



Transport for NSW

Beaches Link and Gore Hill Freeway Connection

Appendix Y

Compilation of environmental
management measures

Compilation of environmental management measures

This appendix collates the environmental management measures for the project that were identified through the impact assessment process. All measures listed in the below table will be incorporated into the construction environmental management plan and/or the operational framework for the project (as required). This summary of environmental management measures is based on the management measures detailed in Chapter 8 (Construction traffic and transport) to Chapter 27 (Cumulative impacts).

Ref	Phase	Impact	Environmental management measure	Location
Traffic and transport				
Construction				
CTT1	Pre-construction	Construction traffic	A road condition report will be prepared, in consultation with relevant councils and road owners, identifying existing conditions of local roads that will be used by heavy vehicles associated with the project and mechanisms to repair damage to the road network (beyond normal wear and tear) caused by these movements.	BL/GHF
CTT2	Pre-construction	Maritime construction	Transport for NSW will consult with the owners and/or leaseholders and/or licence holders of jetties and moorings that require temporary relocation to determine alternative arrangements. Moorings impacted during construction will be temporarily relocated elsewhere in Middle Harbour in consultation with the lease holder(s) and coordination with the Port Authority of NSW. All efforts will be made to relocate facilities as close to their original locations as possible. Impacted mooring licence holders may be entitled to a fee waiver or fee reimbursement where appropriate.	BL
CTT3	Construction	Maritime construction traffic	Construction vessels will be required to operate in a manner that minimises wash to areas of shoreline.	BL
CTT4	Construction	Maritime construction traffic	Construction marine traffic activities will be scheduled to avoid times and locations of high recreational marine traffic where feasible and reasonable.	BL

Ref	Phase	Impact	Environmental management measure	Location
CTT5	Construction	Maritime construction traffic	Harbour closures scheduling will be carried out in consultation with Port Authority of NSW, other divisions of Transport for NSW and other relevant stakeholders.	BL
CTT6	Construction	Construction traffic	Ongoing consultation, as relevant to the location, will be carried out with Greater Sydney Operations, the Port Authority of NSW, local councils, emergency services and bus operators to minimise traffic and transport impacts.	BL/GHF
CTT7	Construction	Construction traffic	The community will be notified in advance of proposed transport network changes, and maritime restrictions through appropriate media and other appropriate forms of community liaison.	BL/GHF
CTT8	Construction	Construction traffic	Construction road traffic will be managed to minimise impacts of movements during peak periods where feasible and reasonable.	BL/GHF
CTT9	Construction	Construction traffic	Vehicle movements to and from construction sites will be managed to ensure pedestrian, cyclist and road user safety. Depending on the location, this may require manual supervision, physical barriers, temporary traffic signals and modifications to existing signals or, on occasion, police presence.	BL/GHF
CTT10	Construction	Construction traffic	Directional signage, barriers and/or linemarking will be used as required to direct and guide motorists, cyclists and pedestrians past construction sites and on the surrounding network. This will be supplemented by Variable Message Signs to advise all road users of potential delays, traffic diversions, speed restrictions or alternative routes.	BL/GHF
CTT11	Construction	Construction traffic	Where provision of construction on-site parking cannot accommodate the full construction workforce, construction worker parking will be actively managed to minimise impacts on parking on local roads. Depending on the location, this will include encouraging the use of public	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			transport and may include provision of shuttle buses for workforce transport where appropriate.	
CTT12	Construction	Construction traffic	Any adjustments to existing bus stops will be determined in consultation with relevant stakeholders including other divisions of Transport for NSW and advanced notification would be provided to affected bus customers. Relocations will be as close to their existing position where feasible and reasonable.	BL/GHF
CTT13	Construction	Construction traffic	Truck marshalling areas will be identified and used where feasible and reasonable, to minimise potential queueing and traffic and access disruptions in the vicinity of construction support sites.	BL/GHF
CTT14	Construction	Construction traffic	Activities requiring temporary partial road closures will be carried out outside of peak periods and/or during night time to minimise the impact of these activities on the road network where feasible and reasonable.	BL/GHF
CTT15	Construction	Construction traffic	Direct impacts to existing pedestrian and cycling facilities will be minimised where reasonable and feasible. Any detours and adjustments will be designed with consideration of user safety and convenience.	BL/GHF
CTT16	Construction	Maritime construction impacts	Consultation will be carried out with surrounding water based users of Middle Harbour including Mosman Rowing Club and Northbridge Sailing Club to minimise construction impacts.	BL
Operation				
OT1	Operation	Operational traffic	A review of operational network performance will be carried out 12 months and five years from the opening of the project to confirm the operational impacts of the project on surrounding arterial roads and major intersections. The assessment will be based on updated traffic data at the time and the methodology used will be comparable with that used in Appendix F (Technical working paper: Traffic	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			and transport) of the environmental impact statement. Where required, additional feasible and reasonable mitigation measures will be identified in consultation with Department of Planning, Industry and Environment and the relevant council to manage any additional traffic performance impacts identified during the review of operational network performance.	
OT2	Operation	Impacts on local roads	Where required, Transport for NSW will investigate local area traffic management measures to minimise the impact of the project on the surrounding local road network. Such measures will be determined in consultation with relevant councils and implemented where feasible and reasonable.	BL/GHF
Noise and vibration				
Construction				
CNV1	Pre-construction and construction	Construction noise and vibration impacts	<p>A Construction Noise and Vibration Plan will be developed for the project. This plan will:</p> <ul style="list-style-type: none"> a) Identify relevant criteria and management levels in relation to noise and vibration b) Identify noise and vibration sensitive receivers and features in the vicinity of the project c) Include standard and additional mitigation from the <i>Construction Noise and Vibration Guideline</i> (Roads and Maritime Services, 2016) and detail how and when these will be applied in the project d) Describe the approach that will be adopted for carrying out location and activity specific construction noise and vibration impact assessments to assist with designing and selecting of the appropriate mitigation and management measures e) Include protocols that will be adopted to manage works required outside standard construction hours f) Detail the methodology and approach for managing construction noise impacts 	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			<p>g) Detail the process for managing construction vibration, including for heritage structures, considering all types of vibration generating works, including blasting</p> <p>h) Outline the approach for identifying and managing potential cumulative impacts, including ensuring appropriate respite for works outside standard construction hours</p> <p>i) Outline the procedures and approach for noise and vibration monitoring to be carried out to confirm construction noise and vibration levels in relation to noise and vibration management levels</p> <p>j) Detail how construction noise impacts from concurrent or consecutive nearby construction works associated with the project will be managed where feasible and reasonable.</p> <p>The Construction Noise and Vibration Management Plan will be implemented for the duration of construction of the project.</p>	
CNV2	Pre-construction	Construction noise and vibration impacts	<p>Detailed location and activity specific construction noise and vibration impact statements will be prepared and implemented to cover:</p> <ul style="list-style-type: none"> • Construction support sites • Works outside standard construction hours • Works with the potential to result in highly noise affected residential receivers (ie exposed to noise levels that exceed 75 dB(A)) • Works with the potential to exceed relevant human response and cosmetic damage criteria for vibration • Subsurface tunnelling activities. <p>The statements will consider the proposed site layouts and noise generating activities that will occur, identify potentially impacted sensitive receivers and assess predicted noise and vibration levels against the relevant criteria and management levels, and specify the feasible</p>	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			and reasonable mitigation and management measures that will be implemented in accordance with the requirements of the <i>Interim Construction Noise Guideline</i> (DECC, 2009) and the <i>Construction Noise and Vibration Guideline</i> (Roads and Maritime Services, 2016).	
CNV3	Construction	Construction noise and vibration impacts during out of hours work	<p>An out of hours works protocol will be developed for the construction of the project. The protocol will include:</p> <ol style="list-style-type: none"> Details of works required outside standard construction hours justifications of why the works are required outside standard construction hours The noise and vibration impact assessment processes that will be followed to identify potentially affected receivers and clarify potential impacts Mitigation and management measures that are to be considered and implemented where appropriate to manage potential impacts associated with works outside standard construction hours Details of the approval process (internal and external) for works proposed outside standard construction hours. <p>The protocol will be prepared in consultation with Department of Planning, Industry and Environment and the NSW Environment Protection Authority. The project protocol will be implemented during the duration of the construction of the project.</p>	BL/GHF
CNV4	Construction	Construction noise and vibration impacts during out of hours work	<p>For works outside standard construction hours on and adjacent to major roadways, the elevated existing ambient and background noise levels during the following shoulder periods will be investigated and confirmed:</p> <ul style="list-style-type: none"> Shoulder period (night-day) – between 5.00am and 7.00am Shoulder period (evening-night) – between 10.00pm and 12.00am. 	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			Where appropriate, these shoulder periods will be utilised where feasible and reasonable to minimise potential amenity impacts associated with project activities outside standard construction hours.	
CNV5	Construction	Construction noise and vibration impacts	Construction noise and vibration impacts will be monitored periodically throughout all stages of the construction support site to ensure that: <ul style="list-style-type: none"> a) Noise and vibration levels are consistent with the predictions detailed in the relevant construction noise and vibration impact statements b) Noise and vibration impacts are being appropriately managed c) Mitigation measures are effective. 	BL/GHF
CNV6	Construction	Construction noise impacts	Where feasible and reasonable, unless compliance with the relevant traffic noise criteria can be achieved, or alternative arrangements have been agreed with affected receivers, construction vehicle movements will not occur on local roads beyond those required for direct access to construction sites.	BL/GHF
CNV7	Construction	Construction vibration impacts	Vibration generating activities will be managed through the establishment of minimum working distances to achieve vibration screening levels. Where vibration levels are predicted to exceed the screening levels, a more detailed assessment of the impacted structure will be carried out to assess the susceptibility of the structure to damage from vibration due to the project. Appropriate mitigation and management measures, such as equipment substitution and alternative methods, will be identified and implemented to avoid damage. Attended vibration monitoring will be carried out during vibration intensive activities in the vicinity to ensure vibration levels remain below appropriate limits for that structure.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			<p>For heritage items, the more detailed assessment will specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.</p> <p>Pre-construction building structure condition surveys will be carried out in accordance with environmental management measure SG7. Any building and/or structure damage from vibration caused by the project would be repaired at no cost to the owner.</p>	
CNV8	Construction	Construction ground-borne noise impacts	Where ground-borne levels are predicted to exceed the relevant noise management levels, alternative construction techniques and equipment that are likely to generate less ground-borne noise will be investigated and used where feasible and reasonable.	BL/GHF
CNV9	Construction	Construction impacts from surface road works	<p>Mitigation measures will be implemented for surface road works, local area and utility works, where construction activities are predicted to exceed noise management levels at receivers. Where feasible and reasonable the approaches that will be used include:</p> <ol style="list-style-type: none"> a) Carrying out works during the daytime period when near residential receivers b) Selection of plant and equipment to minimise noise and vibration impacts c) Management of plant and equipment to minimise the generation of noise and vibration impacts d) Community consultation, engagement and notification e) Detailed programming and respite protocols f) Where out of hours works are required, programming the noisiest activities to occur during the less sensitive time periods g) Out of hours works protocols h) Limiting timing of noise intensive work 	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			<p>i) Use of portable noise barriers around particularly noisy equipment such as concrete saws and rock hammers in cases where it will effectively reduce noise levels at nearby receivers</p> <p>j) Management of construction traffic to minimise movements during the night periods along local roads</p> <p>k) Establishing minimum vibration working distances for vibration intensive works</p> <p>l) Vibration and blasting trials and/or monitoring along with building condition surveys.</p> <p>Construction support sites that support surface road works will be designed to ensure that primary noise sources are located as far as possible from the nearby noise sensitive receivers, with solid structures (shed, containers, barriers, etc) placed between the noise sensitive receiver where feasible and reasonable to maximise acoustic shielding and block the line of site between the source and the receiver.</p>	
CNV10	Construction	Construction noise impacts	Where feasible and reasonable, noise barriers proposed as part of the project to address road traffic noise will be implemented as early as possible to attenuate construction noise.	BL/GHF
CNV11	Construction	Construction noise impacts	Where it is necessary to relocate or remove existing noise barriers to facilitate construction of new road infrastructure, the new noise barriers will be installed before removing the existing barriers where feasible and reasonable. Where it is not possible to install the new barriers before removing the existing barriers, the duration between removing the existing and installing the new barriers will be minimised. Temporary noise barriers will be installed to ensure that road traffic noise levels do not increase by more than 2 dB(A) at the affected residential receiver buildings, where feasible and reasonable.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
CNV12	Construction	Construction blasting impacts	Any blasting and associated activities will be carried out in a manner that does not generate unacceptable overpressure and vibration impacts or pose a significant risk of impact to structures and sensitive receivers (including threatened fauna and fauna habitat adjacent the Wakehurst Parkway). Prior to any blasting all potentially affected sensitive receivers and features in the vicinity would be identified. Appropriate tests will be carried out at each proposed blasting location to develop site-specific laws that take into account relevant factors such as underlying geology and separation distance to sensitive receivers and features to determine appropriate charge sizes and blasting design to ensure compliance with relevant vibration and overpressure criteria. All blasting will be carried out in accordance with the specific-laws. Monitoring will occur to determine compliance with the relevant criteria, and the site-specific laws will be adjusted as required based on the monitoring results to ensure ongoing compliance. The potentially affected community will be kept informed about proposed blasting activities.	BL/GHF
CNV13	Construction	Cumulative construction noise impacts and construction fatigue	Construction noise from concurrent and consecutive major projects in the vicinity of work locations associated with the project will be managed to minimise cumulative construction noise impacts. Where feasible and reasonable the approaches that will be used include: <ul style="list-style-type: none"> a) Considering the potential for cumulative impacts due to other major projects in the locality during development of the detailed construction methodology. The construction methodology will be developed to minimise overall noise impacts and the need for respite for receivers potentially affected by cumulative impacts wherever feasible and reasonable b) Consulting with other major projects in the vicinity with the aim of coordinating work between the different projects that will affect the same area to ensure that affected receivers get appropriate respite from high 	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			<p>noise impact activities and works outside standard construction hours</p> <p>c) Implementing additional feasible and reasonable source mitigation for cumulative construction activities, where programming is not practical to avoid cumulative noise impacts</p> <p>d) Community consultation to seek feedback on and identify key noise and vibration issues relevant to the local community so that current and future works can be managed to limit cumulative impacts.</p>	
CNV14	Construction	Impact piling	<p>In any given week, impact piling will be carried out over no more than either:</p> <ul style="list-style-type: none"> • a two hour period each work day or • a six hour period on a single work day. 	BL
Operation				
ONV1	Operation	Operational road traffic noise	<p>The operational noise performance of the project will be reviewed during further design development and functionally appropriate operational noise mitigation (quieter pavements eg open grade asphalt, noise barriers, at-property treatments or a combination of treatments) will be confirmed in accordance with <i>NSW Road Noise Policy</i> (DECCW, 2011), <i>Noise Criteria Guideline</i> (Roads and Maritime Services, 2015) and <i>Noise Mitigation Guideline</i> (Roads and Maritime Services, 2015).</p>	BL/GHF
ONV2	Operation	Operational road traffic noise	<p>Within 12 months of the commencement of the operation of the project, actual operational noise performance will be compared to predicted operational noise performance (as reviewed during further design development) to analyse the effectiveness of the operational road traffic noise mitigation measures. Additional reasonable and feasible mitigation will be considered where any additional receivers are identified as qualifying for consideration of</p>	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			noise mitigation in accordance with the <i>Noise Mitigation Guideline</i> (Roads and Maritime Services, 2015).	
ONV3	Design and construction	Operational road traffic noise	For local roads in Balgowlah, North Balgowlah and Seaforth where predicted increases in traffic are likely to result in exceedances of the relevant road traffic noise criteria, traffic calming measures with the aim of limiting potential road traffic noise increases to no more than 2 dB(A) will be investigated in consultation with Northern Beaches Council and implemented. As a minimum, traffic calming measures will be investigated for Wanganella Street at Balgowlah, Woodbine Street at Balgowlah and Judith Street at Seaforth. The need for at-property treatments will be confirmed during further design development and will consider the potential impact of the proposed traffic calming measures on traffic volumes and speeds.	BL
ONV4	Operation	Operational facilities noise	Operational fixed facilities will be designed to meet project specific noise criteria derived in accordance with the <i>Noise Policy for Industry</i> (NSW EPA, 2017).	BL/GHF
ONV5	Operation	Sporting and recreation noise impacts	Open space and recreation facilities at Balgowlah will be designed to meet intrusive noise criteria derived in accordance with the <i>Noise Guide for Local Government</i> (NSW EPA, 2013) where reasonable and feasible. The final layout will be subject to further noise assessment to confirm the need for and details of any additional noise attenuation required.	BL
Air quality				
AQ1	Pre-construction and construction	General	Standard construction air quality mitigation and management measures will be detailed in construction management documentation and implemented during construction, such as: a) Reasonable and feasible dust suppression and/or management measures, including the use of water	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			<p>tanks and/ or carts, sprinklers, site exit controls (eg wheel washing systems and rumble grids), stabilisation of exposed areas or stockpiles, and surface treatments</p> <p>b) Selection of construction equipment and/or materials handling techniques that minimise the potential for dust generation</p> <p>c) Management measures to minimise dust generation during the transfer, handling and on site storage of spoil and construction materials (such as sand, aggregates or fine materials) (eg the covering of vehicle loads)</p> <p>d) Adjustment or management of dust generating activities during unfavourable weather conditions, where reasonable and feasible</p> <p>e) Minimisation of exposed areas during construction</p> <p>f) Measures for managing odour generation likely to result in odour impacts at sensitive receivers in the vicinity during the disturbance, handling and storage of potentially odorous materials, including any contingency measures</p> <p>g) Internal project communication protocols to ensure dust-generating activities in the same area are coordinated and mitigated to manage cumulative dust impacts of the project</p> <p>h) Site inspections will be carried out to monitor the effectiveness of implemented measures and identify any additional measures to be implemented.</p>	
AQ2	Pre-construction and construction	Odour	Further site investigations will be carried during the detailed design and construction planning phase to determine the potential to encounter odorous gases or materials during the proposed excavations at the Flat Rock Drive construction support site (BL2). If the investigations indicate that there is potential for odorous materials to be uncovered or odorous gases to be released, the potential for off-site impacts (informed by meteorological studies	BL

Ref	Phase	Impact	Environmental management measure	Location
			and modelling as required) will be investigated. If unacceptable off-site impacts are predicted, appropriate mitigation and management measures will be identified to minimise potential impacts, with consideration of the investigation results, proposed site activities and meteorological conditions, and the identified measures will be implemented during relevant site activities. Odour monitoring will be carried out during relevant site activities and mitigation and management measures adjusted as required to minimise potential off-site impacts.	
AQ3	Construction	General	Dust and air quality complaints will be managed in accordance with the overarching complaints handling process for the project. Appropriate corrective actions, if required, will be taken to reduce emissions in a timely manner.	BL/GHF
AQ4	Construction	Odour	Any areas of exposed material at the Flat Rock Drive construction support site that have the potential to generate odour will be kept to a minimum during site establishment works and while the area is uncovered. If odorous areas are to remain uncovered at the end of the work shift, temporary cover or other suitable measures to minimise odour emissions will be implemented.	BL
AQ5	Construction	Odour	If the dredged materials require some form of land-based processing prior to disposal, an assessment of potential odour impacts will be carried out for the proposed processing site in accordance with the <i>Technical framework for the assessment and management of odour from stationary sources in NSW</i> (DEC, 2006). This will include modelling to assess whether the use of the site and the proposed processing and treatment activities for the dredged material can comply with a criterion of 2 odour units at all sensitive receivers in the vicinity.	BL
AQ6	Construction	Odour	Where the assessment carried out in environmental management measure AQ5 indicates that compliance is	BL

Ref	Phase	Impact	Environmental management measure	Location
			not likely, an odour management strategy will be developed. The strategy will describe appropriate mitigation and management measures to ensure that the 2 odour units criterion is met, odour survey requirements and contingency actions that will be implemented if significant odour issues are observed in the vicinity of sensitive receivers. The strategy will be developed prior to accepting dredged material at the site and implemented for the duration of the processing of dredged material at the site.	
Human health				
HH1	Construction	Underwater noise impacts	<p>Monitoring during the early stages of impact piling activities at each location will be carried out to measure underwater noise levels and compare against acoustic thresholds to confirm the extent of areas that need to be managed with respect to underwater noise, and to confirm appropriate management measures (as required). Appropriate management measures will be implemented during impact piling.</p> <p>The monitoring results, management areas and proposed management measures will be peer-reviewed to ensure they adequately address potential health impacts.</p> <p>Monitoring will be carried out following implementation of management measures (as required) to confirm they are appropriate and to identify any additional management measures required.</p>	BL (Middle Harbour)
HH2	Construction	Underwater noise impacts	Communication and management measures will be implemented during construction to manage potential underwater noise impacts to water-based recreational users during dredging and piling activities in Middle Harbour. The communication tools and management measures that would be contemplated within the management zone include:	BL (Middle Harbour)

Ref	Phase	Impact	Environmental management measure	Location
			<ul style="list-style-type: none"> a) Coordination of piling programs with the planned activities of key recreational stakeholders to minimise interaction with planned or peak activity periods of these stakeholders, where feasible and reasonable b) Communication of the piling program and management area so recreational users know when the piling, dredging and other noise generating activities will be taking place, what they can expect, and the zones to minimise the possibility of being startled from a sudden increase in sound pressure underwater c) Direct communication with key local recreational stakeholders during the piling and dredging program to provide up-to-date scheduling d) Use of advertisements, signage, letter box drops and project updates to communicate the implementation of a management area during the works. This could include floating markers or signage on approach to the construction work e) Surveillance within the areas in which precautionary guideline level is exceeded to proactively monitor users in the prior to and during relevant activities that could pose a risk to recreational users. 	
Non-Aboriginal heritage				
NAH1	Design	Ongoing Non-Aboriginal heritage impacts	Appropriate heritage interpretation will be incorporated into the urban design for the project in accordance with the <i>NSW Heritage Manual</i> (NSW Heritage Office and Department of Urban Affairs and Planning, 1996), <i>Interpreting Heritage Places and Items: Guidelines</i> (NSW Heritage Office, 2005), and the <i>Heritage Interpretation Policy</i> (NSW Heritage Council, 2005).	BL/GHF
NAH2	Pre-construction	Impacts on specific non-Aboriginal heritage items	Archival recording will be carried out in accordance with the <i>Photographic Recording of Heritage Items Using Film or Digital Capture</i> guideline for areas/items subject to	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			<p>change within the following items, in accordance with Appendix J (Technical working paper: Non-Aboriginal heritage):</p> <ul style="list-style-type: none"> • Item 10: Balgowlah Golf Course, Balgowlah • Item 11: Frenchs Bullock Track, Killarney Heights (pending further detailed survey and detailed design development confirming direct impact). <p>Archival recording will be completed prior to any works that have the potential to impact upon the items and deposited with appropriate stakeholders as determined during further design development (eg local councils).</p>	
NAH3	Pre-construction	Maritime non-Aboriginal heritage impacts	<p>A Maritime Heritage Management Plan that details the objectives and methodologies to conserve maritime heritage and mitigate impacts will be prepared in consultation with a qualified and experienced maritime archaeologist. The Maritime Heritage Management Plan will specify:</p> <ol style="list-style-type: none"> a. Unexpected finds protocols relevant to each type of activity such as dredging or piling b. Artefact management procedures, including identification of approved submerged reburial locations c. Relevant work method requirements and maritime heritage inductions tailored for each type of work activity such as dredging or piling d. Restricted zone, archival, baseline and periodic monitoring protocols including before and during construction, and final site inspections within three months of completion of works for the following maritime heritage sites: <ul style="list-style-type: none"> • Clive Park Tidal Pool • Clive Park Unidentified No. 1 • Pearl Bay Unidentified No. 1. e. An archaeological research design to guide the investigation of Clive Park Unidentified No 1. 	BL

Ref	Phase	Impact	Environmental management measure	Location
NAH4	Pre-construction	Maritime non-Aboriginal heritage impacts	Any pre-dredge bed of the harbour clearance by divers in Middle Harbour will be carried out in the presence of a maritime archaeologist, who will identify any additional inspection or documentation that should be carried out during the clearance dive. This may include inspecting the locations of known or potential submerged maritime heritage sites and items, either recording in situ or recovery and/or relocation.	Middle Harbour
NAH5	Pre-construction	Maritime archival recording	<p>An archival recording of Clive Park Unidentified No. 1 will be carried out to mitigate the likely loss of information resulting from a breakdown of site integrity. The archival recording will have the following objectives or research questions:</p> <ul style="list-style-type: none"> • Identifying and recording the extent of the site • Identifying the type and function of the vessel (which would mean determining its construction) • Identifying what the vessel was carrying at the time of loss • Re-assessing the cultural heritage significance of the site. <p>The archival recording of the wreck would require limited excavation of the site to recover and examine its contents. This excavation will be carried out in accordance with the research design (refer to NAH3) and any artefacts recovered from the site will be buried, after analysis, in an approved location nearby.</p>	Clive Park Unidentified No. 1
NAH6	Pre-construction	Maritime archival recording	<p>A detailed archival recording of the following maritime heritage items will be prepared, consistent with relevant NSW Heritage Council approved standards and guidelines:</p> <ul style="list-style-type: none"> • Clive Park Tidal Pool • Pearl Bay Unidentified No. 1. 	Clive Park Tidal Pool, Pearl Bay Unidentified No.1

Ref	Phase	Impact	Environmental management measure	Location
			The archival records will also capture any relevant information needed to serve as a baseline for monitoring during the project, as identified in the Maritime Heritage Management Plan (see NAH3). The final archival record will be updated with any changes identified during monitoring or investigation prior to lodgement.	
NAH7	Pre-construction	Maritime non-Aboriginal heritage impacts	<p>A side scan sonar survey will be carried out for the following areas, where they are not already covered by existing surveys:</p> <ul style="list-style-type: none"> • Project construction footprint between Northbridge and Seaforth in the vicinity of the immersed tube tunnels and the Middle Harbour cofferdams (BL7 and BL8) • Project construction footprint in the vicinity of the Spit West Reserve construction support site (BL9). <p>A qualified maritime archaeologist will assess the results of the side scan survey to identify any additional potential heritage items requiring investigation and assessment.</p>	Middle Harbour south cofferdam (BL7), Middle Harbour north cofferdam (BL8), Spit West Reserve construction support site (BL9)
NAH8	Pre-construction	Maritime non-Aboriginal heritage impacts	A dive team under the supervision of a maritime archaeologist will inspect the location of each proposed piled mooring to assess the maritime heritage value of any cultural object present and either relocate the object or, if significant, relocate the proposed mooring.	Temporary mooring facility east of Clive Park in Middle Harbour
NAH9	Pre-construction	Non-Aboriginal heritage impacts to Frenchs Bullock Track	<p>The northern section of the Frenchs Bullock Track potentially impacted directly by construction works will be reformed if impacted, as close as possible to the existing alignment.</p> <p>Further detailed survey will be completed to confirm the heritage curtilage of the southern section of Frenchs Bullock Track prior to construction to determine if this section will be directly impacted.</p> <p>Where the heritage curtilage of the Frenchs Bullock Track is within the construction footprint or boundary of proposed permanent infrastructure, impacts to the track will be</p>	BL

Ref	Phase	Impact	Environmental management measure	Location
			avoided where possible through further design development.	
NAH10	Pre-construction and construction	Vibration impacts to non-Aboriginal heritage	A structural survey will be prepared for all maritime infrastructure within the Seaforth 'Harbour Foreshores' that could be subject to vibrational impact to determine minimum working distances and vibration limits to be observed to prevent cosmetic damage. Vibration monitoring will be carried out during works to ensure vibration levels do not exceed appropriate limits. The recommended actions in Appendix G (Technical working paper: Noise and vibration) will be followed.	Harbour foreshores (Seaforth)
NAH11	Construction	Non-Aboriginal heritage impacts during construction	Delineation of restricted zones will be implemented to avoid inadvertent works occurring within the curtilage of heritage items.	BL/GHF
NAH12	Construction	Unexpected discovery of historical heritage materials, features or deposits	If at any time during construction of the project, historical materials, features and/or deposits are encountered, the <i>Standard Management Procedure: Unexpected Heritage Items</i> (Roads and Maritime Services, 2015) will be followed.	BL/GHF
NAH13	Construction	Unexpected discovery of human remains	In the event that construction of the project reveals possible human skeletal material (remains), <i>Standard Management Procedures – Unexpected Heritage Items</i> (Roads and Maritime Services, 2015) will be implemented.	BL/GHF
NAH14	Construction	Non-Aboriginal heritage impacts during construction	Non-Aboriginal heritage awareness training will be provided for contractors prior to commencement of construction works to ensure understanding of potential heritage items that may be impacted during the project, and the procedure required to be carried out in the event of discovery of non-Aboriginal heritage materials, features or deposits, or the discovery of human remains. This includes relevant work method requirements and maritime heritage inductions tailored for each type of work activity such as dredging or piling.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
NAH15	Construction	Non-Aboriginal heritage impacts	Should at-property noise treatment be required at a premise that is heritage listed, this will be carried out in a manner to minimise heritage impact, and advice of a heritage conservation architect will be sought prior to carrying out the works. Any treatments will be sympathetic to the heritage values of the item, designed with heritage architect input and be reversible where feasible.	BL/GHF
Aboriginal heritage				
AH1	Pre-construction and construction	Aboriginal heritage – vibration, and settlement impacts	<p>Before the start of construction, further consultation with Heritage NSW, the Metropolitan Local Aboriginal Land Council, the Aboriginal Heritage Office and the Registered Aboriginal Parties will be carried out to decide an appropriate course of action for the Aboriginal site 45-6-0662 on Wakehurst Parkway, as the location of this site could not be confirmed during field inspection (site is likely covered by gravel/vegetation).</p> <p>If considered appropriate, an archaeological investigation may be carried out at the possible site location to carefully remove the gravel/vegetation, to confirm its presence and record the underlying site condition.</p> <p>If new information regarding site condition is identified during consultation suggesting the site may be subject to impacts due to vibration and settlement, environmental management measures AH2, AH3 and AH4 will apply.</p> <p>In the absence of confirming the site, if during construction works a site is located, the unexpected finds protocol prescribed in AH5 would apply. Further, Heritage NSW, an appropriately qualified archaeologist and the Metropolitan Local Aboriginal Land Council will be contacted and the site will be re-recorded in situ.</p>	Frenchs Forest; Bantry Bay; Wakehurst Parkway (45-6-0662)
AH2	Pre-construction and construction	Aboriginal heritage – vibration impacts	The following process will be carried out to confirm where vibration monitoring at those terrestrial sites within 50 metres of the project corridor will be required:	All registered AHIMS sites subject to vibration intensive activities determined

Ref	Phase	Impact	Environmental management measure	Location
			<ul style="list-style-type: none"> a) Terrestrial Aboriginal site condition surveys of sites will be completed by an appropriately qualified person using those techniques appropriate in determining which sites are considered to be structurally unsound b) Where this determination cannot be made, as a precaution the site will be considered to be structurally unsound c) A screening of vibration intensive activities within 50 metres of structurally unsound sites will be carried out to identify activities that have the potential to exceed vibration levels of 2.5 millimetres per second d) Sites identified as being both structurally unsound and having potential for exceedance in vibration levels of 2.5 millimetres per second will be identified as requiring vibration monitoring where this cannot be reduced at the source. 	to be structurally unsound (see AH2).
AH3	Construction	Aboriginal heritage – vibration impacts	<p>Vibration monitoring will be carried out at sites that have been identified as requiring monitoring in accordance with the process outline in environmental management measure AH2. The monitoring process will:</p> <ul style="list-style-type: none"> • Be developed by a suitably qualified person • Be risk-based • Include appropriate frequency and duration of monitoring including adequate benchmark recording before works commence • Include appropriate management protocols for any exceedances. <p>Where possible, project works will be conducted in a manner to minimise vibration levels, to less than 2.5 millimetres per second at all structurally unsound AHIMS sites.</p>	All registered AHIMS sites located subject to vibration intensive activities determined to be structurally unsound (see AH2).

Ref	Phase	Impact	Environmental management measure	Location
AH4	Construction	Aboriginal heritage – vibration impacts	Where monitoring identifies that vibration levels exceed 2.5 millimetres per second or following vibration intensive activities, subsequent condition survey of sites that are subject to monitoring in AH3 will be carried out. The subsequent condition surveys will record any changes to the integrity of the site that may have resulted from construction vibration. Additional surveys must be carried out by a suitably qualified person and include a Metropolitan Local Aboriginal Land Council representative. AHIMS site cards will be updated accordingly where any changes are observed. Condition surveys may include further photogrammetry and 3D-capture techniques, in which case comparison against the baseline will be carried out.	All registered AHIMS sites subject to vibration monitoring (see AH3).
AH5	Construction	Unexpected discovery of historical heritage materials, features, or deposits	If at any time during the construction of the project, any items of potential Aboriginal archaeological or cultural heritage conservation significance or Ancestral remains are discovered, they will be managed in accordance with the <i>Standard Management Procedure: Unexpected Heritage Items</i> (Roads and Maritime Services, 2015).	BL/GHF
AH6	Construction	Aboriginal heritage - impacts	Cultural and historic heritage awareness training will be carried out for personnel engaged in work that may impact heritage items before commencing works for the project.	BL/GHF
AH7	Pre-construction and construction	Aboriginal heritage - impacts	As part of the project urban design and landscape plan, an Aboriginal heritage interpretation strategy will be developed for the project in consultation with Registered Aboriginal Parties and other relevant Stakeholders. Appropriate Aboriginal heritage interpretation will be incorporated into the project urban design and landscape plan in accordance with the interpretation strategy.	BL/GHF
AH8	Pre-construction	Potential Aboriginal submerged sites heritage impacts	The effectiveness of using high resolution geophysical survey to identify rock overhangs concealed by marine sediments will be assessed. If it is determined that a high	Potential rock shelter(s) at Seaforth located outside of Middle

Ref	Phase	Impact	Environmental management measure	Location
			<p>resolution geophysical survey could produce the desired results, then the survey will be carried out.</p> <p>If the geophysical survey conclusively shows that there are no rock overhangs measuring at least 1.5 metres in height (from the rock base to the rock ceiling), there would be no further archaeological work carried out and any residual risk will be managed through an unexpected finds procedure. However, if the geophysical survey is inconclusive or distinct rock overhangs are identified, then an archaeological dive investigation will be implemented. Much of the diving will be done in near zero visibility and will therefore be limited to what a diver can feasibly and safely do.</p>	<p>Harbour north construction support site (BL8) cofferdam footprint but within the dredge footprint</p>
AH9	Pre-construction and construction	Potential Aboriginal submerged sites heritage impacts	<p>The effectiveness of using high resolution geophysical survey to identify rock overhangs concealed by marine sediments will be assessed. If it is determined that a high resolution geophysical survey could produce the desired results, then the survey will be carried out.</p> <p>If the geophysical survey conclusively shows that there are no rock overhangs measuring at least 1.5 metres in height (from the rock base to the rock ceiling), there would be no further archaeological work carried out and any residual risk will be managed through an unexpected finds procedure. However, if the geophysical survey is inconclusive or distinct rock overhangs are identified, then onsite visual monitoring within the cofferdam will be carried out during the construction period, after the cofferdam has been de-watered. The aim of the monitoring will be to identify voids within the bedrock close to the interface with marine sediments.</p> <p>In the event that a void in the bedrock appears that displays the characteristics of a potential rock shelter, then the marine sediments will be removed by pump. Should the marine sediments bottom out onto the rock no further action would be taken. If the characteristics of the marine sediments change or if fissures are evident, then samples</p>	<p>Within the footprint of Middle Harbour south and north cofferdams construction support sites (BL7 and BL8)</p>

Ref	Phase	Impact	Environmental management measure	Location
			<p>of the sediments will be taken, preferably as an intact core sample.</p> <p>In consultation with a suitably experienced geomorphologist a set of criteria will be established for the identification of pre-inundation soil deposits (peat, charcoal, roots, etc). If pre-inundation soil deposits are evident within samples, a controlled archaeological investigation to recover any artefacts will take place. However, the extent of the archaeological investigation and method of recovery will be determined by the constraints of the bed rock conditions and workplace health and safety protocols and constraints within the cofferdams, including safety protocols for handling of potentially contaminated sediment. Environmental, engineering and workplace health and safety factors such as operating space within an overhang, viscosity of the pre-inundation soil and elevated contamination levels will have an influence on the method of archaeological investigation, which will nonetheless aim to retain spatial and stratigraphic control if at all feasible.</p>	
Geology, soils and groundwater				
SG1	All phases	Groundwater drawdown and quality	The existing groundwater monitoring program for both groundwater levels and quality will be continued through construction. Outcomes of updated groundwater modelling (environmental management measure SG2) will identify any requirements for further groundwater monitoring during the operational phase.	BL/GHF
SG2	All phases	Groundwater drawdown	As more information becomes available on groundwater levels through ongoing groundwater monitoring, groundwater modelling will be updated to refine the predictions. Inflow predictions will be updated prior to finalising detailed design and will include designed tunnel linings, and the detailed design will be updated based on the updated operational inflow and impact predictions.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			<p>If refined predictions of groundwater levels and drawdown indicate that impacts would be greater than the impacts presented in the environmental impact statement, feasible and reasonable mitigation measures will be incorporated into the detailed design and implemented.</p> <p>Groundwater modelling will be conducted considering <i>Australian Groundwater Modelling Guidelines</i> (Barnett et al., 2012), including sensitivity analysis and consideration of future climate change, as required.</p>	
SG3	All phases	Impact to registered groundwater bores	<p>The viability of the following domestic bores will be confirmed prior to construction:</p> <ul style="list-style-type: none"> • GW023150 • GW026513 • GW072478 • GW107970 • GW108224 • GW108991. <p>If drawdown at the bore exceeds two metres (in accordance with the <i>NSW Aquifer Interference Policy</i> (NSW DPI, 2012)) and impacts to the ongoing use of the bores are unacceptable, measures will be taken to 'make good' the impact by restoring the water supply to pre-development levels. The measures taken will be dependent upon the impacts to the bore and will be determined in consultation with the affected licence holder but could include deepening the bore, providing a new bore or providing an alternative water supply.</p>	BL/GHF
SG4	Design	Ground movement impacts	Detailed predictive settlement models will be developed for areas of concern to guide tunnel design and construction methodology, including the selection of options to minimise settlement where required.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
SG5	Pre-construction	Ground movement impacts	An Independent Property Impact Assessment Panel, comprising geotechnical and engineering experts, will be established prior to the commencement of works to independently verify building condition survey reports, resolve any property damage disputes and establish ongoing settlement monitoring requirements.	BL/GHF
SG6	Pre-construction	Water table drawdown impact on baseflow and groundwater dependent ecosystems	A focussed study will be carried out to confirm potential groundwater drawdown and associated baseflow reductions at Burnt Bridge Creek, Flat Rock Creek and Quarry Creek due to tunnelling, and confirm potential impacts on freshwater ecology in the affected watercourses and nearby groundwater dependent ecosystems. The study will consider how existing site features affect the interaction between surface water and groundwater along the affected reaches of these watercourses, and the hydraulic connectivity in the underlying geology. Where unacceptable ecological impacts are predicted, feasible and reasonable mitigation measures to address the impacts will be identified, incorporated into the detailed design, and implemented during construction. The mitigation measures considered will include tunnel linings.	BL
SG7	Pre-construction, construction	Ground movement impacts	Pre-construction building structure condition surveys will be offered and prepared (where the offer is accepted by the owner) for properties (and heritage assets) within the zone of influence of tunnel settlement where the degree of severity has been assessed as 'slight' or above and within the minimum working distances for cosmetic and structural damage due to vibration. The surveys will be carried out by a suitably qualified person prior to the commencement of the tunnelling and vibration intensive activities in the vicinity with the potential to affect the building/structure. Within three (3) months of the completion of construction activities that have the potential to cause settlement or vibration-related damage to the subject surface/subsurface structure, all property owners of buildings for which a pre-	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			<p>construction building condition survey was carried out will be offered a second building condition survey. Where an offer is accepted, a post-construction building condition survey will be carried out by a suitably qualified person. The results of the survey will be documented in a post-construction building condition survey report for each building surveyed.</p> <p>Copies of building condition survey reports will be provided to the owners of the buildings surveyed within one (1) month of the survey being completed.</p> <p>Any building and/or property damage from settlement caused by the project will be repaired at no cost to the owner. Any repairs to listed heritage items required as a result of the settlement damage, will be carried out under the guidance of a suitably qualified and experienced heritage professional.</p>	
SG8	Pre-construction and construction	Impacts on site workers and/or local community through disturbance and mobilisation of contaminated material	<p>Potentially contaminated areas directly affected by the project will be further investigated and managed in accordance with the requirements of guidance endorsed under section 105 of the <i>Contaminated Land Management Act 2008</i>.</p> <p>This includes, but is not limited to, further investigations in potential areas of environmental interest in the project footprint, including:</p> <ul style="list-style-type: none"> • Warringah Freeway (from North Sydney to Cammeray) • Punch Street, Artarmon • Willoughby Leisure Centre and Bicentennial Reserve, Willoughby • Flat Rock Reserve, Northbridge • Spit West Reserve, Mosman • Balgowlah Golf Course, Balgowlah • Wakehurst Parkway (from Seaforth to Frenchs Forest). 	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			<p>Subject to the outcomes of the investigations, a Remediation Action Plan will be implemented in the event that site remediation is warranted.</p> <p>The Remediation Action Plan will be prepared in accordance with <i>Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land</i> (Department of Urban Affairs and Planning and Environment Protection Authority, 1998). If Remediation Action Plan(s) are required for works at Flat Rock Drive (BL2), Balgowlah Golf Course (BL10) construction support sites and surface works and construction support site locations along the Wakehurst Parkway (BL12, BL13 and BL14) these will be developed with consideration of environmental management measure WM6.</p> <p>An independent NSW EPA Accredited Site Auditor will be engaged where contamination is complex to review applicable contamination reports and evaluate the suitability of sites for a specified use as part of the project.</p>	
SG9	Construction	Erosion and sedimentation	<p>Erosion and sediment control measures will be implemented at all work sites and surface road upgrades in accordance with the principles and requirements in <i>Managing Urban Stormwater – Soils and Construction, Volume 1</i> (Landcom, 2004), <i>Managing Urban Stormwater: Volume 2D Main Road Construction</i> (NSW Department of Environment and Climate Change, 2008) and relevant guidelines, procedures and specifications of Transport for NSW.</p> <p>A soil conservation specialist will be engaged for the duration of construction of the project to provide advice regarding erosion and sediment control including review of Erosion and Sediment Control Plans.</p>	BL/GHF
SG10	Construction	Impacts on site workers and/or local community through disturbance and	Asbestos handling, management and disposal will be carried out in accordance with relevant legislation, codes of practice and Australian standards.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
		mobilisation of contaminated material		
SG11	Construction	Impacts on site workers and/or local community through disturbance and mobilisation of contaminated material	A hazardous materials assessment will be carried out prior to and during the demolition of structures. Demolition works will be carried out in accordance with the relevant Australian Standards and relevant NSW WorkCover Codes of Practice, including the Work Health and Safety Regulation 2011 (NSW) to minimise potential exposure of construction personnel and the public to hazardous materials.	BL/GHF
SG12	Construction	Impacts on site workers and/or local community through disturbance and mobilisation of contaminated material	A Construction Waste Management Plan will be prepared and implemented during construction. The plan will include but not be limited to procedures for handling and storing potentially contaminated substances.	BL/GHF
SG13	Construction	Impacts on site workers and/or local community through disturbance and mobilisation of contaminated material	The discovery of previously unidentified contaminated material will be managed in accordance with an unexpected contamination discovery procedure, as outlined in the <i>Guideline for the Management of Contamination</i> (Roads and Maritime Services, 2013).	BL/GHF
SG14	Construction	Impacts from disturbance of acid sulfate soils	Prior to ground disturbance in high risk acid sulfate areas at Spit West Reserve and Middle Harbour testing will be carried out to determine the presence of acid sulfate soils. If acid sulfate soils are encountered, they will be managed in accordance with the <i>Acid Sulfate Soil Manual</i> (Acid Sulfate Soil Management Advisory Committee, 1998).	BL
SG15	Construction	Ground gas impacts	Ground gas investigations will be carried out in Flat Rock Reserve to further assess the potential presence of landfill generated gas which could impact on the construction and/or operation of the project.	BL

Ref	Phase	Impact	Environmental management measure	Location
			Ground gas investigations will be carried out in accordance (where applicable) with the <i>Guideline for the Assessment and Management of Sites Impacted by Hazardous Ground Gases</i> (NSW EPA, 2012).	
SG16	Construction	Groundwater drawdown during operation	Measures will be implemented during tunnel construction to ensure that groundwater inflows during the operation phase do not exceed 1L/s/km on average over the entire tunnel length.	BL
SG17	Construction	Marine contamination impacts	The appropriateness of offshore disposal will be assessed in accordance with the Australian Government Department of Agriculture, Water and the Environment's <i>National Assessment Guidelines for Dredging</i> (Department of Environment, Water, Heritage and the Arts, 2009). Offshore disposal will only occur for material that meets the criteria provided in these guidelines.	BL
SG18	Construction and operation	Groundwater drawdown	The groundwater monitoring program will consider additional locations for monitoring that are subject to medium and high risk of groundwater contamination during construction and operation. Where relevant, modelling/mass balance analysis will be carried out to assess potential impacts on beneficial aquifer use and the likely quality of groundwater inflows.	BL/GHF
SG19	Construction and operation	Groundwater quality impacts	If the groundwater quality monitoring and associated analysis identifies potential impacts to beneficial aquifer use from the migration of contaminated groundwater, or the quality of groundwater tunnel inflows, feasible and reasonable management measures will be identified and implemented.	BL/GHF
SG20	Construction and operation	Contamination due to leakage or spills	Emergency procedures, including material bunding and appropriately sized spill containment kits, will be developed to avoid and manage accidental spillages of fuels, chemicals, and fluids to minimise the risk of human health impacts and contamination of groundwater.	

Ref	Phase	Impact	Environmental management measure	Location
Hydrodynamics and water quality				
WQ1	Design	Stormwater harvesting	The need for a stormwater harvesting water quality basin at Balgowlah will be assessed and determined during further design development. If the stormwater harvesting water quality basin is considered to be required, a suitable alternate location and future use will be determined as part of the dedicated consultation process regarding the final layout of the new and improved public open space and recreation facilities at Balgowlah.	BL (Balgowlah)
WQ2	Design	Spill containment	Spill containment controls along surface roads will be confirmed during further design development and determined with consideration of: <ul style="list-style-type: none"> • The environmental sensitivity of the receiving waterways • The likelihood of vehicle accidents, informed by the annual average daily traffic (AADT) loading along the surface road • Where implementation of controls measures may have a negative impact on other areas of environmental importance, such as biodiversity and heritage. 	BL/GHF
WQ3	Design and operation	Local stormwater system capacity	The capacity for the local stormwater system to receive operational wastewater treatment plant discharge will be confirmed during further design development. If there is a stormwater infrastructure capacity issue with existing infrastructure, mitigation measures such as storage detention to control water outflow during wet weather events will be implemented within the motorway facility site.	GHF
WQ4	Design and operation	Burnt Bridge Creek geomorphology	The localised adjustment of Burnt Bridge Creek will be designed with consideration of existing channel conditions and an understanding of existing hydrology to minimise alterations to, and erosion of, the bed and banks. The	BL

Ref	Phase	Impact	Environmental management measure	Location
			<p>gradient, sinuosity and channel capacity will be consistent with upstream and downstream sections.</p> <p>The extension to the existing culvert will be designed with a low gradient and scour protection to minimise impacts to geomorphology. Where required, the adjustment will include grade controls and bank stabilisation works to manage anticipated high velocity conditions.</p>	
WQ5	Design and operation	Water sensitive urban design	<p>Opportunities for water sensitive urban design will be considered during the development of the design for the stormwater management system for the new and upgraded road infrastructure and during development of the urban design and landscape plans. Identified water sensitive urban design features will be implemented where practical and with consideration to best management practice guidelines including Transport for NSW's <i>Water sensitive urban design guideline</i> (Roads and Maritime Services, 2017).</p>	BL/GHF
WQ6	Design and operation	Surface water discharge	<p>Water quality treatment controls for stormwater will meet the design targets, where possible. Where the design targets cannot be met due to site constraints, water quality treatment controls will be provided to meet or improve existing surface water quality.</p>	BL/GHF
WQ7	Design and operation	Connection to Sydney Water stormwater assets	<p>The need for direct connection to Sydney Water stormwater assets will be reviewed during further design development and in consultation with Sydney Water. Where direct connection to a Sydney Water stormwater asset is required, the project will install and operate water treatment devices during operation to achieve the Sydney Water pollutant load reduction targets where feasible and reasonable.</p>	BL/GHF
WQ8	Design and construction	Watercourse geomorphology	<p>The potential for scour and erosion of watercourse bed and banks will be considered during the design of new discharge outlets.</p>	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			Construction work activities within or next to the watercourses and drainage lines will be minimised as much as reasonably practical to minimise disturbance of sediments in or near the waterway.	
WQ9	Design and construction	Local stormwater system capacity	Further design development will confirm the local stormwater system capacity to receive construction wastewater treatment plant inflows. If there is a stormwater infrastructure capacity issue with existing infrastructure, mitigation measures such as storage detention to control water outflow during wet weather events will be considered and implemented within the construction support site where feasible and reasonable.	BL/GHF
WQ10	Pre-construction and construction	Freshwater quality monitoring	<p>A freshwater quality monitoring program for the construction of the project will be developed and implemented, with consideration of the freshwater monitoring being carried out for the Western Harbour Tunnel and Warringah Freeway Upgrade project and the completed Northern Beaches Hospital road upgrade project.</p> <p>The program will be developed in consultation with the Environment Protection Authority, Department of Planning, Industry and Environment (Natural Resources Access Regulator), Department of Planning, Industry and Environment (Water), and relevant councils.</p> <p>Sampling locations and monitoring methodology including frequency and indicators will be in accordance with the <i>Guideline for Construction Water Quality Monitoring</i> (RTA 2003) and ANZG (2018).</p> <p>If exceedances of the criteria established under the freshwater monitoring program are detected, a management response will be triggered and appropriate mitigation measures to address the exceedance will be identified and implemented.</p>	BL

Ref	Phase	Impact	Environmental management measure	Location
WQ11	Construction	Wastewater discharge	<p>Discharges from wastewater treatment plants during the construction phase will be required to meet the following discharge criteria:</p> <ul style="list-style-type: none"> • The relevant physical and chemical stressors set out in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000) • The ANZG (2018) 90 per cent species protection levels for toxicants generally, with the exception of those toxicants known to bioaccumulate, which will be treated to meet the ANZG (2018) 95 per cent species protection levels • The draft ANZG default guideline values for iron (in fresh and marine water) and zinc (in marine water). 	BL/GHF
WQ12	Construction	Dredge plumes	<p>Monitoring of dredge plumes will be carried out during dredging activities to validate the dredge plume dispersion predictions. Exceedances of the predicted dredge plume extents and intensities will trigger subsequent management responses that will include a range of strategies including, assessing whether secondary impacts are occurring (eg seagrass stress) and if so then further levels of management actions will be implemented, such as adjustments to the dredging process.</p>	BL
WQ13	Construction	Watercourse geomorphology	<p>During construction, the drainage and adjustment works associated with Burnt Bridge Creek and an existing aboveground constructed drainage line within Flat Rock Reserve will be staged to ensure creek flows and velocities are not substantially changed and to avoid downstream erosion and bed and bank stability impacts.</p>	BL/GHF
WQ14	Construction	Sediment basin discharge	<p>Sediment basin discharge impact assessments, commensurate with the potential risk and consistent with the <i>National Water Quality Guidelines</i> (ANZG (2018)) and <i>Managing Urban Stormwater – Soils and Construction</i>,</p>	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			Volume 1 (Landcom, 2004) will be prepared to inform the criteria for discharge from sediment basins.	
WQ15	Construction	Erosion and sedimentation	Disturbed floodplain environments next to the watercourses and/or along overland drainage lines should be stabilised as soon as practical following disturbance.	BL/GHF
WQ16	Construction	Marine water quality	<p>Management measures that will be implemented during dredging activities to minimise impacts on marine water quality, vegetation and habitats will include:</p> <ul style="list-style-type: none"> • Use of a backhoe dredge with a closed environmental clamshell bucket operated within a localised floating silt curtain enclosure to a depth of two to three metres to dredge the top layer of marine sediments • Implementation of 10 to 12 metre deep-draft silt curtains around the dredge works • Implementation of silt curtains in accordance with environmental management measures B31 to B33. 	BL
WQ17	Operation	Wastewater discharge	<p>The Gore Hill Freeway wastewater treatment plant will be designed to treat wastewater generated from tunnel groundwater ingress and rainfall runoff in tunnel portals and the following discharge criteria:</p> <ul style="list-style-type: none"> • The relevant physical and chemical stressors set out in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000) • The ANZG (2018) 95 per cent species protection levels for toxicants generally, with the exception of those toxicants known to bioaccumulate, which would be treated to meet the ANZG (2018) 99 per cent species protection levels • The draft ANZG default guideline values for iron (in fresh and marine water) and zinc (in marine water). 	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
WQ18	Operation	Operational monitoring	<p>Operational phase monitoring of surface water quality of sensitive receiving environments will be described in the operational surface water quality monitoring program and carried out in line with the post construction phase requirements of the <i>Roads and Maritime Guideline for Construction Water Quality Monitoring</i> (RTA, 2003).</p> <p>As a minimum, monthly monitoring will be carried out for the first year of operation or until a suitably qualified and experienced independent expert determines that a site has adequately stabilised and stormwater basin discharge criteria are achieved.</p> <p>Should discharge criteria from operational stormwater basins be exceeded, a management response will be triggered and appropriate mitigation measures to address the exceedance will be identified and implemented.</p>	BL/GHF
Flooding				
F1	Design	Impact of the project on flood behaviour	<p>Where flood levels in the 1% AEP event are predicted to increase at any residential, commercial and/or industrial buildings as a result of operation of the project, a floor level survey will be carried out.</p> <p>If the survey indicates existing buildings would experience above floor inundation during a 1% AEP event as a result of the project, further refinements will be made (as required) to the design of permanent project components to minimise the potential for impacts.</p>	BL/GHF
F2	Design	Operational flooding impacts	Impact of the project on flood behaviour during operation will be confirmed during further project development. This will include the consideration of future climate change and a partial blockage of the local stormwater drainage system.	BL/GHF
F3	Design	Impact of flooding on the project	Flood emergency management measures for construction and operation of the project will be prepared in consultation with State Emergency Services and relevant	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			councils and incorporated into relevant environmental and/or safety management documentation.	
F4	Design	Impact of the project on scour potential	Measures will be assessed during further design development which are aimed at reducing as far as is practical the risk of increased scour in the receiving drainage lines that are located along the Wakehurst Parkway. Scour countermeasures will also be provided at the outlet of new or upgraded transverse and longitudinal drainage lines.	BL/GHF
F5	Design and construction	Impacts of construction sites on flood behaviour	Detailed construction planning will consider flood risk at construction sites and construction support sites. This will include: <ul style="list-style-type: none"> • A review of site layout and staging of construction activities to avoid or minimise obstruction of overland flow paths and limit the extent of flow diversion required • Identification of measures to not worsen flood impacts on the community and on other property and infrastructure during construction up to and including the 1% AEP flood event where reasonable and feasible • Measures to mitigate alterations to local runoff conditions due to construction activities. 	BL/GHF
F6	Construction	Flooding impacts to tunnel excavation	Entries to tunnel excavations, including cut and cover sections of tunnel, will be protected against frequent flooding by locating openings outside flood prone areas, and/or the provision of local bunding and flood protection barriers.	BL/GHF
F7	Construction	Flooding impacts to tunnel excavation	The flood standard adopted at each tunnel entry during construction will be developed taking into consideration the duration of construction, the magnitude of inflows and the potential risks to personal safety and the project works.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
F8	Construction	Flood impacts to construction sites	Spoil stockpiles will be located in areas which are not subject to frequent inundation by floodwater, ideally outside the 10% AEP flood extent. The exact level of flood risk accepted at stockpile sites will depend on the duration of stockpiling operations, the type of material stored, the nature of the receiving drainage lines and also the extent to which it would impact flooding conditions in adjacent development.	BL/GHF
F9	Operation	Flood impacts to construction sites	Site facilities will be located outside high flood hazard areas based on a 1% AEP flood.	BL/GHF
Biodiversity				
B1	Design	Removal of native vegetation and threatened species habitat	The area required and layout of Flat Rock Drive construction support site (BL2) will be refined during further design development and construction planning to avoid direct impacts on PCT 1841, where feasible and reasonable.	BL
B2	Design	Injury and mortality of fauna	Connectivity measures will be designed during further design development in accordance with the <i>Wildlife Connectivity Guidelines: Managing wildlife connectivity of road projects</i> (Draft) (Roads and Maritime Services, 2011) and consider measures to facilitate the crossing of native fauna species including the Eastern Pygmy-possum, Red-crowned Toadlet, Southern Brown Bandicoot and Rosenberg's Goanna. Maintenance requirements for underpasses and rope crossings will be developed during further design development and incorporated into an Operational Environmental Management Plan or existing Environmental Management System as relevant.	BL
B3	Design	Injury and mortality of fauna	Fauna exclusion fencing would be designed to exclude small fauna species from the road corridor such as Eastern Pygmy-possum and will be installed for the full extent of the Wakehurst Parkway within the construction	BL

Ref	Phase	Impact	Environmental management measure	Location
			footprint. The design specifications of the fauna exclusion fence will be developed during further design development including the need for access gates to manage any fauna on the roadside of the fauna exclusion fence based on best available knowledge from other Transport for NSW projects.	
B4	Design and operation	Noise, vibration and light impacts	Artificial light impacts on native fauna in the operational phase of the project will be minimised where feasible and reasonable through further design development, where the project adjoins tracts of fauna habitat (eg along the Wakehurst Parkway) consistent with the requirements of <i>Australian Standards and Guidelines 4282 – 2019 Control of the obtrusive effects of outdoor lighting</i> .	BL/GHF
B5	Pre-construction	Impacts to marine species	Pre-construction surveys of potentially affected marine habitat areas will be carried out as close as practicable to 24 hours prior to commencement of works by suitably qualified and experienced marine ecologists to search for White's Seahorses (and other Syngnathids) and relocate them to nearby habitat.	BL
B6	Pre-construction	Removal of native vegetation and threatened species habitat	Vegetation removal including the clearing of native vegetation and fauna habitat will be further minimised during further design development and construction planning, where feasible and reasonable.	BL/GHF
B7	Pre-construction and construction	Impacts on the Large-eared Pied Bat	Activity-specific controls will be developed to manage impacts from high noise and vibration generating activities (eg controlled blasting and rock hammering) on Large-eared Pied Bat along the Wakehurst Parkway. The controls will be prepared by a suitably qualified and experienced microbat specialist and implemented during surface road works as required.	BL
B8	Pre-construction	Impact to aquatic environments	Any dewatering activities will be undertaken in accordance with the <i>Technical Guideline: Environmental Management of Construction Site Dewatering</i> (RTA, 2011), in a manner that prevents pollution of waters.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			Dewatering of the stormwater harvesting dam at Balgowlah Golf Course will be carried out with consideration of native fauna and appropriate measures will be implemented to relocate native aquatic fauna as required.	
B9	Pre-construction and construction	Underwater noise impacts to marine species	Prior to commencement of impact piling appropriate management measures to minimise noise impacts on fish and aquatic organisms will be developed by a suitably qualified and experienced marine ecologist and implemented during impact piling works. The measures will include investigation and contingency actions should distressed or dead fish be observed within or adjacent to the construction footprint during piling works.	BL
B10	Construction	Removal of native vegetation and threatened species habitat	Vegetation removal along the Wakehurst Parkway will be timed to avoid the winter breeding period for the Eastern Pygmy-possum (May to July), where feasible and reasonable.	BL
B11	Construction	Removal of native vegetation and threatened species habitat	Vegetation removal will be carried out in accordance with <i>Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011).	BL/GHF
B12	Construction	Removal of native vegetation and threatened species habitat	The unexpected species find procedure included in <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011) will be followed if threatened ecological communities, flora or fauna species, not assessed in the biodiversity development assessment report, are identified in the construction footprint.	BL/GHF
B13	Construction	Removal of native vegetation and threatened species habitat	Vegetation will be re-established within the construction footprint, where feasible, in accordance with <i>Guide 3: Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011).	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
B14	Construction	Removal of native vegetation and threatened species habitat	Pre-clearing surveys for threatened fauna species will be carried out in accordance with <i>Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011). This will include inspections of hollows and dead timber for Eastern Pygmy-possum.	BL/GHF
B15	Construction	Removal of threatened flora species	Prior to clearing, the location of the individual of <i>Syzygium paniculatum</i> next to the Wakehurst Parkway will be confirmed. If the individual is outside the construction footprint, but in close proximity to the boundary, the need for a site-specific exclusion zone will be investigated to minimise potential indirect impacts. Should the individual be within the construction footprint, further design investigation will be carried out to determine if impacts can be avoided where reasonable and feasible.	BL
B16	Construction	Removal of threatened flora species	Pre-clearing surveys for threatened flora species will be carried out in accordance with <i>Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011).	BL/GHF
B17	Construction	Noise, vibration and light impacts	Mitigation measures such as quieter construction methods or the use of temporary noise barriers in close proximity to the construction activities will be used wherever feasible and reasonable to minimise noise impacts to the Grey-headed Flying-fox camp. For the Kitchener Street construction support site (BL11), the arrangement of the site layout should maximise acoustic shielding (ie locations of site sheds, offices and fixed structures) to minimise noise impacts from within the site to the direction of the Grey-headed Flying-fox camp.	BL
B18	Construction	Noise, vibration and light impacts	Where feasible and reasonable, noise intensive works with the potential of impacting the Grey-headed Flying-fox camp (ie demolition involving rock hammering or resurfacing works) should be programmed to avoid September to February.	BL

Ref	Phase	Impact	Environmental management measure	Location
B19	Construction	Noise, vibration and light impacts	A person experienced in flying-fox behaviour, (ie able to identify each stage of the reproductive cycle, ABLV-vaccinated and trained to rescue flying-foxes if required) will monitor disturbance levels within the Grey-headed Flying-fox camp at Balgowlah during construction activities that result in noise levels at the camp that exceed the pre-construction ambient noise levels. Monitoring would occur at representative periods (eg fortnightly) while pups are being carried (August-February).	BL
B20	Construction	Noise, vibration and light impacts	Adaptive management measures to minimise impacts on Grey-headed Flying-foxes will be developed in consultation with Department of Planning, Industry and Environment (Environment, Energy and Science) and an appropriately qualified expert in Grey-headed Flying-fox biology and behaviour, if Grey-headed Flying-fox behaviour during monitoring suggests that disturbance levels are high.	BL
B21	Construction	Noise, vibration and light impacts on fauna	Controlled blasting, rock hammering and other potential high noise generating activities along the Wakehurst Parkway will be managed to minimise noise and vibration levels to adjacent fauna habitat where practicable, including but not limited to: <ul style="list-style-type: none"> • Use of noise suppression devices on plant and equipment in accordance with the manufacturer's specifications • Regularly maintain plant and equipment to minimise noise levels when in use • Substituting plant or processes to reduce noise. 	BL
B22	Construction	Injury and mortality of fauna	Fauna will be managed in accordance with <i>Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011).	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
B23	Construction	Injury and mortality of fauna	Pre-clearing surveys for non-threatened fauna species will be carried out in accordance with <i>Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011). Surveys will also include human made structures that have been identified as potentially providing habitat for microbats and are subject to demolition or modification.	BL/GHF
B24	Construction	Injury and mortality of fauna	An observer qualified to spot Little Penguins will be used during marine construction activities. A stop-work procedure will be developed by a suitably qualified and experienced ecologist and implemented upon evidence of the species in the proximity of the works area.	BL
B25	Construction	Invasion and spread of weeds, pests, pathogens and disease	Weed species will be managed in accordance with <i>Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011).	BL/GHF
B26	Construction	Invasion and spread of weeds, pests, pathogens and disease	Pathogens will be managed in accordance with <i>Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011).	BL/GHF
B27	Construction	Removal of aquatic habitat	Aquatic habitats will be protected in accordance with <i>Guide 10: Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA, 2011) and the <i>Policy and guidelines for fish habitat conservation and management</i> (NSW DPI, 2013). This will include flow and sufficient fish passage to be maintained similar to current conditions during instream works where reasonable and feasible.	BL/GHF
B28	Construction	Impacts to marine vegetation and sensitive habitat	Transit routes for vessels entering and departing from construction support sites will be marked out with consideration for propeller wash and distances to sensitive marine habitats.	BL

Ref	Phase	Impact	Environmental management measure	Location
B29	Construction	Impacts to marine vegetation and sensitive habitat	Exclusion zones will be implemented to avoid disturbance to sensitive marine habitats not proposed to be directly impacted by the project. These include any intertidal sand and mudflats, intertidal rocky shore, subtidal rocky reef and seagrass habitats with potential to occur within or next to transit routes and vessel movements. Routine inspections and maintenance of exclusion measures will be carried out.	BL
B30	Construction	Impacts to marine vegetation and sensitive habitat	Scour protection measures including possible velocity reduction from wastewater treatment plant discharge will be implemented where reasonable and feasible to avoid scour impacts on the marine environment.	BL
B31	Construction	Impacts to marine vegetation and sensitive habitat	To minimise the potential impact of turbidity (suspended sediment) on sensitive marine vegetation and habitats, silt curtains will be installed around seagrass patches and subtidal rocky reef contained within the Zone of Influence as described in the Appendix T (Technical working paper: Marine ecology).	BL
B32	Construction	Impacts to marine vegetation and sensitive habitat	Silt curtains will be monitored for effectiveness particularly following inclement weather and maintenance carried out when required. Records of monitoring and maintenance will be kept.	BL
B33	Construction	Impacts to marine vegetation and sensitive habitat	To avoid direct damage to seagrass and subtidal rocky reef from silt curtain movement, there will be a suitable buffer distance between marine habitat and the silt curtain to account for curtain movement due to tides and currents and to prevent shading of the marine vegetation from the silt curtain. The silt curtain will be anchored to bare sediment where practicable to avoid movement.	BL
B34	Construction	Impacts to marine vegetation and sensitive habitat	Subtidal rocky reef habitat removed along the shoreline at the Middle Harbour north cofferdam (BL8) and intertidal rocky shore, sand and mudflat habitats removed at the Spit West Reserve construction support site (BL9) will be	BL

Ref	Phase	Impact	Environmental management measure	Location
			rehabilitated and restored as close as possible to pre-construction conditions where feasible and reasonable.	
B35	Construction	Invasion and spread of marine pests, pathogens and disease	Locally sourced vessels and equipment will be used where feasible and reasonable. Any vessels sourced internationally will be inspected for potential marine pests prior to departing from their previous port. Construction contractors will need to demonstrate that due diligence has been taken to avoid introducing marine pests, pathogens or disease from internationally sourced vessels and/or construction equipment prior to departure.	BL
B36	Construction	Invasion and spread of marine pests, pathogens and disease	A targeted survey will be conducted of the dredge footprint to locate any areas of the marine algal pest <i>Caulerpa taxifolia</i> . If <i>Caulerpa taxifolia</i> is identified within the dredging footprint, surface sediments from these areas will be disposed of onshore rather than in the marine environment.	BL
B37	Construction	Impacts to marine species	A stop work procedure will be developed in accordance with the recommendations in Appendix T (Technical working paper: Marine ecology) to mitigate potential impacts to marine mammals and reptiles within the vicinity of impact piling works.	BL
B38	Construction	Impacts to marine species	Salvage of live fish and other native marine organisms (eg large, mobile macroinvertebrates) will occur during cofferdam dewatering and will be carried out by suitably qualified and experienced marine ecologists. All salvaged organisms will be immediately relocated to similar habitat nearby.	BL
Land use and property				
LP1	All phases	Changes to lease arrangements	Transport for NSW will consult with existing lease holders of properties that will be directly affected by the project regarding any changes to lease arrangements.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
LP2	All phases	Residual land	Identification of residual land of the project will be confirmed during further design development and construction planning. Appropriate strategies for the ongoing management and/or divestment of the residual land will consider the location, land use characteristics, area and adjacent land uses.	BL/GHF
LP3	Pre-construction and construction	Property acquisition	<p>Land acquisition for the project will be carried out in accordance with the <i>Land Acquisition (Just Terms Compensation) Act 1991</i>, the <i>Roads and Maritime Services Land Acquisition Information Guide</i> (Roads and Maritime Services, 2014) and <i>Fact sheet: Property acquisition of subsurface lands</i> (Roads and Maritime Services, 2015) and in accordance with the land acquisition reforms announced by the NSW Government in 2016.</p> <p>Transport for NSW will appoint a Personal Manager - Acquisition to help landowners and residents who may be affected by acquisition for the project. The Personal Manager - Acquisition will be in regular contact with these individuals to provide updates on the project and respond to questions and queries. Should acquisition for the project be confirmed for a particular property, the Personal Manager - Acquisition will work with the affected landowners and residents to offer assistance and support throughout the acquisition and relocation process.</p>	BL/GHF
LP4	Pre-construction and construction	Residual land at Balgowlah	A dedicated consultation process jointly led by Transport for NSW and Northern Beaches Council will take place to give the community an opportunity to provide input on the final layout of the new and improved open space and recreation facilities at Balgowlah. This process will start after the environmental impact statement public exhibition period and well in advance of construction commencing. As part of this consultation process, a community reference group will be established, with representative stakeholder groups and the community, to support	BL (Balgowlah)

Ref	Phase	Impact	Environmental management measure	Location
			Transport for NSW and Northern Beaches Council with the development of this important public space.	
LP5	Construction	Temporary use of land	Land subject to temporary use, including areas of public open space, will be rehabilitated as soon as practicable to an appropriate condition, taking into consideration the location, land use characteristics, area and adjacent land uses or in accordance with the urban design and landscape plan where applicable (environmental management measure V1). Rehabilitation will be carried out in consultation with the relevant landowner, the local council and community (where appropriate).	BL/GHF
LP6	Construction	Access impediments to private property	Where impacts to private property access is unavoidable during construction, landowners or lease holders/tenants where appropriate will be consulted in advance to develop appropriate alternative access arrangements.	BL/GHF
LP7	Operation	Air quality impacts for elevated receivers located around ventilation outlets and motorway facilities	Transport for NSW will assist Northern Beaches Council, North Sydney Council, Willoughby City Council and the Department of Planning, Industry and Environment (as appropriate) in determining relevant land use considerations applicable to future development in the immediate vicinity of ventilation outlets for inclusion in local environmental plans or development control plans, where required, to manage interactions between the project and future development. This may include procedures for identifying the requirement for consultation with Transport for NSW.	BL/GHF
Socio-economics				
SE1	Design	Social infrastructure	Where feasible and reasonable, the extent of permanent impact on public open space areas (for example, Artarmon Park) will be minimised in further design development.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
SE2	Construction	Social infrastructure	Ongoing engagement will be carried out with representatives of user groups and managers of social infrastructure located near surface construction works/construction support sites and sensitive social infrastructure above the tunnel alignment (for example, schools, places of worship, aged care, child care, health and medical facilities) about the timing and duration of construction works and management of potential impacts.	BL/GHF
SE3	Pre-construction and construction	Stakeholders, community and business	Consultation for the project will be carried out in accordance with the Community Consultation Framework provided as Appendix E of the environmental impact statement.	BL/GHF
SE4	Pre-construction and construction	Employment benefits	A workforce strategy for the project that includes strategies to increase employment and training opportunities for groups such as Aboriginal people, women, young people and the unemployed will be developed and implemented to help maximise employment benefits of the project.	BL/GHF
BU1	Pre-construction and construction	Businesses	Where businesses are affected by property acquisition, or lease cessation, the acquisition and compensation process will be implemented in line with the <i>Determination of compensation following the acquisition of a business guideline</i> . Compensation for a business conducted on land that is acquired should be determined in accordance with the <i>Land Acquisition (Just Terms Compensation) Act 1991</i> as relevant.	BL/GHF
BU2	Construction	Businesses	Specific consultation will be carried out with businesses potentially impacted during construction. Consultation will aim to identify specific potential construction impacts for individual businesses.	BL/GHF
BU3	Construction	Businesses	Based on consultation with businesses, specific feasible and reasonable measures to maintain business access, visibility, parking and address other potential impacts as they arise through the construction phase will be identified	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			and implemented. A phone hotline that enables businesses to find out about the project or register any issues will be maintained.	
Landscape character and visual amenity				
V1	Design	Vegetation/ landscaping	The urban design and landscape plan will be further developed during further design development and implemented in line with the strategic urban design framework for the project and appropriate operational mitigation measures (Appendix V (Technical working paper: Urban design, landscape character and visual impact)). The urban design and landscape plan will detail built and landscape features to be implemented during construction and rehabilitation of disturbed areas during construction of the project. The urban design and landscape plan will be made available to the public for feedback.	BL/GHF
V2	Construction	Built form	Construction support sites will be developed to minimise visual impacts for adjacent receivers where feasible and reasonable.	BL/GHF
V3	Construction	Built form	Storage areas and associated works will be located in cleared or otherwise disturbed areas away from residential areas where feasible and reasonable.	BL/GHF
V4	Construction	Built form	Site hoardings will be in neutral colours and designs, in proximity to open space, to help them blend into surrounding environment.	BL/GHF
V5	Construction	Built form	Site hoarding and perimeter site areas will be maintained regularly to include the prompt removal of graffiti.	BL/GHF
V6	Construction	Built form	Site lighting will be designed to minimise glare issues and light spillage into adjoining properties and be generally consistent with the requirements of Australian Standard	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			4282-2019 <i>Control of the obtrusive effects of outdoor lighting.</i>	
V7	Construction	Built form	Hoardings and temporary noise walls will be erected as early as possible within the site establishment phase to provide visual screening.	BL/GHF
V8	Construction	Built form	High quality fencing suitable for parks and public spaces will be used where construction support sites are located in close proximity to sensitive residential receivers and users of recreational space.	BL/GHF
V9	Construction	Vegetation/ landscaping	Existing trees adjacent to the works will be retained and protected where possible to screen construction works.	BL/GHF
V10	Construction	Vegetation/ landscaping	Where possible, trees will be trimmed rather than removed. Works will be supervised by a qualified arborist.	BL/GHF
V11	Construction	Vegetation/ landscaping	All areas disturbed by construction and not required for operation of the project will be restored as soon as practicable to their existing condition or in accordance with the urban design and landscape plan where applicable (environmental management measure V1).	BL/GHF
V12	Construction	Vegetation/ landscaping	Early planting works will be considered to provide a screening buffer that has time to mature before the project is fully operational.	BL/GHF
V13	Construction	Vegetation/ landscaping	Where amenity trees are removed as a result of the establishment of construction support sites, they will be replaced at a ratio equal to or greater than 1:1. The replacement trees will consist of local native provenance species from the vegetation community that once occurred in the locality (rather than plant exotic or non-local native trees) where available and subject to the urban design and landscape plan. Where replacement trees cannot be accommodated within the operational footprint of the project, consultation will be carried out with the adjacent land owner and relevant local council (where appropriate)	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			to determine if they can accommodate the replacement tree(s).	
Hazards and risks				
HR1	Construction and operation	Transportation of dangerous goods and hazardous substances	Dangerous goods and hazardous materials will be stored in accordance with supplier's instructions and relevant legislation. Australian Standards, and applicable guidelines and may include bulk storage tanks, chemical storage cabinets/containers or impervious bunds.	BL/GHF
HR2	Construction	Transportation of dangerous goods and hazardous substances	Dangerous goods and hazardous substances will be transported in accordance with relevant legislation and codes, including the <i>Dangerous Goods (Road and Rail Transport) Act 2008</i> , Road and Rail Transport (Dangerous Goods) (Road) Regulation 1998 and the <i>Australian Code for the Transport of Dangerous Goods by Road and Rail</i> (National Transport Commission, 2007).	BL/GHF
HR3	Construction	Bushfire	Adequate access and egress for fire fighting vehicles and staff will be provided at the Wakehurst Parkway south (BL12), Wakehurst Parkway east (BL13) and Wakehurst Parkway north (BL14) construction support sites. Access roads will have a minimum width of four metres to allow passage of fire fighting vehicles.	Wakehurst Parkway south (BL12), Wakehurst Parkway east (BL13) and Wakehurst Parkway north (BL14) construction support sites
HR4	Construction	Bushfire	Adequate setbacks from bushfire prone vegetation to allow for fire fighting vehicle access will be provided for the Wakehurst Parkway south (BL12), Wakehurst Parkway east (BL13) and Wakehurst Parkway north (BL14) construction support sites.	Wakehurst Parkway south (BL12), Wakehurst Parkway east (BL13) and Wakehurst Parkway north (BL14) construction support sites.
HR5	Construction	Bushfire	An emergency response plan will be prepared for the construction of the project at the Wakehurst Parkway	Wakehurst Parkway south (BL12),

Ref	Phase	Impact	Environmental management measure	Location
			south (BL12), Wakehurst Parkway east (BL13) and Wakehurst Parkway north (BL14) construction support sites, including a bushfire risk matrix.	Wakehurst Parkway east (BL13) and Wakehurst Parkway north (BL14) construction support sites.
HR6	Construction	Bushfire	First response capabilities, including fire extinguishers, water carts and hoses will be assessed and provided at the Wakehurst Parkway south (BL12), Wakehurst Parkway east (BL13) and Wakehurst Parkway north (BL14) construction support sites, where needed.	Wakehurst Parkway south (BL12), Wakehurst Parkway east (BL13) and Wakehurst Parkway north (BL14) construction support sites.
HR7	Operation	Bushfire	Adequate access and egress for fire fighting vehicles and operation vehicles will be provided at the Beaches Link tunnel support facilities at the Wakehurst Parkway at Frenchs Forest.	Beaches Link tunnel support facilities at Wakehurst Parkway at Frenchs Forest
HR8	Operation	Bushfire	Adequate setbacks from bushfire prone vegetation will be provided for the Beaches Link tunnel support facilities at the Wakehurst Parkway at Frenchs Forrest and ventilation outlet at the Wakehurst Parkway, Killarney Heights.	Beaches Link tunnel support facilities at the Wakehurst Parkway at Frenchs Forest and, ventilation outlet at Wakehurst Parkway at Killarney Heights.
HR9	Operation	Fire and life safety	The fire and safety systems and measures adopted for the project will be equivalent to or exceed the fire safety measures recommended by NFPA502 (American) (National Fire Protection Association (NFPA), 2020), Permanent International Association of Road Congresses (PIARC) (European), AS4825-2011 (Standards Australia, 2011) and AS3959-2018 (Standards Australia, 2018), and Transport for NSW standards.	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
HR10	Operation	Transportation of dangerous goods and hazardous substances	The transport of dangerous goods and hazardous substances will be prohibited through the mainline and ramp tunnels.	BL/GHF
HR11	Operation	Incident response	The response to incidents within the motorway will be managed in accordance with the memorandum of understanding between Transport for NSW and the NSW Police Service, NSW Rural Fire Service, NSW Fire Brigade and other emergency services.	BL/GHF
HR12	Operation	Aviation risks	The ventilation outlet and motorway facilities at the Warringah Freeway will be operated in accordance with any conditions of approval from the Secretary of Department of Infrastructure, Transport, Regional Development and Communications to manage penetration of the OLS layers.	BL
Resource use and waste management				
WM1	Construction	Resource use	Construction materials will be sourced in accordance with the project's Sustainability Framework and with a preference for Australian materials and prefabricated products with low embodied energy, where feasible and reasonable.	BL/GHF
WM2	Construction	Resource management	The resource management hierarchy principles established under the <i>Waste Avoidance and Recovery Act 2001</i> of avoid/reduce/reuse/recycle/dispose will be applied.	BL/GHF
WM3	Construction	Waste generation and disposal	Any surplus material requiring offsite disposal to land, including marine sediments unsuitable for offshore disposal, will be classified in accordance with <i>Waste Classification Guidelines</i> (NSW EPA, 2014).	BL/GHF
WM4	Construction	Storage and transport of waste	Wastes will be appropriately transported, stored and handled according to their waste classification and in a	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			manner than prevents pollution of the surrounding environment.	
WM5	Construction	Waste generation and disposal	Opportunities for terrestrial spoil reuse within the project corridor, so as to minimise the quantity of material disposed to land will be investigated and implemented where feasible and reasonable.	BL/GHF
WM6	Construction	Wastewater generation and disposal	Opportunities for wastewater reuse and recycling, including use of stormwater from sediment basins and recirculating water during tunnel excavation to use for dust suppression or off-site reuse, will be investigated and implemented where feasible and reasonable.	BL/GHF
WM7	Construction	Management of mulch	Mulch stockpiles and the potential generation of tannin leachates will be managed through the implementation of <i>Environmental Direction for the Management of Tannins from Vegetation Mulch</i> (Roads and Maritime Services, 2012).	BL/GHF
WM8	Construction	Reuse of vegetation waste	Where reasonable and feasible, salvaged logs from the clearing process will be reused on site and/or reused as part of the fauna connectivity structures with consideration of the <i>Guide 5: Re-use of woody debris and bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011)</i> .	BL/GHF
WM9	Construction	Waste disposal	Further investigations will be carried out at the Flat Rock Drive (BL2), Balgowlah Golf Course (BL10) construction support sites and surface works and construction support site locations along the Wakehurst Parkway (BL12, BL13 and BL14) to determine the feasibility of encapsulation of contaminated materials on site. Where contaminated soils and other materials are to be encapsulated on-site, encapsulation will be designed in accordance with the requirements detailed in the <i>Guidelines for the Assessment of On-site Containment of Contaminated Soil</i> (ANZECC, 1999).	Flat Rock Drive (BL2), Balgowlah Golf Course (BL10), Wakehurst Parkway south (BL12), Wakehurst Parkway east (BL13) and Wakehurst Parkway north (BL14) construction support sites

Ref	Phase	Impact	Environmental management measure	Location
WM10	Operation	Resource use and waste generation	The project will be operated in accordance with the relevant aims of the project's Sustainability Framework to optimise resource efficiency and waste management.	BL/GHF
WM11	Operation	Waste generation and disposal	Waste will be managed and disposed of in accordance with relevant applicable legislation, policies and guidelines, including the <i>Waste Avoidance and Resource Recovery Act 2001</i> and the <i>NSW Waste Avoidance and Resource Recovery Strategy 2014–21</i> (NSW EPA, 2014).	BL/GHF
WM12	Operation	Water use and discharge	Opportunities to reuse treated groundwater during project operation will be considered where feasible and reasonable.	BL/GHF
Sustainability				
SU1	Design	Project sustainability outcomes	Project sustainability objectives and targets will be finalised during further design development, informed by the requirements of the project planning approval.	BL/GHF
SU2	Construction	Project sustainability outcomes	Activities to implement the sustainability framework, including requirements from the Infrastructure Sustainability rating scheme, will be implemented through a Sustainability Management Plan. The management plan will detail measures to meet the sustainability objectives and targets as well as achieving 'Design' and 'As Built' ratings of Excellent under the Infrastructure Sustainability Council of Australia rating scheme.	BL/GHF
Climate change risks				
CC1	Design	Climate change risks and flood modelling projections	The following actions will be carried out during further design development to ensure climate change is adequately addressed: a) Flood modelling will continue to use sea level rise projections and future climate change rainfall projections b) The extent of scour protection will be refined	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
			c) Sensitivity testing for future climate change will be carried out in the detailed design of drainage channels and culverts. Increased capacity will be provided where feasible and reasonable.	
Greenhouse gas emissions				
GHG1	Design	Energy efficiency	Energy efficiency will be considered during further design development with energy efficient systems installed where reasonable and practicable.	BL/GHF
GHG2	Construction	Emission of greenhouse gases during construction	Greenhouse gas emissions will be managed and minimised as part of the Sustainability Management Plan and will be implemented to assist in achieving 'Design' and 'As Built' ratings of Excellent under the Infrastructure Sustainability Council of Australia rating scheme (Version 1.2).	BL/GHF
Cumulative impacts				
CI1	Pre-construction	Cumulative impacts	Considered and tailored multi-party engagement and cooperation will be established prior to construction to ensure all contributors to impacts are working together to minimise adverse impacts or enhance benefits of multiple projects occurring concurrently or consecutively. Haulage routes and road occupancy will be coordinated with other major transport projects via Greater Sydney Operations.	BL/GHF
CI2	Pre-construction	Construction fatigue	Multi-party engagement and cooperation will be established prior to construction to coordinate with the following projects to manage construction fatigue impacts where possible: <ul style="list-style-type: none"> Western Harbour Tunnel and Warringah Freeway Upgrade Sydney Metro City & Southwest Channel 9 site staged residential redevelopment. 	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
CI3	Construction	Cumulative impacts	Communication strategies for the project will be managed consistently across the NSW Government transport portfolio and in accordance with the Community consultation framework for the project.	BL/GHF
CI4	Construction	Complaints fatigue	Complaint fatigue will be managed as outlined in Chapter 7 (Stakeholder and community engagement) of the environmental impact statement. Complaint management tools for the project are outlined in Appendix E (Community consultation framework).	BL/GHF
CI5	Construction	Spoil management	Co-ordination and engagement with proponents of other major projects, including external to Transport for NSW, will be undertaken prior to construction to identify the opportunity for beneficial reuse of construction spoil where it cannot be reused on site and prior to consideration of disposal options.	BL/GHF