on the road surfaces would increase, and greater loads of pollutants may be washed off and discharged to receiving environments;
- Contaminated sediments mobilised by works in and around Alexandra Canal;
- Discharge of groundwater and construction water extracted during construction;
- Leachate - contaminated runoff during works in the landfill.

Potential geomorphology impacts could arise from:

- Construction activities adjacent to or within watercourses could impact channel bed, causing fracturing and cracking of creek beds and altered bank conditions;
- Water discharged from the construction groundwater water treatment plants may lead to localised erosion within the receiving waters;
- Water discharged from the groundwater water treatment plants may increase the base flows experienced in receiving waterways, reducing the capacity for the watercourses to convey storm flows;
- Mobilised sediment build up in the streams;
- Impermeable surfaces created by the project would lead to increases in the volume and rate of runoff, which could cause erosion.
- Discharge of operational wastewater sources, including for maintenance, cleaning and fire deluge systems;
- Impact to water quality of receiving watercourses due to the discharge of treated groundwater and other waste waters (such as tunnel wash or deluge system water);
- Discharge of inadequately treated water from the water treatment plants. This includes treated groundwater and leachate captured at the St Peters interchange; and
- Contaminated sediments mobilised by scour caused by new infrastructure installed in and around Alexandra Canal.
- **Council notes that the new M5 project location is also likely to impact flow to Hurstville Council's drainage network. The impact of altered flow into Council's drainage network needs to be considered at every stage of the M5 works.**

Council offers the following comments and recommendations which are based on the attached Molino Stewart assessment of the New M5 EIS in order to mitigate the potential impacts on water quality and hydrology identified above:

Proposed Construction and Operational Phase Mitigation Measures

Groundwater monitoring

Data on groundwater contamination, based on samples taken from within the full extent of the anticipated groundwater drawdown of the proposed new M5, should be informing the EIS assessment. The groundwater technical working paper reports that a Phase 1 Environmental Site Assessment was undertaken along the alignment to identify potential groundwater contamination associated with historical land uses. While there was some preliminary monitoring of ground water via bores that were installed to assess opportunities and constraints for the project, this sampling was performed over a relatively short period of time and can only be considered a preliminary investigation. These bores would not have been designed to provide baseline data for the assessment of water quality. The layout of the bore locations are not representative of the entire project area and therefore indicate that all information has not been considered, particularly when the potential impact on groundwater may extend for some kilometres from the alignment.

Given the extent of the impact for groundwater, this would not be sufficient to characterise the groundwater contamination that may affect the project and to understand the potential impacts that may arise from contaminated groundwater.

The EIS states that groundwater monitoring would begin prior to the commencement of construction (baseline monitoring) and would continue during construction. Monitoring would continue post the completion of construction and that six monthly groundwater monitoring is proposed to occur for three years after the tunnel becomes operational, after which the requirement for on-going monitoring will be assessed. This is considered to be entirely inadequate, given that the point has been made consistently in the EIS that it takes some time for ground water to reach a steady state. As such, after three years the full extent of the impact of the project on the groundwater table could not possibly be known. The groundwater modelling reports that 'within years and certainly tens of years, it is possible that a steady state may evolve'.

All surface water and ground water monitoring proposed for monitoring water quality and contamination of groundwater and the impacts of the proposed project should be sufficient in both extent and duration to allow full monitoring and interpretation of the project impacts both before the project commences (minimum 12 month base monitoring) and after the project commences.

Further, the EIS states that a groundwater and soil salinity report will be prepared prior to the commencement of earthworks to assess the potential impacts to the local hydrogeological regime. This data should be collected now as part of the baseline data collection and this should be informing the EIS.

Recommendation 2.1: Further groundwater baseline data, including soil salinity data, of a minimum 12 months duration, which is representative of the entire project site should be obtained as a priority and the assessment revisited once this information is available. The monitoring program should also be developed in consultation with all relevant government agencies.

Groundwater modelling

The ground water model has been prepared primarily as a steady state model. As such, there has been no modelling of likely impacts to groundwater after construction or in the years immediately following construction. The groundwater technical working paper reports that the steady state inflows are likely to be lower than inflows during construction and the early years of operation. Council notes that it is recognised within the EIS discussions, that high groundwater inflow during excavation is possible in faulted or fractured zones or where other water bearing geological features exist such as beneath the Cooks River paleochannels or beneath Wolli Creek, however actions to mitigate against this are not provided in the EIS.

Council notes that the model used for the EIS does not assess or predict what will happen to the connected surface water systems of the Cooks River, Wolli Creek or Bardwell Creek. As such, the impact has not been able to be considered or quantified and therefore has not been assessed as part of this EIS. **This represents a deficiency in the assessment**. The predicted drawdowns in the water table outlined in the EIS will impact connected surface waters which are gaining systems. The impact will be greatest during periods of low flow which is the most critical time for riparian corridors which depend on groundwater supply.

Recommendation 2.2: The EIS needs to assess the impacts on the surface water bodies that will arise due to the drawdown of the water table.

Recommendation 2.3: Data on the full extent of the impacts on the water table from theM5 East needs to be collected from across the actual site alignment to inform the groundwater modelling (not data from other roadways and tunnels which is 'expected' to be an accurate representation of what will occur on the New M5 project).

Groundwater inflows

The tunnel cells are assumed to be drain cells as they are not lined. The working paper notes that the potential impacts of ventilation tunnels and shafts were not simulated as these features may be lined with concrete, and in any case, any drawdown caused by this infrastructure would be expected to be small compared to (and therefore dominated by) the effects of the tunnels. This assumption does not reflect the experience reported for the M5 project elsewhere in the technical working paper i.e. that the ventilation tunnels and shafts of the M5 East had been considered for lining given the high amount of inflow they were contributing. This would be understood to mean that these comparatively small lengths were responsible for a disproportionally high rate of inflows. There is no firm commitment made within the EIS that any part of the system will be lined (only that it will applied as required if inflows are too high). As such, it is possible that the inflows may be higher than those modelled for the EIS.

It is noted that deep incised paleochannels infilled with saturated sediments are present beneath the Cooks River and Wolli Creek. To reduce the risk of large groundwater inflows to the tunnel from the paleochannels it is proposed to construct the tunnels beneath the paleochannels. However the report also notes that there is potential for the paleochannels to extend deeper than expected (based on current information) and consequently there is a risk that the alignment could intersect a paleochannel. This could potentially result in much higher inflows and the management of such an event is only addressed with a cursory statement in the EIS.

The EIS reports that an unconsolidated Botany Sands outcrop is present within the proposed project alignment (Alexandria Landfill and Kogarah Golf Course). To mitigate impacts, shallow tunnel infrastructure such as dive structures and ventilation shafts would require shoring to stabilise the excavations and prevent groundwater inflow.

A preferable mitigation measure would have been confirmation that any part of the works will be lined to prevent any inflows. The EIS commits to using *appropriate waterproofing measures...to permanently reduce the inflow to an acceptable quantity where the project alignment passes close to watercourses and/or where higher than expected inflows are experienced.* As there has been no investigation into the inflow rates that may be experienced nor any criteria or limits established for when waterproofing measures need to be adopted during construction, this mitigation measure does not provide any imperative for action to be taken.

Recommendation 2.4: As potential impacts should be assessed and understood as part of the EIS, it is recommended that the potential impacts of groundwater inflow, groundwater drawdown and the impacts of salt water intrusion into the groundwater be understood now before the project commences.

Surface Water Interactions with Ground Water

The EIS notes that: *surface water can only flow to the groundwater system when the groundwater levels are lower than the surface water levels or when the alluvial water table falls below the surface water level in the creeks.* Given that there will be drawdown of the groundwater table, it would be expected that there will be new areas where the groundwater level will be lower than the surface water level. This is confirmed by the statement within the groundwater working paper that: *the Cooks River and its tributaries across the majority of the project area in the lower topographic areas are generally gaining streams; that is groundwater discharges from the aquifer into the stream or creek.*

As noted by the eWater Modelling Guidelines (2012), the extraction of large volumes of groundwater in close proximity to streams and rivers has the potential to reduce stream flows. In un-regulated upland streams, the primary impacts are on low-flow conditions that are crucial to ecosystem health (e-Water, 2012).

CDM Smith's groundwater model features for the New M5 EIS were:

- No flow boundary conditions and prescribed head used to represent the boundary conditions;
- A recharge was applied at the ground surface at a constant average rate;
- There was no allowance for the flux between the rivers and groundwater. The river interaction within the tidal zone was incorporated by setting the boundary at mean sea level;
- Above the tidal level, the flux between surface water bodies above the tidal zone was not accounted for within the model. The only flux considered was evapotranspiration along the drainage lines. CDM Smith reported that this representation tends to hold the water table below the drainage line level.

The groundwater model has not been developed to predict the interaction with surface water or is it able to model any changes to surface water bodies that may arise from the proposed project.

Recommendation 2.5: The groundwater model should be altered to include the interaction between groundwater and surface water and the impacts that the drawdown on ground water will have on surface water systems.

In addition the groundwater technical working paper does not model the input of construction inflows to the proposed New M5 tunnel system, only the steady state groundwater inflows are modelled and it is reported that these may not occur until some years, possibly decades, after the construction has been completed. These are estimated to be approximately 12.9 L/s, over 19.9 kilometres of tunnels (0.65 L/s/km). Further, the steady state inflows are likely to be lower than inflows during construction in the early years of operation.

The groundwater modelling report within the groundwater technical working paper says that localised inflows of two to three litres per second were reported within the M5 East project, reducing to 1.5 litres per second within two to three weeks of construction. The average inflow of groundwater since opening of the tunnel in December 2001 has been 0.75 to 0.9 litres per second per kilometre of single tube tunnel. Thus the current flows are 3.3 to 4 times lower than the flows around the final stages of construction.

Working on a similar reduction ratio, the proposed New M5 project could produce between 40 L/s and 50 L/s over the full length of the tunnels towards the end of construction. Surface water is then in addition to this. **This would indicate that the stated daily discharge flow allowance of 32 L/s would be a significant underestimation of the potential combined surface and groundwater discharges from the project.**

As this is a constant discharge throughout the duration of construction, it is not appropriate to compare this flow to the one year ARI event to assess of the significance of this discharge, and hence the potential impact/s. The one year ARI event is a minor flood event, not a constant flow. It is not considered valid to use this as justification for dismissing this constant discharge into creek systems above the tidal zone.

Surface water

There is little detail provided in the EIS on how surface water will be managed and therefore only high level consideration of impacts. The discharges that have been calculated for the surface water discharges during construction do not provide the detail for what the contributions are from the surface water and what contributions will be derived from groundwater.

The surface water technical working paper acknowledges that there are both historical and recent data samples. However, one of the datasets data used to present comparisons of the Cooks River indicators against the ANZECC guidelines was data that was over 14 years old. There is no explanation as to why more recent data is not used

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

- The Cooks River;
- Botany Bay;
- Towra Point Wetlands;
- Saltmarsh and other wetlands around the airport;
- Green and Golden Bell Frog ponds at Arncliffe. These were constructed in conjunction with the M5 East Motorway. and
- Seagrass in Botany Bay.

However there are other creeks, marshes and wetlands within the vicinity of the project area which are not mentioned.

For example it is not understood why Wolli Creek and Bardwell Creek are not considered sensitive receiving environments in the EIS report. The value of these corridors does not appear to be reflected in the discussion regarding water quality. In 2012, the Sydney Metropolitan Catchment Management Authority prepared the Wolli Creek Riparian Corridor Management Plan. It reports:

"Wolli Valley is a unique feature in the urban landscape of inner southern Sydney. The prominent feature of the valley is a large area of bushland alongside Wolli and Bardwell Creek. A large proportion (30 ha, another 20 ha to come) of the bushland along Wolli Creek is protected under the Wolli Creek Regional Park and is actively maintained by National Parks and Wildlife Service (NPWS) staff, with significant contribution made by the Wolli Creek Preservation Society volunteers."

Recommendation 2.6: The EIS should also acknowledge Wolli Creek and Bardwell Creek as sensitive receiving environments.

Within the water quality measures of the surface water technical report there is mention of re-vegetation and/or stabilisation of disturbed areas to occur as soon as feasible. Later, it says disturbed floodplain environments adjacent to watercourses (including waterfront land) and/or along overland drainage lines would be stabilised and vegetation managed in accordance with the Guidelines for Controlled Activities on Waterfront Land (DPI, 2012). This is accepted practice. However it would be expected that further detail should be provided on what this will involve, given that there are significant disturbances of creek lines and riparian areas. Council also notes that the Wolli Creek Riparian Corridor Management Plan was not acknowledged or consulted as part of the EIS process.

Recommendation 2.7: A vegetation management plan should be developed with the input from Councils and other relevant stakeholders. The Wolli Creek Riparian Corridor Management Plan should be fully considered as part of the EIS assessment process and the impacts assessed in relation to the objectives the plan.

The surface water technical working paper reports that within the Wolli Creek catchment, the project would include the construction of additional pavement resulting in an increase in the imperviousness within the project footprint in this area (22.74 hectares in total) from an existing imperviousness of about 68 per cent, to an imperviousness of **100 per cent**. This represents an increase of about seven hectares of impervious surfaces to the pavement drainage catchment. This increase in imperviousness creates the potential for higher pollutant loads to be washed into the receiving Wolli Creek environment.

It was reported that the MUSIC modelling for the project demonstrated that the proposed treatments measures will permit project compliance with the reduction targets for total phosphorus (TP) and total nitrogen (TN). However, that only a 64 percent reduction in total suspended solids (TSS) is achieved. This means that 36 percent or approximately 10 tonnes/year of the TSS generated by the additional impervious areas will be discharged into the Wolli Creek catchment.

As there is no quantification of the increased impermeable areas and where the flow paths are altered, these construction impacts have not been fully analysed to inform an understanding of the expected extent of impacts.

Recommendation 2.8: The EIS should provide quantification of the increased area of impermeable surfaces and details of where flow paths will be altered in order that a full analysis be undertaken to determine the impacts. This information is required in order to accurately assess increases in flows entering the waterways and the extent of increased erosion and pollution inputs that are likely to occur.

Additionally, in relation to pollution influx via run off, the mitigation measures do not require spill containment for spills on the Motorway as a matter of course. Rather, it is to be provided only 'if warranted'. This would not seem an appropriate mitigation of environmental risk.

Fracturing or cracking of creek beds

There is little discussion within the EIS of the risks relating to the fracturing or cracking of creek beds, beyond the EIS noting that appropriate waterproofing measures will be used if inflows are elevated. This is not considered to be a sufficient assessment of potential impacts.

Recommendation 2.9: Council calls for a more thorough investigation into the risks of fracturing or cracking creek beds and the development of mitigation measures required preventing this from occurring.

Within the assessment of construction impacts, the statement is made that the discharge of treated ground / construction water would have a minor increase in flow rates of receiving water courses.

Discharge to Wolli Creek would be to the concrete lined section upstream of Bexley Road. Between Bexley Road and the fish weir at Turrella the discharge would contribute up to 13.1 litres per second to a highly altered reach of creek, affected by both upstream lining and downstream hydraulic controls. Further, it states that this small amount of discharge would not have the potential to impact what was the natural flow variability in the creek. However, while there are controls at these two points within Wolli Creek, there is nevertheless a natural creek bed between these two points and it is inferred that this is to be a continuous flow; as such it may actually be discharging at this rate all day, every day. Based on a predicted flow of 13.1 litres per second this would result in a **continuous flow of 1.3 ML/d into Wolli Creek.**

Comment: A constant flow like this has the ability to contribute to channel incision or headcutting, altering the geomorphology of this natural section of river. While this may only be localised, there is no information presented on what the normal flow variability is within Wolli Creek. As such, the discharge of a continuous flow should not be dismissed as a potential impact.

The total discharge of both surface flows and groundwater flows provided for the project are 32 L/s (Table 23 in the EIS). There is no information on how this was derived, or what contribution is from groundwater and surface water respectively.

Recommendation 2.10: Council requests that information be provided on how the discharge rates for surface flows and ground water flows were determined within the ground water technical working paper.

Impacts of clearing of riparian zones for construction

The surface water technical working paper states that direct construction activities within or adjacent to the watercourse and/or riparian zone are likely to involve the clearing of vegetation and excavation of channel bed and bank areas, including installation of bridge abutments. These direct activities are likely to disturb the existing floodplain and/or in-channel geomorphic units, exposing them to scour erosion, altering the trajectory of the channel planform. The proposed project includes works proposed within the watercourses or other riparian areas, including the construction water treatment plants. As such, there will be clearing of vegetation and excavation of channel bed and bank areas. The extent of this clearing is not quantified within the working paper.

Recommendation 2.11: Council request more analysis be given to impacts of clearing vegetation on water quality and more detail be provided on the extent of clearing.

Similarly, there is a statement that other potential construction impacts on the geomorphology include: increased impermeable area and / or altered flow paths that may result in increased over bank flows entering the waterway causing erosion; tunnelling activities causing bedrock fracturing and / or subsidence with the watercourse bed.

Treatment of water during construction.

The groundwater and surface water technical working papers are not clear on what criteria is adopted for treating water during construction. Council notes that construction water treatment plants would be used during construction at five locations.

Recommendation 2.12: Given that the five treatment plants will be spread out across the alignment and each will be receiving water of varying quality the EIS needs to gather sufficient data on the water quality at each location and specify the pollution reduction criteria that will be used for each plant.

Bore water users

The EIS has only analysed the impact on bores within a one kilometre buffer of the project alignment. The EIS has only predicted potential impacts on existing groundwater users in terms of drawdown rates. There is no assessment of the potential decline in groundwater quality as a result of the project and the impact this might have on bore water users or vegetation. As the potential for bore water contamination is high this also needs to be assessed for bore water users.

Recommendation 2.13: The impact on existing and future bore water users from reduced water quality should also be assessed along with reduced drawdown. Further, the impact on bore water users should be assessed across the whole project area (not just the 1km buffer zone).

Recommendation: 2.14 An overarching alternative recommendation which would address many of the concerns presented above is for the precautionary principal to be applied and for a commitment to be given for the new M5 tunnels to be constructed as lined tunnels for their full length.

Flooding

Hurstville City Council recently commissioned a draft Hurstville Local Government Area (LGA) Overland Flow Flood Study. The draft study, which was recently on public exhibition, represents the completion of Stages 1 and 2 of the floodplain management process as per the requirements of the NSW Floodplain Development Manual. The purpose of the draft study was to define the flood behaviour under historical and existing floodplain conditions in the Hurstville LGA while addressing possible future variations in flood behaviour. The study can be found at:

http://www.hurstville.nsw.gov.au/Draft-Hurstville-LGA-Overland-Flow-Flood-Study.html

Recommendation 2.15: The EIS should give full consideration to the draft Hurstville Overland Flood Study to be able to determine the potential impact on overland flow as a result of disturbance to surface and ground water systems during the New M5 project construction and operational phases.

3. Biodiversity

The range of potential biodiversity impacts from the New M5 is significant. It is unclear from the Biodiversity Assessment Report (BAR) whether the mitigation measures are adequate to address the direct and indirect impacts of the proposal.

There are a number of species and vegetation communities that were not considered in the BAR including the Powerful Owl, Micro-bats and indirect impacts to Swamp Oak, Freshwater Wetlands and Coastal Saltmarsh vegetation near the Marsh Street / Eve Street wetlands. There is also potential impact to Sydney Turpentine Ironbark Forest EEC within Beverley Park, Tallawalla Road, Kingsgrove and potentially other vegetation due to temporary changes to groundwater levels during construction. These need further quantification to be fully assessed.

The identified impacts to the Green and Golden Bell Frog population on the Kogarah Golf Course are significant and permanent. The BAR does not fully consider these impacts on the potential extinction of a local population of this species. In the absence of a detailed amphibian survey being conducted as part of the BAR, and if the required biodiversity offsets cannot be acquired within the Arncliffe area then a species impact statement (SIS) should be developed to provide further information. The SIS should guide the additional mitigation measures proposed for this species, and be developed in consultation with local Councils.

During the preparation of the EIS, the project was referred to the Commonwealth Minister for the Environment (2015/7520) under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) because of the potential for the project to impact on the following matters of national environmental significance (MNES):

- A population of Green and Golden Bell Frogs (*Litoria aurea*), known to inhabit the Kogarah Golf Course at Arncliffe;
- An area of the Cooks River Castlereagh Ironbark Forest (CRCIF), vegetation community in Beverly Grove.

Under the Bilateral Agreement relating to environmental assessment (February 2015) between the Commonwealth Government and the NSW Government, this EIS has been adapted to meet the assessment requirements of both the Commonwealth EPBC Act and the EP&A Act. The requirements of the bilateral agreement have been considered and taken into account as part of this environmental impact statement.

The Biodiversity Assessment Report (BAR) was undertaken in accordance with the survey guidelines specified by the Secretary's Environmental Assessment Requirements (SEARs) and provided an assessment of the potential ecological impacts of the proposal, with specific reference to vegetation and habitat clearing, connectivity, edge effects, weed dispersal, riparian and aquatic habitat impacts, soil and water quality impacts and operational impacts. The assessment was undertaken in accordance with the Framework for Biodiversity Assessment (FBA) (OEH, 2014a) and the NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014b), and by a person accredited in accordance with section 142B(1)(c) of the Threatened Species Conservation Act, 1995.

Impacts on species, populations and ecological communities that required further consideration and provision of information outlined in the FBA were described. Species specific surveys were undertaken for those species in accordance with the survey requirements specified by the OEH.

The database searches identified threatened species, populations, communities and habitats with the potential to occur or known to occur within the biodiversity study area.

Limitations in determining species impacted by the proposal

The FBA credit calculator tool was used to determine the potential species likely to be impacted by the proposed New M5 construction works. This selection of species for further consideration of potential impacts is based on previous studies and the existence of available habitat within the construction footprint. It was not an exhaustive list of potential species that may be encountered. Consequently additional species were considered by OEH as being worthy of further consideration.

However, in obtaining a more comprehensive list of potential species and ecological communities likely to be affected by the proposed construction works, there has not been a thorough review of information obtained for the local areas as held by the local government authorities. In particular, there was inadequate consideration of any:

- Additional information obtained by Hurstville, Rockdale and Canterbury on local threatened fauna/flora species as part of the development application process or
- Species hotspots or known areas of significant habitat that may not be recorded in threatened species databases but identified in biodiversity studies, such as the important Wolli Creek Regional Park
- Management plans and strategies prepared for local government authorities that document the particular aspects of local biodiversity such as the Grey-headed Flying-fox management plan for Turella.

There are provisions within the FBA to consider local information where it can be demonstrated that this information provides a more comprehensive summary of the existing biodiversity compared to government databases. The desktop review conducted for the BAR could have considered additional sources of information to obtain a more comprehensive species list potentially impacted by the proposal. Some of these sources of information are included below.

Previous studies for M5 East

Cumberland Flora and Fauna Interpretive Services was engaged by the former Roads and Traffic Authority (RTA now Roads and Maritime) to undertake detailed surveys of the Beverly Grove bushland, which occurs within part of the M5 East Motorway corridor between Beverly Hills and Kingsgrove. The surveys were conducted to assess if the M5 East realignment would impact on areas of high conservation significance including Cooks River Clay Plain Scrub Forest EEC. This community has been renamed by the NSW Scientific Committee in 2002 as CRCIF, which is listed as an EEC under the TSC Act and critically endangered under the EPBC Act.

The bushland at Beverly Grove was considered to be of high conservation significance due to its proximity and potential integration with STIF. The patch of CRCIF is at the eastern most extent of its geographical distribution. The assessment recommended bushland rehabilitation works to be undertaken within this community.

Local Government Studies

Each of the Councils in the project area, including Hurstville City Council hold detailed information on the flora and fauna of their local government areas which was not considered during the background review. Local information can provide important background on the potential for threatened species to utilise areas along the New M5 project alignment as part of a foraging or sheltering habitat as part of seasonal movements along the drainage lines.

Likelihood of occurrence assessment

Based on the project design for tunnels rather than a surface expression, the BAR discounted the likely presence of many of the species predicted to occur with the area.

Whilst OEH have provided additional species for consideration in addition to those outlined in the SEARs, the process has truncated the potential threatened species lists and focussed on only a number of key species and communities. This number is further reduced following the likelihood of occurrence assessment that only focuses on the immediate environment within the project alignment and does not include the range of surrounding vegetation types.

This process fails to fully consider the potential for stepping stone habitat or occasional use of local patches of vegetation within the project alignment as part of a regional biodiversity corridor, passing through Bardwell Valley, then towards either Stotts Reserve to Wolli Regional Park; or via Coolibah Reserve and continuing towards Wolli Regional Park. These reserves are included Priority Natural Areas with moderate conservation significance in the Rockdale City Council Biodiversity Strategy.

Adequacy of the survey method

The BAR was prepared using the FBA. Section 2.1.1.4 of the FBA indicates that where a proponent is proposing to establish an offset site as part of the Biodiversity Offset Strategy (BOS) for the Major Project, the Biobanking Assessment Methodology (BBAM) must be used to assess the biodiversity values of the offset site and to identify the number and type of biodiversity credits that may be created on the offset site.

This relies on the FBA credit calculator tool in determining the potential species impacted by a project and does not consider additional species identified during the background review.

Landscape assessment of Threatened species

In assessing the biodiversity values, the FBA is a multi-step process commencing with describing the landscape, obtaining quadrat and transect-based vegetation assessments to determine site values before assessing the threatened species and populations present.

The process involved extracting information from the Threatened Species Profile Database of those species listed in the SEARs and any supplementary species lists for a range of parameters.

Where a species can be predicted by habitat surrogates (ecosystem credits) there is no requirement to undertake specific targeted surveys as these species are reliably predicted to occur and appropriate offset credits determined.

Where a species can be predicted by habitat surrogates must be assessed in a separate step. The candidate species credit species is identified if it was listed in the TSPD; the project site is within the geographical distribution of that species; the development site contains habitat features or components associated with that species; or past surveys undertaken in the area indicate that the species is present. The categorisation of potential ecosystem credit species or species credit species for further investigation was based on the assessment as to whether the list of species determined using the FBA credit calculator met the conditions outlined for in the Part 6 of the FBA.

a) Ecosystem credit species

No ecosystem species derived using the FBA credit calculator tool fully met the criteria and no further investigation was conducted.

b) Species credit species

Only the Green and Golden Bell Frog was considered for further investigation based on the review of the species list determined using the FBA credit calculator.

c) Limitations

The FBA credit calculator was applied to derive a predicted species list for further investigation. The species list interrogated to assess the requirements for further targeted species survey did not include the additional species provided in the supplementary SEARs, or those provided by OEH as supplementary species. **Consequently no targeted surveys for threatened species were undertaken in the BAR. Therefore the assessment of potential impacts from the proposal cannot be fully assessed where threatened species could occur within the project alignment.**

Survey methodology

A candidate species is not considered to be present on the development site where:

- After carrying out an assessment of the habitat components, the assessor determines that the habitat is substantially degraded such that the particular species is unlikely to utilise the development site; or
- An expert report prepared in accordance with Subsection 6.6.2 states that the species is unlikely to be present at the development site; or
- The species is a vagrant species and unlikely to use habitat on the development site; or
- Records of the species presence in relation to the location of the development site are at least 20 years old or, in the opinion of the assessor, have doubtful authenticity.
- Where these conditions are not satisfied, then targeted species surveys should be conducted. The methodology for such species is outlined in the FBA and includes:
- Threatened Biodiversity Survey and Assessment guidelines (DEC, 2004),
- Survey guidelines for Australia's threatened mammals (DSEWPC, 2011),
- Survey guidelines for Australia's threatened bats (DEWHA, 2010a); and
- Survey guidelines for Australia's threatened frogs (DEWHA, 2010b).

The effort was prioritised within the study area according to the vegetation community present and potential habitat for threatened flora and fauna species and focused only on the project alignment and a small buffer around the construction footprint.

The survey effort and coverage was restricted to the immediate project alignment with many of the areas of investigation having restricted or no access. The EIS acknowledges that the survey effort did not cover the optimal season for detection for many of the species likely to occur and hence the information is inconclusive. Whilst this is a function of the political and financial constraints for major infrastructure projects, in the absence of a thorough field assessment, the precautionary principle should have been adopted. **Under this principle, if suitable habitat exists within the project alignment, however degraded or modified, then a species should be considered likely to utilise this habitat, either permanently or as part of a wider range.** It is not clear from the BAR to what extent the assessment and therefore conclusions are based on this position.

Examples are provided in the attached Molino Stewart report for particular species as outlined in the BAR which demonstrate the limitations in the survey. These include the Green and Golden Bell Frog, the Grey Headed Flying Fox, Micro-bats, birds and hollow-bearing tree surveys.

Vegetation Communities Assessments

Four plant communities were recorded within the project alignment based on database searches and literature reviews, verified through quadrat sampling and random walks through the existing vegetation. Some patches of vegetation were not able to be assessed due to restricted access to private lands.

Based on the NSW Scientific Committee criteria, three of these vegetation communities were considered in the BAR representative of the following endangered ecological communities (EECs):

- Cooks River/Castlereagh Ironbark Forest
- Swamp Sclerophyll Forest on Coastal Floodplains
- Sydney Turpentine Ironbark Forest

A consideration of these vegetation communities impacted by the project is included in the Molino Stewart report attached.

Based on Molino's Stewart's assessment of the OEH vegetation mapping, a patch of vegetation within the Marsh Street / Eve Street wetlands includes Swamp Oak and could be representative of Swamp Oak Swamp Forest EEC. Similarly, the freshwater wetlands may also be consistent with the Sydney Freshwater Wetlands EEC. There are also vegetation communities located outside of the survey buffer for the project alignment that could be impacted by indirect effects of the construction works and should also be considered in the BAR and these are also detailed in the attached Molino Stewart report.

Groundwater dependent ecosystems

The proposed New M5 project footprint lies within the Cook River catchment. The Technical Working Paper for Groundwater – Appendix Q of the EIS indicates that modern alluvium underlies and flanks the Cooks River and its tributaries forming an unconfined aquifer. Groundwater quality within the alluvium is variable but typically of low salinity in the upper reaches and becoming brackish in the lower reaches due to tidal influences and mixing. The river alluvium is generally of high permeability and the groundwater within the alluvium can be a source of either recharge or discharge depending on whether upward or downward hydraulic gradients are present.

The lower topographic areas of the Cooks River and its tributaries are generally gaining streams; that is groundwater discharges from the aquifer into the stream or creek. In the upper reaches of the catchment such as Bardwell Park and along the Bardwell Valley the creeks are likely to be losing streams; that is water from the creeks discharges to the underlying aquifer via primary and secondary porosity features.

Groundwater dependent vegetation communities likely to be affected:

The BAR lists a number of vegetation communities identified within the project alignment that have the potential to be directly affected by any changes to groundwater associated with the New M5 proposal. These include:

- CRCIF within Beverly Grove Park is about 1.8 hectares in area and contains several native vegetation communities which are indicative of shallow groundwater tables and waterlogged soils;
- Seventeen hectares of Hinterland Sandstone Gully Forest with a moderate to high potential to be dependent on groundwater within Bardwell Valley Parkland and Broadford Street Reserve;
- About 3.5 hectares of Coastal Sandstone Ridgetop Woodland within Stotts Reserve, Bexley North. This vegetation has a moderate to high potential to be dependent on groundwater;
- About 3.4 hectares of Estuarine Fringe Forest between the southern bank of Wolli Creek and the rail line behind Wolli Creek Station, with a low to moderate potential to be dependent on groundwater.

However, in assessing the impacts of groundwater dependent ecosystems (GDE), the FBA only requires an assessment where direct impact associated with vegetation clearing may occur. There are no provisions for indirect impacts to be quantified.

Indirect impacts

The dewatering of the tunnelling works during the construction phase will continue throughout the life of the project. For the lower topographic areas, the drawdown of the water table is predicted to be balanced by tidal flushing. This will progressively increase the salinity of groundwater within the deepest root zone for canopy species and may lead to floristic changes in the vegetation communities. For instance, there would be a likely replacement of *Melaleuca* species by *Casuarina* species lining the waterways (Cooks River, palaeochannels, back swamps and depressions) resulting in potential reduction on foraging habitat for the Grey–headed flying-fox. This may also alter the assemblage of communities that occur on top of the Botany Sands sand sheet.

The draw down and groundwater salinity changes will also have the potential to impact the Marsh Street / Eve Street wetlands next to Kogarah Golf Course. This area overlies the Botany Sands and would be subjected to an inflow of saline water to replace the ongoing drawdown of the groundwater table for the project. The extent of this drawdown in relation to natural recharge and tidal flushing is not quantified in the BAR, hence impacts can only be inferred. There is the probability that this may be a significant impact to these wetlands, resulting in a shift in floristic composition from permanently inundated aquatic species to ephemeral, more salt-tolerant species. A flow on effect of altering the groundwater conditions and floristic diversity on the Green and Golden Bell Frog is not known or considered in the BAR.

For the upper reaches of the Cooks River and tributaries, including Bardwell Creek and Wolli Creek, there is the potential for changes in groundwater to affect existing vegetation. The Wolli Creek Riparian Corridor Management Plan lists five EEC along the section from Kingsgrove to the confluence with Cooks River including Freshwater Wetlands and Swamp Sclerophyll Forest on Coastal Floodplains. These two EEC are susceptible to any adjustment to the groundwater levels due to the extent of the drawdown of the groundwater table or salinity changes from seawater recharge.

The patch of STIF EEC vegetation at Beverley Park (Tallawalla Road), in close proximity to the project alignment, may be affected by drawdown of groundwater and that this impact has not been fully quantified in the BAR. This patch of vegetation was included in the list of GDE likely to be affected by indirect impacts. The extent of the drawdown is significant and long-term and is likely to have a significant impact that should be considered in the biodiversity assessment.

The Bardwell Valley biodiversity corridor is locally significant, linking vegetated areas from Bardwell Park to Stotts Reserve and Wolli Regional Park; and towards Coolibah Reserve and Wolli Regional Park. This native vegetation occurs along drainage lines. Any disruptions to the groundwater levels, discharge zones or subsurface flows due to the New M5 proposal will have an impact on this biodiversity corridor. The extent of this impact is unable to be assessed based on the available information provided in the BAR, but will potentially affect natural regeneration of existing vegetation communities, placing mature vegetation under water stress. It will also provide opportunities for colonisation of the area by extra-local or exotic species more suited to a changed groundwater regime.

Framework for Biodiversity Assessment (FBA) Species Credits

The environmental assessment requirements for the New M5 direct the assessment of impacts on the biodiversity through the defined assessment methodology under the FBA framework. This will quantify and describe the biodiversity values on the development site. As part of this process, the NSW Biodiversity Offsets Policy for Major Projects applies and biodiversity offsets are required to mitigate any unavoidable impacts.

The FBA requires proponents to provide offsets on a like for like basis. This means that the biodiversity present at the development site should be the same type of ecological community or have the same habitat values as the biodiversity present at the offset site. Where these like for like offsets cannot be obtained, there are supplementary measures that, when undertaken as part of the Biodiversity Offset Strategy (BOS), are likely to lead to improvements in biodiversity or other

environmental values. The Biodiversity Offsets Policy for Major Projects requires that supplementary measures be of an equivalent monetary cost to the provision of offsets.

Underpinning this entire scheme is the adequacy of the FBA in assessing the existing biodiversity on the site. From discussions above, it is our view that the BAR provided as part of the EIS has not fully considered a range of species and communities that may potentially be affected directly or indirectly by the New M5 project. Therefore the BOS is potentially not considering all relevant impacts and as such, the BOS may not adequately mitigate all project impacts.

Cooks River Castlereagh Ironbark Forest EEC

The removal of 1.40 ha of a patch of 1.81 ha of CRCIF between the existing M5 and Canterbury Park Golf Course requires the acquisition of 31 ecosystem credits as determined by the FBA credit calculator. However, the loss of 78 percent of the patch of existing native vegetation is significant and likely to place the residual 0.42 ha at risk of long-term extinction. In determining the appropriate species credits to mitigate this loss, the calculation should consider:

- Firstly, the entire patch size as being removed, i.e. using the full 1.82 Ha rather than the minimum necessary for the construction footprint; and
- Secondly, the loss of this patch of vegetation, when considered as part of the wider CRCIF EEC / STIF EEC community surrounding the golf course, will impact on a range of threatened fauna that also need to be considered in the credit calculation.

Swamp Sclerophyll Forest EEC

Part of the Swamp Sclerophyll Forest EEC occurring on Kogarah golf course will be removed for the MOC 3 compound. This shall be mitigated by the acquisition of 27 ecosystem credits. No consideration was made on the potential loss of winter foraging resources for the Grey-headed Flying-fox in this calculation. The biodiversity offset requirements are therefore unlikely to fully mitigate the loss of habitat due to the project and therefore should be reviewed in light of potential impacts to a range of other fauna species dependent upon the Swamp Sclerophyll Forest EEC.

Green and Golden Bell Frog

The clearing of vegetation for the MOC 3 compound on Kogarah Golf Course will impact on 7.82 ha (20 percent) of known habitat for the Green and Golden Bell Frog in the Arncliffe area. It is calculated that 203 species credits will be the required offset for this impact. In addition, land shall be acquired near the existing Marsh Street / Eve Street wetlands for construction of artificial habitat, similar to the RTA ponds constructed adjacent to the Kogarah Golf Course in compensation for impacts from the M5 Motorway construction works.

This offset is inadequate to fully mitigate the habitat loss and potential for the nationally-significant Arncliffe population of Green and Golden Bell Frog to be placed at risk of extinction. The extent to which this offset is inadequate is demonstrated in the following points:

- The calculation of the species credits only considers the amount of clearing for the construction footprint of the MOC 3 compound and does not consider adjoining areas of potential habitat.
- The review of the Green and Golden Bell Frog in the BAR outlines that key breeding was occurring within the RTA ponds with limited episodic breeding within some of the ponds on the golf course. No recent breeding was observed within the Marsh Street / Eve Street wetlands.

- Furthermore, the BAR also indicates the edges of a couple of the golf course fairways provide sheltering habitat with movement observed between a number of the ponds towards the RTA wetlands, but also via a cycle underpass towards the Marsh Street / Eve Street wetlands. The arrangement of the MOC 3 compound will place a barrier to these movement patterns and therefore will have an area of impact greater that the construction footprint of the MOC 3 compound.

The assessment of the RTA ponds as key breeding habitat does not consider the importance of the Marsh Street / Eve Street wetlands as potential habitat for this species. This is despite evidence that movement of these frogs did occur via the bicycle underpass between the golf course and the wetlands, and presumably between the RTA ponds and the Marsh Street / Eve Street wetlands. At the very least these wetlands provide sheltering habitat and hence any impacts through changes in groundwater associated with the construction of the New M5 will affect this area. The extent of this potential impact was not quantified in the BAR and also not included in the species credit calculation for the Green and Golden Bell Frog.

Grey headed Flying Fox

No species offset credits are proposed for the potential impact on the Grey-headed Flying-fox. The Grey-headed Flying-fox was not listed within those species potentially impacted by the project using the FBA credit calculator. Additionally, the BAR concludes that due to the large range of foraging for this species, patches of vegetation to be removed within the project alignment would not result in a significant loss of resources and hence would not significantly impact the bats residing within the Turrella colony. However, it is not clear from the BAR what is the extent of winter flowering trees within the potential foraging range of this species, or whether the patch of Swamp Sclerophyll Forest EEC to be removed from Kogarah Golf Course for the MOC 3 compound is significant in providing a seasonal resource for this species.

There is also the potential for other patches of vegetation within the Marsh Street / Eve Street wetlands to be affected by changes in the groundwater due to the construction works and may result in a loss of foraging habitat.

The loss of foraging sites, particularly seasonally-available resources should be reassessed to consider the impact on the Grey-headed Flying-fox colony at Turrella and biodiversity offsets considered to mitigate these impacts.

Flora and fauna impacts

The New M5 will have short and long-term impacts for a range of threatened fauna and EECs. The following section outlined these impacts and the inadequacies of the mitigation measures proposed in the EIS.

Green and Golden Bell Frog population of the Cooks River

The clearing of known habitat for the Green and Golden Bell Frog for the MOC 3 compound will interrupt known movement patterns between waterways on golf course and construction RTA ponds and between the waterways and fairways on the golf course at the Marsh Street / Eve Street Wetlands. This impact is significant and will have long term consequences including placing the nationally-significant Arncliffe population at risk of extinction. The proposed biodiversity offsets do not fully consider the impacts to this species through loss of breeding habitat, removal of potential sheltering sites and disruptions to movement patterns between areas of known occupation surrounding the Kogarah Golf Course.

If the required Biodiversity Offset credits are obtained for habitat outside of the Arncliffe Green and Golden Bell Frog population, then there is a significant risk of extinction to this local population through the removal of 20 percent of the known habitat. Moreover, there are inherent difficulties in creating artificial wetlands to supplement the existing RTA ponds. Any such wetlands will require ongoing monitoring and management for extended timeframe before a stable breeding population would be achieved. Therefore they are not an immediate solution to the loss of habitat for the construction works.

In addition to the required biodiversity offset, additional mitigation measures proposed for this population include the preparation of a Green and Golden Bell Frog Management Plan as part of the Flora and Fauna Management Plan for the New M5. This document shall only be prepared after the close of public comments for the New M5 EIS and therefore is not available for public scrutiny. Any management plans must:

- Adopt lessons learned from other infrastructure projects; and
- Be available to local government for comment and input during the process of developing these management plans.

Cooks River/Castlereagh Ironbark Forest

The removal of 1.40 Ha of a total patch size of 1.82 Ha at Beverley Grove will have a significant and long-term impact on this vegetation. It is unlikely that the residual vegetation will continue as a patch of native vegetation without future vegetation management. This patch of vegetation was previously identified during the assessment for the M5 East realignment works as being at the easternmost extent of the distribution range, of high conservation significance and should be rehabilitated. There are no similar patches in the area for which to obtain an appropriate biodiversity offset.

The habitat value of the existing CRCIF will be degraded due to this loss of canopy vegetation. Moreover, when considered in association with other patches of STIF EEC occurring within the golf course, the loss of such vegetation will disrupt the connectivity and impact on a range of species not considered in the BAR.

Sydney Turpentine-Ironbark Forest

This vegetation community occurs adjacent to CRCIF in retained vegetation along the fairways of Canterbury Golf Course and in a public reserve to the south of the existing M5 Motorway. Whilst outside of the project alignment there is the potential that groundwater changes due to construction may affect natural regeneration of this community.

Fauna surveys were not undertaken within patches of STIF EEC and hence no assessment of the potential for these patches of vegetation when considered as a whole to provide temporary habitat for a range of species. In particular these areas are within a regionally important biodiversity corridor along Wolli Creek that is known to include habitat for the Powerful Owl.

Coastal Saltmarsh

The groundwater changes during construction are likely to affect Coastal Saltmarsh vegetation within the drawdown area. The extent of this impact was not quantified in the BAR and further information should be provided to assess the long-term implications to this EEC

Sydney Freshwater Wetlands

This vegetation is likely to exist in a degraded condition within the Marsh Street / Eve Street wetlands adjacent to the MOC 3 compound. Any groundwater changes due to construction works will affect these wetlands. The extent of this impact was not quantified in the BAR and further

information should be provided to assess the long-term implications to this EEC. A vegetation management plan should be developed as part of the mitigation measures for this wetland to enhance the available habitat for a range of migratory birds and frog species.

Swamp Oak Floodplain Forest

This vegetation was recorded within the Marsh Street / Eve Street wetlands but outside of the project alignment. Interruptions to groundwater levels due to the project may impact on this community although details of potential impacts were not quantified in the BAR. A vegetation management plan for the Marsh Street / Eve Street wetlands should be developed to enhance the habitat value of the communities in this area to support migratory birds and frog species

Bangalay Sand Forest

This community was not recorded within the project alignment but may occur on the sand sheets surrounding Botany Bay. The potential for groundwater changes due to the project to affect this community was not quantified in the BAR. In the absence of available information, a precautionary principle should be adopted and measures developed to mitigate any potential adverse effects from the New M5 proposal.

River Flat Eucalypt Forest

This community was not recorded within the project alignment but may possibly be extant along the non-tidal sections of Wolli Creek. Changes to the hydrological regime, groundwater discharge areas and subsurface flows may affect any River Flat Eucalypt Forest EEC. Further investigation of the degree of hydrological changes along this waterway should be prepared before any assessment of the long-term effects to this EEC can be determined.

Cooks River Clay Plain Scrub Forest

This community is included as part of the CRCIF and is likely to occur in the vicinity of Canterbury Golf Course. Changes in groundwater levels due to the construction works , or due to clearing of existing vegetation, may affect this community and should be considered in any biodiversity offsets for the Cooks River EEC.

Swamp Sclerophyll Forest on Coastal Floodplains

The clearing of 1.82 ha of moderate to good quality Swamp Sclerophyll Forest EEC will be required for the current arrangement for the MOC 3 compound. The impact of this clearing will be compensated through the acquisition of biodiversity offsets determined in accordance with the FBA credit calculator. This vegetation community is not listed as a threatened ecological community under the EPBC Act and hence no assessment of the significance of the clearing of this vegetation was provided in the BAR. Without this information, it is difficult to know the extent of the Swamp Sclerophyll Forest retained on the Kogarah Golf Course and whether the removal of the 1.82 Ha for the MOC 3 compound will affect the long-term survival of the residua vegetation.

The habitat value of this patch of vegetation was also not fully considered within the BAR. In particular, winter flowering *Melaleuca quinquenervia* is an important food resource for the Grey-headed Flying-fox. Given the proximity of the Turrella colony, the removal of the Swamp Sclerophyll Forest may have a significant impact on the availability of seasonal foraging resources within the local area.

The fairways near the RTA ponds were also identified as habitat for the Green and Golden Bell Frog, either for sheltering, occasional breeding; or a corridors for movement between the waterways on the golf course and either the RTA ponds or the Marsh Street / Eve Street Wetlands.

There has been no consideration of the potential impacts the removal of the Swamp Sclerophyll Forest EEC vegetation may have on these threatened species.

Birds

The migratory bird survey was limited to the immediate impact area of the project alignment and focused on the Eve Street wetlands. No consideration was presented for the potential for occasional use of the waterways within the Kogarah Golf Course or the Wolli Creek / Alexandra Canal. These areas are likely to provide occasional habitat although further surveys are required.

Grey-headed Flying-Fox

The proximity of the Turrella colony to the project alignment should indicate that the New M5 proposal may impact on the Grey-headed Flying-fox. The initial species lists for further consideration under the bilateral agreement as determined using the FBA credit calculator did not include the Grey-headed Flying-fox. OEH recommended additional investigation of this species.

Rockdale City Council has commissioned a Management Plan for the Grey-headed Flying-fox camp as Turrella. This plan indicates that this camp was a significant permanent colony in southern Sydney. Winter food resources include Sydney Red Gum (*Angophora costata*) and other flowering Eucalypts common in southern Sydney. However it is unclear to what extent, if any, the Grey-headed Flying-fox colony management plan was considered in the BAR. There was no detailed investigation into the importance of *Melaleuca quinquenervia* and *M. ericifolia* vegetation in providing winter food resources for this species. Without this information, an assessment of the potential impact to this species cannot be established. The reliance on a large foraging range of up to 20 km from any colony should not be justification for excluding local food resources where these may provide a scare seasonal supply.

Groundwater dependent ecosystems

The New M5 proposal will have lasting impacts on the hydrology due to dewatering and discharge of groundwater during construction and operation of the New M5. These changes will have a significant impact on existing vegetation communities within the potential groundwater drawdown area. In addition, changes to surface runoff from impervious surfaces and flow regimes through installation of detention basins and stormwater management systems will have localised impacts.

The FBA does not address the direct impacts that are not associated with vegetation clearing and hence does not quantify those indirect impacts from changes to groundwater changes.

It is likely that the proposal will affect existing natural environments such as the Marsh Street / Eve Street wetlands, Stotts Reserve and Coolibah Reserve as well as local open spaces within the local government area. The impact of existing vegetation communities in these areas was not quantified.

Species not considered in the BAR

The reliance on the FBA credit calculator, SEARs and OEH guidance to derive a species list for further investigation of potential impact from the New M5 disregarded local knowledge of the biodiversity within the project area. A number of species that are likely to be impacted by the proposal that have not been considered in the BAR are included below.

The Powerful Owl is known to occur within the regionally-significant biodiversity corridor along Bardwell Valley towards Wolli Creek. The removal of native vegetation for the construction footprint has the potential to affect the foraging resources within the home range for this species.

A number of micro-bats were identified by OEH in its advice to the proponents as being worthy of further investigation, including the Eastern Freetail Bat and the Greater Broad-nosed Bat. In

addition, a large number of recorded sightings of the Eastern Bentwing Bat have also been documented for the area. No echolocation detecting surveys were conducted in the BAR to provide information regarding the potential for these micro-bat species to occur within the project alignment.

The BAR identified areas of Swamp Sclerophyll Forest (Kogarah Golf Course) and Swamp Oak (Eve Street wetlands) including *Allocasuarina* and *Casuarina* species. These trees provide potential foraging resources for the Glossy Black Cockatoo but no assessment for the impact to this species was considered.

Cumulative impacts

CRCIF near Canterbury Golf Course is managed for conservation by the Roads and Maritime Services (RMS) as a condition of approval for the construction of the M5 East Motorway in 1998. Any impact to this vegetation for the New M5 proposal is not consistent with the objectives stated in SEPP Infrastructure or the Biodiversity Offsets Policy for Major Projects. Removal of this vegetation will place the residual patch at risk of local extinction and may also affect nearby STIF EEC vegetation.

The RTA ponds next to Kogarah Golf Course were also constructed as a condition for approval of M5 Motorway to provide breeding habitat for the Arncliffe population of Green and Golden Bell Frog. The clearing of 20 percent of potential habitat for this species from the Kogarah Golf Course is required for the New M5. Regular monitoring of the RTA ponds and adjoining areas indicates that the Green and Golden Bell Frog in the Arncliffe locality is stable but is not expanding. Any subsequent impacts will have a significant effect on this species.

The BAR is inconclusive in demonstrating that the proposed mitigation measures for the Green and Golden Bell Frog are adequate to ensure that the long-term survival of this nationally-significant population is not placed at risk of extinction due to the New M5 proposal. The clearing of potential habitat from the golf course and installation of barrier fencing surrounding the MOC 3 compound will have an immediate impact. The effectiveness of any proposed artificial wetlands to supplement existing habitat may not be achieved in the immediate timeframe. Mitigating these impacts through the BOS can only support the Arncliffe population if the biodiversity offset credits are obtained within the local context.

Species Impact Statements

The project was referred to the Commonwealth Minister for the Environment on 17 July 2015. The referral suggested that on the basis of the potential adverse impacts to the Cooks River / Castlereagh Ironbark Forest and Green and Golden Bell Frog, the project should be considered a controlled action.

The Minister for the Environment's delegate declared the project a controlled action on 13 August 2015. The project was determined to be likely to have a significant impact on two MNES, CRCIF and the Green and Golden Bell Frog.

Green and Golden Bell Frog

Without adequate population surveys, movement patterns and any assessment of the importance of the surrounding areas that are outside of the project alignment but provide habitat for this species; a species impact statement should be prepared as Stage 2 of the EIS process. It is unlikely that the biodiversity offset required for impact to this species in accordance with the FBA credit calculator will be obtained within the Arncliffe area and that the local population may be placed at risk of extinction. There is also no certainty that the proposed mitigation measures in addition to the

biodiversity offset, including the creation of additional breeding habitat, will be successful or provide immediately viable habitat alternatives to clearing of a known habitat.

CRCIF

The impact to the patch of CRCIF vegetation at Beverley Grove will be significant and long term and may result in the loss of the entire patch of vegetation at this location. This is the most easterly extent of the known distribution of this community and the implications for this loss are not clearly outlined in the BAR. Further investigation of the importance of this vegetation should be considered.

Biodiversity Recommendations

The following recommendations are proposed to address issues identified in the review of the BAR where the impacts on threatened species assessed using the FBA are inadequate or inconclusive. The additional information is based on the potential for additional species to use habitat features present within the project alignment, or where surveys for predicted species have not been undertaken in the biodiversity assessment.

Recommendation 3.1: Green and Golden Bell Frog

- **3.1.1** Redesign the layout of the MOC 3. At present, the southern extension of this compound creates a significant barrier to movement through Kogarah Golf Course towards the constructed RTA ponds and Marsh Street / Eve Street wetlands. Preference would be for a wider compound aligned along the northern boundary of the golf course next to Marsh Street to maintain connection between the waterways on the golf course and the cycleway under the M5 East motorway.
- **3.1.2** Commence the establishment of any artificial wetland that is designed to supplement the existing RTA ponds at the earliest possible time to provide suitable habitat prior to removal of existing habitat from Kogarah golf course.
- **3.1.3** Develop a fauna relocation plan to populate other potential breeding sites.
- **3.1.4** Develop a management plan for the waterways on the golf course to provide additional breeding opportunities. This may involve the dewatering of these areas and removal of exotic fish.
- **3.1.5** Include local government in review process of subsequent Flora and Fauna management plans for the New M5.

Recommendation 3.2: Grey-headed Flying-fox

- **3.2.1** Undertake survey of Turrella colony to assess population dynamics, potential outward flight paths, foraging resources.
- **3.2.2** Determine the local abundance of seasonally-available foraging resources and assess significance of removal of Swamp Sclerophyll Forest EEC.
- **3.2.3** Consider Rockdale Council's management plan for Grey-headed Flying-fox.

Recommendation 3.3: Cooks River Castlereagh Ironbark Forest EEC

- **3.3.1** Consider that the removal of part of this vegetation will result in the local extinction of this entire patch of vegetation and therefore provide biodiversity offset for removal of the 1.82 ha.
- **3.3.2** Undertake surveys to assess whether threatened fauna utilise this patch of vegetation, in combination with other areas of similar vegetation within the Canterbury Golf Course and Beverley Park to the south as part of a large range such as the Powerful Owl, micro-bats.

Recommendation 3.4: Marsh Street / Eve Street wetlands

- **3.4.1** Marsh Street / Eve Street Wetlands – develop a vegetation management plan to enhance the existing habitat of the Swamp Oak and Freshwater Wetlands EEC identified in this area, and potentially areas of Coastal Saltmarsh to support migratory birds and frog species.

4. Traffic and Transport

Council supports the proposed additional capacity (tunnels) along M5 East Motorway as it would reduce through traffic movements (rat-runs) along local/regional road networks, specifically Tooronga Tce-Commercial Rd, Morgan St and King Georges Rd-Stoney Creek Rd routes improving amenity for local residents.

However, there will be a number of impacts during the construction period (3½ years). These include:

- Potential impacts on local streets from construction related vehicles and those of employee's working on the project. This was raised at the M5 Workshop and Council requested WestConnex provide a Construction Traffic Management Plan (when ready) for Council to comment on before any construction related vehicles begin using local roads.

  Recommendation 4.1: Council requests a copy of the Construction Traffic Management Plan (once developed) to provide comments before it is implemented on any local streets.

- WestConnex is proposing to use the M5 Motorway for haulage vehicles; concerns are raised regarding the additional heavy vehicle traffic that will be generated along the M5 Motorway during peak periods.

  Recommendation 4.2: Council recommends the restriction of haulage of excavated material to off peak periods, preferably limited to night-time.

- Potential impacts may occur with regards to on-street parking in the Beverly Hills area as a result of additional demand generated from shift construction workers of the New M5 Motorway.

  Recommendation 4.3: Council request that WestConnex ensures adequate off-street parking facilities are provided for all the workers of the construction site.

- Council notes that a toll of up to $6.00 is planned on the M5 East Tunnel as part of the WestConnex Project. It has been identified in the EIS that this is likely to cause a large volume of drivers to take an alternative route via local roads in order to avoid paying the toll. Council is concerned at the impact this may have on local traffic in our community.

  Recommendation 4.4: Council requests that the Department of Planning and Environment ensure that WestConnex work with RMS to develop a strategy prior to operation of the New M5 to minimise the impact of toll avoidance on the Hurstville local road network and this strategy

should be detailed in the revised EIS. Council requests that it be consulted during the development of this strategy. The proposed operational review to be conducted by RMS 12 months after the opening of the New M5 infers that a band-aid approach will be adopted rather than strategically addressing the issue prior to commencement.

- Council wishes to understand the process that will be applied in the event of an accident or break down inside the new proposed M5 East tunnel. How will the flow on effect of traffic queuing along the tunnel and consequently along local roads be managed keeping in mind that there are no exit ramps until St Peters.

Recommendation 4.5: Council be provided details of accident / breakdown response plans and that these plans be developed in such a way that minimizes the impact of traffic queuing on local road networks.

5. Urban Design and Visual Impacts

The following submission points relate to urban design and visual impacts of the "western surface works" and the "Kingsgrove motorway operations complex" in the WestConnex New M5 Environmental Impact Statement (November 2015).

Ventilation Facilities:

The proposed detailed design of the ventilation facilities within the Kingsgrove motorway operations complex has not been provided in the EIS, an envelope design has been provided with a preliminary architectural treatment concept (refer Figure below).

Figure 24 MOC1 facility at Kingsgrove indicative visualisation

82 New M5 WestConnex Urban Design Urban Design

The EIS notes that the detailed design would be guided by the "ventilation performance requirements" and the following design principles: reflective of site and context, integration

with landscape, sculptural urban scale objects – urban landmarks, forms informed by function, identifiable by their materiality and appropriate use of materials. As shown in the figure above, the ventilation facilities will be a landmark feature with significant visual impact.

Recommendation 5.1: Hurstville Council should be consulted in the future design of the ventilation facilities and the "landscape and urban design plan" and the recommendations of the New M5 urban Design Review Panel.

Shared Pedestrian/Cycle Paths:

Council supports the retention of the existing shared pedestrian and cycle paths and the retention and extension of pedestrian and cycle access in the Kindilan Underpass. It is noted that the width of the underpass will be reduced to allow construction vehicle access between the Kingsgrove North construction compound and Kingsgrove South construction compound. It is also noted that the southern pathway is to be closed and users diverted under the Kindilan underpass and onto the northern pathway during construction; the need to investigate opportunities to provide an alternative southern cycle route for the length of the existing shared path impacted by the western surface works is supported.

Landscape Design:

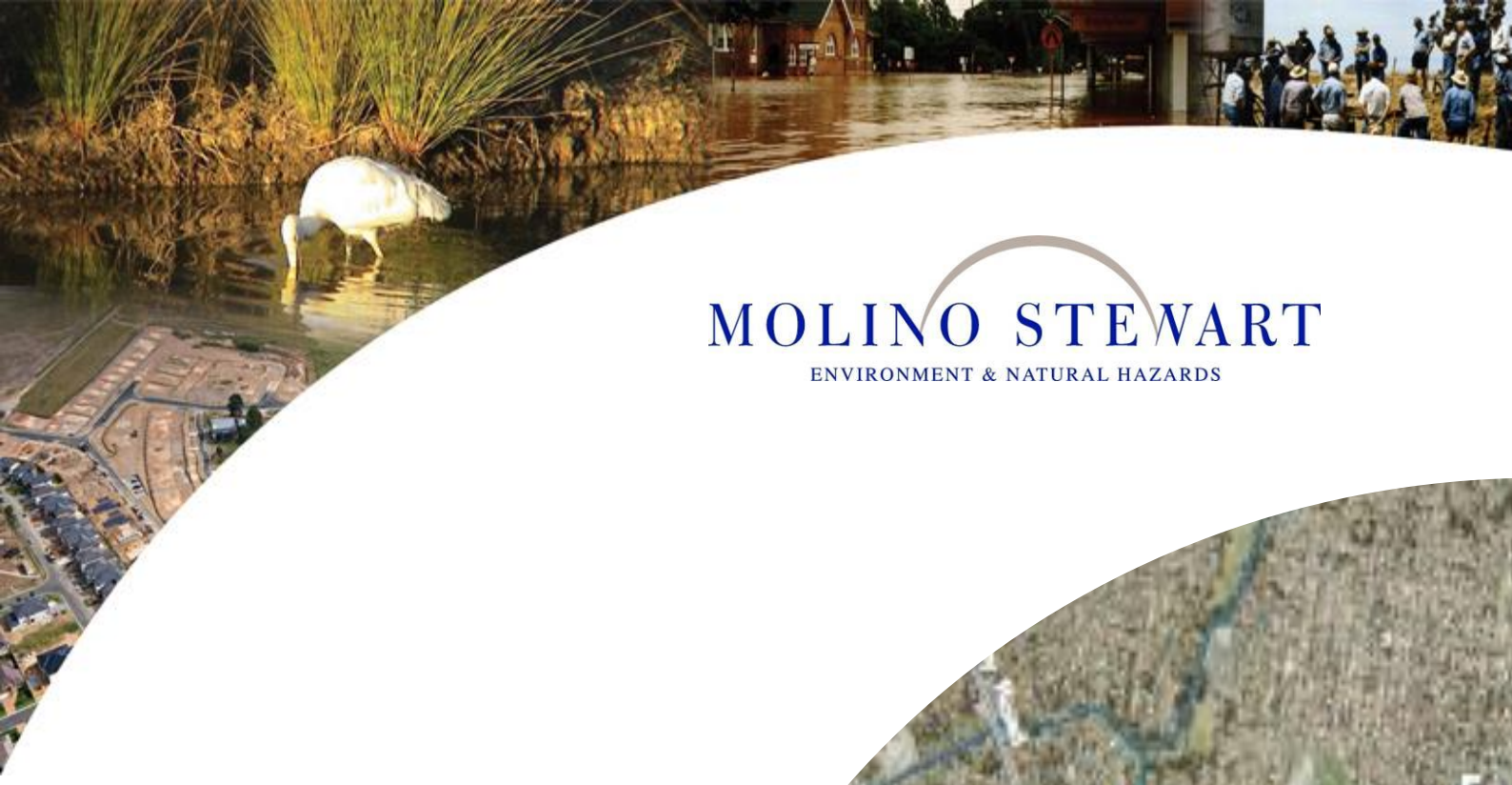
Council supports the landscape design objectives of providing a clear landscaped zone and safe sight distance setbacks to avoid the creation of hidden public places whilst maximising passive surveillance opportunities. The landscape design objective of maintaining and enhancing the existing landscape character and vegetation patterns and the landscape intent to screen as much of the built form as possible is also supported.

Recommendation 5.2: Council should be consulted on the future proposed landscape treatment.

Lighting and Signage:

The lighting design for shared paths located with the M5 Linear Park impacted by the project or located adjacent to compounds should be designed to minimise light spill to adjoining residential properties while maintaining a safe night time environment for path users.

The proposed future signage strategy detailing the design for temporary wayfinding and safety is also supported and Council should be consulted on the signage details, specifically in relation to the location and design.



MOLINO STEWART

ENVIRONMENT & NATURAL HAZARDS

Rockdale City Council,
Canterbury City Council &
Hurstville City Council

Review of Components of EIS of New M5

Final Report

MOLINO STEWART
ENVIRONMENT & NATURAL HAZARDS

Review of Components of EIS of New M5

FINAL REPORT

for

Rockdale City Council, Canterbury City Council & Hurstville City Council

by

Molino Stewart Pty Ltd
ACN 067 774 332

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ENVIRONMENT & NATURAL HAZARDS

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

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1 INTRODUCTION

1.1 BACKGROUND

The NSW Government has identified the WestConnex Motorway project as a priority, and as a result, the delivery of this infrastructure is being accelerated. The proposed WestConnex comprises a number of component parts including Stage 2: New M5 (Beverly Hills to St Peters)

The proposed New M5 will run from the existing M5 East corridor at Beverly Hills via a tunnel to St Peters, providing access to the airport, south Sydney and Port Botany precincts. This passes through a number of local government areas including Rockdale, Canterbury and Hurstville

This project will include the construction of:

- Twin tunnels running underground from Kingsgrove to St Peters;
- Interchange at an industrial site at St Peters;
- Connections from the interchange to key roads in the area, including Campbell Road/Street, Euston Road and across the canal to Bourke Road;
- Widening of Campbell Road/Street and Euston Road through existing road widening reservations; and
- Western tunnel entry and exit points at Kingsgrove, adjacent to the Kingsgrove industrial estate.

A ventilation facility is proposed to be built on government land close to the start of the tunnel and during construction, temporary work sites will be established on both sides of the M5 East Motorway. Construction is proposed to commence in mid-2016 and will take 3.5 years.

Three parcels of government-owned land on Bexley Road in North Bexley will be used to construct the proposed New M5 tunnels. The midway tunnelling point for the proposed New M5 tunnel will be located on government owned land currently occupied by the Kogarah Golf Club.

1.2 THIS REVIEW

The proposed New M5 EIS was released for public exhibition in late November and has an exhibition period until 29th January, 2016. Rockdale, Canterbury and Hurstville City Councils are particularly concerned about the impacts of the Motorway, interchange and local road upgrades on the following issues:

- Local air quality;
- Hydrology (particularly in relation to Wolli Creek);
- Water quality; and
- Biodiversity issues.

The Councils are planning to make a submission (either individually or as a group), identifying and raising their concerns with the WestConnex project.

Molino Stewart has undertaken this review of the biodiversity, air quality, and water quality and hydrology components of the New M5 EIS on behalf of Rockdale City Council, Canterbury City Council and Hurstville City Council. It is essentially an adequacy review of the EIS report in relation to the above components. It has a local focus, reflecting the Councils' concerns regarding the local impacts and cumulative impacts of infrastructure of this scale within their local government areas.

2 AIR QUALITY

2.1 AIR QUALITY LIMITS & GOALS

2.1.1 Ambient Air

This review of the New M5 Project Working Paper and EIS has included a consideration of background levels of the air pollutants carbon monoxide, nitrogen dioxide, PM10 particulate matter, PM2.5 particulate matter, and benzene.

The maximum concentration levels for these pollutants currently established by the NSW Office of Environment and Heritage (NSW OEH) are summarised in Table 1.

Table 1 NSW Air Quality Criteria

Pollutant	Maximum	Averaging Period	Agency
Nitrogen Dioxide	120 ppb [C]	1 hour	NSW EPA, NEPM 1998
	30 ppb [C]	1 year	NSW EPA, NEPM 1998
Carbon Monoxide	87 ppm [A]	15 minute	WHO 2000
	25 ppm [A]	1 hour	WHO 2000
	9 ppm [A]	8 hour	NSW EPA, NEPM 1998
Particulate Matter < 10 μm (PM10)	50 μg/m^3 [B]	24 hours	NSW EPA, NEPM 1998
	30 μg/m^3 [B]	1 year	NSW EPA, NEPM 1998
Particulate Matter < 2.5 μm (PM2.5)	25 μg/m^3 [B]	24 hours	NSW EPA, NEPM 2003
	8 μg/m^3 [B]	1 year	NSW EPA 1998
Benzene	3 ppb [C]	annual	NEPM

Notes: A. ppm = parts per million, by volume
B. μg/m^3 = micrograms per cubic metre
C. ppb = parts per billion, by volume

2.1.2 Road Tunnel Air

A wide range of guidelines apply to air quality within road tunnels. Pollutants generally considered include carbon monoxide and nitrogen dioxide. Historically, pollutant levels in road tunnels have been considered in terms of visibility (or haze), rather than on a strict health based determination – as is the case for ambient air (refer Table 5.1). Guidelines are generally determined on a project or case specific basis, and take into account project or case specific circumstances.

The Air Quality Working Paper and the EIS for the New M5 Project reference a number of guidelines for in-tunnel air quality, including the guidelines determined for the NorthConnex Tunnel project, and other Sydney road tunnels, which are summarised for reference (and as an indicative guide) in Table 2 and Table 3 below.

Table 2 Operational Limits for CO and NO2 in the NorthConnex Tunnel

Pollutant	Averaging Period	Concentration Limit (ppm)
In-tunnel average along tunnel length		
Carbon Monoxide	Rolling 15-minute	87
	Rolling 30-minute	50
Nitrogen Dioxide	Rolling 15-minute	0.5
In-tunnel single point exposure limit		
Carbon Monoxide	Rolling 3-minute	200

Table 3 Operational Limits for CO, NO2 and Visibility in Sydney Road Tunnels

Tunnel	CO Concentration (PPM; rolling average)			NO_2 Concentration (ppm)	Visibility (extinction coefficient), m^{-1})
	3-min	15-min	30-min		
Cross City Tunnel	200	87	50	N/A	0.005 - 0.012
Lane Cove Tunnel	-	87	50	N/A	0.005 - 0.012
M5 East Tunnel	200	87	50	N/A	0.005 - 0.012

2.2 POTENTIAL IMPACTS OF ELEVATED AIR POLLUTION LEVELS

2.2.1 Particulate Matter

Airborne particles are sometimes referred to as ‘particulate matter’ or ‘PM’. They include dust, dirt, soot, smoke and liquid droplets. Some particles are large enough or dark enough to be seen as soot or smoke, while others are so small they can only be detected individually with a microscope. Some particles are emitted directly into the air from a variety of sources that are either natural or related to human activity. Natural sources include bushfires, dust storms, pollens and sea spray. Those related to human activity include motor vehicle emissions, industrial processes, dust generated by unpaved roads and emissions from wood-heaters. Particles can be classified on the basis of their size, referred to as their 'aerodynamic diameter'. 'Coarse particles' are those between 10 and 2.5 micrometres (µm) in diameter; 'fine particles' are smaller than 2.5 µm; and 'ultrafine particles' are smaller than 0.1 µm. For comparison, the diameter of a human hair is 100 µm and this is approximately 10 times the diameter of the largest 'coarse particles'. Particles can also be classified according to their chemical composition. The toxicity of particles is often dependent on their size and chemical composition. Studies have linked exposure to particle pollution to a number of health problems including respiratory illnesses (such as asthma and bronchitis) and cardiovascular disease. In addition, the chemical components of some particles, particularly combustion products, have been shown to cause cancer. These effects are often more pronounced for vulnerable groups, such as the very young and the elderly. Particle pollution is also a major cause of reduced visibility. This can be a serious safety issue on roads and in traffic tunnels and can also affect our enjoyment of the natural landscape. Particle pollution is a major air quality issue in Australia. In some regions of Australia, particularly during the cooler months, smoke from wood-heaters results in elevated particle levels that are a health risk for many in the community. Meteorological conditions, such as still air and inversions (where cold air is trapped below warm air), can slow down the removal of pollutants and increase the impacts of this pollution.

2.2.2 Nitrogen Dioxide

Nitrogen dioxide is an unpleasant smelling gas, with a sharp, irritating odour. Some nitrogen dioxide is formed naturally in the atmosphere by lightning and some is produced by plants, soil and water. However, only about one percent of the total amount of nitrogen dioxide found in our cities' air is formed this way. Nitrogen dioxide is a significant air pollutant because it contributes to the formation of photochemical smog, which can have significant impacts on human health. The major source of nitrogen dioxide in Australia is the burning of fossil fuels: coal, oil and gas. Most of the nitrogen dioxide in cities comes from motor vehicle exhaust (about 80 percent). Other sources of nitrogen dioxide are oil and metal refining, electricity generation from coal-fired power stations, other manufacturing industries and food processing. Un-flued gas heaters and cookers are the major sources of nitrogen dioxide within Australian homes. The main effect of breathing raised levels of nitrogen dioxide is the increased likelihood of respiratory problems. Nitrogen dioxide inflames the lining of the lungs, and it can reduce immunity to lung infections. This can cause problems such as wheezing, coughing, colds, influenza and bronchitis. Increased levels of nitrogen dioxide can have significant impacts on people with asthma because it can cause more frequent and more intense attacks. Children with asthma and older people with heart disease are most at risk. Since the early 1990s, even the highest levels of nitrogen dioxide reached in most Australian towns and cities are thought to be acceptable for humans. In some of Australia's larger cities, it is possible that the concentration of nitrogen dioxide sometimes increases for a short time to levels that have an adverse health effect on people who are most at risk. Air pollution authorities are monitoring the situation to see if this is the case.

2.2.3 Benzene

Benzene is known to have an adverse effect on human health, although the benzene concentrations considered likely to pose a health risk in adult workplace environments are significantly higher than those associated with traffic emissions, and noted in ambient city or urban air. It is generally considered that approximately 80 percent of the benzene present in urban or city air results from emissions of benzene from petrol fuelled cars, caused by both the benzene content of the petrol, and the partial combustion of the fuel. Concern has been expressed that relatively low concentrations of benzene in air can result in the increased incidence of some forms of leukaemia in young children.

This concern has resulted in the strict guideline limits for benzene shown in Table 1 above.

2.3 REVIEW OF THE EIS

2.3.1 Air Quality

Air quality is considered in WestConnex New M5 Air Quality Assessment Report November 2015 (Appendix H, Technical Working Paper – Air Quality, which forms part of the overall EIS. This working Paper was prepared for Roads and Maritime Services by Pacific Environment. The EIS itself was prepared by AECOM.

Both documents are substantial in scope and size. The working paper extends to some 700 pages, while the Air Quality component of the EIS (Chapter 10) comprises some 120 pages.

2.4 OVERALL REVIEW OF THE WORKING PAPER & THE EIS

The structure and general scope of both the Air Quality Technical Working Paper and the EIS are summarised below. General review comments regarding each section of the two documents (which collectively comprise the air quality component of the New M5 Project EIS) have been provided. The review comments have been colour coded on the following basis:

Issues or topics that have been appropriately dealt with in the working paper and the EIS, and where no further action is considered necessary.	

Important issues that have been appropriately dealt with in the working paper and the EIS, but where some level of further action is recommended.	

Significant issues that are not considered to have been fully or appropriately dealt with in the working paper and the EIS, and where further action or change is recommended.	

Where relevant, greater detail in relation to particular issues has been provided in Section 2.5 of this review.

2.4.1 Introduction

A general introduction to the New M5 project is provided in Section 1 of the working paper, and in Chapter 1 of the EIS. The following issues are among those addressed:

- Overview of WestConnex;
- Overview of the New M5 Project;
- Project location;
- Secretary's Environmental Assessment Requirements (SEARs);
- Purpose and scope of the reports; and
- Structure of the reports.

Review Comment:

The introductory material provided is thorough, accurate and appropriate.

2.4.2 The Project

The New M5 Project is described in Section 2 of the working paper, and in Chapters 4 and 5 of the EIS.

The project description includes details of:

- Project features;
- Construction activities; and
- Specific aspects of design relating to in-tunnel and ambient air quality

Details provided include:

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

- Infrastructure to introduce tolling on the existing M5 East Motorway; and
- Surface road upgrade works within the corridor of the M5 South West Motorway and M5 East Motorway; and
- The ventilation facilities for the project, being:
  - Kingsgrove ventilation facility. This facility provides the outlet for the westbound traffic of the New M5 tunnel (St Peters to Kingsgrove);
  - Arncliffe ventilation facility. This facility provides the outlet for the first section of eastbound traffic of the New M5 tunnel (Kingsgrove to Arncliffe), and the fresh air supply for the second section of the eastbound New M5 tunnel (Arncliffe to St Peters). It will also provide the outlet for the northbound Southern extension tunnel (Kogarah to Arncliffe); and
  - St Peters ventilation facility (New M5 outlet). This facility provides the outlet for the second section of the eastbound New M5 tunnel (Arncliffe to St Peters), the future outlet for the eastbound traffic to the M4-M5 Link stub (Arncliffe to St Peters), and the future fresh air supply to the northbound M4-M5 Link (St Peters to Rozelle).

The ventilation facilities for the future M4-M5 Link project and Southern extension have also been considered in this assessment but do not form part of the project.

Review Comment:

The project descriptions presented in both the Working paper and the EIS are thorough and extensive, and provide a very adequate and detailed description of the proposed project.

2.4.3 Potential impacts of air pollution

The following synopsis of the New M5 Project was provided in the consultancy brief, and provides the basis for the review that has been undertaken, and that is reported in this document.

Where relevant; additional details and scope have been identified in the text.

2.4.4 Air Quality & Health

Air quality is a vital indicator of the amenity and safety of urban environments.

Elevated levels of various air pollutants has been clearly linked with the increased risk and incidence of a number of health problems, and with increased mortality rates.

Air quality is obviously a particular issue in relation to road and road tunnel infrastructure, where the generation of motor vehicle exhaust gases from the combustion of petroleum fuels provides a specific and relatively localised source of potentially dangerous air pollutants.

This is particularly the case within road tunnels, near road tunnel exhaust discharge facilities and near busy roads; where concentrations of air pollutants can very easily peak to levels above those considered safe.

In New South Wales, benchmarks for acceptable maximum ambient concentrations of various air pollutants are established by the NSW Office of Environment and Heritage (OEH), taking into account input from the National Health and Medical Research Council (NHMRC).

These benchmarks are readily acknowledged in both the New M5 Air Quality Assessment Report November 2015 (Appendix H, Technical Working Paper – Air Quality), and the EIS for the project. Further details are provided in Section 4 of this review.

These air quality standards, or goals, increasingly reflect a national approach to air quality management, and guideline limits known as National Environment Protection Measures (NEPM's) have been established for most significant air pollutants.

Air pollutants considered to be of particular relevance to public health, and to major road and road tunnel projects such as the New M5 Project, include (but are not limited to) nitrogen dioxide, carbon monoxide, fine airborne particulate matter (PM10), fine airborne particulate matter (PM2.5) and benzene.

Airborne lead has also been a pollutant of major concern, particularly in relation to the health and well-being of children. However, the presence of airborne lead in the urban environment has been very largely eliminated by the phased removal of lead from petrol - a process completed in Australia in the mid to late 1990's.

In respect of the criteria air pollutants mentioned above; details of air quality goals currently and prospectively applicable in NSW are summarised in 3.1.

Further and more detailed information is presented in both the working paper, and the EIS itself.

2.4.5 Key Air Quality Issues for the New M5 Project

Key air quality issues for the New M5 East Project are considered in Section 3 of the Working paper and in Chapter 10 of the EIS.

Issues considered include:

- Roads, tunnels and air quality;
- Sydney tunnels and air quality;
- Advisory Committee on Tunnel Air Quality;
- WestConnex Strategic Environmental Review; and
- Summary of key air quality issues.

Review Comment:

The descriptions of assessment methodology provided in both the working paper and the EIS provide accurate descriptions of the methodology adopted in the various assessments.

2.4.6 Regulation of Emissions, Air Pollution and Exposure

The regulation of emissions, air pollution and public exposure to air pollution are considered in Section 4 of the technical working paper, and in Chapter 10 of the EIS. The following issues are addressed:

- Policies and regulations for road vehicle emissions;
- Fuel quality regulations;
- In-tunnel pollution limits;
- Tunnel portal emission restrictions; and
- Ambient air quality standards and criteria.

Review Comment:

The air quality regulatory requirements considered in the working paper and the EIS are thorough and wide ranging. They are considered to provide an adequate regulatory reference framework for the assessment undertaken.

2.4.7 Overview of Assessment Methodology

The approach and methodology used in the assessment are considered in Section 5 of the working paper, and in Chapter 10 parts 10.1 and 10.2 of the EIS. The issues addressed include:

Key documents, guidelines and policies;

- Consultation with government agencies and ACTAQ;
- Previous road and tunnel project assessments;
- General approach; and
- Treatment of uncertainty

Review Comment:

The issues considered and taken into account in both the technical working paper and the EIS are considered to be adequate and appropriate, and to cover the key air quality issues associated with a major road and tunnel infrastructure development of the type and scale proposed.

2.4.8 Existing Environment

The existing environment applicable to the various assessments undertaken is described in Section 6 of the working paper, and in Chapter 10 of the EIS. The issues addressed include:

- Terrain and land use;
- Climate;
- Meteorology;
- Emissions;
- In-tunnel air quality; and
- Ambient air quality.

Review Comment:

The consideration of existing and background environmental issues and settings provided in both the working paper and the EIS is considered to be thorough, adequate, and appropriate.

2.4.9 Assessment of General Construction Impacts

The assessment of air quality impacts generated by construction activities associated with the New M5 Project is considered in Sections 2.3 and 7 of the technical working paper, and in Chapter 10 part 10.2 of the EIS.

Activities and operations considered include:

- Construction footprint;
- Construction activities for the project; and
- Assessment procedure:
  - Step 1: Screening
  - Step 2: Risk assessment
  - Step 3: Mitigation
  - Step 4: Significance of risks

In the absence of specific direction for projects in NSW, the potential impacts of the construction phase of this project were assessed using guidelines published by the UK Institute of Air Quality Management.

The authors of the working paper were required to apply professional judgement at some stages. Where justification for assumptions could not be fully informed by data a precautionary (and appropriate) approach appears to have been adopted.

The UK guidelines were adapted for use in NSW, taking into account factors such as the assessment criteria for PM10 (airborne particulate matter with an aerodynamic diameter of less than 10 µm or micrometres).

The assessment was qualitative in the sense that it assessed the risk that construction works may have on local air quality.

The risk assessment determined that standard management measures would be sufficient to mitigate the effects of construction works on local air quality at the nearest receptors.

Review Comment:

The approach applied to the assessment of the impacts of construction activities associated with the New M5 Project on local air quality appears to have been reasonable and appropriate.

The conclusion reached in both the working paper and the EIS that "standard management measures would be sufficient to mitigate the effects of construction works on local air quality at the nearest receptors" also appears to be reasonably based.

However, it is recommended (as is no doubt intended) that appropriate and specific Construction Phase Air Quality Management Plans (or sub-plans) are developed and implemented for individual components of the overall construction task.

It is also recommended that local government bodies at immediate interest arrange for and apply an appropriate watching brief to the Construction Management Plan process, to ensure that the various plans (or sub-plans) are applied and work effectively, and that air quality outcomes are consistent with relevant guidelines levels adopted in the plans (or sub-plans).

2.4.10 Alexandria Landfill Closure and Remediation

The Alexandria Landfill site at St Peters will be closed, remediated and redeveloped as part of the New M5 Project. The redevelopment of the site means that it will need to be closed and managed in accordance with the Protection of the Environment Operations (POEO) Act.

Assessment of odour and dust impacts are covered in Section 8 of the Air Quality Working Paper and in Chapter 10 Parts 10.3 and 10.7 of the EIS.

Assessments were undertaken to estimate the potential impacts of the closure and remediation of the landfill on dust (PM) and odour.

Appropriate NSW DEC/PA odour assessment methodologies were adopted in the Technical Paper, which flowed to the EIS itself.

Off-site PM concentrations and dust deposition levels due to the landfill closure and remediation were predicted using the US EPA AERMOD dispersion modelling system, which includes AERMET, to provide meteorological input files, and AERMAP, which is used for the preparation of terrain data.

Meteorological data from Sydney Airport for 2014 were used as input to AERMET.

A Landfill Closure Management Plan.is presented in the EIS.

Review Comment:

The various assessments of odour and dust impacts presented in the both the Working paper and the EIS itself were undertaken using appropriate methodology.

The results of these assessments indicated that while some level of odour impact may be experienced at adjoining industrial sites during the remediation process, the level of impact would be within acceptable limits, and short term in nature.

Dust impacts were assessed as being moderate and, when taken in addition with already relatively high background airborne particulate levels, resulted in total fine particulate impacts lower than relevant air quality guidelines.

The assessment and proposed management of odour and particulates associated with the closure, remediation and redevelopment of the Alexandria Landfill appear to have been appropriately and thoroughly carried out, and subject to the application of the proposed Landfill Closure Management Plan, impacts can be expected to be acceptable, and within relevant guideline levels.

However it is recommended that local government bodies at immediate interest arrange for and apply an appropriate watching brief to the process, to ensure that the Management Plan is applied and works effectively, and that odour and dust outcomes are indeed within relevant guideline levels, as predicted.

2.4.11 Assessment of Operational Impacts

Assessment of the operational impacts of the New M5 Project on air quality is considered in Section 9 of the Working Paper, and in Chapter 10 Parts 10.4 and 10.8 of the EIS.

This is a very important part of the assessment, as it deals with the ongoing issues of in-tunnel air quality, and air quality near tunnel emission stacks that have in the past been of primary concern to communities and others considering the environmental impacts of road tunnels, both in Australia and internationally.

The assessments deal, among other things, with:

- Emission calculations;
- In-tunnel air quality;
- Dispersion modelling
- Results for expected traffic scenarios (ground level concentrations);
- Results for expected traffic scenarios (elevated receptors);
- Results for regulatory worst case scenarios;
- Summary of key assumptions; and
- Sensitivity tests.

a) In-Tunnel Air Quality

In-tunnel air quality for the project was modelled using the IDA Tunnel software and Australia specific emission factors from the Permanent International Association of Road Congresses (PIARC). Traffic volume projections were taken from the WestConnex

Road Traffic Model (WRTM) and other sources were used to provide a representative traffic mix for the tunnel.

Consideration was given to peak in-tunnel concentrations of carbon monoxide (CO) and nitrogen dioxide (NO_2), as well as the peak extinction coefficient (for visibility). The work covered expected traffic scenarios, capacity traffic scenarios (at a range of speeds, including congestion) and a vehicle breakdown scenario.

The following general conclusions have been drawn from the assessment:

- The information presented in the report has confirmed that the tunnel ventilation system will be designed to maintain in-tunnel air quality well within operational limits for all scenarios.

b) Surface Air Quality

The operational ambient air quality assessment was based upon the use of the GRAL1 (Graz Lagrangian) model system. The model system consists of two main modules: a prognostic wind field model (Graz Mesoscale Model - GRAMM) and a dispersion model (GRAL itself). Traffic data were taken from the WRTM, with around 6,000 separate road links being modelled. The traffic data were used in conjunction with emission factors developed by NSW Environment Protection Authority.

The following general conclusions have been drawn from the assessment:

- The predicted concentrations of all criteria pollutants at receptors were usually dominated by the existing background contribution. This applied to short-term criteria as well as annual means. The background concentrations were especially dominant for PM10 and PM2.5 (airborne particulate matter with an aerodynamic diameter of less than 10 µm and 2.5 µm respectively).
- For some pollutants and metrics (such as annual mean NO_2) there was also a significant contribution from the modelled surface road traffic.
- Under expected traffic conditions the contribution of tunnel ventilation outlets to pollutant concentrations was negligible for all receptors.
- Any predicted changes in concentration were driven by changes in the traffic volumes on the modelled surface road network, not by the tunnel ventilation outlets.
- Exceedances of some air quality criteria (1-hour NO2, 24-hour PM10, annual PM2.5 and 24-hour PM2.5) were predicted to occur at a small proportion of receptors, both with and without the project. However, the total numbers of receptors with exceedances decreased slightly with the project. The exception to this was annual mean PM2.5, for which concentrations were (by definition in the assessment) always above the corresponding criterion.
- The spatial changes in air quality as a result of the project were quite complex, reflecting the complex changes in traffic on the network. Substantial reductions in concentrations along the M5 East Motorway, both to the east and west of the M5 East tunnel, as well as along General Holmes Drive and other roads around the airport were predicted. Reductions in concentration were also predicted along the section of King Georges Road to the north of the M5 East Motorway, around the northern perimeter of Sydney Park, and on a number of other roads. However, increases in concentration were predicted for King Georges Road to the south of the M5 East Motorway, Stoney Creek Road and Bexley Road to the south of the M5 East Motorway, Harrow Road, Bay Street, Forest Road and around the southern perimeter of Sydney Park, amongst other roads.
- Where increases in pollutant concentration at receptors were predicted, these were mostly small. Very small proportions of receptors were predicted to have larger increases.

Review Comment:

Surface Air Quality Impacts Generally

T*he approaches and methodologies used in the assessment of air quality impacts were extensive and detailed.*

In terms of general air quality impacts at surface receptors, the methodologies used and the conclusions reached appear reasonable. In the main, air quality at surface locations was found to be dominated by existing background and general traffic conditions, and that the effect of the New M5 Project will be negligible or slightly net positive in this broader air quality context.

This appears to be a reasonable conclusion. Road traffic obviously plays a significant role in urban air quality and pollution, but if the general existing road transport scenario is accepted for the purposes of this review, as it has been, then the findings of both the working paper and the EIS in terms of general surface air quality impacts appear to be reasonable.

It is acknowledged that there is an argument that building new road infrastructure induces more traffic, and therefore more air pollution, and while this argument may well have merit, it is considered outside the scope of this review. What has been reviewed is simply the merits or otherwise of the air quality assessment that has been undertaken in relation to the New M5 Project proposal.

In-Tunnel Air Quality and Air Quality near Emission Stacks

The Working Paper and EIS found that "the tunnel ventilation system will be designed to maintain in-tunnel air quality well within operational limits for all scenarios".

While this objective will no doubt apply, the nature of the proposed tunnel ventilation system may well involve a limitation in terms of achieving appropriate air quality within the tunnel at all times.

What is proposed is a longitudinal ventilation system, in which fresh air enters with the traffic, and then travels the length of the tunnel with the "piston" effect of the traffic, supported by fans mounted in the roof of the tunnel. In general, under this system, air within the tunnel becomes progressively more contaminated by vehicle exhaust pollutants along the length of travel in the tunnel, until it is discharged near the end of the tunnel (in each direction) via exhaust stacks.

There are a number of factors not considered or fully considered in the working paper and EIS that may have the effect of increasing motor vehicle exhaust pollutant loadings within the tunnel (refer more detailed comments in Section 5).

Longitudinal ventilation is an effective ventilation approach in shorter tunnels, and in tunnels with moderate traffic loads. It is not necessarily an effective ventilation system in longer; heavily trafficked tunnels such as the proposed New M5 Project tunnel (refer more detailed comments in Section 6).

In turn, any inadequacy in the control of air pollutant levels within the tunnel will have an impact on the quality of discharges from the associated exhaust stacks, and any assumptions made regarding surface air quality near those stacks.

In relation to in-tunnel air quality, and related surface air quality near emission stacks, it is recommended that an alternative approach (or approaches) is (are) included in the project proposal, and modelled in the working paper and EIS, as indicated in 4.2.11 "Management of Impacts", below.

2.4.12 Assessment of Cumulative Impacts

The assessment of cumulative air quality impacts is considered in Section 10 of the Working paper, and Chapter 10 Part 10.9 of the EIS itself.

Cumulative impacts have been considered in relation to both in-tunnel air quality, and ambient air quality.

Review Comment:

The assessment methodologies and approaches adopted in both the working paper and the EIS regarding cumulative air quality impacts are considered to be adequate, and appropriate, notwithstanding the limitations expressed in 4.2.9 above and 4.2.11 below regarding possible limitations and vulnerabilities in the assessment and modelling of some aspects of in-tunnel air quality, and associated air quality near emission stacks.

The methodology and approach adopted in relation to the assessment of cumulative air quality impacts is adequate and appropriate to model any revised cumulative impact that might apply as a consequence of any increase in in-tunnel pollutant loads that might be considered, and any associated changes to air quality impacts near exhaust emission stacks that might follow as a consequence.

2.4.13 Management of Impacts

The management of air quality impacts associated with the New M5 Project is considered in Section 11 of the technical working paper, and Chapter 10.10 of the EIS. Both construction and operational impacts are considered.

a) Construction Impacts

Various measures for the management of construction impacts are identified in the working paper, and the EIS. Most of the recommended measures are referenced as "good practice" approaches on construction sites.

The EIS indicates that a Construction Air Quality Management Plan will be produced to cover all construction phases of the project, and that this plan will contain details of the site-specific mitigation measures to be applied.

b) Operational impacts

The report has provided a review of the measures that are available for improving tunnel-related air quality, and describes their potential application in the context of the project. The measures that will be adopted for the project are summarised below. The project design provisions to reduce pollutant emissions and concentrations within the tunnel will include:

- Minimal gradients. The main alignment tunnels would have a maximum uphill gradient of four per cent;
- Large main line tunnel cross-sectional area (90 square metres);
- Increased height to reduce the risk of incidents involving high vehicles blocking the tunnel. The project ventilation system has been designed and would be operated so that it will achieve some of the most stringent standards in the world for in-tunnel air quality, and will be effective at maintaining local air quality. The design of the ventilation system will ensure zero portal emissions. The ventilation system will be automatically controlled using real-time traffic data covering both traffic mix and speed, and feedback from air quality sensors in the tunnel, to ensure in-tunnel conditions are managed effectively in accordance with the agreed criteria. Furthermore, specific ventilation modes will be developed to manage breakdown, congested and emergency situations. The provision of a tunnel filtration system does not represent a feasible and reasonable mitigation measure and is not being proposed. The reasons for this are as follows:
  - The project's in-tunnel air pollutant levels, which are comparable to best practice and accepted elsewhere in Australia and throughout the world, will be achieved without filtration;
  - Emissions from the ventilation outlets of the project tunnel will have

a negligible impact on existing ambient pollutant concentrations;

- Of the systems that have been installed, the majority have subsequently been switched off or are currently being operated infrequently;
- Incorporating filtration in the ventilation outlets would require a significant increase in the size of the tunnel facilities to accommodate the equipment. It would result in increased project size, community footprint, and capital cost. The energy usage would be substantial and does not represent a sustainable approach; and
- If compliance with in-tunnel air quality limits cannot be achieved with the proposed ventilation system, the most effective solution will be the introduction of additional ventilation outlets and additional air supply locations. This is a proven solution and more sustainable and reliable than tunnel filtration systems.

Review Comment:

Management of Construction Impacts

The management of construction impacts on air quality as presented and proposed in both the Working Paper and the EIS is considered to be generally sound, and subject to the development and application of the management procedures and protocols proposed, it is considered that construction activities associated with the New M5 Project will have minimal and acceptable impacts on surrounding individuals, operations and activities.

This finding is presented on the basis of the recommendations made in 4.2.7 and 4.2.8 above, namely that in relation to construction activities generally:

Local government bodies at immediate interest arrange for and apply an appropriate watching brief to the Construction Management Plan process, to ensure that the various plans (or sub-plans) are applied and work effectively, and that air quality outcomes are consistent with relevant guidelines levels adopted in the plans (or sub-plans).

And in relation to the Alexandria Landfill Closure and Remediation that:
Local government bodies at immediate interest arrange for and apply an appropriate watching brief to the process, to ensure that the Landfill Closure Management Plan is applied and works effectively, and that odour and dust outcomes are indeed within relevant guideline levels, as predicted.

Management of Operational Impacts

In general terms, the proposed management of operational air quality impacts is considered to be reasonable and adequate.

However, in relation to the management of in-tunnel air quality, and as a consequence air quality in the immediate vicinity of the proposed tunnel emission stacks, it is considered that the proposed tunnel ventilation system may be neither adequate or appropriate to ensure safe and compliant air quality at all times, as a consequence it is recommended that:

An alternative tunnel ventilation approach (or approaches) is (are) included in the project proposal, and modelled in the working paper and EIS, to provide any necessary improvement in operational in-tunnel air quality, should that be required;

And that, in relation to air quality near emission stacks, that:

An alternative approach to the management of air quality in the immediate vicinity of the proposed tunnel emission stacks is included in the project proposal, and modelled in the working paper and EIS, to complement the inclusion of an alternative tunnel ventilation strategy as recommended above.

Further and more detailed comments are provided in Sections 2.7 and 2.8 below.

2.5 KEY ISSUES

Section 4 of this review has identified a number of key air quality issues where the provision of additional or more detailed information in relation to air quality, in the

working paper, the EIS and the Project itself is considered appropriate, or necessary.

The following comments apply to those key issues.

2.5.1 The Importance of Air Quality

a) General

Section 3 of this review provided a brief overview of air quality and associated health issues.

Air quality inside and outside road tunnels is important, as is recognised in the technical working paper, and the EIS.

Elevated levels of pollutants such as nitrogen dioxide, carbon monoxide, airborne particulate matter and others is known to cause significant increases in the incidence of a number of serious illnesses, and in the health costs and premature deaths associated with those illnesses.

Contaminated air within road tunnels is a particular and important concern, as is any flow on effect to surface air caused by the discharge of contaminated tunnel exhaust air.

Contaminated air within road tunnels affects the road tunnel environment itself. Such air can also become entrained within vehicle cabins, and as a consequence exposure to that contaminated air can continue for an extended period after the initial tunnel exposure.

b) Fine Particulates

Fine airborne particulate matter is an air pollutant of concern, and of particular relevance to road tunnels.

Fine airborne articulate matter is typically considered in two categories – PM10 and PM2.5.

The numbers refer to the size of the particle involved. PM10 includes particles with what is called a “mean aerodynamic diameter” less than 10 micrometres, and PM2.5 involves smaller particles, with diameters less than 2.5 micrometres.

By way of comparison, a human hair is about 100 micrometres, so roughly 40 PM2.5 particles could be placed on its width.

Fine airborne particles are of concern for a number of reasons.

Their very small size means that material of this nature can readily bypass the human body’s natural “filters”, and enter the respiratory system, where undue levels of particulate matter can have very serious health implications.

A second important concern is that very fine particulate matter has a very large surface area, and has the capacity to adsorb other pollutant and toxic materials onto its surface, exacerbating health risks within the human respiratory system.

As acknowledged in the technical working paper and the EIS, the concentration of particulate matter in Sydney’s air is already high, and quite often exceeds safe regulatory levels and health based concentration goals.

Maximum 24-hour average concentrations of PM2.5 particulate matter in Sydney air over the latest ten year period for which data is publicly available are shown in Figure 1.

This data is drawn from the NSW Office of Environment and Heritage (OEH) Report National Environment Protection (Ambient Air Quality) Measure New South Wales Annual Compliance Report 2012 (Final Version November 2013) – the latest such report publicly available that provides this analysis.

The figures presented in Figure 1 represent an average of data from the only four monitoring stations in the Sydney area where PM2.5 concentrations are measured, those being Chullora, Earlwood, Liverpool and Richmond.

What can be readily seen is that maximum PM2.5 levels in Sydney’s air consistently approach or exceed the established safe maximum daily air quality criterion of 25 micrograms per cubic metre (µg/m3), and the annual average criterion of 8 micrograms per cubic metre (µg/m3).

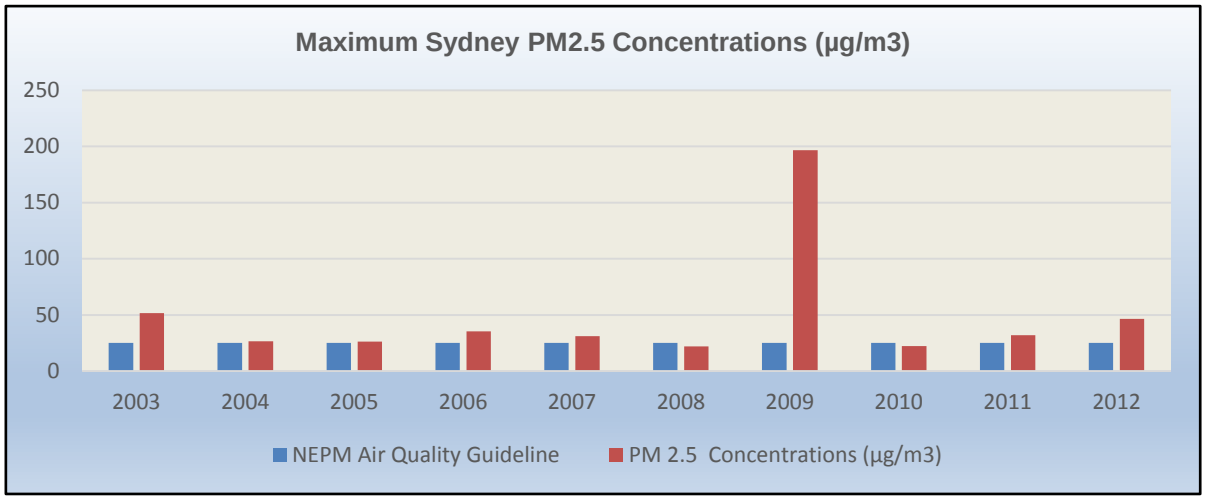

Figure 1 PM2.5 Concentrations in Sydney's Air

This is not in any way a function of the New M5 Project. Indeed, in an overall sense, as indicated in both the technical working paper and the EIS, given a continuation of transport strategies and policies that include a high reliance on road based transport modes, projects such as the New M5 provide an overall slight but net improvement in overall air quality outcomes.

However, in terms of road tunnel ventilation, one obvious concern is that the ambient or "fresh" air introduced into tunnel ventilation systems can already be heavily burdened with PM2.5 particles to an extent greater that allowed by relevant air quality guidelines. This of course means that the additional contaminants generated by motor vehicle exhaust emissions within road tunnels simply adds to the base level of pollution already present.

There is a great and growing concern internationally regarding the long term impacts of fine airborne particulate matter on human health, in particular the effect of ultrafine particles in the PM2.5 category. Fine airborne particulate matter from hydrocarbon combustion, in particular motor vehicle operation, is thought to involve a higher level of risk to human health than similarly dimension particles from other sources.

High concentrations of fine airborne particulate matter in background air have obvious implications for the management of air within road tunnels, and the discharge of exhaust air from tunnels.

2.5.2 Air Quality During Construction

The maintenance of safe and healthy air during all major construction projects is important.

The New M5 is a major construction project, and both the working paper and the EIS acknowledge the importance of managing air quality during construction, and provide mechanisms or proposed mechanisms for this process.

In the case of the closure and remediation of the Alexandria Landfill, a specific Landfill Closure Management Plan is included.

In the case of construction activities more generally, Construction Air Quality Management Plans are proposed.

This is a reasonable and sensible approach. Subject to the implementation of the Landfill Closure Management Plan; the development and effective implementation of Construction Air Quality Management Plans for specific construction elements of the project, and the recommendations made in Section 4 in relation to these matters; the effective management of air quality during the various construction

phases of the New M5 Project is considered to be readily achievable.

2.5.3 Air Quality Near Surface Roads

Air quality in the immediate vicinity of surface roads is subject to a peaking of air pollutant levels as a consequence of motor vehicle exhaust emissions.

These peak levels then tend to reduce to urban average background levels.

The working paper and the EIS both correctly point out that the New M5 Project will have fairly minimal and acceptable impacts on existing surface air quality, and in an overall sense will marginally improve air quality. The project will provide a mechanism for improved traffic flows, and therefore for more efficient motor vehicle operation, and as a consequence generally reduced emission levels.

As pointed out in Section 4, this review comment is based on an assumption that Sydney's transport mix will continue to include a relatively high level of reliance on road based motor vehicle transport, in line with current practice.

As also pointed out earlier in this review, there is an argument that the provision of additional and improved road transport infrastructure elements has the effect of inducing more road transport, and therefore as a consequence of increasing air pollution levels. In comparison, an alternate approach to transport might involve a significantly lower reliance on road transport modes.

While acknowledging this argument, and without commenting on its merits or otherwise, this review has been based on an assessment of the New M5 Project in the context of current circumstances, and a general continuation of those circumstances into the future.

In this context, the New M5 Project is not considered likely to result in any significant or serious impacts to surface air quality, and may well generate marginal improvements.

2.5.4 In Tunnel Air Quality

In tunnel air quality is considered to be problematic, and as pointed out in the review comments provided in Section 4 is considered to warrant further review comment, and more detailed and critical analysis in the both the working paper, and the EIS.

The New M5 Project assumptions include the use of longitudinal ventilation in each of the two parallel and unidirectional tunnel sections proposed.

Under this tunnel ventilation approach, which is discussed in greater detail in Section 6, fresh external air enters the tunnel with the traffic, and flows with the traffic during the traverse of the tunnel, driven by both the piston effect of the traffic, and fans mounted to the tunnel ceiling.

This has proven to be a cost and operationally effective method of tunnel ventilation in shorter tunnels, typically up to 3 kilometres in length, and in tunnels which do not involve heavy traffic loads.

The assumption made in relation to the New M5 Project is that this form of tunnel ventilation, and therefore of air quality management within the two parallel road tunnels associated with the project, will work effectively in the relatively long (nine kilometre) and heavily trafficked tunnels involved.

This assumption may prove to be correct, and both the working paper and the EIS present arguments to this effect.

However, based on both local and international experience, there are risks that this may not be the case.

The working paper and the EIS point to the successful use of longitudinal ventilation in other Sydney tunnels, including the Cross City Tunnel, and the Lane Cove Tunnel.

While it is true that longitudinal ventilation is used in these tunnels, they are both considerably shorter (approximately 2.1 and 3.4 kilometres respectively) than the proposed New M5 Tunnel. They also carry relatively light traffic loads – to the significant financial disadvantage of the original consortia involved in their development.

The New M5 Tunnel appears almost certain to carry a very significant traffic load, with commensurate pollution burdens within the tunnels.

In addition, the assumptions made in both the working paper and the EIS may not reflect worst case air quality conditions.

The following examples indicate mechanisms that can, and will, provide peak pollution loadings, over and above those assumed in the working paper and EIS:

- Emissions in Excess of Design Specifications: To a very large extent, modelling relies on vehicle emission performance in accord with manufacturers design specifications and standards. The recent widely publicised Volkswagen experience, where actual vehicle emissions proved to very greatly exceed design specifications, indicates that vehicle exhaust emissions are not always as low as claimed.
- Effectiveness of Vehicle Pollution Control Devices: Motor vehicles are fitted with various devices to control exhaust emissions of pollutants, including catalytic converters and particulate traps. These devices can degrade with age. Catalytic converters can decline very significantly in performance after 60,000 kilometres of use, after which pollutant levels in exhaust gases can increase significantly.
- Higher Emission Vehicles: Not all vehicles are in optimal operating condition, and many older vehicles have higher emission pollutant levels than more modern vehicles. While the trend is towards more modern, lower polluting vehicles and engines, the total vehicle fleet remains imperfect, and sub-optimal.

It is considered important that the New M5 Project, the working paper and the EIS all include and take account of an alternative tunnel ventilation strategy, to cover the contingency position that the proposed system proves to be inadequate in terms of tunnel ventilation and air quality management.

The Working Paper and EIS both include the comment that:

"*If compliance with in-tunnel air quality limits cannot be achieved with the proposed ventilation system, the most effective solution will be the introduction of additional ventilation outlets and additional air supply locations. This is a proven solution and more sustainable and reliable than tunnel filtration systems*."

Given that a longitudinal ventilation system is proposed, any required upgrade of the overall system will in all likelihood involve an upgrade to that longitudinal system, as reflected in the above comment.

However, it is considered very important that this contingency is fully incorporated into the project, and fully and properly considered and assessed in the working paper and the EIS.

This is important.

If the initial longitudinal ventilation does require modification and upgrade, which is considered likely, that will in all probability involve additional fresh air inlet points, and two or possibly more additional exhaust air discharge points.

The latter are sensitive infrastructure elements, and will clearly require careful assessment.

That assessment should be undertaken prior to project approval.

Alternative options for tunnel ventilation should also be considered. These include some form of transverse ventilation, as discussed in Section 6, and in-line air treatment technologies that may overcome the need for additional emission discharge points in the event that the initially proposed longitudinal ventilation does in fact prove to be inadequate.

2.5.5 Air Quality Near Emission Stacks

Issues in relation to air quality are, rightfully, to the forefront of public concern when road tunnels are considered.

The design requirements of emission stacks are also, obviously, closely linked to the actual condition of the exhaust gases to be discharged and the pollutant loadings in those exhaust gases.

The working paper and the EIS both proceed on the basis that the existing proposed tunnel ventilation system will result in effective management of air quality within the two tunnels, and that the exhaust air to be

discharged will include commensurate and relatively low pollutant burdens.

The contingency scenario described in Section 5.4 above needs to be considered.

If pollutant levels within the tunnel are higher than anticipated, then pollutant loadings in exhaust gases will be higher as a consequence.

In general, while flexibility exists to alter discharge stack heights and emission velocities to deal with variations in pollutant burdens, this contingency should be addressed in the New M5 project, the working paper and the EIS.

It should be noted in this respect that the emission stack proposed for the Alexandria landfill site is constrained in terms of height due to the need to comply with the CASA restrictions relating to the velocity of the air within the flight paths.

This contingency consideration will need to include any air quality management limitations available through stack height and discharge velocity such as apply to the proposed Alexandria emission stack It may also need to include contingency provision for the inclusion of air cleaning or filtration technologies at the emission stacks.

Contrary to the assertions made in both the working paper and the EIS, credible and proven air cleaning technologies exist, and are currently in use and being installed in road tunnels elsewhere in the world (refer Section 6.5).

As pointed out in 5.4 above, any need to modify or upgrade the currently proposed longitudinal ventilation system may also involve the need to consider and assess additional emission discharge stacks.

This contingency assessment should be included in both the working paper and the EIS.

2.6 TUNNEL VENTILATION

2.6.1 Introduction

Road tunnels can be ventilated in a number of ways.

Short tunnels can be naturally ventilated, with reliance on the traffic in the tunnels to effect ventilation via a “piston” effect.

Larger and more heavily trafficked tunnels generally require some form of mechanical ventilation, to assist the process of air flow, and the maintenance of safe and breathable air within the tunnel.

2.6.2 Potential Ventilation & Air Quality Concerns

In terms of tunnel ventilation and air quality, the current New M5 Project proposal raises two concerns.

The first is that the longitudinal ventilation of two nine kilometer tunnel tubes may not be effective; that an undue and potentially harmful build-up of pollutant gases will develop along the length of the tunnels, and that pollutant concentrations may become unacceptably high towards the ends of the two tunnels.

The second is that the discharge of untreated tunnel exhaust gases through the stacks proposed at each end of the two tunnels will cause air quality issues in the vicinity of the emission stacks.

This section of the review addresses the first of these two potential concerns.

It addresses the risk that the longitudinal ventilation system proposed may not be adequate for the long, heavily trafficked tunnels involved.

2.6.3 Road Tunnel Ventilation Options

Before proceeding further, it is probably useful to briefly consider and describe two alternative approaches to road tunnel ventilation.

These are the longitudinal ventilation approach proposed in this case and transverse or cross

ventilation, where air within tunnels is progressively refreshed.

Longitudinal is the lower cost option. It is used in tunnels like the M5 East, the Cross City Tunnel and the Lane Cove Tunnel.

Transverse ventilation is more expensive. It is included in the design of the Sydney Harbour Tunnel, and is used in many heavily trafficked urban road tunnels internationally.

Current road tunnel projects in Tokyo and elsewhere in Japan; in South Korea, and elsewhere in the world involve the use of various transverse ventilation systems.

a) Longitudinal Ventilation

Principle

- Longitudinal ventilation is based on the principle of impulse transmission.
- In longitudinally ventilated tunnels, a relatively small proportion of the total air stream within the tunnel is drawn in by jet fans mounted on the tunnel roof, and blown back into the air stream with high kinetic energy.
- This has the effect of injecting energy into the tunnel air stream, facilitating movement of the air towards the tunnel exit.

Application

- Longitudinal ventilation is generally used in road tunnels up to three kilometres in length, but can also be effective in tunnels of up to five kilometres in length where traffic in the tunnel is unidirectional, as is the case in the New M5 Project.
- If the overall tunnel ventilation system can be divided up into several sections, longer tunnel lengths can be effectively ventilated by a longitudinal system.
- An indicative longitudinal ventilation system is illustrated in Figure 2.

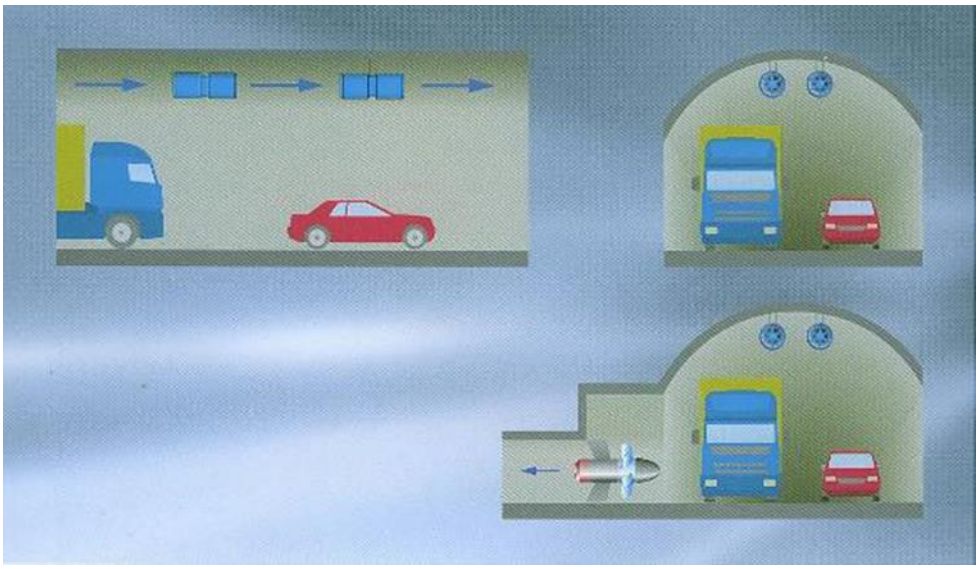

Figure 2 Indicative Longitudinal Road Tunnel Ventilation System

b) Transverse Ventilation

Principle

- Transverse ventilation differs from longitudinal in that fresh air is delivered and extracted uniformly over the length of the tunnel.
- The name of the system derives from the fact that air flows “transversely”, or across the traffic space, rather than “longitudinally”, or in the direction of the traffic space.
- Fresh air injection at the sides of the tunnel, above the road surface, and extraction of air above the traffic space, is widely employed in transverse ventilation systems.
- Semi-transverse ventilation is also possible.
- Semi-transverse ventilation involves a combination of longitudinal and transverse ventilation. One commonly used application is a fresh air semi-transverse system, in which fresh air is delivered uniformly (and transversely) over the length of the tunnel, and exhaust air is removed longitudinally through the tunnel portals.
- An alternative option is an exhaust air semi-transverse system, in which fresh air is supplied “longitudinally”, and exhaust air is removed uniformly (and transversely) over the length of the tunnel.
- Transverse ventilation is illustrated in Figure 3.

Application

- Transverse ventilation is most frequently used in long road tunnels, with heavy traffic loads.

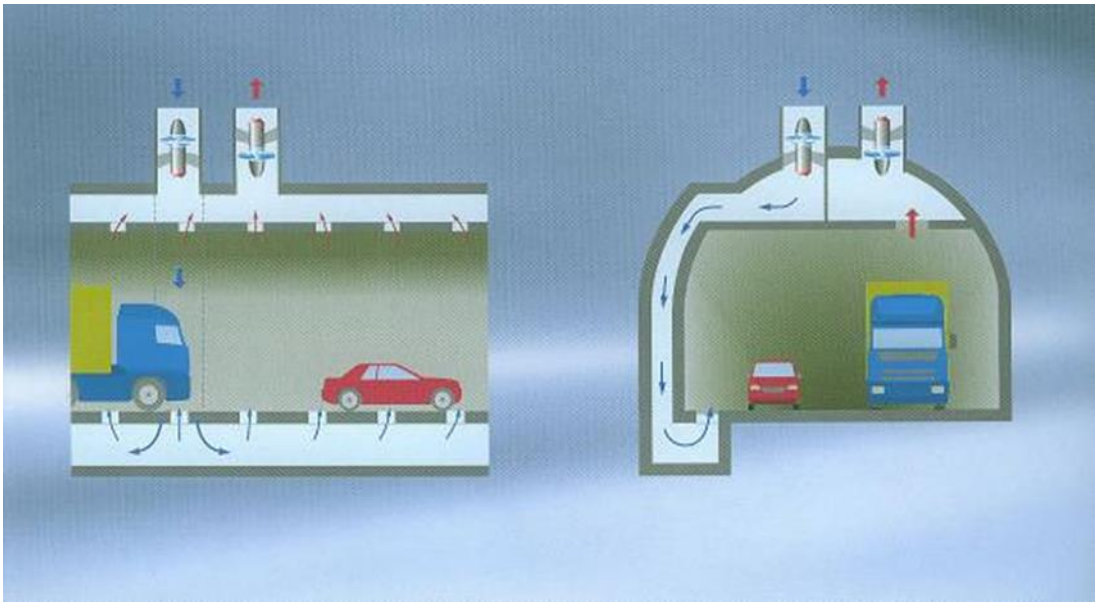

Figure 3 Indicative Transverse Road Tunnel Ventilation System

2.6.4 Limitations of Longitudinal Ventilation

Longitudinal ventilation can be cost and operationally effective.

However, its operational effectiveness in long and heavily trafficked tunnels is problematic.

The potential difficulty in such tunnels is that the tunnel users are effectively part of the waste or exhaust stream. They provide, through the collective piston effect of their vehicles, a considerable proportion of the energy needed to drive that exhaust gas stream.

In long tunnels, and the nine kilometres of the New M5 tunnels is long by international standards – there is a significant potential for the exceedance of air quality standards past the mid-point of the tunnels.

The performance of the M5 East Tunnel is relevant. It is longitudinally ventilated.

The M5 East Tunnel comprises two parallel tunnel tubes, and has an overall length of around four kilometres. In the case of the M5 East, however, “fresh” air is introduced to each tunnel tube at the mid-point of the tunnel, and refreshed again at the entrances at each end. Exhaust air is then removed from each tunnel tube sat the mid-point.

In effect, the M5 East involves four two kilometre sections.

Despite these relatively short tunnel sections, significant air quality problems have emerged within the tunnel – particularly with the final two kilometre west bound sections.

While acknowledging that a range of worthwhile initiatives have been introduced in an attempt to improve air quality in the existing M5 East Tunnel, and the significant design improvements proposed for the New M5 Project (and effectively detailed in both the working paper and the EIS) it remains that longitudinal ventilation has not yet been proven fully effective in a long, heavily trafficked road tunnel in Australia, i.e. it has failed to be effective in an busy operational road tunnel (the M5 East) effectively involving only two kilometre ventilation sections.

2.6.5 Advantages of Transverse Ventilation

The longitudinal ventilation system proposed for road tunnels associated with the WestConnex development, including the New M5 Project under review, is probably the most cost effective ventilation option available, but may not be the most operationally effective option.

Unlike some past road tunnel projects in Sydney, the New M5 Project is considered very likely to reach or exceed its design traffic loadings.

The road corridor involved is a very heavily trafficked thoroughfare, and future traffic growth in line with projections presented in both the working paper and the EIS appear certain.

It is almost certain that the two tunnels associated with the New M5 Project will accommodate high volumes of traffic, including a significant proportion of heavy transport vehicles.

Whatever the tunnel, under a longitudinal ventilation system, air quality along the tunnel will progressively worsen with increasing and accumulating vehicle exhaust emissions.

Under a transverse ventilation system, air within the tunnels would be continuously refreshed or flushed across the direction of traffic flow, resulting in consistent air quality over the length of the tunnel. In a longitudinal system, tunnel users travel along what is both the tunnel's travel zone and its waste air conduit – part of a progressively worsening effluent stream.

In a transverse system, the waste air is transported in a separate waste air tunnel or conduit – separate from the motorists using the traffic lane of the tunnel.

2.6.6 Filtration or Treatment of Tunnel Air

The working paper and the EIS both dismiss the filtration or cleaning of road tunnel air and emissions as a viable operating option.

Both documents indicate that air treatment or filtration is not used in road tunnels internationally.

This is simply not the case.

A recent major road tunnel project in Tokyo (the Yamate Tunnel, part of the Central Circular Route), which is the longest road tunnel in the world, involved the very extensive use of air cleaning or filtration as part of its ventilation and air quality management strategy.

The Kurigo Tunnel in Fukushima Japan, currently under construction, is a nine kilometre tunnel (similar in length to the New M5) also involves the extensive use of air treatment or filtration.

Road tunnels recently constructed in South Korea also involve the active use of air cleaning technology.

The Wanchai by-pass tunnel in Hong Kong, currently under construction, involves air treatment and filtration.

This is not to say air treatment or filtration systems are appropriate in every road tunnel, or that there have not been instances in the past when such technologies have been inappropriately or unnecessarily installed.

In circumstances where a mechanical ventilation system can perform adequately, then clearly such a system is preferable on economic grounds.

It remains, however, that the use of such technology is a valid option in relevant circumstances, and it is inaccurate and unhelpful for the working Paper and the EIS to indicate otherwise.

2.6.7 Need for Precaution and Care

Properly planned and delivered road transport projects are important. They offer the potential to significantly improve traffic and amenity in areas of Sydney's road network where such improvements are sorely needed. Subject to sound planning and delivery processes, such projects are to be encouraged, provided a sensible long term perspective in respect of balanced transport modes is maintained,

together with a sustainable balance between private and public transport.

The purpose of the comments and recommendations made in this review is not to diminish the positives that will flow from good road transport projects generally, and from the New M5 Project specifically, but to seek an appropriate degree of prudence and precaution in the delivery of effective and appropriate ventilation and air quality outcomes. In a general consideration of ventilation and air quality issues, a worrying scenario emerges.

That scenario is that both the tunnel ventilation subsystem proposed, and the air quality outcomes anticipated, may well be based on a very optimistic view of the various key influences involved.

Longitudinal ventilation of road tunnels can be very effective, but its operational efficacy in heavily trafficked road tunnels longer than five kilometres can be problematic. In a worst case scenario, despite the best design intentions in relation to air volumes and in-tunnel fan capacities, longitudinal ventilation may well strike inherent performance limits in a very heavily trafficked road tunnel nine kilometres long, and with a high proportion of heavy vehicles in its traffic mix.

Even without taking into account the quality of the “fresh” air introduced into the tunnel ventilation system, under adverse conditions air quality in a busy and congested tunnel is likely to exceed relevant air pollution guidelines beyond the mid points of each of the two proposed tunnel tubes.

The reality that, from time to time, the level of fine particle pollution present in the “fresh” air introduced into the tunnel ventilation system may well already exceed the established health based air quality standard simply serves to exacerbate this risk.

The two New M5 Project road tunnels will need to deliver safe in-tunnel air quality all of the time. The ventilation systems associated with the tunnels will need to have the technical capacity and capability to underwrite that outcome.

Road projects involving long tunnel sections must not only deliver effective transport outcomes, but must do so in a safe and heathy way over the full range of applicable operating conditions and parameters.

The cost of ventilation and air quality systems is important. The cost of getting ventilation and air quality outcomes wrong is much more important.

3 HYDROLOGY AND WATER QUALITY

The proposed New M5 project footprint lies within the Cooks River catchment. This is a highly urbanised catchment and as such, there have been impacts on water quality and hydrology from existing development. However, a significant project such as the proposed New M5 project has the potential to impact on these aspects, both in its own right and cumulatively.

In a highly urbanised catchment, there are significant numbers of existing residential, commercial or industrial properties and infrastructure that may be impacted by altered drainage, hydrological and hydrogeological patterns.

In relation to the natural environment, while much of the catchment is urbanised, there are still areas with high environmental values, such as Wolli Creek. As these are few remaining remnants of vegetation within the catchment, these remnants can have even higher value to maintaining a level of ecological habitat and connectivity.

Further, there have been significant efforts made to improve water quality within the Cooks River and Botany Bay.

3.1 POTENTIAL WATER QUALITY AND HYDROLOGY IMPACTS

The potential water quality and hydrology impacts arising from the construction and operations phase of the proposed New M5 project are listed below.

3.1.1 Groundwater

a) Construction

- Groundwater inflow
- Groundwater drawdown
- Reduced groundwater recharge
- Changes in groundwater quality
- Implications for existing groundwater users
- Impacts to the environment, including environmental receivers dependent on groundwater

b) Operations

- Groundwater inflow;
- Drawdown of groundwater and drying out of the catchment;
- Loss of baseflow to creeks that may adversely affect sensitive groundwater dependent ecosystems (GDEs);
- Reduction in groundwater levels in registered boreholes used for water supply;
- Changes in groundwater quality, due to contamination arising from the operations;
- Changes to groundwater quality with the incursion of saline soils or other contaminants;
- Treatment and discharge of potentially saline or low pH groundwater; and
- Impacts to the environment, including environmental receivers dependent on groundwater.

3.1.2 Surface water

a) Construction

Impacts discharged to local watercourses may include:

- Earthworks and exposed soil, followed by wind or rain has the potential to mobilise sediments that could be discharged to local watercourses;
- Spills of chemicals or construction materials during construction;
- Construction activities adjacent to or within waterways could introduce foreign contaminants such as oil or greases, and disturb contaminated sediments, potentially having an adverse impact on water quality;
- The project would increase the impervious surfaces in the road corridor. Consequently, pollutant loads building up on the road surfaces would increase, and greater loads of pollutants may be

washed off and discharged to receiving environments;

- Contaminated sediments mobilised by works in and around Alexandra Canal;
- Discharge of groundwater and construction water extracted during construction;
- Leachate - contaminated runoff during works in the landfill.

Geomorphology impacts could potentially arise from:

- Construction activities adjacent to or within watercourses could impact channel bed and bank conditions;
- Water discharged from the construction groundwater water treatment plants may lead to localised erosion within the receiving waters;
- Water discharged from the groundwater water treatment plants may increase the baseflows experienced in receiving waterways, reducing the capacity for the watercourses to convey storm flows;
- Mobilised sediment could build up in the streams;
- Impermeable surfaces created by the project would lead to increases in the volume and rate of runoff, which could cause erosion.

b) Operations

Water quality impacts could potentially arise from:

- Increased stormwater discharge due to larger and new pavement surface areas;
- Accidental spills or leaks of fuels and/or oils and/or chemicals from vehicle accidents, or from operational plant and equipment;
- Damage to Council drainage networks located near or beneath construction areas;
- Discharge of operational wastewater sources, including for maintenance, cleaning and fire deluge systems;
- Impact to water quality of receiving watercourses due to the discharge of treated groundwater and other waste waters (such as tunnel wash or deluge system water);
- Discharge of inadequately treated water from the water treatment plants. This includes treated groundwater and leachate captured at the St Peters interchange; and
- Contaminated sediments mobilised by scour caused by new infrastructure installed in and around Alexandra Canal.

Geomorphology impacts could potentially arise from:

- Impermeable surfaces created by the project would lead to increases in the volume and rate of runoff, which could cause scour; and
- Water discharged from treatment plants could change the bed profile and sediment processes.

3.2 STANDARDS, GOALS AND REQUIREMENTS

3.2.1 Groundwater

The New M5 tunnel inflow design criterion is one litre per second per kilometre *averaged over every kilometre of tunnel*. This criterion is more stringent that of other Sydney tunnels where the inflow criterion is typically one litre per second per kilometre *averaged over the length of tunnel*. The design criterion is broadly based on inflows experienced in other Sydney tunnels within similar geological and hydrogeological conditions.

The EIS states that the project would be constructed to limit groundwater inflow along the tunnel length to no greater than one litre per second across any given kilometre of tunnel. It reports that this will be achieved in areas of high local hydraulic conductivity zones, where the natural rock mass permeability may have to be reduced, by using materials such as shotcrete and grout.

The Lane Cove tunnel initial inflows were 1.7 L/s/km then dropped to 0.6 L/s/km. While the EIS says that the other tunnels considered were constructed in similar geological conditions, it doesn't go into details.

Table 4 in Appendix Q says that the measured drainage rate for the M5 East Motorway is 0.9 L/s/km, whereas the groundwater modelling

report (prepared by CDM Smith, 2015 and attached to Appendix Q) presents a slightly different scenario, noting that the inflows for this tunnel are particularly relevant.

The groundwater modelling report says that localised inflows of two to three litres per second were reported, reducing to 1.5 litres per second within two to three weeks of construction. The average inflow of groundwater since opening of the M5 East tunnel in December 2001 has been 0.75 to 0.9 litres per second per kilometre of single tube tunnel. It reports that prior to construction, investigations were carried out near the eastern end of the tunnel, in the Turrella area where shafts and tunnels cross the contact between the alluvial sediments adjacent to Wolli Creek and the underlying Hawkesbury Sandstone. The investigations identified the possible need to seal sections of the shafts and tunnels to minimise inflows and drawdown of the water table.

Treatment

The groundwater and surface water technical working papers are not clear on what criteria is adopted for treating this water during construction. Construction water treatment plants would be used during construction at five locations. It would not be appropriate to adopt the 80th and/or 20th percentile values derived for the operational treatment plant, which will be discharging to the Cooks River/Alexandria Canal, given that five treatment plants will be spread out across the alignment and should not all be assumed to have the same water quality.

3.2.2 Surface water

The list of standards and policies that have been applied to the water quality assessment is listed in Chapter 2 of the surface water quality technical paper.

The key documents referenced are:

- the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARNCANZ, 2000), used to assess the existing water quality of watercourses in proximity to the project and to guide future monitoring of ambient conditions
- The NSW Water Quality and River Flow Objectives that have been developed for the Cooks River catchment.
- The Managing Urban Stormwater (MUS) – Soils and Construction, in particular Volume 1, 4th Edition (Landcom, 2004) (commonly known as The Blue Book 1) and Volume 2D, Main Road Construction (DECC, 2008) (commonly known as The Blue Book 2).
- Managing Urban Stormwater: Environmental Targets (Consultation Draft, 2007) sets the stormwater pollution control targets applicable to the operational phase of the project.
- The Botany Bay and Catchment Water Quality Improvement Plan was used to set targets for pollutant load reductions, applying the large re-development reduction target.

These along with the other policies and guidelines listed as being applicable to the project set a sound framework for consideration of the impacts.

3.3 CONSTRUCTION PHASE

3.3.1 Analysis and methodology

a) Groundwater

The groundwater technical working paper sets out the assessment undertaken for the groundwater within the project area.

Groundwater modelling

A three dimensional numerical groundwater model was developed to simulate existing groundwater conditions. By simulating the proposed tunnel alignments the groundwater model has also been used to predict future groundwater conditions and impacts related to the project. The groundwater modelling was undertaken by CDM Smith Australia (CDM Smith, 2015 in AECOM 2015).

The groundwater modelling report describing the model design, parameters, grid, hydraulic boundaries and assumptions is provided in Appendix A of the groundwater technical working paper.

Groundwater model development methodology presented in the groundwater technical working paper is sound.

The groundwater model for the project applied:

- Prescribed head boundary conditions at the coastline and along tidal rivers;
- Drain boundary conditions (with conductances) for tunnels;
- Evapotranspiration (ET or EVT) boundary conditions along drainage lines;
- Horizontal and vertical hydraulic conductivities for alluvium, shale and sandstone.

As with all models there are a number of assumptions that need to be applied. Most of these appear to be reasonable, but embedded within them are a number of implications.

Surface water in the Cooks River, Alexandra Canal and Wolli Creek would control groundwater levels and prevent large scale lowering of the water table. The implication of this is that fresh, brackish or saline water (dependant on where the groundwater recharge is being drawn from) would be entering the groundwater system. It also means that the will be a loss of surface water.

The model has been prepared primarily as a steady state model. As such, there is no predication as to what will be happening after construction or in the years immediately following construction. The groundwater technical working paper reports that the steady state inflows are likely to be lower than inflows during construction and the early years of operation. It is recognised within the EIS discussions, that high groundwater inflow during excavation is possible in faulted or fractured zones or other water bearing geological features such as beneath the Cooks River palaeochannels or beneath Wolli Creek.

Prescribed head and no-flow boundaries were assumed on model boundaries. The model does not attempt to try and model what happens to the surface water creek lines that the project intersects.

The tunnel cells are assumed to be drain cells, that is, not lined. The working paper notes that the potential impacts of ventilation tunnels and shafts were not simulated as these features may be lined with concrete, and in any case, any drawdown caused by this infrastructure would be expected to be small compared to (and therefore dominated by) the effects of the tunnels.

This assumption would not reflect what is the experience reported for the M5 East project elsewhere in the technical working paper i.e. that the ventilation tunnels and shafts of the M5 East had been considered for lining given the high amount of inflow they were contributing. This would be understood to mean that these comparatively small lengths were responsible for a disproportionally high rate of inflows. There is also no commitment made within the EIS that any part of the system will be lined. As such, it is possible that the inflows may be higher than modelled.

Calibration

CDM Smith used water table measurements from the existing M5 East Motorway project to calibrate the groundwater model developed for this project. However, it was noted there was a paucity of the water table data, and that it was not measured over either of the tunnels. As such, CDM Smith stated calibration was problematic. Due to this, it is unlikely that the model has been properly calibrated. CDM Smith reported that the model predicted water table elevations that were higher than those observed. This would indicate the model is not fully assessing the impacts of the groundwater drawdown.

Results

The groundwater modelling does not predict what the short term impacts – i.e during construction or immediately thereafter - on groundwater will be so the potential inflows are not known.

During tunnelling there is initially no drawdown of the water table, but eventually over time, and certainly within tens of years, the effects of depressurisation at depth would impact the water table causing a water table decline (CDM Smith, 2015).

The bores that were put in place were for the purposes of investigation. They were not designed to provide a baseline for the assessment of water quality. The layout of the bore locations would not indicate that all information has been considered, particularly

when the potential impact on groundwater may extend for some kilometres from the alignment. For example, while there is a consideration of the contamination of the groundwater around Alexandria, within the western end of the alignment, there appears to have not been full consideration of the previous land uses and the potential for contamination. For example, the potential impacts of the former landfill site at Bardwell Park.

Treatment of groundwater is addressed in the surface water quality paper.

Fracturing or cracking of creek beds

There is little discussion within the EIS of the risks relating to the fracturing or cracking of creek beds, beyond the EIS noting that appropriate waterproofing measures will be used if inflows are elevated. This is not considered to be a sufficient assessment of potential impacts.

Acid sulphate soils

The EIS reports the majority of the project corridor has a low to extremely low probability of occurrence of acid sulfate soils. Land adjacent to watercourses, namely the Cooks River, Wolli Creek and Alexandra Canal was identified as having a high probability of being potential acid sulfate soils.

There is a potential to expose acid sulphate soils within the alluvial deposits around creek lines. Excavation of these soils is most likely when there are surface works around these locations. Arncliffe surface works has been identified as one potential site with risk. These will be treated if necessary.

The disturbance of acid sulfate soils has the potential to generate acidic groundwater that would require treatment prior to discharge. It may also impact surface water quality – this is discussed further elsewhere.

b) Surface water

The surface water technical working paper sets out to describe the water quality within the existing environment. The Cooks River Alliance Riverhealth project publishes report cards.

The surface water technical working paper references the 2013 Cooks River report card, stating that the Cooks River freshwater sites have an ecological condition rated as 'Poor' (D). Estuary conditions of the Cooks River were 'Fair' (B).

This characterisation does not recognise the dynamic nature of water quality and that water quality would be better characterised through the analysis of a long term data set.

In 2015, the Cooks River Alliance Riverhealth project published its 2013-2014 Cooks River report card. This showed that the Mid-Cooks River Estuary had moved from a 'Poor' rating in 2012-2013 to a 'Fair' rating in 2013-2014 for both the water quality score and the overall score. Further, in both years while the overall score may be poor for the Cooks River freshwater sites, the water quality score in both years is 'Fair'.

This would indicate that the efforts being made by the partnership of councils working towards improving the health of the Cooks River are having a positive effect. It would be unfortunate to not take this effort for continual improvement into account when setting design criteria for treatment of project discharges.

The surface water technical working paper acknowledges that there are both historical and recent data samples. However, one of the datasets data used to present comparisons of the Cooks River indicators against the ANZECC guidelines was data that was over 14 years old. There is no explanation as to why more recent data is not used, but given the dynamic nature of catchments and the efforts than have been made by Cooks River Alliance, Sydney Water and other stakeholders to improve the Cooks River, and that these efforts have included water quality monitoring, the use of up-to-date data would be expected.

The ANZECC Water Quality Guidelines have been used to define ANZECC trigger values for relevant water quality parameters. The surface water technical working paper applies the 80 per cent protection of species trigger for toxicants, noting that this was chosen due to the disturbed water quality of the waterways. The ANZECC guidelines do not set trigger values for highly disturbed ecosystems, recommending that trigger values for slightly to moderately disturbed ecosystem be applied. However, the ANZECC Water Quality

Guidelines (ANZECC, 2000) state that if local biological effects data is unavailable that the 95 percent protection levels should be applied as a as default.

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

- The Cooks River;
- Botany Bay;
- Towra Point Wetlands;
- Saltmarsh and other wetlands around the airport;
- Green and Golden Bell Frog ponds at Arncliffe. These were constructed in conjunction with the M5 East Motorway. Water quality data from the two (east and west) ponds; and
- Seagrass in Botany Bay.

There are other marshes and wetlands within the vicinity of the project area, however these are not mentioned. Further information and discussion on these are identified in the Biodiversity section of this report. It is puzzling why Wolli Creek and Bardwell Creek are not considered sensitive receiving environments. The value of these corridors does not appear to be reflected in the discussion regarding water quality, which appears to downplay their importance. In 2012, the Sydney Metropolitan Catchment Management Authority prepared the Wolli Creek Riparian Corridor Management Plan. It reports:

> *Wolli Valley is a unique feature in the urban landscape of inner southern Sydney. The prominent feature of the valley is a large area of bushland alongside Wolli and Bardwell Creek. A large proportion (30 ha, another 20 ha to come) of the bushland along Wolli Creek is protected under the Wolli Creek Regional Park and is actively maintained by National Parks and Wildlife Service (NPWS) staff, with significant contribution made by the Wolli Creek Preservation Society volunteers.*

As such, the EIS should also acknowledge Wolli Creek and Bardwell Creek as sensitive receiving environments.

The surface water technical working paper states that a sensitive environment in particularly close proximity to construction is the RTA ponds that provide breeding habitat for the Green and Golden Bell Frog near Marsh Street, Arncliffe. The species also utilise most of the Kogarah Golf Course for foraging, sheltering and occasionally breeding. This is correct and this is discussed further in the Biodiversity review section. The project proposes that certain golf course ponds located within the construction footprint would be decommissioned. Within the technical working paper states there is the statement that the golf course ponds are expected to have poor water quality due to nutrient runoff associated with golf course management activities. However, it would appear that the Green and Golden Bell Frog does not find this a limitation to its use of the ponds and is not justification for the removal of these ponds. Further, if the water quality of these ponds is relevant, then they should be tested accordingly prior to any further design being done.

The surface water technical working paper states that the most frequent return interval flows from the Cooks River Flood Study (WMA, 2009 in AECOM, 2015), the two-year average recurrence interval ARI were used to derive an extrapolated approximation for the one year ARI flow and used for comparison to predicted discharge of treated groundwater. No further information is provided in the surface water technical paper on this process, but it is stated that the one year ARI flow is 58.9 cubic metres per second at Bexley Road.

Within the assessment of construction impacts, the statement is made that the discharge of treated ground / construction water would have a minor increase in flow rates of receiving water courses. Discharge to Wolli Creek would be to the concrete lined section upstream of Bexley Road. Between Bexley Road and the fish weir at Turrella the discharge would contribute up to 13.1 litres per second to a highly altered reach of creek, affected by both upstream lining and downstream hydraulic controls. Further, it states that this small amount of discharge would not have the potential to impact what was the natural flow variability in the creek.

While there are controls at these two points within Wolli Creek, there is nevertheless a natural creek bed between these two points. Further, while the use of a one year ARI flow to determine what frequent events are, this is a

measure used as a criteria for detention basin outflows and the like, for discharges are an intermittent flush event. With the release of a treated ground / construction water, it is inferred that this is to be a continuous flow; as such it may actually be discharging this all day, every day. Based on a predicted flow of 13.1 litres per second this would result in continuous flow of 1.3 ML/d into Wolli Creek.

As a constant trickle flow like this has the ability to contribute to channel incision or headcutting, altering the geomorphology of this natural section of river. While this may only be localised, there is no information presented on what is the normal flow variability within the Wolli Creek. As such, the discharge of a continuous flow should not be dismissed out of hand as a potential impact.

Within the surface water technical working paper, there are expected influents and discharge flows and concentrations presented in the discussion of construction impacts. These are derived from monitoring of the M5 East treatment plant. It is acknowledged that the M5 East treatment plant would provide some predictive value for the potential groundwater quality for the proposed New M5. However the proposed New M5 alignment is not a duplication of the M5 East. The groundwater that the proposed New M5 will intersect will vary in quantity and quality. As such, to assess the potential impacts of the proposed New M5, data on the groundwater contamination within the alignment of the proposed New M5 should be informing any assessment. Further, during construction, there will be different levels of contamination. Whilst it does not state it explicitly, given that the reference for the M5 East data is 2014, it would be expected this relates to an operational phase therefore some years have passed since construction was completed.

As noted, data on the groundwater contamination within the full extent of the anticipated groundwater drawdown of the proposed New M5 should be informing any assessment. The groundwater technical working paper reports that a Phase 1 Environmental Site Assessment was undertaken along the alignment to identify potential groundwater contamination associated with historical land uses. Given the extent of the impact for groundwater, this would not be sufficient to characterise the groundwater contamination that may affect the project and to understand the potential impacts that may arise from contaminated groundwater. The potential contamination of sites such as the Alexandria Landfill are noted, however there is a history of land uses on the southern side of the Cooks River – for example a former landfill around Bardwell Park – which could have also contaminated groundwater within this area.

The total discharge of both surface flows and groundwater flows for the project are 32 L/s (Table 23). There is no information on how this was derived, what contribution is from groundwater and surface water respectively.

The groundwater technical working paper does not model construction inflows to the proposed New M5 tunnel system, only the steady state inflows are modelled and it is reported that these may not occur until some years, possibly decades, after the construction has been completed. These are estimated to be approximately 12.9 L/s, over 19.9 kilometres of tunnels (0.65 L/s/km). Further, the steady state inflows are likely to be lower than inflows during construction in the early years of operation.

The groundwater modelling report within the groundwater technical working paper says that localised inflows of two to three litres per second were reported within the M5 East project, reducing to 1.5 litres per second within two to three weeks of construction. The average inflow of groundwater since opening of the tunnel in December 2001 has been 0.75 to 0.9 litres per second per kilometre of single tube tunnel. Thus the current flows are 3.3 to 4 times lower than the flows around the final stages of construction.

Working on a similar reduction ratio, the proposed New M5 project could produce between 40 L/s and 50 L/s over the full length of the tunnels towards the end of construction. Surface water is then in addition to this. This would indicate that allowing a daily discharge flow of 32 L/s would be a significant underestimation of the potential combined surface and groundwater discharges from the project.

As this is a constant discharge throughout the duration of construction, it is not appropriate to compare this flow to the one year ARI event to assess of the significance of this discharge, and hence the potential impact/s. The one year ARI event is a minor flood event, not a constant flow. It is not considered valid to use this as justification for dismissing this constant discharge into creek systems above the tidal zone.

The surface water technical working paper states that direct construction activities within or adjacent to the watercourse and/or riparian zone are likely to involve the clearing of vegetation and excavation of channel bed and bank areas, including installation of bridge abutments. These direct activities are likely to disturb the existing floodplain and/or in-channel geomorphic units, exposing them to scour erosion, altering the trajectory of the channel planform. The proposed project includes works proposed within the watercourses or other riparian areas, including the construction water treatment plants. As such, there will be clearing of vegetation and excavation of channel bed and bank areas. The extent of this is not quantified within the working paper. Given the removal of vegetation within riparian corridors is a process that leads to degradation of water quality, more analysis on this impact to inform the understanding would be expected.

Similarly, there is a statement that other potential construction impacts on the geomorphology include: increased impermeable area and / or altered flow paths that may result in increased over bank flows entering the waterway causing erosion; tunnelling activities causing bedrock fracturing and / or subsidence with the watercourse bed. As there is no quantification of the increased impermeable areas and where the flow paths are altered, these construction impacts have not been fully analysed to inform an understanding of the expected extent of impacts.

3.3.2 Proposed mitigation measures

a) Groundwater

The EIS states that groundwater monitoring would commence prior to the commencement of construction (baseline monitoring) and would continue during construction. Monitoring would continue post the completion of construction. Six monthly groundwater monitoring should occur for three years after the tunnel becomes operational after which the requirement for on-going monitoring will be assessed. This is considered to be entirely inadequate, given that the point has been made consistently that it takes some time to reach steady state. As such, after three years the full extent of the impact of the project on the groundwater table could not possibly be known. The groundwater modelling reports that ‘within years and certainly tens of years, it is possible that a steady state may evolve’.

The EIS states the project construction would limit groundwater inflow along the tunnel length to no greater than 1 litre per second across any given kilometre of tunnel. In areas of high local hydraulic conductivity zones, the natural rock mass permeability may have to be reduced, such as by the use of shotcrete and grout, to achieve one litre per second across any given kilometre of tunnel.

To limit groundwater inflow, tunnel lining would be installed progressively as the road-headers advance. Two types of lining would be used for the project, depending on the local geology. Different types of waterproofing would be applied depending on the inflow type and rate. Should the inflow be expected to exceed the inflow criteria set in the long term, grouting would be carried out to reduce the inflow to an acceptable inflow rate. This approach is to limit groundwater extraction during construction by maintaining groundwater inflow to below the project criterion of one litre per second per kilometre

The EIS does not set timeframes around when does the criteria become applicable, what measure is to be used where, how is it understood at the time of construction what type of lining is needed to achieve the criteria. There is not sufficient detail to assess this as a

commitment or a measurable mitigation measure.

It is noted that deep incised palaeochannels infilled with saturated sediments are present beneath the Cooks River and Wolli Creek. To reduce the risk of large groundwater inflows to the tunnel from the palaeochannels it is proposed to construct the tunnels beneath the palaeochannels. However the report also notes that there is potential for the palaeochannels to extend deeper than expected (based on current information) and consequently there is a risk that the alignment could intersect a palaeochannel. This could potentially result in much higher inflows and the management of such an event is only addressed with a cursory statement in the EIS.

The EIS reports that unconsolidated Botany Sands outcrop within the proposed project alignment (Alexandria Landfill and Kogarah Golf Course). To mitigate impacts, shallow tunnel infrastructure such as dive structures and ventilation shafts would require shoring to stabilise the excavations and prevent groundwater inflow. A preferable mitigation measure would have been confirmation that any part of the works will be lined to prevent any inflows given that the whole Botany Sands hydrogeological unit is over allocated.

The EIS commits to using *appropriate waterproofing measures…to permanently reduce the inflow to an acceptable quantity where the project alignment passes close to watercourses and/or where higher than expected inflows are experienced*. As there has been no investigation into what may be experienced or limits set regarding what the inflows limits are during construction or when the limits need to be met during operation, this mitigation measure does not provide any imperative for action to be taken.

The EIS reports that a groundwater and soil salinity report would be prepared prior to the commencement of earthworks to assess the potential impacts to the local hydrogeological regime. As impacts should be assessed and understood as part of the EIS, it is recommended that this potential impact be understood at this stage.

b) Surface water

The surface water technical working paper says that tunnelling would occur beneath Wolli Creek and its tributaries. The construction methodology would minimise potential impacts to surface geology, such as fracturing and subsidence. As a result no impact on the geomorphology of the watercourses is expected. Without further information on how the impacts will be minimise, the effectiveness of any potential method cannot be determined.

As noted in the surface water technical working paper, dust generated by construction activity, if not properly managed, has the potential to impact the water quality of the RTA ponds and frog habitat on the golf course. It proposes the use of sheds for spoil handling, and dust suppression measures would mitigate and manage the potential for indirect impacts. Additional measures specific to the species and project are also detailed in the plan of management (Ecological Australia, 2015) (refer to the Biodiversity review for further discussion). It also says that more detail on the water quality monitoring regime including frequency, sampling locations and parameters would be provided in the Habitat Creation and Captive Breeding Plan due for completion by March 2016. As this plan is not available during the EIS exhibition, it should be provided to all stakeholders, including the local councils, for review and comment during development.

Within the water quality measures, there is mention of re-vegetation and/or stabilisation of disturbed areas to occur as soon as feasible. Later, it says disturbed floodplain environments adjacent to watercourses (including waterfront land) and/or along overland drainage lines would be stabilised and vegetation managed in accordance with the Guidelines for Controlled Activities on Waterfront Land (DPI, 2012). This is accepted practice. However it would be expected that further detail should be provided on what this will involve, given that there are significant disturbances of creek lines and riparian areas. At a minimum, a vegetation management plan should be developed with the input from relevant stakeholders. Along Wolli Creek, the Wolli Creek Riparian Corridor Management Plan should have been acknowledged, the impacts assessed in relation to the objectives

the plan is aiming to achieve and revegetation of disturbed areas in accordance with the plan.

All the measures relating to hydrology/flooding are very much focussed on the protection of the project assets and flood mitigation. There is no consideration of how to protect the creek lines within the affected catchment. To some extent, this is addressed in the geomorphology measures, but only to the extent of minimising work activities within these environments, the alignment of discharge outlets and stabilising floodplain environments. It is not certain what is expected by the latter measure.

The mitigation measures do not require an acid sulfate management plan or a contaminated soil management plan. Rather, the mitigation of these risks is addressed by stating that contaminated sediments and potential acid sulfate soil would be segregated and disposed of at a licensed facility or treated onsite.

The requirement for measures to minimise the disturbance of sediments in Alexandra Canal during construction of new discharge stormwater outlets is necessary; however, again there is minimal detail, with the EIS simply stating that these would satisfy the requirements of the existing Remediation Order for the canal. There is no detail on what these requirements are.

Water quality monitoring commenced in June 2015. The mitigation measures state monitoring would continue to collect up to at least 12 months of data or up to the commencement of construction (whichever is sooner) to represent pre-construction conditions for the project. Monitoring would continue during construction of the project. Given the inherent variability of water quality data, it is recommended that 12 months of data should be considered a minimum and preferably considerably a longer duration dataset should be collected prior to construction. It is then required that monitoring continue during construction. It says that samples would be taken twice a month, once in dry and once in wet conditions where possible. This should be re-assessed to better tie in with climatic conditions and site activities. It is normal that there is monitoring immediately following rain events so the potential discharge of pollutants can be assessed.

The measures within contaminated runoff and spills are quite standard. However, there are no measures around relating to the water treatment plant performance.

3.4 OPERATIONAL PHASE

3.4.1 Analysis and methodology

a) Groundwater

Tunnel Inflows

The groundwater model discussed in the construction analysis above was used to predicted groundwater impacts. As noted above, the modelling objective was to characterise predicted behaviour once a steady state situation has been reached.

The groundwater inflows once the steady state conditions were predicted to be 1.115 m3/d into the tunnels. Over the 19.9 kilometres of tunnels, this equates to 0.65 L/s/km; giving a total predicted discharge of 12.9 L/s from both tunnels combined.

However this rate is averaged over the length of the tunnel, and this is not consistent with the criteria adopted for inflows, which states the limit will be 1.0 L/s across any kilometre of the tunnel. So while the overall discharge is predicted to meet the average, there is no prediction of how the proposed project performs against the ‘any kilometre’ criteria.

Groundwater Drawdown

The predicted impact on the water table once it has reached steady state, an indeterminate period of years after the operational phase has commenced, is shown in Figure 4 (CDM Smith, 2015).

The predictions presented by this figure are that the water table will ultimately be below sea level when it is represented in purple, pink or white.

The water table is predicted to remain high within the vicinity of Bardwell Creek, with CDM Smith (2015) stating that is probably due to the presence of deep alluvium along this drainage

line. This would implicate that the water table does not drop but is replenished by Bardwell Creek. The impacts of this are not further considered.

There is a very large drawdown along the main tunnel alignment between Bardwell Creek and Cooks River. It is less in the vicinity of Cooks River, due to the connection with the ocean. This is because it is predicting that the river will be replenishing the ground water supply as water is drained into the tunnels below.

A hydraulic gradient (the change in total groundwater head with a change in distance in a given direction, which yields a maximum rate of decrease in head) will develop from the river in both easterly and westerly directions. This will result in the brackish or saline water moving from the river into the groundwater system. The implication of this is that the groundwater would increase in salinity until equilibrium is reached with the river/ocean conditions.

The area in which there is no drawdown as the project crosses the Cooks River is thus predicting the length of tunnel receiving water from the Cooks River. It is longer than the length actually lying under the alluvium.

The groundwater modelling report quite clearly states that saltwater intrusion will take place, and the groundwater would ultimately be saline, at a salinity approaching that of seawater (CDM Smith, 2015). Looking at the impacts predicted in Figure 4, this could be expected to occur across all areas between the pink shading and the surface water bodies within this section would be expected to become more saline, then extending potentially to the centre of the tunnel alignment.

While it is recognised within the EIS that there is potential for groundwater extracted from the alluvium to become more saline with the steep hydraulic gradient inducing saline water from tidal rivers towards the tunnels, there is not further consideration given to the impacts of the changed water quality on the people or the ecosystems dependant on the groundwater. Further, it is not noted that if the water quality in these rivers is currently poor, which the surface water assessment goes to some effort to establish, then it would also be expected there would be potential for the groundwater quality to further decline as surface contamination is drawn into the system. This is not discussed as a potential impact within the EIS.

Further analysis relating to the biodiversity implications is considered in Section 4.

Bore water users

The EIS has analysed the impact on bores within a one kilometre buffer of the project alignment. It reports that the majority of these bores are shallow, less than 10 m deep.

The EIS has only predicted potential impacts on existing groundwater users in terms of drawdown. The results show that the predicted impacts on these bores should be manageable, with commitments to mitigate any impacts should they not be.

However, there is no assessment of potential change in the quality of the groundwater impacting these users. As demonstrated in the above analysis, the existing groundwater users may be negatively affected through impacts on water quality and contamination.

Tables 19-14 and 19-15 in the EIS set out the response to the minimal impact considerations of the NSW Aquifer Interference Policy. Setting aside whether the information and assumptions within the EIS are correct, there is a minimal impact consideration relating to water quality. This says that any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity. The EIS reports this won't happen. Given that there has not been any modelling of the potential impacts to water quality, this cannot be concluded.

Further, it is disingenuous to say that the proposal will not impact water quality. The responses in this table are not giving consideration to the fact that there will be a hydraulic gradient set up that will draw saline water from tidal zones into the groundwater system. That is, the source of impact to groundwater quality will not arise from the tunnel but saline water will be drawn towards it.

The impact on water quality has not been considered. It should be as it is directly as a

result of groundwater drawdown arising from the project.

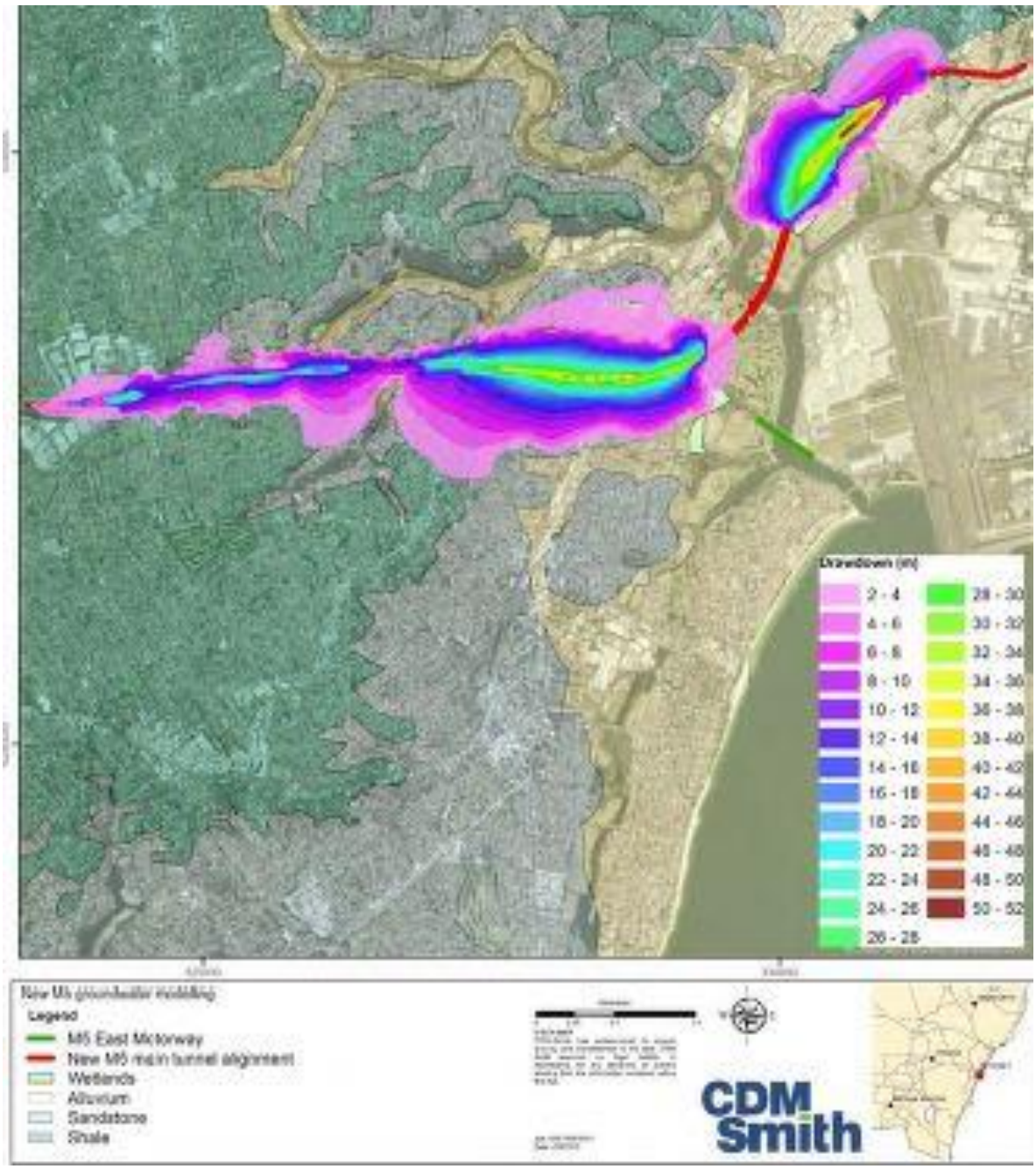

Figure 4 Groundwater drawdowns predicted

Surface Water Interactions

The EIS notes that: *surface water can only flow to the groundwater system when the groundwater levels are lower than the surface water levels or when the alluvial water table falls below the surface water level in the creeks. In the lower catchment reaches if brackish water from the Cooks River or Wolli Creek replaces groundwater lost from the alluvium the groundwater quality may be degraded.* Given that there will be drawdown of the groundwater table, it would be expected that there will be new areas where the groundwater level will be lower than the surface water level. This is confirmed by the statement within the groundwater working paper that: *the Cooks River and its tributaries across the majority of the project area in the lower topographic areas are generally gaining streams; that is groundwater discharges from the aquifer into the stream or creek.*

As noted by the eWater Modelling Guidelines (2012), the extraction of large volumes of groundwater in close proximity to streams and rivers has the potential to reduce stream flows. In un-regulated upland streams, the primary impacts are on low-flow conditions that are crucial to ecosystem health (e-Water, 2012).

CDM Smith's groundwater model features were:

- No flow boundary conditions and prescribed head used to represent the boundary conditions;
- A recharge was applied at the ground surface at a constant average rate;
- There was no allowance for the flux between the rivers and groundwater. The river interaction within the tidal zone was incorporated by setting the boundary at mean sea level;
- Above the tidal level, the flux between surface water bodies above the tidal zone was not accounted for within the model. The only flux considered was evapotranspiration along the drainage lines. CDM Smith reported that this representation tends to hold the water table below the drainage line level.

The groundwater model has not been developed to predict the interaction with surface water or is it able to model any changes to surface water bodies that may arise from the proposed project.

Induced Recharge

CDM Smith (2015) reported that the effect on groundwater dependent ecosystems may not be as great as predicted due to the impact of 'induced recharge'. This was said to be when vegetation takes less water when the water table drops, such that the difference between the infiltration and evapotranspiration increases. That is, the loss in groundwater due to evapotranspiration reduces, reducing the extent to which the water table is drawn upon by vegetation. This is a speculative, as it has not been modelled. However, it is a likely impact that evapotranspiration is reduced when the water table falls, as the plants reliant on it are no longer able to access this water source. However, this 'benefit' may arise when the existing vegetation, particularly that within the groundwater dependent ecosystems has died off and in the longer term, replaced with vegetation that can better manage the drier regime. This is akin to saying that there will be a net positive impact of discharges from a sewer outfall reducing if the reduction is due to the water authority shutting down the water supply.

Further, the technical working paper does not discuss that induced recharge, or induced leakage, is likely to also occur. This describes the transition from a gaining stream to a losing stream that may occur as a water table falls. This is illustrated in Figure 5 (Land & Water, 2007). This will impact those tributaries to the Cooks River that are above the tidal range that are in a natural state. However, as there's been no consideration of this in the groundwater modelling exercise, the extent of this impact is not predicted and has not been considered in the assessment.

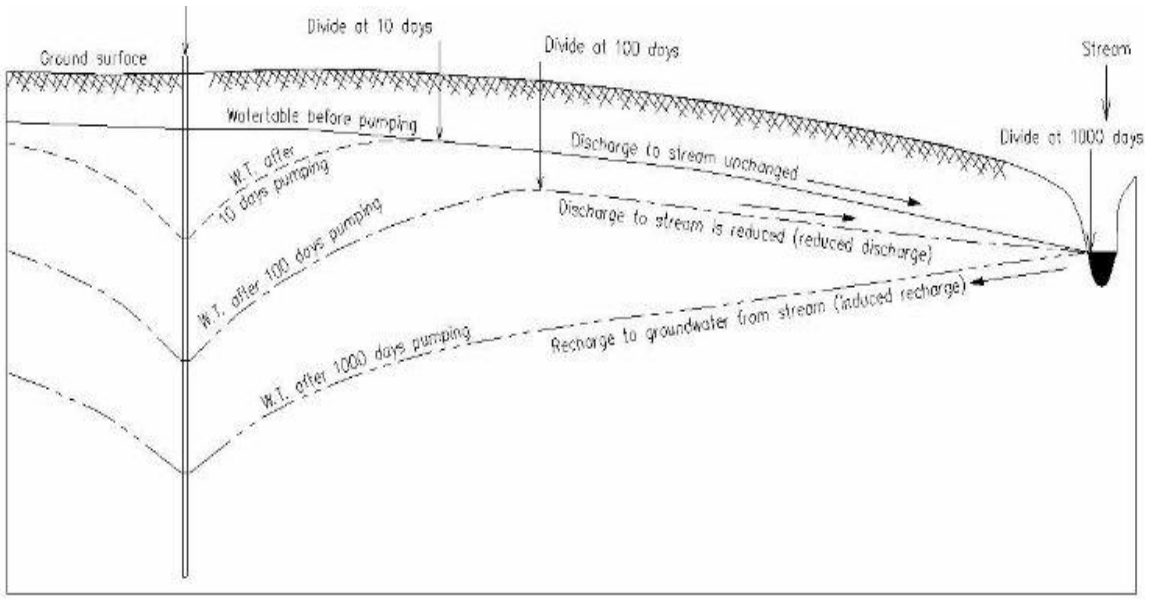

Figure 5 Induced Recharge

b) Surface water

The surface water technical working paper reports that within the Wolli Creek catchment, the project would include the construction of additional pavement resulting in an increase in the imperviousness within the project footprint in this area (22.74 hectares in total) from an existing imperviousness of about 68 per cent, to an imperviousness of 100 per cent. This represents an increase of about seven hectares of impervious surfaces to the pavement drainage catchment. This increase in imperviousness creates the potential for higher pollutant loads to be washed into the receiving Wolli Creek environment.

It was reported that the MUSIC modelling for the project demonstrated that the proposed treatments measures will permit project compliance with the reduction targets for total phosphorus (TP) and total nitrogen (TN). However, that only a 64 percent reduction in total suspended solids (TSS) is achieved. This means that 36 percent or approximately 10 tonnes/year of the TSS generated by the additional impervious areas will be discharged into the Wolli Creek catchment.

Modelling for the Alexandra Canal and the Eastern Channel shows that the pollution reduction provided is expected to exceed the reduction targets for both catchments.

The stormwater discharges into the Alexandria Canal are reported to have the potential to disturb the sediments within this canal. These bed sediments have been identified as containing chlorinated hydrocarbons, including organochloride pesticides (chlordane, total DDT and dieldrin), polychlorinated biphenyls (PCBs) and metals. The surface water technical working paper reports that there is uncertainty in understanding the impacts associated the sediment distribution in the canal

The surface water technical working paper reports that an operational water treatment plant would be built within the Arncliffe Motorway operations complex. This plant would treat groundwater inflows into the tunnels. Surface water flows collected within the tunnels would also be collected and pumped to the operational water treatment plant. The water treatment plant would be designed to receive and treat two separate streams:

- Contaminated groundwater from the eastern section of the project
- Non-contaminated groundwater from the western section of the project, stormwater, wash down, fire testing, hydrant and deluge water.

On the basis of this assumption, the impact assessment reports that the eastern and western streams will be treated separately and differently.

As noted earlier, data on the groundwater contamination within the full extent of the anticipated groundwater drawdown of the proposed new M5 should be informing any assessment. The groundwater technical working paper reports that a Phase 1 Environmental Site Assessment was undertaken along the alignment to identify potential groundwater contamination associated with historical land uses. Given the extent of the impact for groundwater, this would not be sufficient to characterise the groundwater contamination that may affect the project and to understand the potential impacts that may arise from contaminated groundwater. The potential contamination of sites such as the Alexandria Landfill are noted, however, there is a history of land uses on the southern side of the Cooks River – for example a former landfill around Bardwell Park – which could have also contaminated groundwater within this area.

There would not appear to be sufficient information to have an informed understanding of the potential impacts of groundwater quality at this stage to determine what treatment approaches are necessary. Further information should be obtained as a priority and the assessment revisited once this information is available.

In relation to the water quality reference criteria developed, the approach appears to be reasonable and in accordance with ANZECC guidelines. However, there is a paucity of data upon which this criteria has been developed, as is also noted in the methodology.

The discussion relating to the changes in impervious areas from the construction section is also applicable to the operational phase, as the permanent change in impervious areas is predicated to be seven hectares. It is reported that the relatively minor reduction in time of concentration of the peak flow attributed to the project works is unlikely to impact the geomorphology of the creek. However, there is more than just a change in time of concentration that impacts geomorphology of a creek – there is also the change in the quantity and the frequency of the flow and the changed velocity regime. The extent of the potential impact has not been documented sufficiently to allow it to be understood and if necessary, mitigated.

The surface water technical working paper reports that new discharges into the Alexandra Canal would increase the potential for bank failure as material at the toe of the canal walls could be lost. Scour protection would alleviate this issue. This level of potential impact raises further concerns in relation to the Alexandra Canal contaminated soils matter discussed previously.

3.4.2 Proposed mitigation measures

a) Groundwater

Table 19-7 of the EIS lists the proposed mitigation measures for groundwater impacts. These and other matters noted during the review of the groundwater sections are discussed here.

Bore water users

A review of current groundwater use has been conducted to identify registered groundwater users and the environment within a one kilometre buffer of the project corridor. In the event that groundwater users are impacted by the project by a decline in groundwater levels in existing bores, in excess of two metres; provisions are to be implemented to 'make good' the supply by restoring the water supply to pre-development levels. The measures taken would be dependent upon the location of the impacted bore but could include, deepening the bore, providing a new bore, providing an alternative water supply, or alternatively providing appropriate monetary compensation.

As noted above, water quality and contamination impacts have not been considered and therefore there has been no

consideration of this potential impact in the mitigation measures.

Groundwater dependant ecosystems

There are no mitigation measures identified that relate to vegetation impacts. This is discussed further in the Biodiversity section.

Monitoring

The groundwater modelling identified that there is insufficient information on groundwater levels within the area and made recommendations as to the type of monitoring undertaken in the future. It is not clear if this has been incorporated into the monitoring program as there is not a lot of detail around this measure and no certainty as to what an ongoing monitoring program will contain.

The EIS states that groundwater monitoring would commence prior to the commencement of construction (baseline monitoring) and would continue during construction. Monitoring would continue post the completion of construction. Six monthly groundwater monitoring should occur for three years after the tunnel becomes operational after which the requirement for on-going monitoring will be assessed. This is considered to be entirely inadequate, given that the point has been made consistently that it takes some time to reach steady state. As such, after three years the full extent of the impact of the project on the groundwater table could not possibly be known. The groundwater modelling reports that: *within years and certainly tens of years, it is possible that a steady state may evolve*.

The EIS states the project construction would limit groundwater inflow along the tunnel length to no greater than one litre per second across any given kilometre of tunnel. In areas of high local hydraulic conductivity zones, the natural rock mass permeability may have to be reduced, such as the use of shotcrete and grout, to achieve one litre per second across any given kilometre of tunnel.

The EIS does not set timeframes around when does the criteria become applicable, what measure is to be used where or how is it understood at the time of construction what type of lining is needed to achieve the criteria. There is not sufficient detail to assess this as a commitment or a measurable mitigation measure.

Further, the EIS says there is currently no groundwater quality monitoring program and this will be prepared as part of operations. However a program should be in place prior to construction commencing to set a baseline. If this is not done upfront, there is no mechanism to measure and manage all potential impacts.

b) Surface water

All the measures relating to hydrology/flooding are very much focussed on the protection of the project assets and flood mitigation. There is no consideration of how to protect the creek lines within the affected catchment.

Within the water quality measures, there is mention of re-vegetation and/or stabilisation of disturbed areas to occur as soon as feasible. No detail is provided on what this will involve. Given that there are disturbances of creek lines and riparian areas, this is insufficient. At a minimum, a vegetation management plan should be developed with the input from relevant stakeholders. Along Wolli Creek, the Wolli Creek Riparian Corridor Management Plan should have been acknowledged, the impacts assessed in relation to the objectives the plan is aiming to achieve and revegetation of disturbed areas in accordance with the plan.

Rather than dismissing or otherwise justifying why the 10 tonnes/year of the TSS generated by the additional impervious areas that will be discharged into the Wolli Creek catchment is acceptable, further mitigation measures should be proposed. These could include the construction of treatment measures elsewhere in the catchment to provide additional treatment in the Wolli Creek catchment, or contribution to organisations responsible for water treatment measures. This should be undertaken in consultation with the relevant asset owners (the local council/s and Sydney Water).

The mitigation measures require operational water quality monitoring to be conducted for 12 months post-construction or as otherwise required by the conditions of approval. Twelve months would seem a very short time frame given the variability of water quality. The Water Quality Monitoring Program is presented in Appendix B. The program gives no detail on

the timing or duration of the monitoring requirements, or the aims or objectives of the program, what is to happen with the data, how it is to be analysed, presented etc.

Further, there is no water quality monitoring proposed for the Marsh Street area to measure the ongoing impacts to the Green and Golden Bell Frog habitat. There is also no paired site for the operational treatment plant discharge point. Any poor results detected at the operational treatment plant discharge point cannot be compared to an upstream site to determine if the operational treatment plant discharge point is responsible.

The mitigation measures do not require spill containment for spills on the Motorway as a matter of course. Rather, it is to be provided only 'if warranted'. This would not seem an appropriate mitigation of environmental risk. It would be anticipated that this Motorway would carry a significant number of heavy vehicles, and these would be carrying material which would pose risks should there be a spill. This should be considered and mitigated against.

3.5 CUMULATIVE IMPACTS

a) Groundwater

As reported in the groundwater technical working paper, it is not known if the M5 East tunnel system has yet reached a steady state. It is known that it has quite high inflows along the length of the tunnel that is within sandstone (the section beneath the Cooks River is lined). Transient observations were only made in 2015, 17 years after the construction of the M5 East Motorway commenced. As such, no conclusion can be drawn as to whether or not the water table has reached equilibrium. Further, none of the observations were made over the centreline of any tunnel and, as such, have not assessed the greatest impact of this tunnel.

The groundwater model attempted to calibrate using some data from within the vicinity of the existing M5 East Motorway. It was observed that the water table drawdown in some areas around Wolli Creek was not significantly affected, and it was suggested that this was because water was draining from Wolli Creek and recharging the aquifer. Nevertheless, there was still a significant drop in the water table along the existing tunnel alignment.

The construction of the New M5 Motorway would start a new transient process of groundwater leaking into the tunnel system. This would be superimposed on the groundwater impacts that are already occurring from the M5 East.

Given that there are already significant impacts on the groundwater due to the existing tunnels, but that the full extent of these are not yet properly understood, it would not seem to be aligned with the precautionary principal to subject the same area and the same surface water and groundwater systems to further development. This would seem to be high risk for those people and ecosystems reliant on these systems.

b) Surface water

For the construction phase, the cumulative water quality and geomorphology impacts discussed in the surface water technical working paper are the erosion of exposed soil resulting in sedimentation and water pollution associated with sediment-laden runoff.

The other cumulative impacts are the clearing of riparian vegetation, and increase in discharges to waterways. These should be considered here.

In operations, the cumulative impacts should also consider the discharge of additional water pollutants. The modelling results reported an additional 10 tonnes/year of the TSS generated by the additional impervious areas will be discharged into the Wolli Creek catchment.

The operational phase discussion in the technical working paper reports that the increase in impervious surface within the Wolli Creek catchment would be roughly seven hectares representing less than one per cent of the 1,100 hectares catchment draining to Bexley Road. However, when this is added to the previous major road upgrade, the M5 East, plus the expected ongoing upgrades flagged with the other WestConnex project, the ever increasing impervious surfaces have a degrading impact on water quality. Within the

cumulative impact discussion, the technical working paper says surface water quality is maintained through the routine application of stormwater treatment devices to new infrastructure and development projects to ensure that water discharged to Botany Bay complies with legislative requirements. However, the project as presented failed to meet targets within the Wolli Creek catchment. Further, these targets were not set at 100 per cent reduction of the pollutants generated by a project. Therefore, surface water quality is not being maintained but further degraded with each new project.

4 BIODIVERSITY

4.1 BACKGROUND

The proposed New M5 Motorway project would be located within the Canterbury, Hurstville, Rockdale, Marrickville, Sydney and Botany Bay local government areas which include existing motorways, residential areas, urban landscaped areas, golf courses and remnant native vegetation in varying condition and with varying levels of connectivity to other remnant native vegetation.

The construction footprint is that area impacted, cleared and/or disturbed during the construction of the project, including both above ground and underground elements of the project. It is assumed in the EIS that there would be complete vegetation clearance within the construction footprint to ensure that the ecological assessment complied with regulatory requirements (*NSW Environmental Planning and Assessment Act 1979* (EP&A Act).

During the preparation of the EIS, the project had been referred to the Commonwealth Minister for the Environment (2015/7520) under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) because of the potential for the project to impact on the following matters of national environmental significance (MNES):

- A population of Green and Golden Bell Frogs (*Litoria aurea*), known to inhabit the Kogarah Golf Course at Arncliffe;
- An area of the Cooks River Castlereagh Ironbark Forest (CRCIF), vegetation community in Beverly Grove.

a) Assessment framework

Under the Bilateral Agreement relating to environmental assessment (February 2015) between the Commonwealth Government and the NSW Government, this EIS has been adapted to meet the assessment requirements of both the Commonwealth EPBC Act and the EP&A Act. The requirements of the bilateral agreement have been considered and taken into account as part of this environmental impact statement.

The Biodiversity Assessment Report (BAR) was undertaken in accordance with the survey guidelines specified by the Secretary's Environmental Assessment Requirements (SEARs) and provided an assessment of the potential ecological impacts of the proposal, with specific reference to vegetation and habitat clearing, connectivity, edge effects, weed dispersal, riparian and aquatic habitat impacts, soil and water quality impacts and operational impacts. The assessment was undertaken in accordance with the Framework for Biodiversity Assessment (FBA) (OEH, 2014a) and the NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014b), and by a person accredited in accordance with section 142B(1)(c) of the Threatened Species Conservation Act, 1995.

Impacts on species, populations and ecological communities that required further consideration and provision of information outlined in the FBA were described. Species specific surveys were undertaken for those species in accordance with the survey requirements specified by the OEH

b) Target species lists

The assessment of potential ecological impacts was to comply with the requirements of the *Guidelines for preparing Assessment Documentation relevant to the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) — WestConnex New M5 Project (EPBC 2015/7520)*. The assessment contained detailed identification and assessment of direct and indirect impacts on threatened species and ecological communities that were likely to, or may be significantly impacted by the proposal, including but not limited to:

- Cooks River Castlereagh Ironbark Forest of the Sydney Basin Bioregion;
- Green and Golden Bell Frog (*Litoria aurea*);
- Turpentine Ironbark Forest in the Sydney Basin Bioregion;
- Bynoe's Wattle (*Acacia bynoeana*);
- Downy Wattle (*Acacia pubescens*);

- Deane's Paperbark (*Melaleuca deanei*);
- Hairy Geebung (*Persoonia hirsuta*);
- Spiked Rice-flower (*Pimelea spicata*);
- Magenta Lilly Pilly (*Syzygium paniculatum*); and
- Black-eyed Susan (*Tetratheca juncea*).

Matters for further consideration provided by the NSW Office of Environment and Heritage (OEH), in addition to the SEARs, include:

- Cooks River/Castlereagh Ironbark Forest (CRCIF)
- Sydney Turpentine-Ironbark Forest (STIF)
- Swamp Oak Floodplain Forest
- River-flat Eucalypt Forest
- Swamp Sclerophyll Forest
- Gosford Wattle (*Acacia prominens*) endangered population in the Hurstville and Kogarah Local Government Areas (LGA)
- Long-nosed Bandicoot (*Perameles nasuta*) endangered population in inner western Sydney
- White-fronted Chat (*Epthianura albifrons*) endangered population in the Sydney Metropolitan Catchment Management Area
- Sunshine Wattle (*Acacia* terminalis subsp. Terminalis)
- Siah's Backbone (*Streblus pendulinus* aka *Streblus brunonianus*) ()
- Narrow-leafed Wilsonia (Wilsonia backhousei) (
- Australasian Bittern (*Botaurus poiciloptilus*)
- Sanderling (*Calidris alba*)
- Curlew Sandpiper (*Calidris ferruginea*)
- Greater Sand-plover (*Charadrius leschenaultii*)
- Lesser Sand-plover (*Charadrius mongolus*)
- Sooty Oystercatcher (*Haematopus fuliginosus*)
- Pied Oystercatcher (*Haematopus longirostris*)
- Broad-billed Sandpiper (*Limicola falcinellus*)
- Little Tern (*Sternula albifrons*)
- Terek Sandpiper (*Xenus cinereus*)
- Green and Golden Bell Frog (*Litoria aurea*)
- Black Bittern (*Ixobrychus flavicollis*)
- Grey-headed Flying Fox (*Pteropus poliocephalus*) (if camps are impacted)
- Eastern Freetail Bat (*Mormopterus norfolkensis*) (if maternity or roost sites are impacted)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) (if breeding or roost sites are impacted).
- An additional list of species requiring targeted survey was provided by OEH. The species were:
- Whalebone Tree (*Streblus pendulinus* aka *Streblus brunonianus*) ()
- Sanderling (*Calidris alba*) Curlew Sandpiper (*Calidris ferruginea*)
- Terek Sandpiper (*Xenus cinereus*)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) (if breeding or roost sites are impacted).
- Eastern Freetail Bat *(Mormopterus norfolkensis)* (if maternity or roost sites are impacted)

4.2 DESKTOP REVIEW OF DATA

The desktop review of background information documented in the BAR in accordance with the FBA included:

- OEH Atlas of NSW Wildlife (10 kilometre radius search), carried out in November 2014
- EPBC Act Protected Matters Search Tool (10 kilometre radius search), carried out in December 2014
- NSW DPI Fisheries threatened and protected species record viewer, carried out in June 2015
- NSW DPI Fisheries Key Fish Habitat Map, carried out in June 2015

- Bureau of Meteorology Groundwater Dependent Ecosystem Atlas, carried out in June 2015.

The database searches identified threatened species, populations, communities and habitats with the potential to occur or known to occur within the biodiversity study area.

4.2.1 Limitations in determining species impacted by the proposal

The FBA credit calculator tool was used to determine the potential species likely to be impacted by the proposed New M5 construction works. This selection of species for further consideration of potential impacts is based on previous studies and the existence of available habitat within the construction footprint. It was not an exhaustive list of potential species that may be encountered. Consequently additional species were considered by OEH as being worthy of further consideration.

However, in obtaining a more comprehensive list of potential species and ecological communities likely to be affected by the proposed construction works, there has not been a thorough review of information obtained for the local areas as held by the local government authorities. In particular, there was inadequate consideration of any:

- Additional information obtained by Rockdale, Canterbury and Hurstville Councils on local threatened fauna/flora species as part of the development application process or
- Species hotspots or known areas of significant habitat that may not be recorded in threatened species databases but identified in biodiversity studies, such as the important Wolli Creek Regional Park
- Management plans and strategies prepared for local government authorities that document the particular aspects of local biodiversity such as the Grey-headed Flying-fox management plan for Turella.

There are provisions within the FBA to consider local information where it can be demonstrated that this information provides a more comprehensive summary of the existing biodiversity compared to government databases. The desktop review conducted for the BAR could have considered additional sources of information to obtain a more comprehensive species list potentially impacted by the proposal. Some of these sources of information are included below.

a) Potential threatened species

The Bardwell Valley and Wolli Regional Park has been identified by Rockdale City Council as a potential hotspot for the Powerful Owl. These areas provide roosting habitat to support a breeding population and a foraging range that extends beyond the New M5 project footprint. This species was not considered likely to be impacted by the proposed construction works as part of the likelihood of occurrence assessment. However, there was no consideration of the potential for isolated patches of vegetation within the project alignment to provide foraging habitat as part of a wider home range for such species.

b) Previous studies for M5 East

Cumberland Flora and Fauna Interpretive Services was engaged by the former Roads and Traffic Authority (RTA now Roads and Maritime) to undertake detailed surveys of the Beverly Grove bushland, which occurs within part of the M5 East Motorway corridor between Beverly Hills and Kingsgrove. The surveys were conducted to assess if the M5 East realignment would impact on areas of high conservation significance including Cooks River Clay Plain Scrub Forest EEC. This community has been renamed by the NSW Scientific Committee in 2002 as CRCIF, which is listed as an EEC under the TSC Act and critically endangered under the EPBC Act.

The bushland at Beverly Grove was considered to be of high conservation significance due to its proximity and potential integration with STIF. The patch of CRCIF is at the eastern most extent of its geographical distribution. The assessment recommended bushland rehabilitation works to be undertaken within this community.

c) Local Government Studies

The Rockdale City Council Biodiversity Strategy and Grey-headed Flying-fox Management Plan for the Turrella Flying-fox colony were not considered during the background review. Local information can provide important background on the potential for threatened species to utilise areas along the New M5 project alignment as part of a foraging or sheltering habitat as part of seasonal movements along the drainage lines.

4.2.2 Likelihood of occurrence assessment

Based on the project design for tunnels rather than a surface expression, the BAR discounted the likely presence of many of the species predicted to occur with the area. Whilst OEH have provided additional species for consideration in addition to those outlined in the SEARs, the process has truncated the potential threatened species lists and focussed on only a number of key species and communities. This number is further reduced following the likelihood of occurrence assessment that only focuses on the immediate environment within the project alignment and does not include the range of surrounding vegetation types.

This process fails to fully consider the potential for stepping stone habitat or occasional use of local patches of vegetation within the project alignment as part of a regional biodiversity corridor, passing through Bardwell Valley, then towards either Stotts Reserve to Wolli Regional Park; or via Coolibah Reserve and continuing towards Wolli Regional Park. These reserves are included Priority Natural Areas with moderate conservation significance in the Rockdale City Council Biodiversity Strategy.

4.3 ADEQUACY OF THE FIELD SURVEY METHODOLOGY

The BAR was prepared using the FBA. Section 2.1.1.4 of the FBA indicates that where a proponent is proposing to establish an offset site as part of the Biodiversity Offset Strategy (BOS) for the Major Project, the Biobanking Assessment Methodology (BBAM) must be used to assess the biodiversity values of the offset site and to identify the number and type of biodiversity credits that may be created on the offset site.

This relies on the FBA credit calculator tool in determining the potential species impacted by a project and does not consider additional species identified during the background review.

4.3.1 Landscape assessment of Threatened species

In assessing the biodiversity values, the FBA is a multi-step process commencing with describing the landscape, obtaining quadrat and transect-based vegetation assessments to determine site values before assessing the threatened species and populations present.

The process involved extracting information from the Threatened Species Profile Database of those species listed in the SEARs and any supplementary species lists for a range of parameters.

Where a species can be predicted by habitat surrogates (ecosystem credits) there is no requirement to undertake specific targeted surveys as these species are reliably predicted to occur and appropriate offset credits determined.

Where a species can be predicted by habitat surrogates must be assessed in a separate step. The candidate species credit species is identified if it was listed in the TSPD; the project site is within the geographical distribution of that species; the development site contains habitat features or components associated with that species; or past surveys undertaken in the area indicate that the species is present.

The categorisation of potential ecosystem credit species or species credit species for further investigation was based on the assessment as to whether the list of species determined using the FBA credit calculator met the conditions outlined for in the Part 6 of the FBA.

a) Ecosystem credit species

No ecosystem species derived using the FBA credit calculator tool fully met the criteria and no further investigation was conducted.

b) Species credit species

Only the Green and Golden Bell Frog was considered for further investigation based on the review of the species list determined using the FBA credit calculator.

c) Limitations

The FBA credit calculator was applied to derive a predicted species list for further investigation. The species list interrogated to assess the requirements for further targeted species survey did not include the additional species provided in the supplementary SEARs, or those provided by OEH as supplementary species. Consequently no targeted surveys for threatened species were undertaken in the BAR. Therefore the assessment of potential impacts from the proposal cannot be fully assessed where threatened species could occur within the project alignment.

4.3.2 Survey methodology

A candidate species is not considered to be present on the development site where:

- After carrying out an assessment of the habitat components, the assessor determines that the habitat is substantially degraded such that the particular species is unlikely to utilise the development site; or
- An expert report prepared in accordance with Subsection 6.6.2 states that the species is unlikely to be present at the development site; or
- The species is a vagrant species and unlikely to use habitat on the development site; or
- Records of the species presence in relation to the location of the development site are at least 20 years old or, in the opinion of the assessor, have doubtful authenticity.

Where these conditions are not satisfied, then targeted species surveys should be conducted.

The methodology for such species is outlined in the FBA and includes:

- Threatened Biodiversity Survey and Assessment guidelines (DEC, 2004),
- Survey guidelines for Australia's threatened mammals (DSEWPC, 2011),
- Survey guidelines for Australia's threatened bats (DEWHA, 2010a); and
- Survey guidelines for Australia's threatened frogs (DEWHA, 2010b).

The effort was prioritised within the study area according to the vegetation community present and potential habitat for threatened flora and fauna species and focused only on the project alignment and a small buffer around the construction footprint.

The survey effort and coverage was restricted to the immediate project alignment with many of the areas of investigation having restricted or no access. The EIS acknowledges that the survey effort did not cover the optimal season for detection for many of the species likely to occur and hence the information is inconclusive. Whilst this is a function of the political and financial constraints for major infrastructure projects, in the absence of a thorough field assessment, the precautionary principle should have been adopted. Under this principle, if suitable habitat exists within the project alignment, however degraded or modified, then a species should be considered likely to utilise this habitat, either permanently or as part of a wider range. It is not clear from the BAR to what extent the assessment and therefore conclusions are based on this position. To illustrate, the following sections identify a number of limitations in the survey for particular species as outlined in the BAR.

4.3.3 Green and Golden Bell Frog

The desktop review of previously published information on threatened fauna within the project alignment indicated the presence of an important breeding population of Green and Golden Bell Frog within the constructed wetlands and pools of Kogarah Golf Course and adjacent Marsh Street and Eve Street wetlands. No access was granted to undertake any survey within the golf course and information on the presence of the Green and

Golden Bell Frog in the area was obtained from previous surveys and annual monitoring reports.

No survey effort was conducted to assess the potential for a resident Green and Golden Bell Frog population within the Marsh Street and Eve Street Wetlands, or at other locations within the project alignment. There are recent records of isolated breeding events within the golf course ponds and waterways but the importance of these aquatic environments was not assessed in the BAR. Rather, there was a reliance of the impacts of exotic fish species within the waterways to discredit potential breeding events.

4.3.4 Grey headed Flying Fox

Based on a preliminary review of the biodiversity assessment presented in the proposed New M5 EIS, the specialist technical report (Appendix S) acknowledges the presence of the Grey-headed flying-fox camp within 500 metres of the alignment at Turrella. This camp has contained between 10 and 15,000 Grey-headed Flying-fox in the past and is considered a significant breeding colony for southern Sydney and listed as a nationally-important camp under the EPBC Act that provides roosting habitat critical to the survival of the Grey-headed Flying-fox. The BAR indicated the importance of this colony but discounted any potential impacts on this species since direct clearing of any vegetation for the New M5 construction would be greater than 500 metres from the colony and hence a referral under the EPBC Act would not be required under the current Grey-headed Flying-fox Camp Management Guidelines (Commonwealth of Australia, 2015a).

No study was undertaken as part of the BAR for the EIS to indicate the current size of this colony; the present status of the resident population (number of bats, breeding or otherwise, etc.); or information on the direction that these bats leave the camp in the evening to forage.

The Grey-headed Flying-fox Management Plan prepared for Rockdale City Council indicates a changing pattern of outwards flight paths that reflects the seasonal availability of food resources in the local environment. Key canopy trees include *Angophora costata Melaleuca ericifolia and M. quinquenervia* and a range of winter-flowering *Eucalyptus sp.* that are common in the southern suburbs of Sydney. Many of the patches of native vegetation to be cleared as part of the project are in this general southerly direction from the Turrella Colony and include some of these key species. The importance of the potential foraging resources was discounted on the basis of the large range that the Grey-headed Flying-fox occupies with many trips exceeding 20 km from any camp site. Essentially the importance of local resources would be minor given the external availability of resources in the wider Sydney Basin. However, no survey of the flight paths was undertaken as part of the BAR to indicate:

- Whether the Grey-headed Flying-fox foraged in vegetation within the project alignment; or
- The extent of seasonally available food resources within the range of the Turrella Colony in order to assess the importance of small patches of vegetation that may provide scarce seasonal food resources.

Whilst the camp is located outside of the project alignment, there is a high potential for seasonal use of local food resources. In particular, the NSW Scientific Committee in its final determination for Swamp Sclerophyll Forest indicated that flowering *Melaleuca quinquenervia* is an important food resource for the Grey-headed Flying-fox (NSW Scientific Committee, 2004). This tree is a key species within the Swamp Sclerophyll Forest community and was recorded in the species list provided in the EIS for surveys conducted within the Kogarah Golf Course. However, no survey of any potential Swamp Sclerophyll Forest vegetation was conducted at an appropriate time to assess if this vegetation community provided a seasonal food resource for the Grey-headed Flying-fox.

4.3.5 Micro-bats

OEH provided a list of potential threatened species for further consideration as part of the EIS in addition to the SEARs. This list included

two micro-bats (Greater Broad-nosed Bat and Eastern Freetail Bat). No echolocation detecting surveys were conducted within any areas of potential habitat or foraging activity for these species. From a review of the aerial imagery supplied for the project alignment, there appear to be suitable patches of native vegetation to support these micro-bat species but no information was presented in the EIS to review any impacts. Key locations for future investigation of micro-bat activity should include Canterbury Golf Course, Beverley Park and Kogarah golf courses where the fairways provide ideal flyways. In addition existing waterways support a range of insects with seasonal foraging available where canopy trees are in flower. No information of the presence of tree hollows or other man-made structures that may provide roosting habitat within these golf courses was provided.

4.3.6 Avifauna

The timing and survey effort applied to assessing migratory birds was consistent with the EPBC Act guidelines (Commonwealth of Australia, 2015b), although was undertaken at the extreme limit of the optimal period. The migratory bird survey was conducted over one hour in the early morning of each of four days in April (optimal time being August to April). Climatic information supplied indicates two of these days were wet and windy (not ideal for bird surveys) but no information was provided of the tidal conditions or if the survey was targeting roosting shorebird species (surveys to be conducted at high tide) or foraging shorebird species (surveys conducted at low tide).

The migratory bird survey was limited to the Eve Street Wetlands next to Kogarah Golf Course as this was the only area deemed likely to support migratory birds within the project alignment. No surveys were conducted along Wolli Creek or Alexandra Canal or the larger dams within the Kogarah golf course. On the basis of the survey effort, no assessment was possible to consider if there was occasional use of potential habitat within the project alignment by migratory birds.

4.3.7 Hollow-bearing Tree survey

The hollow bearing tree survey was undertaken between 8am until 4pm over two days in late autumn. No spotlighting or observations of any identified tree hollows at sunset was undertaken to determine if the tree hollows provided habitat for any arboreal animals or were utilised as nesting sites for small birds.

The EIS acknowledges that access to private land upon which potential hollow-bearing trees were located was not available. Furthermore, the survey period was outside of the preferred timeframe for assessing most threatened species likely to be present along the project alignment. Despite these acknowledged limitations the survey effort allocated little resources to determining the value of any potentially hollow-bearing trees recorded within the project alignment. A survey that records presence of absence of tree hollows provides little information if no consideration of the likely species that may occupy these habitat features was provided. Whilst most of the smaller tree hollows may be utilised by small birds, without further survey and assessment, this would remain an assumption. As a result, the information obtained as part of this aspect of the BAR provides inadequate information from which any assessment of the importance of potential habitat to be removed for the New M5 project could be made.

4.4 VEGETATION COMMUNITIES ASSESSMENTS

Four plant communities were recorded within the project alignment based on database searches and literature reviews, verified through quadrat sampling and random walks through the existing vegetation. Some patches of vegetation were not able to be assessed due to restricted access to private lands.

Based on the NSW Scientific Committee criteria, three of these vegetation communities were considered in the BAR representative of the following endangered ecological communities (EECs):

- Cooks River/Castlereagh Ironbark Forest

- Swamp Sclerophyll Forest on Coastal Floodplains
- Sydney Turpentine Ironbark Forest

A consideration of these vegetation communities impacted by the project is included below.

Based on Molino's Stewart's assessment of the OEH vegetation mapping, a patch of vegetation within the Marsh Street / Eve Street wetlands includes Swamp Oak and could be representative of Swamp Oak Swamp Forest EEC. Similarly, the freshwater wetlands may also be consistent with the Sydney Freshwater Wetlands EEC (Figure 1). There is also vegetation communities located outside of the survey buffer for the project alignment that could be impacted by indirect effects of the construction works and should also be considered in the BAR.

4.4.1 Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion

A patch of 1.81 ha of vegetation consistent with CRCIF of the Sydney Basin Bioregion occurs within the project alignment at Beverley Grove. This vegetation community is listed as endangered under the TSC Act and critically endangered under the EPBC Act. The BAR assessed the vegetation to be removed for the construction footprint to be a maximum of 1.40Ha, equating to 78 percent of the existing patch of EEC. The BAR does not indicate the likely consequences to the residual patch of CRCIF. It is highly likely that the removal of 78 percent of the community will impact on the whole and hence the project will have a significant impact on CRCIF. The EIS acknowledges this impact will be substantial, but only accounts for the biodiversity offset for the amount of clearing rather than considering the likely loss of function and habitat value for the entire patch of CRCIF vegetation at Beverley Grove.

What is not clear from the BAR is the connectivity between nearby patches of both CRCIF and the floristically similar STIF EEC that occur throughout the Canterbury Golf Course and nearby Beverley Park along Tallawalla Road (Figure 2).

When considered in isolation, the small patch of identified CRCIF vegetation within the project alignment at Beverley Grove would not provide significant fauna habitat given the patch size, edge effects with the existing M5 Motorway and pedestrian activity along a pathway that bisects this patch of vegetation. Other more substantial patches of CRCIF EEC remain throughout the Sydney Basin bioregion. Therefore the EIS concludes that the loss is unlikely to have a significant impact on the long-term future of CRCIF EEC vegetation within the Sydney Basin, particularly where the loss of this patch of vegetation is fully offset according to the FBA credit calculator and the Biodiversity Offsets Policy for Major Projects.

There are a number of failings with the BAR in this regard.

Firstly, the patch of vegetation immediately to the north of the existing M5 Motorway was to be protected as a biodiversity offset and was included as a condition for the construction of the M5 Motorway. Removal of this vegetation raises a couple of questions:

- Should an area of vegetation set aside to be managed in perpetuity as a condition of approval for the prior infrastructure project now be assessed for clearing for construction of the New M5 footprint?
- How is this proposal then consistent with the principles of the FBA and NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014b)?

To illustrate, Principle 1 of the Biodiversity Offsets Policy states: *before offsets are considered, impacts must first be avoided and unavoidable impacts minimised through mitigation measures. Only then should offsets be considered for the remaining impacts*. Principle 5 indicates that offsets must be enduring, enforceable and auditable.

The EIS does not provide sufficient detail to demonstrate how the design of the proposal seeks to avoid or minimise the impact prior to following the biodiversity offset process. Secondly, any biodiversity offset must be enduring and not subject to future clearing as part of the construction for future infrastructure projects.

Secondly, the ecological significance of the 1.87Ha patch of CRCIF vegetation next to the

M5 Motorway does not fully consider the connections with surrounding patches of vegetation within the Canterbury Golf Course and in nearby public reserves along Tallawalla Road, some of which are also representative of CRCIF or STIF EEC. When considered as a whole, these patches of vegetation would act as a stepping stone habitat and are likely to supply temporary refuge for fauna species which may include threatened fauna. No information of the floristic composition or potential fauna habitat within the golf course was provided in the BAR to make any assessment of the importance of the larger patch of native vegetation.

4.4.2 Sydney Turpentine-Ironbark Forest

A small patch of STIF EEC vegetation was identified to the south of the project alignment in the survey for the BAR. The vegetation occurs within Beverley Park next to Tallawalla Road, Kingsgrove but is unlikely to occur within the area of impact of the surface construction works. As this vegetation was outside the immediate construction footprint, the BAR did not consider it further. However, as discussed above, this patch of native vegetation should be considered as part of a larger area of vegetation at Beverley Grove. This larger area of vegetation would include the STIF EEC a Beverley Park, the patch of CRCIF vegetation next to the M5 Motorway and that retained along the fairways of the golf course to the north of the M5. This larger patch of vegetation may provide refuge habitat for fauna species. No survey was undertaken to assess if any fauna, particularly avifauna or micro-bats move between the patch of STIF EEC and the patch of CRCIF EEC vegetation.

At present, there is a level of connectivity between the STIF EEC in Beverley Park and the CRCIF to the north of the M5 East Motorway. However, the proposed surface works for the New M5 project will have a significant impact on any fauna movement between these patches of native vegetation through the:

- Clearing of the CRCIF to the north of the M5 East Motorway and creating a significant break in connectivity; and
- Exclusion fencing and barriers during the surface construction works.

No survey was provided in the BAR to determine the current level of fauna activity within these connected patches of vegetation.

4.4.3 Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregion

Information was not presented within the EIS to assess whether Coastal Saltmarsh vegetation occurs within the Marsh Street / Eve Street wetlands. OEH vegetation mapping indicates that such vegetation is possible and verification should have been considered. Whilst the construction footprint will not clear vegetation within these wetlands, external factors such as changes in the groundwater levels associated with the tunnelling works may have both a short and long term effect on any coastal saltmarsh vegetation.

The wetlands communities were also likely to provide foraging areas for migratory shorebirds, hence this wetland vegetation should be assessed for potential habitat for these birds.

Figure 6 Vegetation mapping of Sydney showing communities within Eve Street wetlands that may include several endangered ecological communities

Figure 7 Vegetation mapping for western Sydney showing occurrence of CRCIF EEC and areas of STIF EEC within Canterbury Golf Course and Beverley Park

4.4.4 Sydney Freshwater Wetlands in the Sydney Basin Bioregion

No information was provided in the EIS regarding Freshwater Wetlands EEC vegetation within the project alignment. The Marsh Street / Eve Street wetlands are immediately next to the Kogarah Golf Course and do contain vegetation consistent with this EEC. The community is also connected by existing open stormwater channels to ponds within the golf course. The vegetation is likely to provide habitat for the Green and Golden Bell Frog within the Arncliffe area.

4.4.5 Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Swamp Oak (*Casuarina glauca*) dominated vegetation was indicated in OEH mapping for Sydney metropolitan area within the wetlands next to Kogarah Golf Course. Swamp Oak is a diagnostic species for the Swamp Oak Swamp Floodplain Forest EEC. This community is susceptible to changes in groundwater levels and would be impacted by any drawdown associated with the tunnelling activities. No assessment of the potential for this community to occur within the Marsh Street / Eve Street wetlands or the likely impact to this EEC from changing groundwater levels was provided in the EIS.

4.4.6 Bangalay Sand Forest, Sydney Basin and South East Corner bioregions

This vegetation community is present within the coastal sands surrounding Botany Bay. Whilst outside of the immediate project alignment, patches of this vegetation community may be impacted by localised changes in groundwater levels during construction operations and significant drawdown of the groundwater table during the operational phase of the project. The FBA does not require any consideration of the downstream impacts from hydrological changes or environmental flows on surface vegetation and groundwater dependent ecosystems and hence the extent of this impact in not quantified within the BAR

4.4.7 River Flat Eucalypt Forest

The project alignment does not intercept vegetation consistent with River Flat Eucalypt Forest EEC. However, this community may occur along the non-tidal reaches of Wolli Creek and other tributaries to the Cooks River. Any changes to the current groundwater levels may have an impact on these vegetation communities and should be considered in the EIS within this context.

4.4.8 Cooks River Clay Plain Scrub Forest (particularly at Beverly Grove)

This community was renamed as part of the CRCIF EEC under the TSC Act. The nomination for listing as a unique community under the EPBC Act was unsuccessful and should be considered as a sub-alliance and variant within the broader CRCIF due to the similarities in floristic composition, geographical location and environmental parameters.

Examples of vegetation consistent with the floristic description of Cooks River Clay Pan Scrub Forest are possible within the project alignment but detailed investigation was not conducted. Whilst the impact to the CRCIF is discussed above, no consideration of patches of vegetation that are consistent with the Cooks River Clay Pan Scrub community were provided in the EIS.

4.4.9 Littoral Rainforest/ Littoral Rainforest and Coastal Vine Thickets of Eastern Australia

This vegetation was not recorded within the flora survey for the EIS and, given the degraded environment surrounding Botany Bay, was also not considered likely within the project alignment or potential impact buffer surrounding the construction works. The flora list does not include key species likely within this vegetation community and hence its

absence from the study area is likely. The Wolli Creek Riparian Management Plan (Birtle et al., 2012) and Cooks River Estuarine Management Plan (Eco Logical Australia, 2010) do not indicate this community is present in the area likely to be affected by the drawdown of groundwater for the project.

4.4.10 Swamp Sclerophyll Forest on Coastal Floodplains

Vegetation consistent with the determination for Swamp Sclerophyll Forest on coastal Floodplains of the North Coast, Sydney Basin and South East Corner bioregions endangered ecological community (Swamp Sclerophyll Forest EEC) was recorded during the quadrat survey of vegetation on the Kogarah Golf Course that would be impacted by the Arncliffe surface works (referred to as Arncliffe Motorway Operations Complex, MOC 3) construction compound. The clearing of 1.82 ha of moderate to good quality vegetation will be required for the current arrangement for the MOC 3 compound. The impact of this clearing is to be compensated through the acquisition of biodiversity offsets determined in accordance with the FBA credit calculator.

The loss of the vegetation community from the golf course area may also remove potential foraging habitat for the Grey-headed Flying-fox. In particular, Broad-leaved Paperbark (*Melaleuca quniquenervia*) was recorded in the quadrat survey. This canopy tree is regarded as an important winter-flowering food resource for the Grey-headed Flying-fox and a key aspect of the EEC listing of the Swamp Sclerophyll Forest vegetation.

The BAR did not consider this vegetation in any detail. No information was presented to assess the importance of this vegetation community as a seasonal food resource for the Grey-headed Flying-fox. Information was also lacking on the condition and habitat potential for the Swamp Sclerophyll Forest vegetation on the golf course, the floristic composition or if natural regeneration is possible. The information provided in the BAR is inadequate to determine if the existing vegetation along the fairways of the golf course meets the criteria for listings as an EEC under the TSC Act. Furthermore, the importance of this vegetation as providing habitat for threatened fauna (Grey-headed Flying-fox, Green and Golden Bell Frog) cannot be assessed.

There are inconsistencies in the biodiversity assessment for this community. If the vegetation community to be removed for the MOC 3 compound does not meet the criteria for listing as Swamp Sclerophyll Forest EEC, then why does the FBA credit calculator assign biodiversity offset credits in compensation for the habitat loss? Furthermore, if the vegetation community is Swamp Sclerophyll Forest, then why are the potential impacts to threatened fauna that utilise this vegetation for seasonally food resources also not considered in the calculation of the biodiversity offset credits? In addition, if this community does meet the requirements for consideration as an EEC under the TSC Act, then a 7 part test for the assessment of significance for the removal of this vegetation loss should have been provided in the BAR.

The EIS does not clarify the importance of this vegetation community as an EEC, or how the clearing will impact other threatened species.

4.5 GROUNDWATER DEPENDENT ECOSYSTEMS

The proposed New M5 project footprint lies within the Cook River catchment. The Technical Working Paper for Groundwater – Appendix Q of the EIS indicates that modern alluvium underlies and flanks the Cooks River and its tributaries forming an unconfined aquifer. Groundwater quality within the alluvium is variable but typically of low salinity in the upper reaches and becoming brackish in the lower reaches due to tidal influences and mixing. The river alluvium is generally of high permeability and the groundwater within the alluvium can be a source of either recharge or discharge depending on whether upward or downward hydraulic gradients are present.

The lower topographic areas of the Cooks River and its tributaries are generally gaining streams; that is groundwater discharges from the aquifer into the stream or creek. In the upper reaches of the catchment such as

Bardwell Park and along the Bardwell Valley the creeks are likely to be losing streams; that is water from the creeks discharges to the underlying aquifer via primary and secondary porosity features.

4.5.1 Vegetation communities likely to be affected

The BAR lists a number of vegetation communities identified within the project alignment that have the potential to be directly affected by any changes to groundwater associated with the New M5 proposal. These include:

- CRCIF within Beverly Grove Park is about 1.8 hectares in area and contains several native vegetation communities which are indicative of shallow groundwater tables and waterlogged soils;
- Seventeen hectares of Hinterland Sandstone Gully Forest with a moderate to high potential to be dependent on groundwater within Bardwell Valley Parkland and Broadford Street Reserve;
- About 3.5 hectares of Coastal Sandstone Ridgetop Woodland within Stotts Reserve, Bexley North. This vegetation has a moderate to high potential to be dependent on groundwater;
- About 3.4 hectares of Estuarine Fringe Forest between the southern bank of Wolli Creek and the rail line behind Wolli Creek Station, with a low to moderate potential to be dependent on groundwater.

However, in assessing the impacts of groundwater dependent ecosystems (GDE), the FBA only requires an assessment where direct impact associated with vegetation clearing may occur. There are no provisions for indirect impacts to be quantified.

4.5.2 Indirect impacts

The dewatering of the tunnelling works during the construction phase will continue throughout the life of the project. For the lower topographic areas, the drawdown of the water table is predicted to be balanced by tidal flushing. This will progressively increase the salinity of groundwater within the deepest root zone for canopy species and may lead to floristic changes in the vegetation communities. For instance, there would be a likely replacement of *Melaleuca* species by *Casuarina* species lining the waterways (Cooks River, palaeochannels, back swamps and depressions) resulting in potential reduction on foraging habitat for the Grey–headed flying-fox. This may also alter the assemblage of communities that occur on top of the Botany Sands sand sheet.

The draw down and groundwater salinity changes will also have the potential to impact the Marsh Street / Eve Street wetlands next to Kogarah Golf Course. This area overlies the Botany Sands and would be subjected to an inflow of saline water to replace the ongoing drawdown of the groundwater table for the project. The extent of this drawdown in relation to natural recharge and tidal flushing is not quantified in the BAR, hence impacts can only be inferred. There is the probability that this may be a significant impact to these wetlands, resulting in a shift in floristic composition from permanently inundated aquatic species to ephemeral, more salt-tolerant species. A flow on effect of altering the groundwater conditions and floristic diversity on the Green and Golden Bell Frog is not known or considered in the BAR.

For the upper reaches of the Cooks River and tributaries, including Bardwell Creek and Wolli Creek, there is the potential for changes in groundwater to affect existing vegetation. The Wolli Creek Riparian Corridor Management Plan lists five EEC along the section from Kingsgrove to the confluence with Cooks River including Freshwater Wetlands and Swamp Sclerophyll Forest on Coastal Floodplains. These two EEC are susceptible to any adjustment to the groundwater levels due to the extent of the drawdown of the groundwater table or salinity changes from seawater recharge.

Council biodiversity staff have expressed concern that the patch of STIF EEC vegetation at Beverley Park (Tallawalla Road), in close proximity to the project alignment, may be affected by drawdown of groundwater and that this impact has not been fully quantified in the BAR. This patch of vegetation was included in

the list of GDE likely to be affected by indirect impacts. The extent of the drawdown is significant and long-term and is likely to have a significant impact that should be considered in the biodiversity assessment.

The Bardwell Valley biodiversity corridor is locally significant, linking vegetated areas from Bardwell Park to Stotts Reserve and Wolli Regional Park; and towards Coolibah Reserve and Wolli Regional Park. This native vegetation occurs along drainage lines. Any disruptions to the groundwater levels, discharge zones or subsurface flows due to the New M5 proposal will have an impact on this biodiversity corridor. The extent of this impact is unable to be assessed based on the available information provided in the BAR, but will potentially affect natural regeneration of existing vegetation communities, placing mature vegetation under water stress. It will also provide opportunities for colonisation of the area by extra-local or exotic species more suited to a changed groundwater regime.

4.6 FBA SPECIES CREDITS

The SEARs for the New M5 direct the assessment of impacts on the biodiversity through the defined assessment methodology under the FBA framework. This will quantify and describe the biodiversity values on the development site. As part of this process, the NSW Biodiversity Offsets Policy for Major Projects applies and biodiversity offsets are required to mitigate any unavoidable impacts.

The FBA requires proponents to provide offsets on a like for like basis. This means that the biodiversity present at the development site should be the same type of ecological community or have the same habitat values as the biodiversity present at the offset site. Where these like for like offsets cannot be obtained, there are supplementary measures that, when undertaken as part of the Biodiversity Offset Strategy (BOS), are likely to lead to improvements in biodiversity or other environmental values. The Biodiversity Offsets Policy for Major Projects requires that supplementary measures be of an equivalent monetary cost to the provision of offsets.

Underpinning this entire scheme is the adequacy of the FBA in assessing the existing biodiversity on the site. From discussions above, it is our view that the BAR provided as part of the EIS has not fully considered a range of species and communities that may potentially be affected directly or indirectly by the New M5 project. Therefore the BOS is potentially not considering all relevant impacts and as such, the BOS may not adequately mitigate all project impacts

4.6.1 Cooks River Castlereagh Ironbark Forest EEC

The removal of 1.40 ha of a patch of 1.81 ha of CRCIF between the existing M5 and Canterbury Park Golf Course requires the acquisition of 31 ecosystem credits as determined by the FBA credit calculator. However, the loss of 78 percent of the patch of existing native vegetation is significant and likely to place the residual 0.42 ha at risk of long-term extinction. In determining the appropriate species credits to mitigate this loss, the calculation should consider:

- Firstly, the entire patch size as being removed, i.e. using the full 1.82 Ha rather than the minimum necessary for the construction footprint; and
- Secondly, the loss of this patch of vegetation, when considered as part of the wider CRCIF EEC / STIF EEC community surrounding the golf course, will impact on a range of threatened fauna that also need to be considered in the credit calculation.

4.6.2 Swamp Sclerophyll Forest EEC

Part of the Swamp Sclerophyll Forest EEC occurring on Kogarah golf course will be removed for the MOC 3 compound. This shall be mitigated by the acquisition of 27 ecosystem credits. No consideration was made on the potential loss of winter foraging resources for the Grey-headed Flying-fox in this calculation. The biodiversity offset requirements are therefore unlikely to fully mitigate the loss of habitat due to the project and therefore should be reviewed in light of potential impacts to a range of other fauna

species dependent upon the Swamp Sclerophyll Forest EEC.

4.6.3 Green and Golden Bell Frog

The clearing of vegetation for the MOC 3 compound on Kogarah Golf Course will impact on 7.82 ha (20 percent) of known habitat for the Green and Golden Bell Frog in the Arncliffe area. It is calculated that 203 species credits will be the required offset for this impact. In addition, land shall be acquired near the existing Marsh Street / Eve Street wetlands for construction of artificial habitat, similar to the RTA ponds constructed adjacent to the Kogarah Golf Course in compensation for impacts from the M5 Motorway construction works.

This offset is inadequate to fully mitigate the habitat loss and potential for the nationally-significant Arncliffe population of Green and Golden Bell Frog to be placed at risk of extinction. The extent to which this offset is inadequate is demonstrated in the following points:

- The calculation of the species credits only considers the amount of clearing for the construction footprint of the MOC 3 compound and does not consider adjoining areas of potential habitat.
- The review of the Green and Golden Bell Frog in the BAR outlines that key breeding was occurring within the RTA ponds with limited episodic breeding within some of the ponds on the golf course. No recent breeding was observed within the Marsh Street / Eve Street wetlands.
- Furthermore, the BAR also indicates the edges of a couple of the golf course fairways provide sheltering habitat with movement observed between a number of the ponds towards the RTA wetlands, but also via a cycle underpass towards the Marsh Street / Eve Street wetlands. The arrangement of the MOC 3 compound will place a barrier to these movement patterns and therefore will have an area of impact greater that the construction footprint of the MOC 3 compound.

The assessment of the RTA ponds as key breeding habitat does not consider the importance of the Marsh Street / Eve Street wetlands as potential habitat for this species. This is despite evidence that movement of these frogs did occur via the bicycle underpass between the golf course and the wetlands, and presumably between the RTA ponds and the Marsh Street / Eve Street wetlands. At the very least these wetlands provide sheltering habitat and hence any impacts through changes in groundwater associated with the construction of the New M5 will affect this area. The extent of this potential impact was not quantified in the BAR and also not included in the species credit calculation for the Green and Golden Bell Frog.

4.6.4 Grey headed Flying Fox

No species offset credits are proposed for the potential impact on the Grey-headed Flying-fox. The Grey-headed Flying-fox was not listed within those species potentially impacted by the project using the FBA credit calculator. Additionally, the BAR concludes that due to the large range of foraging for this species, patches of vegetation to be removed within the project alignment would not result in a significant loss of resources and hence would not significantly impact the bats residing within the Turrella colony. However, it is not clear from the BAR what is the extent of winter flowering trees within the potential foraging range of this species, or whether the patch of Swamp Sclerophyll Forest EEC to be removed from Kogarah Golf Course for the MOC 3 compound is significant in providing a seasonal resource for this species.

There is also the potential for other patches of vegetation within the Marsh Street / Eve Street wetlands to be affected by changes in the groundwater due to the construction works and may result in a loss of foraging habitat.

The loss of foraging sites, particularly seasonally-available resources should be reassessed to consider the impact on the Grey-headed Flying-fox colony at Turrella and biodiversity offsets considered to mitigate these impacts.

4.7 FLORA AND FAUNA IMPACTS

The New M5 will have short and long-term impacts for a range of threatened fauna and EECs. The following section outlined these impacts and the inadequacies of the mitigation measures proposed in the EIS.

a) Green and Golden Bell Frog population of the Cooks River

The clearing of known habitat for the Green and Golden Bell Frog for the MOC 3 compound will interrupt known movement patterns between waterways on golf course and construction RTA ponds and between the waterways and fairways on the golf course at the Marsh Street / Eve Street Wetlands. This impact is significant and will have long term consequences including placing the nationally-significant Arncliffe population at risk of extinction. The proposed biodiversity offsets do not fully consider the impacts to this species through loss of breeding habitat, removal of potential sheltering sites and disruptions to movement patterns between areas of known occupation surrounding the Kogarah Golf Course.

If the required Biodiversity Offset credits are obtained for habitat outside of the Arncliffe Green and Golden Bell Frog population, then there is a significant risk of extinction to this local population through the removal of 20 percent of the known habitat. Moreover, there are inherent difficulties in creating artificial wetlands to supplement the existing RTA ponds. Any such wetlands will require ongoing monitoring and management for extended timeframe before a stable breeding population would be achieved. Therefore they are not an immediate solution to the loss of habitat for the construction works.

In addition to the required biodiversity offset, additional mitigation measures proposed for this population include the preparation of a Green and Golden Bell Frog Management Plan as part of the Flora and Fauna Management Plan for the New M5. This document shall only be prepared after the close of public comments for the New M5 EIS and therefore is not available for public scrutiny. Any management plans must:

- Adopt lessons learned from other infrastructure projects; and
- Be available to local government for comment and input during the process of developing these management plans.

b) Cooks River/Castlereagh Ironbark Forest

The removal of 1.40 Ha of a total patch size of 1.82 Ha at Beverley Grove will have a significant and long-term impact on this vegetation. It is unlikely that the residual vegetation will continue as a patch of native vegetation without future vegetation management. This patch of vegetation was previously identified during the assessment for the M5 East realignment works as being at the easternmost extent of the distribution range, of high conservation significance and should be rehabilitated. There are no similar patches in the area for which to obtain an appropriate biodiversity offset.

The habitat value of the existing CRCIF will be degraded due to this loss of canopy vegetation. Moreover, when considered in association with other patches of STIF EEC occurring within the golf course, the loss of such vegetation will disrupt the connectivity and impact on a range of species not considered in the BAR.

c) Sydney Turpentine-Ironbark Forest

This vegetation community occurs adjacent to CRCIF in retained vegetation along the fairways of Canterbury Golf Course and in a public reserve to the south of the existing M5 Motorway. Whilst outside of the project alignment there is the potential that groundwater changes due to construction may affect natural regeneration of this community.

Fauna surveys were not undertaken within patches of STIF EEC and hence no assessment of the potential for these patches of vegetation when considered as a whole to provide temporary habitat for a range of species. In particular these areas are within a regionally important biodiversity corridor along Wolli Creek that is known to include habitat for the Powerful Owl.

d) Coastal Saltmarsh

The groundwater changes during construction are likely to affect Coastal Saltmarsh vegetation within the drawdown area. The extent of this impact was not quantified in the BAR and further information should be provided to assess the long-term implications to this EEC

e) Sydney Freshwater Wetlands

This vegetation is likely to exist in a degraded condition within the Marsh Street / Eve Street wetlands adjacent to the MOC 3 compound. Any groundwater changes due to construction works will affect these wetlands. The extent of this impact was not quantified in the BAR and further information should be provided to assess the long-term implications to this EEC. A vegetation management plan should be developed as part of the mitigation measures for this wetland to enhance the available habitat for a range of migratory birds and frog species.

f) Swamp Oak Floodplain Forest

This vegetation was recorded within the Marsh Street / Eve Street wetlands but outside of the project alignment. Interruptions to groundwater levels due to the project may impact on this community although details of potential impacts were not quantified in the BAR. A vegetation management plan for the Marsh Street / Eve Street wetlands should be developed to enhance the habitat value of the communities in this area to support migratory birds and frog species

g) Bangalay Sand Forest

This community was not recorded within the project alignment but may occur on the sand sheets surrounding Botany Bay. The potential for groundwater changes due to the project to affect this community was not quantified in the BAR. In the absence of available information, a precautionary principle should be adopted and measures developed to mitigate any potential adverse affects from the New M5 proposal.

h) River Flat Eucalypt Forest

This community was not recorded within the project alignment but may possibly be extant along the non-tidal sections of Wolli Creek. Changes to the hydrological regime, groundwater discharge areas and subsurface flows may affect any River Flat Eucalypt Forest EEC. Further investigation of the degree of hydrological changes along this waterway should be prepared before any assessment of the long-term affects to this EEC can be determined.

i) Cooks River Clay Plain Scrub Forest

This community is included as part of the CRCIF and is likely to occur in the vicinity of Canterbury Golf Course. Changes in groundwater levels due to the construction works , or due to clearing of existing vegetation, may affect this community and should be considered in any biodiversity offsets for the Cooks River EEC.

j) Swamp Sclerophyll Forest on Coastal Floodplains

The clearing of 1.82 ha of moderate to good quality Swamp Sclerophyll Forest EEC will be required for the current arrangement for the MOC 3 compound. The impact of this clearing will be compensated through the acquisition of biodiversity offsets determined in accordance with the FBA credit calculator. This vegetation community is not listed as a threatened ecological community under the EPBC Act and hence no assessment of the significance of the clearing of this vegetation was provided in the BAR. Without this information, it is difficult to know the extent of the Swamp Sclerophyll Forest retained on the Kogarah Golf Course and whether the removal of the 1.82 Ha for the MOC 3 compound will affect the long-term survival of the residua vegetation.

The habitat value of this patch of vegetation was also not fully considered within the BAR. In particular, winter flowering *Melaleuca quinquenervia* is an important food resource for the Grey-headed Flying-fox. Given the proximity of the Turrella colony, the removal of the Swamp Sclerophyll Forest may have a significant impact on the availability of

seasonal foraging resources within the local area.

The fairways near the RTA ponds were also identified as habitat for the Green and Golden Bell Frog, either for sheltering, occasional breeding; or a corridors for movement between the waterways on the golf course and either the RTA ponds or the Marsh Street / Eve Street Wetlands.

There has been no consideration of the potential impacts the removal of the Swamp Sclerophyll Forest EEC vegetation may have on these threatened species.

k) Avifauna

The migratory bird survey was limited to the immediate impact area of the project alignment and focused on the Eve Street wetlands. No consideration was presented for the potential for occasional use of the waterways within the Kogarah Golf Course or the Wolli Creek / Alexandra Canal. These areas are likely to provide occasional habitat although further surveys are required.

l) Grey-headed Flying-Fox

The proximity of the Turrella colony to the project alignment should indicate that the New M5 proposal may impact on the Grey-headed Flying-fox. The initial species lists for further consideration under the bilateral agreement as determined using the FBA credit calculator did not include the Grey-headed Flying-fox. OEH recommended additional investigation of this species.

Rockdale City Council has commissioned a Management Plan for the Grey-headed Flying-fox camp as Turrella. This plan indicates that this camp was a significant permanent colony in southern Sydney. Winter food resources include Sydney Red Gum (*Angophora costata*) and other flowering Eucalypts common in southern Sydney. However it is unclear to what extent, if any, the Grey-headed Flying-fox colony management plan was considered in the BAR. There was no detailed investigation into the importance of *Melaleuca quinquenervia* and *M. ericifolia* vegetation in providing winter food resources for this species. Without this information, an assessment of the potential impact to this species cannot be established. The reliance on a large foraging range of up to 20 km from any colony should not be justification for excluding local food resources where these may provide a scare seasonal supply.

m) Groundwater dependent ecosystems

The New M5 proposal will have lasting impacts on the hydrology due to dewatering and discharge of groundwater during construction and operation of the New M5. These changes will have a significant impact on existing vegetation communities within the potential groundwater drawdown area. In addition, changes to surface runoff from impervious surfaces and flow regimes through installation of detention basins and stormwater management systems will have localised impacts.

The FBA does not address the direct impacts that are not associated with vegetation clearing and hence does not quantify those indirect impacts from changes to groundwater changes.

It is likely that the proposal will affect existing natural environments such as the Marsh Street / Eve Street wetlands, Stotts Reserve and Coolibah Reserve as well as local open spaces within the local government area. The impact of existing vegetation communities in these areas was not quantified.

n) Species not considered in the BAR

The reliance on the FBA credit calculator, SEARs and OEH guidance to derive a species list for further investigation of potential impact from the New M5 disregarded local knowledge of the biodiversity within the project area. A number of species that are likely to be impacted by the proposal that have not been considered in the BAR are included below.

The Powerful Owl is known to occur within the regionally-significant biodiversity corridor along Bardwell Valley towards Wolli Creek. The removal of native vegetation for the construction footprint has the potential to affect the foraging resources within the home range for this species.

A number of micro-bats were identified by OEH in its advice to the proponents as being

worthy of further investigation, including the Eastern Freetail Bat and the Greater Broad-nosed Bat. In addition, a large number of recorded sightings of the Eastern Bentwing Bat have also been documented for the area. No echolocation detecting surveys were conducted in the BAR to provide information regarding the potential for these micro-bat species to occur within the project alignment.

The BAR identified areas of Swamp Sclerophyll Forest (Kogarah Golf Course) and Swamp Oak (Eve Street wetlands) including *Allocasuarina* and *Casuarina* species. These trees provide potential foraging resources for the Glossy Black Cockatoo but no assessment for the impact to this species was considered.

4.8 CUMULATIVE IMPACTS

CRCIF near Canterbury Golf Course is managed for conservation by the Roads and Maritime Services (RMS) as a condition of approval for the construction of the M5 East Motorway in 1998. Any impact to this vegetation for the New M5 proposal is not consistent with the objectives stated in SEPP Infrastructure or the Biodiversity Offsets Policy for Major Projects. Removal of this vegetation will place the residual patch at risk of local extinction and may also affect nearby STIF EEC vegetation.

The RTA ponds next to Kogarah Golf Course were also constructed as a condition for approval of M5 Motorway to provide breeding habitat for the Arncliffe population of Green and Golden Bell Frog. The clearing of 20 percent of potential habitat for this species from the Kogarah Golf Course is required for the New M5. Regular monitoring of the RTA ponds and adjoining areas indicates that the Green and Golden Bell Frog in the Arncliffe locality is stable but is not expanding. Any subsequent impacts will have a significant effect on this species.

The BAR is inconclusive in demonstrating that the proposed mitigation measures for the Green and Golden Bell Frog are adequate to ensure that the long-term survival of this nationally-significant population is not placed at risk of extinction due to the New M5 proposal. The clearing of potential habitat from the golf course and installation of barrier fencing surrounding the MOC 3 compound will have an immediate impact. The effectiveness of any proposed artificial wetlands to supplement existing habitat may not be achieved in the immediate timeframe. Mitigating these impacts through the BOS can only support the Arncliffe population if the biodiversity offset credits are obtained within the local context.

4.9 SPECIES IMPACT STATEMENTS

The project was referred to the Commonwealth Minister for the Environment on 17 July 2015. The referral suggested that on the basis of the potential adverse impacts to the Cooks River / Castlereagh Ironbark Forest and Green and Golden Bell Frog, the project should be considered a controlled action.

The Minister for the Environment's delegate declared the project a controlled action on 13 August 2015. The project was determined to be likely to have a significant impact on two MNES, CRCIF and the Green and Golden Bell Frog.

a) Green and Golden Bell Frog

Without adequate population surveys, movement patterns and any assessment of the importance of the surrounding areas that are outside of the project alignment but provide habitat for this species; a species impact statement should be prepared as Stage 2 of the EIS process. It is unlikely that the biodiversity offset required for impact to this species in accordance with the FBA credit calculator will be obtained within the Arncliffe area and that the local population may be placed at risk of extinction. There is also no certainty that the proposed mitigation measures in addition to the biodiversity offset, including the creation of additional breeding habitat, will be successful or provide immediately viable habitat alternatives to clearing of a known habitat.

b) CRCIF

The impact to the patch of CRCIF vegetation at Beverley Grove will be significant and long term and may result in the loss of the entire patch of vegetation at this location. This is the most easterly extent of the known distribution of this community and the implications for this loss are not clearly outlined in the BAR. Further investigation of the importance of this vegetation should be considered.

4.10 BIODIVERSITY OFFSET STRATEGY

The biodiversity offset credits determined in accordance with the FBA credit calculator only consider the direct impacts to threatened species and ecological communities within the project alignment. There has been no consideration of the indirect impacts of the proposal on a number of species or communities that occur outside of the alignment. Indirect effects not associated with vegetation clearing, such as the changes to the groundwater table during construction and operation of the New M5 are not assessed in the BAR.

The following table lists some of the limitations in the biodiversity offset strategy.

Table 4 Limitations with the required biodiversity offsets

Species / Community	Limitations
CRCIF	Only considers clearing of 1.40 ha (78 percent). Will make residual unviable so offsets should account for the total patch size (1.87 ha). Does not consider the connectivity with STIF EEC vegetation (Tallawalla Rd, Kingsgrove). Does not consider habitat value of connectivity with nearby patches of STIF and CRCIF vegetation from Beverley Park to Canterbury Golf Course.
Swamp Sclerophyll Forest EEC	Accounts for clearing of 1.82 ha from Kogarah golf course; no information is provided on viability of residual Swamp Sclerophyll Forest EEC vegetation. Does not consider importance of this vegetation in providing winter food resources for Grey-headed Flying-fox. Does not account for potential for other threatened species to use this EEC including micro-bats and Glossy Black Cockatoo.
Green and Golden Bell Frog	Accounts for loss of 7.82 Ha of habitat from Kogarah golf course (20 percent of available habitat). No restriction that biodiversity offset must be acquired within Arncliffe area so potential for local population to be a risk of extinction. Details of Green and Golden Bell Frog Management Plan as part of the Flora and Fauna Management Plan for the New M5 is not available until after public comments on the EIS close. Local Councils should be involved in the development of these plans and provide review comments.
Grey-headed Flying-fox	No species credits are required. Loss of Swamp Sclerophyll Forest from Kogarah Golf Course may remove important winter food resources but no assessment was considered.
Micro-bats	Not specifically targeted in BAR. Included in SEARs and OEH correspondence but dismissed from further investigation in likelihood of occurrence assessment. Potential habitat is available for some species within patches of existing vegetation along project alignment.
Sydney Turpentine Ironbark Forest EEC	Not considered in BAR. Good connectivity exists between CRCIF near golf course to north of M5 and STIF EEC at Beverley Park to south of M5 creating a local biodiversity corridor along Tallawalla Road. No consideration of the value of this patch of vegetation to fauna when considered as part of the larger patch that includes the STIF EEC and CRCIF. No consideration of the indirect impacts of groundwater changes due to the construction works of natural regeneration of the STIF EEC.

5 CONCLUSIONS

This report presents the findings of a general review of the:

- Air quality issues associated with the New M5 Project Environmental Impact Statement, and the accompanying Working Paper (Appendix H, Technical Working Paper – Air Quality).
- The water quality and hydrology issues and the New M5 Technical Working Paper: Surface water (Appendix N), Technical Working Paper: Groundwater (Appendix Q), supplemented by a review of other relevant sections of the EIS, namely the introductory and summary information relating to the project, chapters 16, 18 and 19 and Appendix P.
- The biodiversity review has considered the relevant sections of the WestConnex New M5 EIS, in particular chapter 21 in the main report and the specialist biodiversity assessment report included as Appendices S and T

All documents are substantial in scope and size. The working paper extends to some 700 pages, while the Air Quality component of the EIS (Chapter 10), which is derived largely from the working paper, comprises some 120 pages. The other chapters and working papers are of similar scale.

In addition, other relevant information provided by the three Councils commissioning this review and available through public searches has informed this review.

This review does not attempt to provide a line by line or page by page analysis of the EIS or the working papers, but rather to address the key air quality, surface water quality, hydrology and biodiversity issues involved.

Key findings and recommendations, as presented in the text of this review, are summarised below.

It is recommended that additional and more specific advice is sought as required on any issues of detail, that is outside the scope and content of this general review.

5.1 AIR QUALITY

5.1.1 KEY FINDINGS

The key findings of this review are:

- General Issues & Approach: The general approach to the EIS, including the description of the project; the identification of relevant air quality issues; the identification of regulatory requirements; the definition of the existing environment, and the outline of methodology used in the working paper and the EIS are considered to be generally adequate and appropriate.
- Construction Impacts: The approach adopted to the assessment of the impacts of construction activities associated with the New M5 Project on local air quality appears to have been reasonable and appropriate, and the conclusion reached in both the working paper and the EIS that “standard management measures would be sufficient to mitigate the effects of construction works on local air quality at the nearest receptors” also appears to be reasonably based.
- Alexandria Landfill Closure and Remediation: The assessment and proposed management of odour and particulates associated with the closure, remediation and redevelopment of the Alexandria Landfill appear to have been appropriately and thoroughly carried out. Subject to the application of the proposed Landfill Closure Management Plan, impacts can be expected to be acceptable, and within relevant guideline levels.
- Assessment of Operational Impacts (Surface Air Quality): The findings of both the working paper and the EIS in terms of general surface air quality impacts appear to be reasonable.
- Assessment of Operational Impacts (In-Tunnel Air Quality): For reasons fully detailed in this review, it is considered that the longitudinal ventilation system currently proposed for the two New M5 tunnels may not be adequate or appropriate to ensure safe and compliant air quality within the tunnels at all times.
- Assessment of Operational Impacts (Emission Stacks): Any inadequacy in the control of air pollutant levels within the

tunnels will have an impact on the quality of discharges from the associated exhaust stacks, and any assumptions made regarding surface air quality near those stacks.

- Cumulative Impacts: The methodology and approach adopted in relation to the assessment of cumulative air quality impacts is adequate and appropriate in relation to current project assumptions. It is also considered to be adequate and appropriate to model and assess any revised cumulative impact that might apply as a consequence of any increase in in-tunnel pollutant loads that might be considered, and any associated changes to air quality impacts near exhaust emission stacks that might follow as a consequence.
- Management of Construction Impacts: The management of construction impacts on air quality as presented and proposed in both the working paper and the EIS is considered to be generally sound. Subject to the development and application of the management procedures and protocols proposed, it is considered that construction activities associated with the New M5 Project will have minimal and acceptable impacts on surrounding individuals, operations and activities.
- Management of Operational Impacts (In-Tunnel & Emission Stacks): In general terms, the proposed management of operational air quality impacts presented in the working paper and the EIS is considered to be reasonable and adequate. However, in relation to the management of in-tunnel air quality, and as a consequence air quality in the immediate vicinity of the proposed tunnel emission stacks, it is considered that the proposed tunnel ventilation system may be neither adequate nor appropriate to ensure safe and compliant air quality at all times.

5.1.2 RECOMMENDATIONS

The recommendations of this review are:

- Construction Impacts: It is recommended (as is no doubt intended) that appropriate and specific Construction Phase Air Quality Management Plans (or sub-plans) are developed and implemented for individual components of the overall construction task. It is also recommended that local government bodies at immediate interest arrange for and apply an appropriate watching brief to the Construction Management Plan process, to ensure that the various plans (or sub-plans) are applied and work effectively, and that air quality outcomes are consistent with relevant guidelines levels adopted in the plans (or sub-plans).
- Alexandria Landfill Closure & Remediation: It is recommended that local government bodies at immediate interest arrange for and apply an appropriate watching brief to the process, to ensure that the Landfill Closure Management Plan is applied and works effectively, and that odour and dust outcomes are indeed within relevant guideline levels, as predicted.
- Assessment of Operational Impacts (In-Tunnel Air Quality): In relation to in-tunnel air quality it is recommended that alternative approaches to the ventilation and management of in-tunnel air, as proposed in this report, are included in the project proposal, and modelled and assessed in the working paper and EIS
- Assessment of Operational Impacts (Emission Stacks): In relation to surface air quality near emission stacks, it is recommended that alternative approaches to the management of emission stack discharges, as proposed in this report, are included in the project proposal, and modelled and assessed in the working paper and EIS
- Cumulative Impacts: It is recommended that the cumulative impacts applicable as a consequence of any increase in in-tunnel pollutant loads that might be considered, and any associated changes to air quality impacts near exhaust emission stacks that might follow as a consequence, are assessed and presented in both the working paper and the EIS.
- Management of Construction Impacts: It is recommended that local government bodies at immediate interest arrange for and apply an appropriate watching brief to the Construction Management Plan process, to ensure that the various plans (or sub-plans) are applied and work effectively, and that air quality outcomes are consistent with relevant guidelines levels adopted in the plans (or sub-plans).

- Management of Operational Impacts (In-Tunnel): It is recommended that an alternative tunnel ventilation approach (or approaches) is (are) included in the project proposal, and modelled in the working paper and EIS, to provide a basis for any necessary improvement in operational in-tunnel air quality that may be required.
- Management of Operational Impacts (Emission Stacks): It is recommended that an alternative approach (or approaches) to the management of air quality in the immediate vicinity of the proposed tunnel emission stacks is included in the project proposal, and modelled in the working paper and EIS, to complement the need for and recommended inclusion of an alternative tunnel ventilation strategy.

This document presents the findings and recommendations of a general review of the New M5 Project EIS, and the associated Air Quality Working Paper.

These findings and recommendations are to some extent general in nature, and are not intended to, nor can they in the circumstances, provide a fully detailed, line by line, page by page analysis of the either the EIS, or the associated working paper.

5.2 WATER AND HYDROLOGY

5.2.1 Surface water

There is little detail around how surface water will be managed and therefore only high level consideration of impacts. The discharges that have been calculated for the surface water discharges during construction do not provide the detail for what the contributions are from the surface water and what contributions will be derived from groundwater. The groundwater model only assesses a steady state condition, and as such, there is no assessment of what will happen during construction period and the model can provide no input for the calculations. The values that are provided for the surface water discharges appear to underestimate the likely flows during this period.

There is a lack of proper assessment for what the geomorphological impact will be on sensitive receiving environments that water is proposed to be discharged to and not all sensitive receiving environments were considered by the EIS.

The EIS has assumed non-contaminated groundwater will be arriving from the western section of the project. There has not been sufficient investigation or monitoring to conclude this.

The mitigation measures do not require spill containment for spills on the Motorway as a matter of course. Rather, it is to be provided only ‘if warranted’. This would not seem an appropriate mitigation of environmental risk.

The EIS seeks to paint a picture of poor water quality within highly disturbed ecosystems. This is not the case across all catchments within the project area nor does this recognised there have been significant efforts made to improve the water quality within some of the catchments. The data used to set the targets is in some cases old and there is no discussion of trends.

There is little detail of what the levels of water contaminants will be during construction and how the no clear criteria for the treatment of the groundwater during construction. The criteria set for water quality treatment should be cognisant of where in the catchment water is being released from and where it is being discharged to.

There is little discussion of the impacts on the Wolli Creek riparian corridor, no consideration of the Wolli Creek Riparian Corridor Management Plan, no detail provided on what rehabilitation there will be subsequent to works being undertaken.

The operational water quality reduction targets have not been met on the western side for the TSS. This means that 36 percent or approximately 10 tonnes/year of the TSS generated by the additional impervious areas will be discharged into the Wolli Creek catchment. There is no mitigation measure compensating this.

The cumulative impacts of clearing of riparian vegetation, and increase in discharges to waterways have not been considered.

5.2.2 Groundwater

CDM Smith (2015) used water table measurements from the existing M5 East Motorway project to calibrate the groundwater model developed for this project. However, it was noted there was a paucity of the water table data, and that it was not measured over either of the tunnels. As such, the calibration was problematic and it is unlikely the model has been properly calibrated. CDM Smith reported that the model predicted water table elevations that were higher than those observed. This would indicate the model is not fully assessing the impacts of the groundwater drawdown. Some of the assumptions made within the modelling and subsequent analysis could further underestimate impacts.

The model does not model or predict what will happen to the connected surface water systems. As such, the impact has not been able to be considered or quantified and therefore has not been assessed as part of this EIS. This is a deficiency in the assessment, as, at present the Cooks River tributaries are gaining systems. With the predicted drawdowns in the water table, this will reverse and surface water from these tributaries will be lost. This impact will be greatest during periods of low flow, which is when it is most critical for the riparian corridors and surrounding vegetation to have the groundwater supply available.

Groundwater quality has not been modelled nor have any predictions been made. However, it is stated that since the M5 East Motorway and the main alignment tunnels of the project are mostly below sea level, water would flow from permanent tidal water bodies towards the tunnels. Some tunnel inflows would ultimately be saline, at a salinity approaching that of seawater. Such an outcome means there is a migration of seawater from river boundaries towards the regions underlying tunnels. This seawater intrusion would be extend across a significant area, affected all areas between the tidal water bodies and the tunnel alignment, caused by the tunnels acting as sinks for groundwater.

The EIS has only considered bore users within one kilometre of the tunnel alignment and no consideration of the change in water quality on ground water users or the vegetation within the full area of impact has been undertaken.

The EIS states the project would be constructed to limit groundwater inflow along the tunnel length to no greater than one litre per second across any given kilometre of tunnel. The EIS does not set timeframes around when does the criteria become applicable, little information on what measures are to be used and where, how is it understood at the time of construction what type of lining is needed to achieve the criteria. There is not sufficient detail to assess this as a commitment or a measurable mitigation measure.

The EIS has undertaken some monitoring for groundwater for the proposed works. However, this has only been undertaken for a relatively short time and would normally have been considered only preliminary investigation for the purposes of assessing opportunities and constraints for the project. As there are normally significant variations in groundwater levels over time and within the period over which monitoring has been undertaken would not be expected to allow this variation to be understood or accommodated for within this assessment.

The EIS states that groundwater monitoring would commence prior to the commencement of construction (baseline monitoring) and would continue during construction. Monitoring would continue post the completion of construction. Six monthly groundwater monitoring should occur for three years after the tunnel becomes operational after which the requirement for on-going monitoring will be assessed. Given there is numerous references to the long timeframes for steady state conditions to be met, and that the timeframes are not known, it is entirely inadequate to set three years as the starting point for the monitoring timeframe.

Further, unknown M5 East/New M5 then additional tunnels proposed for WestConnex. There should be an imperative being placed on gathering as much information about groundwater and potential impacts as possible, rather than finding out in many years to come what impacts there have been done only when those impacts have occurred.

There is little discussion within the EIS of the risks relating to the fracturing or cracking of creek beds, beyond the EIS noting that appropriate waterproofing measures will be used if inflows are elevated.

The cumulative impacts on the groundwater have not and cannot be fully assessment. Transient observations for the groundwater impacts of the M5 East Motorway were only made in 2015, 17 years after the construction of the commenced. As such, no conclusion can be drawn as to whether or not the water table has reached equilibrium. Further, none of the observations were made over the centreline of any tunnel and, as such, have not assessed the greatest impact of this tunnel.

Given that there are already significant impacts on the groundwater due to the existing tunnels, but that the full extent of these are not yet properly understood, and that the construction of the New M5 Motorway would start a new additional process of groundwater leaking into the tunnel system, it would not seem to be aligned with the precautionary principal to subject the same area and the same surface water and groundwater systems to further development. This would seem to be an unacceptable risk for those people and ecosystems reliant on these systems.

To propose that groundwater monitoring should occur for three years after the tunnel becomes operational after which the requirement for on-going monitoring will be assessed is entirely inadequate.

5.2.3 Recommendations

The EIS needs to assess the impacts on salt water intrusion to the groundwater

The EIS needs to assess the impacts on the surface water bodies that will arise due to the drawdown of the water table

Data on the full extent of the impacts on the water table from the M5 East needs to be collected and inform the groundwater modelling

An alternative to the above three recommendations being implemented would be for the precautionary principal to be applied and the proposed project to be constructed as lined tunnels

Up-to-date water quality data for both surface water and ground water needs to be collected across the entire area of potential impact. This should be for a sufficient duration (longer than 12 months at a minimum) and used to inform the impact assessment.

Further investigation is necessary to understand and minimise the risks relating to the fracturing or cracking of creek beds

The timeframe applicable for when the inflow criteria set for the proposed project needs to be clearly stated to allow clear compliance

The EIS needs to have full consideration of the Wolli Creek Riparian Corridor Management Plan

The EIS has only considered bore users within one kilometre of the tunnel alignment and no consideration of the change in water quality on ground water users or the vegetation within the full area of impact has been undertaken.

All surface water and ground water monitoring proposed for monitoring the impacts of the proposed project should be sufficient in both extent and duration to allow full monitoring and interpretation of the project impacts. The monitoring programs should be developed in consultation with all relevant government agencies, including the local councils.

5.3 BIODIVERSITY

The New M5 proposal is acknowledged as an external constrain. Rockdale, Hurstville and Canterbury City Council wish to work with the NSW government and agencies to minimise the impacts on their natural environment. The range of impacts is significant. It is unclear from the BAR whether the mitigation measures are adequate to address the direct and indirect impacts of the proposal.

There are a number of species and vegetation communities that were not considered in the BAR including the Powerful Owl, Micro-bats and indirect impacts to Swamp Oak, Freshwater Wetlands and Coastal Saltmarsh vegetation near the Marsh Street / Eve Street wetlands. There is also potential impact to

STIF EEC within Beverley Park, Tallawalla Road, Kingsgrove and potentially other vegetation due to temporary changes to groundwater levels during construction. These need further quantification to be fully assessed.

The identified impacts to the Green and Golden Bell Frog population on the Kogarah Golf Course are significant and permanent. The BAR does not fully consider these impacts on the potential extinction of a local population of this species. In the absence of a detailed amphibian survey being conducted as part of the BAR, and if the required biodiversity offsets cannot be acquired within the Arncliffe area then a species impact statement (SIS) should be developed to provide further information. The SIS should guide the additional mitigation measures proposed for this species, and be developed in consultation with local Councils.

5.3.1 Recommendations

The following recommendations are proposed to address issues identified in the review of the BAR where the impacts on threatened species assessed using the FBA are inadequate or inconclusive. The additional information is based on the potential for additional species to use habitat features present within the project alignment, or where surveys for predicted species have not been undertaken in the biodiversity assessment.

a) Green and Golden Bell Frog

Redesign the layout of the MOC 3. At present, the southern extension of this compound creates a significant barrier to movement through Kogarah Golf Course towards the constructed RTA ponds and Marsh Street / Eve Street wetlands. Preference would be for a wider compound aligned along the northern boundary of the golf course next to Marsh Street to maintain connection between the waterways on the golf course and the cycleway under the M5 East motorway.

Commence the establishment of any artificial wetland that is designed to supplement the existing RTA ponds at the earliest possible time to provide suitable habitat prior to removal of existing habitat from Kogarah golf course.

Develop a fauna relocation plan to populate other potential breeding sites.

Develop a management plan for the waterways on the golf course to provide additional breeding opportunities. This may involve the dewatering of these areas and removal of exotic fish.

Include local government in review process of subsequent Flora and Fauna management plans for the New M5.

b) Grey-headed Flying-fox

Undertake survey of Turrella colony to assess population dynamics, potential outward flight paths, foraging resources.

Determine the local abundance of seasonally-available foraging resources and assess significance of removal of Swamp Sclerophyll Forest EEC.

Consider Rockdale Council management plan for Grey-headed Flying-fox.

c) Cooks River Castlereagh Ironbark Forest EEC

Consider that the removal of part of this vegetation will result in the local extinction of this entire patch of vegetation and therefore provide biodiversity offset for removal of the 1.82 ha.

Undertake surveys to assess whether threatened fauna utilise this patch of vegetation, in combination with other areas of similar vegetation within the Canterbury Golf Course and Beverley Park to the south as part of a large range such as the Powerful Owl, micro-bats.

d) Marsh Street / Eve Street wetlands

Marsh Street / Eve Street Wetlands – develop a vegetation management plan to enhance the existing habitat of the Swamp Oak and Freshwater Wetlands EEC identified in this area, and potentially areas of Coastal Saltmarsh to support migratory birds and frog species.

6 LIMITATIONS AND AUTHORISATION

This review of air quality, water quality and hydrology, and biodiversity aspects of the New M5 Project has been undertaken in accordance with the methods and approaches described herein.

What it is intended to provide is a thorough and accurate general review and assessment of the documents listed below, and the key air quality, water quality and hydrology, and biodiversity issues involved.

6.1.1 Air quality

The review has considered the WestConnex New M5 Air Quality Assessment Report November 2015 (Appendix H, Technical Working Paper – Air Quality), which forms part of the overall EIS.

These two documents are very extensive, and the review presented here is not intended to provide a line by line or page by page analysis.

6.1.2 Water Quality and Hydrology

The review has considered the WestConnex New M5 Technical Working Paper: Surface water (Appendix N), Technical Working Paper: Groundwater (Appendix Q), supplemented by a review of other relevant sections of the EIS, namely the introductory and summary information relating to the project, chapters 16, 18 and 19 and Appendix P.

In addition, other relevant information provided by the three Councils commissioning this review and available through public searches has informed this review.

6.1.3 Biodiversity

The review has considered the relevant sections of the WestConnex New M5 EIS, in particular chapter 21 in the main report and the specialist biodiversity assessment report included as Appendices S and T

In addition, other relevant information provided by the three Councils commissioning this review and available through public searches has informed this review

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