



Climate Change Monitoring and Adaptive Management Framework

M12 Motorway – Central

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Plan prepared by:	Plan reviewed by:	Plan endorsed by:
Peter Monsted	Tom Bath	Scott Calleja
Seymour Whyte Environment and Sustainability Manager	Seymour Whyte Environmental Site Representative	Seymour Whyte Project Director
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Glossary/ Abbreviations

Abbreviations	Expanded text
AR5	IPCC 5 th Assessment Report
AR6	IPPC 6 th Assessment Report
ARSR	Amendment Report Submissions Report
BoM	Bureau of Meteorology
CCMAMF	Climate Change Monitoring and Adaptive Management Framework
CCRA	Climate Change Risk Assessment
CO ₂	Carbon dioxide
CoA	Conditions of Approval
Commonwealth CoA	Federal Conditions of Approval under the EPBC Act
Construction	Includes all activities required to construct the CSSI as described in the documents listed in Condition A1, including commissioning trials of equipment and temporary use of any part of the CSSI, but excluding Low Impact Work which is carried out to complete prior to the approval of the OCEMP, works approved under a Site Establishment Management Plan, demolition of acquired residential houses, structures and sheds, and works specified in Appendix B of the Infrastructure Approval and approved under an environmental management plan(s) in accordance with Condition A24.
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSWMP	Construction Soil and Water Management Sub-plan
DPE	Department of Planning and Environment (formerly Department of Planning, Industry and Environment, DPIE)
EES	Environment, Energy and Science (a group within DPE)
EIS	Environmental Impact Statement
Environmental Assessment Documentation	Collective reference to the M12 EIS, Submissions Report and Amendment Report and supplementary reports as detailed in NSW CoA
Environmental Representative, ER	A suitably qualified and experienced person independent of project design and construction personnel employed for the duration of construction. The principal point of advice in relation to all questions and complaints concerning environmental performance.
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>

Abbreviations	Expanded text
ESM	TfNSW Environment and Sustainability Manager
ESR	Environmental Site Representative (Seymour Whyte)
Extreme event	Referred to as extreme heat, extreme precipitation, severe storm or wind event and/or bushfire
Federal Approval	Approval (EPBC 2018/8286) for carrying out the M12 Project under Part 8 of the Environmental Protection and Biodiversity Conservation Act 1999 subject to specific CoA as detailed in Annexure A of the approval.
Final construction footprint	The area shown in the map(s) submitted under Commonwealth CoA 2, determined by TfNSW in accordance with a consistency assessment(s) or a modification assessment under the <i>NSW Environmental Planning and Assessment Act 1979</i> where no new significant impacts to protected matters are identified.
Framework	All activities related to this CCMAMF
Infrastructure Approval	Approval (SSI 9364) for carrying out of the M12 Project under Section 5.19 of the Environmental Planning and Assessment Act 1979 subject to specific CoA as detailed in Schedule 2 of the approval.
IPCC	Intergovernmental Panel on Climate Change
ISCA	Infrastructure Sustainability Council of Australia
NSW CoA	NSW Conditions of Approval
OCCMAMF	Overarching Climate Change Monitoring and Adaptive Management Framework
OCEMP	Overarching Construction Environmental Management Plan
OEMP	Operational Environmental Management Plan
Planning Secretary	Secretary of the NSW Department of Planning and Environment, or delegate
Ppm	Parts per million
Primary CoA/REMM	CoA/REMM that are specific to the development of this Framework
Project, the	The CSSI as approved by the Minister for Planning and Public Spaces on the 23 April 2021 (SSI 9364)
Project CCRAs	Collective term for Climate Change Risk Assessments and climate change monitoring and adaptive management frameworks from M12 West, Central and East Detailed Design packages
QA	Quality Assurance
RCP	Representative Concentration Pathway
REMM	Revised Environmental Management Measure

Abbreviations	Expanded text
RMS	Former Roads & Maritime Services (now Transport for NSW)
Secondary CoA/REMM	CoA/REMM that are related to, but not specific to, the development of this Framework
SEMP	Site Establishment Management Plan
TfNSW	Transport for New South Wales
WHS	Workplace Health and Safety
Work	<p>Any physical work to build or facilitate the building of the CSSI, including low impact work, environmental management measures and utility works.</p> <p>However, it does not include activities that inform or enable detailed design of the CSSI and generate noise that is no more than 5 dB(A) above the rating background level at any sensitive receiver.</p>
WSIA	Western Sydney International Airport

1 Introduction

1.1 Context

This Climate Change Monitoring and Adaptive Management Framework (CCMAMF or Framework) forms part of the Construction Environmental Management Plan (CEMP) for the M12 Motorway - Central package.

This CCMAMF has been prepared under the Overarching Construction Environmental Management Plan (OCEMP) and relevant sub-plans developed for M12 Motorway (the Project), to address the requirements of the Minister's Conditions of Approval (CoA), Revised Environmental Management Measures (REMMs) listed in the Environmental Impact Statement (EIS), Submissions Report, Amendment Report, and Amendment Report Submissions Report (ARSR), ARSR Amendment Report, all applicable legislation, and Transport for New South Wales (TfNSW) specifications.

1.2 Background

1.2.1 M12 Motorway (the Project)

TfNSW is planning to construct and operate the M12 Motorway (the Project) to provide direct access between the Western Sydney International Airport (WSIA) at Badgerys Creek and Sydney's motorway network. The M12 Motorway will run between the M7 Motorway at Cecil Hills and The Northern Road at Luddenham for about 16 kilometres (km) and is expected to be opened to traffic prior to opening of the WSIA.

Key features of the Project include:

- An east-west 16 km motorway between the M7 Motorway, Cecil Hills and The Northern Road, Luddenham
- A motorway built for four lanes (with provision for up to six lanes) with a median to separate opposing traffic flows
- A direct connection to Western Sydney International Airport
- A new connection to The Northern Road with traffic lights
- A motorway-to-motorway interchange at the M7 Motorway
- Provision for a future interchange connecting Mamre Road and Devonshire Road at the M12 Motorway.

A detailed Project description is provided in Section 2.1 of the CEMP.

1.2.2 Statutory Context

The Project is subject to an approval under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) as Critical State Significant Infrastructure (CSSI). The Project is also a controlled action under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), requiring a separate approval from the Australian Minister for the Environment.

The Project was assessed as part of an EIS, Submission Report, Amendment Report, ARSR and ARSR amendment report which are herein referred to as the Environmental Assessment Documentation. REMMs are nominated in these assessments to manage the identified impacts.

Approval for the Project under the EP&A Act was granted by the Minister for Planning on 23 April 2021 (CSSI 9364). Approval for the Project under the EPBC Act was granted by the Australian Minister for the Environment on 3 June 2021 (EPBC 2018/8286).

1.2.3 M12 Motorway Delivery Strategy

The Project will be constructed in three separate stages under four separate construction contracts:

- **M12 West (construct only contract)** – between The Northern Road, Luddenham and about 250 metres east of Badgerys Creek
- **M12 Central (construct only contract)** (the subject of this Plan) – between about 500 metres west of South Creek and the Western Sydney Parklands at Duff Road, Cecil Park
- **M12 East (construct only contract)** Elizabeth Drive connections, south of Cecil Park
- **M12 East (design and construct contract)** – the M7/M12 interchange.

Each package of work is to be delivered under separate contracts on behalf of the proponent TfNSW. While the packages will commence at different times there will be periods during which the packages works will overlap. Co-ordination between the contractors will be required to manage cumulative impacts.

1.3 M12 Central

Seymour Whyte has been engaged to deliver the M12 Central package. Construction of the M12 Central package involves building 7.5 km of motorway from west of Badgerys Creek to the Water Tower Access Road within Western Sydney Parklands.

The M12 Central package will provide a dual carriageway with a wide median to allow for future widening to six lanes. Safety barriers will be provided along the length of the package. Emergency stopping bays and emergency crossovers will also be provided at regular intervals. A shared user path with lighting will provide an active transport link along the motorway and eastward to the M7.

The M12 Central package includes the following bridges:

- Twin bridges over South Creek
- A bridge for Clifton Avenue over the M12 Motorway
- Twin bridges over Kemps Creek
- Twin bridges over Elizabeth Drive near Mamre Road
- Twin Bridges over Range Road
- A bridge for the Water Tower Access Road over the M12 Motorway
- A private property access bridge in University of Sydney land.

Retaining walls will be provided around Range Road to help limit Project impacts on Range Road. Adjustments will be made to local roads including Clifton Avenue and Salisbury Road.

The M12 Central package also requires relocation of utility services including electricity, water, gas and telecommunications. Urban design features of this package include Aboriginal artwork on bridges, rest areas on shared user paths, interpretive signage and landscape planting.

A detailed description of the M12 Central package is provided in Section 2.3 of the CEMP.

1.4 Scope of the Plan

The scope of this Framework is to describe the climate change monitoring and adaptive management measures to be adopted for the M12 Central package during construction in accordance with REMM CC02. This Framework has been prepared under and consistent with the OCEMP, and in particular the OCCMAMF. In the preparation and ongoing implementation of this Plan, SMART (Specific, Measurable, Achievable, Realistic and Timely) principles are to be considered and applied.

As defined by the NSW Environment, Energy and Science (EES) Group, “*Adaptive management is a procedure for implementing management while learning about which management actions are most effective at achieving specified objectives. Adaptive management is often referred to as structured ‘learning by doing’.*”¹ This concept has been applied throughout the Framework.

This Framework is applicable to all activities during construction of the M12 Central package, including all areas where physical works will occur or areas that may be otherwise impacted by the construction works, and under the control of Seymour Whyte. All Seymour Whyte staff and sub-contractors are required to operate fully under the requirements of this Framework and related environmental management plans, over the full duration of the construction program.

This Framework does not consider climate change monitoring and adaptive management measures for design and/or operation.

1.5 Environmental Management Systems overview

The Environmental Management System (EMS) for the M12 Central package is described in Section 3 of the CEMP. The EMS is consistent with the overarching EMS described in Section 3 of the OCEMP.

To achieve the intended environmental performance outcomes, Seymour Whyte have established, implemented, maintained and continually improved an EMS in accordance with the requirements of ISO14001:2015. The Seymour Whyte EMS will be adopted as the guiding environmental management framework for the M12 Central package.

The EMS consists of governance documentation, incorporating environmental management plans, policies, procedures and tools including:

- **M12 Central Environment and Sustainability Policy.** Outlines the commitments and intentions established by Seymour Whyte to ensure environmental performance and sustainability objectives and targets are achieved (Appendix A3 of the CEMP)
- **CEMP.** Details the processes and procedures to be implemented during the M12 Central package to comply with applicable CoA, REMMs, Environment Protection Licence (EPL), legislative obligations and contractual requirements. The relevant compliance obligations are detailed in Appendix A1, with a cross reference to where they are met in this Plan
- **Environmental Management Sub-plans.** These documents describe procedures and controls for specific environmental aspects requiring more rigorous management strategies

¹ Adaptive Management definition sourced from NSW EES
<https://www.environment.nsw.gov.au/research/adaptive-management.htm>

- **M12 Central Construction Air Quantity Management Plan.** Specifically monitoring vehicle and plant emissions during construction
- **Monitoring Programs.** Details the monitoring regime to be implemented during construction to compare the actual performance of construction against the objectives outlined in the relevant Plan, including setting specific triggers and associated responses
- **Site Establishment Management Plan (SEMP).** Addresses the construction of ancillary facilities away from high risk areas
- **Sensitive Area Plans (SAPs).** A series of maps providing key features of the alignment and relevant environmental constraints. Features include waterways, heritage, biodiversity contamination and sensitive receivers amongst other site relevant features.
- **Environmental Work Method Statements (EWMS).** Management measures identified in this Plan may also be incorporated into site or activity specific Environmental Work Method Statements (EWMS). EWMS incorporate appropriate mitigation measures and controls and identify key procedures to be used concurrently with the EWMS
- Procedures, strategies and protocols. Detailed procedures for inclusion in work packs.

1.5.1 CCMAMF preparation, endorsement and approval

The OCCMAMF has been prepared to satisfy REMM CC02 to detail the adaptive management approach to climate change during construction and will be reviewed and approved by the TfNSW Project Director and the ER. This stage-specific CCMAMF for the M12 Central package has been developed under and consistent with the approved OCCMAMF.

This CCMAMF will be reviewed by the TfNSW ESM (or delegate) and the ER to confirm it is consistent with, and incorporates, all relevant elements of the OCCMAMF, prior to submission to the Planning Secretary for information. Construction of the M12 Central package will not commence until this Framework is reviewed to the satisfaction of the ER and ESM and provided to the Planning Secretary for information.

1.5.2 Interactions with other management plans

This Frameworks has the following interrelationships with other management plans and documents:

- M12 Central Sustainability Management Plan which has been developed under the overarching Project Sustainability Strategy which was developed in accordance with REMM SU01 and NSW CoA E91 and E92
- M12 Motorway Central Package 100% Detailed Design Report: Climate change monitoring and adaptive management framework (GHD, 2021)
- Site Establishment Management Plan (SEMP), which addresses the construction of ancillary facilities away from high risk areas
- Construction Environmental Management Plan (CEMP) specifically relating to management measures and monitoring requirements during construction
- Construction Flora and Fauna Management Plan (CFFMP), which includes the minimisation of vegetation removal
- Construction Soil and Water Management Plan (CSWMP) including site inspection prior, during and following storm events
- Construction Flood Management Plan (CFMP) which includes measures to minimise flooding risks during construction

- Construction Air Quality Management Plan (CAQMP), which includes measures to minimise dust, odour and emissions during construction
- Construction Contaminated Land Management Plan (CCLMP), which identifies the measure to manage identified areas of contamination and potential Acid Sulfate Soils that may generate offensive odours and/or gases
- Construction Waste and Resources Management Plan (CWRMP), which identifies the appropriate storage, handling, treatment, reuse, recycling and/or disposal of construction waste material, that may generate offensive odours and/or gases

1.6 Consultation

The State Infrastructure Approval and Federal Approval do not have any consultation requirements relating to the OCCMAMF or CCMAMF preparation or endorsement.

Ongoing consultation between TfNSW, Seymour Whyte, neighbouring Project packages, other construction projects, stakeholders, the community and relevant agencies regarding the management of climate change risks will be undertaken during the construction of the M12 Central package as required. The process for the consultation will be consistent with the OCS and as described in the M12 Central Communication and Stakeholder Engagement Strategy.

2 Purpose and objectives

2.1 Purpose

The purpose of this Framework is to describe how Seymour Whyte will manage potential climate change impacts during construction of the M12 Central package.

This Framework provides an overarching management framework to enable Seymour Whyte to establish and maintain best practice controls to manage potential climate change impacts during construction of the M12 Central package. The strategies defined in this Framework have been developed to address the REMM CC02. This CCMAMF includes general requirements for implementation, monitoring and auditing which will be applied to, and further developed in, the stage specific Construction Contractors' CCMAMFs. Implementing this CCMAMF effectively will enable the Project to meet regulatory and policy requirements in a systematic manner and continually improve climate change performance.

The Framework provides:

- An overview of the M12 Central package's existing climate and relevant climate change projections
- Climate change impacts related to construction phase of the Project
- Climate change control measures during construction
- Monitoring procedures and criteria to evaluate effectiveness of climate change control measures during construction
- Procedures for periodic review of the Climate Change Risk Assessment (CCRA) and this Framework.

TfNSW's OCCMAMF and this M12 Central stage-specific CCMAMF will be available to all site personnel and sub-contractors via the Project document control management system and onsite.

2.2 Objectives

The key objective of this CCMAMF is to ensure that all relevant requirements related to climate change mitigation and adaptive management are described, scheduled and assigned responsibility.

To aid in achieving this objective all CoA, REMMs and licence/permit requirements relevant to climate change mitigation and adaptive management are described, scheduled and assigned responsibility as outlined in:

- Environmental Assessment Documentation
- Infrastructure Approval CoA (SSI 9364)
- TfNSW Quality Assurance (QA) Specifications
- Infrastructure Sustainability Council (ISC) technical manual
- TfNSW Sustainability Strategy 2019-2023
- All relevant legislation and other requirements described in Section 3 of this Plan.

2.3 Targets

Targets for climate change mitigation and adaptive management during construction of M12 Central package include:



- Full compliance with the relevant legislative requirements, CoA and REMMs
- Maintain resilience to climate change impacts to minimise adverse impacts on the health of personnel during construction and delays to the construction program
- All construction personnel to undergo site induction training which will include detail on best practise for adaptive management of climate change impacts and this Framework
- Manage extreme events during the construction of the M12 Central package through the implementation of feasible and reasonable management measures, such as those detailed in Section 5.

3 Environmental Requirements

In accordance with NSW CoA A7, references in the terms of this Plan to any guideline, protocol, Australian Standard or policy are to such guidelines, protocols, Standards or policies in the form they are in at the date of the Infrastructure Approval (CSSI 9364).

3.1 Relevant legislation and guidelines

3.1.1 Legislation

Legislation relevant to the development of this Framework include:

- *Environmental Planning and Assessment Act, 1979*

3.1.2 Guidelines and standards

The main guidelines, specifications and policy documents relevant to this Framework include:

- United Nations Sustainable Development Goals
- Transport Environment and Sustainability Policy Framework and Statement (TfNSW)
- TfNSW Sustainable Design Guidelines Version 4.0
- Infrastructure Sustainability rating tool Version 1.2 (Infrastructure Sustainability Council of Australia)
- Commonwealth Direct Action Plan including the Emissions Reduction Fund and Safeguard Mechanism
- National Climate Resilience and Adaptation Strategy
- NSW Climate Change Policy Framework
- Climate Change Fund Strategic Plan 2017-2022
- NSW Future Transport Strategy 2056
- A Metropolis of Three Cities – the Greater Sydney Region Plan (Greater Sydney Commission)
- Western City District Plan (Greater Sydney Commission)
- NSW Government Resource Efficiency Policy
- NSW Waste Avoidance and Resource Recovery Strategy 2014-21
- Technical Guide for Climate Change Adaptation for the State Road Network
- Australian Standard AS 5334-2013 *Climate change adaptation for settlements and infrastructure – A risk-based approach*
- Australian and New Zealand Standard AS/NZ ISO 31000:2018 *Risk Management – Guidelines*.

3.2 NSW and Federal Conditions of Approval

There are no requirements under the NSW or Federal Conditions of Approval (CoA) to prepare and implement a climate change monitoring and adaptive management framework. Secondary CoAs relevant to this Framework have been listed in Appendix A.

3.3 Revised Environmental Management Measures

The primary REMM relevant to the development of this Framework is listed in Table 3-1. Secondary REMMs relevant to this Framework have been listed in Appendix A. A cross reference is also included to indicate where the REMM is addressed in this document or other Project management documents.

Table 3-1: Primary REMMS relevant to this Framework

REMM No.	Requirement	Document Reference
CC02	A climate change monitoring and adaptive management framework will be prepared and implemented for the Project.	OCCMAMF This CCMAMF
	The framework will incorporate performance monitoring criteria and measures	Section 4.3 Section 5
	The framework will incorporate the requirement for periodic review of the climate change risk assessment and framework against updated climate data to ensure currency.	Section 4.2 Section 7.2

3.4 TfNSW design documentation

Design development has progressed, providing additional environmental assessment, and where relevant, it has been included within this Framework. Specific documentation related to this Framework includes the following PS300 documents:

- M12 Motorway Central Package 100% Detailed Design Report: Climate Change Risk Assessment (CCRA), monitoring and adaptive management framework (GHD, 2021a)
- M12 Motorway – Central Package Detailed Design, Sustainability Management Plan (GHD, 2021b).

3.5 Infrastructure Sustainability Council

The Project is targeting an ‘Excellent’ rating under the Infrastructure Sustainability (IS) Rating Scheme, administered by the Infrastructure Sustainability Council (ISC). The IS Rating is an assessment of a project’s sustainability performance across a number of categories, including climate change.

There are two (2) climate change related IS rating credits requirements, specifically Cli-1 ‘Climate change risk assessment’, and Cli-2 ‘Adaptation measures’ which are identified in Table 3-2.

Table 3-2: IS Rating climate change risk assessment credit criteria

IS credit	Level	Criteria
Cli-1 Climate change risk assessment	Level 1	A readily available climate change projection is identified and adopted for the asset region over the forecast useful life of the asset. AND Direct climate change risks to the asset over the forecast useful life are identified and assessed.

IS credit	Level	Criteria
Cli-1	Level 2	<p>The requirements of Level 1 are achieved.</p> <p>AND</p> <p>A number of readily available climate change projections are identified and adopted for the asset region over the forecast useful life of the asset.</p> <p>AND</p> <p>The climate change risk assessment also considered indirect climate change risks to the asset.</p> <p>AND</p> <p>A multi-disciplinary team participated in identifying climate change risks and issues.</p>
Cli-1	Level 3	<p>The requirements of Level 2 are achieved.</p> <p>AND</p> <p>Modelling is undertaken to characterise the likely impacts of the projected climate change for all High and Extreme priority climate change risks.</p> <p>AND</p> <p>A comprehensive set of affected external stakeholders participated in identifying climate change risks and issues.</p>
Cli-2 Adaption measures	Level 1	<p>Adaptation options to treat all extreme and high priority climate change risks are identified, assessed and appropriate measures implemented</p> <p>AND</p> <p>After treatment there are no extreme priority residual climate change risks.</p>
Cli-2	Level 2	<p>The requirements of Level 1 are achieved.</p> <p>AND</p> <p>Adaptation options to treat 25-50% of all medium priority climate change risks are identified, assessed and appropriate measures implemented.</p>
Cli-2	Level 3	<p>The requirements of Level 2 are achieved.</p> <p>AND</p> <p>The optimal scale and timing of options is addressed (which may be triggered by when a specific climate threshold is likely to be achieved).</p> <p>AND</p> <p>Adaptation options to treat at least 50% of all medium priority climate change risks are identified, assessed and appropriate measures implemented.</p> <p>AND</p> <p>After treatment there are no high priority residual climate change risks.</p>

4 Existing Environment

Greenhouse gases (GHG) are gases that when released into the atmosphere effectively trap heat influencing global temperatures. The release of GHGs into the atmosphere is caused by both natural processes (such as bushfires) and human activities (e.g. burning fossil fuels and land clearing).

GHG have been rapidly increasing since the industrial revolution leading to an increase in the earth's average surface temperature and has contributed to the phenomenon of 'climate change'.

The term 'climate' refers to the typical weather conditions for a specific geographical area, usually averaged over at least 30 years. Climate variability represents the 'normal' day to day seasonal and year to year variability in the components of climate (e.g. temperature, rainfall). However, climate variability may also generate extreme conditions such as flooding, heatwaves and hail which require management.

Climate change is likely to bring about changes in both average climate conditions and the frequency and severity of extreme events. This progressive change has implications for sea levels, ocean temperatures and the functionality of natural ecosystems. Climate change also means that asset owners and managers can no longer rely on prevailing assumptions that climate will be more or less the same as it was over the past 50 or 100 years.

The EIS summarised the key findings on climate change as outlined in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5). The findings include:

- Warming of the climate is unequivocal; the atmosphere and oceans have warmed, the amounts of snow and ice have diminished, and sea level has risen
- Surface temperature is projected to rise over the 21st century. It is very likely that heat waves will occur more often and last longer, and that extreme precipitation events will become more intense and frequent. The ocean will continue to warm and acidify, and global mean sea level will rise
- In urban areas, climate change is projected to increase risks for people, economies and ecosystems, including risks from heat stress, storms, extreme rainfall, flooding, water scarcity, sea level rise, and storm surges
- Australia is currently experiencing the effects of climate change, including extreme temperatures, changes to rainfall, frequency and intensity of storm events, increases in bushfire weather, ocean warming and acidification, and sea level rise
- Building adaptive capacity is crucial for effective selection and implementation of adaptation options.

In August 2021, the first part to the IPCC Sixth Assessment Report (AR6) was released (IPCC, 2021). The outcomes of the first part of the AR6 report contained similar climate change outcomes as AR5. The AR6 Synthesis Report is due to be released in 2022 and this Framework will be reviewed and updated as required at this time to identify any changed risks and determine additional adaptation measures to be implemented for construction if required. The update and amendment of this Framework is further detailed in Section 7.2.

4.1 Climate change projections

As per AS 5334:2013, *Climate change adaptation for settlements and infrastructure – A risk based approach*, the climate change projections selected include a medium-term moderate emissions scenario and a long-term high emissions scenario. They include a 2050 projection under Representative Concentration Pathway (RCP) 4.5 and a 2090 projection under a more extreme

RCP 8.5. AS 5334 states, this is preferable to provide a range in the data to guide the risk assessment. For comparison, all climate risks were also assessed using the climate baseline data collected from Prospect Reservoir Weather Station.

The RCPs are described according to atmospheric CO₂ concentration levels (measured in parts per million (ppm)) and may also be described by anomalies in global mean surface air temperatures for the period 2081-2100 relative to the average period 1986-2005 (refer Table 4-1). A summary of historical annual trends and projected changes to climate variables for each scenario is provided in Appendix B.

Table 4-1: Climate change projection scenarios

Global climate response	RCP scenario	Project increase in global surface temperature by 2081-2100
Slower response, emissions peak around 2040, then decline.	RCP 4.5, atmospheric concentration of CO ₂ projected at approx. 540 ppm by 2100.	Mean projected increase 1.8 °C Anomaly range +1.1 – 2.6 °C
Little curbing of emissions, continuing rapid rise throughout the 21st century.	RCP 8.5, atmospheric concentration of CO ₂ projected at approx. 940 ppm by 2100 and continuing to increase.	Mean projected increase 3.7 °C Anomaly range +2.6 – 4.8 °C

4.2 Climate Change Risk Assessment

A Climate Change Risk Assessment (CCRA) has been developed for the M12 Central package (GHD, 2021a). The CCRA built upon the EIS, and updates were made to the selection of climate variables, as well as baseline and projection data and climate change scenarios specific to the M12 Central package.

The CCRA has taken into consideration the requirements of AS 5334:2013, *Climate change adaptation for settlements and infrastructure – A risk based approach* (which follows the risk principles and guidelines of AS 31000:2009, *Risk Management – Principles and guidelines*) and the RMS Technical Guide on *Climate Change Adaptation for the Road Network*.

The CCRA represents a historical trend of weather data obtained from an appropriate nearby weather station, expressed as an average value for different climate variables measured at that station for completeness of data. The Prospect Reservoir Weather Station was used for M12 Central CCRA as the station contained significant climate baseline data and was proximal to the M12 Central package.

Climate change risks relevant to the construction of the M12 Central package were determined using climate change projections to the year 2050. A total of 52 risks were identified following the CCRA completed for M12 Central package. No 'very high' risks were identified, however seven 'high' and 26 'medium' risks were identified based on 2050 scenario. This included 18 new risks, which had not previously been identified during the planning phase risk assessment process in the Environmental Assessment Documentation.

It should be noted that the near-term 2030 RCP 8.5 scenario used in the EIS was replaced with the 2050 RCP 4.5 scenario for M12 Central CCRA. The AS 5334 requires that both a moderate and extreme emissions scenario should be considered (which was lacking from the EIS), in that the usability of the resulting assessment will be minimal in the context of the design life of the asset components and the estimated construction completion year of 2025.

Using the Project CCRAs completed by GHD and during the EIS, it can be concluded that three main risks were identified for construction with a moderate or high-risk rating, as shown in Table 4-2. Adaptation and mitigation measures for the identified risks are detailed in Section 5.

Table 4-2: Climate change risks during construction

Risk scenario	Likelihood	Consequence	Risk rating 2050 (GHD, 2021a)
Extreme heat			
Increased frequency, severity, and duration of extreme temperatures (days exceeding 35°C) leading to adverse health impacts for construction workers and potential health and safety incidents.	Possible	Serious	Moderate
Extreme precipitation			
Increased frequency, severity and duration of extreme precipitation events leading to unsuitable and unsafe conditions for construction to proceed, resulting in an increase in 'stop work' days and subsequent delays to the construction program.	Possible	Serious	Moderate
Bushfires			
Increased frequency and severity of bushfires leading to smoke generation, resulting in potential health effects for construction workers and health and safety incidents, potential increase in 'stop work' days, and subsequent delays to construction program.	Possible	Major	High

The CCRA will be reviewed periodically (minimum annually) throughout construction to ensure currency based on the latest scientific evidence and research and the track the implementation of adaptation responses. Where required, the CCRA will be updated, and this CCMAMF will be updated in response, as detailed in Section 7.2.

4.2.1 Climate Change Risk Workshop

The CCRA review process will include a Climate Change Risk Workshop. The workshop will require a multi-disciplinary team with representatives from Seymour Whyte, TfNSW, GDH (M12 Central designers). Disciplines represented should include Project Managers, designers, operators and maintainers (if possible), environmental staff and community relations staff. Seymour Whyte will complete the first workshop prior to commencement of construction.

External stakeholders will also be invited to participate in the Climate Change Risk Workshop including Sydney Water, Western Sydney International Airport and Relevant Councils.

Design responses should be prioritised over operational responses, where practical, as approved by TfNSW. Where adaptation responses are deferred, the optimal scale and timing of implementing the adaptation options is also to be addressed.

Where relevant, the CEMP and Sub-plans will be updated following the Climate Change Risk Workshop if mitigation measures require implementation during the construction phase.

4.3 Performance monitoring criteria

Monitoring of climate change adaptation measures is required to ensure the M12 Central package maintains resilience to climate change impacts to minimise adverse impacts on personnel’s health during construction and operation, the public’s health during operation and delays to construction program.

A list of monitoring activities and evaluation criteria are specified in Table 4-3. These activities and criteria will be supplemented during construction by the measures outlined in the CEMP (Section 7.1 and Section 7.2) and relevant Sub-plans, as well the M12 Central Sustainability Management Plan.

Seymour Whyte will supplement the monitoring measures to manage and evaluate the effectiveness of adaptation measures, implement changes and revise any of the performance monitoring criteria where required.

Table 4-3: Climate change performance monitoring criteria and measures

Performance monitoring criteria	Monitoring measures	Timing	Responsibility
Evaluate effectiveness of communicating upcoming extreme climate to personnel and planning for delays to program	Monitor weather forecast to check for upcoming days with predicted extreme heat, extreme precipitation, and bushfire warnings to enable wet weather procedures or stop works to be enacted	Daily	Environmental Site Representative (ESR) Safety Manager
If construction ancillary facilities have been affected by severe storms, consider relocation or additional weather protection	Site inspection to be undertaken before, during and after rainfall events	Before, during and after rainfall	ESR Safety Manager
Determine if the WHS practices are effective in preventing personnel health impacts, if not, implement improved protocols	Monitor effectiveness of workplace health and safety practices, including stop work protocols, to be reviewed after the event of extreme heat days	After days exceeding 35°C	Safety Manager
Evaluate health and wellbeing of personnel on extreme heat days and determine if additional protocols shall be implemented to minimise health risk	Monitor the health and wellbeing of personnel on high heat days and determine whether stop work protocols should be implemented	Days exceeding 30°C but under 35°C	Safety Manager

5 Climate Change Adaption and Mitigation Measures

The adaptation and mitigation options have been designed to control and minimise the risk of climate change during construction. These options are based on the relevant construction risk scenarios detailed in identified in the Environmental Assessment Documentation and CCRA. The construction risk scenarios include:

- Extreme heat: Increased frequency, severity, and duration of extreme temperatures (days exceeding 35°C) leading to adverse health impacts for construction workers and potential health and safety incidents
- Extreme precipitation: Increased frequency, severity and duration of extreme precipitation events leading to unsuitable and unsafe conditions for construction to proceed, resulting in an increase in 'stop work' days and subsequent delays to the construction program
- Bushfires: Increased frequency and severity of bushfires leading to smoke generation, resulting in potential health effects for construction workers and health and safety incidents, potential increase in 'stop work' days, and subsequent delays to construction program.

Table 5-1 details the adaptive management options for workplace health and safety and environmental planning during construction that will be implemented by Seymour Whyte and be adopted in the relevant M12 Central package documentation.

Table 5-1: Climate Change adaptation and mitigation measures during construction

ID	Management Measure	When to implement	Responsibility	Reference of source	Evidence of implementation
CC01	The location of temporary construction ancillary facilities has considered the risk of flood and strong winds associated with severe storm events, with site uses more vulnerable to the impacts of severe storms located away from the areas of highest risk to minimise impact and the requirements detailed in NSW CoA A15-A20	Prior to construction	ESR Safety Manager	Section 5 CCRA WHS Protocol	Site planning Site Establishment Management Plan Ancillary Facility Assessments (for additional facilities not assessed in the environmental documentation)
CC02	Prior to attending site, all personnel will undergo induction training detailing the procedures to be undertaken during extreme weather events, including (but not limited to) extreme heat, extreme precipitation, severe storm or wind event and/or bushfire	Prior to construction and during construction	ESR Safety Manager	Section 5 CCRA WHS Protocol	Induction material and training records CEMP Project WHS Management Plan
CC03	Weather conditions will be monitored, and the construction program will be adapted wherever feasible during extreme events	During construction	ESR Safety Manager	Section 5 CCRA WHS Protocol	Weather forecasts / flood watch warning included in Pre-start records Automatic Weather Station operational records

ID	Management Measure	When to implement	Responsibility	Reference of source	Evidence of implementation
CC04	Stop work protocols will be incorporated into the Work Packs and EWMS for extreme events and implemented during construction.	During construction	ESR Safety Manager	Section 5 CCRA WHS Protocol	Induction material and training records Work Packs EWMS Project WHS Management Plan
CC05	<p>Adaptive management approach to be applied to workplace health and safety planning for construction during periods of extreme heat.</p> <p>Examples of potential work health safety practices may include stop work protocols (see CC04) for extreme heat days, or increased training and education for personnel regarding health and safety procedures during periods of extreme heat.</p>	During construction	ESR Safety Manager	Section 5 CCRA WHS Protocol	Induction material and training records Work Packs EWMS Project WHS Management Plan

6 Compliance Management

6.1 Roles and responsibilities

The organisational structure for the M12 Central package and overall roles and responsibilities are outlined in Section 5.1 of the CEMP.

Specific responsibilities for the implementation of this Framework are detailed in Section 5.

6.2 Training

To ensure that this Framework is effectively implemented, all site personnel (including sub-contractors) will undergo site induction training that includes climate adaptation and mitigation management prior to undertaking their duties.

Training specific to this Framework will be focused on the adaption measures to be implemented including the Adaptive Management Procedure (EES, 2021) and the Stop Works Procedure.

For further information on training, refer to Section 5.3 of the CEMP.

6.3 Monitoring and inspections

The monitoring of climate change adaptation measures is required to ensure the M12 Central package maintains resilience to climate change impacts to minimise adverse impacts on the health of personnel during construction and delays to the construction program.

Monitoring performance criteria and measures are addressed in Section 4.3. Environmental inspections are detailed in Section 7.1 of the CEMP.

To verify design and construction phase adaptations have been implemented to address all high risk priority climate change risks and at least 50% of medium priority climate change risks, quality inspections will be completed to develop As-Built documentation.

6.4 Auditing

Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this CCMAMF, CoA and other relevant approvals, licenses and guidelines. Audit requirements are detailed in Section 7.4 of the CEMP.

The implementation of this Framework will be audited independently by the Independent Sustainability Professional (ISP) during Management system monitoring and review and Sustainability audits of the management system as outlined in the M12 Central Sustainability Management Plan.

6.5 Reporting and identified records

Reporting requirements and responsibilities are documented in Section 7.5 of the CEMP.

Accurate records will be maintained substantiating all construction activities associated with the M12 Central package or relevant to the conditions of approval, including measures taken to implement this CAQMP. Records will be made available to the DPE and Commonwealth Department of Agriculture, Water and the Environment (DAWE) upon request, within the timeframe nominated in the request.



To demonstrate appropriate mitigation measures have been implemented to address all high risk priority climate change risks, and at least 50% of medium priority climate change risks, the Climate Change Risk Assessment will be updated by Completion with supporting documentation (or traces to the document control system where quality records are submitted). This will be included in the documentation provided for the ISC As-Built submission for Cli-2 Adaptation measures.

7 Review and improvement

7.1 Continuous improvement

Continuous improvement of this Framework will be achieved by the ongoing evaluation of environmental management performance against environmental policies, objectives and targets for the purpose of identifying opportunities for improvement. The continuous improvement process will be designed to:

- Identify areas of opportunity for improvement of environmental management and performance
- Identify environmental risks not already included in the risk register
- Determine the cause or causes of non-conformances and deficiencies
- Develop and implement a plan of corrective and preventative action to address any non-conformances and deficiencies
- Verify the effectiveness of the corrective and preventative actions
- Document any changes in procedures resulting from process improvement
- Make comparisons with objectives and targets.

The ESR is responsible for ensuring stage-specific environmental risks are identified and included in the M12 Central package risk register and appropriate mitigation measures implemented throughout the construction, as part of the continuous improvement process. The process for ongoing risk identification and management during construction is outlined in Section 4.1.2 of the CEMP.

7.2 Update and amendment

Periodic reviews will be undertaken and implemented for improvements to this Framework during construction. This Framework may be updated following:

- Receipt of updated IPCC Assessment Reports such as AR6 (August 2021) and the IPCC AR6 Synthesis Report (due to be released in 2022) identifying new climate change data resulting in an update to the Project CCRAs
- Changes to detailed design or construction methodology that may impact the risks or adaptation measures identified and/or generate new risks to the M12 Central package.
- The processes described in Section 7.7 of the CEMP

A copy of the updated Project CCRAs identifying changes to the M12 Central package's climate change risks and adaptations shall be distributed to all relevant stakeholders including Sydney Water, Western Sydney International Airport and Relevant Councils. Seymour Whyte will update the M12 Central package CCMAMF based on updates of the Project CCRAs.

Further detail on periodic review of this Framework can be found within Section 1.12 of the CEMP.



Climate Change Monitoring and Adaptive Management Framework Sub-plan

Appendix A – Secondary CoA, Secondary REMMs and TfNSW QA specifications

M12 Motorway - Central

February 2022

Appendix A Secondary CoAs, Secondary REMMs and TfNSW QA Specifications

Secondary requirements that are related, but not specific to, the development of this Plan are outlined in this appendix. Cross references are provided to indicate where the requirements are addressed in this Plan or other Project management documents. This includes:

- Secondary NSW Conditions of Approval (CoA) which are listed in Table A1
- Secondary Revised Environmental Management Measures (REMMs) which are listed in Table A2
- Relevant requirements of the TfNSW QA Specifications which are listed in Table A3.

Table A1: Secondary NSW CoA

CoA	Requirement	Reference
E91	A Sustainability Strategy must be prepared to achieve a minimum excellent 'Design' and 'As built' rating under the Infrastructure Sustainability Council of Australia infrastructure rating tool.	Section 1.5.2 Sustainability Strategy Sustainability Management Plan
E92	The Sustainability Strategy must be submitted to the Planning Secretary before the commencement of construction and must be implemented throughout construction and operation.	Section 1.5.2 Sustainability Strategy Sustainability Management Plan

Table A2: Secondary REMMs

REMM No.	Requirement	Document Reference
CC03	An adaptive management approach will be applied to workplace health and safety planning during construction and operation in line with the WHSMP. This will include use of TfNSW Work Health and Safety Procedures.	Section 5 WHS Protocol
SU01	A sustainability management plan for the project will be developed and implemented during detailed design, to give effect to the sustainability strategy for the project. The management plan will detail measures to meet the sustainability objectives and targets and Infrastructure Sustainability rating tool credit requirements.	Section 1.5.2 Sustainability Strategy Sustainability Management Plan

Table A3: TfNSW QA specifications

Specification	Requirement	Document Reference
G1, Annexure L 2.3 (a)	a) Review the project climate change risk assessment (CCRA) undertaken during detailed design, and ensure adaption measures are implemented as per design. Where appropriate, update the CCRA for the construction of the Works in accordance with AS 5334-2013 (Climate change adaptation for settlements and infrastructure – A risk based approach) and TfNSW Climate Risk Assessment Guideline SD-081. Any deviations in the design that may affect a climate change adaptation measure must be captured and reported on. You must also review and address construction stage climate change risks identified during concept design and, where relevant, incorporate into the CCRA.	Section 4.2
G1, Annexure L 2.3 (b)	b) You must undertake a Climate Change Risk Workshop as part of the CCRA review process, which at a minimum involves a multi-disciplinary team and the Principal.	Section 4.2.1

Specification	Requirement	Document Reference
G1, Annexure L 2.3 (c)	c) Identify and implement adaptation measures to comprehensively address, as a minimum, 'extreme' and 'high' and 25-50% of all 'medium' rated risks identified in the climate change risk assessment.	Section 4.2
R179 2.3.2	Contractor supplied plant materials must be grown by a nursery in a local area of similar climate to the Works.	Landscaping Procurement Package



Appendix B Climate baseline and projection data

The table below has been sourced from the M12 Central 100% Detailed Design climate change monitoring and adaptive framework report (GHD, 2021a).

Variable	Current Climate*		Climate Change Predictions		Source
	Prospect Reservoir Weather Station	Baseline Period	General Trend	M12 Central near term, moderate scenario 2050, RCP 4.5	
Temperature					
Mean maximum daily temperature (°C) – Annual	23.3	1986-2005	↑	+1.3 (1 to 1.9) i.e. 24.6°C (24.3 to 25.2)	1,2
Mean maximum daily temperature (°C) – Summer (DJF)	28.1	1986-2005	↑	+1.3 (0.8 to 2.2) i.e. 29.4°C (28.9 to 30.3)	1,2
Mean minimum daily temperature (°C) – Annual	12.2	1986-2005	↑	+1.3 (0.9 to 1.6) i.e. 13.4°C (13.1 to 13.8)	1,2
Days p.a. over 35°C	10.5	1986-2005	↑	16.3 days	1,2
Days p.a. over 40°C	1.0	1986-2005	↑	2.4 days	1,2
Days p.a. below 2°C	2.5	1986-2005	↓	0.45 days	1,2
Days p.a. below 0°C	0.1	1986-2005	↓	0 days	1,2
Highest temperature for baseline 1986-2005 (°C)	44.7 15 Jan 2001	Discrete event	↑	+1.8 (0.6 to 2.1) i.e. 46.5°C (45.3 to 46.8)	3
Highest temperature for years on record at AWS (°C)	45.3 7 Jan 2018	Discrete event		N/A	
Lowest temperature for baseline 1986-2005 (°C)	-0.5 13 August 2005	Discrete event	↑	+1.2 (0.5 to 1.4) i.e. 0.7°C (0 to 0.9)	3
Lowest temperature for years on record at AWS (°C)	-0.8 30 June 2010	Discrete event		N/A	
Precipitation					
Mean Rainfall (mm) - Annual	879.4	1986-2005	↑↓ Seasonal variation	+0.5% (-11.4 to 7.7) i.e. 883.4 mm (778.9 to 946.7)	1,2
Mean Rainfall (mm) – Spring (SON)	181.1	1986-2005	↓	-0.2% (-18.9 to 12.1) ie 180.7 mm (147 to 203.1)	1,2
Mean Rainfall (mm) – Summer (DJF)	289.5	1986-2005	↑	+4.1% (-9.9 to 19.4) i.e. 301.4 mm (260.8 to 345.6)	1,2

Variable	Current Climate*		Climate Change Predictions		Source
	Prospect Reservoir Weather Station	Baseline Period	General Trend	M12 Central near term, moderate scenario 2050, RCP 4.5	
Mean Rainfall (mm) – Autumn (MAM)	245.1	1986-2005	↓	-2.6% (-17 to 18.3) i.e. 238.7 mm (203.3 to 289.8)	1,2
Mean Rainfall (mm) – Winter (JJA)	163.7	1986-2005	↓	-5% (-19.6 to 8.3) i.e. 155.5 mm (131.7 to 177.3)	1,2
Highest daily rainfall event (mm) for baseline 1986-2005	321.0 06 Aug 1986	1986-2005	↑	+4.4% (-1.5 to 13.5) i.e. 335 mm (316.3 to 364.5)	3
Highest daily rainfall (mm) for years on record at AWS	321.0 06 Aug 1986	Discrete event		N/A	
Maximum 1 day rainfall for a 20 year ARI event	N/A	N/A		+9.8% (-1.7 to 22.9)	3
Extreme events					
Severe fire danger days per year	1.1	1986-2005	↑	1.2 to 1.5 days*	4
Lightning	20-25 thunder days per year	1990-1999	↑	5-6% increase per °C warming i.e. 7% to 8.4% increase in 6,7 lightning frequency	6,7
Soil					
Soil moisture	N/A	1986-2005	↓	-2.1% (-10.2 to 2)%*	1
Daily variables					
Evapotranspiration (%)	N/A	N/A	↑	+5.4% (3 to 6.9)	1
Maximum wind gust speed (km/h) for years 2003-2005	89.0	2003-2005	↑	N/A	5
Avg. 9 am wind speed (km/h)	9.6	1986-2005	↓	-1.3% (-4.6 to 0) i.e. 9.4 km/h (9.1 to 9.6)	1,2
Avg. 3 pm wind speed (km/h)	15.1	1986-2005	↓	-1.3% (-4.6 to 0) i.e. 14.9 km/h (14.4 to 15.1)	1,2
Avg. 9 am relative humidity (%)	73.5	1986-2005	↓	-0.4% (-1.6 to 1.3) i.e. 73.1 % (72.3 to 74.4)	1,2
Avg. 3 pm relative humidity (%)	50.5	1986-2005	↓	-0.4% (-1.6 to 1.3) i.e. 50.3 % (49.7 to 51.2)	1,2

Variable	Current Climate*		Climate Change Predictions		Source
	Prospect Reservoir Weather Station	Baseline Period	General Trend	M12 Central near term, moderate scenario 2050, RCP 4.5	
Mean daily solar exposure (MJ/(m*m))	16.4	1990-2005	↑	+0.5% (-0.6 to 2.2) i.e. 16.5 MJ/(m*m) (16.3 to 1, 2 16.7)	1,2

Notes:

- 1 CSIRO BOM 2015, Climate Change in Australia Projections Cluster Report - East Coast, Appendix Table 1c East Coast South
 - 2 CSIRO BOM 2015, Climate Change in Australia Summary Data Explorer, East Coast Cluster Projections
 - 3 CSIRO BOM 2015, Climate Change in Australia Extremes Data Explorer, East Coast Cluster Projections
 - 4 CSIRO BOM 2015, Climate Change in Australia Projections Cluster Report - East Coast, Appendix Table 2, Projections and baseline for Canberra
 - 5 CSIRO BOM 2015, Climate Change in Australia Projections Cluster Report - East Coast, Figure 4.4.2
 - 6 State of NSW and Department of Environment, Climate Change and Water 2010, Impacts of Climate Change on Natural Hazards Profile, Sydney/Central Coast Region
 - 7 IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K.]
- * Projection data was not available for RCP 4.5 2050 therefore RCP 4.5 2030 was used as the closest available proxy
- NB: Severe fire danger days per year based on Forest Fire Danger Index >50. Based on three climate models given as range from lowest to highest value of 3 projections
- NB: Highest temperature recorded in baseline period uses CSIRO projection for 'hottest day' for summer (DJF)
- NB: Highest daily rainfall provides indication of change to most extreme annual rainfall event using CSIRO 'wettest day' projections (annual)
- NB: all projections use global climate models from the IPCC's Fifth Assessment report, excepting hail and lightning projections