SIMEC MINING

VOLUME 1

Environmental Impact Statement - Main Report

Prepared for Tahmoor Coal

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Environmental Impact Statement

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Certification

Submission of Environmental Impact Statement

Prepared to support the application for Development Consent SSD 17_8445 as required under Section 4.12(8) of the *Environmental Planning and Assessment Act 1979.*

In respect of:

Applicant and Land Details

Applicant	Tahmoor Coal Pty Ltd 2975 Remembrance Driveway, Bargo
Subject	Tahmoor Coal Pty Ltd is seeking approval for the Tahmoor South Project (SSD 17_8445) under Division 4.7, Part 4 of the *Environmental Planning and Assessment Act 1979.*
Project Summary	Tahmoor Coal Pty Ltd is seeking approval for the Tahmoor South Project (the proposed development), being the extension of underground coal mining at Tahmoor Mine, to the south of Tahmoor Coal's existing Surface Facilities Area. The proposed development would continue to be accessed via the existing surface facilities at Tahmoor Mine and would utilise the existing surface infrastructure at the Tahmoor Mine Surface Facilities Area. Some surface infrastructure upgrades are proposed to facilitate the extension, including expansion of the existing rejects emplacement area (REA), additions to the existing bathhouses and associated access ways, upgrades to the Coal Handling and Preparation Plant (CHPP), construction of new mine ventilation shafts, and upgrades to offsite service infrastructure.
Lot and DP	Refer **Appendix B**

Environmental Impact Statement

An Environmental Impact Statement (EIS) is attached. The EIS assesses the likely environmental impacts of the Project including the matters referred to in the Secretary's Environmental Assessment Requirements provided to the Applicant on 20 June 2018 under Section 4.12(8) of the *Environmental Planning and Assessment Act 1979.*

Declaration

I certify that I have prepared the contents of this EIS in accordance with the requirements of the *Environmental Planning and Assessment Act 1979* and *Environmental Planning and Assessment Regulation 2000* and that, to the best of my knowledge, the information contained in this report is not false or misleading.

Signature: _____ **Date:** 21 December 2018

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Executive Summary

Tahmoor Coal Pty Ltd (Tahmoor Coal) owns and operates the Tahmoor Mine, an existing underground coal mine approximately 80 kilometres (km) south-west of Sydney in the Southern Coalfields of New South Wales (NSW) within the Wollondilly Local Government Area (LGA).

Tahmoor Coal produces up to three million tonnes per annum (Mtpa) of run of mine (ROM) coal from its existing operation at the Tahmoor Mine. The Tahmoor Mine was granted planning and environmental approvals to commence coal mining operations in the mid to late 1970s. Underground mining at the existing operation is anticipated to be completed by 2022, depending upon geological and mining conditions.

Tahmoor Coal is seeking approval for the Tahmoor South Project (the proposed development), being the extension of underground coal mining at Tahmoor Mine, to the south of Tahmoor Coal's existing Surface Facilities Area. The proposed development would continue to be accessed via the existing surface facilities at Tahmoor Mine and would utilise the existing surface infrastructure at the Tahmoor Mine Surface Facilities Area. Some surface infrastructure upgrades are proposed to facilitate the extension, including expansion of the existing rejects emplacement area (REA), additions to the existing bathhouses and associated access ways, upgrades to the Coal Handling and Preparation Plant (CHPP), construction of new mine ventilation shafts, and upgrades to offsite service infrastructure.

The proposed development would use longwall mining to extract coal from the Bulli seam within existing mining tenements; CCL 716 and CCL 747. Coal extraction of up to four (4) million tonnes (Mt) of Run of Mine (ROM) coal per annum is proposed as part of the development. Once the coal has been extracted and brought to the surface, it would be processed at Tahmoor Mine's existing CHPP, and then transported to customers via the existing rail loop, the Main Southern Railway and the Moss Vale to Unanderra Railway to Port Kembla for Australian and international markets. Product coal would also be transported via rail to Newcastle (Port Waratah) from time to time. Up to 200,000 tonnes per annum of either product coal or reject material is proposed to be transported to customers via road.

Tahmoor Mine has been operating for around 40 years, and in this time has developed extensive experience in successfully managing the impacts of mining operations, particularly the effects of subsidence on the built and natural environment using a range of management measures and communication tools. These management measures would continue to be used to communicate with the local community and effectively mitigate and manage the potential effects of the proposed development including subsidence and other issues.

The proposed development would prolong the life of the Tahmoor Mine to provide for the ongoing direct employment of approximately 390 employees and enable existing coal markets to be serviced. The Tahmoor South Project would provide ongoing significant local, regional and State economic benefits in the form of additional wages, royalties and flow-on positive economic effects, and would maximise recovery of the existing coal resource within coal lease areas.

Tahmoor Coal has undertaken extensive stakeholder and community consultation regarding the proposed development since 2012. The project design has subsequently undergone numerous revisions to avoid longwall mining directly under sensitive features such as the Metropolitan Special Area, bedrock rivers with standing pools, items of Aboriginal heritage and significant landscape features such as river gorges.

This Environmental Impact Statement (EIS) contains detailed studies into the potential environmental, social and adverse economic impacts of the proposed development. The scope of technical specialist assessments has been determined based on the preliminary environmental risk screening undertaken for the Preliminary Environmental Assessment (PEA), preparation of a social impact assessment scoping report, consultation with Government agencies, consideration of the Secretary's Environmental Assessment Requirements (SEARs) which were issued on 6 June 2017 and revised on 20 June 2018, and through the EIS and subsidence risk workshops undertaken for the proposed development. The key findings of the impact assessment for the proposed development are summarised in **Table 1**.

Table 1 Key Findings of the EIS

Key issue	Key findings	Relevant EIS section
Key Issues		
Subsidence	As a result of stakeholder and community consultation and consideration of predicted subsidence impacts within the Subsidence Study Area (SSA), the Mine Plan has incorporated a number of changes to reduce predicted subsidence impacts on built and natural features. The Subsidence Impact Assessment (MSEC, 2018) for the proposed development predicts that the maximum subsidence levels would impact on some natural and built features within the SSA. The assessment of potential subsidence impacts determined that 55% of the houses within the SSA would be unaffected or require minor adjustments only. Far field horizontal movements are predicted to occur; however, impacts experienced at sensitive features are not expected to be significant or measureable (i.e. less than 0.3 mm/m). The overall findings of the assessment are that the levels of impact and damage to identified natural features and built infrastructure are manageable. Importantly, the extensive experience gained by Tahmoor Coal in successfully managing subsidence impacts from Tahmoor Mine to-date would be applied to the proposed development and the existing subsidence management framework would be employed at the Tahmoor South Project. Management measures would be documented in an Extraction Plan (EP), which would be developed and implemented in consultation with relevant stakeholders. EP sub-plans would be developed to manage potential impacts to specific features through consultation with infrastructure owners and approved by the relevant government agencies.	**Section 11.1, Appendix F**
Geomorphology	The Geomorphology Technical Report found that provided the proposed mitigation and management measure are implemented, the proposed development is not anticipated to present a significant risk to change in the geomorphic character of waterways in the Project Area. The qualitative assessment of geomorphology found that the overall risk of geomorphic change as a result of mining-induced subsidence was minor. As waterways are resilient and generally in good condition, changes that do occur as a result of the proposed development would be expected to recover.	**Section 11.2, Appendix H**

Key issue	Key findings	Relevant EIS section
Groundwater	The Groundwater assessment predicted annual average mine inflow rates of approximately 1,700 mega litres (ML) of water per annum over the life of the proposed developed. The peak annual flows are predicted to be between 2,850ML in 2029 and 2,600 ML of water in 2032. The existing groundwater entitlement held by Tahmoor Coal allows for 1,642 ML of water per annum and additional license(s) would be purchased in the open market to account for the additional inflows. The groundwater modelling indicates baseflow reductions at streams, however these reductions would be relatively minor in comparison to total flow. The modelling indicated that the percentage of mean flow reduction (as a result of baseflow changes) for all waterways would be less than 3.8% under the proposed development and less than 4.9% under the cumulative scenarios. It is noted that the reductions in baseflow would likely be most noticeable during periods of low flow. The Groundwater assessment predicted that up to 30 registered bores and three unregistered bores would experience drawdown of greater than 2 metres (m) as a result of the proposed development. The assessment found that mining-induced mixing of groundwater would result in minor changes to the salinity of the Hawkesbury Sandstone and Bulgo Sandstone, the two most commonly utilised aquifers. However, there are no anticipated risks of reduced beneficial uses of the Nepean Groundwater Management Area porous rock aquifer and the assessment indicates that risks to groundwater quality would decrease with distance from the active mining area. 'Make good' measures would be implemented by Tahmoor Coal at all impacted bores to account for drawdown and/ or groundwater quality impacts. Trigger action response plan (TARP) measures would be adopted to manage the impacts of the proposed development on groundwater to minimise impacts. Tahmoor Coal would continue to maintain its established regional groundwater monitoring network designed to monitor potential risks to existing ground water users and implement make good measures, as required.	**Section 11.3, Appendix I**

Key issue	Key findings	Relevant EIS section
Surface Water and Hydrology	The results of predictive modelling of the proposed water management system indicate that the proposed development would not result in additional water quality impacts due to releases and overflows from the site water management system compared to the existing situation. Subsidence predictions identified watercourses that lie directly over the longwalls are exposed to a greater range of subsidence impacts. However, based on subsidence predictions for the proposed development it is considered that while localised changes, diversions and ponding to surface water may occur, they would be minor. Management measures would include further baseline monitoring programs, monitoring during mining, and post-mining monitoring programs. TARPs would be prepared for the proposed development, focusing on water quality exceedances, unexpected flow loss, and unexpected loss of pool water holding capacity. The assessment of flooding identified that the upper reaches of catchments are more susceptible to flood inundation due to the flatter terrain and low capacity drainage channels in these areas, with minor localised increases of flooding predicted at Tea Tree Hollow (upstream). The results show that flooding is unlikely to be increased in the Bargo Township as a result of the proposed development, with the exception of minor localised flooding at Dymond Road and Wattle Street. This flooding extent would not impact surrounding residential developments. Given the minor nature of predicted flood impacts the project would have no impact on existing emergency management procedures.	**Section 11.4, Appendix J**
Thirlmere Lakes	The water balance model determined that the most significant outflow component from the Thirlmere Lakes is evaporation/evapotranspiration. Groundwater recharge comprises approximately a quarter of outflows. The Project would only affect the groundwater recharge component, albeit to a minor extent. It has been determined that the proposed development would have negligible groundwater and surface water impacts on the Thirlmere Lakes that would be comparable to levels of natural variability and would be imperceptible in many circumstances. Potential impacts to terrestrial and aquatic ecology within the Thirlmere Lakes were also determined to be minor to negligible.	**Section 11.5, Appendix I, Appendix J**

Key issue	Key findings	Relevant EIS section
Other Issues		
Terrestrial ecology	The Terrestrial Ecology Assessment undertaken for the proposed development identified that potential impacts to terrestrial vegetation throughout the study area are not anticipated to be significant as a result of subsidence. Riparian vegetation is more susceptible to subsidence impacts. However, impacts are considered to be manageable. Impacts to native vegetation (Including Shale Sandstone Transition Forest (SSTF) Endangered Ecological Community (EEC)) would occur as a result of clearing necessitated by the expansion of the REA and construction of other surface infrastructure. An Offset Strategy has been proposed to compensate for impacts to the SSTF EEC as impacts cannot be avoided. Impacts to threatened species within the study area would be mitigated and managed through the implementation of a Biodiversity Management Plan and an on-going monitoring program.	**Section 11.6, Appendix K**
Aquatic ecology	The Aquatic Ecology Assessment identified that aquatic habitats of streams within the SSA may be impacted by subsidence related impacts, including Tea Tree Hollow, Dog Trap Creek and downstream watercourses. Impacts at these waterways could include changes to stream beds, altering surface water flows and ponding, and changes to water quality. Significant subsidence movements are not predicted at the Nepean and Bargo Rivers and these rivers would not be directly undermined, indicating that the quality and quantity of available aquatic habitat in the area is unlikely to be impacted. Whilst stream bed changes as a result of subsidence have the potential to result in losses of habitat in sections of the streams, at a sub-catchment to catchment scale, changes to overall invertebrate assemblage and family richness were predicted to be minor. In addition, none of the waterways predicted to be impacted were considered likely to provide suitable habitat for threatened aquatic species and no threatened aquatic species were recorded during multiple site surveys. A range of measures would be implemented to mitigate impacts including: subsidence monitoring of macroinvertebrates to be conducted for a baseline period of two years prior to longwall extraction, a Before After Control Impact (BACI) designed monitoring program to compliment the baseline information collected and assess monitoring impacts in an adaptive management framework. Stream rehabilitation measures to remediate subsidence impacts, and the preparation and implementation of a Corrective Management Action Plans (CMAPs) and TARP for potential impacts to pools and other aquatic habitat features. The CMAP will draw upon the experience and remediation methodology developed by Tahmoor Coal from the implementation of the CMAPs for Myrtle Creek and Redbank Creek at Tahmoor North.	**Section 11.7, Appendix K**

Key issue	Key findings	Relevant EIS section
Aboriginal heritage	Majority of potential impacts on cultural heritage sites are limited to potential subsidence impacts. One archaeological site of low scientific significance falls within the footprint of a ventilation shaft and may be impacted directly A total of 40 sites were identified during the assessment (including previously recorded and newly recorded sites) including one cultural heritage site and 39 archaeological sites. Archaeological sites included a number of sandstone shelter sites with art primarily at Dog Trap Creek. Of the 39 archaeological sites, four are considered to be of high significance and two are considered to be of moderate significance (all six comprising sandstone shelter sites with art at Dog Trap Creek). Twenty six (26) archaeological sites have the potential to be impacted by subsidence impacts. One archaeological site has been identified as having potential to be directly impacted by the surface infrastructure. Notably, the mine plan has been designed to avoid direct undermining of the high significance archaeological heritage sites along Dog Trap Creek. Mitigation and management for potential impacts to cultural heritage includes the preparation and implementation of a Heritage Management Plan for the proposed development. Should monitoring detect the early development of potentially severe differential movements at these archaeological sites during the extraction of the early longwalls, adaptive management would be applied. During detailed design and construction planning care would be taken to site surface infrastructure to avoid disturbance of identified archaeological sites, as far as practicable. If direct impacts cannot be avoided in the location of surface infrastructure, further management would be undertaken in consultation with the RAPs and a suitably qualified archaeologist, as part of a Heritage Management Plan.	**Section 11.8, Appendix L**
Non-Aboriginal heritage	The Historic Heritage Assessment identified that potential impacts on heritage items are primarily limited to subsidence associated impacts. A total of 23 historical heritage items were identified during the assessment, with 19 located directly above the proposed longwall mining area. Of these items, only one State Heritage listed item was identified (the Wirrimbirra Sanctuary). The assessment concluded that there was nil to low likelihood of significant impacts to any of the built structures of heritage value identified in the project area. This included historic heritage items within the Wirrimbirra Sanctuary. Mitigation measures have been identified to manage potential impacts, including the preparation and implementation of a site specific Heritage Management Plan for each heritage site of local significance identified within the Project Area. Detailed site inspection would be undertaken at Wirrimbirra Sanctuary prior to the commencement of mining to confirm the condition and structural integrity of the historic items within the sanctuary and inform the preparation of the site-specific Heritage Management Plan for the site to manage subsidence related impacts.	**Section 11.9, Appendix L**

Key issue	Key findings	Relevant EIS section
Noise and vibration	The noise emissions from the proposed development are predicted to reduce compared to existing Tahmoor Mine operational noise emissions at almost all noise-sensitive receptors during the day and evening periods and, importantly, most significantly during the night-time period at all noise-sensitive receptors. During the day and evening periods mitigated operational noise is expected to be lower at all but two assessment locations, residences at 185 and 215 Charlies Point Road. Negotiations between Tahmoor Coal and the owners of the two residences have commenced, for the purpose of acquiring the two properties. Road traffic noise associated with construction and operation of the project is predicted to satisfy the requirements of the *Road Noise Policy 2011*. Hence, the project is not expected to generate significant road traffic noise impacts at the nearest potentially affected receivers. Construction noise levels are predicted to exceed the relevant noise management levels at some locations but would remain below the highly noise affected level for all works during standard construction hours at all assessment locations. Construction noise levels outside of standard hours are predicted to exceed the noise management levels at the two nearest sensitive receptors on Charlies Point Road. The maximum noise level is likely to be below the sleep disturbance screening criteria at all nearby assessment locations. Based on the safe working distances for construction related vibration from typical plant items and the location of surrounding sensitive receptors, it is unlikely that human response vibration criteria or cosmetic damage criteria will be exceeded. The exception to this is the residence at 185 Charlies Point Road, with whom negotiations have commenced for the purpose of acquiring the property. Vibration from operational activity is not expected to change, with ground-borne vibration from equipment operating at the pit-top not expected to be perceptible. Tahmoor Coal will continue to monitor and actively manage construction noise and vibration as part of the proposed development, and will continue to investigate options for further operational noise mitigation into the future.	**Sections 11.10, Appendix M**

Key issue	Key findings	Relevant EIS section
Air quality	Potential air quality impacts during the construction phase would be short term and temporary in nature. Notably, estimated PM_{10} emissions from construction of the proposed development would be significantly less than the estimated emissions for operational mining activities. Operation of the proposed development is not predicted to result in exceedances of air quality criteria for annual average $PM_{2.5}$, annual average PM_{10}, annual average TSP or annual average deposited dust under the worst case scenario. No sensitive receptors are predicted to exceed the maximum 24-hour PM2.5 criterion of 25 µg/m^3 as a result of the proposed development (project only contributions). One private receptor near the REA (R10) is predicted to experience maximum 24-hour average PM10 concentrations above the relevant criterion of 50 µg/m^3 due to the proposed development's operations alone on one day of the year only. With the incorporation of a TARP and other dust management practices, these exceedances would be well managed.	**Section 11.11, Appendix N**
Greenhouse gas	The proposed development would generate an annual average of 0.84 million tonnes CO2-e of Scope 1 emissions, equating to approximately 13.5 million tonnes CO2-e over its life. Importantly, average annual Scope 1 emissions would represent a very small portion of Australia's commitment under the Paris Agreement, at about 0.19%. In addition, the proposed development would generate approximately 1.5 million tonnes CO2-e of Scope 2 emissions and approximately 104.5 million tonnes CO2-e of Scope 3 emissions over its life. Management and mitigation measures would be incorporated into the proposed development to reduce Scope 1, 2 and 3 emissions where feasible and practical.	**Section 11.12, Appendix O**
Traffic and transport	The Traffic Impact Assessment for the proposed development identified existing and future traffic volumes on the local road network. While an increase in construction and operational traffic is anticipated as a result of the proposed development, given the capacity of the existing road network the impact of this increase is considered minor. The upgrade of the mine access intersection with Remembrance Driveway is expected to improve road safety at this intersection. The potential impacts of the proposed development would be managed through Construction Traffic Management Plans which would be prepared in consultation with both RMS and Wollondilly Shire Council.	**Section 11.13, Appendix P**

Key issue	Key findings	Relevant EIS section
Social	Social impacts of the proposed development have been assessed with consideration of the local and regional context of the Project Area. The proposed development is likely to continue to generate social impacts in line with those already experienced by the community. Ongoing community consultation and engagement procedures would be implemented to keep the community informed of mine activities, respond to complaints and concerns and seek feedback. In addition, Tahmoor Coal would implement a Social Involvement Policy to provide for mine closure planning and transitioning of employment to minimise the future impacts of mine closure. The proposed development would extend the life of the Tahmoor Mine enabling existing coal markets to continue to be serviced and importantly, allowing the ongoing direct employment for approximately 390 employees for an additional 13 years, as well as the employment of between 50 and 175 additional staff for the transition period The proposed development would generate significant economic benefits including royalties and net income to the Wollondilly region and State. Additionally, the project would facilitate Tahmoor Coal's ongoing role in supporting the local community, through ongoing community contributions for a further 13 years.	**Section 11.15, Appendix Q**
Economic	In accordance with the NSW Treasury guidelines, a Cost Benefit Analysis and Local Effects Analysis was undertaken for the Tahmoor South Project comparing the proposed development central case to a baseline case of the proposed development not proceeding, to assess the net benefits to the NSW community. The economic assessment predicted a net benefit of around $699.5 million to be generated by the proposed development over its life, of which up to $132.0 million would flow through to the local Wollondilly region (in Net Present Value terms). Community benefits would be generated primarily through employment which would peak at 422 full time equivalent employees in the operational stages following development and construction phase of the proposed development. The proposed development is also expected to generate increased economic activity and employment within the wider NSW community, through wage spending and demand for downstream services and suppliers.	**Section 11.16, Appendix R**
Visual landscape	New visual elements associated with the proposed development would be minimal and would be limited to expansion of the REA, construction of two new ventilation shafts and upgrades to the Surface Facilities Area. The proposed development is not expected to create a visual impact on existing land use within and surrounding the Project Area.	**Section 11.17, Appendix S**

Key issue	Key findings	Relevant EIS section
Soils and land capability	There is no Biophysical Strategic Agricultural Land in the Project Area. The land in the project areas comprises land with a soil and land capability class of 4, 6 or 7 (moderate, low and very low capability land, respectively), with generally poor fertility soils. No land impacted by the proposed development is currently used for agricultural purposes. A total of 43 ha of bushland that is classified as potential agricultural land would be permanently removed as part of the REA expansion. Provided the existing mitigation measures and proposed rehabilitation measures are implemented, the proposed development is unlikely to significantly alter the land capability of the Project Area.	**Section 11.18, Appendix T**
Land use	Land use within the Project Area and DAA has been identified as predominately rural with some urban townships. Conservation Areas surround the Project Area however a small portion of only one, the Upper Nepean State Conservation Area, is located within the Project Area (though not within the proposed development). Subsidence impacts to the Upper Nepean State Conservation Area are considered to be negligible. Impacts to urban land uses are limited to physical impacts to dwellings and public infrastructure which are considered minor and manageable. Temporary impacts to Rural land are anticipated as a result of surface infrastructure upgrades and expansion of the REA, as well as subsidence related impacts to agriculture structures. However, these impacts are expected to be minor and readily managed through the EP.	**Section 11.19, Appendix T**
Waste	Construction waste from the proposed development would be managed in accordance with the existing Waste Management Strategy. The proposed development once fully operational would not result in a significant change in the amount or type of wastes generated on site. The Waste Management Plan for the existing Tahmoor Mine would be amended to reflect the operation of the proposed development.	**Section 11.21**
Hazards	The risks associated with the storage of dangerous goods, underground fire and explosion and bushfire on the proposed development would not differ to that which is present for the operation of the existing Tahmoor Mine. These risks would be managed through the implementation of the existing Hazardous Materials Management Procedure, Bushfire Management Plan and pre and post gas drainage.	**Section 11.22**

Key issue	Key findings	Relevant EIS section
Rail transport and port capacity	The Rail transport and port capacity assessment found that the generation of product coal from the proposed development would be accommodated within the four rail paths that are currently utilised for the operation of the existing Tahmoor Mine. There would be no change to the frequency or number of existing rail movements or operations. The assessment also found that the Port Kembla Coal Terminal has the capacity to receive four train paths of coal product per day from the proposed development, and has the capacity to store and handle the product coal that the proposed development would generate. The proposed development would facilitate the prolonged economic use of the Port Kembla Coal Terminal. Based on the assessment, the proposed development would not alter the existing impacts of the Tahmoor Mine on port and rail capacity other than the prolongation of utilising this infrastructure.	**Section 11.14, Appendix P**

Management and mitigation measures outlined in this EIS would be implemented throughout the detailed planning, construction and operational phases of the proposed development. These safeguards would minimise any potential adverse impacts arising from the proposed development on the surrounding environment.

Project approval is sought for the extension of an existing underground coal mine and use of an existing Surface Facilities Area within an existing mining lease area. With the implementation of appropriate mitigation measures, the proposed development would meet environmental performance requirements. Further it would result in direct and indirect economic benefits to the local community, and has been assessed in accordance with the principles of Ecologically Sustainable Development (ESD) in order for the proposed development to be considered for approval.

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Glossary of Terms

Term	Definition
Aboriginal cultural heritage	The tangible (objects) and intangible (dreaming stories, song lines, and places) cultural practices and traditions associated with past and present day Aboriginal communities.
Aboriginal stakeholders	Members of a local Aboriginal land council, registered holders of Native Title, Aboriginal groups or other Aboriginal people who have registered their interest with Tahmoor Coal to be consulted about a proposed development.
annual recurrence interval (ARI)	Used to describe the frequency or probability of floods occurring (e.g. a 100 year ARI flood is a flood that occurs or is exceeded on average once every 100 years).
anticline	Upwards-arched fold in the rock strata, where the beds dip outwards in two or more directions from the crest.
aquifer	Geologic formation, group of formations, or part of a formation capable of transmitting and yielding quantities of water.
archaeological site	A site with material evidence of past Aboriginal or non-Aboriginal activity in which evidence of past activity is preserved.
archaeology	The scientific study of human history, particularly the relics and cultural remains of the distant past.
arterial roads	The main or trunk roads of the State road network.
Assessment Background Level	The Assessment Background Level (ABL), as defined by the NSW Industrial Noise Policy 2000, is a measure of the background level for noise, representing discrete assessment periods (i.e. day, evening or night) for each day. It is determined by calculating the 10th percentile (lowest 10%) background noise level over a 90 minute period (LA90).
background noise level	The NSW Industrial Noise Policy 2000 defines the background noise level as the ambient sound-pressure noise level in the absence of the sound under investigation exceeded for 90% of the measurement period. Normally equated to the average minimum A-weighted sound pressure level.
bed	Stratum of coal or other sedimentary deposit.
bin	Coal storage structure, either underground or surface structure.
blast	A controlled explosion which is used to loosen the substance being mined.
bore	A cylindrical drill hole sunk into the ground from which water is pumped for use or monitoring.
borehole	A hole produced in the ground by drilling for the investigation and assessment of soil and rock profiles.
Bulli seam	Shallowest coal horizon in the Illawarra Coal Measures in the Southern Coalfield. The Bulli coal seam is a primary source of coking coal, located in the Illawarra and Southern Coalfields of New South Wales.
catchment	The area from which a surface watercourse or a groundwater system derives its water.
Construction Environmental Management Plan (CEMP)	Construction Environmental Management Plan. A site specific plan developed for the construction phase of a project to ensure that all contractors and sub-contractors comply with the environmental conditions of approval for the proposed development and that environmental risks are properly managed.
clearing	The removal of vegetation or other obstacles at or above ground level.

Term	Definition
coal preparation	Treatment by screening of coal of various sizes to meet a purchasers requirements and treatment by one or more processes to reduce the amount of waste (ash) present in the coal.
coking coal	Coal suitable for the manufacture of coke.
compressive strain	Compressive strains decrease in the distance between two points and may cause shear cracking, steps, or concave curvatures at the ground surface.
continuous miner	The electric powered cutting machine used to remove coal from the active mining face and load it into the shuttle car.
conveyor	The means of transporting coal from the face and to the underground bin or surface. It consists of a belt being driven by a motor drum system over a structure roller assembly.
cover	The overburden above the coal resource.
depth of cover	The depth from the surface to the mine workings.
Critically Endangered Ecological Community (EEC)	An ecological community identified by the *Biodiversity Conservation Act 2016* that is facing an extremely high risk of extinction in Australia in the immediate future, as determined in accordance with criteria prescribed by the regulations.
cumulative impacts	Combination of individual effects of the same kind due to multiple actions from various sources over time.
cut	Mechanically slice a coal seam to extract the coal resource.
cut-through	This is the mine opening at an angle to the main heading direction. It is the roadway which joins one roadway to another; they are numbered in sequence going in along the length of the development.
decibel	A scale unit used in the comparison of powers and levels of sound energy. Used for measuring noise.
mine development	The operations involved in preparing a mine for extraction, including cutting roadways and headings. Also includes tunnelling, sinking, crosscutting, drifting, and raising.
discharge	A release of water from a particular source.
downcast	Shaft or other mine opening down which fresh air from the surface passes.
drainage	Natural or artificial means for the interception and removal of surface or subsurface water.
drift	An inclined access from the surface to the coal seam or from coal seam to another coal seam. A drift often contains a conveyor belt or man-riding train.
drive	A heading, drift, or face.
earthworks	Operations involved in loosening, excavating, placing, shaping and compacting soil or rock.
ecology	The study of the relationship between living things and the environment.

Term	Definition
ecologically sustainable development	As defined in the *Protection of the Environment Administration Act 1991*, requires the effective integration of economic and environmental considerations in decision making processes including: • The precautionary principle; • Inter-generational equity; • Conservation of biological diversity and ecological integrity; and • Improved valuation, pricing and incentive mechanisms (includes polluter pays, full life cycle costs, cost effective pursuit of environmental goals).
ecosystem	As defined in the *Environment Protection and Biodiversity Conservation Act 1999*, an ecosystem is a 'dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.'
Endangered Ecological Community (EEC)	An ecological community identified by the *Biodiversity Conservation Act 2016* that is facing a very high risk of extinction in New South Wales in the near future, as determined in accordance with criteria prescribed by the regulations, and is not eligible to be listed as a critically endangered ecological community.
edge effects	A change in species composition, physical conditions or other ecological factors at the boundary between two ecosystems or the ecological changes that occur at the boundaries of ecosystems (including changes in species composition, gradients of moisture, sunlight, soil and air temperature, wind speed and other factors).
emission	The discharge of a substance into the environment.
Environmental Management Plan (EMP)	A plan used to manage environmental impacts during each phase of project development. It is a synthesis of proposed mitigation, management and monitoring actions, set to a timeline with defined responsibilities and follow up actions.
Environmental Management System (EMS)	A quality system that enables an organisation to identify, monitor and control its environmental aspects. An EMS is part of an overall management system, which includes organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy.
environment	As defined within the *Environmental Planning and Assessment Act, 1979*, all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings.
Environment Protection Licence (EPL)	EPLs are issued by NSW Environment Protection Authority (EPA) under the *Protection of the Environment Operations Act 1997*. EPLs with respect to scheduled development work or scheduled activities or non-scheduled activities may regulate all forms of pollution (including water pollution) resulting from that work or those activities. EPLs authorising or controlling an activity carried on at any premises may also regulate pollution resulting from any other activity carried on at the premises to which the licence applies.
Existing Tahmoor Mining Area	Encompasses all existing mining areas associated with the Tahmoor Mine, including the Surface Facilities Area.
extraction height	The heights at which the seam is extracted.

Term	Definition
Extraction Plan (EP)	An Extraction Plan governs the management of subsidence impacts to natural and built features from longwall mining by: • Providing an overview of the planned coal resource recovery methods; • Identifying and characterisation of the natural and built features within the Extraction Plan Area; • Identifying the predicted subsidence impacts and/or environmental consequences within the Extraction Plan Area associated with the planned coal recovery; • Identifying, and implementing as appropriate, a monitoring and management regime to control the identified subsidence risks; and • Implementing a review and auditing process to provide feedback Extraction Plans replace the function of Subsidence Management Plans. On 1 July 2014 a consolidated Extraction Plan (EP) Process replaced the NSW Division of Resources and Geosciences' former Subsidence Management Plan process. Under the Extraction Plan, mine subsidence would be jointly regulated by the Resource and Geosciences Division (responsible for compliance and enforcement of the EP) and Planning Services Division (responsible for compliance and enforcement of the EP as it relates to the Development Consent) of the Department of Planning & Environment (DPE).
exploration	The work done to prove or establish the extent and quality of the coal resource.
face	The inbye end of the mine roadway, usually the working place for coal extraction.
fan	Part of the ventilation system used to pass air through the mine workings. The 'main' fan is located on the surface but other booster fans may be located underground within the workings.
fault	Break in the continuity of a coal seam or rock strata.
FIDOL factor	An acronym used in odour impact assessments when collectively considering the issues of Frequency, Intensity, Duration, Offensiveness and Location of odour events.
first workings	Driving roadways in solid coal (before commencement) to act as either active working areas or function as development for subsequent extraction.
frequency (sound)	The number of cycles per second (Hertz) of anything that oscillates is called the "frequency". Most sounds comprise a composite of frequencies of varying sound-pressure levels in the range of 20 to 20,000 Hertz.
gate road	Roadway leading to a working place in longwall mining.
goaf	The goaf is the part of a longwall mine from which the coal has been removed. After longwall mining is complete, typically, the roof collapses filling the void.
GMRGS Plan	Greater Metropolitan Region Groundwater Sources Plan
greenhouse gases	Gases with the potential to cause climate change (e.g. methane, carbon dioxide and others listed in the *National Greenhouse and Energy Reporting Act 2007*). Expressed in terms of carbon dioxide equivalent.
green waste	Organic waste resulting from the trimming, pruning, lopping, cutting or felling of any form of vegetation, for example grass, trees or shrubs.

Term	Definition
groundwater	Water located within an aquifer, i.e. water that is held in the rocks and soil beneath the earth's surface.
habitat	The place where a species, population or ecological community lives (whether permanently, periodically or occasionally).
heading	Roadways forming the opening in the direction of longwall development.
hydrocarbon	Any organic compound (gaseous, liquid or solid) consisting only of carbon and hydrogen.
hydrogeology	The study of subsurface water in its geological context.
hydrology	The study of rainfall and surface water runoff processes.
impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
inbye	The direction along a roadway towards the face, thus going away from the surface entry. Additionally, inbye can also refer to a direction that is further into the mine, away from the surface entry, from a current position in the mine.
intake	Any passage taking fresh air into the workings.
interburden	The rock between two geological features.
intrusive noise	Intrusive noise, as defined in the NSW Industrial Noise Policy 2000, refers to noise that intrudes above the background level by more than 5 decibels.
Key Threatening Process	As defined under the *Biodiversity Conservation Ac 2016*, a key threatening process is any listed process under the Act that adversely affects threatened species, populations or ecological communities, or that could cause species, populations or ecological communities that are not threatened to become threatened.
knickpoint	A local steep fall in channel bed elevation.
landscape character	The aggregate of built, natural and cultural aspects that make up an area and provide a sense of place. Includes all aspects of a tract of land including built, planted and natural topographical and ecological features.
local road	A council controlled road which provides for local circulation and access.
longwall	A system of coal mining, where the coal seam is extracted from on a broad front or long face.
mine roof	The layer that lies over the coal seam.
outbye	Locations between the active face and the surface. Additionally, outbye can also refer to a direction that is further out of the mine, toward the surface entry, from a current position in the mine.
overburden	The geological units and material above the coal seam proposed or being mined.
panel	The mining unit that has previously been extracted or is currently being extracted.
perched water	Unconfined groundwater held above the water table by a layer of impermeable rock or sediment.
pollutant	Any matter that is not naturally present in the environment.
portal	Entrance to a tunnel.

Term	Definition
preparation plant	A place where coal is sized, treated by one or more processes, including washing, to reduce the amount of waste (ash) present and prepared for market.
product coal	Coal that has been processed within the processing plant to remove unwanted waste rock and prepared to customers specifications
Project Area	Shown on **Figure 4.1**
proposed development	Extension of underground coal mining and associated activities at Tahmoor Mine within the Project Area. Referred to as The Tahmoor South Project, as described in **Section 4.0** of this EIS. The terms project and proposal are used interchangeably with the proposed development.
Rating Background Level (RBL)	The Rating Background Level, as defined in the NSW Industrial Noise Policy 2000, is the overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period (as opposed to over each 24-hour period used for the assessment background level).
Rehabilitation Management Plan (RMP)	Due to the commencement of the *Mining Amendment Act 2008* and *Mining Regulation 2010* on 15 November 2010, Rehabilitation Management Plans (RMP) are intended to replace the existing requirements for MOPs.
return air	Air that has passed through the workings and may contain gas or dust.
revegetation	Direct seeding or planting (generally with native species) within an area in order to re-establish vegetation that was previously removed from that area.
riparian	Relating to the banks of a natural waterway.
rising main	Pipes in shaft or drift delivering drainage water to surface.
run-off	The portion of water that drains away as surface flow.
Run of Mine (ROM)	Raw coal production that contains coal and rock.
seam	Layer or bed of coal.
sensitive receiver	A location where a person works or resides, including residential, hospitals, hotels, shopping centres, play grounds, recreational centres or similar.
shaft	An opening, usually vertical, that connects the surface with the underground workings.
shear	Vertical cut made in the coal face by the cutting machine. In longwall operations it refers to the cut of coal taken along the complete longwall face.
shuttle car	An electrically-propelled vehicle on rubber tires or caterpillar treads used to transfer materials, such as coal.
stockpile	Stored materials such as product coal, soil, sand, gravel and spoil/waste.
strain	The change in horizontal distance between two points at the surface after mining, divided by the pre-mining distance between the points and usually expressed in mm/m.
subsidence	The vertical lowering, sinking or collapse of the ground surface.
Subsidence Study Area	The predicted limit of vertical subsidence, taken as the 20 mm subsidence contour or a minimum of 600 m from the nearest edge of the proposed longwalls, whichever is the furthest.

Term	Definition
Surface Facilities Area	The surface components of the mine containing infrastructure related to mining operations.
surface water	Water flowing or held in streams, rivers and other wetlands in the landscape.
syncline	A trough-like fold in rocks.
tensile strain	The relative increase in the distance between two points on the surface.
tilt	The change in the slope of the ground as a result of subsidence, calculated as the change in subsidence between two points divided by the distance between the points and usually expressed in mm/m.
tributary	A river or stream flowing into a larger river or lake.
upcast	Shaft or other mine opening through which air returns to the surface after ventilating the mine workings.
vulnerable	As defined under the *Biodiversity Conservation Act 2016*, a species that is facing a high risk of extinction in New South Wales in the medium-term future.
water table	The surface of saturation in an unconfined aquifer at which the pressure of the water is equal to that of the atmosphere.
waterway	Any flowing stream of water, whether natural or artificially regulated (not necessarily permanent).

Acronyms

Acronym	Term/ Definition
µm	Micrometres
ABS	Australian Bureau of Statistics
ACHA	Aboriginal Cultural Heritage Assessment
ACHCR	Aboriginal cultural heritage consultation requirements
AEP	Annual Exceedance Probability
AHIMS	Aboriginal Heritage Information Management System
AIS	Agricultural Impact Statement
AQIA	Air Quality Impact Assessment
ARI	Annual Recurrence Interval
ARTC	Australian Rail Track Corporation
ASS	Acid sulfate soils
AST	Above-ground Storage Tank
AUSRIVAS	Australian River Assessment System
BC Act	*Biodiversity Conservation Act 2016*
BSAL	Biophysical strategic agricultural land
BTEX	Benzene, toluene, ethylbenzene and xylenes
CAMBA	China-Australia Migratory Bird Agreement
CBA	Cost Benefit Analysis
CCL	Consolidated Coal Lease
CEM	Continuous emission monitoring
CEMP	Construction Environmental Management Plan
CH_4	Methane
CHMP	Cultural Heritage Management Plan
CHPP	Coal Handling and Preparation Plant
CL	Coal Lease
CLM Act	*Contaminated Land Management Act 1997*
CNVMP	Construction Noise and Vibration Management Plan
CO	Carbon monoxide
CO_2	Carbon dioxide
CSI	Corporate Social Involvement
CTMP	Construction Traffic Management Plan
DAA	Disturbance assessment area
dB(A)	Decibels using the A-weighted scale measured according to the frequencies perceptible to the human ear.
DECCW	NSW Department of Environment, Climate Change and Water
DoEE	Commonwealth Department of Environment and Energy

Acronym	Term/ Definition
DI Water	NSW Department of Industry - Water
DPE	NSW Department of Planning and Environment
DPI	Department of Primary Industries
DRG	NSW DPE - Division of Resources and Geoscience (formerly the Division of Resources and Energy under NSW Trade & Investment)
DSC	Dams Safety Committee
EDL	Energy Developments Limited
EEC	Endangered Ecological Community
EIA	Economic Impact Analysis
EIS	Environmental Impact Statement
EL	Exploration Licence
EMS	Environmental Management System
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EP&A Regulation	*Environment Planning and Assessment Regulations 2000*
EP	Extraction Plan
EPA	NSW Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Act 1999* (Cth)
EPL	Environment Protection Licence
ESA	Environmental Site Assessment
ESD	Ecological Sustainable Development
FM Act	*Fisheries Management Act 1994*
GHG	Greenhouse gas
GL	Gigalitre
GME	groundwater monitoring event
GMRGS	Greater Metropolitan Region Groundwater Sources
GRP	Gross Regional Product
GSP	Gross State Product
ha	Hectare/s
HVAS	High Volume Air Sampler
ICNG	*Interim Construction Noise Guideline*
IESC	Independent Expert Scientific Committee
ILUA	Indigenous Land Use Agreement
INP	*Industrial Noise Policy 2000*
IPM	Incremental Profile Method
JAMBA	Japan-Australia Migratory Bird Agreement
kPa	kilopascals
LALC	Local Aboriginal Land Council
LDP	licensed discharge point

Acronym	Term/ Definition
LEC	NSW Land and Environment Court
LEP	Local Environmental Plan
LOP	licensed overflow point
LGA	Local Government Area
LNAPL	Light non-aqueous phase liquid
LoS	Level of service
m AHD	metres Australian Height Datum
MAH	Monocyclic Aromatic Hydrocarbons
mg/L	milligrams per litre
micron	One millionth of a metre (abbreviation µ)
Mining SEPP	*State Environment Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*
ML	Megalitre
MNES	Matters of National Environmental Significance (from the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*).
MOP	Mining Operations Plan
MPL	Mining Purpose Lease
MSA	Metropolitan Special Area
MSEC	Mine Subsidence Engineering Consultants Pty Ltd
Mtpa	Million tonnes per annum
NGER	National Greenhouse and Energy Reporting
NHMRC	National Health and Medical Research Council
NML	noise management levels
NMP	Noise Management Plan
NO	Nitric Oxide/Nitrogen monoxide
NO_2	Nitrogen dioxide
NorBe	neutral or beneficial effect
NO_x	Oxides of nitrogen
NPfI	*Noise Policy for Industry 2017*
NPV	Net Present Value
NPWS	National Parks and Wildlife Service
NSW	New South Wales
NVIA	Noise and Vibration Impact Assessment
O_3	Ozone
OEH	Office of Environment and Heritage
OU	odour unit
PAC	Planning Assessment Commission
PAH	Polycyclic Aromatic Hydrocarbons

Acronym	Term/ Definition
PCB	Polychlorinated biphenyls
PEA	Preliminary Environmental Assessment
PFM	Planning Focus Meeting
pH	A measure of acidity or alkalinity of a solution. The potential of hydrogen.
PM	Particulate matter
PM_{10}	Particulate matter less than 10 microns in diameter.
$PM_{2.5}$	Particulate matter less than 2.5 microns in diameter.
POEO Act	*Protection of the Environment Operations Act 1997*
PRP	Pollution Reduction Program
RAP	Registered Aboriginal Party
RBLs	Rating Background Levels
REA	Rejects emplacement area. Can also be called refuse emplacement area.
RMP	Rehabilitation Management Plan
RING	*Rail Infrastructure Noise Guideline 2013*
RMS	Roads and Maritime Services
RMZ	Risk Management Zone
RNP	*Road Noise Policy 2011*
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
ROM	Run Of Mine
SA NSW	Subsidence Advisory New South Wales
SEARs	Secretary's Environmental Assessment Requirements
SEPP	*State Environmental Planning Policy*
SHSW	Southern Highlands Shale Woodland
SIA	Social Impact Assessment
SIS	Surface to InSeam
SMP	Subsidence Management Plan
SO_2	Sulfur dioxide
SSA	Subsidence Study Area
SSTF	Shale Sandstone Transition Forest
TARP	Trigger Action Response Plan
TCCCC	Tahmoor Coal Community Consultative Committee
TEOM	Tapered Element Oscillating Microbalance Instrument
TIA	Traffic Impact Assessment
TPH	Total petroleum hydrocarbons
TRH	Total recoverable hydrocarbons
TSC Act	*Threatened Species Conservation Act 1995* (NSW)
TSP	Total Suspended Particulate matter

Acronym	Term/ Definition
UPSS	Underground Petroleum Storage Systems
UST	Underground storage tank
VHCs	Volatile halogenated compounds
VIA	Visual Impact Assessment
VOC	Volatile organic compounds
vpd	Vehicles per day
vph	Vehicles per hour
WARR Strategy	Waste Avoidance and Resource Recovery Strategy
WCMG	Waste Coal Mine Gas
Wingecarribee LEP 2010	Wingecarribee Local Environmental Plan 2010
Wollondilly LEP 2011	Wollondilly Local Environmental Plan 2011
WSP	Water Sharing Plans

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1.0 Introduction

This section provides an introduction to the Tahmoor Mine, the proposed Tahmoor South Project, the approval process for the proposed development, and the purpose and content of this Environmental Impact Statement (EIS).

1.1 Overview

Tahmoor Coal Pty Ltd (Tahmoor Coal) owns and operates the Tahmoor Mine. Tahmoor Coal trades as Tahmoor Coking Coal Operations (TCCO) within the SIMEC Mining Division of the GFG Alliance Group. The Tahmoor Mine is an underground coal mine approximately 80 kilometres (km) south-west of Sydney in the Southern Coalfields of New South Wales (NSW) (**Figure 1.1**).

Tahmoor Coal produces up to three million tonnes per annum (Mtpa) of run of mine (ROM) coal from its existing operation at the Tahmoor Mine, and undertakes underground mining under existing development consents, licences and the conditions of relevant mining leases. Underground mining, within the Existing Tahmoor Mining Area (refer to **Figure 1.2**), is anticipated to be completed by 2022, depending upon geological and mining conditions. **Section 1.2** discusses mining leases in detail.

Tahmoor Coal is seeking approval for the Tahmoor South Project (the proposed development), being the extension of underground coal mining to the south of the Tahmoor Mine Surface Facilities Area. The proposed development would continue to be accessed via the existing surface facilities at the Tahmoor Mine, located between the towns of Tahmoor and Bargo.

The proposed development seeks to extend the life of underground mining at the Tahmoor Mine until approximately 2035. The proposed development would enable mining to be undertaken within the southern portion of Tahmoor Coal's (and its wholly owned subsidiary Bargo Collieries Pty Ltd) existing lease areas, and operations and employment of the current workforce to continue for approximately a further 13 years. Additional surface lease areas will be required for surface facilities (refer to **Section 1.3** and **Figure 1.5)**

The Project Area is shown on **Figure 1.3** and comprises an area adjacent to, and to the south of, the Existing Tahmoor Mining Area. The Project Area also overlaps the Surface Facilities Area of the Existing Tahmoor Mining Area comprising the surface facilities, historical workings and existing mine infrastructure. The proposed development would extend mining at Tahmoor Mine within the Project Area, using longwall mining methods to mine the Bulli seam with the continued use of ancillary infrastructure at the existing Tahmoor Mine Surface Facilities Area. The mine plan for the project has undergone revisions to avoid longwall mining directly under sensitive features such as the Metropolitan Special Area (MSA), bedrock rivers with standing pools, items of Aboriginal heritage and significant landscape features such as river gorges. The Project Area traverses both the Wollondilly and Wingecarribee Local Government Areas (LGA) and covers the coal lease areas held by Tahmoor Coal and its wholly owned subsidiary Bargo Collieries Pty Ltd, including Consolidated Coal Lease (CCL) 747. Within the Project Area, the proposed development (including all longwall mining and surface development) would be confined to the Wollondilly LGA.

The Preliminary Environmental Assessment (PEA) for the proposed development was submitted to the then Department of Planning and Infrastructure (now NSW Department of Planning and Environment (DPE)) on 13 September 2012 to identify key environmental planning issues to inform the development of Director-General's Requirements (DGRs) for the preparation of this EIS.

In 2012 Director General's Requirements (DGRs) were issued and an EIS completed in 2014, however it was not submitted to the DPE. The proposed development was placed on hold and subsequently withdrawn in late 2015. In May 2017 the PEA was resubmitted to DPE requesting Secretary's Environmental Assessment Requirements (SEARs) in order to recommence the project development application and update the EIS. The SEARs for the Tahmoor South Project were issued on 9 June 2017 and revised on 20 June 2018 (social impact assessment requirements).

The project was determined to be a controlled action, under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act), by Department of Environment and Energy on 12 January 2018 and supplementary SEARs were issued for the project on 14 February 2018 to include Commonwealth environmental assessment requirements. The Commonwealth government has accredited the NSW environmental assessment process under the *Environmental Planning & Assessment Act 1979* (EP&A Act) in a bilateral agreement between the governments. As such, the project will be assessed under the provisions of the EP&A Act in accordance with the bilateral agreement.

This EIS and the associated development application have been prepared in accordance with the SEARs and supplementary SEARs and also the requirements of the EP&A Act and the *Environmental Planning & Assessment Regulation 2000* (EP&A Regulation) to seek approval from the NSW Minister for Planning (or delegate) and the Commonwealth Minister for the Environment (or delegate) for the Tahmoor South Project.

1.2 Background

The Tahmoor Mine consists of two Colliery Holdings, registered under section 163 of the *Mining Act 1992* (Mining Act):

- Tahmoor Colliery Holding – covering an area of 6,735 hectares (ha) with surface rights over 231.7 ha and consisting of Consolidated Coal Lease (CCL) 716 and Mining Leases (ML) 1308, 1376 and 1539; and
- Bargo Colliery Holding – consisting of CCL747 and covering 4,769 ha with surface rights over 921 ha.

A colliery is an underground mine, its associated buildings and equipment which has been established to specifically mine coal. Within this EIS, the term mine is used in preference to colliery.

Coal exploration operations commenced at the Tahmoor Mine during the 1960s by the NSW Government. This was then followed by the granting of exploration titles to private companies.

The Tahmoor and Bargo areas were initially secured by separate entities and developed as independent mines. Both the Tahmoor and Bargo Mines were granted planning and environmental approvals to commence coal mining operations in the mid to late 1970s.

The current Tahmoor Mine operation consists of:

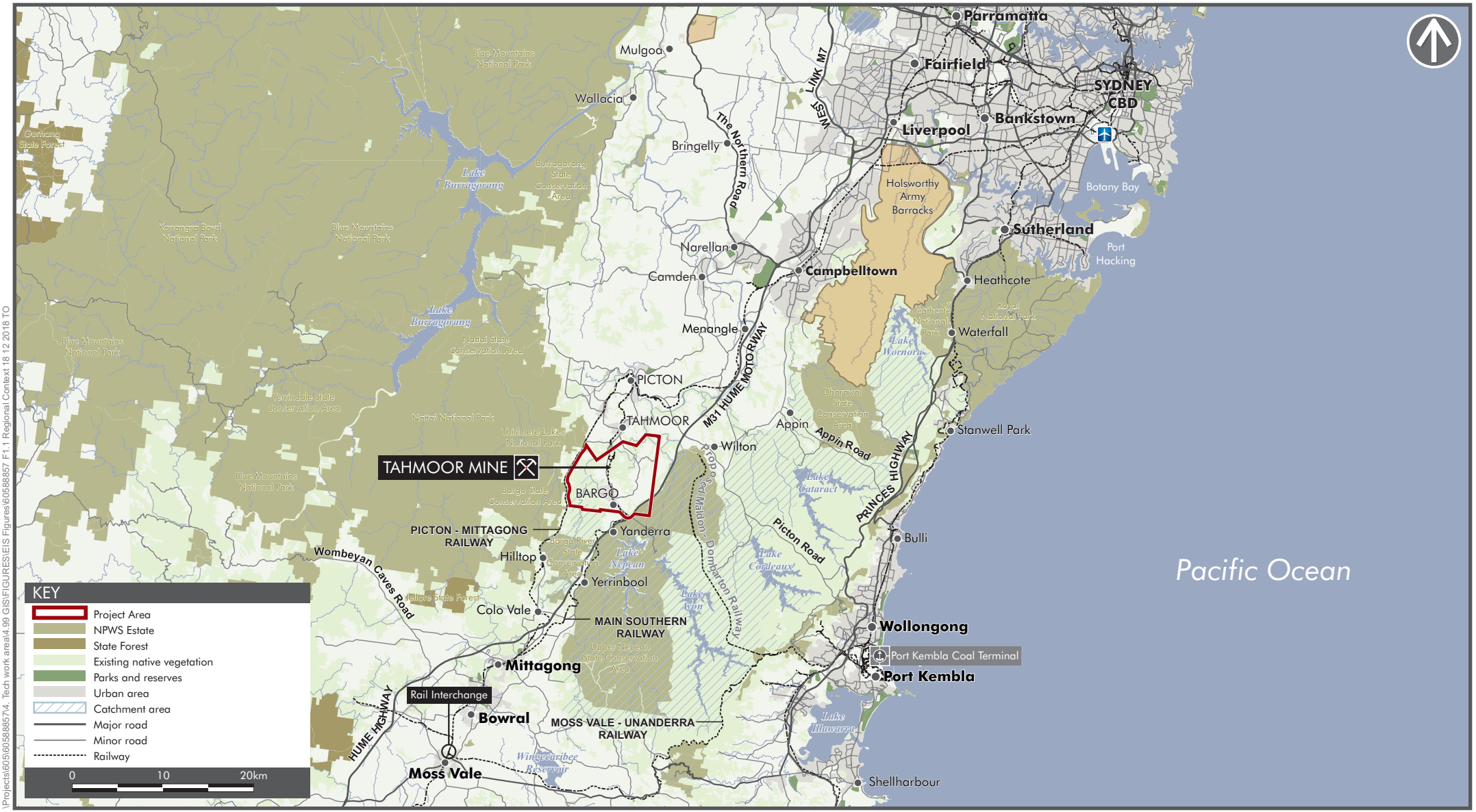
- the Tahmoor Mine, which commenced mining operations in 1979 and has undertaken coal production until the present day; and
- the Bargo Mine, where limited development, including sinking the Bargo shaft, was undertaken between 1979 and 1981. Mine development work was discontinued in June 1981, followed by project feasibility investigations and exploration activities (refer **Section 1.2.2**).

Tahmoor Mine is divided into three distinct mining areas (refer to **Figure 1.4**):

- Tahmoor Central (Longwalls 1-21);
- Tahmoor North (Longwalls 22-37); and
- Tahmoor South (the proposed development).

Tahmoor South comprises a single mining domain: the Central Domain.

Two additional domains, the Eastern and Southern Domains, were identified during project planning and pre-feasibility studies (refer to **Figure 1.4**). Mining in these domains are not proposed as part of the proposed development due to geological features and a greater proportion of risk management zones (RMZs) and sensitive features in these areas.



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SIMEC MINING

REGIONAL CONTEXT

Tahmoor South Project
Environmental Impact Statement

FIGURE 1.1

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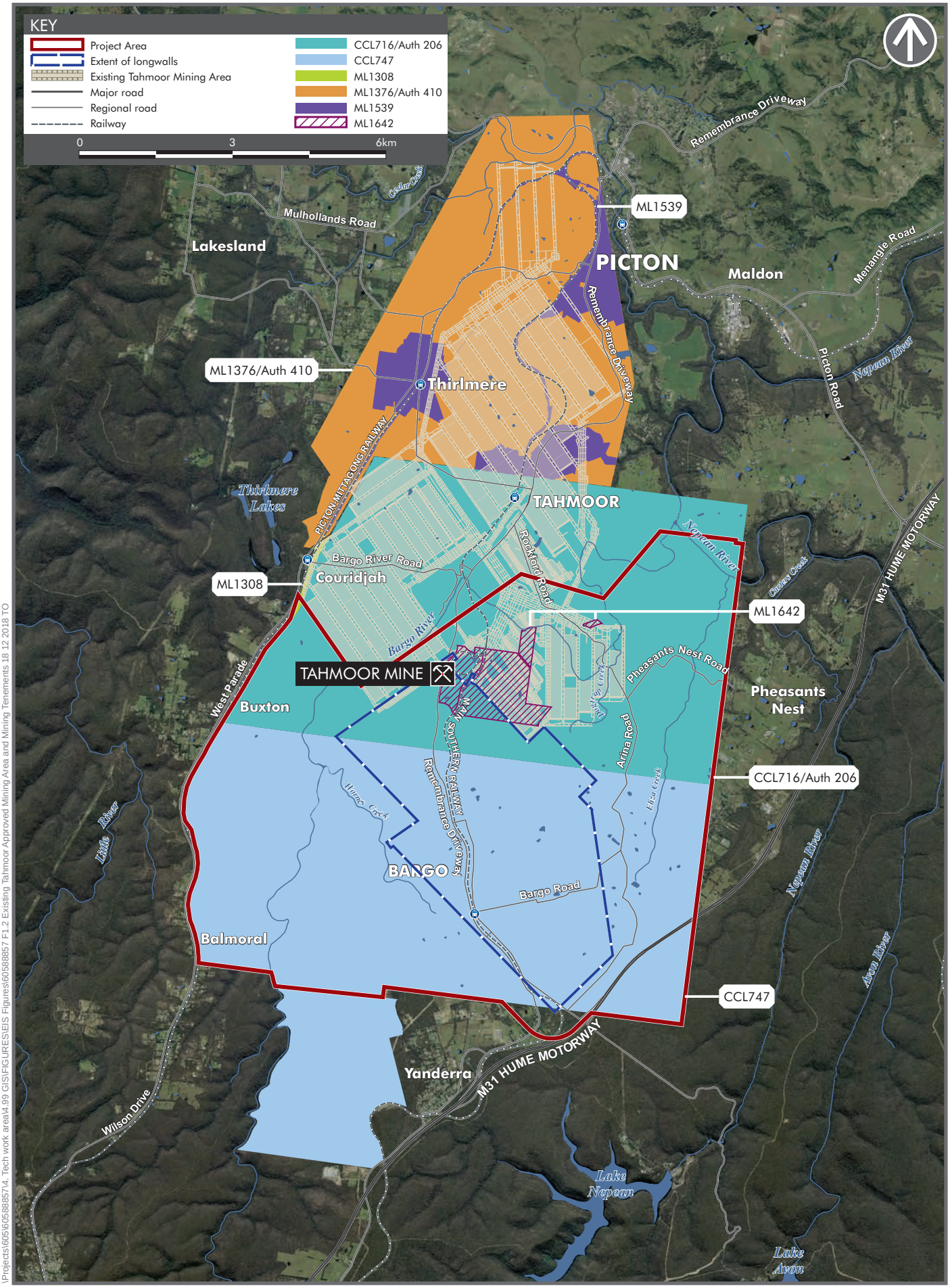

\Projects\605\605885714. Tech work area\4.99 GIS\FIGURES\EIS Figures\605885857-F1.2 Existing Tahmoor Approved Mining Area and Mining Tenements 18 12 2018 TO

SIMEC MINING

EXISTING MINING AREAS AND MINING TENEMENTS AT TAHMOOR MINE

Tahmoor South Project
Environmental Impact Statement

FIGURE 1.2

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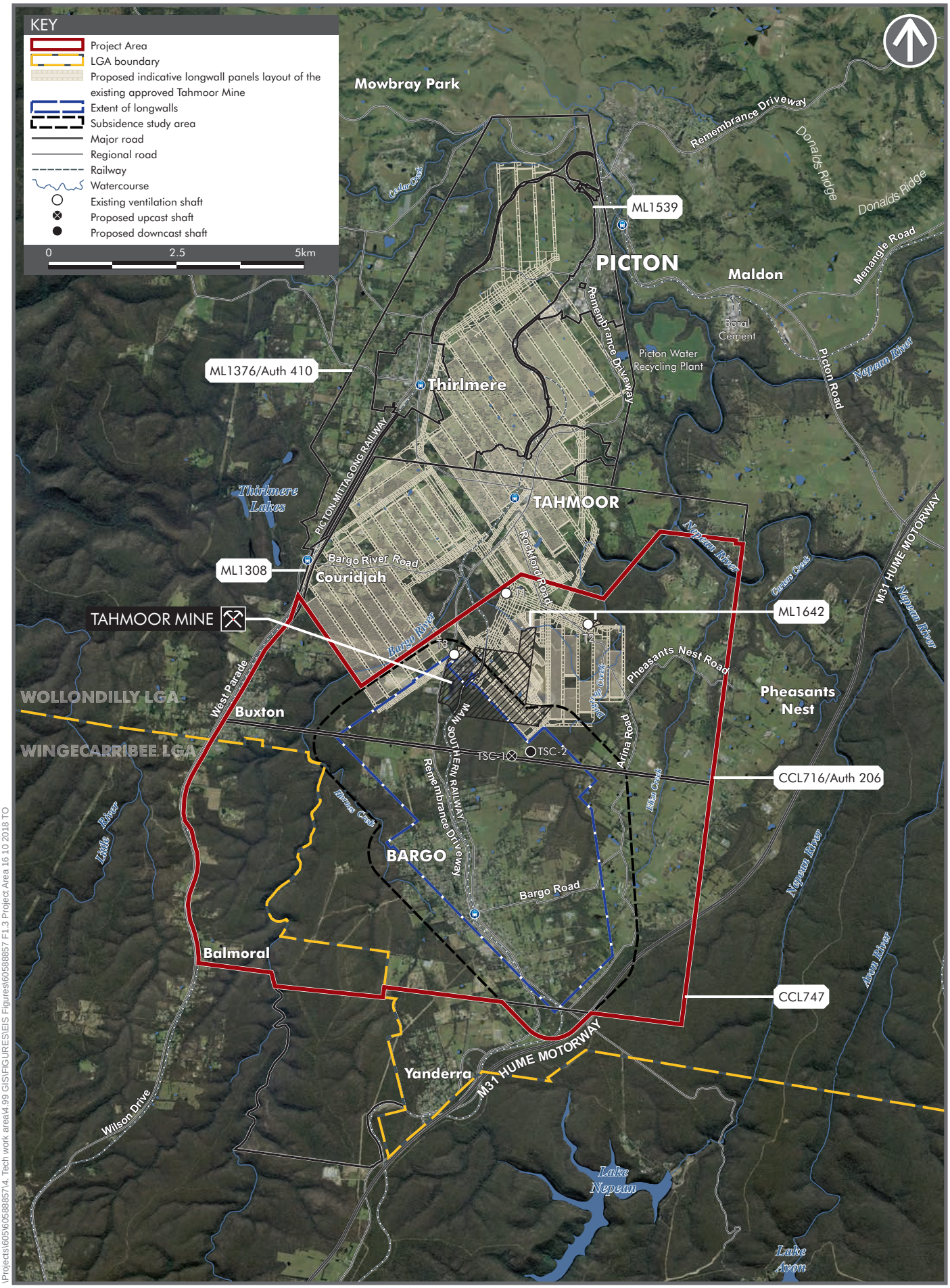

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SIMEC MINING

PROJECT AREA

Tahmoor South Project
Environmental Impact Statement

FIGURE 1.3

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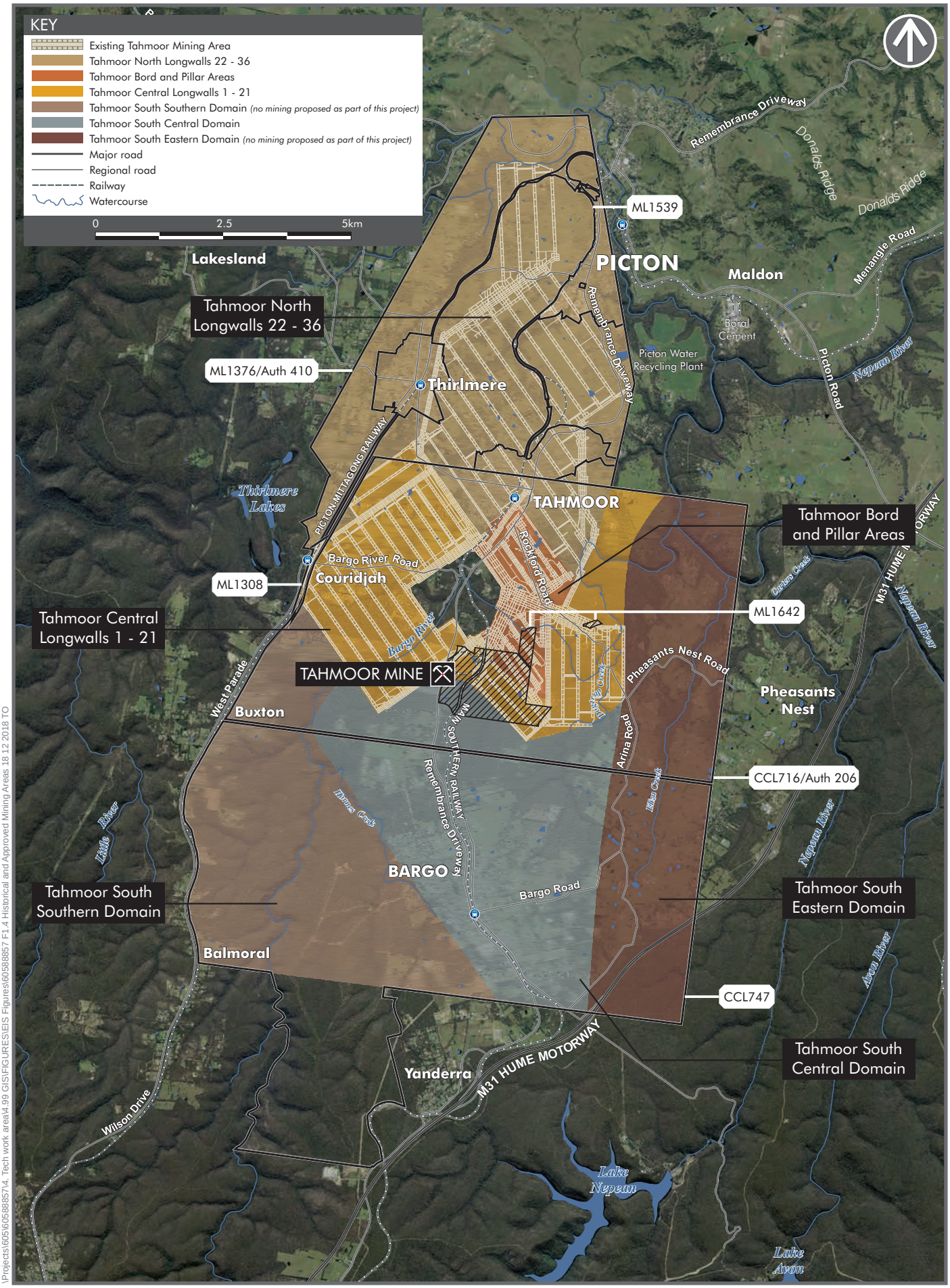

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SIMEC MINING

HISTORICAL AND PROPOSED MINING AREAS

Tahmoor South Project
Environmental Impact Statement

FIGURE 1.4

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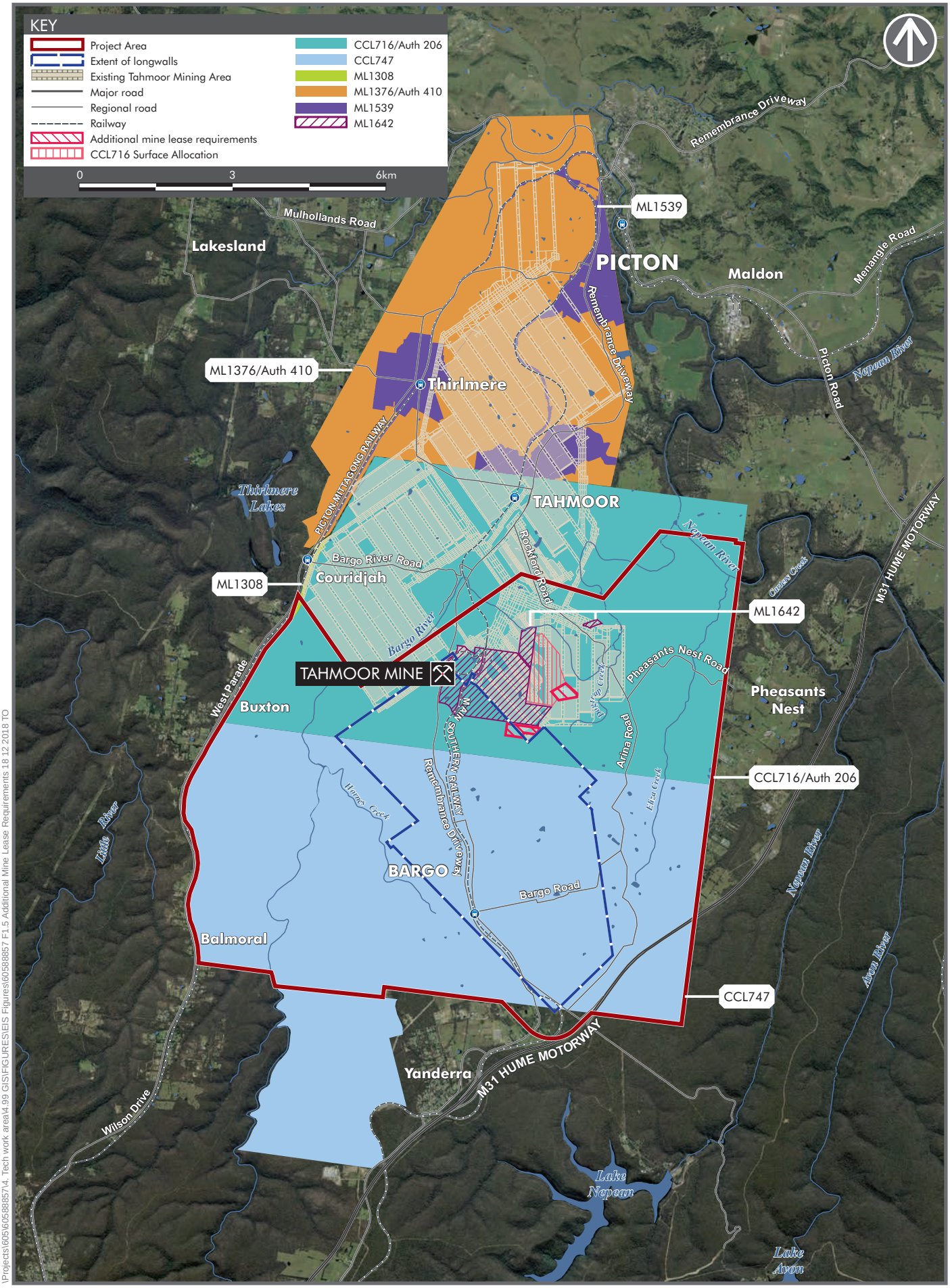

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SIMEC MINING

ADDITIONAL MINE LEASE REQUIREMENTS

Tahmoor South Project
Environmental Impact Statement

FIGURE 1.5

1.2.1 Tahmoor Mine

Regional exploration drilling was undertaken in the area by the NSW Government during the 1960s. In the early 1970s, Clutha Development Pty Ltd commenced geological exploration of coal resources at Tahmoor under Exploration Licence (EL) No. 350. Clutha Development Pty Ltd then obtained development consent in 1975 for the underground coal mine, followed by a separate approval in 1979 for a Coal Handling and Preparation Plant (CHPP) and Rejects Emplacement Area (REA).

The Tahmoor Mine commenced operations in 1979 within the Existing Tahmoor Mining Area, which consists of the Tahmoor North and Tahmoor Central mining areas (refer to **Figure 1.4**). An overview of the ownership history of the Tahmoor Mine is provided in **Table 1.1**. The first commercial coal was produced at Tahmoor Mine in 1979.

Clutha Development Pty Ltd was granted five mining leases between 1970 and 1976, which were replaced by CCL 716 which was granted to Tahmoor Coal on 15 June 1990. During Tahmoor Coal's ownership of the Tahmoor Mine (refer to **Table 1.1**), four additional mining leases were granted for exploration and mining purposes between 1993 and 2010. These mining leases are summarised in **Table 1.2** below.

Table 1.1 History of Tahmoor Mine Ownership

Tahmoor Mine Ownership History	Parent Company and/ or Controlling Entity	Date from
Clutha Development Pty Ltd	Not applicable	April 1974
BP Coal Development Pty Ltd	Not applicable	December 1985
Novacoal Australia Pty Ltd	Novacoal Australia Pty Ltd was a business unit within Kembla Coal and Coke Pty Ltd (a subsidiary of CRA Limited)	December 1989
Tahmoor Coal Pty Ltd	Austral Coal Limited	February 1997
Tahmoor Coal Pty Ltd	Centennial Coal Pty Ltd	July 2005
Tahmoor Coal Pty Ltd	Glencore Coal Pty Ltd	November 2007 to April 2018
Tahmoor Coal Pty Ltd	SIMEC (Australia) Mining Pty Ltd. Tahmoor Coal trades as TCCO within the SIMEC Mining Division of the GFG Alliance Group.	April 2018

Table 1.2 Historic Mining Leases Granted for the Tahmoor Mine

Mining Lease	Date Granted	Description	Area
Clutha Development Pty Ltd			
Coal Lease (CL) 6	20 November 1970	Mining of coal from EL350	4,080 ha
Mining Purpose Lease (MPL) 87	19 February 1976	For the construction of dams and roads	19.12 ha
MPL 88	19 February 1976	For the construction of buildings and roads	61.98 ha
MPL 163	24 February 1976	Construction of a transmission line	0.6068 ha
MPL 164	19 February 1976	Construction of a transmission line	1.657 ha
Tahmoor Coal Pty Ltd			
Mining Lease 1308	2 March 1993	Expires 2 March 2035	13.16 ha
Mining Lease 1376	28 August 1995	Expired 28 August 2016 and an application for renewal has been submitted.	2,095 ha
Mining Lease 1539	16 June 2003	Expires 16 June 2024	547 ha
Mining Lease 1642	27 August 2010	Expires 27 August 2031	206.4 ha

The Tahmoor Mine initially operated using board and pillar mining methods. These early methods were replaced by longwall mining methods in 1987 when a gas extraction facility and longwall mining unit were commissioned and installed. An overview of the approvals history for Tahmoor Mine is provided in **Table 1.3**.

Tahmoor Coal has previously sought approval under Part 5 of the EP&A Act to undertake exploration activities within the Tahmoor South mining area for the Bargo coal resource. Current operations at the Tahmoor Mine are undertaken within the Tahmoor North mining area under the approvals shown in **Table 1.3** and illustrated in **Figure 1.4**. Coal is currently mined from the Bulli seam, producing mostly hard coking coal for steel production. Tahmoor Mine also produces a small amount of thermal coal which is used for power generation. Coal products from the mine are primarily transported via rail to Port Kembla Coal Terminal or Newcastle Port Waratah from time to time for delivery to both Australian and international markets. As described in **Table 1.3**, Tahmoor Mine also has approval to transport up to 50,000 tonnes per annum (tpa) of coal by road within the Wollondilly Shire or in circumstances where rail transport is unavailable.

Mining within the Tahmoor North mining area is scheduled for completion by approximately 2022, depending upon geological and mining conditions.

Exploration activities within the existing lease areas are currently carried out pursuant to Exploration Authority 410, Exploration Authority 206, and CCL 747 which are regulated under the Mining Act. A detailed description of the existing operations at Tahmoor Mine is provided in **Section 3.0**.

Table 1.3 History of Tahmoor Mine Consents

Consent	Consent Authority	Date	No. / Modification	Description
Tahmoor Mine (1975 Consent)	Wollondilly Shire Council	26/03/1975	7105/47	Mining from Bulli Seam in Tahmoor Central area, ROM trucked to Glenlee CHPP, 2.6 Mtpa ROM, two access shafts and one ventilation shaft
Tahmoor Mine - CHPP & REA (1979 Consent)	NSW Planning & Environment Commission	23/08/1979	7105/47	CHPP and REA, product transport via rail
	NSW Planning and Environment Commission	16/09/1985	Modification 1 76/20188	Transport by road of two trial shipments of 1,000 tonnes each
	NSW Planning and Environment Commission	05/11/1986	Modification 3 D80004/018	Upgrade of surface facilities for longwall mining
	NSW Department of Planning	08/07/1988	Modification 4	All coal transport from site via rail except for the following: • up to 50,000 tpa by road for local and domestic use within the Wollondilly LGA only; and • Coal transport by road where rail transport is not available.
	NSW Department of Planning	14/08/1990	Modification 5	Extension to CHPP
	NSW Department of Planning	13/09/1994	Modification 6	Transport of coal to Corrimal Cokeworks by road transport if the West Cliff mine was unable to supply
Tahmoor Gas Extraction	Wollondilly Shire Council	16/12/1985	190/85	Surface civil and mechanical work for gas extraction

Consent	Consent Authority	Date	No. / Modification	Description
Tahmoor North (1994 Consent)	NSW Land and Environment Court (LEC)	16/06/1994	LEC No. 10712 of 1993	Points of law on adequacy of EIS
	NSW LEC	07/09/1994	LEC No. 10712 of 1993	Tahmoor North mining from Bulli Seam, expansion of REA, Bridge Street shaft
	Wollondilly Shire Council	08/06/2007	Modification 1	Modification to conditions relating to damage of heritage items
Tahmoor North (1999 Consent)	NSW Department of Planning	25/02/1999	67/1998	Mining within ML 1376 following a Commission of Inquiry
	NSW Department of Planning	05/12/2006	67-5-2006 Modification 1	Modification of subsidence conditions
	NSW Department of Planning and Infrastructure	08/04/2012	67-5-2006 Modification 2	Modification for Redbank Tunnel Rail Deviation
	NSW Department of Planning and Infrastructure	01/11/2012	Modification 3	Modifications related to Redbank Tunnel Rail Deviation
	NSW Department of Planning and Infrastructure	15/10/2018	Modification 4	Modification to the project area for Tahmoor North to allow for low levels of predicted subsidence from approved Longwall 32.

1.2.2 Bargo Mine

The NSW Government commenced scout drilling of the coal resource within the area surrounding Bargo in 1965 and subsequently allocated the Bargo coal area to J&A Brown and Abermain Seaham Collieries Pty Ltd via EL No. 275, granted on 23 March 1970. A joint venture was formed between J&A Brown and Abermain Seaham Collieries Pty Ltd and Peko-Wallsend in May 1970 (the Bargo Joint Venture) to conduct a drilling program to investigate the coal resource. The joint venture formed Bargo Collieries Pty Ltd on 11 January 1972.

The Bargo Joint Venture was expanded on 21 July 1975, with the inclusion of BHP Limited. The Bargo Joint Venture completed a detailed feasibility assessment for the Bargo Mine during 1976. An application for planning and environmental approval for mining was submitted to Wollondilly Shire and Mittagong Shire Councils in 1975 and approvals were granted in 1976.

The following mining leases were granted to Bargo Collieries Pty Ltd in 1978:

- CL 186 – to mine coal from the area covered by EL275, covering 4,040 ha;
- MPL 156 – for shafts, roads, drift and pipelines, covering 71.7 ha; and
- MPL 157 – for buildings, railway and dam, covering 860 ha.

The Bargo Joint Venture commenced shaft construction at the Bargo Mine in May 1979, followed by trial mining and in seam work in January 1981. The 6.1 metre (m) diameter concrete lined shaft was constructed to a total depth of 444 m and extended through to the base of the Wongawilli Seam. Further development, to assess mining conditions and to obtain coal for coal quality assessments, was conducted in both the Bulli and Wongawilli Seams. This development was accompanied by approximately 740 m of roadways in the Bulli Seam and 53 m within the Wongawilli Seam.

On 23 May 1990, CCL 747 was granted to Bargo Collieries Pty Ltd. CCL747 consolidated and replaced CL186, MPL156 and MPL157.

Although physically commenced, the Bargo Mine development did not progress to commercial production due to economic conditions at the time. Following several feasibility studies undertaken by the Bargo Joint Venture partners, Bargo Collieries Pty Ltd was sold to Tahmoor Coal Pty Ltd in May 1999. An overview of the ownership history of the Bargo Mine is provided in **Table 1.4** and approvals gained for the Bargo Mine are provided in **Table 1.5**. Further information on the mining titles is provided in **Section 2.5**.

Table 1.4 History of Ownership of Bargo Mine

Bargo Mine Ownership History	Parent Company	Date
J&A Brown and Abermain Seaham Collieries Pty Ltd	A subsidiary of Coal and Allied Industries Ltd	March 1970
Bargo Joint Venture	Coal and Allied Industries Limited and Peko-Wallsend Limited	May 1970
Bargo Collieries Pty Ltd	Coal and Allied Industries Limited and Peko-Wallsend Limited	January 1972
Bargo Collieries Pty Ltd	Coal and Allied Industries Limited, Peko-Wallsend Limited and BHP Limited	July 1975
Bargo Collieries Pty Ltd	Tahmoor Coal Pty Ltd (a subsidiary of Austral Coal Limited)	May 1999
Bargo Collieries Pty Ltd	Tahmoor Coal Pty Ltd (a subsidiary of Centennial Coal Pty Ltd)	July 2005
Bargo Collieries Pty Ltd	Tahmoor Coal Pty Ltd (a subsidiary Glencore Coal Pty Ltd)	November 2007
Bargo Collieries Pty Ltd	Tahmoor Coal Pty Ltd (a subsidiary SIMEC (Australia) Mining Pty Ltd)	April 2018 to Present

An overview of the approvals for the Bargo Mine are provided in **Table 1.5**. Further information on the mining titles is provided in **Section 2.5**.

Table 1.5 History of approvals at Bargo Mine

Date	Consent Authority	Description
15/09/1975	Mittagong Shire Council	Mining from the Bulli and Wongawilli Seams, 3.65 Mtpa ROM, CHPP and REA, rail loop, drift and ventilation shaft, 60 year mine life
21/04/1976	Wollondilly Shire Council	Mining from the Bulli and Wongawilli Seams, 3.65 Mtpa ROM, CHPP and REA, rail loop, drift and ventilation shaft, 60 year mine life
09/05/1978	NSW Planning and Environment Commission	Concurrence required for Mittagong Council
03/11/1978	Mittagong Shire Council	Mining from the Bulli and Wongawilli Seams, 3.65 Mtpa ROM, CHPP and REA, rail loop, drift and ventilation shaft, 60 year mine life

1.3 Proposed Tahmoor South Project

Tahmoor Coal is seeking development consent for the continuation of mining at Tahmoor Mine, extending underground operations and associated infrastructure south, within the approved Bargo area. The proposed development seeks to extend the life of underground mining at Tahmoor Mine for an additional 13 years until approximately 2035.

The proposed development would use longwall mining to extract up to four (4) Mtpa of ROM coal from the Bulli seam. The majority of product coal produced (approximately 90-95%) would be coking coal, with a secondary thermal coal product (approximately 5-10%). Once the coal has been extracted and brought to the surface, it would be processed at Tahmoor Mine's existing CHPP and coal clearance facilities, and then transported principally via the existing rail loop, the Main Southern Railway and the Moss Vale to Unanderra Railway to Port Kembla for Australian and international markets. Some coal may also be transported to Port Waratah in Newcastle from time to time. Up to 200,000 tonnes per annum of either product coal or reject material is proposed to be transported to customers via road.

The proposed development would operate within the Project Area. The Project Area includes the extent of longwall mining to be undertaken as part of the proposed development, the existing Surface Facilities Area, other existing mine infrastructure of the Tahmoor Mine and immediately surrounding areas within the Wollondilly and Wingecarribee Local Government Areas (LGA). While the Project Area extends into Wingecarribee LGA, no project infrastructure or longwall panels associated with the proposed development would be located within this LGA. The Project Area is shown on **Figure 1.3** and encompasses CCL 747, Mining Lease 1642, a portion of CCL 716 (Exploration Authorisation 206) and the portion of the Subsidence Study Area (SSA) surrounding the proposed mine plan which extends beyond these areas. The SSA defines the predicted limit of vertical subsidence (taken to be the 20 mm subsidence contour) or a minimum of 600 m from the edge of the closest longwall (whichever is further), and forms the basis of the impact assessment undertaken for the proposed development.

During preparation of this EIS refinements have been made to the proposed development in response to environmental constraints and feedback from stakeholders and community members. The mine plan for the project has been revised a number of times to avoid longwall mining directly under sensitive features such as the Metropolitan Special Area, bedrock rivers with standing pools including Eliza Creek, items of Aboriginal heritage and significant landscape features such as river gorges.

In order to undertake the proposed development, Tahmoor Coal would require additional surface mining leases to encompass the proposed surface activities as shown on **Figure 1.5**.

The proposed development would utilise the existing surface infrastructure at the Tahmoor Mine Surface Facilities Area, with some upgrades proposed to facilitate the extension. The proposed development would also incorporate the planning for rehabilitation and mine closure.

The Tahmoor South Project proposes to extend underground mining operations at Tahmoor Mine within the Project Area including the following activities:

- undertake mine development and mine, using longwall mining methods, in the Bulli seam within CCL 747 and CCL 716, for approximately 13 years;
- extract up to four (4) Mtpa of ROM coal from longwalls situated within the Central Domain;
- continued use of existing mine ventilation shafts and the construction of two additional mine ventilation shafts;
- process up to four (4) Mtpa of ROM coal through the existing CHPP;
- transport product coal principally via rail to Port Kembla Coal Terminal and occasionally to Newcastle Port Waratah, using the existing rail load out, rail loop rail infrastructure;
- transport up to 200,000 tonnes per annum of either product coal or reject material via road;
- continue to use ancillary infrastructure and services until 2035;
- upgrade and augment the existing surface facilities, amenities, equipment and infrastructure to accommodate the extension of mining; and
- rehabilitate the Surface Facilities Area and associated infrastructure following the completion of mining.

An overview of the existing operations is provided in **Section 3.0** and further details regarding the proposed development are provided in **Section 4.0**.

Tahmoor Coal would continue mining from the Existing Tahmoor Mining Area (**Figure 1.2**) and use the existing surface facilities until the completion of mining in Tahmoor North in approximately 2022. The timing of completion of mining at Tahmoor North is dependent upon geological, mining and economic conditions.

Certain, existing development consents would be surrendered and Tahmoor Mine would transition to operating solely under the new development consent sought in the development application for the proposed development. Further detail regarding the proposed development consent strategy for Tahmoor Mine, including the interrelationship between the existing and proposed approvals, is provided in **Section 7.0**.

1.4 The Proponent

1.4.1 Tahmoor Coal Pty Ltd

The proponent is Tahmoor Coal Pty Ltd, Tahmoor Coal supplies coking and thermal coal to Australian and international markets. Tahmoor Coal is an operating business within the SIMEC Mining division of GFG Alliance.

1.4.2 GFG Alliance

GFG Alliance is an international group of businesses, founded and owned by the British Gupta Family. The Alliance's integrated business model encompasses mining, energy generation, metals and engineering, underpinned by industry-friendly financial services, a substantial property portfolio and a skills and education-focused charitable foundation.

For more than 60 years GFG Alliance has operated in sectors that are fundamental to the economy: energy, metals, engineering, logistics, and more recently infrastructure, financial services, property and mining.

GFG Alliance's main operating businesses are the Liberty House Group and the SIMEC Group.

Liberty House Group

Liberty House is an international industrial and metals business that provides an integrated solution ranging from global metals trading, metal making and processing through to engineering solutions.

Liberty House Group has five main divisions:

- Liberty Commodities - a global solutions provider to the international steel and non-ferrous metals industries.
- Liberty Recycling - operates ferrous and non-ferrous metals recycling in UK, USA, Australia and Europe. Australian operations include:
  - Rooty Hill (Sydney) mini mill; and
  - Laverton (Melbourne) mini mill.
- Liberty Steel - a global supplier of engineered steels with operations in UK, USA, Australia, India and Europe. Australian operations include:
  - Primary Steel works at Whyalla;
  - Rod & Bar mills at Sydney, Melbourne and Newcastle;
  - Wire mills at Newcastle, Geelong & Jindera;
  - Pipe & Tube mills at Newcastle & Brisbane; and
  - Distribution centres at 119 locations.
- Liberty Aluminium - owns the only remaining primary aluminium smelter in the United Kingdom.
- Liberty Engineering - engineers and manufactures components to customers in the automotive, general engineering, construction, motorsport, aerospace and other sectors.

SIMEC Group

The SIMEC Group is an international energy and natural resources business which supports the GFG Alliance with an infrastructure and trading platform. SIMEC has 5 major divisions which focus on Shipping, Infrastructure, Mining, Energy and Commodities:

- SIMEC Shipping charters, leases and owns of vessels and ports.
- SIMEC Infrastructure owns and operates commercial ports, railway stock, marine fleets and storage facilities. Australian operations include ports at Whyalla and shareholder in Port Kembla Coal Terminal.
- SIMEC Mining is a globally focused mining business. Australia operations include:
  - Iron ore assets in South Australia's Middleback Ranges; and
  - Coking coal asset at Tahmoor NSW.
- SIMEC Energy is a producer or renewable power, with a portfolio of assets across hydro, bio power, waste to energy, on- and off-shore wind, solar and pumped hydro. Australia operations include major shareholding in SIMEC Zen Energy.
- SIMEC Commodities specialises in the trade energy and energy related commodities.

1.5 Project Need

Development consent is required to enable Tahmoor Mine to continue to operate after mining is completed at Tahmoor North within the Existing Tahmoor Mining Area. The proposed development would:

- extend the life of the Tahmoor Mine to enable the ongoing direct employment for approximately 390 employees;
- provide ongoing significant local, regional, State and Federal economic benefits in the form of additional wages, royalties and flow-on positive economic effects;
- maximise recovery of the existing coal resource within Tahmoor Coal's lease areas; and
- enable existing coking, rather than thermal, coal markets to be serviced (refer **Section 1.5.1**, below).

The need for the proposed development is discussed in more detail in **Section 6.1**.

1.5.1 Coking Coal

Coal is classified by rank, from lowest to highest, based on its carbon and moisture content. Lower rank coals contain less carbon, more moisture and have lower calorific values. Based on its rank, coal is generally classified as either "thermal" coal or "metallurgical" (coking) coal. Thermal coal is lower in carbon content and calorific value, higher in moisture value, is the world's most abundant fossil fuel and is primarily used to produce energy. Coking coal is less abundant than thermal coal and is primarily used in the production of metallurgical coke which is an important part of manufacturing steel. Steel is an alloy based primarily on iron. As iron occurs only as iron oxides in the earth's crust, the ores must be converted, or 'reduced', using carbon. The primary source of this carbon is coking coal.

There are two types of metallurgical coal used to make coke: hard coking coal and semisoft coking coal. The Tahmoor Mine produces a hard coking coal, which is ideal for coke because it melts, swells and re-solidifies when placed into a superheated furnace. This type of coal also has lower levels of impurities.

1.6 Environmental Assessment Process and Purpose

1.6.1 Approval pathway

The proposed development is declared to be State significant development under clause 8 and Schedule 1 of the *State Environment Planning Policy (State and Regional Development) 2011* and is therefore subject to an assessment by the Minister for Planning (or his/her delegate) under Division 4.7, Part 4 of the EP&A Act. The development application will be determined by the Minister pursuant to s4.5(a) of the EP&A Act. An EIS is required to support the application for development consent.

Under the current approvals, mining at Tahmoor North is expected to be complete by approximately 2022, the timing of which is dependent upon geological, mining and economic conditions. If the Tahmoor South Project is granted development consent, it would authorise the proposed continuation of mining operations at Tahmoor Mine for approximately a further 13 years and maximise the recovery of the coal resource. In addition, if development consent is granted, some of the existing consents for the Bargo and Tahmoor Mines would be surrendered based on a schedule of completed activities (refer to **Section 7.2**).

1.6.2 Preliminary Environmental Assessment

The PEA, submitted to the Secretary of DPE on 1 May 2017, outlined the proposed development, provided background environmental data and identified key issues for assessment in the EIS, including:

- Subsidence and Geology;
- Surface Water;
- Groundwater; and
- Ecology.

1.6.3 Environmental Assessment Requirements

This EIS has been prepared in accordance with Division 4.7, Part 4 of the EP&A Act and Schedule 1 of the EP&A Regulation. Part 4 of the EP&A Act ensures that the potential environmental impacts of a proposal are properly assessed and considered in the decision-making process.

Under Part 2 of Schedule 2 of the EP&A Regulation, the EIS must be prepared in accordance with the requirements issued by the Secretary of the DPE. SEARs for the EIS were issued on 9 June 2017 and updated on 20 June 2018 and are attached as **Appendix A** to this EIS.

The proposed development may have a significant impact on Matters of National Environmental Significance (MNES). Consequently, the proposed development was referred to the Commonwealth Minister of Environment under the provisions of the EPBC Act. The proposed development was subsequently declared to be a Controlled Action and supplementary SEARs were issued by the DPE as discussed in **Section 1.6.4**.

The key matters raised by the Secretary of DPE to be considered in the EIS are outlined in **Table 1.6**, together with the relevant section of the EIS which addresses that matter.

Table 1.6 SEARs of the EIS issued 20 June 2018

Description	Reference in EIS
General	
The Environmental Impact Statement (EIS) for the development must comply with the requirements in Clauses 6 and 7 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000.*	This document
In particular, the EIS must include: • an executive summary; • a full description of the development, including: - historical mining operations at the mine and in the region; - the resource which would be extracted, demonstrating efficient resource	**Executive Summary** **Section 1.2** **Section 4.0**

Description	Reference in EIS
recovery within environmental constraints; - the proposed mine layout and development scheduling; - coal processing and transportation; - proposed infrastructure and facilities (including any existing or proposed infrastructure that would be required for the development, which is subject to a separate approvals process); and - the likely interactions between the proposed development and the existing Tahmoor Coal Mine, and any other existing, approved or proposed mining-related development in the vicinity of the site (including any relevant statutory approvals, environmental management regime relating to these operations);	**Section 5.0** **Section 7.0**
• a list of approvals that must be obtained before development can commence;	**Section 8.0**
• a risk assessment of the potential environmental impacts of the development, identifying key assessment issues;	**Section 10.0**
• an assessment of the likely impacts of the development on the environment, focusing on the specific issues identified below, and including: - a description of the existing environment likely to be affected by the development, using sufficient baseline data; - an assessment of the likely impacts of all stages of the development, including appropriate worst-case scenarios and consideration of any cumulative impacts, taking into consideration any relevant legislation, environmental planning instruments, guidelines, policies, plans and industry codes of practice; - a description of the measures that would be implemented to avoid, mitigate and/or offset the likely impacts of the development, and an assessment of: ▪ whether these measures are consistent with industry best practice, and represent the full range of reasonable and feasible mitigation measures that could be implemented; ▪ the likely effectiveness of these measures, including performance measures where relevant; and ▪ whether contingency measures, (including Trigger Action Response Plans) would be necessary to manage any residual risks; and • a description of the measures that would be implemented to monitor and report on the environmental performance of the development if it is approved;	**Section 11.0**
• consideration of alternatives, including the development of a mine plan which avoids key sensitive surface features, and the 'do nothing' option;	**Section 6.0**
• a consolidated summary of all the proposed environmental management and monitoring measures, identifying all the commitments in the EIS;	**Section 12.0**
• consideration of the development against all relevant environmental planning instruments (including Part 3 of the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*); and	**Section 8.0**
• a conclusion justifying why the development should be approved, taking into consideration: - alternatives; - the suitability of the site for the development; - the economic, social, biophysical and environmental impacts of the project as a whole; and - whether the project is consistent with the objects of the *Environmental Planning and Assessment Act 1979*; and	**Section 13.0**
• a signed statement from the author of the EIS, certifying that the information contained within the document is neither false nor misleading.	**Quality Information**
While not exhaustive, Attachment 1 lists some of the environmental planning	**Appendix A**

Description	Reference in EIS
instruments, guidelines, policies, and plans that may be relevant to the environmental assessment of this development.	
In addition to the matters set out in Schedule 1 of the *Environmental Planning and Assessment Regulation 2000*, the development application must be accompanied by a signed report from a suitably qualified independent person that includes an accurate estimate of the: • capital investment value of the development (as defined in Clause 3 of the *Environmental Planning and Assessment Regulation 2000*), including details of all the assumptions and components from which the capital investment value calculation is derived; and • jobs that would be created during each stage of the development.	**Provided separately to DPE** **Appendix Q** **Section 11.15** **Section 4.6**
Specific Issues	
The EIS must address the following specific issues:	
Subsidence – including a detailed quantitative and qualitative assessment of the potential conventional and non-conventional subsidence impacts and environmental consequences of the development on the natural and built environments, paying particular attention to features that are considered to have significant ecological, economic, social, cultural and environmental value, taking into consideration: • recorded regional and historic subsidence levels, impacts and environmental consequences; • the potential extent of fracturing of the strata above the longwall panels; and • the implementation of a comprehensive subsidence monitoring program which is capable of detecting vertical, horizontal and far-field subsidence movements.	**Section 11.1**
Water – including: • an assessment of the likely impacts of the development on the quantity and quality of surface and groundwater resources, having regard to EPA's, DI Water's and WaterNSW's requirements and recommendations (see Attachment 2); • an assessment of the likely impacts of the development on aquifers, watercourses, swamps, riparian land, water supply infrastructure and systems and other water users; • an assessment of any drinking water catchment losses from mining, and whether the development can be operated to achieve a neutral or beneficial effect on water quality in the Sydney Drinking Water Catchment, consistent with the provisions *of State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011*; • a detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply and transfer infrastructure and water storage structures; • a detailed description of the proposed water management system (including sewerage), beneficial water re-use program and all other proposed measures to mitigate surface water and groundwater impacts; • the proposed surface water and groundwater monitoring regime, which should include a comprehensive array of shallow and deep piezometers and extensometers across the underground mining area which are capable of detecting fluctuations in groundwater levels and the influence of fracture networks on regional groundwater resources; and • an assessment of the potential flooding impacts of the development.	**Sections 11.2, 11.3, 11.4, 11.5**

Description	Reference in EIS
Noise and Vibration – including: • an assessment of the likely operational, rail "wheel squeal" and construction noise impacts of the development under the *NSW Industrial Noise Policy* (as may be updated or replaced), paying particular attention to the obligations in chapters 8 and 9 of the policy, and the *Voluntary Land Acquisition and Mitigation Policy* (DPE); • if a claim is made for specific construction noise criteria for certain activities, then this claim must be justified and accompanied by an assessment of the likely construction noise impacts of these activities under the *Interim Construction Noise Guideline* (ICNG); • an assessment of the likely road noise impacts of the development under the *NSW Road Noise Policy (RNP)*; and • an assessment of the potential vibration and low frequency noise impacts of the development.	**Section 11.10**
Air – including: • an assessment of the likely air quality impacts of the development in accordance with the Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW, having regard to EPA's requirements (see Attachment 2); • an assessment of the likely greenhouse gas (GHG) impacts of the development; and • an odour assessment of the ventilation shafts in accordance with the *Technical Framework – Assessment and Management of Odour from Stationary Sources in NSW*	**Section 11.11**
Biodiversity – including: • an assessment of the likely biodiversity impacts of the development, including impacts to terrestrial and aquatic species and habitats, in accordance with the Framework for Biodiversity Assessment, by a person accredited in accordance with s142(B)(1)(c) of the *Threatened Species Conservation Act 1995*, and having regard to OEH's requirements (Attachment 2); and • a strategy to offset any residual impacts of the development in accordance with the *NSW Biodiversity Offsets Policy for Major Projects*.	**Sections 11.6, 11.7**
Land – including an assessment of the compatibility of the development with other land uses (including existing and planned urban development) in the vicinity, in accordance with the requirements of Clause 12 of *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007.*	**Sections 11.4, 11.18, 11.19**

Description	Reference in EIS
Rehabilitation and Final Landform – including: • an assessment of the likely impacts of the development on existing landforms and topography, including justification of the final landform design of the rejects emplacement area expansion and its long term geotechnical stability; • a detailed description of the progressive rehabilitation measures that would be implemented for the development; • a detailed description of the proposed rehabilitation and mine closure strategies for the project, having regard to DRG's (Division of Resources and Geoscience) requirements (see Attachment 2) and the key principles in Strategic Framework for Mine Closure, and the: - rehabilitation objectives, methodology, monitoring programs, performance standards and proposed completion criteria; - decommissioning and management of surface infrastructure; - nominated final land uses, having regard to any relevant strategic land use planning or resource management plans or policies; and - potential for integrating the rehabilitation strategy with offset strategies proposed for the development; • the measures which would be put in place for the long-term protection and management of the site, any biodiversity offset areas following the cessation of mining; and • measures to avoid the propagation of acid sulphate soils.	**Section 11.23**
Heritage – including an assessment of the likely Aboriginal and historic heritage (cultural and archaeological) impacts of the development, having regard to OEH's requirements (Attachment 2).	**Sections 11.8, 11.9**
Transport – including an assessment of the likely transport impacts of the development on the capacity, condition, safety and efficiency of the rail network and the local and State road network.	**Sections 11.13, 11.14**
Visual – including an assessment of the likely visual impacts of the development on private landowners in the vicinity of the development and key vantage points in the public domain, and minimising the lighting impacts of the development.	**Section 11.17**
Hazards – including an assessment of the likely risks to public safety, paying particular attention to potential bushfire risks, and the handling and use of any dangerous goods.	**Section 11.22**
Waste – including a waste management strategy.	**Section 11.20 & Section 11.21**
Social & Economic – including: • a detailed assessment of the likely social impacts of the development on the local and regional community in accordance with the Social Impact Assessment Guideline for State Significant Mining, Petroleum Production and Extractive Industry Development (2017); and • an assessment of the likely economic impacts of the development, paying particular attention to: - the significance of the resource; - the costs and benefits of the development, identifying if it would result in - a net benefit to NSW, including consideration of fluctuation in commodity markets and exchange rates; and - the demand for the provision of local infrastructure and services.	**Section 11.15 & 11.16**

Description	Reference in EIS
Consultation	
During the preparation of the EIS, you must consult with local government, State Government and Commonwealth Government authorities, service providers, community groups, Registered Aboriginal Parties and affected landowners. The EIS must describe the consultation that was carried out, identify the issues raised during this consultation, and explain how these issues have been addressed in the EIS.	**Section 9.0**

Written comments were received from relevant statutory agencies identified in the SEARs to assist with the preparation of the EIS. **Appendix A** summarises the key issues identified by the statutory agencies together with the relevant section of the EIS which addresses the matter.

1.6.4 Commonwealth Department of the Environment – EPBC Referral and Supplementary Requirements

The project was referred to the DoEE on 20 October 2017 (EPBC 2017/8084) to determine if the project is a controlled action under the EPBC Act, based on potential impacts to listed threatened species and communities, and water resources.

The proposed development was declared to be a Controlled Action under the EPBC Act on 12 January 2018.

The Commonwealth government has accredited the NSW State significant development assessment process under Part 4 of the EP&A Act in a bilateral agreement between the two governments. This means that potential impacts to Matters of National Environmental Significance (MNES) can be assessed in an integrated manner in the EIS as part of the State significant development assessment process in accordance with the bilateral agreement. To ensure that sufficient information is provided to enable an adequate assessment of the relevant MNES, DPE issued supplementary SEARs for the EIS on 14 February 2018.

The supplementary SEARs for the EIS are outlined in **Table 1.7** together with the relevant section of the EIS which addresses the requirements. The potential impacts of the proposed development on MNES are summarised in the EPBC Referral for the proposed development and **Section 11.6** of this EIS. Further details of the EPBC referral are also provided in **Section 8.3.1** of this EIS.

It is noted that the DoEE referral and Controlled Action determination of the proposed development was based on an earlier mine plan layout, which included mining in both the Central and Eastern domains. As discussed in **Section 6.2.4**, subsequent mine planning has led to a revised mine plan involving mining in the Central Domain only (current proposed development) which would result in a smaller surface footprint associated with ventilation facilities and less native vegetation clearing and associated habitat loss (49.2 ha compared to 53.3 ha). Terrestrial ecology impacts are further assessed in **Section 11.5**.

Table 1.7 Commonwealth Environmental Assessment Requirements

Description	Reference in EIS
The SEARs issued for the Tahmoor South Coal Project on 9 June 2017 have been revised and are as follows:	
General Requirements **Project Description** - including: • The title of the action, background and current status; • The precise location and description of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on MNES; • How the action relates to any other actions that have been, or are being taken, in the region affected by the action; and • How the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts on MNES.	**Section 1.1 – 1.5**
Impacts: • The EIS must include an assessment of the relevant impacts of the action on threatened species and communities and water resources; including: - a description and detailed assessment of the nature and extent of the likely direct, indirect and consequential impacts, including short term and long term relevant impacts; - a statement whether any relevant impacts are likely to be known, unpredictable or irreversible analysis of the significance of the relevant impacts; - analysis of the significance of the relevant impacts; and - any technical data and other information used or needed to make a detailed assessment of relevant impacts.	**Section 11.0**

Description	Reference in EIS
Avoidance, mitigation and offsetting: • For each of the relevant matters protected that are likely to be significantly impacted by the development, the EIS must provide information on proposed avoidance and mitigation measures to deal with the relevant impacts of the action, including: - a description and an assessment of the expected or predicted effectiveness of the mitigation measures; - any statutory policy basis for the mitigation measures; - the cost of the mitigation measures; - an outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including any provision for independent environmental auditing; and - the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program. • Where a significant residual adverse impact to a relevant protected threatened species or community is considered likely; the EIS must provide information on the proposed offset strategy, including discussion of the conservation benefit associated with the proposed offset strategy; • For each of the relevant matters likely to be impacted by the action the EIS must provide reference to, and consideration of, relevant Commonwealth guidelines and policy statements including any: - Conservation advice or recovery plan for the species or community; - Relevant threat abatement plan for a process that threatens the species or community; - Wildlife conservation plan for the species; and - Any strategic assessment. • In addition to the general requirements described above, specific information is required with respect to each of the determined controlling provisions. These requirements are outlined in paragraphs 9-18.	**Section 11.6 – 11.7** **Appendix K**

Description	Reference in EIS
Key Issues: **Biodiversity** • The EIS must identify each EPBC Act listed threatened species and community likely to be impacted by the action. For any species and communities that are likely to be impacted, the proponent must provide a description of the nature, quantum and consequences of the impacts. For species and communities potentially located in the vicinity that are not likely to be impacted, provide evidence why they are likely to be impacted; • For each of the EPBC Act listed threatened species and communities likely to be impacted by the action the EIS must provide a separate: - Description of the habitat (including identification and mapping of suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice and recovery plans; - Details of the scope, timing and methodology for studies or surveys used an how they are consistent with (or justification for divergence from) published Australian Government guidelines and policy statements; - Description of the relevant impacts of the action having regard to the full national extent of the species or community's range; - Description of the specific proposed avoidance and mitigation measures to deal with relevant impacts of the action; - Identification of significant residual adverse impacts likely to occur after the proposed activities to avoid and mitigate all impacts are taken into account; - A description of any offsets proposed to address residual adverse significant impacts and how these offsets will be established; - Details of how the current published NSW Framework for Biodiversity Assessment (FBA) has been applied in accordance with the objects of the EPBC Act to offset significant residual adverse impacts; and - Details of the offset package to compensate for significant residual impacts including details of the credit profiles required to offset the action in accordance with the FBA and/or mapping and descriptions of the extent and condition of the relevant habitat and/or threatened communities occurring on proposed offset sites; and • Any significant residual impacts not addressed by the FBA may need to be addressed in accordance with the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offset Policy*.	**Section 11.6 – 11.7**

Description	Reference in EIS
Water resource, in relation to coal seam gas development and large coal mining development • the EIS should provide a description of the location, extent and ecological characteristics and values of the identified water resource potentially affected by the project; • the assessment of impacts should include information on: - any substantial and measurable changes to the hydrological regime of the water resource, for example a substantial change to the volume, timing, duration or frequency of ground and surface water flows; - the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the water resource being seriously affected; and - substantial and measurable change in the water quality and quantity of the water resource – for example a substantial change to the volume. • the EIS must provide adequate information to allow the project to be reviewed by the Independent Expert Scientific Committee (IESC) on Coal Seam Gas and Large Coal Mining Development, as outlined in the *Information guidelines for independent expert scientific committee advice on coal seam gas and large coal mining development proposals*.	**Section 11.1 – 11.5** **Sections 11.3** and **11.4**
Other approvals and conditions • information in relation to any other approvals or conditions required must include the information prescribed in Schedule 4 Clause 5 (a) (b) (c) and (d) of the EPBC Regulations 2000.	**Section 8.0**
Environmental Record of person proposing to take the action • information in relation to the environment record of a person proposing to take the action must include details as prescribed in Schedule 4 Clause 6 of the EPBC Regulations 2000.	**Section 1.1** **Section 3.7**
Information Sources • for information given in an EIS, the EIS must state the source of the information, how recent the information is, how the reliability of the information was tested; and what uncertainties (if any) are in the information.	**Section 15.0**

Description	Reference in EIS
• The Department of the Environment's Environment Reporting Tool (ERT) identifies that threaten species and communities may occur within the vicinity of the proposed action. Based on the information in the referral documentation, the location of the action, species records and likely habitat presents in the area, there are likely to be significant impacts to: - Shale/Sandstone Transition Forest (SSFT) ecological community – Critically Endangered; - Bargo Geebung (*Persoonia bargoensis*) – Vulnerable; - Small-flower Grevillea (*Grevillea parviflora* subsq. *Parviflora* – Vulnerable; and - Rufous Pomaderris (*Pomaderris brunnea*) – Vulnerable. • There is some risk that there may be significant impacts on the following matters and the levels of impact should be further investigated: - Turpentine-Ironbark Forest of the Sydney Basin Bioregion – Critically Endangered; - Woronora Beard-heath (*Leucopogon exolasius*) – Vulnerable; - Koala (*Phascolarctos conereus*) – Vulnerable; - Macquarie Perch (*Macquarie australasica*) – Endangered; and - Greater Glider (*Petauroides volans*) – Vulnerable. • The proponent should ensure that a comprehensive and scientifically rigorous water monitoring and adaptive management programme is put in place to ensure Thirlmere Lakes are not being impacted by the proposed action. The listed studies should be considered by the proponent when assessing the impacts of the proposed action on groundwater and surface water.	**Section 11.6**

1.6.5 Stakeholder Consultation

During the preparation of this EIS, key stakeholders were consulted, including local community groups and key local, State and Federal Government agencies. Throughout the preparation of the EIS, these stakeholders have been kept informed of the progress of the proposed development. Further details regarding stakeholder consultation are provided in **Section 9.0**.

1.6.6 Purpose of this Report

The purpose of this EIS is to describe the proposed development and address the SEARs as required under Schedule 2 of the Regulation, and the supplementary SEARs received from the Commonwealth. The EIS assesses the environmental, social and economic impacts of the proposed development and identifies the measures necessary to manage and mitigate adverse environmental impacts. The purpose of the EIS is to allow the IPC and the Commonwealth Minister of the Environment to make an informed decision with regard to the approval of the proposed development.

1.7 Structure of this Environmental Impact Statement

This EIS is generally structured as follows:

- **Section 1.0** provides an introduction to the proposed development, including information about the applicant, the development context, the need for the development and the approvals regime;
- **Section 2.0** provides the site context and location of current operations, as well as a brief description of the land uses and ownership surrounding Tahmoor Mine;
- **Section 3.0** describes the existing operations at Tahmoor Mine;
- **Section 4.0** describes the proposed development and the scope of the Development Application;
- **Section 5.0** outlines the mine planning process and the potential sensitivities of the surrounding environment;

- **Section 6.0** provides information on the need for the proposed development and outlines the alternatives that were considered by Tahmoor Coal during the formulation of the Development Application;
- **Section 7.0** describes the approval pathway for the proposed development and its relationship to the existing consents;
- **Section 8.0** describes the legislative context of the proposed development;
- **Section 9.0** describes the stakeholder consultation process undertaken throughout the EIS in accordance with the SEARs;
- **Section 10.0** outlines the key environmental issues identified in the risk assessment, PEA, stakeholder consultation and SEARs, and their prioritisation;
- **Section 11.0** provides an assessment of the potential impacts of the proposed development on a range of environmental, social and economic issues and outlines mitigation and management measures to be implemented at Tahmoor Mine. Environmental issues include potential impacts from subsidence on groundwater; hydrology; Aboriginal and non-Aboriginal heritage; aquatic ecology; infrastructure and services; and geomorphology; as well as potential impacts associated with the Surface Facilities Area relating to noise and vibration; surface water; terrestrial ecology; air quality; greenhouse gas; traffic and transport; acid mine drainage and spontaneous combustion; visual landscape and lighting; soils; waste and hazards. The residual and cumulative environmental consequences of the proposed development are also discussed;
- **Section 12.0** Summarizes the environmental management and mitigation measures proposed for the development;
- **Section 13.0** details the justification for the development with respect to net project benefits and the principles of Ecologically Sustainable Development (ESD); and
- **Section 14.0** provides a summary of findings and a conclusion to the EIS.

2.0 Site and Context

2.1 Proposed Development Location and Site Context

Tahmoor Mine is located approximately 80 km southwest of the Sydney Central Business District (CBD) and 50 km northwest of Wollongong and Port Kembla, in the Southern Coalfields of NSW (refer to **Figure 1.1**). It is approximately 30 km southwest of the suburb of Campbelltown and to the west of the M31 Hume Motorway.

Tahmoor Mine's existing Surface Facilities Area is located approximately 2.5 km south of the village of Tahmoor and approximately 4 km north of the village of Bargo (refer **Figure 1.1**). Tahmoor Mine extends across mining leases 1308, 1376, 1539, 1642, Exploration Authority 410 and Exploration Authority 206, CCL 716 and CCL 747, which are illustrated in **Figure 1.2**.

The proposed development would be located immediately south of the existing coal mining operations of Tahmoor Mine, and across existing mining leases CCL 747, CCL 716, Mining Lease 1642, and Exploration Authority 206 (refer to **Figure 1.3**). Access to the underground mine for the proposed development would be via the existing Surface Facilities Area and related infrastructure at Tahmoor Mine.

2.2 Regional Context

Tahmoor Mine is located on the outer south western urban fringe of Sydney, approximately five km south of Picton and 20 km northeast of Mittagong. The mining area is bounded on the west by the Picton-Mittagong Railway. The Main Southern Railway bisects Tahmoor Mine's Surface Facilities Area and connects to the site via a rail loop.

The Project Area, comprising a conservative study area for the proposed development extends across the Wollondilly and Wingecarribee LGAs. All current surface infrastructure and longwall panels for the existing operation are located in the Wollondilly LGA. While the Project Area extends into the Wingecarribee LGA, no proposed infrastructure or longwall panels would be located within this LGA. Land use in the region is characterised by a mix of village residential, rural residential, market gardens, agriculture, vacant Crown land and conservation areas.

Coal mining has been carried out in the Southern Coalfields for around 200 years, contributing to the development of mining towns throughout the Southern Highlands and Illawarra. In addition to the Tahmoor Mine, there are another eight mining operations in the Southern Coalfields, including:

- Appin and Appin West Colliery;
- West Cliff Colliery;
- North Cliff Colliery (not operating);
- Peabody Metropolitan Colliery;
- Russell Vale Colliery (care and maintenance);
- Dendrobium Colliery;
- Wollongong Coal Wongawilli Colliery; and
- Boral Berrima Colliery (closure/care and maintenance).

Further details regarding the operation of these mines are provided in **Table 2.1**. The mining tenure of these eight operations is shown on **Figure 2.1**.

The region encompasses large areas dedicated to conservation. These include the Upper Nepean State Conservation Area to the east of the M31 Hume Motorway, and the Bargo River State Conservation Area, Nattai National Park, Thirlmere Lakes National Park and Blue Mountains National Park to the west of the Tahmoor Mine (refer to **Figure 1.1**). Nattai National Park, Thirlmere Lakes National Park and Blue Mountains National Park form part of the Blue Mountains World Heritage Area, protected under the EPBC Act.

The Project Area covers a small part of and is adjacent to the Sydney Drinking Water Catchment, with major drinking water catchments in the areas to the east, surrounding Lake Nepean, Lake Avon, Lake Cordeaux and Lake Cataract located within the Metropolitan Special Area (MSA) (Note: the MSA area includes and covers the Upper Nepean State Conservation Area). The Project Area is downstream of these areas, mostly within the Bargo catchment and contributing to the Nepean Catchments downstream of the MSA. Importantly, no longwall panels, nor surface infrastructure, are proposed in the MSA. The proposed development has been specifically designed to avoid extending longwall panels into the MSA as described in **Section 6.2.4**.

Townships, villages and rural residences dot the landscape, the nearest of which include the towns of Tahmoor and Bargo, and the villages of Couridjah, Balmoral and Buxton (refer to **Figure 1.3**). These villages are serviced by road transport routes including Picton Road, Remembrance Driveway, and Wilson Drive and the Main Southern Railway infrastructure corridor.

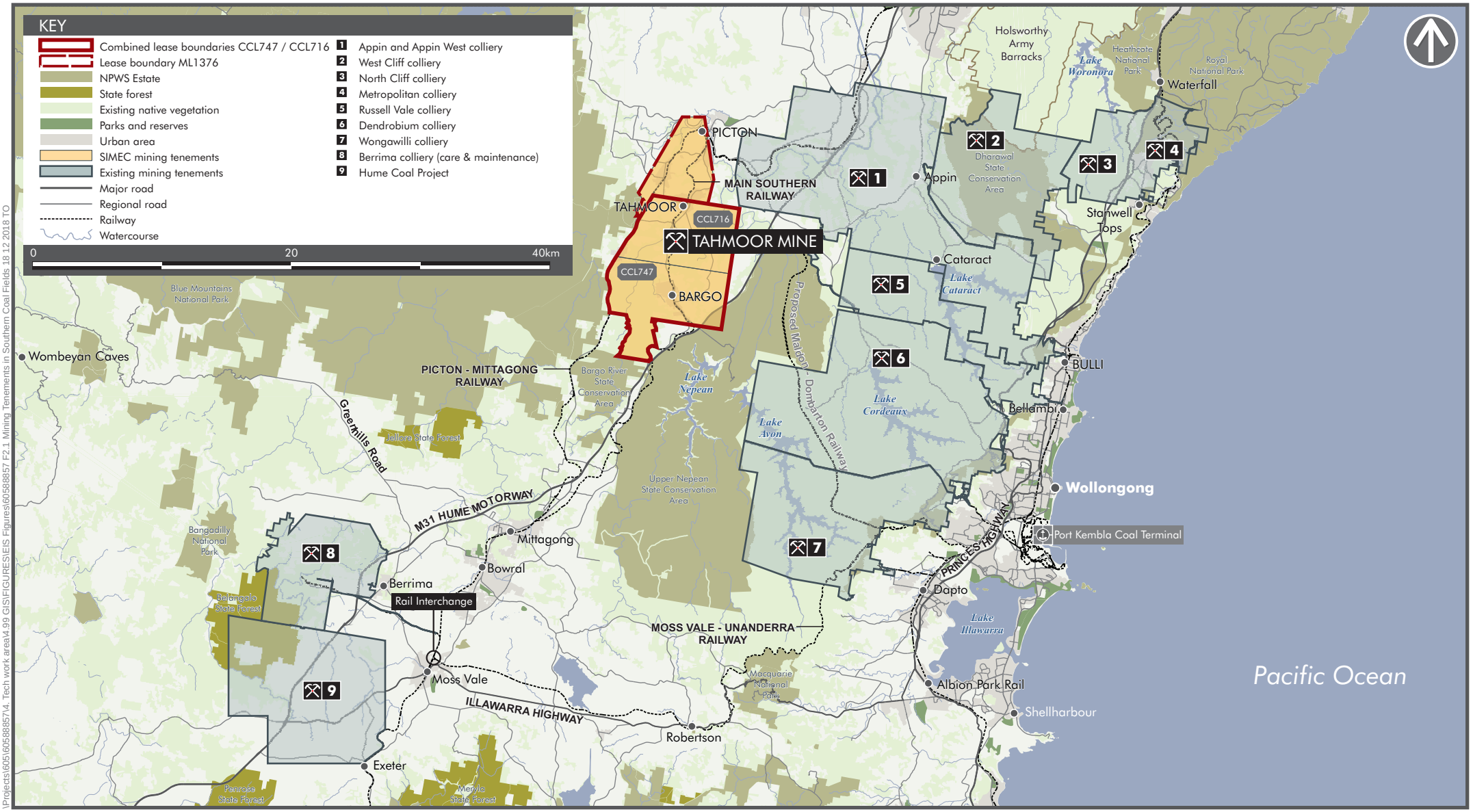
2.2.1 The Southern Coalfields

Tahmoor Mine is located within the Southern Coalfields of NSW. The Southern Coalfields is one of five major coalfields located within the Sydney-Gunnedah Basin. It is located south of Sydney and to the west of Wollongong with topography that is defined by the Illawarra and Woronora Plateau.

The geology of the Southern Coalfields includes the Illawarra Coal Measures and is the only NSW source of premium quality hard coking coal, which is primarily used for steel production. There are six operational underground coal mines in the Southern Coalfields and three are non-operational or under closure or care and maintenance, shown on **Figure 2.1** and detailed in **Table 2.1**.

Table 2.1 Current mining operations and exploration in the Southern Coalfields

Coal Mine	Current Owner/Operator	Source of Coal (Seam)	Status
Appin and Appin West Colliery (formerly Tower Colliery) (labelled 1 on **Figure 2.1**)	Illawarra Coal Holdings Pty Ltd	Bulli	Operating
West Cliff Colliery (labelled 2 on **Figure 2.1**)	Illawarra Coal Holdings Pty Ltd	Bulli	Operating
North Cliff Colliery (labelled 3 on **Figure 2.1**)	Illawarra Coal Holdings Pty Ltd	Bulli	Non Operational
Peabody Metropolitan Colliery (labelled 4 on Figure 2.1)	Helensburgh Coal Pty Ltd, a subsidiary of Peabody Energy Australia Coal Pty Ltd.	Bulli	Operating
Russell Vale Colliery (labelled 5 on **Figure 2.1**)	Wollongong Coal Ltd.	Bulli	Care & Maintenance
Dendrobium Colliery (labelled 6 on **Figure 2.1**)	Illawarra Coal Holdings Pty Ltd	Wongawilli	Operating
Wongawilli Colliery (labelled 7 on **Figure 2.1**)	Wollongong Coal Ltd.	Wongawilli	Operating
Tahmoor Mine	Tahmoor Coal Pty Ltd.	Bulli	Operating
Berrima (Medway) Colliery (labelled 8 on **Figure 2.1**)	Boral Cement Pty Ltd.	Wongawilli	Closure, care & Maintenance
Hume Coal Project (labelled 9 on **Figure 2.1**)	POSCO (Pohang Iron and Steel Company)	Wongawilli	Proposed



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SIMEC MINING

MINING OPERATIONS IN THE SOUTHERN COALFIELDS

Tahmoor South Project
Environmental Impact Statement

FIGURE 2.1

Underground coal mining in the Southern Coalfields has been the subject of a number of environmental investigations which have specifically focused on the unique environmental context of the region, including:

- *Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield: Strategic Review* (NSW Department of Planning, July 2008);
- *The Metropolitan Coal Project Review Report* (NSW Planning Assessment Commission (PAC), 2009);
- *Bulli Seam Operations PAC Report* (PAC, 2010);
- *Thirlmere Lakes Inquiry – Final Report of the Independent Committee* (Independent Thirlmere Lakes Inquiry Committee, 2012);
- Thirlmere Lakes Inquiry - Review of the Final Report of the Independent Committee (NSW Chief Scientist and Engineer, 2013); and
- *On measuring the cumulative impacts which impact ground and surface water in the Sydney Water Catchment* (NSW Chief Scientist and Engineer, 2014).

The finding of these investigations have been considered as part of the mine planning process for the proposed development and during the preparation of this environmental assessment, and are discussed in detail in **Section 5.3**.

2.2.2 Geology and Soils

The region is underlain by sandstone of the Hawkesbury Sandstone Group and shales within the Wianamatta Group. The coal bearing sequence in the region is the Late Permian Illawarra Coal Measures, and includes a number of coal seams, including the Bulli seam, the Balgownie seam (approximately 10 m below the Bulli seam) and the Wongawilli seam (approximately 30 m below the Bulli seam).

The proposed development would target the Bulli coal seam, which is currently mined at the Tahmoor Mine. The Bulli coal seam in the Project Area is located approximately 375 to 430 m below the surface and is approximately 1.8 to 3.3 m in thickness.

The Nepean Fault complex is a regional geological structure present in the eastern section of the Project Area which exhibits a general north-south trend. The Nepean Fault complex occurs as a series of smaller ‘en echelon’ faults, which are closely-spaced, parallel or sub parallel, overlapping or step-like structural features which lie oblique to the overall structural trend. Further information on this fault complex and its relationship to the proposed development is provided in **Section 5.1.** A number of smaller geological faults exist within the proposed development, including the Central Fault.

The Project Area lies mostly within the residual Blacktown and Lucas Heights soil landscapes of the region, which are intersected by the highly permeable and erosional Gymea and colluvial Hawkesbury landscapes associated with local watercourses (Hazelton and Tille, 1990) (**Figure 2.2**).

2.3 Local Context

The Project Area is generally bounded by the Bargo and Nepean Rivers to the north, West Parade and the Picton-Mittagong Railway to the west, the Nepean River, MSA and Upper Nepean State Conservation Area to the east, and Crown land and the M31 Hume Motorway to the south (refer to **Figure 2.4**). The mine infrastructure at the Surface Facilities Area is surrounded by vegetated land and gullies, bounded by Remembrance Driveway to the west and bisected by the Main Southern Railway.

2.3.1 Land Use

The Project Area extends beneath semi-rural and partly forested landscapes, along with a mix of rural and environmental land uses. The Project Area is located in a region with a long history of agricultural use. Rural uses within the Project Area include small-scale agricultural activities such as poultry, cattle grazing, trotting horse training, greyhound training and several horse studs. While incised gullies and plateaux have largely remained undisturbed, large areas of flat and low gradient slopes have

undergone moderate landscape disturbances as a result of large-scale vegetation clearance relating to agricultural activities, generally on the areas with the shale derived soils.

The Project Area extends under the residential, semi-rural and agricultural areas of the villages of Buxton, Bargo and Balmoral. The Surface Facilities Area is located approximately 3 km south of Tahmoor and 3.5 km north of Bargo. The proximity of residential receivers is discussed in the context of the air quality, noise and traffic impact assessments in **Section 11.0**.

Surface infrastructure features within the Project Area include:

- Tahmoor Mine Surface Facilities Area, existing ventilation shafts and rail loop;
- Main Southern Railway, which runs north to south through the Project Area, carries passenger and freight services between Sydney and Melbourne and connects Tahmoor Mine to Port Kembla for coal transport via the Moss Vale to Unanderra Railway;
- residential areas of Bargo, Buxton and Balmoral and commercial development associated with the Bargo township;
- the M31 Hume Highway;
- Sydney to Moomba Gas Pipeline;
- Gorodok Ethane Pipeline;
- utilities infrastructure, including water pipelines and transmission lines; and
- farms, dams and other agricultural features.

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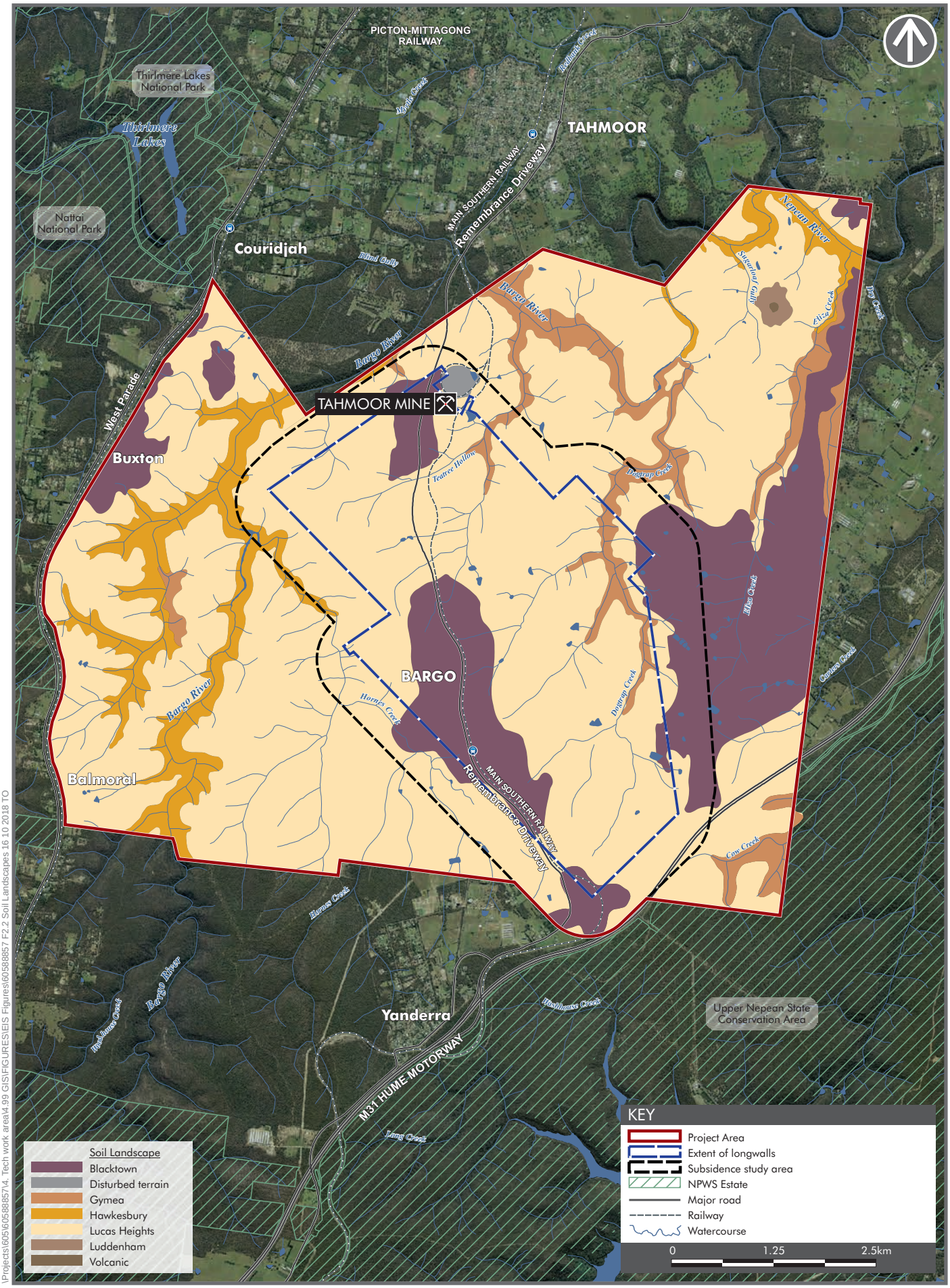

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SOIL LANDSCAPES OF THE PROJECT AREA

Tahmoor South Project
Environmental Impact Statement

FIGURE 2.2

2.3.2 Natural Features

The Project Area exhibits a gently undulating landscape with generally low relief and small slopes. However, topography becomes steeper nearer to the valleys of the Bargo and Nepean Rivers which lie in the northern and western portions of the Project Area, respectively. These areas, generally associated with the steeply incised sandstone embankments and escarpments, are more densely vegetated (undisturbed forest) and, in the case of the Nepean River, form part of designated protected areas. Approximately one third of the Project Area remains forested, in particular in the west of CCL 747, surrounding the Surface Facilities Area and along the Bargo River.

Tributaries of the Bargo and Nepean Rivers traverse the Project Area, contributing to the undulating landscape (refer to **Figure 2.3**). These include both named and unnamed watercourses of varying stream orders. Watercourses within the Project Area include:

- Bargo River;
- Hornes Creek;
- Tea Tree Hollow;
- Dog Trap Creek;
- Carters Creek;
- Eliza Creek;
- Dry Creek; and
- Cow Creek.

Natural features in the local area include Thirlmere Lakes, which includes unique wetland systems protected within the Thirlmere Lakes National Park to the northwest of the Project Area (refer to **Figure 2.3**). Thirlmere Lakes National Park also forms part of the Greater Blue Mountains World Heritage Area. Lake Nepean lies south of the Project Area. The Upper Nepean State Conservation Area and MSA are located to the southeast and are partially overlain by the southeast corner of the Project Area (although the proposed development itself would be located outside of these sensitive areas) (refer to **Figure 2.3**).

2.4 Land Ownership

Within the Project Area, land ownership is a combination of Crown land, Government authority owned land, private land, and land owned by Tahmoor Coal. The land ownership across the Project Area is illustrated in **Figure 2.4**.

Crown land occupies approximately one third of the Project Area. Privately owned rural residential and commercial properties are located in the villages of Bargo and Buxton and the town of Tahmoor and on the cleared agricultural land in the east of the Project Area. The Surface Facilities Area, existing ventilation shafts and areas in relation to the Bargo lease areas in the south of the Project Area are owned by Tahmoor Coal.

A detailed schedule of land within the Project Area is included in **Appendix B**.

2.5 Mining and Exploration Tenure

Mining tenure over the Project Area includes:

- CCL 747, held by Bargo Collieries Pty Ltd; and
- CCL 716, Mining Lease 1642, and Exploration Authorisation 206 held by Tahmoor Coal Pty Ltd.

The proposed development would utilise existing surface infrastructure facilities at the Tahmoor Mine, located within Mining Lease 1642, also held by Tahmoor Coal Pty Ltd (**Figure 1.3**). Mine tenure pertaining to the proposed development is listed in **Table 2.2**.

Table 2.2 Mining tenements relevant to the proposed development

Mining Tenement	Details	Purpose (historical or proposed)
CCL 716	Tahmoor Coal Pty Ltd Area: 4,800 ha Expiry: 13 March 2021	Historical workings within the Bulli seam. Mining of the Bulli seam within CCL 716. Ventilation shafts as required by the mine plan.
CCL 747	Bargo Collieries Pty Ltd (a subsidiary of Tahmoor Coal Pty Ltd) Area: 4,769 ha Expiry: 6 November 2025	Mining of the Bulli seam within CCL 747. Ventilation shafts as required by the mine plan.
Mining Lease 1642	Tahmoor Coal Pty Ltd Area: 206.4 ha Expiry: 27 August 2031	Mining lease for surface infrastructure and the mine drift entries.
Exploration Authorisation 206	Tahmoor Coal Pty Ltd Area: 4,080 ha Expiry: 21 January 2018 and an application for renewal has been submitted	Historical exploration drilling and seismic surveys.

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NATURAL SURFACE FEATURES OF THE PROJECT AREA

Tahmoor South Project
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FIGURE 2.3

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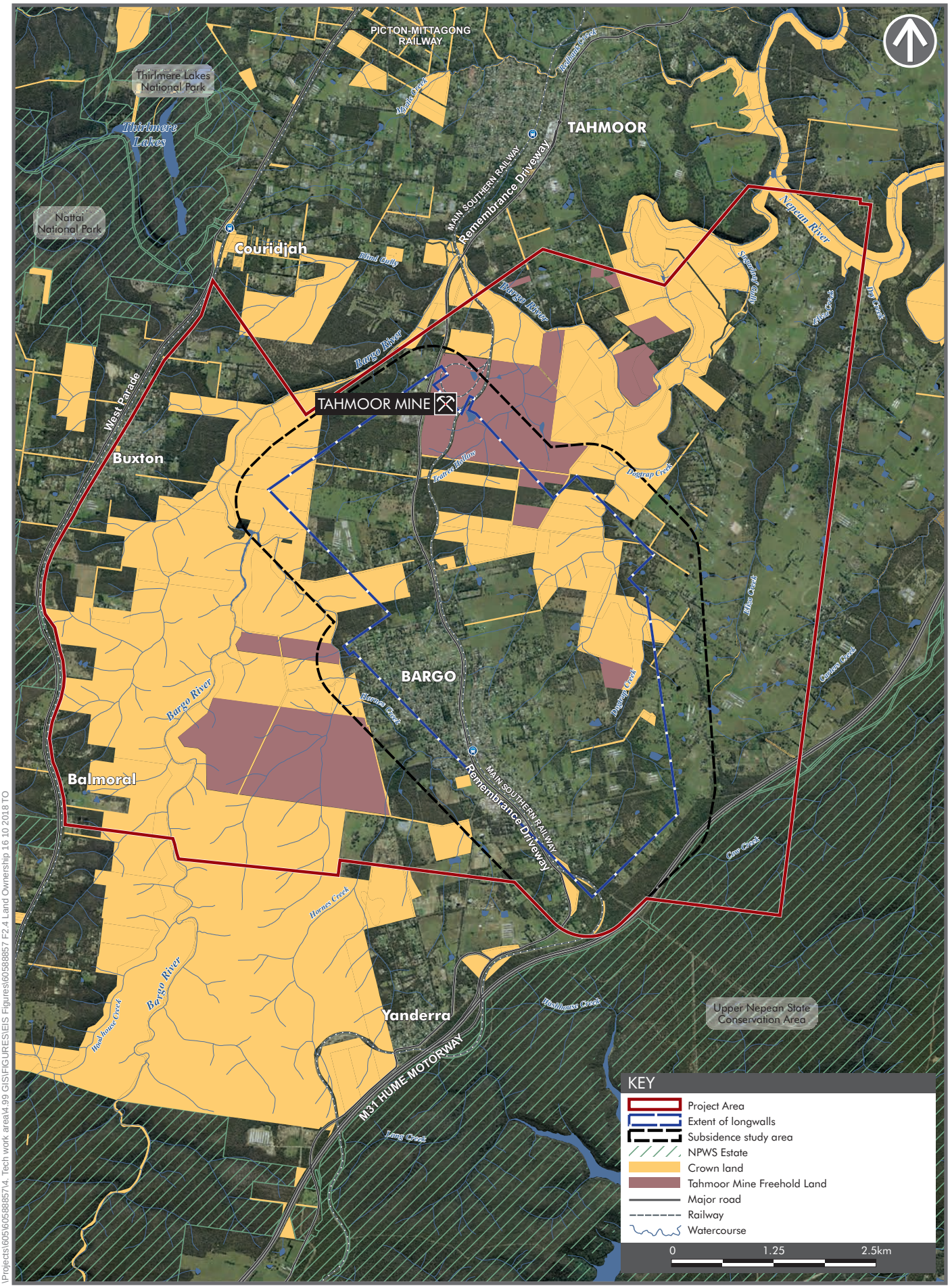

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LAND OWNERSHIP OF THE PROJECT AREA

Tahmoor South Project
Environmental Impact Statement

FIGURE 2.4

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3.0 Existing Operations

3.1 Overview

Tahmoor Mine uses longwall mining methods to extract up to 3 million tonnes of ROM coal per annum from the Bulli seam. Once coal has been extracted and brought to the surface, it is processed at the CHPP. Product coal is then transported via an existing mine rail loop, the Main Southern Railway and the Moss Vale to Unanderra Railway to Port Kembla or to Port Waratah in Newcastle from time to time.

Coal extracted from the Bulli seam produces mostly hard coking coal exported for steel production. Tahmoor Mine also produces a small amount of export thermal coal which is used for power generation. Longwall mining under the current approved mine plan is expected to continue until 2022, depending upon geological, mining and economic conditions (refer to **Section 3.6**), with the current workforce of approximately 390 ongoing permanent and contract staff.

The components of the existing approved operations are shown on **Figure 3.1** to **Figure 3.4**, and in summary comprise:

- longwall mining in Tahmoor North (refer to **Section 3.2.1**);
- coal processing at the CHPP and coal clearance facilities (refer to **Section 3.3.1**);
- disposal of coal rejects at the REA (refer to **Section 3.3.3**);
- mine and surface water management (refer to **Section 3.3.6**);
- rail transport of product coal to Port Kembla and Port Waratah (refer to **Section 3.2.7**);
- on-going exploration activities (refer to **Section 3.4**); and
- mine closure and rehabilitation (refer to **Section 3.5**).

Each of the individual components of the existing operations, along with an overview of the Environmental Management System (EMS) at Tahmoor Mine, is described in further detail in the following sections (**3.2** to **3.7**).

3.2 Underground Mining Operations

3.2.1 Existing Tahmoor Mining Area

The Existing Tahmoor Mining Area is illustrated in **Figure 3.1**.

Coal extraction from the Bulli seam is currently undertaken within CCL 716, Mining Lease 1376 and Mining Lease 1539. The existing Surface Facilities Area and mine drift (which provides staff and materials access to the underground workings) are located within Mining Lease 1642 (refer to **Figure 1.2**).

The lease areas are operationally divided into three mining areas being Tahmoor North, Tahmoor Central and Tahmoor South (refer to **Figure 1.4**). Tahmoor Central was the original mining area of Tahmoor Mine; Tahmoor North is the area where mining is currently occurring; and Tahmoor South is the area where mining would occur under the proposed development.

Coal is currently extracted from Tahmoor North (refer to **Figure 3.1**) at a depth of between approximately 400 and 450 m below ground level. The thickness of the Bulli seam varies from between 1.7 to 2.3 m in this area. Extracted and future longwalls in the Tahmoor North mining area are orientated in a south-east/ north-west direction, underlying the town of Tahmoor and are generally located between the Bargo River in the south-east, the township of Thirlmere in the west and Picton in the north (refer to **Figure 3.1**).

3.2.2 Gas Drainage Operations

The Bulli seam, and the coal seams that underlie the Bulli seam (Balgownie and Wongawilli seams), contain gas, including carbon dioxide (CO_2) and methane (CH_4), which is extracted ahead of longwall mining to provide a safe working environment within the mine. This process is referred to as pre-gas drainage.

Pre-gas drainage is achieved by underground drilling boreholes directly into the coal seam to allow gas flow. This process forms part of the existing underground inseam gas drainage system. Gas drainage from recently mined areas is also undertaken (referred to as post gas drainage) by extracting gas from the overlying rock strata (or goaf) to capture a large portion of these gases before they leak into the mine.

Gas management infrastructure at the Tahmoor Mine consists of a Mine Gas Plant, Gas Plant Vent, Gas Flare Plant, and the Waste Coal Mine Gas (WCMG) Power Plant. These processes are described below.

Gas generated from pre- and post-gas drainage is transferred to the Gas Plant by the underground gas drainage system. The Gas Plant has an existing capacity of approximately 30,000 m^3 per hour from up to six vacuum pump modules. The Gas Plant vacuum pump modules are modified from time to time to meet gas drainage demands and requirements from the different parts of the mine. Gas collected at the Gas Plant is tested to determine its composition. Depending on the composition, the gas is processed via one of the three options:

- if the gas has sufficient CH_4 content, it is used to generate electricity at the WCMG Power Plant;
- if the gas composition does not meet the specification for electricity generation, the gas is sent to the onsite Gas Flare Plant where the CH_4 is flared; and
- if the gas does not have sufficient CH_4 for the operation of the Gas Flare Plant, it is vented to the atmosphere at the Gas Plant through the Gas Plant Vent.

The WCMG Power Plant at Tahmoor Mine, is located on two hectares of land adjacent to the Gas Plant. The WCMG Power plant was commissioned in 2000 and consists of seven spark ignition gas engines, each of one megawatt capacity. The WCMG Power Plant operates under a separate Environment Protection Licence (EPL) to Tahmoor Mine, EPL 11768.

The WCMG Power Plant burns gas to generate electricity, which is used in the first instance by Tahmoor Mine and any surplus electricity is reticulated into the NSW electricity grid. Utilisation of mine gas in this way provides two main benefits, namely an energy source for Tahmoor Mine and a reduction in the mine's contribution to greenhouse gas emissions. The WCMG Power Plant at Tahmoor Mine captures and converts up to 130,000 tonnes of CO_2 equivalent emissions each year. The volume of mine gas converted to electricity each year is dependent on the ratio of CH_4 to CO_2, which varies throughout the coal seam.

The Tahmoor Mine Flare Plant has sufficient design capacity of approximately 9,000 litres per second to accommodate all projected gas drainage from the proposed development, should it be required.

The existing Tahmoor Mine Gas Plant, Gas Flare Plant and the WCMG Power Plant has sufficient capacity for the operation of the proposed development.

3.2.3 Mine Ventilation

Tahmoor Mine uses a combination of upcast and downcast ventilation shafts to provide a reliable ventilation system and adequate supply of clean air to personnel in the mine. The ventilation shafts currently in use for the existing operations are shown on **Figure 3.1** and include:

- Tahmoor Shaft No. 1: a downcast ventilation shaft that is located north of the Bargo River, on the southern side of Stratford Road;
- Tahmoor Shaft No. 2: an upcast ventilation shaft that is located north of the Bargo River, on the northern side of Rockford Road;

- Tahmoor Shaft No. 3: a downcast ventilation shaft that is located within the Surface Facilities Area of Tahmoor Mine, directly northwest of the rail loop, which includes shaft winder with man riding capabilities; and
- Mine drift: an inclined shaft for man and materials transport.

Mine exhaust air is extracted through the Tahmoor Shaft No. 2 which houses the main ventilation fans for Tahmoor Mine. Tahmoor Shafts No. 1 and No. 3 are used as air intakes for the underground operations. The mine drift also provides air intake to the underground workings.

Gases discharged via the ventilation system are classified as fugitive emissions. Mine exhaust air contains gases including CO_2, CH_4 and oxygen. Mine exhaust air is continuously monitored as part of the environmental management program at Tahmoor Mine. Treatment of mine exhaust air from the main ventilation fans at Tahmoor Shaft No. 2 is not undertaken (refer to **Section 3.7**).

3.2.4 Mining Method and Equipment

Underground mining is undertaken using conventional longwall development through operation of a number of continuous miners. Longwall development refers to the mining of a series of roadways (gate roads) and cut-throughs between the roadways to form pillars of coal that support the overlying strata during the extraction of coal. Longwalls in the Tahmoor North mining area are 285 m wide, measured as the distance between gate road centrelines. The gate roads themselves are 5.2 m wide and 3 m tall.

Following the development of gate roads and cut-throughs, coal is cut from the coal face by a longwall shearer, which proceeds in the direction of mining. Coal is transported to the Surface Facilities Area via a system of underground conveyors and the mine's drift (refer to **Section 3.2.4**). The longwall retreats as coal is mined and the overlying rock is collapsed into the void (forming the goaf) left behind by the coal extraction (refer to **Figure 3.2**).

3.2.5 Mine Access

Access to the underground mine for staff and materials is via a drift that extends from the Surface Facilities Area to the mine pit bottom. In addition, a 70 person vertical travel lift (man rider) is located at Tahmoor Shaft No. 3, to provide secondary access from the Surface Facilities Area to the underground workings.

3.2.6 Coal Production Limits

The Tahmoor Mine CHPP has approval to process up to three million tonnes of ROM coal per annum.

3.2.7 Coal Logistics

Product coal produced by the mine is primarily transported to the Port Kembla Coal Terminal from a rail loop at the Surface Facilities Area which connects the mine to the Main Southern Railway, and the Moss Vale to Unanderra Railway to Port Kembla. The Main Southern Railway is also used for passenger and freight routes between Sydney and Melbourne. The Moss Vale to Unanderra Railway provides a route off the Main Southern Railway for diesel powered freight trains travelling to Port Kembla.

The Australian Rail and Track Corporation (ARTC) has allocated Tahmoor Mine four train paths per day on the rail network between Tahmoor Mine and Port Kembla via the Moss Vale to Unanderra Railway Line. Product coal can also be transported to the Port Kembla Coal Terminal via the Illawarra Line, when required, such as when track maintenance is being conducted. Some coal is also transported to Port Waratah in Newcastle from time to time.

Tahmoor Coal's current approval allows 50,000 tpa of product coal to be hauled from Tahmoor Mine by road within Wollondilly Shire for local domestic use and allows road transport of product coal in situations when rail transport is unavailable. The current approval also allows road transport of 50,000 tpa of reject material from the site.

3.2.8 Mine Dewatering

To maintain a safe underground mine environment for staff and to enable the efficient mining of coal, water entering the mine from adjacent strata is collected and extracted throughout mining.

Mine water is collected in underground sumps and pumped from the mine to the water management system at the Surface Facilities Area for treatment (refer to **Section 3.3.6** for further details). Treated mine water is then either reused underground for non-potable uses during mining or discharged at the surface to Tea Tree Hollow via an existing licensed discharge point (LDP) (refer to **Section 3.3.6**).

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CURRENT LONGWALL PROGRESS AND VENT SHAFT LOCATIONS

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FIGURE 3.1

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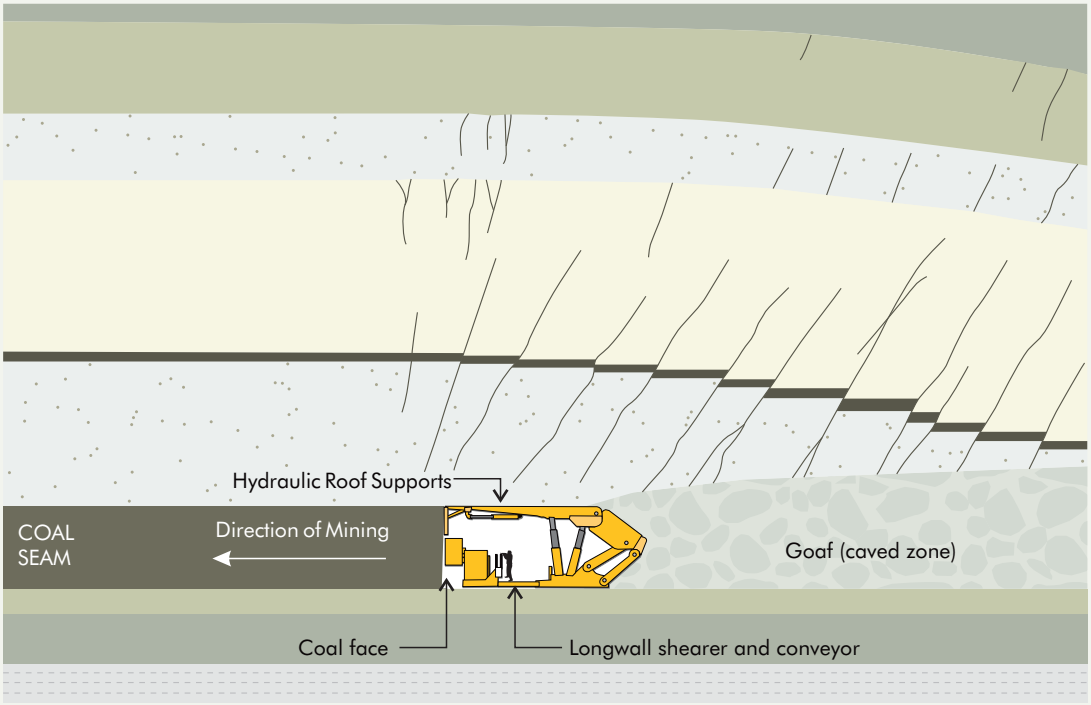
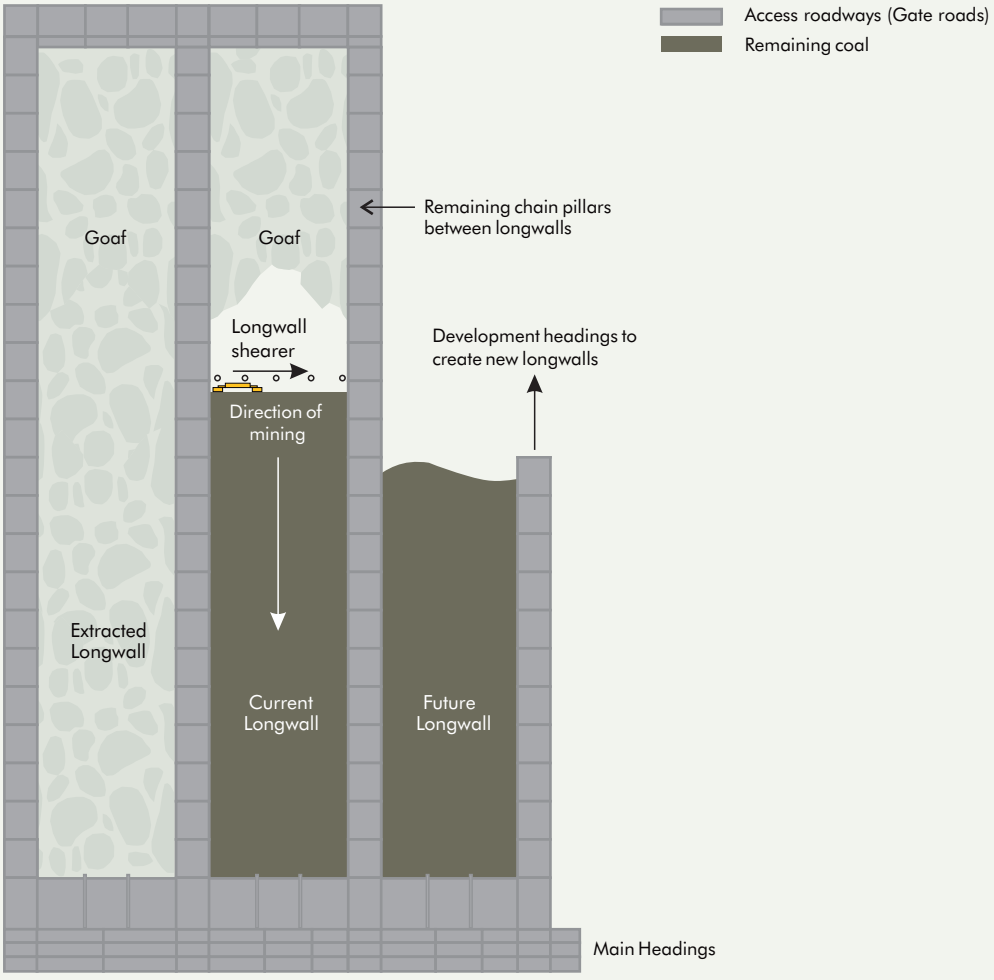


Section View



Plan View

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CONCEPTUAL LONGWALL MINING METHOD

Tahmoor South Project
Environmental Impact Statement

FIGURE 3.2

3.2.9 Subsidence Monitoring and Management

Mining operations at Tahmoor Mine are governed by a Mining Operations Plan (MOP), Subsidence Management Plans (SMPs) and/or Extraction Plans (EPs) prepared specifically for each longwall, or series of longwalls. The MOP, SMPs and EPs are submitted to the DPE and NSW DPE - Division of Resources and Geoscience (DRG) for approval prior to the commencement of mining. Longwall 32 within Tahmoor North was the last longwall approved under a SMP approval for secondary extraction. All secondary extraction past Longwall 32 would be via an EP, which can include up to 5 longwalls.

A series of SMPs or EPs are prepared to manage the impacts of longwall mining on specific features which could potentially be impacted by subsidence. These features include:

- natural features (such as waterways and cliffs);
- heritage items;
- Council owned assets and infrastructure;
- rail assets and infrastructure;
- potable water assets and infrastructure;
- sewer assets and infrastructure;
- gas assets and infrastructure;
- power assets and infrastructure;
- communications assets and infrastructure; and
- public, commercial and residential structures. Specific sub-plans may also be developed for large structures, such as bridges, retail complexes and industrial facilities.

The SMPs or EPs provide details regarding subsidence management, mitigation and monitoring. The objectives of the SMPs or EPs are to:

- ensure the safe and serviceable operation of all surface infrastructure;
- reduce disruption and inconvenience to a minimum;
- monitor ground movements and the condition of surface infrastructure during mining;
- initiate action to mitigate or remedy potentially significant impacts that are expected to occur on the surface;
- provide a plan of action in the event that the impacts of mine subsidence are greater than those that are predicted;
- provide a forum to report, discuss and record impacts to the surface; and
- establish lines of communication and emergency contacts.

An Environmental Management Plan (EMP) is prepared as part of the SMPs/EPs. The EMP establishes procedures to measure, manage, mitigate and repair potential impacts that might occur to natural features. The objectives of the EMP are met by undertaking the following:

- assessment of the potential subsidence impacts to natural features resulting from the proposed mining;
- monitoring ground movements and the condition of natural features during mining;
- initiating action to mitigate or remedy potential significant impacts that are expected to occur on the surface;
- providing a plan of action in the event that the impacts of mine subsidence are greater than those that are predicted;
- providing a forum to report, discuss and record impacts to the surface, including community and government stakeholders and consultants as required; and

- establishing lines of communication and emergency contacts.

The SMPs/EPs are developed in consultation with stakeholders and describe the required measures for monitoring surface subsidence and physical changes that are predicted to occur during mining. Measures detailed in the management plans include:

- the requirements for inspection regimes;
- the layout of monitoring points and parameters to be measured;
- monitoring methods and accuracy;
- the timing and frequency of surveys and inspections; and
- processes for recording and reporting of monitoring results.

Tahmoor Coal actively manages impacts resulting from subsidence movements in line with the SMPs/EPs and EMPs developed for the mine. The mine would continue to implement this management framework to manage impacts to surface features resulting from subsidence associated with its current operations and the proposed development.

Since 2004, Tahmoor Mine has mined under the entire township of Tahmoor, completing these operations in mid-2014 as longwall mining progressed north of the town into more rural areas. In this time, Tahmoor has safely and competently managed the subsidence impacts on major built infrastructure such as:

- the Main Southern Railway rail line;
- Tahmoor Town Centre shopping centre;
- Wollondilly Council road, bridges and drainage structures;
- gas, electricity, water, sewer and drainage infrastructure;
- a poultry processing plant;
- Aboriginal cultural heritage sites; and
- post-European settlement heritage structures.

Tahmoor Mine has subsided in the order of 1,950 residential dwellings and commercial premises, the majority of which experienced little if any damage from mine subsidence impacts. A small percentage experienced more significant impacts which have been rectified or continue to be repaired, replaced or otherwise satisfactorily addressed, by Tahmoor Mine in close working relationship with Subsidence Advisory NSW (SA NSW).

It is noted that due to the commencement of the *Mining Amendment Act 2008* and *Mining Regulation 2010* on 15 November 2010, Rehabilitation Management Plans (RMP) are intended to replace the existing requirements for MOPs. However, it is understood that the implementation of the RMPs has been delayed until supporting guidelines are finalised. Consultation with the DRG would be undertaken to ensure that the MOP or RMP is prepared for the proposed development in accordance with the relevant guidelines.

From 1 July 2014 a consolidated Extraction Plan process has replaced the former SMP process. Under the EP, mine subsidence would be jointly regulated by the Resource and Geosciences Division (responsible for compliance and enforcement of the EP) and Planning Services Division (responsible for compliance and enforcement of the EP as it relates to the Development Consent) of the DPE. Consultation with the relevant divisions of DPE would be undertaken to ensure that the EP is prepared for the proposed development in accordance with the relevant guidelines. Longwall 32 was the last longwall approved under the SMP approval process.

3.3 Surface Facilities Area

Existing surface facilities at Tahmoor Mine include:

- the CHPP;
- stockpiles for ROM and product coal;
- the REA;
- plant and equipment;
- site amenities;
- the Gas Plant,
- the Gas Flare Plant;
- WCMG Power Plant; and
- water management infrastructure.

Each of these components of the Surface Facilities Area are discussed in **Section 3.3.1** to **Section 3.3.6** and presented in **Figure 3.3**.

3.3.1 Coal Handling and Preparation Plant

Tahmoor Mine processes ROM coal using an on-site CHPP (refer to **Figure 3.3**).

The CHPP processes up to 650 tonnes of ROM coal per hour and separates it into two products by removing rock and other foreign materials (coal rejects) through screening and cyclonic processes. High quality coking coal is the major product of the mine which also produces a lesser volume of thermal coal as a secondary product.

At the CHPP, ROM coal is crushed and screened prior to being processed using primary and secondary cyclones and a flotation circuit in the coal washery to produce the coking and thermal coal products. The product coal is then transported via conveyors to stockpiles at the Surface Facilities Area prior to being loaded onto trains for transport to Port Kembla and/ or Port Waratah.

Fine reject material from the coal washery process is dewatered using drum filters and belt press filters. The fine reject material is then mixed with coarse reject material before being transported via conveyor and haul trucks to the REA for disposal.

3.3.2 Stockpiles

Stockpile areas used at Tahmoor Mine include:

- the ROM coal stockpile;
- the product coking coal stockpile; and
- the thermal coal product stockpile.

The ROM coal stockpile is located inside the rail loop at the Surface Facilities Area, adjacent to the CHPP and receives ROM coal from the main drift conveyor.

The coking coal product stockpile receives coking product coal from the CHPP and is located in the southern section of the Surface Facilities Area, between Remembrance Driveway and the Main Southern Railway. Product coal from the coking coal product stockpile is transported via conveyor to the rail load out bin where it is loaded onto trains.

The thermal coal product stockpile is located to the east of the coking coal product stockpile and receives thermal coal from the CHPP. Product coal from the thermal coal product stockpile is transported by conveyor or trucks to the rail load out bin where it is then loaded onto trains.

Occasionally, ROM coal can be stockpiled at locations at the end of either product coal stockpiles. On these occasions the movement of ROM coal is managed by internal site truck haulage between stockpile locations.

3.3.3 Rejects Management

Coal rejects (also sometimes known as refuse) is the waste rock and fine material generated from the CHPP. The rejects consist mostly of the shale and claystone material from the roof and floor of the underground workings with a small proportion of carbonaceous material and coal from the seam. The percentage of coal in the rejects is dependent on the CHPP, the mining process and mining efficiency. The coal rejects material is generally sized at less than 35 millimetres in diameter, is dark grey to black in colour and is inert.

Coal rejects from the CHPP are transported via conveyor to a reject loading bin on the eastern side of the Main Southern Railway where it is collected by haul trucks and emplaced at the REA.

The existing approved REA at the Tahmoor Mine has been in operation since 1980 and is approximately 89 ha in size. The REA has an approved capacity of about 13 Mt and has about 4 Mt of capacity remaining, which is expected to be used by 2022, with the completion of the Tahmoor North operations. Approximately 60 percent (60%) of the REA has been capped and revegetated. Reject material is spread by dozer in layers to achieve suitable compaction. As reject material is progressively placed in the REA, a dozer is used to shape the landform. Once the final landform profile has been achieved, the area is capped and progressively rehabilitated (refer to **Section 3.5**). The final landform profile consists of a stable battered slope, approximately 12 m high with external batters ranging from 1:4 to 1:8.

Erosion and sediment control measures are incorporated into each stage of the REA operation. These measures include sedimentation and retention ponds, clean and contaminated water drains, scour protection and sediment fencing.

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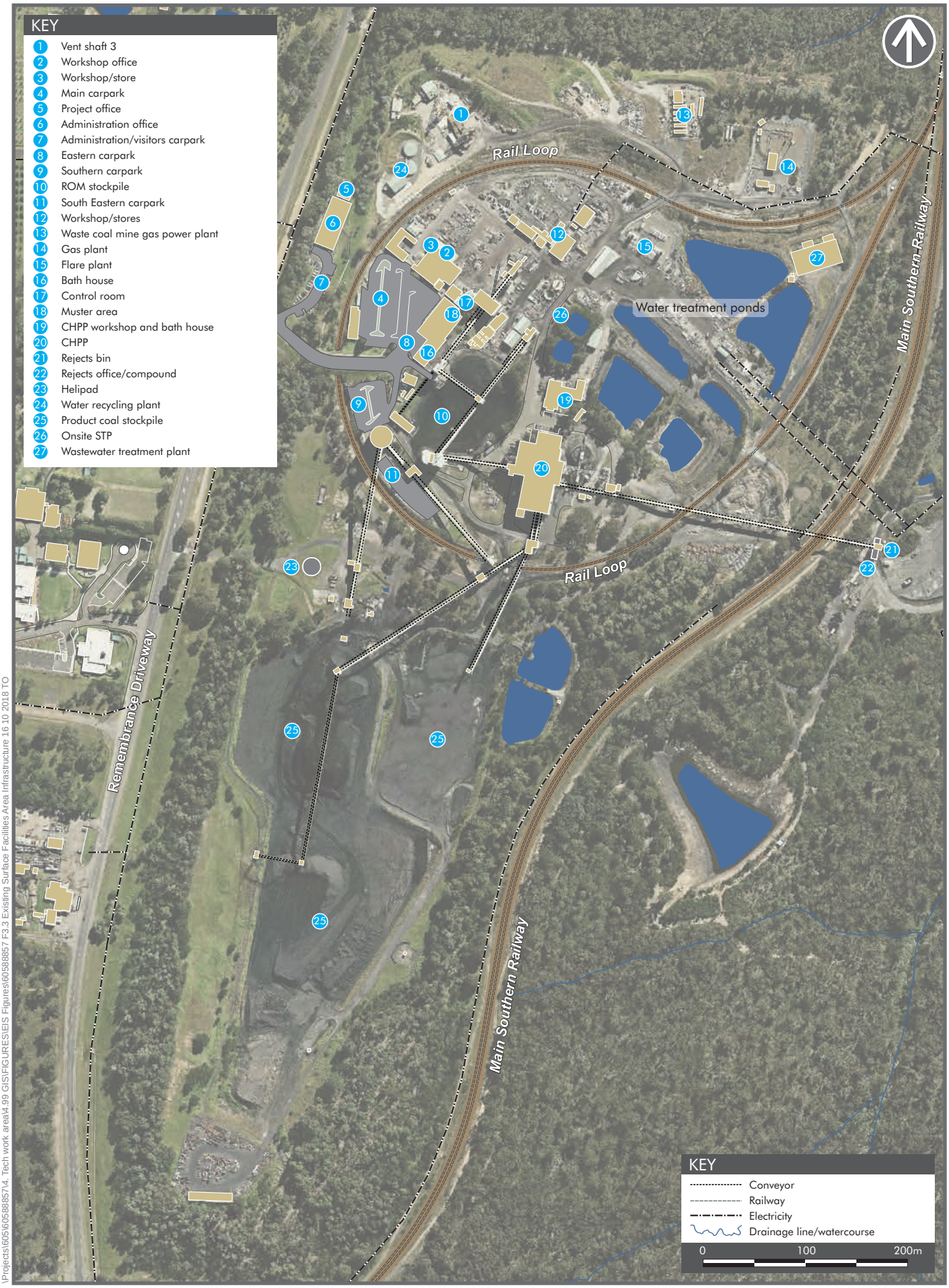

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SIMEC MINING

EXISTING SURFACE FACILITIES AREA INFRASTRUCTURE

Tahmoor South Project
Environmental Impact Statement

FIGURE 3.3

3.3.4 Site Amenities and Layout

The site amenities at the Surface Facilities Area are shown in **Figure 3.3** and include:

- administration building, located on the western side of the Surface Facilities Area between Remembrance Driveway and the rail loop;
- car parking facilities located at the entrance to Tahmoor Mine, as well as inside the rail loop adjacent to the mine office;
- mine office and bathhouse; and
- workshop and store.

3.3.5 Site Access

The entrance to the Tahmoor Mine Surface Facilities Area is located on the eastern side of Remembrance Driveway between Tahmoor and Bargo. Remembrance Driveway serves as a regional connection between Picton, Tahmoor and Bargo and intersects the M31 Hume Motorway south-east of Tahmoor Mine.

3.3.6 Water Management

Water movements at Tahmoor Mine are as follows:

- inflows from surface runoff, direct rainfall onto dam surfaces, potable water draw and groundwater inflows to the underground operations; and
- outflows including discharges to the Bargo River catchment via licensed discharge or overflow points to Tea Tree Hollow, evaporation from dam surfaces, and water loss to product coal and coarse rejects.

Water at Tahmoor Mine is managed consistent with the requirements of a Soil and Water Management Plan that aims to ensure that:

- surface water runoff is reused as process water as required;
- licensed discharge occurs within licence conditions; and
- the quality and quantity of water discharged is in accordance with relevant water quality criteria.

The main components of the water management system are as follows:

- surface water runoff treatment, reuse and discharge of excess water via a licensed discharge point (LDP) and licensed wet weather overflow points (LOPs);
- mine water treatment, reuse and discharge of excess water to Tea Tree Hollow via the LDP1 in accordance with EPL1389; and
- effluent treatment and discharge via LDP1.

The water management system at Tahmoor Mine treats mine and surface water and directs excess water to four discharge locations under the site's existing EPL No. 1389 including one main mine water licensed discharge point (LDP 1) and three wet weather licensed overflow points (LOPs 3, 4 and 5). All four locations LDP 1, LOP 3, LOP 4 and LOP 5 discharge to Tea Tree Hollow.

Each component is discussed below, while the primary water management infrastructure at the Surface Facilities Area is shown on **Figure 3.4, Figure 3.5** and **Figure 3.6**.

Surface Water Management

Surface water runoff from operational areas and stockpiles at Tahmoor Mine is captured by a network of stormwater treatment dams at the Surface Facilities Area to allow suspended solids in the water runoff to settle out. Following treatment, the water discharges or overflows to Tea Tree Hollow at the LDP and LOPs (refer to **Figure 3.4** & **Figure 3.5**). Specifically, surface water runoff from the following areas is managed:

- the surface workshop;

- storage yard and remaining hardstand areas of the Surface Facilities Area;
- the ROM coal and coal product stockpiles;
- the REA; and
- the ventilation shaft areas.

Water runoff from within and around the surface workshop area passes through an oil and water separator prior to entering the stormwater treatment dams. Oil traps and separators are inspected and cleaned monthly by a contractor. Oil drained from equipment is transferred to a waste oil storage area prior to being disposed of offsite.

Stormwater runoff from the storage yard and remaining hardstand areas of the surface facility area (mix of sealed and unsealed ground) is captured by drainage channels and directed to a series of dams for retention prior to discharge via LDP1. Dams M1, M2, M3 and M4 enable settling of solids from surface water runoff and also treat mine water prior to discharge at LDP1.

The coal stockpiles stormwater system areas are drained or pumped to settlement dam S4 prior to being discharged via LDP1. Specifically, water runoff from the stockpiles is contained within bund walls which direct water to two interconnected retention dams (marked as stockpile dams S2 and S3 on **Figure 3.4**, **Figure 3.5** and **Figure 3.6**).

Pumps located on the stockpile dams S2 and S3 provide water for the stockpile dust suppression sprays. Water overflows from S2 and S3 to the main treatment dam (S4). Flow entering S4 from the stockpile dams is automatically dosed with a flocculent to allow suspended solids to settle out in the dam, treated water overflows are discharged via LDP1.

Water runoff from the REA is captured in sediment retention dams S5, S6, S7, S7a, S7b, S8 and S9, with water pumped to S4 dam for treatment, via automatic flocculent dosing, prior to discharge via LDP1. The REA is also currently served by the following discharge and overflow points:

- LOP 4 – wet weather overflow from the treatment dam (S4);
- LOP 3 – wet weather overflow from the haul road dam (S9); and
- LOP 5 – wet weather overflow from reject seepage dam (S8).

In December 2011, Tahmoor Mine's EPL was varied following completion of Pollution Reduction Program (PRP) 15 'Improvement of Stormwater Management' which was designed to meet the requirements of *Managing Urban Stormwater* (Landcom, 2004) ('the Blue Book'), including Volume 2E Mines and Quarries (2008).

Following acceptance of the completed measures required by PRP 15 by the NSW Environment Protection Authority (EPA) in October 2011, discharge quality and volume limits were removed from LOP 3 and LOP 5 on the EPL. Under the EPL, overflow is permitted to occur via the unregulated wet weather overflow points during rain events exceeding the design capacity of the stormwater system.

Stormwater management at the existing ventilation shafts is as follows:

- Tahmoor Shaft 1 (T1): located on Stratford Road serves as a downcast shaft only, with no water discharges. The site is considered a clean water catchment as there are no active surface operations or work areas at the site, with all clean surface stormwater runoff draining to the surrounding bushland and down towards the Bargo River via natural drainage lines;
- Tahmoor Shaft 2 (T2): located on Rockford Road, it is currently used as the main upcast ventilation fan for the Mine. Runoff from the surface area around Tahmoor Shaft 2 (gravel road, core sheds and bushland) flows via a surface drainage channel down to settling dams M5 and M6; and
- Tahmoor Shaft 3 (T3): located adjacent to the Surface Facilities Area, outside the rail loop, and currently serves as a downcast shaft and staff access to the mine via a shaft winder. Runoff from the surface area around Tahmoor Shaft 3 (unsealed roads and vegetated earthen bund) flows to a series of gravel sediment retention dams, before continuing along a surface drainage channel around the outside of the rail loop, eventually joining the overflow water from M4 dam, before discharge via LDP1.

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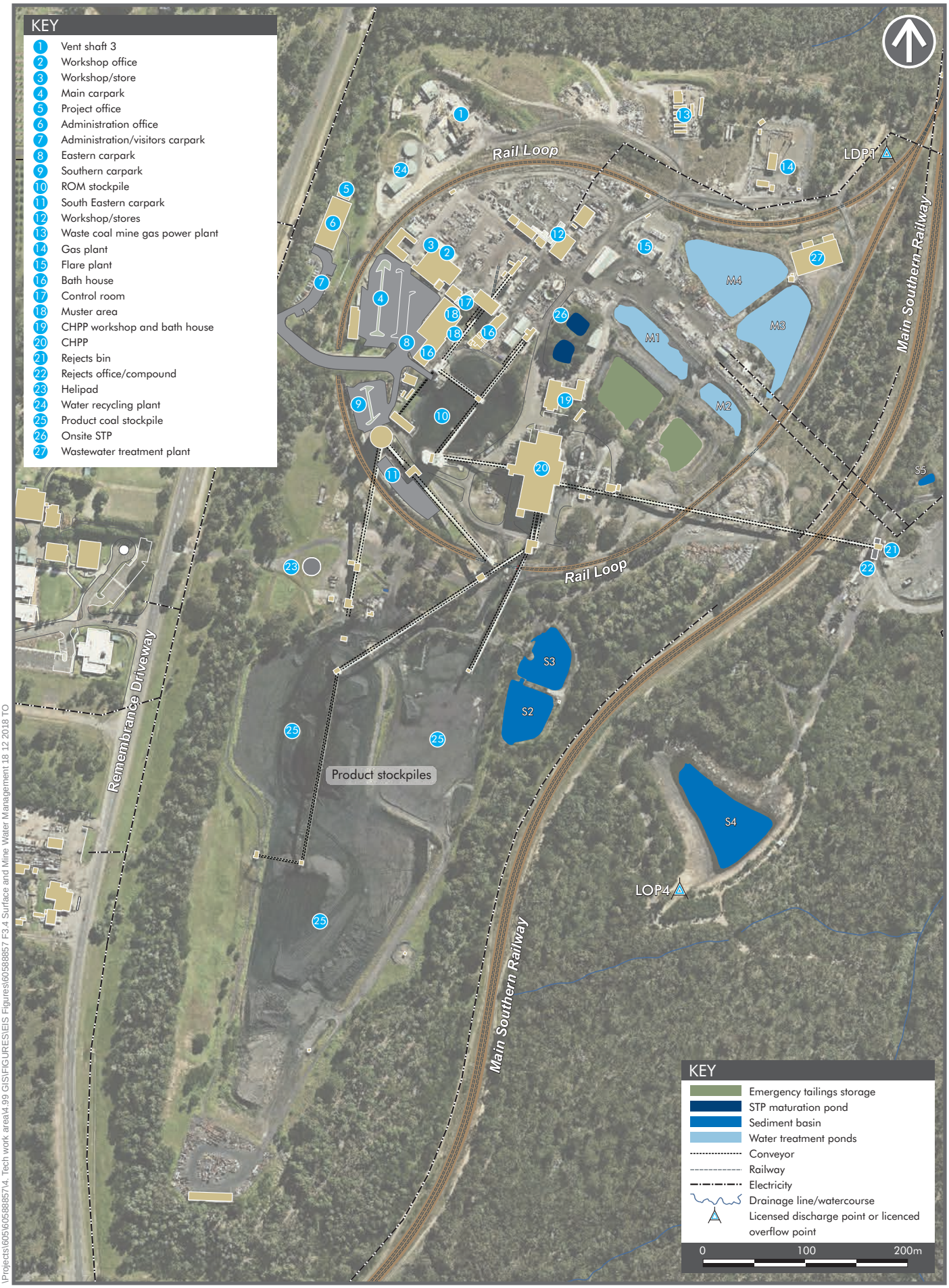

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SURFACE AND MINE WATER MANAGEMENT

Tahmoor South Project
Environmental Impact Statement

FIGURE 3.4

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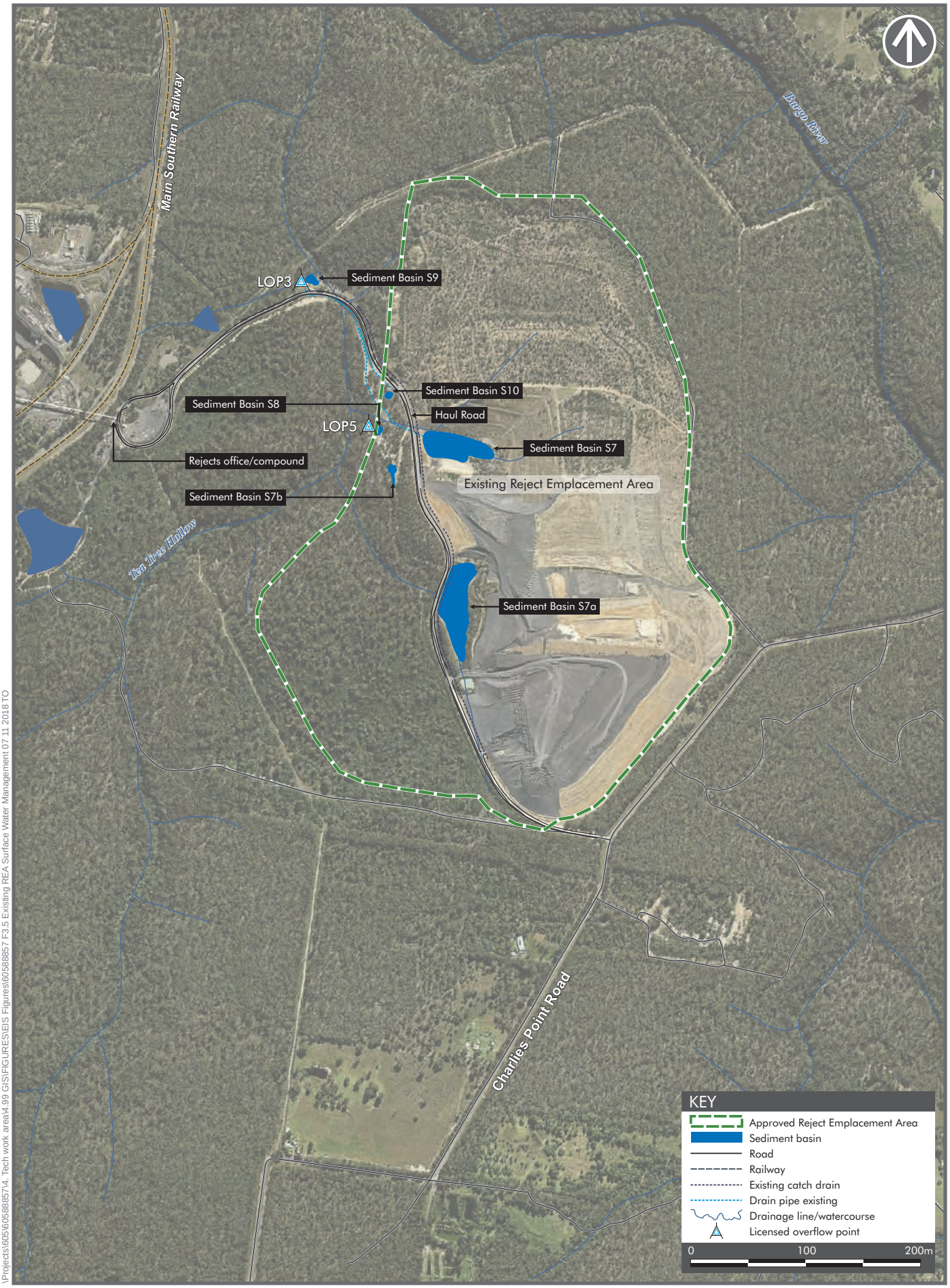

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EXISTING REJECT EMPLACEMENT AREA SURFACE WATER MANAGEMENT

Tahmoor South Project
Environmental Impact Statement

FIGURE 3.5

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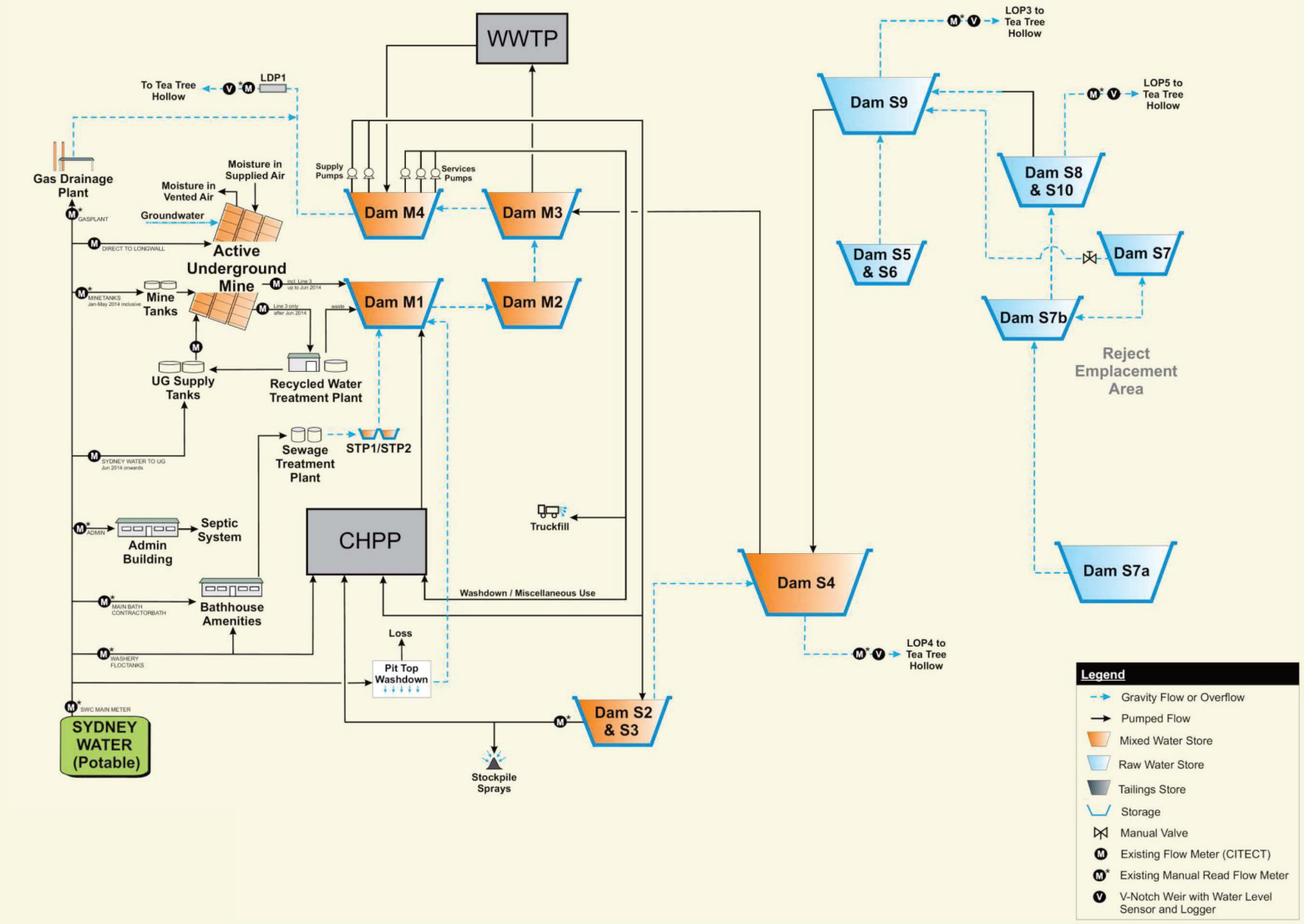


\Projects\605\605888574. Tech work area\4.99 GIS\FIGURES\EIS Figures\605888857 F3.6 Existing Water Management Schematic 16 10 2018 TO

SIMEC MINING

Source: Hydro Engineering & Consulting (2018)

EXISTING WATER MANAGEMENT SYSTEM SCHEMATIC

Tahmoor South Project

Environmental Impact Statement

FIGURE 3.6

Mine Water

Inflows of groundwater into the underground mine from the coal seam and adjacent strata are referred to as mine water. Water from porous sandstone layers above the mine workings seeps into the mine at rates of between approximately 2 and 5 Megalitres (ML) of mine water per day. This water is intercepted by an underground water reticulation system, eventually reaching pit bottom where it is pumped up the main drift to the Surface Facilities Area. Water is pumped to the surface via dewatering lines one and two, and then directed to a series of settling dams (M1, M2, M3 and M4) on the Surface Facilities Area and on to the waste water treatment plant (WWTP). The WWTP has capacity to treat up to 6 ML per day of mine water to reduce the concentrations of Arsenic, Nickel and Zinc in the water discharged from the mine. Treated water is then either reused at the mine or discharged via LDP1 to Tea Tree Hollow, flowing into the Bargo River.

The WWTP was constructed at Tahmoor Underground Mine in June 2015 as part of PRP22 to improve the quality of water discharged from LDP1. Following modifications, detailed commissioning of the WWTP occurred during September to November 2018. PRP22 on EPL 1389 for the WWTP has been extended until November 2018.

Water is also pumped from the bottom of Tahmoor Shaft 3 to the surface via dewatering line three. This water is a cleaner stream with limited exposure to operational areas, and is mainly composed of groundwater with low solids contamination. Water from this source is sent for recycling in the Recycled Water Plant at the Surface Facilities Area. It recycles 1.0 ML of mine water per day for reuse in the underground mine. Mains water use is minimised where possible by using recycled mine water for these non-potable uses.

Potable water is supplied to Tahmoor Mine by Sydney Water, with the take-off from the main pipeline near the main administration building on Remembrance Driveway. The mine uses up to approximately 1.2 ML of water per day. The water drawn from mains supply is offset with water reused from the mine's recycled water plant.

Dewatering from underground operations at Tahmoor Mine is governed by groundwater licence WAL36442 (10WAI18745) with an annual allocation of less than or equal to 1,642 ML. Groundwater dewatering volumes are reported annually in the Annual Review.

Sewage Treatment

A sewage treatment plant discharges effluent into two maturation ponds, which flow through to and are discharged via LDP1.

3.4 Exploration Activities

Tahmoor Mine has undertaken, and continues to undertake, exploration programs ahead of mining operations to determine the geological structure and to better understand the coal resources within its coal lease areas. The exploration program is carried out under a series of approvals granted by DRG under the Mining Act. There are generally two components involved in exploration activities: seismic reflection surveys, and exploration borehole drilling programs, which are explained in further detail below.

Seismic survey for minerals exploration uses a vibration source to investigate the geological structure of the subsurface environment. The vibration source generates a seismic wave which reflects off underground structures. The returning signals from the sources are detected by geophones (similar to a microphone), laid on the land's surface in known locations relative to the position of the source. The recorded signals are then subjected to specialist analytical review and processing to yield comprehensible data which may assist further geological survey and future mine planning.

The seismic reflection survey involves the following:

- standard vehicles to carry and lay out recording cables;
- a specialised truck-mounted Envirovibe unit – to deliver the seismic vibration; and
- use of in some instances a small, manually operated vibration source similar to a small hand-operated soil compactor, may be used.

Exploration boreholes have been drilled throughout the history of mining at Tahmoor Mine to define coal quality across the coal lease areas and to inform mine planning. The information gained during exploration is used to assist the detailed mine design process and further define the coal resource potential ahead of mining activities. The drilling of each exploration borehole is undertaken as follows:

- establishment of the exploration borehole site (one week);
- drilling of the exploration borehole using a truck-mounted or skid-mounted drill rig. A rod truck, core boxes, pumps and compressors and ancillary equipment are also delivered to the drill site (four to eight weeks); and
- decommissioning (including sealing and rehabilitation) of the exploration borehole site (one week plus three to six months of rehabilitation monitoring).

3.5 Rehabilitation and Mine Closure

The primary objectives of closure, decommissioning and rehabilitation of the existing Tahmoor Mine will be to:

- return land affected by the operations to a condition suitable for a range of sustainable future land uses; and
- to provide for the safety of employees and the public during and following mine closure.

Disturbed areas at Tahmoor Mine are progressively rehabilitated in accordance with a Conceptual Mine Closure Plan following completion of works at those locations (exploration boreholes and the REA, for example).

The majority of rehabilitation currently undertaken at Tahmoor Mine is at the REA, as emplaced areas are progressively reshaped, covered with topsoil and revegetated. Revegetation involves planting a combination of sterile, exotic cover crops and native grass, shrub and tree seed mixes to achieve the rehabilitation objective of establishing native bushland. Monitoring of rehabilitated areas is undertaken annually to assess the success and to inform the management of areas of re-established vegetation.

In line with the development consent conditions for the existing operations, mine closure will occur once mining has ceased within the Tahmoor North mining area and once rehabilitation activities are complete. The preliminary final land use option proposed for the existing Tahmoor Mine involves a return to natural bushland. However, it is recognised that given the location and activities of the site, there are potential opportunities to establish a range of final land use options. The selection of viable options will be informed by the preparation of a detailed Mine Closure Plan to be prepared by Tahmoor Coal within five years of the planned completion of current mining. This Plan will include measures to be undertaken to rehabilitate the Surface Facilities Area and related infrastructure, as well as the proposed method of closing the underground workings.

The timing and staging of the rehabilitation and closure of the existing operational areas of Tahmoor Mine, as well as the proposed final land use of the entire site, would be influenced by the requirements and timeframes associated with the proposed extension of mining, if approved, as further outlined in **Sections 4.0** and **Section 11.23.**

3.6 Timeframe

3.6.1 Remaining Mining Schedule

Tahmoor Mine is currently extracting from Longwall 32 within Tahmoor North, which commenced extraction in October 2018. The existing approved Tahmoor Mine has capacity for a future four longwalls with a mine life extending to 2022, depending on geological and mining conditions.

3.6.2 Hours of Operation

Tahmoor Mine operates 24 hours per day, seven days per week. The current working hours of the permanent workforce are split as follows:

- Monday to Fridays three 10 hour overlapping shifts (night shift, day shift, afternoon shift); and
- weekends two 12 hour shifts (night shift and day shift).

3.7 Environmental Management

Tahmoor Mine operates under an existing Environmental Management System (EMS), which governs the management of environment and community aspects, impacts and performance. This document provides a framework for the standards, plans and procedures implemented to ensure operations are managed in accordance with the relevant licences and approvals held by Tahmoor Mine. The following specific environmental management and monitoring plans are currently in place at Tahmoor Mine and form part of the Environmental Framework:

- Cultural Heritage Management Plan (CHMP);
- Biodiversity and Land Management Plan;
- Air Quality and Greenhouse Gas Management Plan;
- Waste Management Plan;
- Noise Management Plan (NMP);
- Conceptual Mine Closure Plan;
- Environmental Monitoring Program;
- Product Stewardship Management Plan;
- Social Involvement Plan;
- Pollution Incident Response Management Plan;
- Energy Savings Plan;
- Reject Emplacement Area Management, Rehabilitation and Water Monitoring Plan;
- Soil and Water Management Plan; and
- Groundwater Management Plan.

3.8 Community Consultation

Tahmoor Mine has developed an effective and responsible community consultation and communication program. Initiated during 2004 as longwall mining first approached the township of Tahmoor, the program has been improved and enhanced over time. A broad program of consultation activities include:

- community information days held at least twice yearly;
- quarterly meetings of the Tahmoor Coal Community Consultative Committee (TCCCC);
- a community newsletter distributed by post;
- a general enquiries email (tahmoorenquiries@simecgfg.com);
- a 24 hour community information telephone service (1800 154 415);
- Tahmoor Coal's website providing project updates;
- Resident Information packs sent to landowners at commencement of each longwall; and
- regular meetings to consult with landowners.

Further details of Tahmoor Coal's community consultation program, related to subsidence impacts are provided in **Section 11.1.5**.

4.0 Proposed Development

4.1 Overview

Tahmoor Coal is seeking development consent for the continuation of mining at Tahmoor Mine, extending underground operations and associated infrastructure south, within the Bargo area. The proposed development seeks to extend the life of underground mining at Tahmoor Mine for an additional 13 years until approximately 2035.

The proposed development would use longwall mining to extract coal from the Bulli seam within the bounds of CCL716 and CCL747. Coal extraction of up to four (4) million tonnes of ROM coal per annum is proposed as part of the development with extraction of up to 48Mt of ROM coal over the life of the project. The project would consist of approximately:

- 35Mt coking product;
- 3.5Mt thermal product; and
- 9.5Mt rejects.

These approximate market mix volumes include moisture and are therefore an estimate only. Once the coal has been extracted and brought to the surface, it would be processed at Tahmoor Mine's existing CHPP and coal clearance facilities, and then transported via the existing rail loop, the Main Southern Railway and the Moss Vale to Unanderra Railway to Port Kembla and Newcastle (from time to time) for Australian and international markets. Up to 200,000 tonnes per annum of either product coal or reject material is proposed to be transported to customers via road.

The proposed development would use the existing surface infrastructure at the Tahmoor Mine Surface Facilities Area. Some upgrades are proposed to facilitate the extension.

The proposed development also incorporates the planning for rehabilitation and mine closure once mining ceases.

The components of the proposed development are shown on **Figure 4.1** to **Figure 4.10**, and in summary comprise:

- longwall mining in the Central Domain (refer to **Section 4.2.1**);
- mine development including underground redevelopment, ventilation shaft construction, pre-gas drainage and service connection (refer to **Section 4.2.2**);
- upgrades to the existing Surface Facilities Area including:
  - upgrades to the CHPP;
  - expansion of the existing REA;
  - additional mobile plant for coal handling;
  - additions to the existing bathhouses and associated access ways; and
  - upgrades to onsite and offsite service infrastructure, including electrical supply (refer to **Section 4.3**);
- rail transport of product coal to Port Kembla and Newcastle (from time to time) (refer to **Section 3.2.7**);
- Up to 200,000 tonnes per annum of either product coal or reject material is proposed to be transported to customers via road;
- mine closure and rehabilitation (refer to **Section 4.4**); and
- environmental management (refer **Section 4.7**).

Each of the individual components of the proposed development, along with an overview of the proposed environmental management measures, is described in further detail in **Sections 4.2** to **4.7**.

4.2 Underground Mining Operations

4.2.1 Mining Area

Coal from the Bulli Seam would be mined within CCL 747 and CCL 716 (refer to **Figure 1.2**) as part of the Tahmoor South Project. The lease areas for the proposed development have been operationally divided up into different mining domains based on geological complexity and mining potential, as described in **Section 5.4**. The Tahmoor South Project comprises mining in the Central Domain only (refer to **Figure 1.4**). Further discussion on the other domains and alternatives considered is provided in **Section 5**.

The proposed development seeks to undertake longwall mining of the Bulli seam within the Central Domain, at a depth of between approximately 365 m and 410 m below ground level. The Central Domain, depicted in **Figure 1.4** is bounded by known geological fault zones.

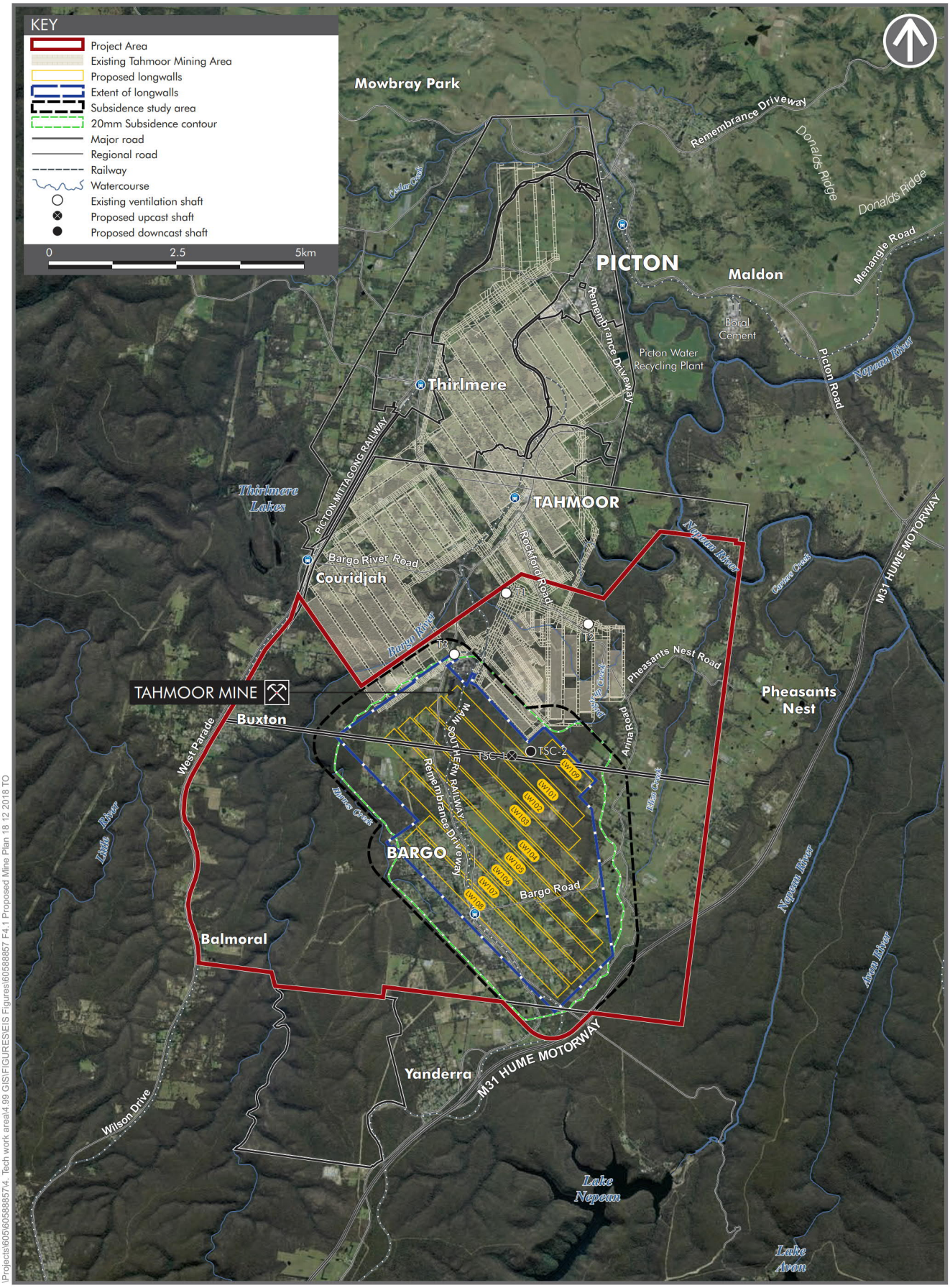
During the mine planning process, a constraints analysis, risk assessment and preliminary fieldwork were undertaken to identify sensitive natural surface features (such as waterways, cliffs, and Aboriginal heritage sites) and to develop RMZs. Subsequent to the risk assessment the proposed longwall layout was modified to minimise significant subsidence impacts to these natural features. The underground extent of the mine proposed on **Figure 4.1** represents this configuration. Further detail regarding how each environmental and social issue has been taken into account during the mine planning process is described in **Sections 5.0** and **6.0**.

The indicative longwall panel layout is shown on **Figure 4.1**. The longwall layout is conceptual only and would be refined in the extraction plan process. The refined longwalls plan would remain within the extent of longwalls. Longwalls in the Central Domain would be orientated in a south-east/north-west direction and would be located within the Bargo area.

The extent of longwalls shown on **Figure 4.1** defines the maximum extent of the footprint of the proposed longwall mining and consists of both first (roadways) and secondary (longwall) workings. The impact assessment for the proposed development focuses on the SSA and assumes that longwall mining only occurs within the extent of longwalls, with the exception of main development roadways (first workings).

The extent of longwalls provides for some flexibility for changes to mining development work and longwall layout during detailed design, subject to geological conditions. It is proposed that minor changes to the layout would be approved under the EP approval process. The final detailed design of the longwall layouts would be subject to review and approval in consultation with the relevant authorities and to the satisfaction of the Secretary of the DPE. Mining operations which are proposed to be undertaken within the area designated as the extent of longwalls include first workings; comprising main headings, gate roads and cut throughs, as well as the development of the longwall panels (secondary workings).

As part of the proposed development, subsidence predictions have been undertaken for residential, commercial and business structures, public infrastructure such as pools and public amenities, utility services such as water and gas mains, and other associated infrastructure. These predictions and potential impacts would be captured within an EP prior to longwall mining for the proposed development and would incorporate the management measures identified herein.



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PROPOSED MINE PLAN AND VENTILATION SHAFTS

Tahmoor South Project
Environmental Impact Statement

FIGURE 4.1

Note: The 'extent of longwalls' boundary encompasses the proposed extent of underground workings, being the proposed longwall panels and mains headings (first workings).

4.2.2 Mine Development

To enable the continuation of mining to occur sequentially with the current mining operations in Tahmoor North, which are scheduled for completion during 2022, it is anticipated that Tahmoor South Project's development works need to commence in approximately 2019 under existing development consents. These pre-development activities include:

- recovery of existing underground development roadways;
- redevelopment of the underground pit bottom;
- pre-gas drainage;
- longwall development including establishment of gate roads;
- installation of electrical, water and gas management networks; and
- the purchase and installation of equipment.

An additional 50 -175 personnel would be required for the Tahmoor South Project development works, which may occur concurrently with the ongoing mining operations at Tahmoor North. Additional site amenities, including bath houses and additional onsite car parks would be required to accommodate the increased workforce during the transition period from mining operations at Tahmoor North and the Tahmoor South Project's development works.

4.2.3 Mine Ventilation

The proposed development would partially use the existing mine ventilation system, comprising three ventilation shafts one upcast (T2) and two downcast shafts (T1 and T3). However, the upcast shaft (T2) would only be used in emergency situations.

Two additional ventilation shafts would be required to provide a reliable and adequate supply of ventilation air to personnel in the mine:

- TSC1: an upcast ventilation shaft that would be located on Tahmoor Coal's Charlies Point Road property; and
- TSC2: a downcast ventilation shaft that would be located on Crown Land adjacent to Tahmoor Coal's Charlies Point Road property.

The locations of the ventilation shafts are shown on **Figure 4.2.**

The construction of the ventilation shafts would require the disturbance of a footprint of approximately 4 to 6 hectares at each location. Access to TSC1 and TSC2 would be from the existing road network.

A conceptual construction site layout for each of the two proposed ventilation shafts is shown in **Figure 4.3** and **Figure 4.4**. Construction would involve the following:

- Construction of internal roads to allow access for construction and operational maintenance vehicles.
- Establishment of the construction site to allow sufficient space for stockpiling of shaft liners for TSC1 and TSC2, temporary spoil emplacement, water management, storage and safe movement on-site during construction activities. Establishment of the ventilation shaft site would involve:
    - Installation of environmental controls such as silt fences, fencing and a lockable gate, as well as display of appropriate signage relating to restricted entry;
    - Clearing of vegetation and stripping of topsoil. Topsoil would be temporarily stockpiled for rehabilitation post construction;
    - Excavation and construction of a temporary hardstand area for operation of drilling equipment. The hardstand footprint would be determined by the size and number of liner pieces to be manufactured and excavated to a depth of approximately 0.2 m. The temporary hardstand areas would include:
        - road base surrounding the site compound area and drill rig slab for site facilities;
        - laydown areas and a levelled hardstand area for storage of the ventilation shaft liners;

  - a stable access way between the liner storage area and the shaft to facilitate transport of the cured liner segments on purpose built trailers; and
  - a concrete pad 20 m by 15 m is to be constructed around the top of the shaft as a foundation for the drill rig and to provide a clean work area.
- Connection of 66 kV electrical power and establishment of electrical substations at ventilation shaft sites;
- Sinking of the shaft using blind boring methods (or similar method), and lining of the shafts using a composite concrete and steel liner (or similar method); and
- Construction and installation of ventilation fans. The upcast shaft site fan would also incorporate a fan outlet stack, approximately 30 m high, to control odour discharge from the mine.

The shaft construction sites would incorporate water treatment controls, with water extracted from the ventilation shaft being piped to the existing Surface Facilities Area, treated and discharged via the existing licensed discharge point (LDP1). Following the construction phase, the footprint of the operational area of each ventilation shaft would be reduced to approximately two hectares, plus provision for an access road. The area immediately surrounding the ventilation shaft would be rehabilitated following the construction phase. The ventilation fans would operate for the life of the proposed development.

At the TSC1 ventilation shaft site, additional service surface to seam boreholes would be constructed to provide power, communications, gas drainage and water to the mine and service shafts constructed for ballast and concrete delivery into the mine. A service building housing an office and amenities would also be constructed together with a services compound for stockpiled ballast. A 30,000 litre self bunded diesel fuel tank would also be located at the TSC1 ventilation shaft site to provide a fuel supply to underground equipment.

4.2.4 Gas Drainage Operations

Coal mines need to control underground gas concentration levels to below safe limits so that miners are able to work in a safe environment and mining operations can be undertaken as efficiently as possible.

The coal seams within the Southern Coalfield are generally known to be gassy, with CH_4 and CO_2 released from the goaf during mining. Gas in the underground workings would be managed by a series of gas drainage operations including:

- pre gas drainage, whereby gas would be extracted from the coal seam prior to longwall mining;
- post gas drainage, whereby gas would be extracted from the goaf; and
- gas extraction via the mine ventilation system, which would occur throughout mining.

Gas management would continue to use the existing infrastructure, including the Tahmoor Mine Gas Plant, Gas Plant Vent and Flare Plant, as well as the WCMG Power Plant. Some components of the existing gas management infrastructure may need to be upgraded throughout the life of the proposed development, such as the installation of the additional two vacuum pumps at the Gas Plant when required.

Pre Gas Drainage

The purpose of pre gas drainage is to reduce gas volumes in the coal seams prior to mining, with the Bulli, Wongawilli and Balgownie seams targeted for pre gas drainage at Tahmoor Mine. Pre gas drainage of the gas levels in the seams is required to facilitate the timely commencement and progression of mining as well as to reduce the demands on the mine ventilation system for the purpose of gas dilution during operations.

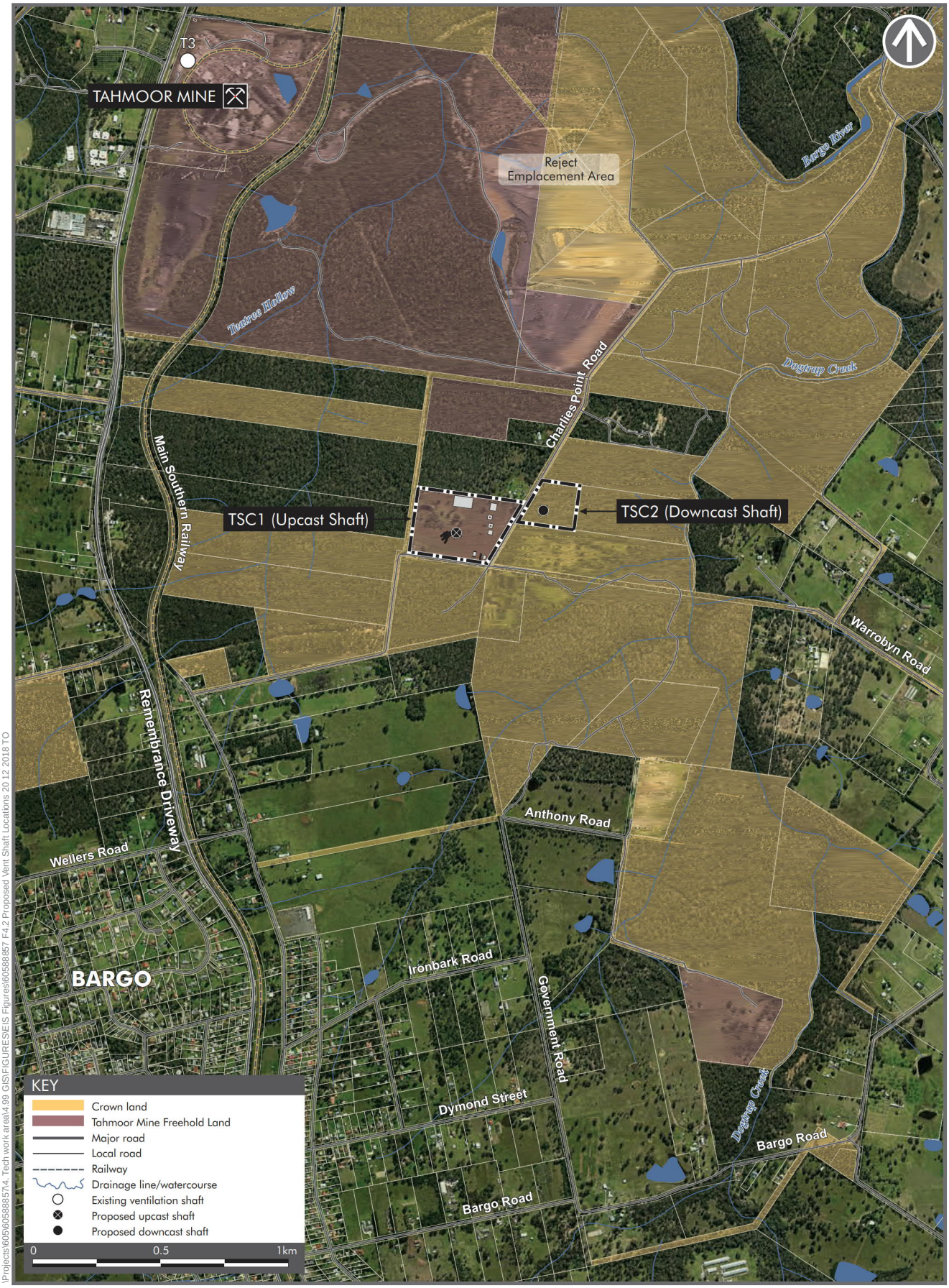
Pre gas drainage activities are mainly undertaken underground, via drilling and drainage from the roadways developed for longwall panels. Underground pre gas drainage works at Tahmoor Mine would drain gas following development of the mine roadways and prior to longwall development. Gas would be drawn from the coal seam by vacuum and piped to the Gas Plant at the Surface Facilities Area via the underground pipe network. Underground gas drainage of the coal seam would continue ahead of longwall development for the life of mining.

Post Gas Drainage

Post gas drainage would be required as strata relaxation caused by the retreating underground longwall face would liberate volumes of gas into the mine workings from the underlying Wongawilli seam and from overlying strata, released due to fracturing of the goaf. To capture this gas during the proposed development, cross-measure boreholes are proposed to be drilled from the mine workings into the Wongawilli seam. These boreholes would be designed to collect the gas at its source or to intercept gas before it migrates into the mine workings. At the conclusion of mining from each panel, the panel would be sealed and gas drawn from the sealed areas as part of the post gas drainage operations. The gas collected from the in-seam and cross-measure boreholes would be drawn by vacuum via the underground pipe network to the Gas Plant located at the Surface Facilities Area.

Gas in Ventilation

The ventilation system would deliver fresh air into the mine from the existing and proposed downcast ventilation shafts and would extract stale air from the mine via the existing and proposed upcast ventilation shafts (refer to **Section 4.2.3**). Similar to the existing operations, the ventilation system would carry the remaining diluted gases out of the mine via the upcast mine ventilation shafts (refer to **Section 4.2.3**).



\Projects\60560588857\4. Tech work area\4.99 GIS\FIGURES\EIS Figures\60588857 F4.2 Proposed Vent Shaft Locations 20 12 2018 TO

SIMEC MINING

PROPOSED VENTILATION SHAFT LOCATIONS

Tahmoor South Project
Environmental Impact Statement

FIGURE 4.2

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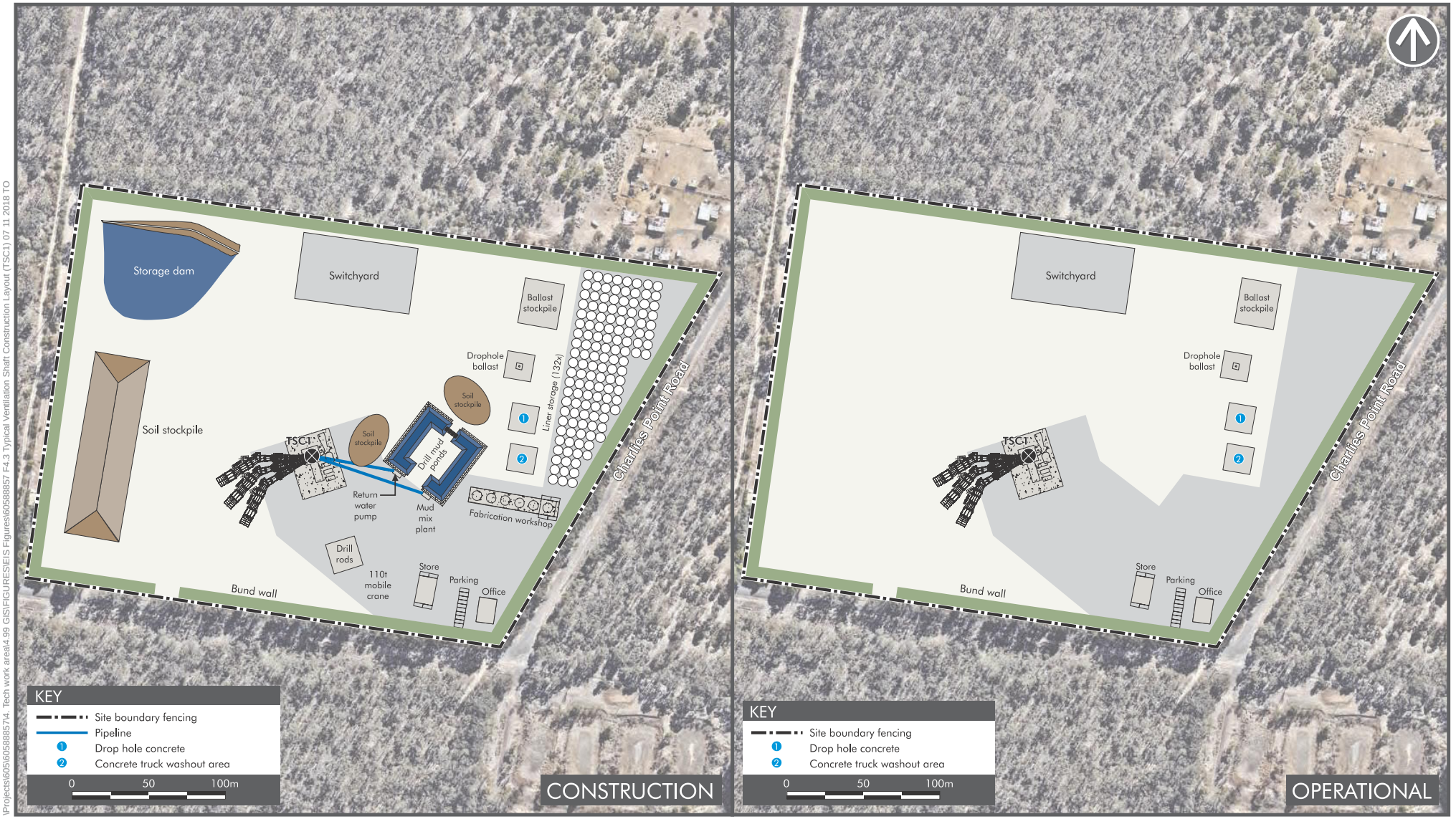

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SIMEC MINING

CONCEPTUAL VENTILATION SHAFT LAYOUT (TSC1)

Tahmoor South Project

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FIGURE 4.3

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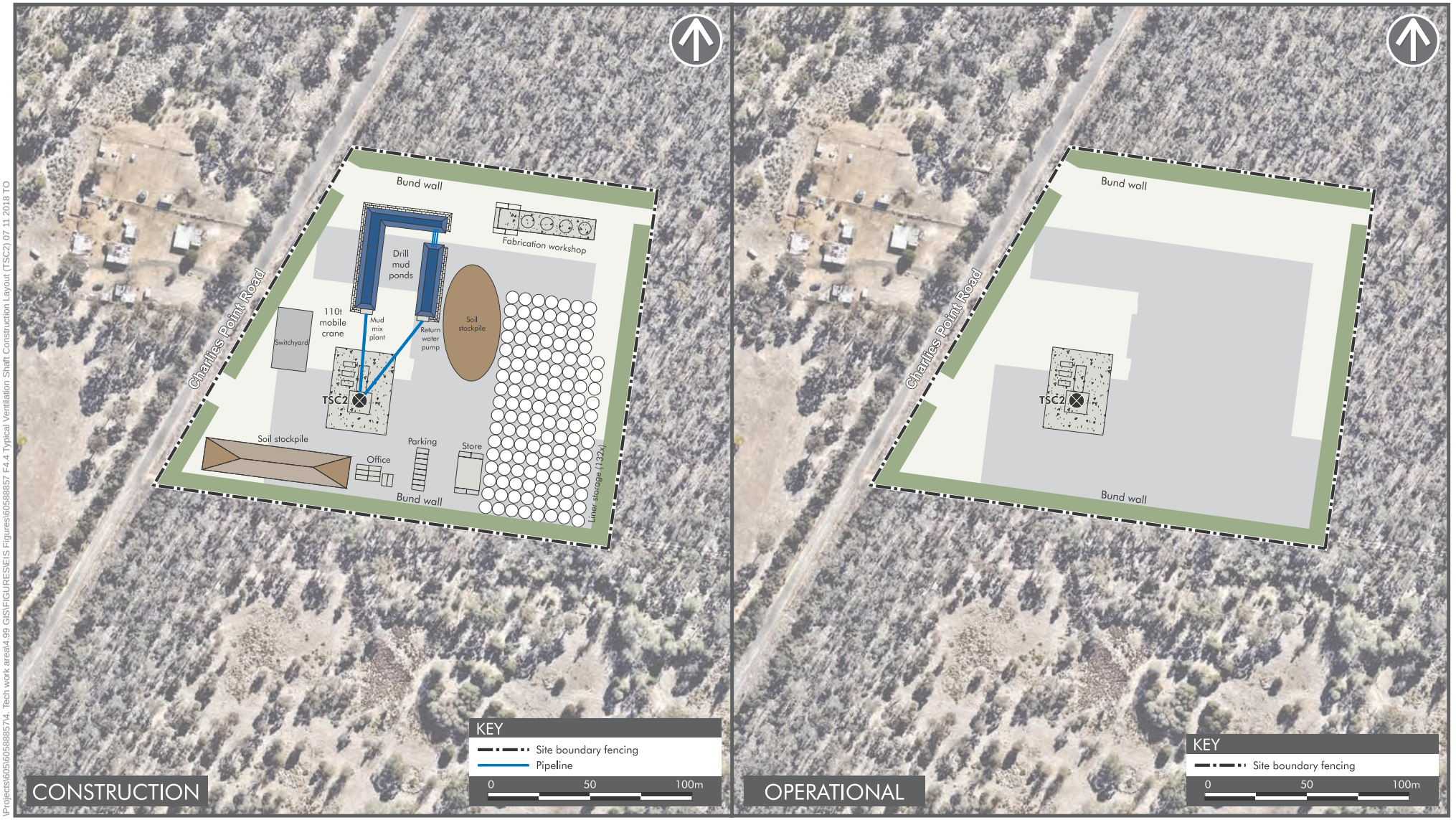

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SIMEC MINING

CONCEPTUAL VENTILATION SHAFT LAYOUT (TSC2)

Tahmoor South Project

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FIGURE 4.4

4.2.5 Mining Method and Equipment

Underground mining would be undertaken via the main roadway and longwall development using continuous miners. Longwall development refers to the mining of a series of roadways (gate roads) and cut-throughs, to form pillars of coal that would support the overlying strata during the extraction of coal. Longwalls would be up to approximately 305 m wide. The gate roads would be approximately 5.2 m wide and have a height of up to 3 m. **Figure 3.2** and **Figure 4.5** provide a schematic illustration of the relationship between the longwalls and gate roads.

Coal would be cut from the coal face by the longwall shearer, loaded onto the armoured face conveyor and transported to the Surface Facilities Area via a series of underground conveyors. The longwall would retreat as coal is mined and the overlying rock strata would collapse into the void left by the coal extraction, forming the goaf.

Tahmoor Coal would continue to review and investigate improved or alternate mining methods and technology throughout the life of the proposed development. Improved methods would be utilised where available and found to be commercially viable to allow for the efficient and economically viable extraction of the coal resource. Tahmoor Coal would ensure that the resulting environmental and social impacts of improved or alternate methods are consistent with those predicted in this EIS.

4.2.6 Mine Access

The proposed development would use the existing infrastructure at Tahmoor Mine for employee and material access to the mine. Access to the Central Domain would be via the existing Tahmoor Mine Surface Facilities Area, the existing drift, and men and materials travel lift installed within the T3 downcast shaft. The T3 vertical men and material travel lift has a capacity for 70 persons and approximately 12 tonnes of materials.

4.2.7 Coal Production and Transport

Product coal would continue to be transported from Tahmoor Mine to Port Kembla, via the existing mine rail load out, rail loop, the Main Southern Railway and the Moss Vale to Unanderra Railway (**Figure 1.1**). Transport of product coal from the proposed development to Newcastle (Port Waratah) could also occur from time to time.

Tahmoor Mine currently has four allocated train paths per day from ARTC for the rail network between the Tahmoor Mine and Port Kembla. This current allocation is equivalent to the transport of approximately 4.6 million tonnes of product coal per annum and is sufficient for the life of the Tahmoor South Project (which is expected to generate up to 3.5 million tonnes of product coal per annum). A rail transport study has been undertaken for the proposed development, which indicates that the existing rail capacity would be sufficient for the proposed transport of product coal to Port Kembla under the proposed development, and no increase in rail capacity between Tahmoor Mine and Port Kembla would be required. As such, existing rail infrastructure and the number of allowable train movements would remain unchanged (refer to **Section 11.14.4** for further details).

The proposed development would also transport and receive the following by road transport:

- Product coal to domestic end users where rail transport is unavailable;
- Imported coal to blend with Tahmoor Coal for special blends to meet specific customer requirements; and
- Reject material to potential domestic users where rail transport is unavailable and a market opportunity for beneficial use of rejects exists or is being investigated.

Transport of product coal, rejects from the Tahmoor Mine and importation of coal would be restricted to a maximum of 200,000 tonnes per annum and a maximum of 3,000 tonnes per day. Road transport would be generally on a campaign basis and during these transport campaign periods generate a maximum of eight truck movements per hour during the period between 6 am to 7 pm.

4.2.8 Mine Dewatering

To maintain a safe and efficient underground mine environment, water entering the underground workings needs to be managed. Mine water is proposed to be collected in underground sumps and pumped from the mine to the existing water management system at the Surface Facilities Area for treatment. Treated mine water would be either reused underground for non-potable uses or discharged at the surface via the existing LDP1 to Tea Tree Hollow.

The proposed development is predicted to generate average daily groundwater inflows ranging from around 4.7ML/d to a peak of around of 7.5-8 ML/d in 2029-30 and 2032. In annual terms, the inflows equate to an average of 1,700 ML of water per annum over the period of mining for the proposed development. The peak annual flows are predicted to be approximately 2,850ML in 2029 and 2,600 ML of water in 2032.

A site water balance assessment undertaken for the proposed development (HEC, 2018) indicated that simulated average releases of treated water to Tea Tree Hollow via LDP1 over the life of the proposed development remained compliant with the current EPL daily volumetric limits (refer **Section 11.3.5**). An application would be made to vary the EPL in the instance that discharge volumes at the mine increase beyond this estimate.

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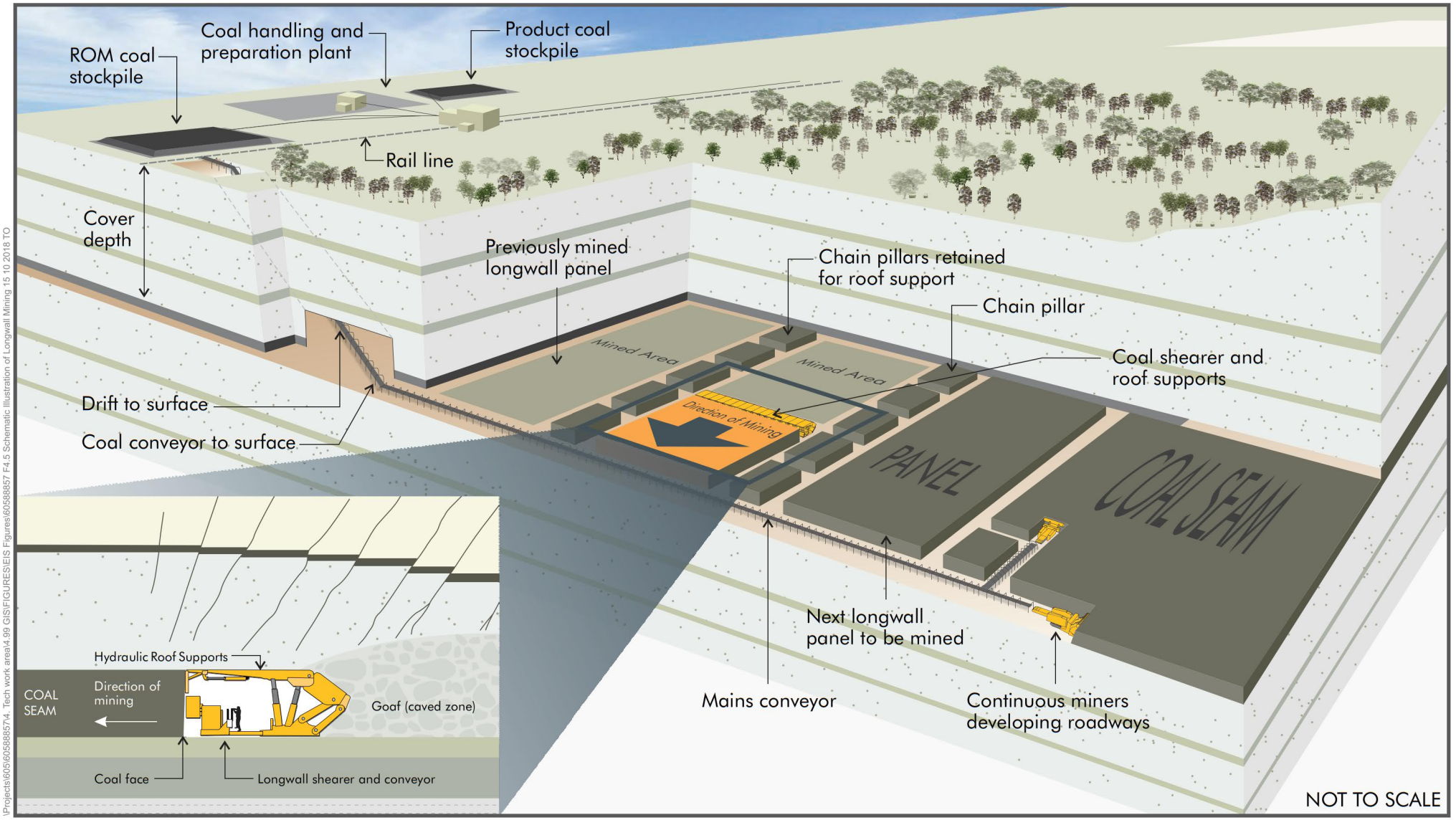

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SCHEMATIC ILLUSTRATION OF LONGWALL MINING

Tahmoor South Project
Environmental Impact Statement

FIGURE 4.5

4.3 Surface Facilities Area

The existing surface facilities and infrastructure at the Tahmoor Mine Surface Facilities Area, operating within surface CCL 716 and Mining Lease 1642, would be utilised for the proposed development.

Upgrades to some aspects of the Surface Facilities Area would be required and are associated with the increase in annual coal production for the proposed development. Upgrades to existing surface infrastructure would be undertaken within the footprint of the existing Tahmoor Mine surface lease (Mining Lease 1642) and additional surface lease areas required for the proposed development, as shown on **Figure 1.5**.

4.3.1 Coal Handling and Preparation Plant

The existing CHPP would be utilised for the proposed development. The existing CHPP would be upgraded as shown on **Figure 4.6**, including the installation of:

- a new coarse rejects screen;
- additional belt press filter capacity;
- an increase in thickener capacity; and
- other upgrades as required.

The existing ROM stockpile area would continue to be used. During peak production ROM coal may be trucked from the ROM stockpile to the coal product stockpiles and re-trucked back to the ROM stockpile when required. Reject material generated from the coal washing process at the CHPP would be transported to the expanded REA via the existing reject conveyor to the reject bin for disposal. It would then be transported by haul truck to the REA (refer to **Section 4.3.2**).

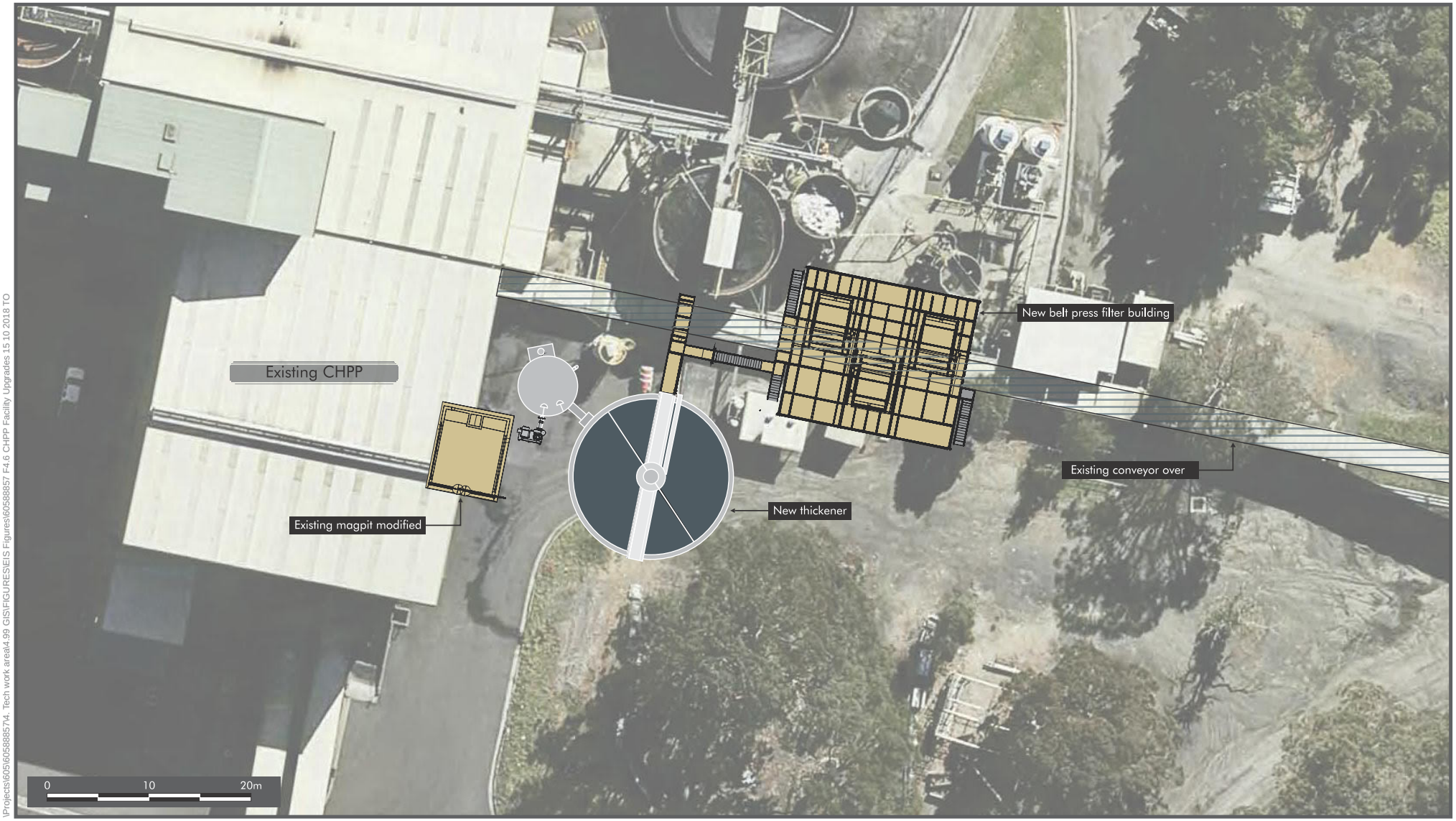
4.3.2 Rejects Management

The existing REA has an area of approximately 89 ha and an approved capacity of about 13 Mt, of which about 4 Mt of capacity remains, which is expected to be used for the completion of the Tahmoor North operations. The existing REA would be expanded onto adjacent areas to accommodate the reject material associated with the proposed development (**Figure 4.7**).

The expansion area would cover up to an additional 43 hectares, providing the additional emplacement capacity required for the life of the proposed development: approximately 12 million tonnes of rejects (refer to **Figure 4.8**). The maximum height of the REA would be increased from RL 300 m to RL 305 m in the southern section of the REA (refer to **Figure 4.9**).

The rejects disposal method has been selected based on a review of a range of disposal options taking into consideration a number of project objectives including:

- provide a safe solution, causing no hazards to mine operations and with low impact on mine stability;
- minimise the impact on the environment where possible, including dust emissions, visual impact, groundwater and sub-surface contamination, use of foreign reagents;
- provide an economic solution, with minimal capital and operating cost, returning a positive benefit to cost ratio, providing employment for the local community and minimising the impact on mine production;
- adopt a sound technical solution, utilising proven technology with high availability and reliability, versatility and flexibility; and
- provide a solution that would enable the disposal of the total volume of rejects forecast for the Tahmoor South project.



\Projects\605\605888857\4. Tech work area\4.99 GIS\FIGURES\EIS Figures\605888857 F4.6 CHPP Facility Upgrades 15 10 2018 TO

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CHPP FACILITY UPGRADES

Tahmoor South Project

Environmental Impact Statement

FIGURE 4.6

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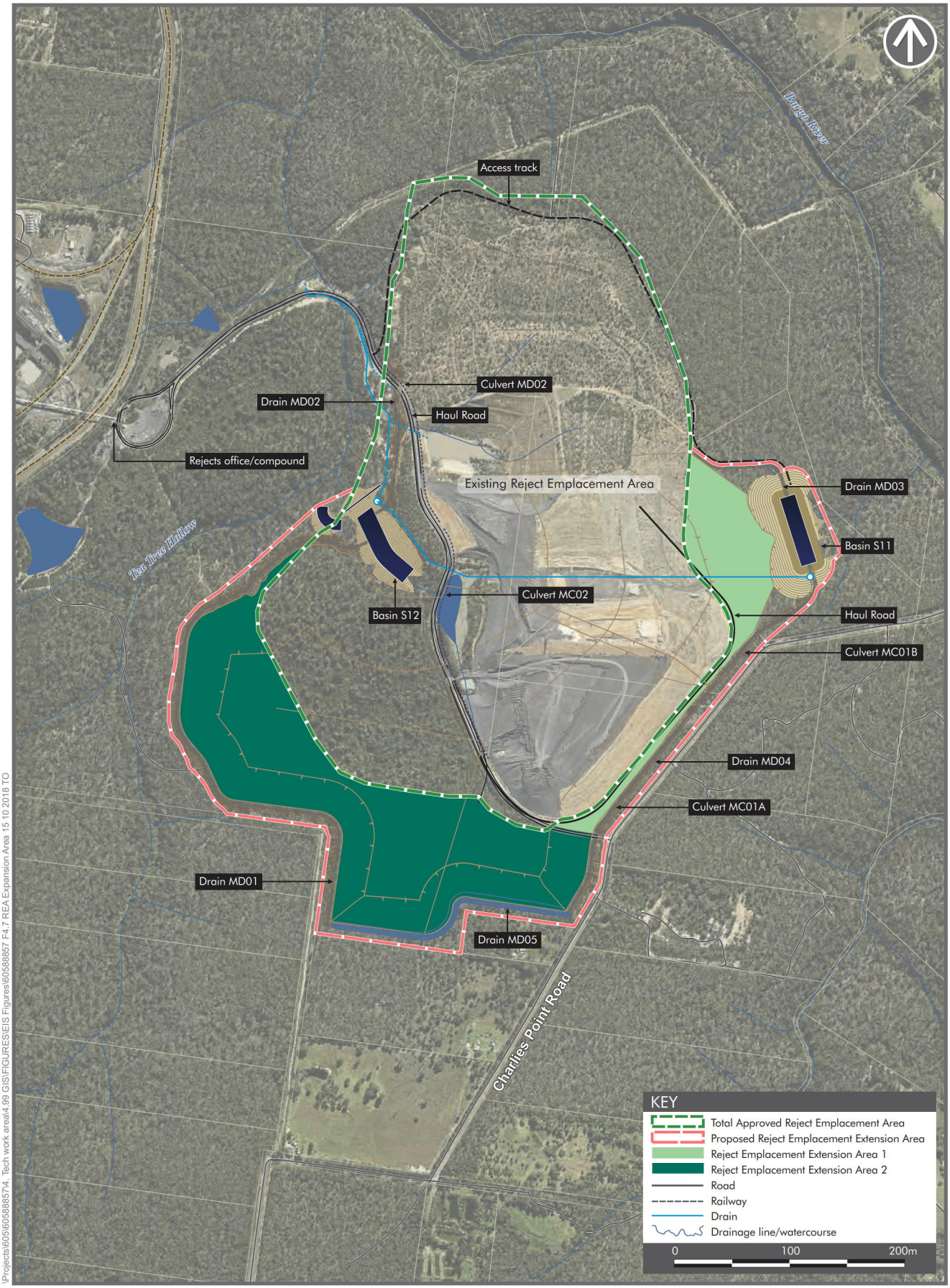

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REJECT EMPLACEMENT EXTENSION AREAS

Tahmoor South Project
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FIGURE 4.7

The proposed expansion of the existing REA takes into consideration a balance of environmental impacts including dust, noise and visual impacts to surrounding properties as well as the impacts to biodiversity.

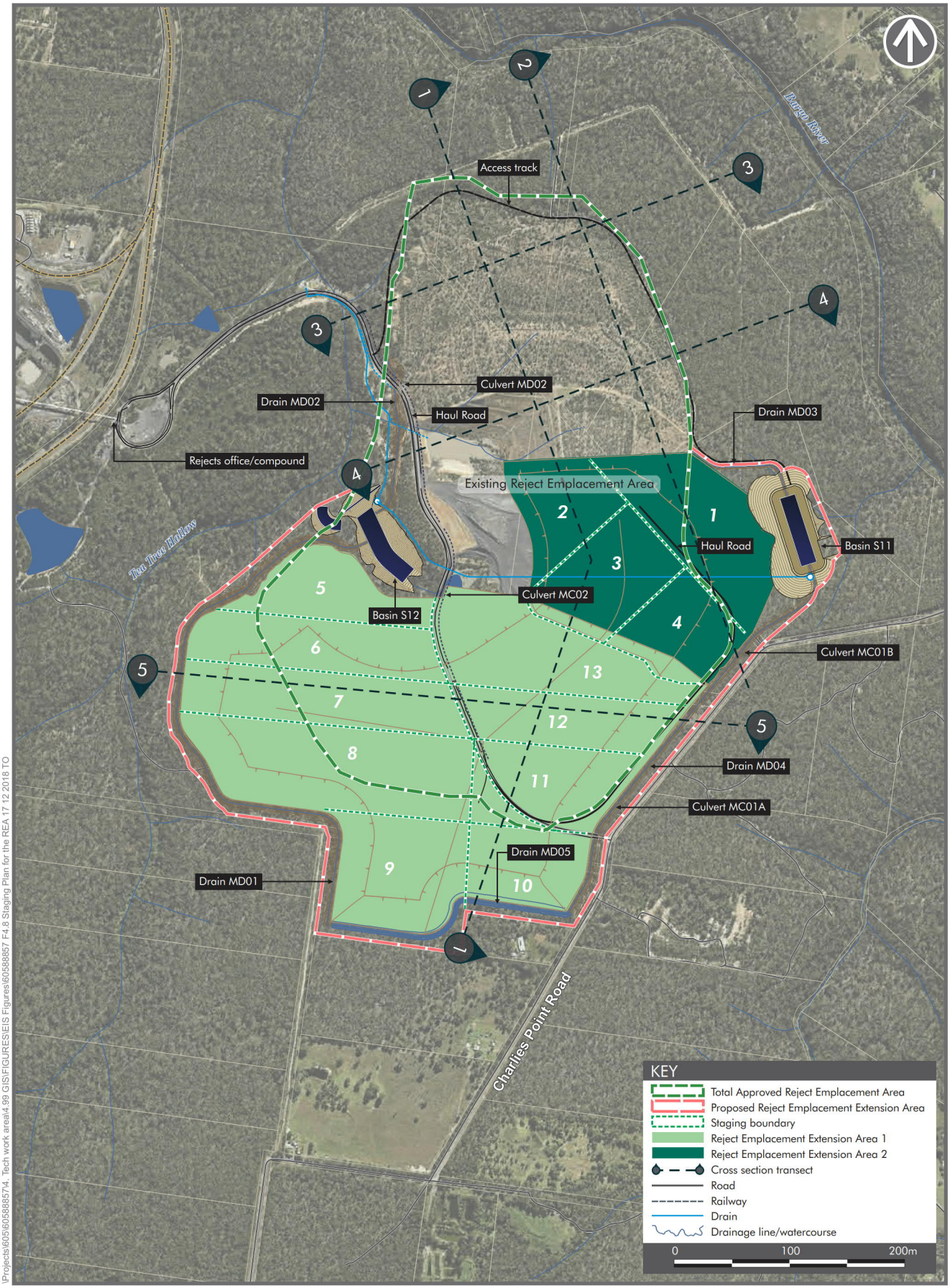
The southern section of the REA is proposed to be increased in height. Consideration was given to raising the northern section of the existing REA which has been rehabilitated however this increased the number of impacted properties from dust and noise impact, hence was not included in the proposed final design.

The preferred disposal strategy consists of two new areas adjoining the existing REA, using a staged fill plan approach. The REA would be progressively rehabilitated over the life of the mine.

Construction and maintenance of new internal haul roads around and within the REA would be required to cater for the REA expansion. The existing stormwater infrastructure would be expanded to include bunding, additional surface water drainage controls and sedimentation dams for the additional areas.

Alternative uses for rejects would be investigated during the life of the project and to facilitate beneficial uses of reject material.

Rejects management for the proposed development is discussed in further detail in **Section 11.20.**



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STAGING PLAN FOR THE REA
Tahmoor South Project
Environmental Impact Statement

FIGURE 4.8

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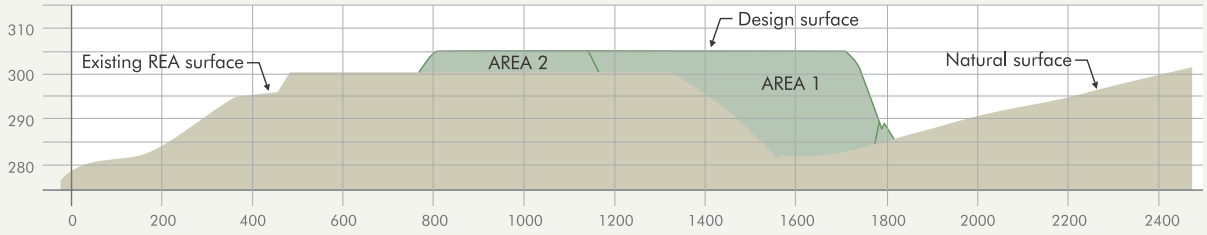
SECTION 1



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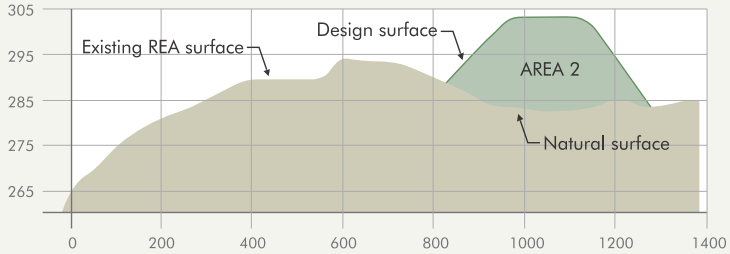

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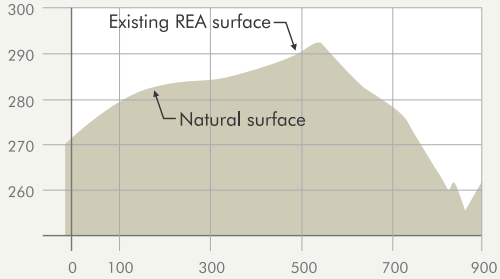

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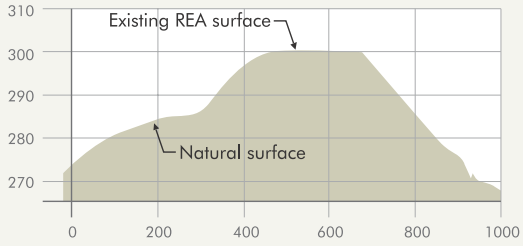
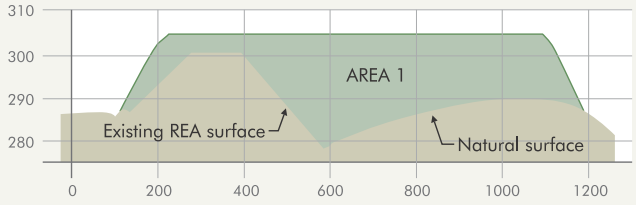


SECTION 5



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SITE SECTIONS FOR THE PROPOSED REA

Tahmoor South Project

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FIGURE 4.9

4.3.3 Plant and Equipment

The proposed development would use existing plant and equipment at the Surface Facilities Area. It would also require:

- additional mobile plant for coal material handling at the Surface Facilities Area, and
- ancillary equipment such as trucks, cranes and forklifts for use around the Surface Facilities Area to manage product and equipment stores.

Tahmoor Coal would investigate and utilise improved or alternate coal handling and preparation methods and technology throughout the life of the proposed development to allow for the efficient processing of coal and reject. Tahmoor Coal would ensure that environmental and social impacts resulting from the use of alternate methods are consistent with those predicted in this EIS.

4.3.4 Site Amenities and Layout

While the existing site amenities at the Tahmoor Mine Surface Facilities Area would be used for the proposed development, additional bathhouses would be required to accommodate the expanded workforce.

These would be constructed adjacent to the existing amenities and would consist of pre-fabricated modular buildings (**Figure 4.10**). The existing sewage treatment plant would be upgraded to accommodate the additional employees.

The proposed development would also require minor upgrades of the existing services such as onsite firefighting, water reticulation and power supply systems (**Figure 4.10**).

4.3.5 Infrastructure Services Upgrades

A range of infrastructure services including existing offsite electrical, telecommunications and water reticulation infrastructure currently servicing the Tahmoor Mine would continue to be used with some upgrades. In addition, the construction and commissioning of an extension to the existing 66kV overhead power line from the REA along Charlies Point Road to the proposed ventilation shaft sites would be required.

4.3.6 Site Access and Improvements

The existing vehicular access arrangements to Tahmoor Mine's Surface Facilities Area via Remembrance Driveway, approximately three kilometres south of Tahmoor and five kilometres north of Bargo would continue to provide access for mine personnel, contractors and materials.

There is currently a passing lane northbound and a deceleration turning lane southbound on Remembrance Driveway at the turnoff to Tahmoor Mine. These lanes allow vehicles entering Tahmoor Mine from the south to turn into the Mine without impeding other traffic on Remembrance Driveway.

The existing intersection at the entry to Tahmoor Mine from Remembrance Driveway would be upgraded as part of the proposed development to provide a dedicated right hand turning bay for vehicles entering the Surface Facilities Area from the south and extended acceleration and deceleration lanes for vehicles entering and exiting from the north and south.

The intersection upgrade would accommodate additional traffic movements during the concurrent undertaking of pre-mining activities for the proposed development and the finalisation of longwall mining in Tahmoor North. The intersection upgrade is described further in **Section 11.13**. The upgraded intersection would provide a Level of Service (LoS) of A/B, which is appropriate for the projected traffic along Remembrance Driveway for the life of the project.

Car Parking

The proposed development would involve the construction of a new car parking area with approximately 150 new spaces, to relieve the pressure on existing facilities and to provide additional capacity for the proposed development. The new car parking area would be located to the south of the existing entrance to Tahmoor Mine (**Figure 4.10**).

4.4 Rehabilitation and Mine Closure

A conceptual Mine Closure Plan has been developed for the proposed development, and is included in **Appendix V**. Rehabilitation of the proposed development would be undertaken using a staged approach comprising:

- progressive rehabilitation of the expanded REA; and
- mine closure and rehabilitation of the Surface Facilities Area and ventilation shafts.

Areas of the REA would be progressively rehabilitated over the life of the proposed development. This process would involve capping the reject material with topsoil and establishing vegetation. Annual monitoring would be undertaken to determine the success of revegetation and to inform ongoing management of the rehabilitated areas.

There are a number of post mining land use options that may be applicable to the proposed development including passive recreation, native bushland conservation or employment lands such as light industrial. Currently, it is considered that the likely final land use option for most of the surface areas would be native bushland. However, final land use options would be confirmed in a detailed closure planning process, which involves undertaking a final land use analysis. A detailed closure plan would be developed no later than five years from mine closure. In broad terms, rehabilitation of the Surface Facilities Area and ventilation shafts would involve:

- removal of infrastructure and services;
- levelling, re-contouring and grading to achieve safely battered slopes and surfaces;
- applying topsoil for rehabilitation where required;
- establishing native bushland vegetation which would require minimal ongoing care and maintenance; and
- monitoring of rehabilitated areas to assess the success and inform the management of areas of re-established vegetation.

Infrastructure and facilities may be retained where compatible with the end land uses which would be identified in the detailed closure planning process.

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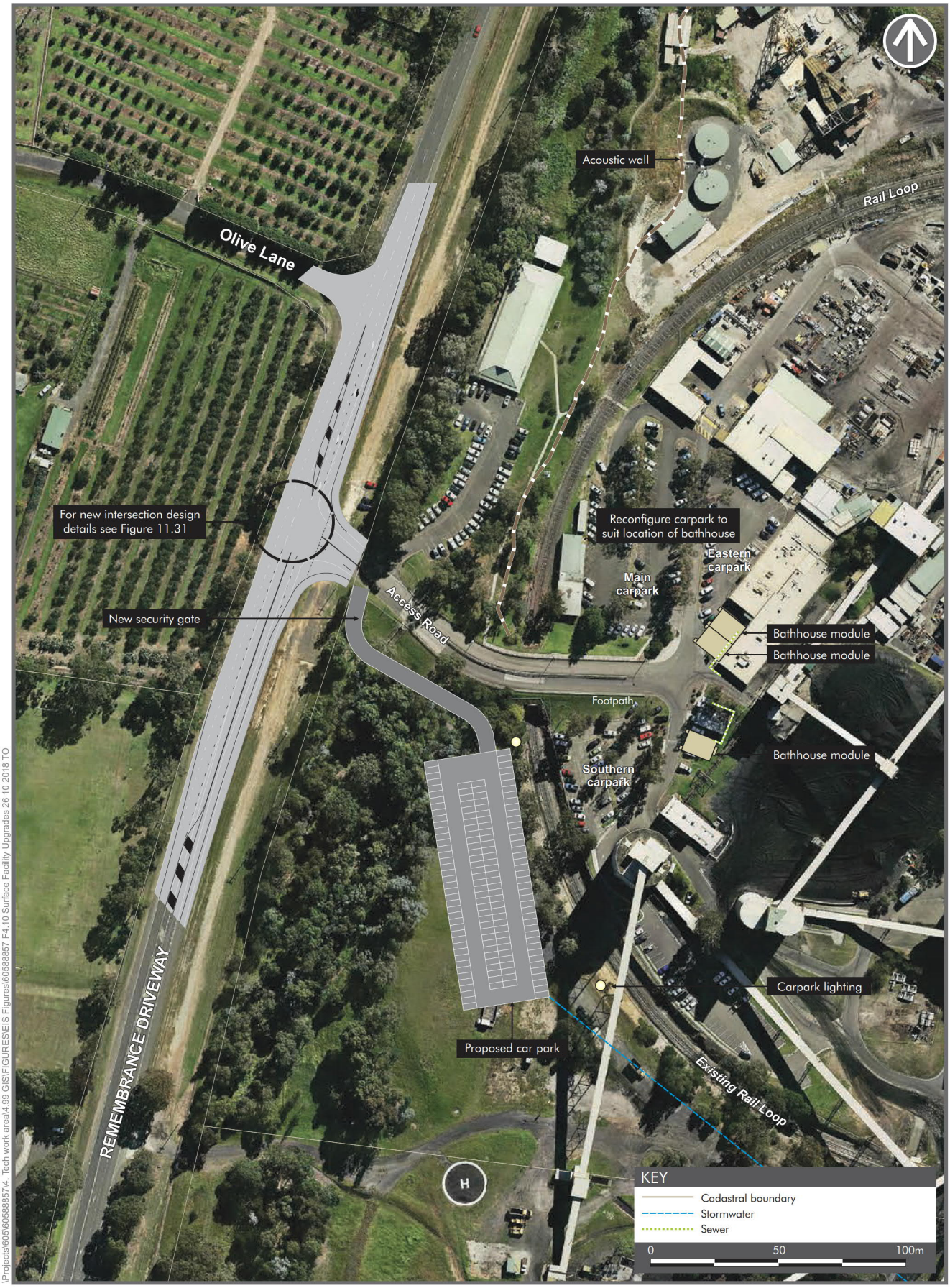

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SIMEC MINING

SURFACE FACILITY UPGRADES
Tahmoor South Project
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Source: Arkhill Engineers (11/06/2013)

FIGURE 4.10

4.5 Project Timeframes

4.5.1 Indicative Mining Schedule

The proposed development seeks to extend the life of underground mining at Tahmoor Mine beyond the predicted completion of mining at Tahmoor North in 2022, with this timing depending upon geological, mining and economic conditions.

A number of pre-mining activities are required to be completed prior to commencement of longwall mining for the Tahmoor South Project. These pre-mining activities include:

- gas drainage;
- redevelopment of the pit bottom;
- longwall development including establishment of gate roads;
- installation of electrical, water and gas management networks; and
- the purchase and installation of equipment.

The proposed development's pre-mining activities are anticipated to take approximately three to four years to complete before longwall mining can commence in the Central Domain. Longwall mining is proposed to commence in the Central Domain once mining is completed at Tahmoor North. Mining at Tahmoor North is anticipated to be completed by 2022 depending upon geological, mining and economic conditions.

Mining for the proposed development would be complete by approximately 2035, with surface works, rehabilitation and mine closure occurring after the completion of mining activities. **Table 4.1** provides an outline of the indicative schedule for mining.

Table 4.1 Indicative mining schedule (dependent on geological, mining and economic conditions)

Activity	Year
Pre mining activities	Start in 2019
Central Domain development	Approximately 2019
Mining of Tahmoor North complete	Approximately 2022
Central Domain longwall mining	Approximately 2022 – 2035

4.6 Workforce and Hours of Operation

4.6.1 Workforce

The proposed development would involve ongoing employment of the existing workforce at Tahmoor Mine, which totals approximately 390 ongoing permanent and contract staff. In addition, there would be a period of concurrent operations for a period of approximately three to four years, involving pre-mining activities for the proposed development and longwall mining in Tahmoor North, during which time approximately 50 to 175 additional people would be required to augment the current workforce.

4.6.2 Hours of Operation

The proposed development, including construction activities, would operate 24 hours a day, seven days per week, consistent with the working hours of the current operations at the Tahmoor Mine.

Construction of the ventilation shafts, upgrades and augmentation of the existing infrastructure, services and amenities at the Surface Facilities Area, and upgrades to the intersection at the entrance to the Surface Facilities Area would be generally undertaken between Monday and Sunday from 7 am to 6 pm. During ventilation shaft construction, the shaft drilling rig and shaft lining would operate continuously 24 hours a day, seven days a week.

4.7 Environmental Management

Environmental management at Tahmoor Mine is currently governed by the *Environmental Management System Strategy and Framework* (refer to **Section 3.7**). The proposed development would be managed within this Framework and in line with existing procedures. Where required, the existing procedures and management plans would be updated to reflect the specific details of the proposed development.

In addition, a MOP or RMP would be prepared to meet the requirements of the Mining Act and *Mining Regulation 2016*. The DRG would be consulted to ensure that the MOP or RMP is prepared in accordance with the current guidelines at the time.

4.7.1 Subsidence Monitoring and Management

Tahmoor Mine currently manages and monitors subsidence as part of the existing operations at Tahmoor North. The systems and programmes currently in place to monitor and manage subsidence (refer **Section 3.2.9**) would continue during the proposed development and would be augmented to monitor the effects of mining within the Central Domain (refer to **Section 11.1**).

Specifically, subsidence would be managed through implementation of an EP in consultation with stakeholders. The management plans would describe measures to be undertaken to monitor surface subsidence and physical changes that are predicted to occur during mining. Measures detailed in the management plans would include:

- the requirements for inspection regimes for natural and built surface features;
- the layout of monitoring points and parameters to be measured;
- monitoring methods and accuracy;
- the timing and frequency of surveys and inspections; and
- processes for recording and reporting of monitoring results.

The management and monitoring plans would be prepared and lodged with the DRG prior to the commencement of mining.

4.7.2 Water Management

Surface water runoff from operational areas and stockpiles would continue to be captured by the existing stormwater treatment dams at the Surface Facilities Area. Following treatment, the water would continue to be discharged to Tea Tree Hollow at LDP1.

Potable water supply for use at the Surface Facilities Area and underground would be drawn from the town water main, and non-potable supply sourced from the recycled water treatment plant at the Surface Facilities Area. Mine water would be treated and recycled for non-potable underground use, or pass through the stormwater treatment dams and be discharged via the LDP and LOPs.

Licensed Discharge Point

The proposed development would collect water underground in sumps and pump this water via underground pipes to the surface. As per the existing operations, the proposed development would continue to discharge a portion of the stormwater and treated mine water via licensed discharge point LDP1 under EPL 1389 (see **Section 3.3.6**).

Site Water Balance

The major components of the mine water balance for the proposed development would be:

- inflows from surface runoff, direct rainfall onto dam surfaces, potable water draw and groundwater inflows to the underground operations; and
- outflows including discharges to the Bargo River catchment via the LDP and LOPs to Tea Tree Hollow; evaporation from dam surfaces; and water loss to product coal and coarse rejects.

The site water balance is discussed in detail in **Section 11.4**.

Site Water Management Plan

Water management during operation of the proposed development would be governed by the water management plan currently in place at Tahmoor Mine. The water management plan would be updated to encompass the operations associated with the proposed development and would be implemented in line with the following objectives:

- utilise available surface water runoff for use as process water;
- minimise instances of licensed discharge;
- minimise the magnitude of licensed discharge; and
- the quality and quantity of water discharged to be in accordance with licensed water quality criteria.

5.0 Mine Design Considerations

Pre-feasibility and feasibility investigations were undertaken for the proposed development to inform the extent of mining and the longwall layout. These studies considered the way in which the geology and surface environment of the Project Area may constrain the extent of longwall mining that could feasibly be undertaken as part of the proposed development.

In addition, significant surface environmental features, likely to be sensitive to subsidence impacts, were identified and mapped. A risk management approach was adopted to consider the potential impacts of the proposed development on these significant and sensitive environmental features using early subsidence predictions. The risk management approach was then used to identify preliminary RMZs for the proposed development. These preliminary RMZs informed the development of the mine plan including the extent of mining and the proposed layout of the longwalls.

This section details the geology, hydrogeology and surface environmental features as they relate to the development of the mine plan within the Project Area.

5.1 Geology

Tahmoor Mine is situated within the Southern Coalfield of NSW which is part of the greater Sydney-Bowen Geological Basin. This major basin extends from Central Queensland to Wollongong in southern NSW. The Basin is bound by the Lachlan Fold Belt to the west and New England Fold Belt to the east.

5.1.1 Stratigraphy

Geology of the Sydney Basin is characterised by numerous coal sequences. Permian Illawarra Coal Measures are the main coal bearing sequence in the Southern Coalfield, which are overlain by Triassic strata of the Narrabeen and Wianamatta Groups (**Figure 5.1** and **Figure 5.2**). The Illawarra Coal Measures range in thickness from 80 m to 130 m and contain the economically important Bulli and Wongawilli coal seams.

The overlying Triassic strata are up to 400 m thick and contain sandstone (Hawkesbury Sandstone) and shale (Wianamatta Group). These are the only rock units to outcrop within the Project Area. The basement rock in the region is defined by Palaeozoic igneous to metamorphic rocks of the Lachlan Fold Belt.

The Permian Illawarra Coal Measures are an interbedded geological sequence that is up to 100 m thick and includes layers of siltstone, sandstone, claystone and contain seven identified coal horizons, namely the:

- Bulli seam;
- Balgownie seam;
- Cape Horn seam;
- Wongawilli seam;
- American Creek seam;
- Tongarra seam; and
- Woonona seam.

Of the above listed coal seams, only Bulli, Wongawilli and Tongarra seams are thick enough to be considered as potential mining targets within Tahmoor Coal's leases.

Bulli Seam

The Bulli seam is a hard coking coal with a seam thickness that ranges from 1.6 m – 3.4 m within the Project Area. However, towards the southwest of the Project Area, the Bulli seam thins to less than 1 m thick. For most of the Project Area, a stone parting with average thickness of 0.1 m splits the bottom of the Bulli seam.

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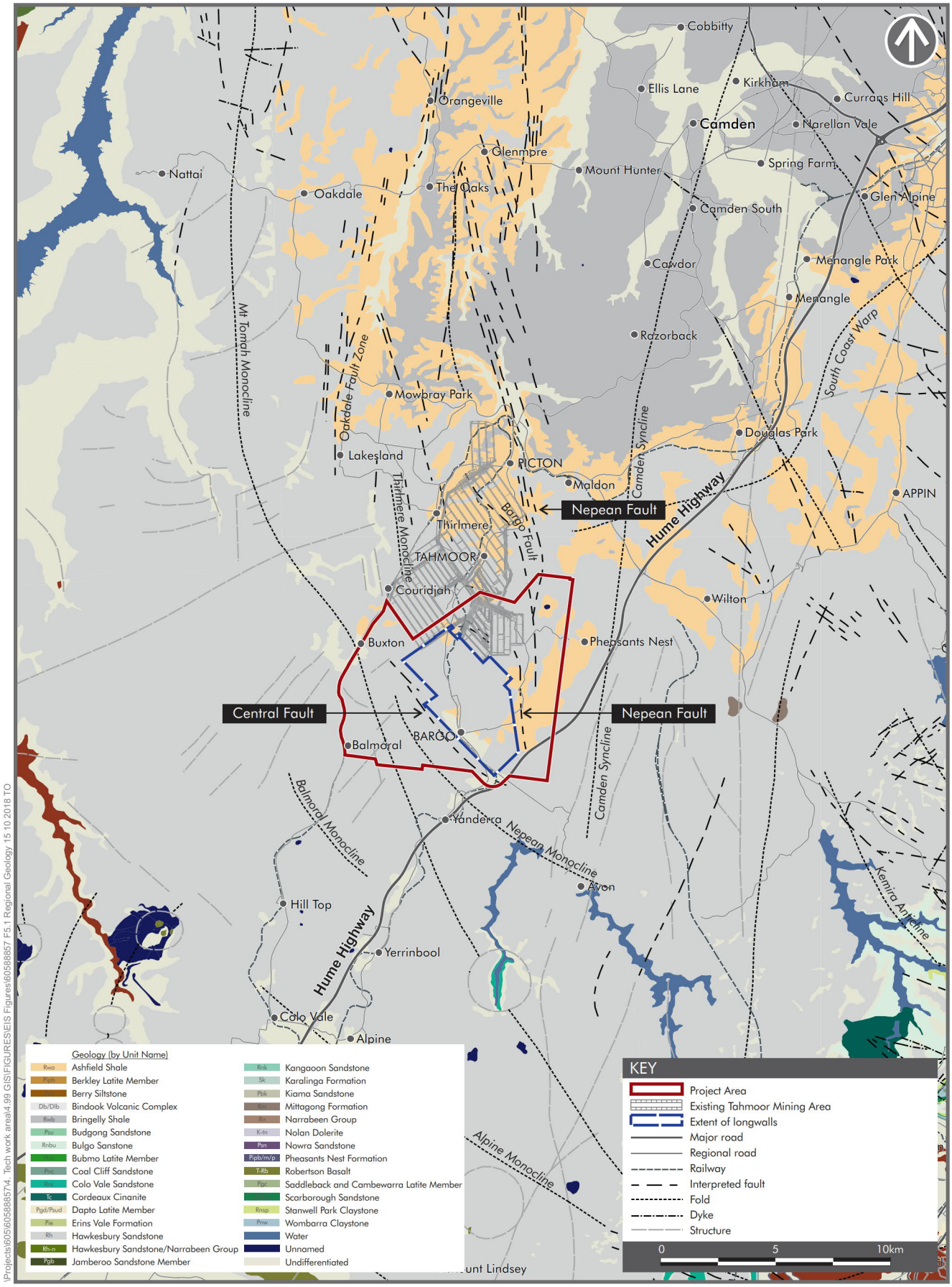

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SIMEC MINING

REGIONAL GEOLOGY

Tahmoor South Project
Environmental Impact Statement

FIGURE 5.1

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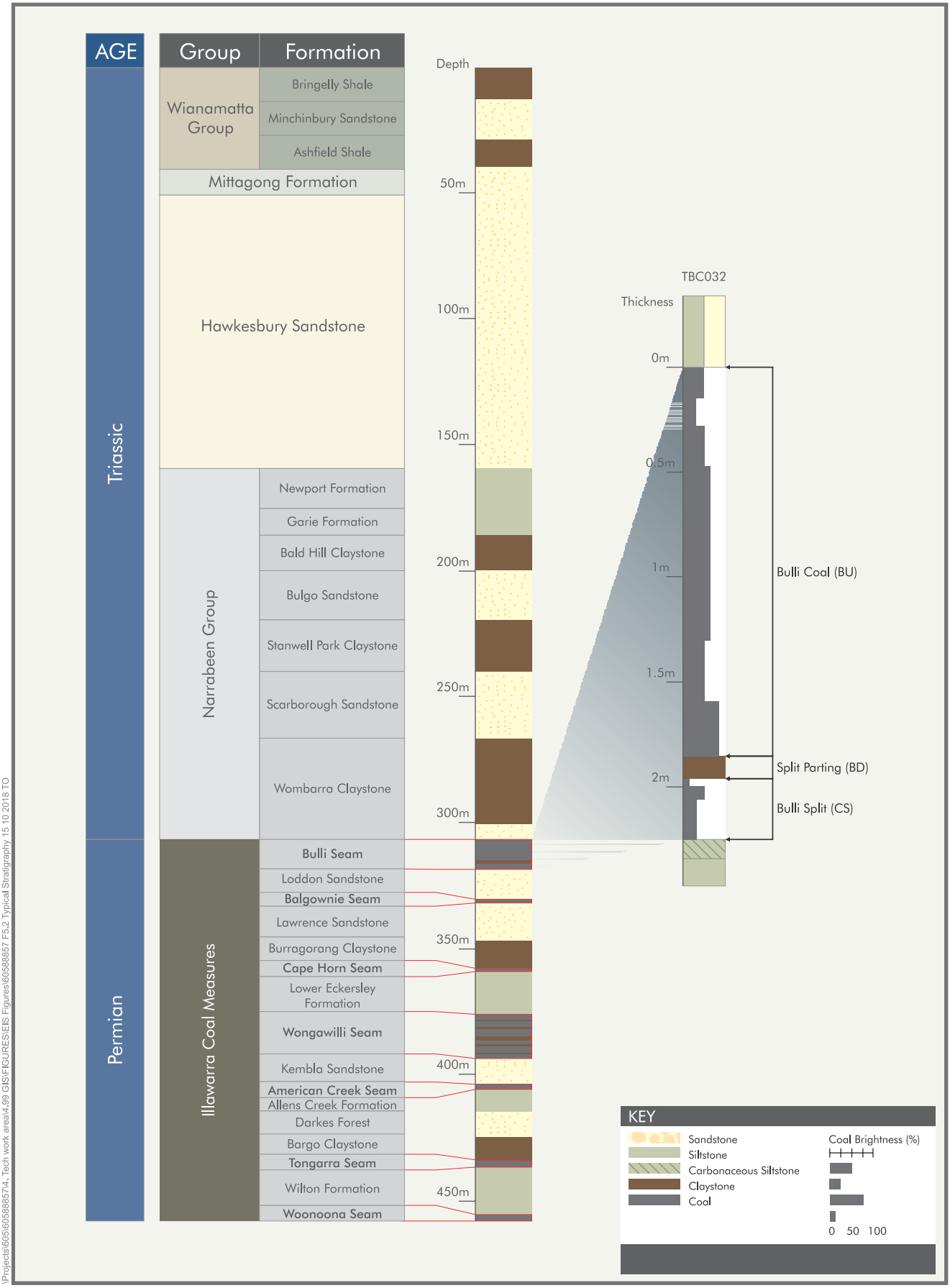

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SIMEC MINING

TYPICAL STRATIGRAPHY OF THE REGION

Tahmoor South Project
Environmental Impact Statement

Source: McElroy Bryan Geological Services (July 2013)

FIGURE 5.2

The Bulli seam can be described in three sections:

- Bulli Coal - The top and most consistent section across the deposit comprising bright/dull coal with an average thickness of 2.2 m;
- Bulli Parting - A stone parting located towards the base of the seam with average thickness of 0.1 m (reaches 0.7 m thick in isolated parts of the deposit) and comprises carbonaceous claystone tending to tuff; and
- Bulli Split - A basal coaly band with average thickness of 0.2 m and comprising dull to stony coal.

Balgownie Seam

The Balgownie Seam is located approximately 10 m below the Bulli seam and comprises dull and bright banded coal with average thickness of 0.3 m. Strata between Bulli and Balgownie seams comprises Loddon Sandstone which is characterised by fine-medium sandstone with sporadic carbonaceous siltstone. Directly below the Balgownie Seam is fine sandstone grading to siltstone and is known as the Lawrence Sandstone.

Balgownie Seam deteriorates towards the south to carbonaceous claystone and completely disappears in the southern half of the Project Area.

Cape Horn Seam

The Cape Horn Seam sits approximately 5 m below the Balgownie Seam and is a coal horizon varying from 0.1 m - 0.7 m thick. This coal band deteriorates to carbonaceous shale in some areas of the deposit. Below this coal seam is the Lower Eckersley Formation, ranging from 2 m – 7 m thick and comprising an interbedded sequence of siltstone/claystone overlying the Wongawilli Seam.

Wongawilli Seam

The Wongawilli Seam is mined elsewhere within the Southern Coalfields and may be targeted in the future for longwall mining within the Project Area but does not comprise part of the current proposed development. This seam sits 8 m – 22 m below the Bulli seam and has an approximate thickness of 10 m. The seam comprises two sections (upper and lower) separated by the Farnborough Tuff. The Farnborough Tuff is a tuffaceous claystone varying in thickness from 0.5 m - 1.5 m thick, and is a distinctive regional marker horizon. The buff to grey coloured claystone has abrupt upper and lower contacts.

American Creek Seam

The American Creek Seam occurs approximately 7 m below the Wongawilli Seam and is approximately 1 m thick. This seam is usually found as two plies comprising dull coal tending to carbonaceous claystone with a siltstone parting between the plies.

Tongarra Seam

The Tongarra Seam sits approximately 30 m below the American Creek Seam and 60 m below the Bulli seam. This seam consists of dull coal with thin claystone bands and ranges from 1 m – 2 m thick.

Woonona Seam

The Woonona Seam is the deepest seam intersected within the Project Area at depths ranging from 360 m – 530 m. This seam is approximately 20 m below the Tongarra Seam with approximate thickness of 2 m.

5.1.2 Geotechnical Constraints

Geotechnical constraints to longwall mining include the presence of geological fault zones and igneous intrusions.

The southern portion of the Sydney Basin contains numerous regional scale geological structures. These structures form a linear north-northeast trending structurally complex zone comprising the Lapstone Monocline and Fault System and Nepean Fault further south. The Nepean Fault Zone marks the eastern boundary to mining at Tahmoor North. For the proposed development the Central Domain is bounded to the east by the Nepean Fault Zone and to the west by the Central Fault. The sub-parallel trending Oakdale Fault, Glenbrook Fault, Bargo Fault and Thirlmere Monocline are also present within the regional structural zone.

The Project Area is situated on the western limb of the north plunging Camden Syncline. This area sits within the Macdonald Trough which is bound to the west by the Blue Mountains and to the east by the Illawarra Escarpment. The northwest trending Mount Tomah Monocline is associated with a regional hinge line which defines the boundary between these two structural domains.

Geological Faults

Two major fault zones exist within the Project Area (refer to **Figure 5.1**): the Nepean Fault and the Central Fault zones. The presence of these fault zones within the Project Area has constrained the extent of longwalls and defined the mining domain for the proposed development. The Central Domain is bounded to the east by the Nepean Fault Zone and to the west by the Central Fault.

The Nepean Fault Zone is the most significant geological structural feature in the Project Area and is approximately 350 m wide and trends north south. It is a normal fault system which appears to exhibit an echelon style. Seismic surveys indicate the Nepean Fault Zone comprises many near vertical faults with an overall displacement in the order of up to 60 m.

The Central Fault is a normal fault trending northwest with a vertical displacement up to 20 m, east side up. The Central Fault has surface expression which affects the dissected valley of Hornes Creek as it flows towards the Bargo River gorge. This fault was identified in the 2D seismic surveys undertaken for the proposed development and was also intercepted in one drill hole where the Wongawilli Seam has been displaced.

Igneous Activity

As with other parts of the Sydney Basin, the Southern Coalfield has been affected by post Permian igneous activity. Igneous intrusions of Tertiary age are prevalent in the eastern and central parts of the Southern Coalfield. When intersected at the coal seam level these intrusion have an adverse effect on coal quality. Igneous activity at depth can also cause the doming of strata in the southern-central portion of the Southern Coalfield which in turn impacts on the feasibility of coal extraction.

Surface basalt flows are predominately confined to the southern portion of the Southern Coalfield and are not present within the Project Area. The Coombes Sugarloaf diatreme is the only known igneous feature which outcrops within the Project Area. The Coombes Sugarloaf diatreme is located in the north-east corner of the Project Area and has an approximate diameter at surface of 280 m.

Dykes and sills have been encountered in underground mining operations at Tahmoor North and may also be encountered during operation of the proposed development. At this point in time, the only igneous body identified within the Project Area, at the level of the Bulli seam, is a sill approximately 30 cm thick and located in the southeast corner of the Project Area.

The small scale igneous bodies at Tahmoor North have not caused significant operational issues, and it is not expected that similar features encountered during mining at Tahmoor South would disrupt operations.

5.2 Hydrogeology

Groundwater inflow (water make) enters underground mines from the target coal seam as well as the surrounding strata. The volume of groundwater inflow varies depending on natural inputs to the system, aquifer properties and dimensions of the mine workings. Water make is managed through a system of underground pumps and holding dams prior to extraction of some water make to the surface water management system, including processing at the recycled water management plant, with excess water discharged to Tea Tree Hollow via LDP 1.

Groundwater monitoring has been undertaken within the Project Area in order to provide input into a regional hydrogeological model. The groundwater monitoring has included packer testing of the Bulli and Wongawilli Seams to determine seam permeability.

Vibrating wire piezometers have been installed in numerous holes at specific stratigraphic horizons to gain groundwater hydraulic pressure data. In 13 bore holes, up to 10 piezometers were installed within the stratigraphic package from Hawkesbury Sandstone down to the Wongawilli Seam. In 17 bore holes, one piezometer was placed at each of the Bulli and Wongawilli Seams.

Conceptual and numerical hydrogeological models were established for the proposed development to assess the adequacy of the current management of water make (refer **Section 11.3**). The hydrogeology of the Project Area is discussed in detail in **Section 11.3**.

5.3 Environmental Planning Constraints and Considerations

The mine design for the proposed development took into account the geological constraints, the sensitivity and significance of the surface features as well as RMZs for those surface features. The approach taken to mine design is detailed below.

The principles of mine design for the proposed development involved a risk management approach in the context of recent publications regarding impacts of longwall mining in the Southern Coalfields. These include:

- the *2008 Southern Coalfield Inquiry (Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield – Strategic Review)*;
- the Thirlmere Lakes Inquiry Chief Scientist and Engineer reports; and
- the NSW Planning and Assessment Commission (PAC) reports for Metropolitan Coal Project and the Bulli Seam Operations Project.

5.3.1 Southern Coalfield Inquiry

An independent inquiry into underground coal mining in the Southern Coalfields was established by the NSW Government on 6 December 2006 (the Southern Coalfields Inquiry). The Southern Coalfields Inquiry was established in response to concerns held by the then State Government over past and potential future impacts of mining-induced ground movements on significant natural features in the Southern Coalfields. This action followed community concerns regarding mine-related subsidence impacts to the Cataract River that occurred as a result of mining at Appin West Colliery.

The purpose of the Southern Coalfields Inquiry was to:

1. *Undertake a strategic review of the impacts of underground mining in the Southern Coalfields on significant natural features (i.e. rivers and significant streams, swamps and cliff lines), with particular emphasis on risks to water flows, water quality and aquatic ecosystems;*
2. *Provide advice on best practice in regard to:*
    a. *Assessment of subsidence impacts;*
    b. *Avoiding and/or minimising adverse impacts on significant natural features;*
    c. *Management, monitoring and remediation of subsidence and subsidence-related impacts;*
3. *Report on the social and economic significance to the region and the State of the coal resources in the Southern Coalfields.*

The Southern Coalfields Inquiry, in considering the natural features of the Southern Coalfields and the impacts of subsidence, concluded:

- the site conditions within the Southern Coalfields including a dissected landscape of incised rivers and gorge country as well as geological features including faults and dykes, give rise to non-conventional subsidence impacts such as valley closure, upsidence and regional far-field horizontal displacement; and

- it is the valley closure and upsidence effects from underground mining that create the majority of impacts on significant natural features such as the cracking of stream beds, rock falls from cliff lines and alteration of groundwater chemistry in shallow aquifers.

The Southern Coalfields Inquiry made recommendations regarding best practice in relation to the assessment of subsidence impacts, ways to minimise adverse impacts on significant natural features, and the management, monitoring and remediation of subsidence and subsidence related impacts.

This environmental assessment for the proposed development has considered the recommendations of the Southern Coalfield Inquiry report as summarised in **Table 5.1**, and further discussion of the relevant environmental impacts and proposed management measures is included in **Section 11.0**.

Table 5.1 Consistency of the proposed development with recommendations of the Southern Coalfields Inquiry

Recommendations for environmental assessments	Comment	Section of EIS
A minimum of two years of baseline data, collected at an appropriate frequency and scale, should be provided for significant natural features, whether located within an RMZ or not.	At least two years of baseline data has been collected for surface water (hydrology and water quality), groundwater (level and geochemistry) and ecology (terrestrial and aquatic).	**Sections 11.3**, **11.4**, **11.6**, and **11.7** **Appendix I, J**, and **K**
Identification and assessment of significance for all natural features located within 600 m of the edge of secondary extraction.	Natural features within 600 m of the edge of secondary extraction have been identified and assessed in terms of significance.	**Sections 11.1**, **11.2**, **11.3, 11.4**, **11.5**, **11.6**, **11.7**, **Appendix F, H, J, K**
Better distinction between subsidence effects, subsidence impacts and environmental consequences.	A Subsidence Impact Assessment (MSEC, 2018) was undertaken for the proposed development. The environmental consequences of subsidence impacts have been assessed by the Geomorphology, Groundwater, Surface Water and Ecology assessments.	**Sections 11.1**, **11.2**, **11.3**, **11.4**, **11.5**, **11.6** and **11.7**, **Appendix F, H, I, J, K**
Increased transparency, quantification and focus in describing anticipated subsidence impacts and consequences.	A Subsidence Impact Assessment (MSEC, 2018) was undertaken for the proposed development and included a detailed methodology and assessment of subsidence impacts.	**Section 11.1** and **Appendix F**
Establish the presence of, and understand major geological features such as faults and dykes which may lead to non-conventional subsidence.	Tahmoor Coal has undertaken an extensive exploration program to identify geological features. The Subsidence Impact Assessment (MSEC, 2018) considered the presence of geological features which may lead to non-conventional subsidence and included discussion of impacts in the context of elevated levels of subsidence observed in the vicinity of the Nepean Fault at Tahmoor North.	**Section 11.1** and **Appendix F**

Recommendations for environmental assessments	Comment	Section of EIS
Increased communication between subsidence engineers and specialists in ecology, hydrology, geomorphology, etc.	The subsidence engineers and specialists in ecology, hydrology, geomorphology, and archaeological heritage collaborated during the preparation of this EIS in order to identify the significance of natural features and to quantify the risk of impacts to natural features within the Project Area. This collaboration took the form of a series of risk workshops for the proposed development and a three day field visit to walk the length of key waterways as a group.	**Section 5.3.6**
Key aspects of the subsidence assessment (particularly in respect of predicted impacts on significant natural features and their consequences) should be subject to independent scientific peer review and/or use of expert opinion in the assessment process.	The Subsidence Impact Assessment (MSEC, 2018) was subjected to an independent peer review by Ken Mills, Principal Geotechnical Engineer at SCT Operations Pty Ltd.	**Section 11.1** and **Appendix F**
Increased use of net benefit reviews by both mining proponents and regulatory agencies in assessing applications.	The net benefit of the proposed development has been considered in the context of environmental, social and economic impacts.	**Section 13.1**
Validation of subsidence prediction technology through monitoring of results against earlier predictions to improve the accuracy and confidence of subsidence predictions.	The Subsidence Impact Assessment (MSEC, 2018) included a summary of subsidence observations from the existing operations at Tahmoor North. These observations were used to inform the impact assessment for the proposed development, particularly relating to the potential for unconventional subsidence to occur.	**Section 11.1** and **Appendix F**
Mining companies should not rely on mitigation measures, for stream bed cracking, as a forward management strategy for highly-significant features. Where mitigation measures are proposed as a contingency, detailed information and evidence concerning the effectiveness of proposed remediation measures is required.	Where highly significant features have been identified (such as the Bargo River gorge, the Nepean River, Eliza Creek and Aboriginal heritage sites along Dog Trap Creek) the first management strategy employed for the proposed development has been to avoid the impacts through re-design of the mine plan and shortening of longwalls. Secondary management strategies for these and other natural features include mitigation measures.	**Section 5.3.7**

A review and update of the findings of the *2008 Southern Coalfield Inquiry (Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield – Strategic Review)* is currently underway for mining operations at the Dendrobium, Metropolitan, Russell Vale and Wongawilli mines, including recommending measures to improve the way mining effects, impacts and consequences in relation to water quantity are assessed and managed.

5.3.2 Thirlmere Lakes Inquiry

The Thirlmere Lakes are located in Thirlmere Lakes National Park, which forms part of the Greater Blue Mountains World Heritage Area. The lakes are made up of a group of waterways including Lake Gandangarra, Lake Werri Berri, Lake Couridjah, Lake Baraba and Lake Nerrigorang.

In response to community concerns, in 2011 the NSW Government commissioned an inquiry into the possible causes of water level decline in the lakes. An Independent Committee was established as part of the inquiry, comprising four independent scientists and a community representative. Mining activities at Tahmoor Mine were evaluated as one of the possible causes of the water level decline.

The Inquiry found that variations in climate such as droughts and floods were the primary influence on water level changes in Thirlmere Lakes, however identified that other factors may be involved in the present low levels. The Inquiry found evidence of groundwater leakages from the Lakes towards the east and north-east within the Hawkesbury Sandstone Aquifers and towards the west and down Blue Gum Creek. The enquiry did not find any direct evidence of longwall mining impacting on lake water levels or breaching geologic containment structures underneath the lakes, including the Bald Hill Claystone bed.

The Inquiry concluded that there was still much unknown about the geomorphology and hydrology of the lakes and without more research, the exact causes of the decreasing water levels of the lakes could not be determined, highlighting the needed for more research into the hydro-geological functioning of the Lakes system.

The Independent Committee provided:

- five specific recommendations for more research, including further studies and monitoring;
- three recommendations relating to consideration of a 'groundwater mound' to minimise groundwater loss; and
- a recommendation to nominate Thirlmere Lakes National Park as a listing under the Ramsar Convention on Wetlands.

This environmental assessment for the proposed development has considered the recommendations of the Inquiry, including undertaking detailed numerical groundwater and surface water modelling of the project, which incorporated the behaviour of Thirlmere Lakes. Further discussion of the relevant environmental impacts and management measures is included in **Section 11.5**.

NSW Chief Scientist and Engineer Review of the Final Report of the Thirlmere Lakes Inquiry Independent Committee

The NSW Government's Chief Scientist and Engineer undertook a review of the Final Report of the Independent Committee – Thirlmere Lakes Inquiry on behalf of the then Minister for the Environment, the Hon. Robyn Parker MP. The review was completed in February 2013 and was undertaken to assess the validity of the findings of the Thirlmere Lakes Inquiry report, and the link between the findings presented in the report and the recommendations put forward by the Independent Committee. The Chief Scientist and Engineer summarised and commented on the findings of the Thirlmere Lakes Inquiry report, strongly supporting the Inquiry's call for further research and monitoring, rather than providing additional findings regarding the impacts of mining on Thirlmere Lakes.

Thirlmere Lakes Research Program

Following on from the findings of the Thirlmere Lakes Inquiry, the NSW Government committed $200,000 to establish a monitoring program of surface water levels and rainfall at Thirlmere Lakes. In addition, an inter-agency committee of scientists from the Office of Environment and Heritage (OEH), DI Water (formerly Department of Primary Industries - NSW Office of Water), WaterNSW (formerly Sydney Catchment Authority) and the Office of the Chief Scientist and Engineer was established to develop a research program into the causes of changes in water levels in the lakes, based on scientific data and recommendations in the Inquiry Report.

In November 2016, the Inter-Agency Working Group published *The Mysterious Hydrology of Thirlmere Lakes*, summarising the existing scientific understanding of the lakes system and identifying knowledge gaps to help inform a comprehensive research strategy into the Thirlmere Lakes. The report considered knowledge gaps and catalogued areas for further research in the areas of geology, geomorphology and water balance.

In October 2017, the OEH announced a $1.9 million research program over four years to help address the knowledge gaps identified in the Inter-Agency Working Group publication of 2016 and the 2011 Thirlmere Lakes Inquiry.

The new Thirlmere Lakes Research Program will collaborate with research partners at the University of NSW, University of Wollongong and Australian Nuclear Science and Technology Organisation (ANSTO), to investigate the sensitivity of these wetland systems to external influences, including the potential effects of mining activity and groundwater extraction and provide a detailed understanding of the hydrological dynamics of Thirlmere Lakes, including the geology, geomorphology, hydrogeology and hydrology of the system.

As part of this EIS, a conservative assessment of the potential impacts of the project on surface and groundwater has been completed, consistent with the precautionary principle. The assessment includes recommended management and mitigation measures including ongoing monitoring to continually assess, minimise and manage the impacts of the project over the life of the project. Any findings and recommendations resulting from the Thirlmere Lakes Research Program would be considered at the time of release to determine their relevance to the project and to incorporate any new information into the Mine's environmental management programs, if required, in consultation with relevant agencies.

5.3.3 Report on Cumulative Impacts of Activities in Sydney Water Catchment

On 30 May 2014 the NSW Chief Scientist and Engineer provided findings "On measuring the cumulative impacts of activities which impact ground and surface water in the Sydney Water Catchment". Activities assessed as part of the report were coal seam gas developments and underground coal mining.

The report was completed to assess the current approaches to cumulative impact assessment within the catchment and determined whether a more quantitative approach would be possible. Experts in the fields of groundwater and surface water assessments were consulted as part of the review.

The report concluded that with regards to water quality, impacts resulting from activities can generally be mitigated through treatment. However, with regards to quantity, the report determined that "measuring and predicting the impact of single activities is difficult" due to the lack of a unified data set.

Notwithstanding the current limitations associated with cumulative impact assessment, the report concluded that "current activities should proceed while this data is gathered; the current impacts do not seem to affect water quantity in a major way".

5.3.4 Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC)

The IESC on Coal Seam Gas and Large Coal Mining Development (IESC) is a body commissioned under the EPBC Act to provide scientific advice to the Commonwealth Minister of the Environment and relevant State Ministers in relation to coal seam gas or large coal mining development proposals which are likely to have a significant impact on water resources.

The *Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals* (IESC Guidelines, 2015) outline the information required by the IESC in order to provide robust scientific advice on the potential water-related impacts of coal seam gas or large coal mining development proposals.

The proposed development has been assessed against the requirements of the IESC Guidelines 2015 and a table outlining where in the EIS each requirement has been met is provided in **Appendix A**.

5.3.5 Planning Assessment Commission Reports

Subsequent to the Southern Coalfields Inquiry, several applications for the approval of underground mining projects in the Southern Coalfields have been reviewed by the PAC. The outcomes of a number of these reviews have implications for future mining development in the Southern Coalfields, particularly in regards to the way in which environmental assessments are undertaken for future applications.

The PAC reports build on the recommendations of the Southern Coalfields Inquiry and provide further guidance for the environmental assessment of future mining projects in the Southern Coalfields. The recommendations of two PAC reports, for the Metropolitan Coal Project and the Bulli seam Operations Project, are discussed below in the context of the environmental assessment processes which have been undertaken for the proposed development. The reports for the Metropolitan Coal Project and the Bulli seam Operations Project are considered to be the most relevant PAC reports given their location in proximity to the proposed development.

Metropolitan Coal Project

The Metropolitan Coal Project (Peabody Energy) sought approval for an extension of mining operations of the Metropolitan Colliery, located approximately 30 km north of Wollongong, NSW, at Helensburgh. The Metropolitan Coal Project was delegated to the PAC in 2008 and was the first mining proposal to be assessed since the Southern Coalfield Inquiry report was published. The Terms of Reference (ToR) for the PAC with respect to the Project were to:

- Carry out a review of the potential subsidence related impacts of the Metropolitan Coal Project on the value of Sydney's drinking water catchment, and in particular its impact on the Waratah Rivulet and Woronora Reservoir, taking into consideration the recommendations of the Southern Coalfield Inquiry;
- Advise on the significance and acceptability of these potential impacts, and recommend appropriate measures to avoid, minimise or offset these impacts; and
- Identify and comment on any other significant issues raised in submissions regarding the Metropolitan Coal Project or during the public hearings.

In accordance with the ToR, Public Hearings were held on 11 and 12 March 2009. There were 17 verbal submissions at the hearings, comprising three from Government agencies, nine from special interest groups, four from members of the public and one from a mining company, as well as an oral submission from Peabody Energy.

The PAC reviewed relevant information prior to and following the public hearing including the Southern Coalfield Inquiry report, the Environmental Assessment for the Project, additional information provided by the Proponent and its consultants and Government agencies, submissions received on the Environmental Assessment and the Proponent's Preferred Project Report, including a revised mine plan. The information contained in these documents, along with the public hearing submissions were used to inform the determination made by the PAC.

The PAC was directed to specifically take account of the Southern Coalfield Inquiry recommendations in reviewing the Project. In its review of the Metropolitan Coal Project environmental assessment, the PAC made several recommendations with respect to improving the robustness of environmental impact assessments for underground coal mining projects in the Southern Coalfields, particularly in relation to consideration of sensitive landscape features and the extent of background environmental data on which environmental assessments are based. The PAC paid particular attention to the assessment of the following sensitive landscape features:

- significant natural features;
- surface waters including catchment yield, stream health and site water management;
- groundwater;
- swamps;
- terrestrial and aquatic ecosystems;

- cliffs and overhangs; and
- Aboriginal heritage.

The recommendations made by the PAC in its review of the Metropolitan Coal Project environmental assessment and the incorporation of these recommendations in this EIS are provided in **Table 5.2**.

Table 5.2 Consistency of the proposed development with recommendations of the Metropolitan Coal Project PAC report

Recommendations for environmental assessments	Comment	Section of EIS
Application of a risk framework, as expanded by the PAC, for natural features using a RMZ concept and determination of the relative significance of natural features and the acceptability or otherwise of subsidence induced impacts and consequences for those features	RMZs have been developed to inform the extent of longwall mining for the proposed development.	**Section 5.3.7**
Implementation of an 'outcomes based approach' for situations where the predicted subsidence impacts could lead to unacceptable environmental consequences for significant natural features, rather than a prescriptive approach of arbitrary limits and setbacks for mining	An outcomes based approach has been taken for the development of mitigation measures for the project where practicable. For example, should monitoring detect the early development of potentially severe differential movements during the extraction of the initial longwalls, consideration would be given to shortening the commencing position of subsequent longwalls.	**Section 11**
Implementation of the following framework to determine the impact of subsidence on natural features: 1) identify the mine characteristics and types of subsidence impacts likely to be experienced;	Consideration of potential subsidence has informed the mine plan for the proposed development including the development of RMZs. Two Subsidence Risk Workshops were held in March 2013 and December 2013 and attended by Tahmoor Coal, AECOM and relevant project technical specialists. A Subsidence Impact Assessment for the proposed development was undertaken for the project.	**Section 5.3.7** and **Section 11.1**
2) identify significant natural features that might be at risk from the subsidence impacts that could be expected from the proposal;	A number of significant or sensitive natural features were identified within the Project Area. The identification of significant or sensitive items resulted in changes to the mine plan where possible, additional impact assessment, or the preparation of specific treatment plans.	**Section 5.3.7**
3) assess features identified in Step 2 that warrant special significance status in a proposed risk management plan;	Significant or sensitive items and natural features that were assessed as being medium to high risk, and prompted consideration of modifications to the mine plan. These significant natural features informed the development RMZs for further assessment. The RMZs identified via the risk assessment process are presented on **Figure 5.3**. Revision of the	**Section 5.3.7**
4) using the criteria set out in the Southern Coalfields Inquiry Report for deriving RMZ boundaries, draw a RMZ around those features from Step 2 and Step 3 and assess the risk to the feature (or relevant part of the feature); and		

Recommendations for environmental assessments	Comment	Section of EIS
5) develop risk management plans for those features of special significance identified in Step 3, where a risk of impact is a real possibility and for those features identified in Step 2 where a risk of significant impact is a real possibility.	water management plan would be undertaken as described in **Section 11.4.6**.	

Bulli Seam Operations Project

The Bulli Seam Operations Project (BHP Billiton Ltd) sought approval for continued and extended coal mining operations at Appin Mine and West Cliff Colliery; both located approximately 25 km northwest of Wollongong, NSW. More than 70 submissions were received on the Environmental Assessment, resulting in the Bulli Seam Operations Project being delegated to the PAC in 2009. An initial PAC review was undertaken in 2009 for the Project, with further review undertaken in 2011 following the submission of a Preferred Project Report.

The PAC review was focused on subsidence-related impacts of the project on significant natural features, built infrastructure and the values of Sydney's drinking water catchment. The review raised concerns of potential mining beneath near-pristine areas, including conservation areas.

The PAC made a series of recommendations relating to the technical studies required to inform the environmental assessments of future proposals so that sufficient information is made available to Government agencies. The recommendations of the Bulli Seam Operations Project PAC report, relevant to a proponent's environmental impact assessment, are presented in **Table 5.3** along with a cross reference to where the recommendation has been addressed as part of this EIS.

Table 5.3 Consistency of the proposed development with recommendations of the Bulli Seam PAC report

Recommendations for environmental assessments	Comment	Section of EIS
Exploration drilling and core testing is to be undertaken to establish the mechanical and hydraulic properties in proximity to water-dependent systems.	Extensive exploration drilling has been undertaken across the Project Area and the results of the core testing used to inform the subsidence and groundwater assessments.	**Sections 11.1** and **11.3**.
Installation of a regional network of shallow piezometers targeting water dependent systems and underlying rock strata be undertaken to inform an understanding of the hydrology and climatic implications.	An extensive network of piezometers has been installed across and to the north of the Project Area.	**Appendix I, Section 11.3**
Establishment of a network of deep pore pressure monitoring bores be undertaken to assess/quantify the impacts of fracturing within the subsidence zone.	An extensive network of piezometers has been installed across and to the north of the Project Area.	**Appendix F, Appendix I, Sections 11.1** and **11.3**.
Numerical modelling be utilised to enhance the prediction of subsidence zone fracture distributions, connectivity and potential fracture conduit (groundwater) transmission capacities.	Numerical models have been prepared to inform assessments of subsidence and groundwater impacts of the proposed development.	**Appendix F, Appendix I, Sections 11.1** and **11.3**.
Borehole census should be conducted on all potentially yield (or structurally) affected boreholes.	A borehole survey (census) of private bores throughout the Project Area was undertaken.	**Appendix I, Section 11.3**
A comprehensive independent audit of the groundwater model.	The groundwater model and assessment for the proposed development was	**Appendix I, Section 11.3**

Recommendations for environmental assessments	Comment	Section of EIS
	subject to an independent peer review.	
Greater collaboration between specialist areas (for subsidence, hydrology, geomorphology, ecology and Aboriginal heritage) is required to provide a holistic assessment of sensitive surface features.	Throughout the environmental assessment for the proposed development, the subsidence engineers and hydrological, groundwater, heritage and ecological technical specialists collaborated with regards to determining the significance of natural features and the potential consequences of subsidence-induced impacts.	**Section 11**

Incorporation of PAC Recommendations for this EIS

Tahmoor Coal has taken into account the PAC's critique of the Metropolitan Coal Project and Bulli Seam Operations Project environmental assessments, and has implemented a number of steps during the mine planning and environmental assessment processes to address its findings. A particular finding of the reports was that the PAC recognised the close connection that exists between a suite of specialist areas (subsidence, hydrology, geomorphology, ecology and Aboriginal heritage) and outlined the need for all of these specialist areas to be considered in a holistic manner to protect sensitive surface features.

During the preparation of this EIS, the technical specialists have collaborated with regards to determining the significance of natural features and the establishment of RMZs to guide the mine planning process. In addition, the technical specialists have relied on the technical reports of interrelated disciplines when completing each assessment. This approach has allowed for a holistic assessment of potential environmental impacts associated with the proposed development.

5.3.6 Collaboration between Specialists

Throughout the environmental assessment for the proposed development, the subsidence engineers and hydrological, groundwater, heritage and ecological technical specialists collaborated with regards to determining the significance of natural features and the potential consequences of subsidence-induced impacts. Specifically, three days of collaborative group survey of natural surface features within the Project Area, a series of subsidence risk management workshops, follow-up meetings and discussions between technical specialists was undertaken for this purpose. This co-operative process influenced the development of RMZs and the mine planning process for the proposed development.

The approach and outcomes of the collaborative survey and workshops is presented in a summary report *Tahmoor South Project Subsidence Workshop* (Glencore, 2014). This report is provided in **Appendix D**.

During preparation of the technical reports for the EIS, a geotechnical engineer attended and provided input to meetings with the authors of the subsidence and groundwater reports. The technical reports for subsidence and groundwater were subsequently peer reviewed. Further, additional and specific geotechnical reports were prepared for input into the subsidence report including:

- Review of the Hydraulic Conductivity and Geotechnical Characteristics of the overburden at Tahmoor South (SCT, 2013);
- Longwall 10A Height of Fracture Borehole for Tahmoor South Project – observations, Measurements and Interpretation (SCT, 2014); and
- Subsidence Impact Assessment for Selected Archaeological Heritage Sites at Tahmoor South Project (SCT, 2013).

5.3.7 Development of Risk Management Zones

A key outcome of the collaboration between technical specialists described above was the development of the RMZs (Glencore, 2014). In developing RMZs for the proposed development, Tahmoor Coal has incorporated the framework outlined in the Southern Coalfields Inquiry, Metropolitan Coal Project PAC Report and Bulli Seam Operations PAC Report relating to RMZs, for significant natural features warranting protection.

To assist with the identification of the RMZs, the subsidence engineers and technical specialists for hydrology, geomorphology, groundwater, ecology and heritage collaborated during a three day long field visit (6 to 9 March 2013) to waterways within the Project Area (Glencore, 2014). Subsequent to the field visit, two qualitative risk workshops were undertaken involving the relevant stakeholders. A follow up workshop was held on 12 December 2013 (Glencore, 2014).

Subsidence Risk Workshops

The scope of the risk workshops was to identify significant natural features to develop RMZs. In accordance with the Southern Coalfields Inquiry, the risk workshop was limited to consideration of the natural features, including rivers, streams, swamps, cliff lines, Aboriginal heritage, conservation, scenic and recreational values. For each natural feature the potential consequences and causes were considered and significance and sensitivity assigned.

The first risk workshop held in March 2013 identified features that required detailed assessment during preparation of the EIS. The second risk workshop in December 2013 considered the outcomes of the assessments and whether a residual risk still existed (Glencore, 2014).

The working group that took part in the workshops was made up of key stakeholders involved in the proposed development including Tahmoor Coal employees, technical specialists and EIS authors (Glencore, 2014). The involvement of these key stakeholders ensured that the significance and sensitivity of natural features identified through the process were ranked by experienced technical specialists, who understand the proposed development, and Tahmoor Coal employees who have the authority to action key findings and outcomes that resulted from the risk workshop. The workshop attendees are listed in **Appendix D**.

During the risk workshop the working group was tasked with:

- identification of key elements and associated risk descriptions and consequences;
- identification of the cause;
- achieving group consensus on the significance and sensitivity for each potential risk; and
- identification of appropriate treatment plans.

A traffic light approach was adopted and each element was ranked as either having a low, medium or high significance and sensitivity. Where an element was identified as having a medium or high significance and/or sensitivity, a treatment plan was identified.

Identified Areas of Significance

A number of significant or sensitive natural features were identified within the Project Area. The identification of significant or sensitive items resulted in changes to the mine plan where possible, additional impact assessment, or the preparation of specific treatment plans. Significant or sensitive items considered were:

- areas of high environmental, heritage, archaeological and Aboriginal cultural heritage significance;
- wetlands, swamps and water related ecosystems;
- catchments exacerbating erosion and drainage pattern changes;
- significant watercourses;
- significant groundwater resources;
- threatened and protected species;

- stability of escarpments and significant cliff lines, pagodas or steep slopes; and
- prescribed dams.

Significant or sensitive items and natural features that were assessed as being medium to high risk, and prompted consideration of modifications to the mine plan were:

- Pagodas, cliffs, steep slopes which were identified as a public safety risk. The mine plan was designed to minimise potential for impacts to significant cliffs along the Bargo and Nepean Rivers;
- Aboriginal rock shelters which were identified as areas of high archaeological and / or Aboriginal cultural heritage significance. Previous mining at similar depth of cover has shown minimal impacts in the vicinity of Tahmoor Mine. However, the mine plan was designed to minimise potential for impacts to significant rock shelters at Dog Trap Creek as shown on **Figure 5.3**. (Please note that whilst Dog Trap Creek is shown within the longwall extent boundary on **Figure 5.3**, the longwalls themselves have been set back from undermining significant rock shelters under this creek);
- Watercourses directly overlying the longwalls where potential cracking in the rock bed and/or dewatering of pools may occur, including Dog Trap Creek, Horne Creek and Eliza Creek;
- The mine plan was designed to restrict long wall mining to the west of the M31 Hume Highway, thereby minimising impacts to the MSA and associated Upper Nepean State Conservation Area;
- Significant watercourses including the Bargo River and Nepean River. The mine plan was designed to avoid undermining the Bargo River and Nepean River; and
- Groundwater beneath Thirlmere Lakes.

These significant natural features informed the development RMZs for further assessment. The RMZs identified via the risk assessment process are presented on **Figure 5.3**. The modifications to the mine plan to avoid or minimise impacts to significant or sensitive items and natural features is outlined **Section 6.2.4**.

Subsidence Study Area

Consistent with the recommendations from the Southern Coalfields Inquiry made regarding the assessment of subsidence impacts, a SSA was developed for the proposed development in order to define the maximum surface area extent of predicted subsidence, and form the basis of the impact assessment undertaken for the proposed development.

Within the SSA, natural surface features and items of infrastructure were identified and assessed for their potential to experience mine subsidence impacts as a result of the proposed extraction of Longwalls 101 to 109 (extent of longwalls). The extent of the SSA was derived by combining the areas bounded by the following limits:

- The predicted limit of vertical subsidence as a result of the extraction of coal from within the extent of longwalls (**Figure 4.1**). The limit of vertical subsidence was taken as the 20 mm subsidence contour determined using the Incremental Profile Method (IPM); and
- A minimum distance of 600 m from the nearest edge of the proposed longwalls, as recommended by the independent *Inquiry into underground coal mining in the Southern Coalfields of NSW* (SCI, 2008).

In some instances, the predicted limit of vertical subsidence (20 mm contour) extends beyond the recommended 600 m. Therefore, to ensure a conservative assessment, the SSA has been defined based on whichever delineation is furthest from the proposed longwalls. The SSA is shown on **Figure 4.1**.

The SSA defines the limit of main development workings proposed. Main development roadways are the only form of mining that is proposed to be undertaken within the area between the extent of longwalls boundary and the SSA boundary.

Extent of Longwalls

The development of RMZs has influenced the extent of the longwalls as part of the mine plan for the proposed development. The initial mine plan(s) underwent revisions to avoid longwall mining directly under sensitive features such as the MSA, bedrock rivers with standing pools, items of Aboriginal heritage and significant landscape features such as river gorges. Further information regarding modification to the extent of longwalls is provided in **Section 6.2.4**.

5.3.8 Summary

The mine planning process and environmental impact assessment for the proposed development have taken into account the findings of the *Southern Coalfields Inquiry* (2006), Chief Scientist and Engineer reports and the PAC reports for Metropolitan Coal Project and the Bulli Seam Operations Project. In particular, the process adopted for the impact assessment allowed for extensive collaboration between technical specialists to determine RMZs and inform the extent of longwall mining for the proposed development.

5.4 Project Area Mine Design

The mine design for the Project Area evolved during the pre-feasibility and feasibility studies for the proposed development. Tahmoor Coal undertook a series of mine design revisions as environmental and geological constraints became known. The earlier mine designs are attached in **Appendix E**.

The geology and surface features within the Project Area have constrained the mine plan for the proposed development. Consequently, the proposed development consists of a single mining domain only, the Central Domain, which is bounded to the east by the Nepean Fault Zone and to the west by the Central Fault.

Alternative mining domains, the Southern Domain and the Eastern Domain, were identified during project planning and pre-feasibility studies. Mining in the Southern domain is not proposed as part of the proposed development due to geological features and resource definition considerations. The Southern Domain is bounded to the east by the Central Fault and to the west by the CCL747 lease boundary.

The Eastern Domain lies along the eastern side of the Tahmoor South lease and is limited to the west by the Nepean Fault Zone. Mining in this domain is not proposed as part of the Tahmoor South Project due to geological features, resource definition considerations and the requirement for additional surface infrastructure for secondary egress for mine personnel.

5.5 Bulli Seam Coal Resources

Three coal resource categories have been defined within the Project Area, based primarily on drill hole spacing, 2D seismic surveys and underground workings at the southern extent of the existing operations.

The Bulli seam is consistent across the Project Area and was intersected in all exploration drill holes. 2D seismic surveys have, in most instances, acquired reliable data enabling interpretation of coal seam continuity, overall stratigraphy and structures within the deposit. Seismic surveys were carried out on a grid pattern of approximately one kilometre by 300 m within the Central Domain where the proposed mine plan is located.

A Coal Resource Statement for the proposed development has been completed in accordance with the 2012 Joint Ore Reserves Committee Code and coal resources within the Project Area are presented in **Table 5.4**.

Table 5.4 Coal Resources within the Project Area (Glencore Xstrata Resources and Reserves Report, 2017)

	Measured Resources	Indicated Resources	Inferred Resources
Project Area	20 million tonnes	243 million tonnes	114 million tonnes

5.6 Geological Risks

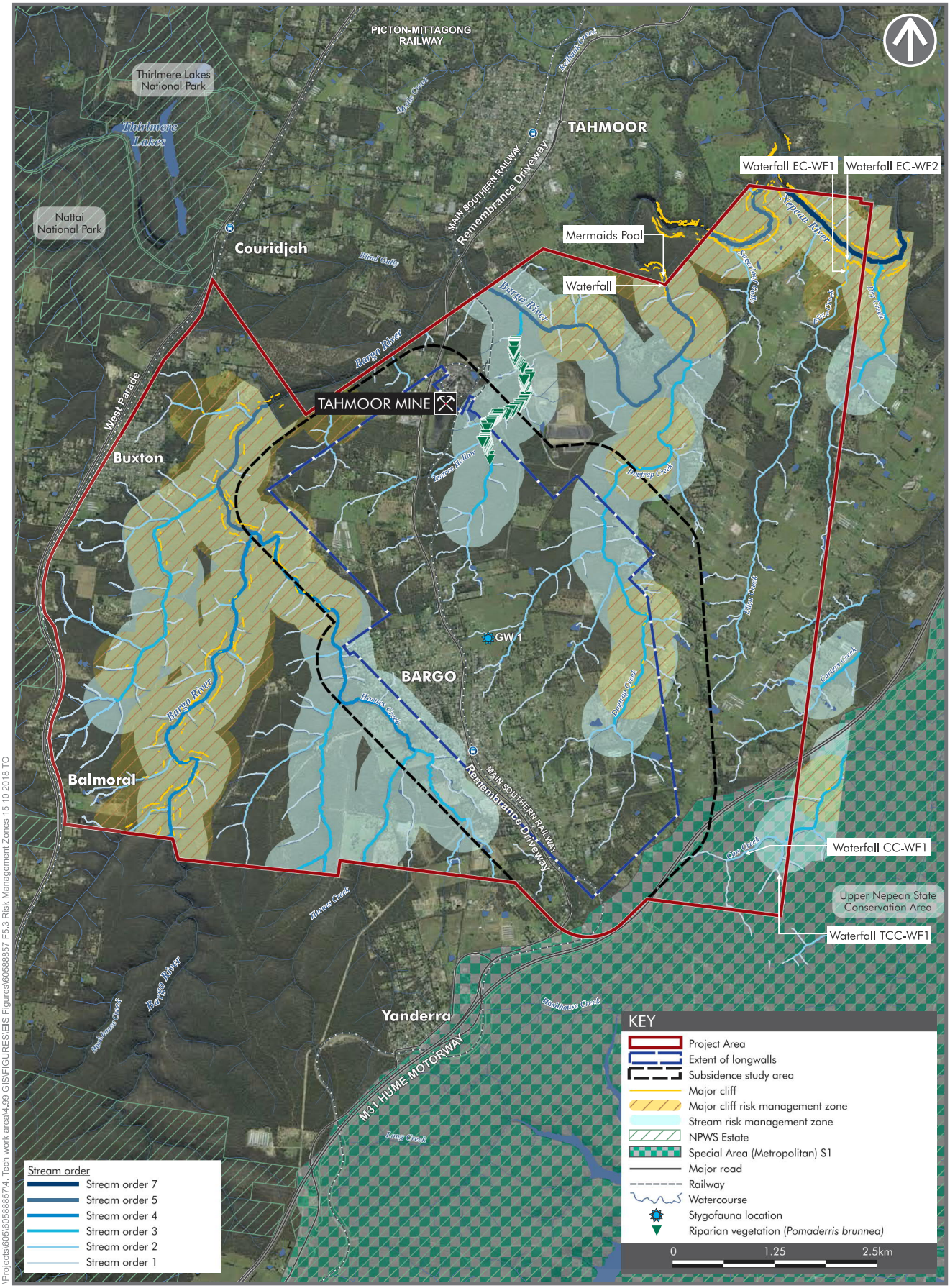
The main geological risks to underground mining identified within the Project Area are:

- the boundary of the intrusive activity (sill) within the Bulli seam close to the southern boundary of CCL747;
- potential for unknown faults and geological structures;
- potential for unknown intrusive bodies (dykes, diatremes) within the boundaries of the mine plan; and
- the potential for seam split in the basal portion of the Bulli seam as this would impact on product yield.

In order to quantify and manage the geological risks listed above, further exploration may be required in the future, which may include:

- a drilling program and survey along the southern boundary of the Project Area to determine the extent of the igneous intrusions;
- a drilling program and survey to further define extent of faulting and geological structure;
- a high resolution airborne magnetic survey over the mine plan area to identify intrusive bodies (dykes and diatremes) reaching the surface; and
- resource drilling within the Project Area to gain greater certainty of the coal resource and increase resource classification to Measured Resources.

Any future exploration activities will be undertaken in accordance with the necessary approvals from the NSW DRG.



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SIMEC MINING

RISK MANAGEMENT ZONES

Tahmoor South Project
Environmental Impact Statement

FIGURE 5.3

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6.0 Project Need and Alternatives

6.1 Need for the Project

The high quality coking coal mined at Tahmoor Mine is a valuable source of raw material for steel manufacturing. The proposed development would allow for the continued supply of this valuable product to existing domestic and international markets.

Similarly, the proposed extent of underground mining and the rate at which extraction would take place (up to four (4) million tonnes of ROM coal per annum) reflects the consideration of known geological, environmental and rail transport limitations. This scale of development also balances the economic viability and capital expenditure required for the development, with the ability to supply product coal into established export markets.

Moreover, in responding to the demands of the export markets, it is considered preferable from an environmental, economic and social perspective to continue an existing mining operation and utilise existing facilities rather than to establish a separate, new mine to access this resource (refer to **Section 6.2.2** for details).

Without approval, completion of mining in the Tahmoor North mining area would result in closure of Tahmoor Mine by approximately 2022 prohibiting the extraction of a coking resource via existing infrastructure. Conversely, if approved, the proposed development would prolong the life of Tahmoor Mine and enable recovery of a greater proportion of the existing resource, which in turn would enable ongoing supply to existing customers and direct ongoing employment for 390 employees for a further 13 years and between 50 and 175 additional employees during the transition period.

6.2 Alternatives Considered

Tahmoor Coal considered alternatives to the proposed development during the concept (pre-feasibility) and detailed design (feasibility) stages of the project planning, over a period of three years. The alternatives considered related to:

- a do nothing option whereby the coal resource within the Project Area would not be developed;
- sequential mining operations or the concurrent operation of two mining operations, including various associated infrastructure configurations;
- a single or multi-seam operation, whereby the proposed development would extract coal from the Bulli and the Wongawilli seams;
- various mine plan scenarios with regards to extent and configuration of longwalls;
- methods of coal extraction; and
- options for rejects emplacement.

The pre-feasibility and feasibility investigations were driven by the aim of avoiding or minimising environmental, social and economic impacts, particularly to key sensitive surface features and achieving operational project objectives including:

- provide a safe solution, causing no hazards to mine operations and with low impact on mine stability;
- minimise the impact on the environment where possible, including dust emissions, visual impact, groundwater and sub-surface contamination, use of foreign reagents;
- provide an economic solution, with minimal capital and operating cost, returning a positive benefit to cost ratio, providing employment and minimising impacts on mine production;
- adopt a sound technical solution, utilising proven technology with high availability and reliability, versatility and flexibility; and
- provide a solution that would enable the disposal of the total volume of rejects forecast for the Tahmoor South project.

In this context, several configurations of project components were considered, to identify the 'optimum' balance between project objectives and minimisation of associated impacts. These alternatives are discussed in the following sections.

6.2.1 Do Nothing

Without development approval, the extraction of coal at Tahmoor Mine cannot continue beyond the completion of mining within the Tahmoor North mining area. Closure of the mine would lead to the loss of approximately 390 jobs in approximately 2022 and loss of the potential for around $699.5 million in net benefits over the project life including flow-on implications for local businesses, and royalties and revenue for government. Closure of the mine would also remove the environmental and amenity impacts associated with operation of the mine, including those which are currently managed within acceptable limits.

Without development approval, mining could continue within the Tahmoor North mining area under Tahmoor Mine's existing development consents (1975 Tahmoor Consent, 1979 Tahmoor Consent, 1994 Tahmoor North Consent and 1999 Tahmoor North Consent). However, the remaining coal reserves within this approved area would be exhausted within approximately four years, projected at the current rate of extraction. Subsequent to completion of mining within the Tahmoor North mining area, and in the absence of development approval for the expansion of mining, Tahmoor Mine would be subject to mine closure and site rehabilitation.

Coal is a major commodity export for Australia and the proposed development would continue to supply coking coal to the global market and associated revenue to the State government. If approved, the proposed development would benefit the local, regional and State economies through:

- direct and indirect ongoing employment for approximately 390 existing personnel and up to 175 additional personnel during the transition phase, allowing for the continued utilisation of an existing and skilled workforce;
- the continuation of economic benefits to local, regional and State communities and governments in the form of additional wages, royalties and flow-on effects with a net benefit of approximately $699.5 million over its 13 year life; and
- local and regional benefits from capital investment and purchasing.

These benefits would not be realised through adoption of the 'do nothing' alternative. The negative consequences of not proceeding with the proposed development therefore relate to lost employment opportunities, and unrealised financial benefits to Tahmoor Coal, local and regional communities and the government.

6.2.2 Separate, Concurrent Operation of Tahmoor Mine and Bargo Mine

In the early stages of mine planning in 2012-2013, Tahmoor Coal investigated the continuation of operations at the existing Tahmoor Mine against an alternate option to duplicate this operation through the establishment of a second, separate mining operation within the Tahmoor South mining area that would operate in addition to the current facilities. Production at the second mine would occur concurrently with operation of the existing Tahmoor Mine Surface Facilities Area.

Establishment of a second mine to the south of the existing operations would enable a significant increase in the rate of ROM coal extraction, product coal production and transport per annum for the company. To enable this production, a second mine would also require duplication of surface facilities, personnel and equipment as well as increased capacity to the coal chain infrastructure. This duplication of mining operations would see increased employment and economic benefits. However, it would rely upon the injection of significant additional capital and operational expenditure by Tahmoor Coal.

Duplication of extraction and production rates from operation of the two adjacent mines would likely increase environmental, social and economic impacts in the local area, including the cumulative effects of the two mines operating concurrently. The significant capital investment required to develop a completely new mine for the Tahmoor South Project was assessed, during the pre-feasibility stage of the proposed development, as not financially viable.

In comparison, operation of a single mine to develop the resource would enable the continued use of the existing Tahmoor Mine infrastructure, requiring lower capital and operational expenditure. For this option, environmental and amenity impacts would be contained within a smaller area of affectation compared to the cumulative potential impacts of two adjacent mines, while economic benefits would still be available to the company, community and governments through operation of the single mine. The extraction and production rates at which the mine could operate would be determined by the current or augmented capacity of the mining infrastructure and processing plant.

The surface infrastructure options investigated during the pre-feasibility assessment were:

1. establishment of a second, separate, independent mining operation to allow concurrent operations, with new surface infrastructure located:
    a. within and relying on previously approved development at the Bargo Colliery (the Bargo Option);
    b. immediately to the north of the existing surface infrastructure area of Tahmoor Mine (the Northern Option); or
    c. south of the existing surface infrastructure area of Tahmoor Mine (the Southern Option).
2. Continued use of existing surface infrastructure of the existing mining operation, integrated and augmented to facilitate mining into the coal resource areas to the south.

These infrastructure options are discussed in further detail in the following sections.

Bargo Option

As outlined in **Section 1.2.2**, new surface infrastructure associated with the Bargo Mine, was approved in 1975/76 by both Wollondilly and Mittagong (now Wingecarribee) Councils for a location approximately 5.5 km to the south-west of the existing Tahmoor Mine between the town of Bargo and the Bargo River.

Development of a separate underground mine at this location was considered during the pre-feasibility assessment for the proposed development. The Bargo Option would have involved the duplication of surface infrastructure facilities to process coal extracted from the Tahmoor South mining area.

The Bargo Option consisted of:

- construction of new surface infrastructure, product stockpile area and rail loop;
- excavation of a new drift entry;
- sinking of additional ventilation shaft sites;
- establishment of an additional REA; and
- extraction of coal from the Bulli seam via longwall mining.

The Bargo Option was ultimately not pursued due to the requirement for significant capital expenditure and the environmental constraints associated with establishment of this additional mining infrastructure, including impacts to key sensitive surface features. The capital expenditure of the Bargo Option was estimated to be almost double the expenditure required for either of the Northern or Southern options (outlined in the following sections) and approximately triple that required for the continuation of activities at the existing Tahmoor Mine Surface Facilities Area.

The Bargo infrastructure option would also have required the Surface Facilities Area to be located within undeveloped forested land, resulting in:

- potential impacts to watercourses located within the footprint of the new Surface Facilities Area;
- exposure to areas of high bushfire risk;
- clearing of up to 220 ha of vegetation mapped as being of high significance due to its relatively undisturbed condition and potential for koala habitat; and
- potential impacts to archaeologically sensitive areas associated with Hornes Creek.

From an economic and environmental perspective the Bargo Option was deemed to be the least favourable of the pre-feasibility mine and surface facilities establishment options assessed to support the extension of mining.

Northern Option

The Northern Option included the construction of a new Surface Facilities Area immediately to the north of Tahmoor Mine's existing Surface Facilities Area, and the configuration of new ROM and product stockpiles. However, analysis of the Northern Option during the pre-feasibility assessment found it too capital intensive, to be a viable option to be carried forward in development of the project.

The pre-feasibility assessment also highlighted the likelihood of increased environmental impacts associated with concurrent operation of the Northern Option and the existing Surface Facilities Area. The Northern Option would require additional clearing of vegetation, including vegetation which may consist of Shale Sandstone Transition Forest (SSTF), a listed ecologically endangered community (EEC). Additionally, the Northern Option would be located closer to residences than the existing Surface Facilities Area, potentially resulting in adverse construction and operational noise impacts.

Southern Option

The Southern Option considered the construction of a new Surface Facilities Area to the south of the existing Tahmoor Mine Surface Facilities Area, along with upgrades to the existing Surface Facilities Area and rail loop. Similar to the Northern Option, analysis of the Southern Option during the pre-feasibility assessment identified this option to be too capital intensive to be viable, and it was discounted from further assessment.

With regards to environmental consequences of this option, the Southern Option would have also resulted in additional clearing of vegetation which may consist of SSTF EEC. The Southern Option would also have been located closer to residences than the existing Surface Facilities Area, with a greater potential for adverse noise impacts.

Option for Sequential Extension of Operations

The alternative to the concurrent operation of two separate mines to access the coal resource is the option to sequentially extend longwall mining into the Tahmoor South mining area via the existing surface infrastructure facilities at Tahmoor Mine.

The pre-feasibility assessment found this option to be the least capital-intensive option with fewer environmental impacts. Sequential extraction of the coal resource within the Project Area would allow the continued use of the existing Tahmoor Mine surface infrastructure area and coal chain logistics, with only upgrades and augmentation of these facilities needed to meet required production rates.

This option would not introduce increased cumulative amenity impacts associated with the concurrent operation of an adjacent mine. However, by its nature, the sequential extension of mining has the potential to extend the period over which operational impacts may occur.

6.2.3 Multi-seam Operation

Options for developing the coal resources for the proposed development included either:

- mining the Bulli seam only; or
- mining the Bulli seam and the Wongawilli seam.

Tahmoor Coal investigated the feasibility of a single or multi-seam operation whereby coal would be extracted from the Bulli seam and the Wongawilli seam below. The pre-feasibility study concluded that mining of the Bulli seam only is the preferred option for the following reasons:

- capital expenditure implications:
  - the existing Tahmoor Mine infrastructure is currently configured for extraction from the Bulli seam and additional mine infrastructure, including drifts, shafts and CHPP would be required to extract from the Wongawilli seam.
- operational expenditure implications:

  - mining of the Wongawilli seam requires greater expense due to the increased depth of the seam, when compared to the Bulli seam; and
  - higher ash content and partings within the Wongawilli seam results in decreased yield in comparison to the Bulli seam, which would require additional capital for CHPP upgrades and additional reject disposal considerations.
- market considerations:
  - the coal from the Bull Seam meets the specifications of the coal currently supplied by Tahmoor Coal under its existing contracts.
- environmental considerations:
  - a higher level of subsidence would likely result from a greater seam thickness extraction in the Wongawilli than the Bulli seam. This, coupled with cumulative subsidence levels of a multi-seam operation would introduce increased environmental and social consequences and the need for additional mitigation and management measures at the surface than those required for mining the Bulli seam alone.

Resolution of the current expenditure constraints and market limitations, along with development of suitable subsidence management measures in future years, may allow mining of the Wongawilli seam under a future consent. However at the current time single seam mining of the Bulli seam is preferred.

6.2.4 Alternative Mine Plan Options

The mine plan for the proposed development has been developed over a period of several years, taking into account the coal quality, sensitive environmental features and geological constraints of the Project Area. The mine plan refers to the orientation, extent and configuration of longwalls and associated mains, as well as the number and location of ventilation shafts.

A formal constraints analysis was undertaken to determine the presence of key sensitive surface features within the Project Area, such as bedrock rivers with standing pools, items of Aboriginal heritage and significant landscape features such as river gorges. Based on this constraints analysis, key features, such as the Bargo River gorge and the MSA, were identified and longwall configurations were designed to avoid those sensitive surface features, as discussed in **Section 5.3**.

Early mine plans for the proposed development included longwalls beneath the Bargo River in the west and south of the mining lease areas (**Appendix E**). However, due to the environmental and social significance of this river, the initial mine plan underwent a revision to avoid longwall mining directly under these sensitive surface features.

Further assessment and survey of sensitive heritage, geomorphological and ecological surface features along Dog Trap Creek has been undertaken as part of baseline monitoring and preparation of this EIS. The results of this assessment have fed into an analysis of the risk of potential impacts to these sensitive surface features due to subsidence, and into the mine planning process, resulting in modification to the extent of longwalls and the location of ventilation shafts in these areas.

The proposed longwalls have been designed to avoid mining beneath four rock shelter sites along Dog Trap Creek with artwork that is of high cultural and archaeological significance. The surface infrastructure for the proposed development would also avoid all grinding grooves and rock shelters and therefore avoid potential surface disturbance impacts to archaeological sites with moderate or high scientific significance.

Additional mine planning undertaken in 2017/2018 identified that mining within the Eastern Domain would not be optimal due to geological and technical mining considerations, in particular, difficulties associated with safe mine personnel egress in the case of a seismic event along the Nepean fault. The removal of longwall mining within the Eastern Domain would result in reduced subsidence impacts to Eliza Creek, which was proposed to be undermined by longwalls within this domain. The reduced area of longwall mining would also reduce the length of mining at the Tahmoor South Project from an estimated 18 years (under both the Central and Eastern Domains) to 13 years (under the current proposed Central Domain only), thereby reducing the overall length of operational impacts of the proposed development.

The change to mining area has also allowed the rationalisation of the number of ventilation shafts required for the proposed development from four ventilation shafts to two, thereby reducing the land clearance requirements associated with electricity and service connections to the ventilation shaft sites. When taking into account the vegetation clearing savings associated with the changes to mine shaft number and locations, the Central Domain-only option would require around four hectares less of vegetation clearing compared to the combined Central and Eastern Doman option. Whilst not mining in the Eastern Domain would result in the foregoing of coal resources to market, given the safety risks to personnel and environmental benefits, the Central Domain-only option was identified as the preferred mine plan.

Further details regarding the mine planning process and identification of the proposed mine plan have been discussed in **Section 5.3**. Previous mine plans for the proposed development are presented in **Appendix E**.

6.2.5 Alternative Coal Extraction Methods

Alternative coal extraction methods which have been considered by Tahmoor Coal during the feasibility studies for the proposed development included alternative methods of coal extraction and longwall widths. These alternative methods of coal extraction are limited by technical, economical, subsidence, environmental and safety reasons. Consequently, they have not been pursued as part of the proposed development.

The alternative coal extraction options considered were:

- Open cut mining. Feasibility dismissed on economic and environmental grounds, with the strip ratio considered to be impractical and too high to be technically viable due to the depth to the Bulli seam (350-420 m below ground level);
- Bord and pillar mining methods. Although these methods may result in lower levels of subsidence and fewer environmental consequences, they would result in low production rates and were assessed as not economically viable;
- Top coal caving. The Bulli seam is not thick enough to support this extraction method within the Project Area, therefore this method was deemed not to be a technically viable option; and
- Longwall mining. This mining method is considered to be the best mining method for the depth of and thickness of the Bulli seam, and would enable financially viable production rates to be achieved. This method has reduced environmental consequences when compared to open cut mining, could utilise existing mine infrastructure, and was assessed as being technically and economically viable within the Project Area.

The alternative longwall width options considered were:

- Longwalls of 305 m in width: assessed as being able to best balance subsidence levels and associated environmental consequences with viable production rates and cost efficiencies within the Project Area;
- Longwalls narrower than 305 m: narrower longwalls would have reduced levels of associated subsidence and environmental consequences at the surface. However, longwalls less than 300 m in width were assessed to be sub-optimal economically, as a function of production and cost efficiency, and therefore implementation of narrower longwalls may preclude the proposed development on financial grounds; and
- Longwalls wider than 305 m: wider longwalls would result in increased subsidence risk and environmental consequences at the surface, as well as the introduction of increased geological constraints. This alternative was not considered to be technically viable.

6.2.6 Alternative Options for Rejects Disposal

Options Study - 2013

Methods of disposal for the washery rejects, alternate to the current operation of the surface REA, were investigated addressing technical, environmental and financial issues and constraints, as the basis for the identification of a preferred option. The Rejects Disposal Options Study (SKM, 2013) for the proposed development is provided in **Appendix U**.

Six disposal options were initially considered, incorporating both underground and surface disposal areas. A multi criteria analysis approach was adopted to determine the relative merit of each option and to shortlist options for further detailed assessment. Key considerations in the shortlisting of options included insufficient volume for storing of rejects in old workings or former goaf areas, the velocity required to move slurry (rather than paste) through a pipeline and the resulting excessive pipe wear, impact to operations and consequential reduced productivity, excessive capital and operating costs. The options that were identified for further detailed investigation were:

- surface disposal at an expanded existing REA; and
- underground disposal as paste material (active goafs via a trailing pipe).

The surface disposal option would involve a continuation of the current rejects disposal methods and an expansion of the existing REA. The technical risks are therefore known and the operation is well established. As this operation is undertaken completely on the surface, personnel would not be exposed to the hazards of the underground environment and this option is therefore considered to be safer than underground alternatives. Although there is sufficient space to expand the existing REA on the surface, the expansion would require clearing of native vegetation (refer to **Section 11.6**). The surface disposal option would also generate noise and dust impacts which require appropriate management (refer to **Sections 11.10** and **11.11**).

The option to dispose of the rejects as paste material into the active goaf is technically complex. The void above the caved zone is highly variable in nature and even under ideal rock conditions, the available volume would be significantly less than required over the life of the mine. When taking into account less than ideal situations, the available volume would be limited and could be reduced to zero.

An options workshop was held to further analyse the shortlisted options. This examination of the two options involved subjecting them to a series of criteria and scoring their suitability against each specific criterion. During the workshop it was identified that due to the capacity of the paste plant, the disposal underground into the active goaf would still require a proportion of the rejects to be disposed within an expanded REA. Consequently, this option developed into and was evaluated as a co-disposal option with approximately 70 per cent of material to be disposed underground and 30 per cent to be disposed on the surface at an expanded REA.

The two options assessed during the options workshop were:

- surface disposal – expanded REA; and
- co-disposal – underground paste material (active goaf via trailing pipe) and surface REA.

These two options were taken into the cost-benefit analysis and options analysis.

Based on the economic decision criteria used to evaluate the cost-benefit analysis, the expansion of the existing REA was determined to be the preferred option. When assessed in the options analysis, it was found that the expansion of the existing REA performed better than the co-disposal option against the following criteria:

- benefit to cost ratio;
- impact on available coal reserves;
- impact on production;
- minimal processing of rejects;
- water usage;
- risk of surface/groundwater and subsurface water chemical contamination;
- control of spills;
- hazards to mine operations;
- potential to damage bulkheads;
- impact of geology / geotechnical to design and operate system;

- low maintenance; and
- proven technology.

Co-disposal performed better than the expansion of the existing emplacement area under the following criteria:

- visual impact; and
- impacts to vegetation.

Options for the expansion of the REA

The expansion of the REA required the reconfiguration and raising of the maximum height for the existing REA. Two options were considered:

- Raising the northern section of the REA (this section has previously been rehabilitated); and
- Raising the southern section of the REA.

It was determined that raising the northern section of the existing REA would increase the total number of properties potentially impacted by dust and noise. Raising the southern section of the REA would not increase the total number of properties potentially impacted by dust and noise and therefore this option was preferred for the proposed development.

Current situation

Since the Rejects Disposal Options Study (SKM) was completed in 2013, underground coal mines have continued to investigate the potential for underground disposal of tailings.

In Australia underground disposal of fly ash or tailings has primarily been used in shallow workings as a measure to prevent damage to infrastructure due to subsidence. There has been limited disposal of tailings or waste rock to active longwall mines due to cost. Underground tailings disposal has been used in active mines in China and India as a subsidence mitigation measure when mining below urban areas (Department of the Environment, 2015).

In order to reduce the volume of coal reject that requires off-site transport Metropolitan Coal Mine in Helensburgh NSW has been trialling the disposal of a portion of its coal rejects via underground backfilling of the mine void. Coal reject material is transported by truck to Glenlee Washery for emplacement and/or disposed in underground workings via the Coal Reject Paste Plant (Metropolitan Coal Mine Waste Management Plan). The trial includes fine rejects only, with course rejects hauled from site, and is not currently run at a commercial scale.

In the case of Tahmoor, expansion of the REA is still the preferred option for rejects disposal, from both a cost and feasibility perspective. This is because the technology required for underground co-disposal is not yet sufficiently advanced in Australia.

6.3 Preferred Option and Project Refinements

The pre-feasibility and feasibility studies and investigation into alternative options determined that the preferred option for the proposed development is:

- the sequential extension of operations at Tahmoor Mine;
- use of the existing surface infrastructure area at Tahmoor Mine;
- single seam mining within the Bulli seam;
- the use of longwall mining methods;
- the development of a mine plan that avoids impacts to sensitive surface features;
- developing longwalls with a maximum panel width of 300 m; and
- surface rejects disposal with an expanded REA.

Sequential operations, rather than duplication of production and establishment of a second mining operation, was identified as feasible due to the cost savings associated with using existing infrastructure and the avoidance of greater environmental and amenity impacts associated with the development of a separate Surface Facilities Area. Sequential extraction of the coal resource within the Project Area would allow for the continued use of existing infrastructure and workforce, providing benefits by way of continuation of employment for the existing, established workforce for a further 13 years.

The preferred mine plan precludes longwalls beneath the Nepean and Bargo Rivers, resulting in fewer impacts to the environment while maximising project feasibility. The preferred option proposes mining from the Bulli seam via longwalls optimised at up to 300 m in width. The preferred mine plan and chosen method of coal extraction forms an optimised outcome for mining which was derived from the careful consideration of potential impacts on sensitive surface features, consistent with recommendations of the Southern Coalfield Inquiry and recent PAC reports for the Metropolitan Coal and Bulli Seam Operations projects.

On the basis of a comparative assessment, it was determined that, on balance, when considered against a number of economic, environmental, social, technical and safety criteria, the surface disposal at an expanded REA was the preferred strategy for disposing of reject material associated with the proposed development. This conclusion is supported by a cost benefit analysis which found that the benefits of surface disposal at an expanded REA far exceeded those associated with the underground co-disposal option.

The preferred disposal strategy consists of two new areas adjoining the existing REA, using a staged fill plan approach (refer to **Figure 4.8**).

6.4 Summary

The proposed development, being an expansion of an existing mine, would enable continuing use of existing infrastructure and allow for the continued extraction of the resource at Tahmoor Mine. On balance, the environmental, social and financial consequences of proceeding with alternative options would be greater than proceeding with expansion of the existing mine as proposed.

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7.0 Environmental Assessment and Consent Framework

This section presents the assessment and consent framework for the proposed development. Included is the consent strategy and assessment pathway for the proposed development and an outline of how development consent, if granted, would affect the existing approvals at Tahmoor Mine. A discussion is also provided regarding the influence of the outcomes of the Southern Coalfields Inquiry and the PAC review of underground mining projects in the Southern Coalfields on the proposed development.

7.1 Proposed Tahmoor South Project Development Consent Strategy

Tahmoor Mine currently operates under a framework of historical development consents relating to the Tahmoor Mine, which commenced operations in 1979 and has continued coal production until the present day.

The assessment pathway for the proposed development involves an application to the Minister for Planning under Division 4.7 of Part 4 of the EP&A Act for State significant development. A single, new development consent is sought to govern the operation of underground mining for the proposed development, including the continued use of the existing Tahmoor Mine surface facilities, following the surrender of the existing consents that relate to the Tahmoor Mine surface facilities. The underground mining operations for the existing Tahmoor North mining operations would continue to be governed by the existing Tahmoor North consents that relate to the underground mining within Tahmoor North.

The environmental assessment pathway was discussed with DPE at several pre-lodgement meetings held with Tahmoor Coal. The DPE generally agreed with the proposed approach which seeks to streamline and modernise the current and proposed regulatory framework at Tahmoor Mine.

7.2 Relationship to Existing Consents

The history of Tahmoor Mine consists of the separate development of the former Tahmoor and Bargo Mines, with exploration and approval of mining of the coal resource within both the Tahmoor and Bargo areas commencing in the 1960s and 1970s.

The history of activities and sequence of development consents at Tahmoor Mine has been provided previously in **Section 1.2**. Underground mining at the Mine is currently being undertaken by Tahmoor Coal within the Tahmoor North mining area under the existing approvals listed in **Table 7.1**.

The environmental assessment pathway for the extension of operations at Tahmoor Mine and the surrender of some of the existing consents is reliant on the approval of the proposed development. If approval is granted, some of the existing consents for the Bargo and Tahmoor Mines would be surrendered based on a schedule of completed activities as presented in **Table 7.1**.

Table 7.1 Relationship of assessment pathway with existing consents for Tahmoor and Bargo Mines

Existing Consent	Scope of Development	Proposed Action in relation to New Development Approval
Bargo Mine		
Bargo Consent Granted by Wollondilly Shire Council on 21 April 1976 and by Mittagong Shire Council on 17 September 1975 (referred to as the Bargo consent).	Development of an underground mine and associated surface facilities to the west of the town of Bargo.	The Bargo Consent would be surrendered.

Existing Consent	Scope of Development	Proposed Action in relation to New Development Approval
Tahmoor Mine		
1975 Tahmoor Consent Reference number: 7105/47 Granted by Wollondilly Shire Council on 26 March 1975 (referred to as the 1975 Tahmoor Consent).	Development and operation of a coal mine approximately three kilometres south of the town of Tahmoor, along with the construction of two man-access shafts.	Consent would be surrendered and the Surface Facilities Area would be governed by the new development consent only.
1979 Tahmoor Consent Granted by the NSW Planning and Environment Commission (referred by Wollondilly Shire Council) on 23 August 1979 (referred to as the 1979 Tahmoor Consent).	Longwall mining; approval for CHPP and REA; and subsequent modifications which enabled gas extraction from the mine, the extension of existing coal washery, the transport of product coal to Port Kembla by rail and the transport of coal by road within the Wollondilly LGA or in the event that rail transport is unavailable.	Consent would be surrendered following completion of the current mining activities at Tahmoor North, and the Surface Facilities Area would be governed by the new development consent only.
1994 Tahmoor North Consent Reference number: D47-0029 Granted by the Land and Environment Court on 7 September 1994 (referred to as the1994 Tahmoor North Consent).	Extension of longwall mining into the Tahmoor North mining area, emplacement of rejects on site and approval to increase production to 3.0 million tonnes ROM coal per annum.	Consent relates to the extension of mining and is required for the completion of mining at the Tahmoor North mining area. This consent would remain valid until the completion of mining in 2022 and mine closure in the Tahmoor North mining area and would then be surrendered.
1999 Tahmoor North Consent Reference number: DA No. 67/1998 Granted by the Minister for Urban Affairs and Planning on 25 February 1999 (referred to as the 1999 Tahmoor North Consent).	Extension of longwall mining into Mining Lease 1376.	Consent relates to the extension of mining and is required for the completion of mining at the Tahmoor North mining area. This consent would remain valid until the completion of mining in 2022 and mine closure in the Tahmoor North mining area and would then be surrendered.
Tahmoor Gas Extraction Reference number: 190/85 Granted by Wollondilly Shire Council on 16/12/1985	Surface civil and mechanical work for gas extraction.	Consent would be surrendered.

The approach of surrendering the existing consents would allow for operations in the Tahmoor North mining area to continue to completion and for the smooth transition to a single consent which would govern activities and the final closure and rehabilitation of Tahmoor Mine as a whole. Further details regarding the timing of mine closure and rehabilitation of Tahmoor Mine and the interrelationship with the existing operations is provided in **Section 11.23**.

8.0 Statutory Planning

This section provides an outline of the statutory context for the determination of the development application for the proposed development, together with details of approvals required under relevant State and Commonwealth legislation. The permissibility of the proposed development and the relevant environmental assessment pathway, under State legislation and relevant environmental planning instruments, is presented.

8.1 Environmental Planning and Assessment Act 1979

Development in NSW is assessed and determined in accordance with the relevant provisions of the EP&A Act. Environmental Planning Instruments, including State Environmental Planning Policies (SEPPs) and Local Environmental Plans (LEPs) are an integral component of the development consent process, particularly in relation to the permissibility of development and matters which should be considered by the consent authority when determining an application for development. The environmental planning instruments relevant to the proposed development are discussed in more detail below.

8.1.1 Permissibility

Clause 7(1) of *State Environment Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (Mining SEPP) states:

> *Development for any of the following purposes may be carried out only with development consent:*
>
> *a. underground mining carried out on any land,*
>
> *b. mining carried out:*
>
> *i. on land where development for the purposes of agriculture or industry may be carried out (with or without development consent), or*
> *ii. on land that is, immediately before the commencement of this clause, the subject of a mining lease under the Mining Act 1992 or a mining licence under the Offshore Minerals Act 1999,*
>
> Clause 3 of the Mining SEPP defines 'underground mining' and 'mining' as follows:
>
> *Mining means the winning or removal of materials by methods such as excavating, dredging, or tunnelling for the purpose of obtaining minerals, and includes:*
>
> *(a) the construction, operation and decommissioning of associated works, and*
>
> *(b) the stockpiling, processing, treatment and transportation of materials extracted, and*
>
> *(c) the rehabilitation of land affected by mining.*
>
> *Underground mining means:*
>
> *(a) mining carried out beneath the earth's surface, including board and pillar mining, longwall mining, top-level caving, sub-level caving and auger mining, and*
>
> *(b) shafts, drill holes, gas and water drainage works, surface rehabilitation works and access pits associated with that mining (whether carried out on or beneath the earth's surface),*
>
> *but does not include open cut mining.*

As outlined in **Section 1.1**, Tahmoor Coal is seeking development consent for the proposed extension of underground mining to the south of the existing Surface Facilities Area at Tahmoor Mine, including longwall mining, additional ventilation shaft construction and the expansion of the REA. The proposed development is considered permissible with consent pursuant to clause 7 (1) (a) of the Mining SEPP because it involves *development for the purposes of* 'underground mining carried out on any land'.

The Surface Facilities Area including REA is located on land zoned RU2 Rural Landscape under the *Wollondilly Local Environmental Plan 2011* (Wollondilly LEP 2011). Under this zoning, development for the purposes of agriculture is permissible. The activities proposed in the REA and surface facility area include "*stockpiling, processing, treatment and transportation"*, as defined under 'mining' in clause 3 of the Mining SEPP. Therefore, activities at the REA and surface area are also considered to be permissible with consent, pursuant to Clause 7(1) (b) (i) of the Mining SEPP as 'development for the purposes of mining' (which includes mining by *tunnelling*), carried out on land on which agriculture may be carried out.

The Project Area extends across the Wollondilly and Wingecarribee LGAs. Within the Project Area, the proposed development would be located within the Wollondilly LGA only, on land subject to the Wollondilly LEP 2011. The proposed development constitutes development that is ordinarily permitted with consent in some land use zones, whilst being prohibited in other zones under the Wollondilly LEP 2011 (refer to **Section 8.1.3**). However, pursuant to clause 3 of the Mining SEPP, in the case of an inconsistency with any other environmental planning instrument, the Mining SEPP prevails to the extent of the inconsistency. As such, the Mining SEPP prevails over the Wollondilly LEP 2011 and the proposed development is permissible with consent pursuant to the Mining SEPP on the Project Area within the LGA.

8.1.2 State Significant Development

The proposed development is declared to be State significant development (SSD) because of the combined effect of section 4.36 of the EP& A Act, which states that a State environmental planning policy (SEPP) may declare any development, or any class or description of development, to be State significant development, and clause 8(1) of *State Environment Planning Policy (State and Regional Development) 2011* (State and Regional Development SEPP) which declares development in Schedules 1 and 2 of the SEPP to be State significant development. Clause 5 of Schedule 1 of the State and Regional Development SEPP includes the following class of development as State significant development:

> *"(1) Development for the purpose of mining that:*
>
> *(a) Is coal or mineral sands mining, or*
>
> *(b) Is in an environmentally sensitive area of State significance, or*
>
> *(c) Has a capital investment value of more than $30 million.*
>
> *(2) Extracting a bulk sample as part of resource appraisal of more than 20,000 tonnes of coal or of any mineral ore.*
>
> *(3) Development for the purpose of mining related works (including primary processing plants or facilities for storage, loading or transporting any mineral, ore or waste material) that:*
>
> *(a) Is ancillary to or an extension of another State significant development project, or*
>
> *(b) Has a capital investment value of more than $30 million.*
>
> *(4) Development for the purpose of underground coal gasification."*

The proposed development meets the category of development identified in Clause 5 of Schedule 1 of the State and Regional Development SEPP, as it is for the purposes of coal mining and as such is classified as State ignificant development for the purposes of Section 4.36 of the EP&A Act. Due to its declaration as State significant development, the proposed development is subject to assessment and determination under Division 4.7, Part 4 of the EP&A Act. The Minister for Planning (or delegate) is the consent authority for the proposed development under Section 4.5 (2)(a) of the EP&A Act. This EIS supports the application for development consent made by Tahmoor Coal, and has been prepared in accordance with section 4.15 of the EP&A Act and Schedule 2 of the EP&A Regulation.

Following submission of the PEA for the proposed development to the Secretary on 1 May 2017, the SEARs were issued to Tahmoor Coal on 9 June 2017 and subsequently revised on 20 June 2018 (in relation to SIA requirements). On 12 January 2018, the proposal was determined to be a controlled action under the EPBC Act in relation to potentially significant impacts on listed threatened species and communities and water resources in relation to a large coal mining development. Subsequently, supplementary SEARs covering Commonwealth environmental assessment requirements were issued for the proposal on 14 February 2018.

This EIS has been prepared to comprehensively address the SEARs and relevant requirements of Schedule 2 of the EP&A Regulation (refer to **Table 1.6**).

8.1.3 Environmental Planning Instruments

In addition to the State and Regional Development SEPP, the following environmental planning instruments include provisions relating to issues that are relevant to the environmental impact assessment of the proposed development:

- *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*;
- *State Environmental Planning Policy No. 33 — Hazardous and Offensive Development*;
- *State Environmental Planning Policy No. 44 – Koala Habitat Protection*;
- *State Environmental Planning Policy No. 55 – Remediation of Land*;
- *Sydney Regional Environmental Plan No. 20 - Hawkesbury-Nepean River (No 2- 1997)*;
- *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011*;
- *Wollondilly LEP 2011*; and
- *Wingecarribee LEP 2010.*

State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007

The Mining SEPP consolidates and contains specific planning provisions related to mining and extractive industries, and is the principal environmental planning instrument that governs the carrying out of the proposed development. The Mining SEPP recognises the importance of mining, petroleum production, and extractive industries within the State. Clause 7 of the Mining SEPP identifies mining development that is permissible with development consent as discussed in **Section 8.1.1**.

The aims of the Mining SEPP are:

> *"(a)To provide for the proper management and development of mineral, petroleum and extractive material resources for the purpose of promoting the social and economic welfare of the State, and*
>
> *(b)To facilitate the orderly and economic use and development of land containing mineral, petroleum and extractive material resources, and*
>
> *(c)To establish appropriate planning controls to encourage ecologically sustainable development through the environmental assessment, and sustainable management, of development of mineral, petroleum and extractive material resources."*

Clauses 12AB to 17 of Part 3 of the Mining SEPP contain specific matters that a consent authority must consider before determining an application for consent for development for the purposes of mining, petroleum production or extractive industry. Detailed assessments of the potential environmental impacts of the proposed development are appended to this EIS and summarised in **Section 11.0**.

Table 8.1 specifically refers to clauses 12AB to 17 of the Mining SEPP and refers to how each of the matters has been addressed in **Section 11.0** of this EIS.

Table 8.1 Heads of consideration under Part 3 of the Mining SEPP

Matter for consideration	Corresponding assessment
Clause 12AB: non-discretionary development standards for mining.	This clause identifies development standards in relation to air quality, noise, blast impacts and aquifer interference for mining development. Where an environmental impact assessment indicates that a mining development would meet these standards, then more onerous requirements cannot be applied by a consent authority. However, the clause also provides that not meeting these standards does not prevent a consent authority from granting consent. **Sections 11.10, 11.11** and **11.3** respectively, of this EIS provide an assessment of potential environmental impacts relating to the proposed development on cumulative noise, cumulative air, and aquifer interference. The proposed development would not involve any blasting. Based on the conclusions of this EIS, cumulative air quality is predicted to achieve the annual average PM_{10} development standards identified in this clause, however there is expected to be residual noise and aquifer interference impacts resulting from the proposed development which fall outside of the standards identified. With respect to operational noise, the assessment has determined project specific noise levels considering intrusive and amenity noise criteria and taking into account existing industrial noise sources in the modelling, and the noise assessment demonstrates a noise reduction compared to the existing situation. With respect to aquifer interference, the impact assessment indicates drawdown impacts of greater than two m at some private bores and a cumulative risk of drawdown under Thirlmere Lakes in the Hawkesbury Sandstone of 0.05m. The existing Tahmoor Mine has operated for over 30 years and successfully managed subsidence and groundwater impacts from longwall mining over that time through the implementation of TARP and 'make good' measures at affected groundwater bores. Subsidence and groundwater impacts associated with the proposed development would be managed using a similar approach informed by the extensive experience of longwall mining in the area. Detailed management measures have been identified in **Sections 11.1-11.5** and **11.10** and **11.11**. In addition, **Sections 6** and **13** of this EIS have assessed the need for the project considering the environmental impacts and net project benefits for the Tahmoor South project, which indicate that the proposed development as a whole is justified and in the public's interest.
Clause 12: compatibility of the proposed development with other land uses.	**Section 11.18** and **11.19** describes the existing uses and approved uses of land in the vicinity of the proposed development, presents the impacts of the proposed development on the existing uses and outlines the measures proposed to avoid or minimise incompatibility with these other uses. The Tahmoor Mine is an existing operation that has operated in the area for over 30 years and the proposed development would involve extending the life of mining operations with proposed activities primarily confined below ground and largely to existing surface facilities. Subsidence and related impacts to surrounding receivers and land use would be managed through the implementation of well-established protocols and measures developed over the years of successful longwall mining operations at the site. Based on the assessment presented in the EIS, the proposed development is considered unlikely to significantly impact on surrounding and future land uses in the area.

Matter for consideration	Corresponding assessment
Clause 12A: Consideration of *voluntary land acquisition and mitigation policy*	**Sections 11.1 – 11.24** of this EIS provide an assessment of potential environmental impacts relating to the proposed development and details of the measures proposed to mitigate and manage potential impacts relating to noise and other environmental factors outlined in the policy. **Section 11.10** (operational noise) of the EIS identifies that there may be instances where noise exceedance would trigger acquisition procedures under the voluntary land acquisition and mitigation policy and this is further detailed in **Section 11.10**.
Clause 13: Compatibility of proposed development with mining, petroleum production or extractive industry.	**Sections 1.2 and 2.2.1**of this EIS presents the mining leases associated with the proposed development and outlines the context of the proposed development within the Southern Coalfields. The proposal would not affect other mines in the Southern Coalfields either directly or indirectly. The Tahmoor Mine is one of a number of underground coal mines operating in the Southern Coalfields and the proposed development would be sited alongside existing operations and as such is considered to be compatible with mining industry in the area.
Clause 14: Natural resource management and environmental management	**Sections 11.4** and **11.3** of this EIS provide the outcomes of a surface water impact assessment (**Appendix J**) and groundwater impact assessment (**Appendix I**) respectively, and details of the measures proposed to mitigate and manage potential impacts on these water resources. **Sections 11.6** and **11.7** and **Appendices J** and **K,** respectively outline the ways in which the proposed development has minimised potential impacts on terrestrial and aquatic ecology. A GHG and energy efficiency assessment identified a number of ways in which Scope 1 and 2 emissions can be reduced, including the ongoing use of the existing WCMG Power Plant at the Surface Facilities Area (refer to **Section 11.12** and **Appendix O**).
Clause 15: Resource recovery	The mine planning process for the proposed development has optimised the efficiency of resource recovery within the context of environmental and geological constraints. The mine planning process is presented in **Section 5.0**. The upgrades proposed for the Surface Facilities Area would optimise the efficient recovery of extractive materials and minimise the creation of coal reject material.
Clause 16: Transport	**Sections 11.13** provides the outcomes of a traffic and transport impact assessment (**Appendix P**). Coal transport within the site would involve: ROM coal being delivered by conveyors from the underground workings to the ROM coal stockpile and the CHPP. Reject material would then be transported by trucks to the REA via a private haul road. There would be no change to existing product coal transportation arrangements (which occurs via rail to Port Kembla and at times to Port Waratah) as a result of the proposal. The proposal would not require an increase to the number or frequency of train movements currently approved for product coal transport. There would also be an allowance for coal transport by road in certain circumstances as detailed in **Section 4.2.7.** Traffic and transport impacts associated with the proposed development have been assessed and found to be manageable and within the capacity of the existing road network.

Matter for consideration	Corresponding assessment
Clause 17: Rehabilitation	The underground nature of the mine plan means that surface disturbance is limited. **Section 11.23** describes the proposed rehabilitation and mine closure elements of the proposed development. In addition, a concept Mine Closure and Rehabilitation Plan has been developed for the proposed development (**Appendix V**) which details the proposed end use and landform of the land once rehabilitated.

Part 4AA Mining and petroleum development on strategic agricultural land

The NSW Government has introduced a Gateway assessment process, whereby new State significant mining and coal seam gas proposals are required to undertake an up-front assessment of potential impacts on 'strategic agricultural land', prior to submitting a development application. The Mining and Petroleum Gateway Panel, an independent panel of scientific experts, was established to oversee the Gateway assessment process. Strategic agricultural land is defined as:

- Biophysical strategic agricultural land (BSAL) – land that has the best quality soil and water resources and is capable of sustaining high levels of productivity, and
- Critical Industry Cluster land – a concentration of significant agricultural industries potentially impacted by coal seam gas or mining development.

Clause 50A of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) requires that a development application for 'mining or petroleum development' as defined by the Mining SEPP be accompanied by a gateway certificate for land shown on the Strategic Agricultural Land Map as critical industry cluster land, In addition it requires:

- a gateway certificate, in respect of a proposed development on any other land; or
- a site verification certificate that certifies that the land on which the proposed development is to be carried out is not BSAL.

Clause 17A of Part 4AA of the Mining SEPP defines 'mining or petroleum development' as development specified in clause 5 (Mining) of Schedule 1 to the State and Regional Development SEPP if certain criteria are satisfied. This includes the requirement of a mining lease under the *Mining Act 1992*. As part of the proposed development, an additional mining lease would be required to accommodate the expanded REA over Crown Land (**Figure 1.5**). Additional surface mining leases are also required for the proposed additional ventilation shafts. The proposal therefore meets the definition of a 'mining or petroleum development' for the purposes of Part 4AA of the Mining SEPP and Clause 50A of the EP&A Regulation.

The proposal would not affect any land mapped as Critical Industry Cluster land, which comprises equine and viticulture industry land in the Upper Hunter, and as such would not require a gateway certificate for this purpose.

The NSW Government has mapped strategic agricultural land across NSW at a desktop level. There is no mapped BSAL in the Project Area. The nearest area of mapped BSAL is located between Douglas Park and Camden, approximately 20 km to the north-east of the Project Area.

Consistent with Section 50A of the EP&A Regulation and the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (2013), a Site Verification Certificate was approved for the proposed development on 29 October 2018, confirming that the proposal is not located on land mapped as BSAL.

State Environmental Planning Policy (Infrastructure) 2007

The *State Environmental Planning Policy (Infrastructure) 2007* (Infrastructure SEPP) assists the NSW Government, local councils and the communities they support by outlining the process for providing infrastructure in NSW.

The proposed development primarily comprises mining activities which is not specified under any part of the Infrastructure SEPP.

The proposed development would also largely utilise a range of infrastructure services including existing offsite electrical, telecommunications and water reticulation infrastructure currently servicing the Tahmoor Mine. However some upgrade to the existing services may be required. In addition, the construction and commissioning of an extension to the existing 66kV overhead power line from the REA to the new ventilation shafts on Charlies Point Road would be required.

The existing intersection at the entry to Tahmoor Mine from Remembrance Driveway would also be upgraded as part of the proposed development to provide a dedicated right hand turning bay for vehicles entering the Surface Facilities Area from the south and extended acceleration and deceleration lanes for vehicles entering and exiting from the north and south.

These proposed upgrades have been assessed as part of this development application under Clause 7 (1) (a) of the Mining SEPP as they are required for the purpose of underground mining. As a result, individual assessment of these works against the relevant provisions of the Infrastructure SEPP is not required. If further upgrades to infrastructure are required in the future, they may be assessed individually under Divisions 5, 17, 21, 24 of the Infrastructure SEPP.

State Environmental Planning Policy No. 33 – Hazardous and Offensive Development

State Environmental Planning Policy No 33 – Hazardous and Offensive Development (SEPP 33) requires a consent authority to consider whether a development may constitute a hazardous or offensive industry as defined by SEPP 33. The provisions of SEPP 33 dictates that proposed mitigation measures are to be taken into account when determining whether a development is a hazardous or offensive industry, and that the consent authority must have sufficient information to make its determination and impose conditions to minimise impacts. The SEPP does not apply to the proposed development, as the development relates to a 'mine' and not an industry.

Although the proposed development is not subject to SEPP 33 the potential land use planning risks associated with the proposed development have been considered in a manner consistent with the approach taken for potentially hazardous industry. An initial screening was undertaken using *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (NSW Department of Planning, 2011) to identify whether the type and quantity of hazardous materials exceed the screening thresholds for potentially hazardous developments (refer to **Section 11.22**). It was confirmed that the proposed development would not exceed the screening thresholds.

State Environmental Planning Policy No. 44 – Koala Habitat Protection

State Environmental Planning Policy No. 44 – Koala Habitat Protection (SEPP 44) requires a consent authority to consider whether land subject to a development application is classified as potential koala habitat and/ or core koala habitat. Before development consent can be granted on land defined as core koala habitat, a plan of management must be prepared for that land.

Some vegetated areas within the Wollondilly LGA (within which the proposed development would be confined) may constitute potential or core koala habitat under SEPP 44. The Terrestrial Ecology Assessment undertaken as part of this EIS has identified that Potential Core Koala Habitat is present within the footprint of the proposed development. Despite the presence of Koala feed tree species within the proposed development area, the Terrestrial Ecology Assessment considered it unlikely that Koalas would occur regularly within the area, given the absence of Koala sightings or evidence of the presence of Koalas (such as scats, or scratches on trees) during field surveys, despite targeted searches (Niche, 2018).

Given the absence of evidence of a resident population of Koalas, the development area is not considered to represent Core Koala habitat as defined by SEPP 44 and would not require the preparation of a plan of management in accordance with clause 9 of SEPP 44. Notwithstanding, in recognition of the Potential Koala Habitat affected by the project, the removal of 43.5 ha of habitat would be offset as part of the offset strategy for the proposal.

State Environmental Planning Policy No. 55 – Remediation of Land

State Environmental Planning Policy No. 55 – Remediation of Land (SEPP 55) requires a consent authority, when assessing and determining a development application, to consider whether the land subject to the development is contaminated. If the land is contaminated, the consent authority is required to define whether the land requires remediation before the intended land use can proceed.

A Phase II Environmental Site Assessment (ESA), undertaken for Tahmoor Mine, identified hydrocarbon contamination within the existing Surface Facilities Area of Tahmoor Mine. The contamination is likely to be diesel from a historical underground storage tank (UST). The extent of migration was considered to be minor given that there was limited hydraulic conductivity and the source of the contamination (diesel) is no longer stored in this area.

Offsite migration of diesel or other Total Petroleum Hydrocarbons (TPH) was considered to be unlikely given the slow recharge of groundwater wells and low hydraulic connectivity. Existing soil and groundwater contamination was considered unlikely to present a risk of harm to human health or the environment. At the time of the Phase II ESA, a remediation action plan was not recommended by SEPP 55.

In order to meet the requirements of SEPP 55, the potential for contaminated land to be encountered as part of the proposed activities has been considered using the outcomes of the Phase II ESA (refer to **Section 11.22**).

State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 (Sydney Drinking Water Catchment SEPP) states that developments carried out on land in the Sydney drinking water catchment should incorporate the Water NSW's current recommended practices and standards.

Whilst the Project Area covers the MSA, no elements of the proposed development within the Project Area (including any longwalls or surface infrastructure) would extend into the MSA. Longwall panels in the vicinity of the MSA have been specifically reduced to ensure that they do not extend into MSA land (refer **Section 6.2.4**). As such, the proposed development would not be carried out on land designated as Sydney drinking water catchment. An assessment of neutral or beneficial effects (NorBe) was completed for the proposed development and determined that the project would have no identifiable potential impact on the nearest creek within the MSA.

Sydney Regional Environmental Plan No. 20 - Hawkesbury-Nepean River (No. 2- 1997)

Sydney Regional Environmental Plan No 20 - Hawkesbury-Nepean River (No 2- 1997) (SREP 20) provides a framework to guide and control development in Sydney's greater metropolitan region to protect the environment of the Hawkesbury-Nepean River system. SREP 20 applies to certain land in the greater metropolitan region, situated within a number of local government areas, including the Wollondilly LGA. The Project Area is located within the southern region of the Hawkesbury-Nepean Catchment area, in the Bargo River sub-catchment.

SREP 20 includes planning policies relating to heritage, water quantity (surface flow and groundwater), water quality, and flora and fauna. These planning policies are listed in **Table 8.2**, which also references the location in this EIS where each planning policy has been addressed.

Table 8.2 SREP 20 planning policies

Planning policy	Corresponding assessment
(1) Total catchment management	Surface water impact assessment in **Section 11.4** and **Appendix J**, details the measures proposed to mitigate and manage potential impacts on these water resources. These assessments have been undertaken in consideration of the principles of total catchment management, including the cumulative environmental impact of the proposed development on the catchment.

Planning policy	Corresponding assessment
(2) Environmentally sensitive areas	Surface water impact assessment in **Section 11.4** and **Appendix J**, details the measures proposed to mitigate and manage potential impacts on water quality. Groundwater impact assessment in **Section 11.3** and **Appendix I**, details the measures proposed to mitigate and manage potential impacts on the water table. A geomorphological assessment in **Section 11.2** and **Appendix H,** together with the outcomes of the subsidence impact assessment (**Appendix F** and summarised in **Section 11.1**), details the measures proposed to mitigate and manage potential impacts of the proposed development on bank stability. An ecology impact assessment, in **Section 11.6**, **Section 11.7** and **Appendices J** and **K**, describes the measures proposed to mitigate and manage potential impacts on aquatic habitats (including wetlands) and riverine vegetation. A land use impact assessment in **Section 11.19** and **Appendix T**, together with the ecology impact assessment and surface water impact assessment, describes the measures proposed to mitigate and manage potential impacts on land reserved or dedicated under the *National Parks and Wildlife Act 1974* and conservation area sub-catchments in order to protect water quality and biodiversity.
(3) Water quality	A surface water impact assessment in **Section 11.4** and **Appendix J**, considers potential increases in pollutant loads on receiving waters, water quality goals, the need for an erosion and sediment control plan, and the management of point source and diffuse source pollution. Groundwater impact assessment in **Section 11.3** and **Appendix I** assesses the impact of the proposed development on water quality for groundwater sources.
(4) Water quantity	Surface water impact assessment in **Section 11.4** and **Appendix JL**, considers potential alterations to river flow and stormwater run-off as a result of the proposed development and presents a water balance, including details of onsite water reuse. Groundwater impact assessment in **Section 11.3** and **Appendix J** assesses the impact of the proposed development on water quantity for groundwater sources.
(5) Cultural heritage	A heritage impact assessment in **Sections 11.7**, **11.9** and **Appendix L**, considers potential impact of the proposed development on items and places of cultural heritage significance.
(6) Flora and fauna	An ecology impact assessment, in **Section 11.6, Section 11.7** and **Appendi**x **K**, describes the measures proposed to mitigate and manage potential impacts on flora and fauna communities, particularly threatened species, populations and ecological communities, aquatic habitats, wetland flora, rare flora and fauna, riverine flora, flora with heritage value, habitats for indigenous and migratory species of fauna, and existing or potential fauna corridors.
(7) Riverine scenic quality	A visual impact assessment (VIA), in **Section 11.17** and **Appendix S**, describes the measures proposed to mitigate and manage potential impacts on the scenic quality of riverine corridors including consideration of the need for controls or conditions to protect those scenic areas.
(8) Agriculture/ aquaculture and fishing	An agriculture impact assessment, in **Section 11.19** and **Appendix T**, describes the measures proposed to mitigate and manage potential impacts on agricultural production in rural zones.
(9) Rural residential development	The proposed development would not constitute rural residential development. Impacts of the proposed development on residential properties are described in **Section 11.0**.

Planning policy	Corresponding assessment
(10) Urban development	The proposed development would not constitute urban development. Impacts of the proposed development on rural residential properties are described in **Section 11.0**.
(11) Recreation and tourism	A land use impact assessment, in **Section 11.15, 11.18 and 11.19**, describe the measures proposed to mitigate and manage potential impacts to recreational and tourist assets.
(12) Metropolitan strategy	A land use impact assessment, in **Section 11.19**, describes the proposed development in the context of the vision, goal, key principles and action plan of the *Sydney Metropolitan Strategy for 2036*, also discussed in **Section 8.2**.

Wollondilly Local Environmental Plan 2011

The Wollondilly LEP 2011 presents local environmental planning provisions for land within the Wollondilly LGA, and outlines permissibility of various land uses within individual land use zones.

The majority of the Project Area is contained within the boundaries of the Wollondilly LGA. All of the Surface Facilities Area and the land under which longwall mining in CCL 747 and CCL 716 is proposed are located within this LGA. The Project Area coincides with a number of land use zones under the Wollondilly LEP 2011. The Surface Facilities Area and REA are on land zoned RU2 Rural Landscape, while the longwall mine plan extends beneath land zoned primarily E2 Environmental Conservation, E4 Environmental Living, RU1 Primary Production, RU2 Rural Landscape and RU4 Rural Small Holdings. The footprint of the mine plan also includes areas of Low and Medium Density and Large Lot Residential (R2, R3 and R5, respectively), and SP2 Infrastructure (Road and Railway) (**Figure 8.1**). The potential impacts of the proposed development on land uses within these land use zones are presented in **Section 11.19**.

The proposed development would constitute activities that are ordinarily permitted with consent in some of these land use zones (RU4), and prohibited in others (RU1 and RU2, for example) under the Wollondilly LEP 2011. However, as discussed in **Section 8.1.1**, the proposed development in its entirety is permissible pursuant to the provisions of the Mining SEPP.

Relevant environmental planning provisions, listed under Part 5 and Part 7 of the Wollondilly LEP 2011, have been considered in the assessment of the proposed development as listed in **Table 8.3**.

Table 8.3 Relevant clauses under Part 5 and Part 7 of the Wollondilly LEP 2011

Matter for consideration	Corresponding assessment
Clause 5.10 Heritage conservation	Development consent would be required where development involves the demolition, moving, alteration, disturbance to, or excavation of a known or unknown item, object, place, conservation area or site of heritage. This clause applies to the proposed development as known, and potentially unknown, Aboriginal and European heritage is located within the Project Area. A European heritage and an Aboriginal archaeology and cultural heritage impact assessment have been prepared for the EIS (refer to **Appendix L**). The Aboriginal cultural heritage assessment (ACHA) was prepared in consultation with members of the local Aboriginal community. The assessment concluded that one of the identified Aboriginal cultural heritage sites has the potential to be impacted by surface disturbance works, while twenty six (26) sites have the potential to be impacted by subsidence impacts. Twenty three (23) historic heritage sites with the SSA are considered unlikely to experience any significant impacts as a result of subsidence from the proposed development. Potential impacts and proposed mitigation measures are provided **Section 11.8** and **11.9**.

Matter for consideration	Corresponding assessment
Clause 7.1 Essential services	Clause 7.1 of the Wollondilly LEP 2011 stipulates that a consent authority must be satisfied that essential services, required by a proposed development, are available or that adequate arrangements have been made to make them available when required. **Section 4.0** of this EIS describes the proposed development including details regarding water supply, electricity supply, and the disposal and management of sewage.
Clause 7.2 Biodiversity protection	This clause relates to the protection of terrestrial and aquatic biodiversity. **Section 11.6** and **Section 11.7** of this EIS provides the outcomes of an ecology impact assessment (**Appendix K**) which describes the measures proposed to mitigate and manage potential impacts on terrestrial and aquatic biodiversity.
Clause 7.3 Water protection	Clause 7.3 of the Wollondilly LEP 2011 relates to the protection of the hydrological functions of riparian land, waterways and aquifers and applies to the proposed development as the Project Area is identified as being within an area identified as sensitive land on the Natural Resources – Water Map. Areas identified as sensitive land on the Natural Resources – Water Map are those riparian areas located adjacent to waterways, essentially acting as a riparian buffer zone for waterways. A greater sensitive area is allocated for larger, more important waterways, including the Bargo River. A surface water impact assessment (refer to **Appendix J**) and a groundwater impact assessment (refer to **Appendix I**) have been prepared for the proposed development. The surface water impact assessment includes a watercourse and catchment assessment, flooding assessment, water balance assessment and assessment of potential water quality impacts from the proposed development. The assessment concluded potential impacts would be localised and minor in nature. Mitigation measures to manage potential hydrological and hydrogeological impacts are identified in **Section 11.4** and **Section 11.3**.
Clause 7.4 Flood planning	Clause 7.4 of the Wollondilly LEP applies to land that is at or below the flood planning level of 1:100 average recurrent interval (ARI) flood event plus 0.5 m freeboard. Clause 7.4 sets objectives to minimise flood risk to life and property, to allow development that is compatible with the lands flood hazard (taking into account projected changes as a result of climate change), and to avoid significant adverse impacts on flood behaviour and the environment. Clause 7.4 applies to the proposed development as the Project Area extends over lands below the flood planning level. Flooding impacts within the Project Area and on the Bargo township were assessed as localised and minor. In addition, the proposed development would potentially impact flood behaviour due to subsidence induced changes to the local hydrological regime. The surface water impact assessment has been prepared for the proposed development identified potential flood impacts and proposed mitigation measures. A summary of the assessment and its conclusions is provided **Section 11.4** and **Appendix J**.
Clause 7.5 Earthworks	Clause 7.5 of the Wollondilly LEP relates to earthworks with the objective to ensure earthworks would not have a detrimental impact on environmental functions and processes, neighbouring uses, cultural or heritage items or features of the surrounding land. Clause 7.5 is relevant to the proposed development's earthwork requirements for the REA, exploration borehole drilling and ventilation shaft construction. An assessment of soils and potential erosion is provided in **Section 11.18**. A soils and water management plan would be prepared prior to construction of the REA and ventilation shafts to manage potential impacts associated with the proposed earthworks.

A number of amendments to the Wollondilly LEP within the Project Area are under consideration. These are outlined in **Table 8.4**.

Table 8.4 Current status of planning proposals and projects within the Project Area

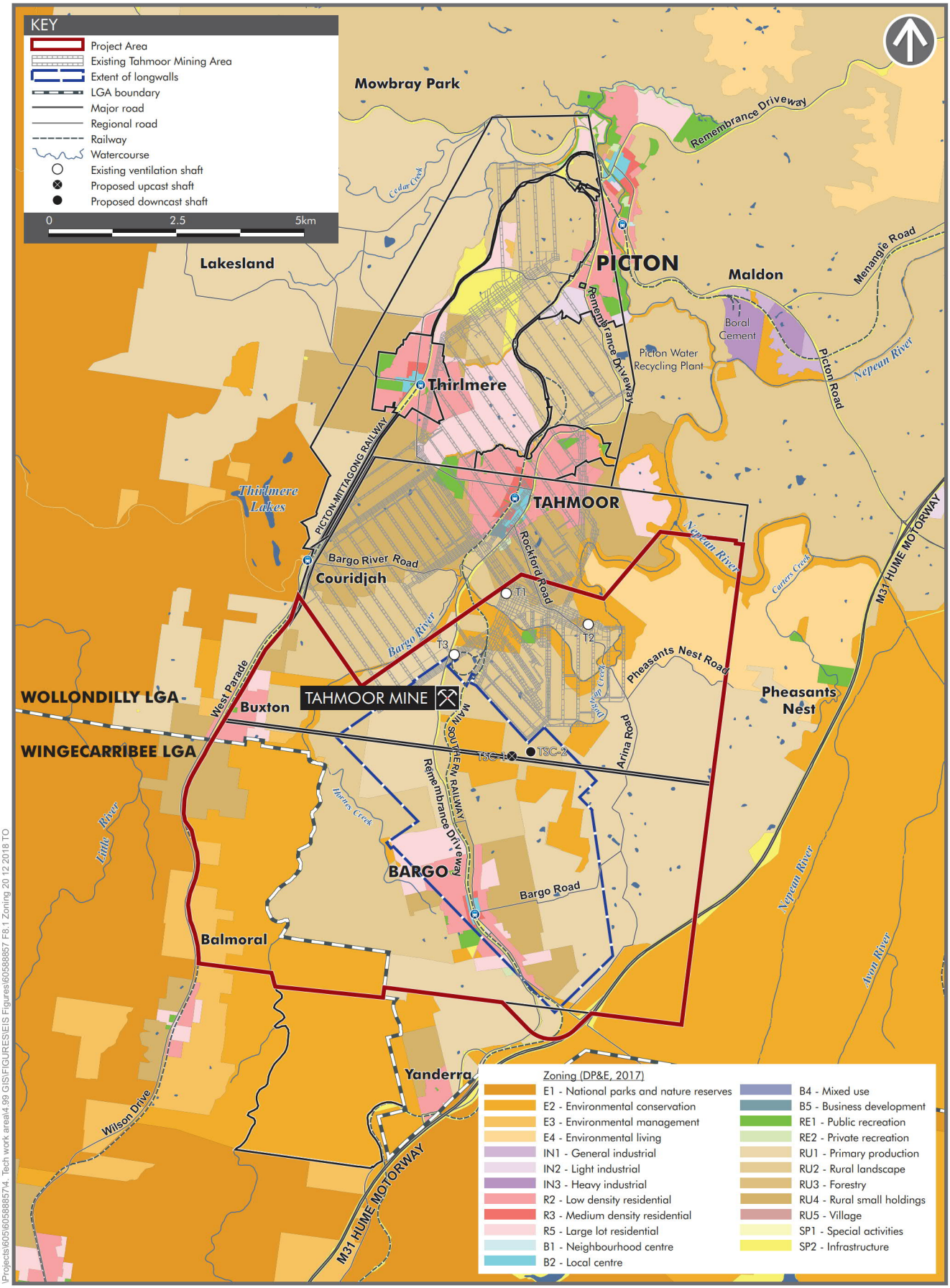
Status	Proposal name	Location	Detail of proposal
Specialist Studies, Public Exhibition & Revision	Land Adjoining Bargo Sportsground	Bargo	Rezone the subject site to allow for future subdivision for large lot residential purposes
	Noongah and Gwynn Hughes Streets	Bargo	Rezone the subject site to permit future subdivision of land for large lot residential and environmental management purposes
	Government Road	Bargo	Rezone the subject site to permit future subdivision for environmental living purposes
	Great Southern Road	Bargo	Rezone the subject site to allow future subdivision of land for low density residential purposes, with a variety of minimum lot sizes
Preliminary Assessment	65-95 Ironbark Road	Bargo	Rezone approximately 8.8 ha of rural zoned land to enable low density residential purposes
Approved	Avon Dam & Hawthorne Roads	Bargo	Rezoning of site to part R2 Low Density Residential and part R5 Large lot residential
	J. R. Stud	Tahmoor	Part R5 Large Lot Residential; Part RE2 Private Recreation; Part Environmental Conservation

Proposed rezoning to allow for additional residential development would increase the number of sensitive receivers in the Project Area, should development proceed. Impacts to potential residential buildings in the Wollondilly LGA have been considered in the subsidence assessment (**Section 11.1**)

Wingecarribee Local Environmental Plan 2010

The proposed development would be undertaken within the Wollondilly LGA. The Project Area extends into Wingecarribee LGA, however no activities associated with the project would take place in the LGA.

Notwithstanding, this relevant environmental planning provisions, listed under Part 5 and Part 7 of the Wingecarribee LEP 2010, have been considered in the assessment of the proposed development, noting that the proposed development would be located in proximity to land subject to this LEP. These matters are listed in **Table 8.5**. No part of the project is in Wingecarribee LGA.



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LAND USE ZONING

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FIGURE 8.1

Table 8.5 Relevant clauses under Part 5 and Part 7 of the Wingecarribee LEP 2010

Matter for consideration[1]	Corresponding assessment
Clause 7.5 Natural resources sensitivity—water	Clause 7.5 relates to the protection of the hydrological functions of riparian land, waterways and aquifers and applies to the proposed development as the Project Area is identified as being within lands identified as 'Natural Water Bodies' on the Natural Resources Sensitivity Map. A surface water impact assessment (refer to **Appendix J**) and a groundwater impact assessment (refer to **Appendix I**) have been prepared for the proposed development. The surface water impact assessment includes a watercourse and catchment assessment, flooding assessment, water balance assessment and assessment of potential impacts on water resources. Mitigation measures to manage potential hydrological and hydrogeological impacts are identified in **Section 11.4** and **11.3**.

Note: 1 Clause 7.5 is considered relevant to the proposed development given potential downstream water resources impacts. Other clauses under Part 5 and Part 7 of the Wingecarribee LEP 2012 are not considered to be relevant because the project would not be undertaken within the LGA.

8.1.4 Other NSW Environmental Approvals

Sections 4.41 and 4.42 of the EP&A Act list other NSW environmental approvals that would not be required for State significant development (section 4.41), or that would need to be issued so that they are substantially consistent with the development consent for the proposed development (section 4.42). Where other environmental approvals are required in addition to those referred to under sections 4.41 and 4.42 of the EP&A Act, these approvals have been considered and outlined where relevant to the assessment of the proposed development.

Notwithstanding, where separate environmental approval processes have been integrated into the assessment regime under the EP&A Act, this EIS has considered and addressed the same issues that would have otherwise been required to be assessed for the separate environmental approval. Each of these separate approvals is considered in **Table 8.6**, **Table 8.7**, and **Table 8.8**.

Table 8.6 Approvals not required under section 4.41 of the EP&A Act

Approval	Comment
Concurrence under Part 3 of the *Coastal Protection Act 1979*.	The *Coastal Protection Act 1979* has been repealed and has been replaced by the *Coastal Management Act 2016.* The Project Area would not be designated as a Coastal Zone as a result of the *Coastal Management Act 2016*.
A permit under section 201of the *Fisheries Management Act 1994 (FM Act)*.	The proposed development would not involve dredging or reclamation works.
A permit under section 205 of the FM Act.	The proposed development would not harm marine vegetation and as such, a permit under section 201 of the FM Act would not be required.
A permit under section 219 of the FM Act.	The proposed development is unlikely to result in the blockage of fish passage.
An approval under Part 4, or an excavation permit under section 139 of the *Heritage Act 1977*.	The extent to which the proposed development is likely to impact heritage items has been assessed as part of this EIS (refer to **Section 11.9**).

Approval	Comment
An Aboriginal heritage impact permit under section 90 of the *National Parks and Wildlife Act 1974.*	The dominant features of Aboriginal heritage in the Project Area comprise rock shelters and artwork, artefact scatters and axe grinding grooves associated with the Bargo River and major creek lines such as Dog Trap Creek, and are identified as environmentally sensitive in regards to items of Aboriginal heritage significance. The proposed development and mine plan has been designed to avoid impacts on Aboriginal heritage objects, places, land or persons wherever reasonable and feasible to do so. The extent to which the proposed development is likely to impact on Aboriginal cultural heritage has been assessed as part of this EIS (refer to **Section 11.8**).
A bushfire safety authority under section 100B of the *Rural Fires Act 1997*.	Components of the proposed development would be located in bushfire prone areas. Bushfire prone land would not require subdivision to accommodate the installation of additional ventilation shafts, or for the expansion of the existing REA. Further discussion on bushfire hazards and management is provided in **Section 11.22**.
A water use approval (section 89), a water management work approval (section 90) or an activity approval (other than an aquifer interference approval) (section 91) of the *Water Management Act 2000*.	The proposed development is located within an area covered by the WSP for the *Greater Metropolitan Region Groundwater Sources* (GMRGS). The provisions of this WSP have been considered within assessments undertaken as part of this EIS (refer to **Section 11.3**). The proposed development would involve water supply works and drainage works, as well as the taking of groundwater. The proposed development would also involve works in, on or under waterfront land, as defined by the WM Act. The potential impacts of the proposed development on water resources and waterfront land is discussed in **Section 11.4.** Tahmoor Mine currently extracts groundwater that drains into underground mine workings, and pumps this water to the surface via three dewatering lines before treating the water and discharging it off site. One groundwater licence is currently held under the WM Act which covers this dewatering activity (Licence Number 10WAl18745), with an annual total of less than or equal to 1,642 ML. The groundwater impact assessment (refer to Section **11.3**) for the Tahmoor South Project predicted that the annual take of groundwater (as mine inflows) would be 4.7 ML per day on average, peaking at 7.5 ML to 8 ML per day, which equates to approximately 2,600 ML to 2,850 ML per annum. Given that the groundwater entitlement volume currently held by Tahmoor Coal is 1,642 ML/annum, an additional entitlement of 1,208 ML would need to be secured via licencing to accommodate the peak predicted take of 2,850 ML/annum. The groundwater assessment has identified sufficient unassigned water is available within the Sydney Basin Nepean Groundwater Source and that this licence requirement can be secured.

Table 8.7 Approvals required to be issued consistently under section 4.42 of the EP&A Act

Approval	Comment
An aquaculture permit under section 144 of the FM Act.	The proposed development does not involve aquaculture.
An approval under section 15 of the *Mine Subsidence Compensation Act 1961* and *Mine Subsidence Compensation Amendment Act 2014* (repealed)	The *Mine Subsidence Compensation Act 1961* and *Mine Subsidence Compensation Amendment Act 2014* were repealed on January 1 2018 and have been replaced by the *Coal Mine Subsidence Compensation Act 2017.* The *Coal Mine Subsidence Compensation Act 2017* provides for the assessment and management of risks associated with subsidence resulting from coal mine operations and includes provisions for the compensation or repair services required to mitigate the damage caused by mine subsidence following underground coal mining. Subsidence Advisory NSW (SA NSW) is responsible for administering the *Coal Mine Subsidence Compensation Act 2017*. SA NSW is also responsible for reducing the risk of mine subsidence damage to properties, through its assessment and control of the types of buildings and improvements which can be erected in Mine Subsidence Districts. Part 3 of the *Coal Mine Subsidence Compensation Act 2017* stipulates that approval must be sought from SA NSW to alter or erect improvements within a mine subsidence district. An 'improvement', for the purposes of the *Coal Mine Subsidence Compensation Act 2017* is defined as: *"(a) any building or work erected or constructed on land;* *(b) infrastructure, whether above or below the surface of the land."* The proposed development would involve a number of activities that constitute 'improvements' under this definition. Furthermore, the majority of the Project Area is contained within the boundaries of the Bargo Mine Subsidence District, with a small portion to the north east extending into the Wilton Mine Subsidence District (refer to **Figure 8.2**). As such, approval for the proposed development would be sought from SA NSW in accordance with Part 3 of the *Coal Mine Subsidence Compensation Act 2017.* Mine subsidence impacts of the proposal have been assessed in **Section 11.1** of this EIS, including the claims process for seeking compensation for any damages attributed to the proposed development.

Approval	Comment
A mining lease under the *Mining Act 1992*.	The overarching objective of the Mining Act is to encourage and facilitate the discovery and development of mineral resources in NSW, having regard to the need to encourage ecologically sustainable development. The Mining Act controls the granting of exploration and mining titles and, amongst other legislative instruments, places controls on methods of exploration and extraction, the disposal of mining waste, and rehabilitation and environmental management activities. The proposed development would operate within CCL 747 and CCL 716 and would utilise existing surface infrastructure facilities at the Tahmoor Mine, located within ML 1642 (refer to **Figure 3.3**) As part of the proposed development, an additional mining lease would be required to accommodate the expanded REA over Crown Land (**Figure 1.5**). Additional surface mining leases are also required for the proposed additional ventilation shafts. Approvals would be sought for all required amendments to existing Mining Leases and additional Mining Leases obtained in accordance with the relevant sections of the Mining Act prior to commencement of the proposed development.
A production lease under the *Petroleum (Onshore) Act 1991*.	The proposed development would involve pre-gas drainage of coal seams. The primary purpose of pre-gas drainage is to create a safe environment for longwall mining. As such the works would be ancillary to the mining activity and further approval under the *Petroleum (Onshore) Act 1991* is not required.
An EPL under Chapter 3 of the *Protection of the Environment Operations Act 1997* (for any of the purposes referred to in section 43 of that Act).	Mining for coal is listed as a scheduled activity under clause 28(2) (a), Schedule 1 of the *Protection of the Environment Operations Act 1997* (POEO Act). With a capacity to produce more than 500 tonnes of coal per day, the proposed development would exceed the threshold under Clause 28 of Schedule 1 of the POEO Act and as such, licensing for the proposed development is required. Tahmoor Mine currently holds EPL 1389, which regulates water quality, air quality and noise for the existing operation. Subsequent to development consent, should it be granted for the proposed development, variations to EPL 1389 would be required. Such variations may include: • Expansion of the Premises Description within the EPL to cover the area of the expanded REA as well as the proposed additional ventilation shafts. • Modification of the scale of the Scheduled Activities of Coal Works and Mining for Coal from the current EPL limit of 2,000,000 tonnes of product coal to reflect the proposed increased ROM and product coal tonnage. Potential also exists for the current noise, air quality, GHG, and water quality licence conditions to be updated during the variation of EPL 1389. Detailed noise, air quality, greenhouse gas, and water quality impact assessments have been undertaken as part of this EIS, within which improvements and the potential for changed licence limits have been considered (refer to **Sections 11.10**, **11.11**, **11.12** and **11.4**).

Approval	Comment
Consent under section 138 of the *Roads Act 1993*.	One of the key objectives of the *Roads Act 1993* is to regulate the carrying out of various activities on public roads. The proposed development would involve an upgrade to the intersection at the entrance to the Surface Facilities Area on Remembrance Driveway. This would trigger the requirement for approval from RMS under section 138 *of the Roads Act 1993*. Approval for these actions would be sought from RMS prior to the commencement of the proposed development.
A licence under the *Pipelines Act 1967*.	The *Pipelines Act 1967* outlines requirements for licences relating to the construction, alteration, or reconstruction of pipelines. The proposed development would involve the construction and operation of a pipeline, for the purposes of the pre-gas drainage operations, which may require a licence under the *Pipelines Act 1967*.

Table 8.8 Other Approvals

Approval	Comment
Water Management Act 2000 - assessment under the *NSW Aquifer Interference Policy*	The *NSW Aquifer Interference Policy* was released in September 2012. It defines the requirements for assessing the impacts of aquifer interference activities on water resources, with the aim of striking a balance between the water use requirements of towns, farmers, industry and the environment. Under the requirements of the *NSW Aquifer Interference Policy*, an activity's predicted impacts are considered acceptable if they do not exceed the Level 1 thresholds provided within the Policy by no more than the accuracy of an otherwise robust model. A detailed assessment of potential impacts of the proposed development on relevant groundwater resources has been undertaken as part of this EIS (refer to **Section 11.3**). Results of this assessment indicate that the proposed development would be classified as Level 2 within the minimal impact considerations of the *NSW Aquifer Interference Policy*. Consequently, the proposed development would require risk mitigation, prevention or avoidance strategies to be implemented so that groundwater impacts are managed within acceptable limits.

Approval	Comment
Dams Safety Act 1978	The Dams Safety Committee (DSC) is the State's regulator for dam safety under the NSW *Dams Safety Act 1978*. It is responsible for the development and implementation of policies and procedures for effective dam safety management to protect life, property and the environment from dam failures. The DSC acts to prevent or mitigate any damage to a prescribed dam. A listing of prescribed dams is provided within Schedule 1 of the *Dams Safety Act 1978* and includes Nepean Dam, located south-east of the Project Area. Prescribed dams are generally surrounded by a Notification Area, within which mining companies are required to address risks of damage to dam structures as well as risks of loss of stored water through the reservoir floor. The DSC, with approval from the Premier in the case of mining, can issue written notice requiring the cessation of any work as may be reasonably necessary to ensure the safety of the prescribed dam. No far field effects are predicted for the Nepean Dam. Consequently, approval from the DSC is not required for the proposed development. No Mining Leases associated with the proposed development fall within the boundary of the Notification Area. Nonetheless, potential impacts on Nepean Dam are discussed in **Section 11.3** of this EIS.
Biodiversity Conservation Act 2016	The *Biodiversity Conservation Act 2016* (BC Act) replaces the *Threatened Species Conservation Act 1997* (TSC Act) and aims to maintain a healthy, productive and resilient environment for the well-being of the community consistent with the principles of ecologically sustainable development. However, the provisions of Part 7 of this Act relating to biodiversity assessment and approvals does not apply to the proposed development as it meets the transitional provisions under the *Biodiversity Conservation (Savings and Transitional) Regulation 2017.* Under Clause 28, Part 7 of the Regulation, '*Former planning provisions continue to apply to pending or interim planning applications'.* In order to be determined a 'pending or interim planning application', a development must meet one of the definitions provided under Clause 27 of Part 7 of the Regulation, The proposed development meets the definition under sub-clause (b) in that the development application will be submitted within 18 months of the commencement of the BC Act, will be accompanied by an EIS, and the SEARS were issued prior to the commencement of the BC Act. Accordingly, the proposed impacts on biodiversity as a result of the proposed development have been assessed in accordance with the requirements of the *Framework for Biodiversity Assessment* (FBA) (OEH, 2014) under the TSC Act.

8.1.5 Summary of Approvals

Based on applicable legislation outlined in **Section 8.1.4** above, a summary of the approvals and permits required for the proposed development is provided below:

- additional water licence under the *Water Management Act 2000;*
- approval under the *Coal Mine Subsidence Compensation Act 2017*;
- new leases and amendments to existing leases under the *Mining Act 1992*;
- variation to existing EPL under the POEO Act;
- road permit under section 138 of the *Roads Act 1993*; and
- licence under the *Pipelines Act 1967*.

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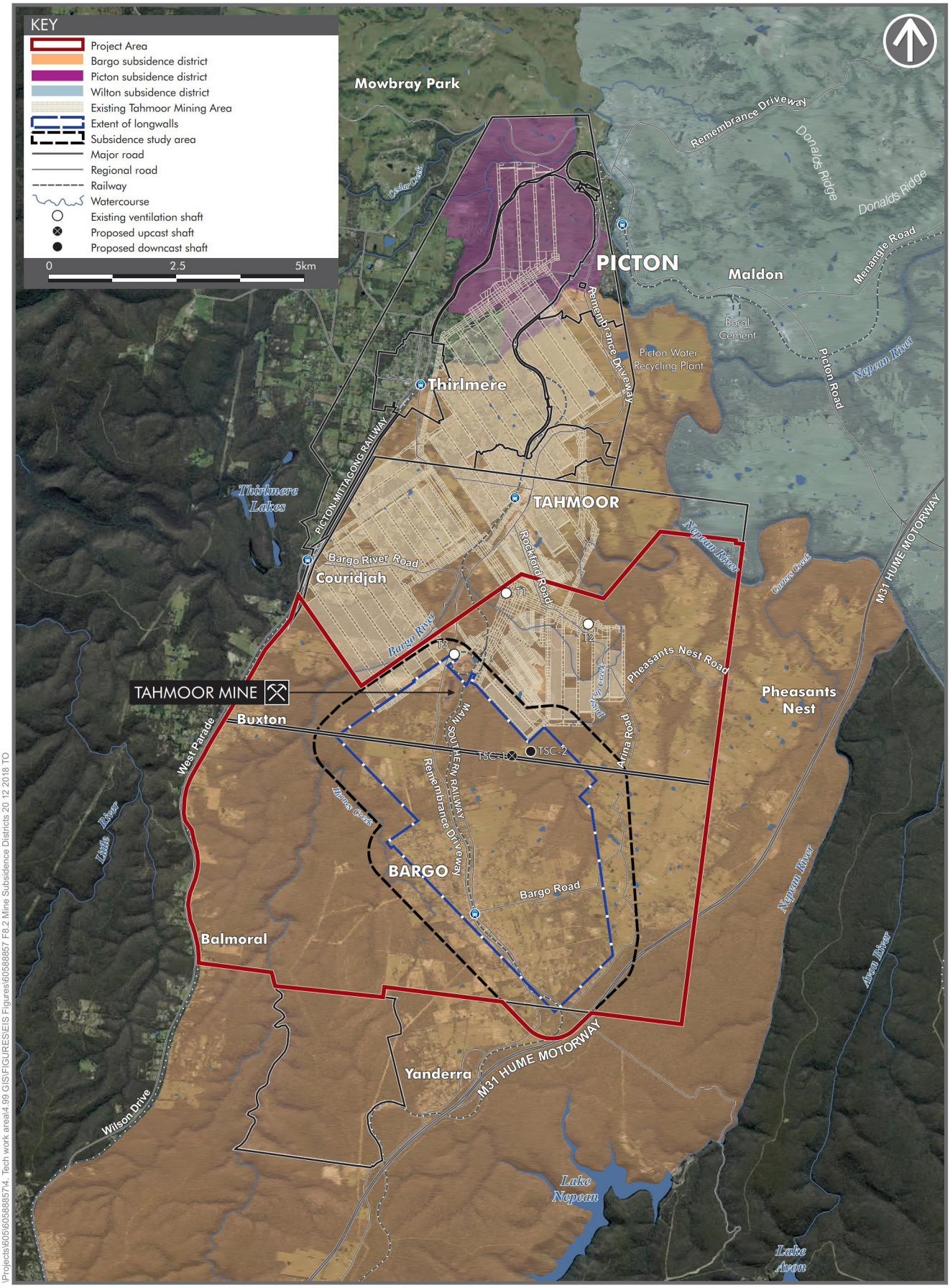

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MINE SUBSIDENCE DISTRICTS

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FIGURE 8.2

8.2 Strategic Land Use Planning

Strategic land use plans relevant to the proposed development include the *A Plan for Growing Sydney (NSW Government, 2014)* and Western District Plan (GSC, 2018). The proposed development has been considered in the context of each of these strategic land use plans, as discussed below.

8.2.1 Integrated Mining Policy

The *Integrated Mining Policy* aims to improve regulation and assessment of major mining projects while balancing the economic benefits with environmental impacts, and keeping the community informed. The policy does not reduce environmental standards or community consultation requirements currently in place for mining projects.

The policy includes indicative SEARs which outline common assessment requirements for mining projects, providing early guidance for the consideration of key issues by proponents prior to DPE issuing project specific SEARs for a development. The key issues assessed as part of this EIS are generally consistent with the indicative SEARs identified in the policy and addresses the project-specific SEARs issued for the development. Details of the assessment are provided in **Section 11.0**.

The *Mine Application Guideline 2015* (NSW Government, 2015) contained within the policy has been prepared to assist proponents in preparing development applications for mining proposals. The guideline is intended to ensure applications adequately describe the project description, strategic context for the proposed development, trade-offs that have been made in the design process, key environmental issues, and consultation undertaken. These matters have been addressed in the EIS in **Section 4.0** Proposed Development, **Section 6.0** Project Need and Alternatives, **Section 9.0** Stakeholder Engagement, and **Section 10.0** Identification of Environmental Issues.

The guideline also outlines the requirements for some projects to obtain a site verification certificate or gateway certificate under the Mining SEPP. As discussed in **Section 8.1.3**, a site verification certificate has been obtained for the proposal, confirming that the proposed development would not affect areas mapped as BSAL, consistent with the requirements of clause 50A of the EP&A Regulation.

The policy also contains *Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals 2015* (NSW Government, 2015). These guidelines focus on two key matters the consent authority must consider when determining a development application for a mining project, '*the collective public interest of households in NSW and the development's likely environmental, social and economic impacts on the local area*'. An Economic Impact Assessment and Social Impact Assessment (SIA) have been completed for the project and have considered these matters (refer to **Appendix Q** Social Impact Assessment and **Appendix R** Economic Impact Assessment). An assessment of the impacts of the proposed development on the environment is provided in **Section 11.0**.

The development application for the proposed development has been prepared generally in accordance with the guidance material presented within the *Integrated Mining Policy*.

8.2.2 A Plan for Growing Sydney

A Plan for Growing Sydney (NSW Government, 2014) (*Growing Sydney*) aims to promote the growth of Sydney by guiding land use planning decision making for the next 20 years. It provides a framework based around the following four key goals:

- Goal 1 – To develop a competitive economy with world-class services and transport;
- Goal 2 – To deliver greater housing choice to meet changing needs and lifestyles;
- Goal 3 – To create strong, healthy and well-connected communities; and
- Goal 4 – To safeguard the natural environment.

Some of the actions of Growing Sydney relate to transforming the productivity of western Sydney through growth and investment, and growing strategic centres such as Penrith, Liverpool and Campbelltown-Macarthur to provide more jobs closer to home.

Should development consent be granted for the proposed development, mining operations at Tahmoor Mine would be authorised to continue for approximately a further 13 years, maximising the recovery of coal resources within Tahmoor Coal's mining lease areas. The proposed extension of the life of the Mine would enable ongoing direct employment and provide a significant resource-based economic contribution at a regional, State and national level in an area already recognised as resource rich. The benefits of the proposed development would therefore assist the broad aims of *Growing Sydney* in providing jobs closer to homes in south-western Sydney. The proposed development would not impact on other strategic directions of *Growing Sydney*. The proposed development would not conflict with future strategic land use in the Bargo Area, which would be a Metropolitan Rural Area under the plan. Retaining local jobs for local communities of Metropolitan Rural Areas is an important outcome under the plan and the project would be consistent with the outcome.

8.2.3 Western District Plan

Of all the Districts in Greater Sydney, the Western District is undergoing the most dramatic change. The *Western District Plan* (Greater Sydney Commission, 2018) (Western District Plan) recognises that there are substantial mineral resources in the Western District, and that coal mining already takes place. The Plan also recognises that primary industries are essential to the Western District's economy and that they may need to be protected to avoid their transition to higher uses such as suburban residential development.

The proposed development would capitalise on extracting resources in a manner consistent with the aims of the Western District Plan relating to environmental protection through the assessment of environmental impacts and ongoing management. The proposed development would not conflict with future strategic land use in the Bargo Area, which would remain a Metropolitan Rural Area under the plan.

8.2.4 Sydney-Canberra Corridor Regional Strategy 2008

The *Sydney-Canberra Corridor Regional Strategy 2006-2031* (Department of Planning 2008) applies to the Wingecarribee LGA. The primary aim of the *Sydney-Canberra Corridor Regional Strategy 2006-2031* is to accommodate and manage growth while ensuring that the rural landscapes and environmental settings that define the region's character are not compromised. The Regional Strategy notes that the Southern Coalfield is an important source of coking and thermal coal and that LEPs will provide for the protection of extractive industries and mineral resources through appropriate land use zonings and planning controls that limit the potential for land use conflicts in the buffer areas around these resources. The proposed development, through the production of coking coal and thermal coal, would be consistent with the strategic land use outcomes envisaged by the Strategy, in that the Strategy acknowledges the regional importance of, and aims to protect, such mining operations through appropriate planning controls. Job creation by the proposed development (50-175 additional positions during the construction/ transition period and retention of existing employment over the extended 13 year mine life) would also align with the overall objectives of the *Sydney-Canberra Corridor Regional Strategy* of accommodating growth in the region.

8.2.5 Southern Coalfield Inquiry

The Southern Coalfields Inquiry was an independent inquiry into underground coal mining in the Southern Coalfields (see **Section 5.3.1**).

The Inquiry was established by the NSW Government on 6 December 2006, and was established in response to concerns held by the then State Government over past and potential future impacts of mining-induced ground movements on significant natural features in the Southern Coalfields. This action followed community concerns regarding mine-related subsidence impacts to the Cataract River that occurred as a result of mining at Appin West Colliery.

The purpose of the Southern Coalfield Inquiry was to:

1. *Undertake a strategic review of the impacts of underground mining in the Southern Coalfields on significant natural features (i.e. rivers and significant streams, swamps and cliff lines), with particular emphasis on risks to water flows, water quality and aquatic ecosystems;*
2. *Provide advice on best practice in regard to:*
    a. *Assessment of subsidence impacts;*

b. Avoiding and/or minimising adverse impacts on significant natural features;

c. Management, monitoring and remediation of subsidence and subsidence-related impacts; and

3. Report on the social and economic significance to the region and the State of the coal resources in the Southern Coalfields.

The Southern Coalfields Inquiry, in considering the natural features of the Southern Coalfields and the impacts of subsidence, concluded:

- the site conditions within the Southern Coalfields, a dissected landscape of incised rivers and gorge country as well as geological features including faults and dykes, give rise to non-conventional subsidence impacts such as valley closure, upsidence and regional far-field horizontal displacement; and
- it is the valley closure and upsidence effects from underground mining that create the majority of impacts on significant natural features such as the cracking of stream beds, rock falls from cliff lines and alteration of groundwater chemistry in shallow aquifers.

The Southern Coalfields Inquiry made recommendations regarding best practice in relation to the assessment of subsidence impacts, ways to minimise adverse impacts on significant natural features, and the management, monitoring and remediation of subsidence and subsidence related impacts.

This environmental assessment for the proposed development has considered the recommendations of the Southern Coalfield Inquiry report as summarised in **Table 5.1**, and further discussion of the relevant environmental impacts and proposed management measures is included in **Section 11.0**.

8.3 Commonwealth Environmental Approvals

8.3.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act requires approval from the Commonwealth Minister for Environment where an action will, or is likely to have, a significant impact on a MNES.

It was identified that the proposed development triggers the requirement for an EPBC Act referral (and potential subsequent need for approval under that Act) through:

1. direct impacts, principally through vegetation clearing associated with the construction and operation of the REA and to a lesser extent, ventilation shafts and surface pre-gas drainage activities; and
2. indirect impacts principally associated with subsidence-related changes to surface elevation, topography and drainage (including potential cracking interactions between groundwater and surface water systems).

The proposed development was referred to the DoEE on 20 October 2017 (EPBC 2017/8084) for consideration as a controlled action, based on potential impacts to listed threatened species and communities, and water resources. The proposed development was determined to be a controlled action by DoEE on 12 January 2018 on the basis that it may impact the following MNES:

- Shale/Sandstone Transition Forest (SSTF) - a Critically endangered ecological community (CEEC) under the EPBC Act, identified within the footprint of the proposed surface facilities including the REA expansion area;
- *Persoonia bargoensis* - listed as vulnerable under the EPBC Act, which has also been identified within the footprint of the proposed REA expansion area;
- *Grevillea parviflora* subsp. *parviflora* - listed as vulnerable under the EPBC Act, which has also been identified within the footprint of the proposed REA expansion area;
- Rufous Pomaderris (*Pomaderris brunnea*) - listed as vulnerable under the EPBC Act; and
- impacts to groundwater resources as a result of longwall mining (Water Trigger).

In addition, the DoEE identified that there is some risk of significant impacts on the following matters and the levels of impact should be further investigated:

- Turpentine-Ironbark Forest of the Sydney Basin Bioregion – Critically Endangered;
- Woronora Beard-heath (*Leucopogon exolasius*) – Vulnerable;
- Koala (*Phascolarctos conereus*) – Vulnerable;
- Macquarie Perch (*Macquaira australasica*) – Endangered; and
- Greater Glider (*Petauroides Volans*) – Vulnerable.

The supplementary SEARs issued by DPE following the declaration of the proposed development as a controlled action confirmed that the proposed development would be assessed in accordance with the NSW Bilateral Agreement (2015).

The potential impacts on listed threatened species and communities, and on water resources, are discussed in detail in **Section 11.3, 11.4, 11.6** and **11.7** , respectively.

It is noted that the DoEE referral and Controlled Action determination of the proposed development was based on an earlier mine plan layout, which included mining in both the Central and Eastern domains. As discussed in **Section 6.2.4**, subsequent mine planning has led to a revised mine plan involving mining in the Central Domain only (current proposed development) which would result in reduced native vegetation clearing and associated habitat loss (49.2 ha compared to 53.3 ha). Terrestrial ecology impacts are further assessed in **Section 11.6**.

8.3.2 Native Title Act 1993

The *Native Title Act 1993* recognises that Aboriginal people have rights and interests to land which derives from their traditional laws and customs. Native Title interests can be resolved in three ways; through a Native Title Claim (applications and determinations), through an Indigenous Land Use Agreement (ILUA), or future act agreements.

To determine the Native Title status of land within the Project Area, a Native Title extinguishment search was conducted for land within the Project Area. The search identified land subject to Native Title which is not extinguished or partially extinguished.

The Gundungurra Tribal Council Aboriginal Corporation has a Native Title claim registered as Gundungurra #6 (dating 21 June 2000) extending from Katoomba to Goulburn and included the Project Area. The claim was withdrawn during June 2014, upon an indigenous land use agreement (ILUA) between the Gundungurra people, the Gundungurra Tribal Council Aboriginal Corporation, Gundungurra Aboriginal Heritage Association and the NSW Government. The ILUA excludes the Project Area.

An ILUA is an agreement between a Native Title group and other parties who use or manage the land and waters. The ILUA process allows for negotiation between indigenous groups and other parties over the use and management of land and water resources, and the ability to establish a formal agreement. An ILUA is binding once it has been registered on the Native Title Tribunal's Register of Indigenous Land Use Agreements. However, the ILUA would not have the potential to impact the proposed development.

During the ACHA for the proposed development Registered Aboriginal Parties and aboriginal stakeholder groups including the Gundungarra Aboriginal Heritage Association Inc. were consulted about the proposed development and given the opportunity to provide input regarding cultural significance (refer to **Section 9.2.2**).

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9.0 Stakeholder Engagement and Project Refinement

Tahmoor Coal has a long history of successful engagement with the local community in which it operates, striving to sustain positive relationships through a process of ongoing consultation and interaction. This interaction provides a means by which Tahmoor Coal can openly and honestly address issues and involve the community in decisions that affect them. Details of existing stakeholder engagement are discussed in **Sections 3.8** and **11.1.3**.

9.1 EIS Consultation

Stakeholder engagement has been undertaken throughout the project planning and environmental impact assessment process, including consultation with local and State Governments, industry regulators, near neighbours, the local Aboriginal community and the wider local community. This section provides an overview of the engagement process applied, its objectives, a description of the various engagement phases and the engagement activities undertaken. Also summarised are the findings of these activities, and references to where these findings have been incorporated and addressed in the assessments undertaken for this EIS.

9.1.1 Planning Focus Meeting

A Planning Focus Meeting (PFM) was held at the DPE Bridge Street Offices on October 18, 2012. The PFM was attended by 10 government regulators representing agencies including DPE, the then NSW Trade & Investment – Division of Resources and Energy (now replaced by the DRG), the then NSW Office of Water (now replaced by DI Water), Wollondilly and Wingecarribee Shire Councils, Sydney Catchment Authority (now Water NSW), NSW EPA, OEH, Roads and Maritime Services (RMS), Transport for NSW, and the Project Team.

The PFM included a presentation and discussion on the proposed development, proposed assessment methodology and identified potential environmental impacts as well as preliminary management and mitigation measures. Key issues raised during the PFM related to:

- the potential impacts of subsidence associated with the proposed development on:
  - infrastructure including the M31 Hume Motorway, railway bridges (refer to **Section 11.1**);
  - Aboriginal heritage values along Dog Trap Creek (refer to **Section 11.8**);
  - the height of fractures and potential impacts on aquifer interference (refer to **Section 11.3**);
  - Thirlmere Lakes (refer to **Section 11.5**); and
- the potential impacts of the proposed development on future land uses (refer to **Section 11.19**).

Following re-commencement of the project and the re-issue of SEARs in June 2017, another Government Agency briefing was held for the proposed development on 18 December 2017 and was attended by DPE, NSW EPA, NSW OEH, and DRG. The purpose of the meeting was to provide DPE and relevant agencies an updated briefing of the proposed development, including the history of the Tahmoor South Project, EIS process to date, and to understand key agency issues for consideration in the EIS. Key issues raised during the meeting, in addition to those raised in 2012, included the following areas for consideration in the EIS:

- impacts to catchment areas/special areas including ephemeral stream impacts, and water quality (refer to **Section 11.4**);
- updates to policy and the Southern Coalfield Inquiry, as they relate to mining in/near special areas, and their role in assessing the proposed development (refer to **Sections 5.3 and 8.0**);
- urban development pressures including:
  - subsidence impacts (refer to **Section 11.1**);
  - compliance of the proposed development with, and the potential for conflict, with strategic planning in the vicinity of the Project Area (refer to **Sections 8.2 and 11.19**); and
- amenity/noise impacts (refer to **Section 11.10**).

9.1.2 Statutory and Agency Consultation

Tahmoor Coal has undertaken comprehensive consultation with key local and State Government agencies as specified in the SEARs for the proposed development. The purpose of this consultation has been to provide agencies with an overview of the proposed development and to seek input into relevant matters addressed in the EIS.

Face to face meetings, where possible, were held with relevant agencies identified in the SEARs to assist with the preparation of the EIS. These agencies included DPE, DPI, NSW EPA, NSW OEH, RMS, Wollondilly and Wingecarribee Shire Councils and Water NSW (formerly the Sydney Catchment Authority). Note at the time of consultation, DPI included the NSW Office of Water (now DI Water). A summary of consultation undertaken with Government agencies is provided in **Table 9.1**.

Table 9.1 Statutory and Agency Consultation Log

Reason for Consultation	Date	Details / issues raised
NSW Department of Planning and Environment (DPE)		
Presentation of proposed development	05/07/12	Overview of proposed development provided to DPE.
Submission of PEA	12/09/12	Overview of proposed development and preliminary identification of potential impacts provided to DPE.
PFM	18/10/12	Overview of proposed development and preliminary identification of potential impacts. Refer to **Section 9.1.1**.
Consolidation of Consents	22/02/13	Overview of existing development consents at Tahmoor Mine and discussion of proposed consent strategy for the proposed development. The proposed consent framework is presented in **Section 7.0.**
Noise Assessment	05/09/13	Discussion regarding noise monitoring and modelling, application of the *Industrial Noise Policy* (INP) and setting of noise goals. This meeting was also attended by EPA. INP and noise goals were considered as part of the Noise Impact Assessment (refer **Section 11.10**).
Noise Assessment	13/11/17	Overview of the updated project and clarification on the assessment methodology. The DPE confirmed the noise assessment was to be conducted in accordance with the NSW *Industrial Noise Policy.*
Government Agency Briefing	18/12/17	Meeting to provide DPE and relevant agencies a briefing of the proposed development, including history of the Tahmoor South Project EIS process to date, and to understand key agency issues for consideration in the EIS.
Pre-lodgement meeting	16/03/18	Meeting to provide an update on the progress of the EIS and the planned lodgement date.
Briefing on approval pathway	02/05/18	Overview of approval pathway
Social impact assessment discussion	13/07/18	Overview of updated guideline and assessment
Project overview	26/09/18 06/09/18	Overview of project and impact assessment overview
Federal Government Department of Environment & Energy (DoEE)		
EBPC referral briefing	22/09/17	Discussion regarding the EPBC referral for the proposed development.

Reason for Consultation	Date	Details / issues raised
Australian Rail Track Corporation (ARTC)		
Presentation of proposed development and subsidence impacts	29/01/14	Overview of proposed development and identification of potential impacts on ARTC infrastructure. The potential impacts of the proposed development on rail infrastructure are discussed in **Section 11.1**.
DI Water (formerly NSW Office of Water (NOW) under DPI) and Water NSW (formerly Sydney Catchment Authority (SCA))		
PFM	18/10/12	Overview of proposed development and preliminary identification of potential impacts. Refer to **Section 9.1.1**.
Presentation of the proposed approach to undertaking the Groundwater Assessment.	31/10/12	Presentation of the baseline monitoring program and proposed model for the Groundwater Assessment. Issues raised included: • Thirlmere Lakes; • Groundwater monitoring program • Extent of fracture zone; • Aquifer Interference Guidelines; • Groundwater licensing; and • Groundwater dependent ecosystems. These issues were investigated as part of the Groundwater Assessment for the proposed development (**Section 11.3**).
Presentation of preliminary model results from the Groundwater Assessment.	27/11/13	The preliminary results from the groundwater model were presented to NOW. Issues raised included: • Extent of bore census. The issues raised were addressed in the Groundwater Assessment for the proposed development (**Section 11.3**).
PFM	18/10/12	Overview of proposed development and preliminary identification of potential impacts. Refer to **Section 9.1.1**.
Presentation of proposed development and discussion of approach to environmental assessments. This meeting was also attended by NPWS.	20/11/12	A field inspection of Cow Creek was undertaken in addition to a meeting on the potential impacts of the proposed development on SCA lands. Impacts to SCA lands have been assessed as part of the Subsidence Impact Assessment (MSEC, 2018), the Groundwater Assessment (HydroSimulations, 2018), the Surface Water Assessment (HEC, 2018) and the Terrestrial Ecology Assessment (Niche Environment and Heritage, 2018). The potential impacts of the proposed development are summarised in **Sections 11.1**, **11.3**, **11.4** and **11.6**).
Presentation of proposed development and discussion of preliminary results from the environmental impact assessments. This meeting was also attended by EPA and OEH.	12/12/13	Concerns were raised by SCA regarding the potential impacts of the proposed development on SCA lands. Impacts to SCA lands have been assessed as part of the Subsidence Impact Assessment (MSEC, 2018), the Groundwater Assessment (HydroSimulations, 2018), the Surface Water Assessment (HEC, 2018) and the Terrestrial Ecology Assessment (Niche Environment and Heritage, 2018). The potential impacts of the proposed development are summarised in **Sections 11.1**, **11.3**, **11.4** and **11.6**).
Project overview	26/09/18	Overview of project and impact assessment overview

Reason for Consultation	Date	Details / issues raised
NSW Department of Industry		
Project overview	22/06/18	Overview of project and impact assessment overview
Wingecarribee Shire Council		
PFM	05/10/12	Overview of proposed development and preliminary identification of potential impacts. Refer to **Section 9.1.1**.
Presentation to General Manager and senior Council staff	12/11/12	Tahmoor Coal provided an overview of proposed development and preliminary identification of potential impacts. Council raised concerns regarding the impacts of coal mining on lands within the Wingecarribee LGA.
Presentation to Wingecarribee Coal Consultation Committee	29/11/13	Tahmoor Coal provided an overview of proposed development and preliminary identification of potential impacts. Committee raised concerns regarding the impacts of coal mining on lands within the Wingecarribee LGA and noted its objection to longwall mining.
Project Briefing	11/10/17	Tahmoor Coal advised that SEARs have been re-issued for the proposed development and work was being undertaken to finalise the EIS. Advised that whilst the Project Area extends into the Wingecarribee LGA, no activities associated with the proposed development would take place in the LGA.
Wollondilly Shire Council		
General discussion regarding proposed development.	17/09/12	Tahmoor Coal provided an overview of proposed development and preliminary identification of potential impacts.
PFM	18/10/12	Overview of proposed development and preliminary identification of potential impacts. Refer to **Section 9.1.1**.
General discussion regarding proposed development and status of the EIS	29/07/13	Tahmoor Coal provided an overview of proposed development and potential impacts to Councillors and Council Executive Management of Council. Council raised specific concerns regarding subsidence and some concerns about more general environmental impacts associated with the proposed development. Council representatives also expressed an interest in the potential economic benefits of the proposed development. The potential for the proposed development to cause subsidence movements, and create impacts resulting from subsidence movements on natural and built features, is presented in **Section 11.1**. The economic benefits of the proposed development are discussed in **Section 11.16**.

Reason for Consultation	Date	Details / issues raised
Meeting with Wollondilly Shire Council Strategic Planners regarding urban growth	03/12/13	Tahmoor Coal and Council discussed the urban growth plans for the township of Bargo and the potential impacts of mine subsidence on urban growth areas. The Subsidence Impact Assessment was updated to include an assessment of conventional subsidence parameters for the 2,000 additional houses identified in the *Wollondilly Growth Management Strategy* (2011). A summary is included in **Section 11.1.4**.
General discussion on the implications that the proposed development may pose for Council's future considerations of development applications within the proposed development Area.	23/01/14	Tahmoor Coal and Council had a further discussion regarding the urban growth plans for the township of Bargo and the potential impacts of mine subsidence on urban growth areas. The meeting was held with Wollondilly Shire Council's Strategic Planners, Illawarra Coal and the Mine Subsidence Board (now SA NSW). Potential impacts to land use have been assessed in **Section 11.19**.
Meeting with General Manager and strategic planning staff to discuss development contributions	14/03/14	Development contributions mechanisms discussed.
Meeting to discuss Planning Agreement	02/05/14	Planning agreement mechanism discussed.
Meeting to discuss Planning Agreement	12/06/14	Planning agreement mechanism discussed.
Project Briefing	07/09/17 26/11/18	Tahmoor Coal advised that SEARs have been re-issued for the proposed development and work was being undertaken to finalise the EIS.
Meeting with Wollondilly Shire Council senior managers	31/05/18	Project overview and impact assessment
Meeting with Wollondilly Shire Council Environment team	31/07/18	Project overview and impact assessment
Meeting with Wollondilly Shire Council Friends of Thirlmere Lakes	03/08/18	Project overview and impact assessment
Meeting with Wollondilly Shire Council Councillors	26/11/18	Project overview and impact assessment
Transport for NSW		
PFM	18/10/12	Overview of proposed development and preliminary identification of potential impacts. Refer to **Section 9.1.1**.
Office of Environment and Heritage		
PFM	18/10/12	Overview of proposed development and preliminary identification of potential impacts. Refer to **Section 9.1.1**.
General discussion regarding proposed development. This meeting was also attended by EPA and SCA.	12/12/13	Overview of proposed development and preliminary identification of potential impacts. The preliminary outcomes of technical specialist investigations and modelling were also presented.

Reason for Consultation	Date	Details / issues raised
Biodiversity offsets required to mitigate the biodiversity impacts of the proposed development.	9/7/14	The Biodiversity Offset Strategy for the proposed development was presented and discussed with OEH. OEH provided in principle support for offset strategy presented, detailed in **Section 11.6.5**.
Project briefing	18/12/17	Overview of project, impact assessment overview and plan to submit development application and EIS in 2018.
Overview of subsidence impacts on streams	20/06/18	Overview of project, impact assessment overview
Biodiversity offsets required to mitigate the biodiversity impacts of the proposed development.	11/09/18 13/11/18	The Biodiversity Offset Strategy for the proposed development was presented and discussed with OEH. OEH provided in principle support for offset strategy presented, detailed in **Section 11.6.5**.
NSW Environment Protection Authority		
PFM	18/10/12	Overview of proposed development and preliminary identification of potential impacts. Refer to **Section 9.1.1**.
Noise Assessment for the proposed development. This meeting was also attended by DPE.	05/09/13	Discussion of noise monitoring and modelling, application of INP and setting of noise goals. INP and noise goals were considered as part of the Noise Impact Assessment (refer **Section 11.10**).
Potential air quality impacts of the proposed development.	09/13	Correspondence regarding the air quality impact assessment (AQIA) undertaken via email in lieu of a face to face meeting.
General discussion regarding proposed development. This meeting was also attended by OEH and SCA.	12/12/13	Tahmoor Coal provided an overview of proposed development and preliminary identification of potential impacts. The preliminary outcomes of technical specialist investigations and modelling were also presented.
Noise Assessment	13/11/17	Overview of the updated project was provided, and clarification sought on the assessment methodology. The NSW EPA confirmed the noise assessment was to be conducted in accordance with the NSW *Industrial Noise Policy*.
Project briefing	18/12/17	Overview of project, impact assessment overview and plan to submit development application and EIS in 2018.
Noise assessment	16/03/18	Overview of the results of the noise assessment.
Project overview	26/09/18	Overview of project and impact assessment overview
NSW DRG (Formerly NSW Trade & Investment – Division of Resources and Energy)		
Presentation of the concept mine plan for the proposed development.	29/06/12	Overview of proposed development and preliminary identification of potential impacts. The DRG provided in principle support for a mine plan capable of maximising the available resource. The importance of managing potential subsidence impacts and other environmental issues was discussed.

Reason for Consultation	Date	Details / issues raised
PFM	18/10/12	Overview of proposed development and preliminary identification of potential impacts. Refer to **Section 9.1.1**.
Meeting to discuss subsidence assessment and impacts	27/11/13	Impacts have been assessed as part of the Subsidence Impact Assessment (MSEC, 2018), the Groundwater Assessment (HydroSimulations, 2018), the Surface Water Assessment (HEC, 2018) and the Terrestrial Ecology Assessment (Niche Environment and Heritage, 2018). The potential impacts of the proposed development are summarised in **Sections 11.1**, **11.3**, **11.4** and **11.6**).
Subsidence infrastructure inspection of: • APA - Sydney - Moomba gas pipeline; and • Gorodok - Ethane pipeline.	28/07/14	Gas pipeline inspection in particular : • Crossing of the pipeline with the Main Southern Railway line; • Location of pipeline in relation to resident's homes; and • Road crossings of pipeline at Avon Dam Road and Remembrance Driveway.
Government Agency Briefing	18/12/17	Meeting to provide DPE and relevant agencies a briefing of the proposed development, including history of the Tahmoor South Project EIS process to date, and to understand key agency issues for consideration in the EIS.
Concept Project Development Plan	16/01/18	Overview of project, impact assessment overview and plan to submit development application and EIS in 2018. An overview of the mine plan constraints and geological background was also provided.
Project briefing	28/06/18	Overview of project
Project overview	05/06/18 22/06/18 26/09/18	Overview of project and impact assessment overview
National Parks and Wildlife Service (NPWS)		
General discussion regarding proposed development This meeting was also attended by SCA.	20/11/12	Field inspection of Cow Creek and a meeting on the potential impacts of the proposed development on SCA lands.
NSW Health		
General discussion regarding proposed development	7/3/14	Overview of the proposed development (via email). NSW Health raised concerns regarding human health impact of the proposed development including air quality and noise impacts. Noise and air quality impacts of the proposed development are presented in **Sections 11.10** and **11.11** respectively.
Subsidence Advisory NSW (SA NSW) (formerly Mine Subsidence Board)		
General discussion regarding proposed development	27/11/13	Overview of proposed development and preliminary identification of potential impacts.

Reason for Consultation	Date	Details / issues raised
General discussion on the implications that the proposed development may pose for Council's future considerations of development applications within the Project Area.	23/01/14	Further discussion regarding the urban growth plans for the township of Bargo and the potential impacts of mine subsidence on urban growth areas. The meeting was held with Wollondilly Shire Council's Strategic Planners, Illawarra Coal and the Mine Subsidence Board. Potential impacts to urban growth areas are considered in **Section 11.15**.
Meeting to discuss subsidence assessment and impacts	27/11/13	Impacts have been assessed as part of the Subsidence Impact Assessment (MSEC, 2018), the Groundwater Assessment (HydroSimulations, 2018), the Surface Water Assessment (HEC, 2018) and the Terrestrial Ecology Assessment (Niche Environment and Heritage, 2018). The potential impacts of the proposed development are summarised in **Sections 11.1**, **11.3**, **11.4** and **11.6**).
Project briefing	16/11/17	Overview of project, impact assessment overview and plan to submit development application and EIS.
Project briefing	17/07/18	Overview of project and impact assessment overview
Roads and Maritime Services (RMS)		
General discussion regarding proposed development	3/12/13	Overview of proposed development and preliminary identification of potential impacts. RMS raised concerns regarding the potential impacts of the proposed development on the M31 Hume Motorway, specifically M31 bridges spanning the Nepean River. The potential impacts of subsidence movements on the M31 Hume Motorway are presented in **Section 11.1.6**.
APA / Gorodok		
General discussion regarding proposed development and subsidence impacts to high pressure gas pipeline	10/12/13	Impacts have been assessed as part of the Subsidence Impact Assessment (MSEC, 2018). The potential impacts of the proposed development are summarised in **Sections 11.1.**
Sydney Water		
General discussion regarding proposed development and subsidence impacts to Sydney Water assets	19/02/14	Impacts have been assessed as part of the Subsidence Impact Assessment (MSEC, 2018). The potential impacts of the proposed development are summarised in **Sections 11.1.**
Federal Member for Hume- Angus Taylor		
General discussion regarding proposed development	13/6/14	General discussion regarding proposed development.

Reason for Consultation	Date	Details / issues raised
Site inspection of Tahmoor Mine	31/07/14	General discussion and update on the Tahmoor South Project and the Tahmoor Mine. Site surface inspection including the following areas: • Gas extraction plant; gas flare plant; and third party gas power generation plant; • The recycle water treatment plant and the waste water treatment plant; • Water discharge points; • Surface buildings; and • CHPP.
General discussion regarding proposed development	27/09/18	General discussion regarding proposed development.
State Member for Wollondilly – Jai Rowell		
General discussion regarding proposed development	24/9/12 08/04/14 05/02/18	General discussion regarding proposed development.
State Member for Goulburn – Pru Goward		
General discussion regarding proposed development	5/10/12	General discussion regarding proposed development.

9.2 Stakeholder Engagement Plan

Prior to preparation of the EIS, Tahmoor Coal developed a Stakeholder Engagement Plan to guide engagement with the community and other stakeholders and documented activities via a clearly defined and staged process. The objectives of the Stakeholder Engagement Plan are to:

- identify key stakeholders and maintain an accurate database;
- engage with key stakeholders to identify potential issues and concerns relating to the proposed development;
- enable stakeholders to have input into the direction of the EIS and project planning. This includes obtaining and encouraging feedback on operation, environmental and social performance;
- build and maintain trust and credibility, and establish effective and ongoing two way consultation with key stakeholders and the community;
- provide timely and accurate information to stakeholders on operational, environmental and social performance. This includes responding to enquiries or complaints in a timely manner;
- provide feedback to stakeholders on how their input has influenced operations or decisions; and
- manage community awareness and expectations of the proposed development. This includes developing clear and consistent key messages specific to each phase of consultation.

The Stakeholder Engagement Plan guided consultation with the community and Aboriginal stakeholders and also outlined the consultation activities to be undertaken following lodgement of the EIS. Summaries of these consultation efforts are provided below.

9.2.1 Consultation with the Local Community

Community Newsletter

Community newsletters were prepared during the preparation of the EIS and distributed as required via the following methods:

- letterbox drop (approximately 4,000 households);

- mailed to project mailing list (approximately 250 individuals and organisations);
- community noticeboards; and
- site noticeboards for employees (approximate audience of 370).

Each newsletter contained updates on the proposed development and information about the preparation and lodgement of the EIS.

Tahmoor Coal Community Consultative Committee

The TCCCC meets quarterly to provide the community with an avenue for the exchange of information relating to the mine and its operations. The TCCCC comprises the following representatives:

- an independently appointed Chairperson;
- four representatives of the local community and other stakeholders;
- two representatives of the local council; and
- two or three Tahmoor Coal representatives, including the Environment and Community Manager.

The Environment and Community Manager and Community Coordinator are responsible for managing the TCCCC. Minutes of TCCCC meetings are maintained as a record of each meeting and are distributed to all TCCCC members, with a copy of the minutes also published on the Tahmoor Coal website.

During the preparation of the initial EIS in 2012-2014, nine TCCCC meetings (May 2012, September 2012, December 2012, March 2013, June 2013, September 2013, December 2013, March 2014 and June 2014) and one TCCCC Surface Tour (November 2013) were held. The TCCCC meetings were also attended by the Project Team to provide updates on the proposed development. At the TCCCC meeting on 15 June 2017, Tahmoor advised the committee that updated assessment requirements (SEARs) for the Tahmoor South Project were requested from DPE with the intention to recommence the proposed development, including submission of the project's EIS. Project updates were then provided at the September 2017, December 2017, June 2018, September 2018 and December 2018 TCCC meetings.

General Community Information

Relevant information has been provided to the public during the environmental assessment phase through various methods including:

- the Tahmoor Coal website;
- community information sessions; and
- local newspaper articles.

The Tahmoor Coal website (www.tahmoorcoal.com.au) provides access to a range of information, including resident updates and contact details.

Nine community information days have been held since the commencement of the environmental assessment phase: a Seismic Community Day on 20 June 2012 as well as eight general Community Information Days on 6 June 2013, 25 July 2013, 19 December 2013, 1 May 2014, 21 September 2017, 20 November 2017, 29 September 2018 and 30 October 2018. Tahmoor Mine Open Days have also been held, on 12 September 2013, 28 November 2013 and 20 September 2018. Social Impact Assessment surveys were held in Bargo on 18 September 2018, 19 September 2018 and 25 September 2018, and in Tahmoor and Picton on 20 September 2018.

Meetings were also held with community organisations within close proximity of the project where Tahmoor Coal informed the community of the project and provided the opportunity for feedback. A summary of the matters discussed is provided in **Table 9.2**.

Media statements are used on an as needs basis to address specific issues and respond to significant events.

Table 9.2 Community Organisation Consultation Log

Reason for Consultation	Date	Details / issues raised
Bargo Dingo Sanctuary		
General discussion regarding proposed development	17/10/18	Tahmoor Coal provided an overview of proposed development and preliminary identification of potential impacts.
Bargo Primary School		
General discussion regarding proposed development	03/10/18	Tahmoor Coal provided an overview of proposed development and preliminary identification of potential impacts.
Infrastructure and Emergency Providers		
General discussion regarding proposed development	17/09/18	Tahmoor Coal provided an overview of proposed development and preliminary identification of potential impacts, including the flood assessment.
National Parks Association of NSW		
General discussion regarding proposed development	28/10/18	Tahmoor Coal provided an overview of proposed development and preliminary identification of potential impacts.
Picton Chamber of Commerce		
General discussion regarding proposed development	26/09/18	Tahmoor Coal provided an overview of proposed development and preliminary identification of potential impacts.
Picton High School		
General discussion regarding proposed development	15/06/18 31/10/18	Tahmoor Coal provided an overview of proposed development and preliminary identification of potential impacts.
Rivers SOS		
General discussion regarding proposed development	13/09/18	Tahmoor Coal provided an overview of proposed development and preliminary identification of potential impacts.
Wollondilly Anglican College		
General discussion regarding proposed development	06/06/14 17/09/18 05/11/18	Tahmoor Coal provided an overview of proposed development and preliminary identification of potential impacts.
Wirrimbirra Flora & Fauna Sanctuary		
General discussion regarding proposed development	24/04/13 30/08/13 28/10/18	Tahmoor Coal provided an overview of proposed development and preliminary identification of potential impacts.
Wirrimbirra Dingos		
General discussion regarding proposed development	24/04/13 24/10/18	Tahmoor Coal provided an overview of proposed development and preliminary identification of potential impacts.

Bargo Progress Association

The Bargo Progress Association is a key community group and stakeholder. The group meets on the last Wednesday of each month, with meetings typically held at the Bargo Sports Club. Consultation with the association has been undertaken regularly throughout the environmental assessment phase, with the Tahmoor Coal Approvals Manager and Community Coordinator attending meetings on 25 July 2012, 27 March 2013, 27 November 2013, 26 March 2014, 27 August 2018 and 25 October 2018. The association was presented with updates as well as newsletters and question and answer sessions.

Stakeholder Feedback

Tahmoor Coal recognises the importance of receiving regular feedback from the community in achieving ongoing improvement and determining the effectiveness of initiatives. During the approvals process, both positive and negative feedback has been considered and, where necessary and feasible, changes have been implemented to address identified issues.

Tahmoor Coal also maintains a 24 hour community information telephone service (1800 154 415) and a general enquiries email (tahmoorenquiries@simecgfg.com). This has allowed issues to be raised directly and anonymously.

9.2.2 Aboriginal Community Consultation

In administering its statutory functions under Part 6 of the NSW *National Parks and Wildlife Act 1974*, the OEH requires that proponents consult with Aboriginal people about the Aboriginal cultural heritage values (cultural significance) of Aboriginal objects and/or places within any given development area (DECCW 2010). This consultation is undertaken with the objective of improving the outcomes of the ACHA.

As part of the ACHA completed for the proposed development (**Appendix L**), consultation with Indigenous stakeholders was undertaken in accordance with the *Draft Guidelines for Aboriginal Cultural Heritage Assessment and Community Consultation* (DEC, 2005) and *The Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW, 2010).

The mine plan for the project has undergone revisions to avoid longwall mining directly under sensitive features where possible including items of Aboriginal heritage significance. The mine plan has been designed to minimise potential for impacts to significant rock shelters at Dog Trap Creek.

Notification and Registration of Interest

Notifications of the proposed development were sent to Registered Aboriginal Parties (RAPs) on 8 January 2013, 16 September 2017, and 12 October 2018, with the objective of identifying potential cultural knowledge holders (registered parties) for the subject area. Advertisements were also published in the Macarthur Advertiser on 13 February 2013 and 23 August 2017, to invite Aboriginal stakeholders to register an interest.

Twenty-one Aboriginal stakeholders registered an interest in the proposed development and as a result these 21 individuals and organisations became RAPs to the proposed development. Details of these RAPs are provided in **Appendix L**, Tahmoor Coal has consulted directly with all RAPs and individuals about the proposed development and has sought their input regarding cultural significance.

Presentation and Gathering of Information

RAPs were provided with a letter containing information about the proposed development and the proposed methodology for an ACHA in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW 2010) on 25 March 2013 and 13 September 2017. RAPs were also sent an invitation to attend an information session, and to respond to a questionnaire about their group's connection to the area on 13 September 2017. A 28 day period was provided for RAPs to:

- suggest any protocols to be adopted into the information gathering process and assessment methodology; and
- highlight any other matters such as issues or areas of cultural significance that might affect, inform or refine the methodology.

An information session was held at the Tahmoor Colliery on 6 October 2017. Attendees were provided with a presentation on the nature and scale of the proposed development, an overview of the impact assessment process, critical timelines and milestones for the completion of assessment activities and delivery of reports, a discussion of the roles, functions and responsibilities of participants and protocols for the management of any sensitive cultural heritage information. The information session also provided RAPs with an opportunity to raise any cultural issues or comments/perspectives and assessment requirements (if any) regarding the proposed development or the proposed methodology.

No comments were received from any of the RAPs in regards to the project methodology.

RAPs were also invited to attend site inspections during preparation of the ACHA. Representatives from the following RAPs were available to conduct the site inspections:

- Tharawal LALC; and
- Cubbitch Barta Native Title Claimants.

Additional meetings were held with Tharawal LALC on 1 May 2014, 9 May 2013, 15 July 2014, 25 July 2013, 5 August 2014 and 30 August 2018. An additional meeting was held with Cubbitch Barta Native Title Claimants on 5 August 2014 and 30 August 2018.

A detailed log of the Aboriginal consultation undertaken throughout the preparation of the EIS is provided in the ACHA provided in **Appendix L**.

Review of Draft ACHA Report

A draft ACHA report was provided to the RAPs for their review and comment on 28 December 2017 in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW 2010). A total of 28 days was provided to enable each of the RAPs to submit comments. The closing date for these comments was 31 January 2018. Prior to this closing date an information session was undertaken on 24 January 2018 at Tahmoor Colliery. The purpose of the information sessions was to discuss the key findings of the draft ACHA and to provide an opportunity for RAPs and other community stakeholders and Elders to discuss, ask questions and/or provide comment on the draft ACHA. Three RAPs provided comment on the draft report during the 28 day period:

- Cubbitch Barta Native Title Claimants;
- Woronora Plateau Gundungurra Elders Council; and
- Didge Ngunawal Clan.

To date, feedback from Aboriginal community consultation has been that all sites within the Project Area (archaeological or cultural) are of value to the Aboriginal community. There were a total of 40 Aboriginal cultural sites identified in the ACHA, including some sites previously registered on the Aboriginal Heritage Information Management System (AHIMS) database and some identified during the field work component of the assessment (refer to **Appendix L**). The ACHA found that four of the 40 Aboriginal sites are of high archaeological significance, two are of moderate archaeological significance and the remaining 32 are considered to be of low archaeological significance.

9.2.3 EIS Exhibition

The EIS for the Tahmoor South Project will be on exhibition to allow for public comment on the proposed development. During and following the EIS exhibition period, consultation with the community will be ongoing via:

- an EIS overview which will be provided to all residents in the Project Area via letter drop;
- face to face meetings;
- newsletters;
- TCCCC;
- Tahmoor Coal's website which will include the EIS and project updates;
- Community Information Days;
- Tahmoor Coal Complaints and Enquiries line and email;
- employee toolbox talks; and
- media statements.

Stakeholder engagement activities will be undertaken with the following groups:

- elected State and Federal representatives;
- Wollondilly Shire Council and Wingecarribee Shire Council;

- Government agencies;
- Bargo Progress Association;
- TCCCC; and
- The wider community.

10.0 Identification of Environmental Issues

This section outlines the risk assessment process that has been undertaken for the proposed development in order to identify and prioritise the environmental, social and economic issues.

10.1 Background

Tahmoor Coal utilises a risk assessment process to identify environmental, social and economic risks. The process involves its employees (and contractors where appropriate) undertaking an Environmental Risk Assessment to systematically identify issues and to recognise areas where further information is required to address existing knowledge gaps.

The development of the proposed mine plan and preparation of this EIS was undertaken through a risk-based and consultative approach, involving consultation with government agencies, technical specialists and the community. The objectives of the Environmental Risk Assessment process were to:

- identify potential environment, social and economic risks associated with the proposed development;
- identify the controls necessary to effectively manage these risks; and
- identify those issues where further information or investigation was required in order to address existing knowledge gaps.

Where risks were considered unacceptable, or there was a knowledge gap in the information available, specialist investigations were undertaken to inform the EIS to ensure the residual consequences for the proposed development are acceptable.

10.2 Identification of Potential Impacts of the Proposed Development

The potential impacts of the proposed development and their associated environmental, social and economic consequences have been identified through:

- the preliminary environmental risk screening undertaken for the PEA;
- consultation with Government agencies and other stakeholders;
- consideration of the SEARs issued for the EIS;
- an Environmental Risk Assessment workshop held in December 2012 and attended by Tahmoor Coal, AECOM and relevant project technical specialists;
- two Subsidence Risk Workshops held in March 2013 and December 2013 and attended by Tahmoor Coal, AECOM and relevant project technical specialists; and
- development and maintenance of an Environmental Risk Register for the proposed development (refer to **Appendix C**).

The potential impacts of the proposed development identified through this risk assessment process were grouped into issue categories. Prior to ranking the level of risk associated with each category, it was identified that without risk controls in place the proposed development is likely to have an impact on the following:

- groundwater;
- geomorphology;
- surface water;
- terrestrial ecology;
- aquatic ecology;
- aboriginal heritage;
- non-aboriginal heritage;

- acoustic amenity;
- air quality;
- greenhouse gas;
- traffic and transport;
- infrastructure and services;
- social and economic matters;
- visual landscape;
- land use and land capability;
- soils; and
- hazards (including acid mine drainage and spontaneous combustion potential).

The proposed development has the potential to impact on these issues as a result of:

- subsidence due to underground longwall mining;
- construction, operation, waste generation and vehicle and rail movements to and from the Surface Facilities Area; and
- site closure and rehabilitation activities.

10.3 Prioritisation of Risks

A process of prioritisation of the identified risks was undertaken to determine the need for consideration of various issues during mine planning, and to determine the level of assessment required to adequately and appropriately address each issue identified.

10.3.1 Approach

Each of the environmental, social and economic risks identified for the proposed development were given a risk prioritisation rating using an ordinal scale (comparative measurement), based on the likelihood of the environmental, social or economic risk occurring and the consequence of that risk should it not be mitigated (refer to **Table 10.1** and **Table 10.2**).

Following the allocation of likelihood and consequence against each environmental, social or economic risk identified for the proposed development, a risk prioritisation ranking was calculated using Tahmoor Coal's risk matrix (refer to **Table 10.2**). This risk matrix provides a ranking of low, medium or high risk and allocates a numerical value (1 to 25) to each risk based on increasing levels of likelihood and consequence.

This screening allows for general prioritisation of environmental, social and economic risks based on their potential likelihood and consequences without consideration of mitigation measures to minimise and manage potential impacts.

Table 10.1 Risk Rating: Risk Likelihood and Consequence Criteria

Likelihood of Risk	
Almost certain (E)	• Almost certain to occur; or • Could occur within months.
Likely (D)	• There is between 50% and 99% probability that an environmental effect would occur; or • There is the balance of probability that an environmental effect would occur; or • An environmental effect could occur monthly.
Possible (C)	• There is between 20% and 50% probability that an environmental effect would occur; or • An environmental effect may occur shortly but there is a distinct probability that it will not; or • An environmental effect could occur within two to five years.
Unlikely (B)	• There is between one percent (1%) and 20% probability that an environmental effect would occur; or • An environmental effect may occur but is not anticipated; or • An environmental effect could occur within five to 20 years.
Very unlikely (A)	• There is less than one percent (1%) probability that an environmental effect would occur; or • An environmental effect may occur under exceptional circumstances; or • An environmental effect is exceptionally unlikely, even in the long term future; or • An environmental effect could occur once every 20 years.
Consequence of Risk	
Severe (5)	A risk that may cause the greatest financial, property and investment return impacts, irreversible health and safety effects, disastrous and significant environmental or community/reputation impacts, or major legal and compliance litigation impacts over a prolonged timeframe.
Major (4)	A risk that may cause major financial, property and investment return impacts, severe health and safety effects, serious and significant environmental or community/reputation impacts, and /or major legal and compliance litigation impacts over the medium term.
Moderate (3)	A risk that may cause moderate financial, property and investment return impacts, serious health and safety effects, moderate reversible environmental or community/reputation impacts, and /or significant legal litigation or compliance major breaches over the short term.
Minor (2)	A risk that may cause minor financial, property and investment return impacts, restricted health and safety effects, minor reversible and local environmental or community/reputation impacts, and /or legislative breaches over the short term.
Insignificant (1)	A risk that may cause negligible financial, property and investment return impacts, first aid health and safety effects, negligible reversible environmental or no community/reputation impacts, and /or minor legal issues or breaches.

Table 10.2 Risk Prioritisation Matrix

Likelihood of Effect	Consequence of Effect				
	Severe (5)	**Major (4)**	**Moderate (3)**	**Minor (2)**	**Insignificant (1)**
Almost Certain (E)	High(25)	High (23)	High (20)	Medium (16)	Medium (11)
Likely (D)	High (24)	High (21)	High (17)	Medium (12)	Medium (7)
Possible (C)	High (22)	High (18)	Medium (13)	Medium (8)	Low (4)
Unlikely (B)	High (19)	Medium (14)	Medium (9)	Low (5)	Low (2)
Very Unlikely (A)	Medium (15)	Medium (10)	Medium (6)	Low (3)	Low (1)

Level of Stakeholder Interest

The expected level of stakeholder interest has also been considered for each risk identified, based on a broad review of key issues raised in submissions in relation to recent major coal mining projects and feedback gained from community open days undertaken for the proposed development (refer to **Table 10.3**). Consideration of stakeholder perception of potential environmental, social and economic risks associated with the proposed development is an important part of determining the level of assessment that should be applied during the preparation of the EIS, given that key stakeholder concerns may not necessarily align with a purely technical analysis of environmental, social and economic risks.

Table 10.3 Risk Rating – Expected Level of Stakeholder Interest

Level of Interest	Definition
High	Issues raised in feedback from most stakeholders or in most submissions made on similar developments.
Medium	Issues raised in feedback from some stakeholders or in some submissions made on similar developments.
Low	Issues not raised, or rarely raised, in feedback from stakeholders or in submissions made on similar developments.

Where a high level of stakeholder interest is expected, a potential environmental impact was determined to be an issue requiring assessment irrespective of the outcomes of environmental, social and economic risk prioritisation.

10.3.2 Ranking

Environmental issues relating to the proposed development were ranked as part of preparation of the PEA for the proposed development. Following further consideration of the proposed development and initial environmental assessment to inform the risk assessment workshop, issues were ranked again reflecting the updated information at the time of the workshop.

Based on Tahmoor Coal's risk assessment approach, environmental, social and economic risks relating to the proposed development have been ranked as having an unmitigated risk of either low, medium, or high priority (refer to **Table 10.4**).

The initial findings of the risk assessment were used to:

- inform mine planning;
- prioritise and focus the required environmental assessments for the proposed development;
- ensure that each of the issues were addressed to a level appropriate to the level of risk; and
- focus the development of appropriate management and mitigation options.

Table 10.4 Environmental Risk Assessment Results

Risk	Unmitigated Environmental Risk		Priority Ranking	Stakeholder Level of Interest	Environmental assessment significance
	Likelihood	Consequence			
Subsidence					
Unacceptable subsidence related impacts to natural features such as waterways, escarpments and overhangs.	Unlikely (B)	Major (4)	Medium (14)	High	High
Subsidence impacts to houses.	Likely (D)	Moderate (3)	High (17)	High	High
Cracking of cliff lines due to subsidence.	Unlikely (B)	Minor (2)	Low (5)	High	Low
Terrestrial Ecology					
Vegetation clearance and habitat loss due to extension of the REA.	Likely (D)	Moderate (3)	High (17)	Medium	High
Potential impact on threatened species or Endangered Ecological Communities resulting from vegetation clearing required for the expansion of the REA.	Unlikely (B)	Major (4)	Medium (14)	Medium	Medium
Subsidence induced damage to rock bars and ecological communities due to subsidence resulting in environmental and visual impacts.	Unlikely (B)	Minor (2)	Low (5)	Medium	Low
Aquatic Ecology					
Changes to aquatic ecology as a consequence of subsidence changes to in-stream habitat.	Possible (C)	Moderate (3)	Medium (13)	High	High
Impacts to groundwater dependent ecosystems.	Possible (C)	Moderate (3)	Medium (13)	Medium	Medium
Groundwater					
Changes to volume and quality of inflows, as a result of mining.	Very unlikely (A)	Major (4)	Medium (10)	High	High
Impacts to local bore users due to depressurisation of aquifers.	Possible (C)	Moderate (3)	Medium (13)	High	High
Impacts to aquifers due to subsidence.	Possible (C)	Minor (2)	Medium (8)	High	Medium

Risk	Unmitigated Environmental Risk		Priority Ranking	Stakeholder Level of Interest	Environmental assessment significance
	Likelihood	Consequence			
Surface Water					
Erosion and sedimentation impacts due to mobilisation of disturbed soils during construction.	Possible (C)	Minor (2)	Medium (8)	Low	Medium
Water quality impacts from discharge.	Likely (D)	Minor (2)	Medium (12)	Medium	High
Site water balance impacts on the receiving environment (surplus/ deficit).	Very unlikely (A)	Minor (2)	Medium (3)	Low	Medium
Surface drainage impacts on surrounding areas as a result of ineffective REA surface drainage design.	Unlikely (B)	Moderate (3)	Medium (9)	Low	Medium
Water quality impacts due to subsidence-induced surface cracking and alteration in surface water/groundwater interaction.	Possible (C)	Moderate (3)	Medium (13)	High	High
Impacts due to far field subsidence impacts – e.g. on Thirlmere Lakes or Lake Avon.	Very unlikely (A)	Severe (5)	Medium (15)	High	High
Hydrology					
Property impacts associated with changes to surface flooding regime due to subsidence.	Unlikely (B)	Minor (2)	Low (5)	High	High
Flow regime impacts as a result of flow from Surface Facilities Area and discharge location.	Almost certain (E)	Minor (2)	Medium (16)	Medium	Medium
Subsidence induced changes to bedslope, may result in changes to stream velocity.	Likely (D)	Minor (2)	Medium (12)	Low	Medium
Water loss in streams due to mining.	Likely (D)	Moderate (3)	High (17)	High	High
Geomorphology					
Subsidence induced changes to bedslope due to mining.	Unlikely (B)	Minor (2)	Low (5)	Low	Low
Subsidence induced damage to rock bars and pools resulting in environmental and visual impacts.	Likely (D)	Minor (2)	Medium (12)	High	High

Risk	Unmitigated Environmental Risk		Priority Ranking	Stakeholder Level of Interest	Environmental assessment significance
	Likelihood	Consequence			
Noise and Vibration					
Noise impacts during construction of the REA and intersection upgrade.	Likely (D)	Minor (2)	Medium (12)	Low	Medium
Noise generated by the operation of ventilation shafts.	Unlikely (B)	Minor (2)	Low (5)	Medium	Medium
Noise associated with increased rail movements associated with the proposed development.	Unlikely (B)	Minor (2)	Low (5)	Medium	Medium
Noise exceeding criteria from REA operation.	Likely (D)	Moderate (3)	High (17)	High	High
Traffic and Transport					
Service impacts associated with an increase in vehicle movements as a consequence of construction and peaks in staffing numbers.	Likely (D)	Minor (2)	Medium (12)	Medium	Medium
Extension of operational traffic movements impacting local networks.	Likely (D)	Minor (2)	Medium (12)	Low	Medium
Impacts on rail and port capacity.	Unlikely (B)	Minor (2)	Low (5)	Low	Low
Aboriginal Heritage					
Subsidence impacts to items of Aboriginal heritage, including Aboriginal paintings, standing rock etc. as a result of mining.	Unlikely (B)	Major (4)	Medium (14)	Medium	Medium
Impact to unregistered significant Aboriginal heritage items as a result of inadequate consultation, a reliance on existing data, or a misinterpretation of cultural knowledge.	Unlikely (B)	Minor (2)	Low (5)	Medium	Medium
Impacts to unknown items of Aboriginal heritage as a result of subsidence due to inadequate identification prior to mining.	Unlikely (B)	Minor (2)	Low (5)	Medium	Medium
Non-aboriginal Heritage					
Impacts to locally listed items of European heritage as a result of subsidence.	Unlikely (B)	Moderate (3)	Medium (9)	Medium	Medium

Risk	Unmitigated Environmental Risk		Priority Ranking	Stakeholder Level of Interest	Environmental assessment significance
	Likelihood	Consequence			
impacts to State listed items of European heritage as a result of subsidence	Unlikely (B)	Minor (2)	Low (5)	Medium	Medium
Visual Landscape					
Impacts from an increase in the size of the REA.	Likely (D)	Minor (2)	Medium (12)	Medium	Medium
Impacts from visible alterations to surface infrastructure.	Likely (D)	Minor (2)	Medium (12)	Low	Medium
Additional ventilation shafts resulting in visual impacts.	Likely (D)	Minor (2)	Medium (12)	Low	Medium
Subsidence-induced visual impacts to streams, topography, cliffs, items of Aboriginal and non-Aboriginal heritage.	Possible (C)	Insignificant (1)	Low (4)	Medium	Medium
Air Quality					
Air quality impacts associated with the operation of additional ventilation shafts.	Possible (C)	Moderate (3)	Medium (13)	Medium	Medium
Dust generation from expansion of the REA or during construction of the intersection upgrade.	Likely (D)	Minor (2)	Medium (12)	Low	Medium
Operational dust generation, such as dust from train wagons during transport.	Unlikely (B)	Minor (2)	Low (5)	Medium	Medium
Dust impacts exceeding criteria from REA and Surface Facilities Area.	Unlikely (B)	Minor (2)	Low (5)	Medium	Medium
Unacceptable odour impacts from new ventilation shaft locations.	Possible (C)	Minor (2)	Medium (8)	High	High
Land Use					
Increase in land-take as a result of the expansion of the REA and installation of additional ventilation shafts.	Likely (D)	Minor (2)	Medium (12)	Low	Medium
Limitation on future land use of REA.	Unlikely (B)	Insignificant (1)	Low (2)	Medium	Low

Risk	Unmitigated Environmental Risk		Priority Ranking	Stakeholder Level of Interest	Environmental assessment significance
	Likelihood	Consequence			
Infrastructure and services					
Subsidence-related impacts to infrastructure (road, rail, pipes, civil).	Unlikely (B)	Moderate (3)	Medium (9)	High	High
Subsidence-related impacts to private property.	Unlikely (B)	Moderate (3)	Medium (9)	High	High
Social and Economic					
Noise and dust impacts exceeding criteria from REA.	Likely (D)	Minor (2)	Medium (12)	High	High
Increase in demand for local services due to increased production and peaks in staffing levels.	Likely (D)	Minor (2)	Medium (12)	Low	Medium
Decrease in urban amenity.	Possible (C)	Minor (2)	Medium (8)	Medium	Medium
Ongoing employment and creation of new employment opportunities.	Likely (D)	Minor (2)	Medium (12)	Low	Medium
Waste					
Disposal of rejects, and construction waste.	Likely (D)	Minor (2)	Medium (12)	Low	Medium
Operational waste creation due to lack of waste reduction process.	Likely (D)	Minor (2)	Medium (12)	Low	Medium
Waste generation associated with CHPP and the REA.	Unlikely (B)	Minor (2)	Low (5)	Low	Low
Hazard					
Impacts to operations associated with a bushfire event.	Unlikely (B)	Major (4)	Medium (14)	Low	Medium
Hazardous event associated with the on-site storage of dangerous goods.	Unlikely (B)	Major (4)	Medium (14)	Low	Medium
Spontaneous combustion in REA.	Unlikely (B)	Moderate (3)	Medium (9)	Low	Medium
Greenhouse Gases					
Carbon consumption during construction.	Likely (D)	Minor (2)	Medium (12)	Low	Medium
Carbon consumption during operation.	Likely (D)	Minor (2)	Medium (12)	Medium	Medium

Risk	Unmitigated Environmental Risk		Priority Ranking	Stakeholder Level of Interest	Environmental assessment significance
	Likelihood	Consequence			
Downstream end use of coal products from the proposed development causing Scope 3 emissions.	Likely (D)	Moderate (3)	High (17)	High	High
Scope 1 GHG emissions may increase from existing due to a potential operational breakdown of the flare plant and a resultant increase in emissions.	Unlikely (B)	Moderate (3)	Medium (9)	Medium	Medium

10.3.3 Assessment of Environmental, Social and Economic Risk

The scope of technical specialist assessments was determined based on the preliminary environmental risk screening undertaken for the PEA, consultation with Government agencies, consideration of the SEARs, and through the EIS and subsidence risk workshops undertaken for the proposed development.

For each of the issues considered in **Table 10.4**, an assessment of significance was made based on the dominant environmental assessment significance ranking as detailed in **Table 10.5**. For example, in the case of subsidence, groundwater, noise, hydrology and infrastructure and services, at least half of environmental significance rankings for these potential risks were rated as high. As a consequence, these issues have been determined as key for the proposed development. This approach identified the majority of environmental and social issues to be of medium significance to the mine planning and EIS assessment process, while one issue was identified as of low significance. The assessment of significance was undertaken based on the information available at the time (prior to the preparation of the EIS) and the preliminary desktop investigations and fieldwork undertaken to date.

Table 10.5 Identification of Key and Other Environmental Issues

Key issue - High	Key issue - Medium	Other Issue - Low
Subsidence Groundwater Hydrology Noise and vibration Infrastructure and services	Geomorphology Surface water Terrestrial ecology Aboriginal heritage Non-Aboriginal heritage Aquatic ecology Air quality Greenhouse gas Traffic and transport Social and economic Visual landscape Soils Waste Hazards Land use and land capability	Rail transport and port capacity

In summary, the environmental, social and economic risks ranked as being issues of key significance for the proposed development were:

- Subsidence
  - subsidence related impacts to natural features such as waterways escarpments and overhangs.
- Terrestrial ecology
  - vegetation clearance and habitat loss due to extension of the REA.
- Aquatic ecology
  - changes to aquatic ecology as a consequence of subsidence changes to in-stream habitat.
- Groundwater
  - changes to volume and quality of inflows, as a result of mining or inability to manage impacts; and
  - impacts to local bore users due to depressurisation of aquifers.
- Surface water and hydrology
  - water quality and stream flow impacts from subsidence changes to stream hydrology; and
  - water quality impacts resulting from discharge to natural waterways.

  - property impacts associated with changes to surface flooding regime due to alterations of local topography as a result of subsidence; and
  - water loss in streams due to mining.
- Noise and vibration
  - noise generated by the operation of ventilation shafts; and
  - noise exceeding criteria from REA operation.
- Air quality
  - dust impacts exceeding criteria from Surface Facilities Area and REA; and
  - unacceptable odour impacts from new ventilation shafts.
- Infrastructure and services
  - subsidence-related impacts to infrastructure (road, rail, pipes, civil); and
  - subsidence-related impacts to private property.
- Social and Economic
  - noise and dust impacts exceeding criteria from Surface Facilities Areas and the REA.
- Waste
  - inadequate management of waste associated with CHPP and REA.
- Hazards
  - impacts to operations associated with a bushfire event.
- Greenhouse gases
  - downstream end use of coal products from the proposed development causing Scope 3 emissions.

The degree to which each environmental, social and economic risk has been taken into account during mine planning and the scale of the assessment undertaken for each issue as part of this EIS, has been based on the assessed level of risk identified through the processes described in this section.

The potential environmental, social and economic consequences of key significance (high and medium potential level of risk) and other (low risk) environmental and social issues associated with the proposed development have been considered during mine planning and are addressed in **Section 11.0**.

An assessment of significance of the potential impacts associated with these environmental, social and economic risks as a result of the proposed development is also provided in **Section 11.0**.

The controls identified as part of the Environmental Risk Assessment process are detailed in the Environmental Risk Register in **Appendix C**.

Based on this risk ranking process and the impact assessments carried out for the EIS, a number of reasonable and feasible mitigation measures have been identified for the proposed development to minimise those risks identified as of high or medium priority. Mitigation measures developed during the assessment process are presented in detail in **Sections 11.0** and **12.0**.

11.0 Impact Assessment

11.1 Subsidence

11.1.1 Overview of Approach to the Subsidence Impact Assessment

The proposed mine plan was developed by Tahmoor Coal following a risk assessment process which considered predicted subsidence impacts on built and natural features including the MSA. Tahmoor Coal made a number of revisions to the original Mine Plan, including removal of mining from the eastern domain, shortening of longwalls from the commencing ends so as to not encroach into the MSA, as well as avoiding undermining of sensitive natural features such as incised bedrock creeks and rivers. Refer to **Section 5.3.7** for further information regarding how potential subsidence impacts have been minimised for the proposed Mine Plan.

A Subsidence Impact Assessment for the proposed development has been prepared by Mine Subsidence Engineering Consultants Pty Ltd (MSEC, October 2018) and is provided in **Appendix F**.

11.1.2 Introduction

This section identifies the maximum subsidence predictions for the project and focuses on an assessment of potential impacts on infrastructure and the built environment. While general subsidence predictions and impacts to natural features have been considered in this section, a detailed impact assessment is contained in the relevant section for each environmental aspect, based on the technical predictions made by MSEC (Refer to **Sections 11.2, 11.3**, **11.4**, **11.5**, **11.6**, **11.7**, **11.8** and **11.9**).

The Subsidence Impact Assessment addressed the SEARs relevant to subsidence impacts. These are listed in **Table 11-1**.

Table 11-1 SEARs for the assessment of subsidence impacts

Subsidence SEARs	Section addressed
Subsidence – including a detailed assessment of the potential conventional and non-conventional subsidence effects, subsidence impacts and environmental consequences of the development on the natural and built environments, paying particular attention to features that are considered to have significant ecological, economic, social, cultural and environmental value, taking into consideration:	Subsidence impacts are assessed specifically in **Section 11.1** and **Appendix F**, and throughout **Section 11.0.**
• recorded regional and historic subsidence levels, impacts and environmental consequences;	**Section 11.1.3** and **Appendix F** (Subsidence Impact Assessment, Section 1)
• the potential extent of fracturing of the strata above the longwall panels; and	**Section 11.1.6, 11.2.4, 11.3.4, 11.4.4** and **Appendix F** (Subsidence Impact Assessment, Section 5-11)
• the implementation of a comprehensive subsidence monitoring program which is capable of detecting vertical, horizontal and far-field subsidence movements.	**Section 11.1.7**

11.1.3 Background

Longwall Mining and Subsidence

Longwall mining involves the progressive removal of portions of a coal seam, which creates a void along the width of the longwall panel. The extraction of coal results in the subsequent collapse of overlying strata, resulting in some vertical lowering of the ground surface above the longwall panel, known as subsidence (refer to **Figure 11.1**).

Subsidence occurs because the roof of the void created by mining is unable to support itself following extraction, causing the overlying strata to fracture and cave into the void (goaf). The collapse results in the settling and bending of overlying strata which, in turn, results in the formation of a subsidence trough on the surface. See **Figure 4.5** in **Section 4.0** (Proposed Development) for a schematic illustration of longwall mining.

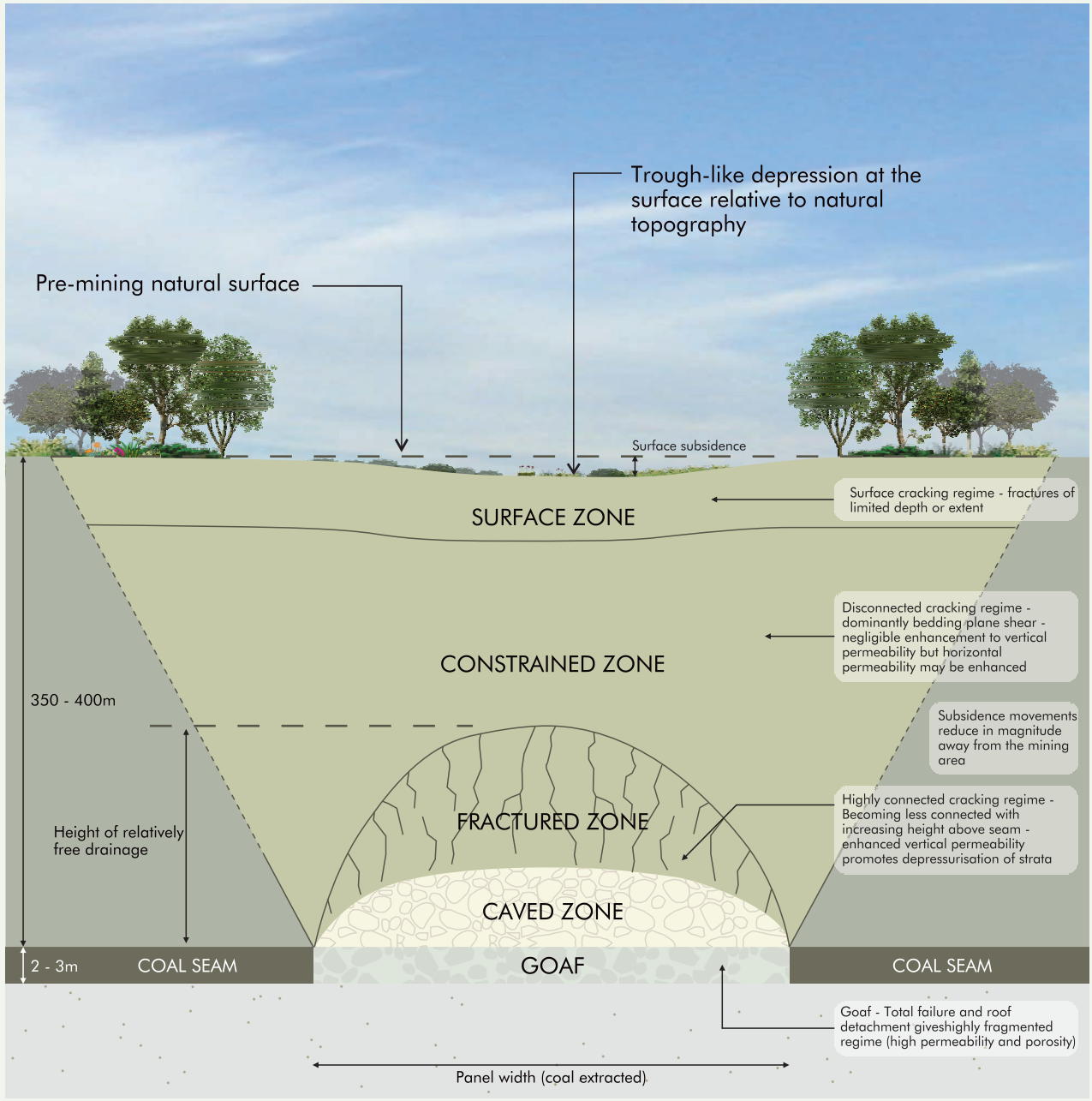
Maximum subsidence of the ground surface typically occurs in the central portion of the depression created at the surface and depends on a number of factors including longwall geometry, depth of cover, extracted seam thickness and overburden geology. There exists a critical width of extraction at which subsidence at the centre of the trough would reach a maximum possible value. The maximum subsidence in the Southern Coalfield, within a single seam and for a single panel of supercritical width of extraction, is generally 65% of the extracted seam thickness. Maximum subsidence at Tahmoor Mine has historically been measured at up to 1,300 mm (Tahmoor Coal, 2017).

In addition to subsidence, longwall mining results in several other surface movements as follows (MSEC, 2018):

- tilt – a change in slope at the surface, calculated as the difference in subsidence between two points on the land surface, divided by the distance between those two points;
- curvature – the bending of the ground as a result of differential subsidence, calculated as the change in tilt between two adjacent sections of the tilt profile divided by the average length of those sections. Curvature can be either hogging (convex) or sagging (concave);
- strain – the relative differential horizontal movements of the ground. Normal strain is calculated as the change in horizontal distance between two points on the ground, divided by the original horizontal distance between them. Tensile strains occur where the distance between two points increases (often near the tops of valleys) and compressive strains occur when the distance between two points decreases (often within the bases of valleys);
- horizontal shear deformation – occurs across monitoring lines and can be described by various parameters including horizontal tilt, horizontal curvature, mid-ordinate deviation, angular distortion and shear index;
- upsidence – occurs where a valley is undermined and is the relative upward movement or uplift created by horizontal compression and buckling behaviour of rock strata in the vicinity of the valley floor. It is often observed that the valley floor subsides to a lesser extent than surrounding ridges tops (reduced subsidence). The magnitude of upsidence is the difference in subsidence between the observed subsidence profile within the valley and the conventional subsidence profile which would have otherwise been expected in flat terrain; and
- closure – this is the reduction in the horizontal distance between the valley sides.

Subsidence can result in either conventional (smooth profile) or non-conventional (irregular profile) ground movements (which can result from changes in geological conditions, steep topography or valley related movements). Historical information available for Tahmoor Mine indicates that both types of subsidence impacts occur. Consequently, both have been considered during the impact assessment for the proposed development.

Longwall mining can also create far-field movements. Far-field movements are the measured horizontal movements located beyond the longwall goaf edges and over solid unmined coal areas. These horizontal movements are often much greater than the observed vertical movements at these locations. Far-field horizontal movements are accompanied by very low levels of strain (usually less than the order of survey tolerance being less than 0.3 mm/m), and generally do not result in impacts on natural features or surface infrastructure. Larger structures such as roads and railway bridges may be more sensitive to far-field horizontal movements.



Adapted from Mine Subsidence Engineering Consultants Pty Ltd

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SUBSIDENCE SCHEMATIC

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FIGURE 11.1

Existing Subsidence Monitoring and Management

The existing Tahmoor Mine operates under SMPs which are prepared by Tahmoor Coal prior to the commencement of each longwall and submitted to DRG for approval. SMPs have been prepared for varying infrastructure and public structures (including roads, rail and utilities) to manage public risk and safety. Longwall 32 within Tahmoor North is the last longwall approved under the SMP approval process. This process is informed by subsidence predictions for those structures and a risk assessment to determine the likelihood of impact, and to identify satisfactory management and remedial measures.

Existing subsidence monitoring at Tahmoor Mine includes the monitoring of:

- 806 residential properties;
- 1064 public amenities and commercial buildings;
- 26.2 km of asphalt pavement road directly above extracted longwalls;
- potable water infrastructure, including:
  - 4.8 km of ductile iron concrete lined pipe; and
  - 19 km of cast iron concrete lined pipe;
- 17.9 km gas pipeline;
- 29.4 km of sewer pipeline;
- electricity distribution infrastructure, including:
  - 38.2 km of electrical cables; and
  - 1019 power poles;
- telecommunication infrastructure, including:
  - 43.1 km of buried copper cable;
  - 2.2 km of buried optical fibre cable; and
  - 4.9 km of aerial cable.

Tahmoor Mine has received approval for a SMP for longwalls 24 to 32. Through implementation of the SMP, Tahmoor Coal has measured subsidence impacts and collated years of data collected for the existing operations at Tahmoor North. This data was used to inform the mine planning process for the proposed development.

A constraints analysis, risk assessment and detailed field investigations were undertaken during the mine planning process for the proposed development to identify sensitive natural surface features (such as waterways, cliffs and Aboriginal heritage sites). Monitoring data from the existing operations at Tahmoor North were used to inform the subsidence assessment to gauge the potential impacts to the sensitive natural features.

11.1.4 Methodology

The Subsidence Impact Assessment:

- defined the SSA of the proposed development as the area of influence or reach of subsidence related impacts from the proposed development;
- quantified the predicted subsidence impacts using a prediction model that incorporated the longwall geometry and dimensions, planned extraction depths, underlying seam information, local and regional observed historical data. The model was then used to assess the potential sensitivity of the predictions (as described further below);
- assessed impacts of the proposed development on natural and built features based on the predicted subsidence impacts. The assessment:

  - identified the features within the existing environment that could be affected by subsidence, in particular the underlying geology, natural surface features (e.g. waterways and cliffs) and built features (e.g. community and/or public infrastructure and buildings);
  - identified maximum predicted subsidence impacts for each of those features; and
  - identified measures to avoid, minimise, remediate and/or offset predicted subsidence impacts.
- included a sensitivity analysis using information derived from observed subsidence movements caused by mining at Tahmoor North.

The Subsidence Impact Assessment is based on single seam mining within the Bulli seam (Refer **Figure 11.10** and **Appendix F**).

Extent of Longwalls

The 'extent of longwalls' defines the maximum extent of the footprint of the proposed longwall mining and consists of both first (roadways) and second (longwall) workings. The impact assessment for the proposed development assumes that longwall mining would occur only within the extent of longwalls.

The extent of longwalls provides for some flexibility for the modification of mining development work and longwall layout during detailed design, subject to geological conditions. It is proposed that minor changes to the layout would be approved under the Extraction Plan approval process (refer to **Section 11.1.7** for further discussion regarding Extraction Plans and the difference between Extraction Plans and SMPs). The final detailed design of the longwall layouts would be subject to review and approval in consultation with the relevant authorities and to the satisfaction of the Secretary of DPE. Mining operations which are proposed to be undertaken within the extent of longwalls include first workings, comprising main headings, gate roads and cut throughs as well as the development of the longwall panels (second workings).

The Tahmoor South project proposes longwall mining of longwall panels 101 to 109 in the Bulli seam within the Central domain, at depths of cover between approximately 365 m and 410 m below the surface ground level. The longwalls would be orientated in a south-east / north-west direction and parts of some longwalls are located under the Bargo township area. The extent of longwalls for the proposed development is shown in **Figure 4.1**.

Subsidence Study Area

The surface area within which natural surface features and items of infrastructure were identified and assessed for their potential to experience mine subsidence impacts as a result of the proposed extraction of longwalls is defined as the SSA.

The SSA assessed was conservatively derived by combining the areas bounded by the following limits:

- the predicted limit of vertical subsidence, taken as the 20 mm subsidence contour resulting from extraction within the proposed extent of longwalls (determined using the Incremental Profile Method); or
- a minimum of 600 m from the nearest edge of longwalls within the proposed extent of longwalls, as recommended by the independent inquiry report titled *Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield – Strategic Review* (NSW Department of Planning, (DoP), 2008).

Therefore to ensure a conservative assessment, the SSA has been defined based on whichever limit outlined above is furthest from the proposed longwalls. The SSA is shown on **Figure 4.1**.

Subsidence Prediction

Incremental Profile Method

The predicted limit of vertical subsidence, taken as the predicted total 20 mm subsidence contour, was determined using the Incremental Profile Method (IPM). The IPM is an empirical model based on a large database of observed monitoring data from previous mining within the Southern, Newcastle,

Hunter and Western Coalfields of NSW and the Bowen Basin in Queensland. The IPM was calibrated for local conditions, based on the extensive ground monitoring data from Tahmoor Mine.

The calibrated prediction model was tested using the latest available subsidence data from mining in the Tahmoor North area, in combination with subsidence data from Longwalls 1 to 19. These longwalls are the closest previously mined longwalls to the proposed development and therefore provide the most relevant subsidence data as they are located in a similar geological environment to that of the proposed development. Subsidence observation and prediction profiles for other nearby mines in the Southern Coalfield were also reviewed to test the suitability of the IPM.

The calibration tests demonstrated that observed subsidence at Tahmoor Mine was generally less than the subsidence predicted by the model, with a 93% level of confidence that the maximum observed total subsidence would be less than the maximum predicted total subsidence for the proposed development. Therefore, the IPM is deemed to provide a reasonable and slightly conservative prediction for subsidence impacts associated with the proposed development.

The IPM was used to predict maximum conventional subsidence parameters including tilt and curvature for the proposed development. Further detailed description of the IPM is provided in the Subsidence Impact Assessment in **Appendix F**.

Increased Subsidence Predictions

Surface subsidence levels associated with the current operations at Tahmoor Mine have been measured to be generally in the order of 1,300 mm (Tahmoor Coal, 2017). During mining at Tahmoor Mine, observed subsidence impacts over Longwalls 24A and the southern parts of Longwalls 25 to 27 exceeded the predicted subsidence movements for individual longwalls. The relative increase in incremental subsidence was up to 2.34 times greater than predicted for this area. An investigation into the exceedance was undertaken and it was concluded that the increased magnitude of subsidence was consistent with localised weathering of joint and bedding planes above a depressed water table adjacent to an incised gorge, which in this case relates to the Bargo River (MSEC, 2018).

The location of increased subsidence was determined to be linked to the alignment of the Nepean Fault and proximity to the Bargo River Gorge. While subsidence was greater than anticipated in this location, the surface strains were within expectations. Potential impacts of increased subsidence on the structures and infrastructures within the overlying urban areas of Tahmoor Township were successfully managed by Tahmoor Mine through the implementation of effective subsidence management plans. The investigations undertaken for the proposed development and this EIS have considered the potential presence of similar geological features occurring within the Project Area, and informed the subsidence predictions and management derived for the proposed development.

Increased subsidence has also been observed within areas located above solid intact coal that are left between two extracted areas. Subsidence in these areas has generally been between 50 and 150 mm above what was predicted using the IPM and generally displays low levels of tilt and strain. In addition to IPM modelling of conventional subsidence parameters, the potential for increased subsidence was considered for the proposed development impacts on natural and built features.

Strain Prediction and Analysis

A linear relationship between curvature and strain is generally adopted to predict maximum conventional tensile and compressive strain impacts. Locations that are predicted to experience hogging curvature are expected to be net tensile strain zones and locations that are predicted to experience sagging curvature are expected to be net compressive strain zones. In the Southern Coalfield, a factor of 15 provides a reasonable relationship between the maximum predicted curvatures and the maximum predicted conventional strains and was therefore adopted for the proposed development.

However, as considerable variation can exist between observed and predicted strains, a statistical approach was also adopted using observed strain data from Tahmoor Mine and other Coalfields. Statistical analysis was applied to the observed data to determine confidence levels for strain predictions (refer to **Appendix F** for further detail). Analysis of strains was undertaken for:

- strains measured in survey bays, to account for features that are in discrete locations such as building structures, farm dams and archaeological sites;

- strains along the length of monitoring lines, to account for linear features such as roads, cables and pipelines; and
- shear strains, to account for the relative horizontal movements that occur perpendicular to the direction of measurement (known as horizontal mid-ordinate deviations).

Impact Assessment Methods

Once subsidence predictions and the SSA had been defined, potential impacts were assessed for the natural and built features present within the SSA. This involved:

- reviewing historical data available for subsidence impacts on specific natural and built features in the Southern Coalfields (such as Nepean River), including data from Tahmoor Mine and other nearby mines;
- predicting maximum subsidence and strain impacts at each feature (where previous data was available) and comparing previously observed and predicted impacts on those features from previous mining activity at Tahmoor Mine and in the Southern Coalfields. Consideration of increased predictions was also taken into account where relevant; and
- assessing the impacts on environmental aspects, using subsidence predictions for those aspects and other assessment methods specific to each assessment. These included groundwater, surface water, terrestrial and aquatic ecology, heritage (Aboriginal and non-Aboriginal), land use and other disciplines which are detailed throughout **Section 11.0**.

While general subsidence predictions and impacts to natural and built features have been considered in this section, a detailed impact assessment of each feature is contained in the relevant section for each environmental aspect, as follows:

- Geomorphology – **Section 11.2**
- Groundwater – **Section 11.3**;
- Surface Water – **Section 11.4**;
- Thirlmere Lakes – **Section 11.5**
- Terrestrial Ecology – **Section 11.6**;
- Aquatic Ecology – **Section 11.7**;
- Aboriginal Heritage – **Section 11.8**; and
- Non-Aboriginal Heritage – **Section 11.9**.

Impact Assessment of Housing and Infrastructure

The Subsidence Impact Assessment for the proposed development included:

- prediction of subsidence impacts to built features within the SSA using a prediction model;
    - for linear infrastructure, such as rail, roads and utilities, the most relevant subsidence parameter is the maximum strains measured along monitoring lines (**Appendix F**); and
    - for discrete structures such as buildings, the most relevant subsidence parameter is the maximum strains measured in individual survey bays (**Appendix F**).
- assessment of subsidence impacts on built features as follows:
    - identification of the built features within the existing environment that could be affected by subsidence, in particular community and/or public infrastructure and buildings, transport and associated infrastructure, and utility services. The locations, sizes, and construction details of houses within the SSA were determined from the aerial photographs of the area, kerbside inspections and Google Street View®. In some cases, the houses were inspected at the request or consent of the landowners;
    - identification of the maximum predicted subsidence impacts for each of those features and therefore the potential impacts on those features; and

- consideration of measures to avoid, minimise, remediate and/or offset predicted subsidence impacts.

For impacts to residential dwellings and houses, a classification system for impacts was used. The classification system used for the proposed development is a revised method, which builds on the previous method used at Tahmoor Mine, which is consistent with the classification of damage of the *Australian Standard 2870-1996*. The previous method was revised due to difficulty of using crack width as a main classifying factor for subsidence impacts which involved too great a focus on structural stability and not on other aspects of buildings. The revised method is more closely aligned with all aspects of a building, its finishes and services to reflect the concern of residents for impacts to internal linings, finishes and services in addition to external walls.

The revised method is detailed in **Appendix F** and the resulting classification table is reproduced in **Table 11-2**. This method was also applied to public amenities where they were of a similar size to housing structures.

The classification method was applied to the proposed development using a probability-based approach for each repair category in order to predict impacts to houses within the Subsidence Area (refer to **Appendix F** for further detail).

Table 11-2 Classification based on the extent of repairs (MSEC, 2018)

Repair Category	Extent of Repairs
Nil/ No Claim	No repairs required
R0 Adjustment	One or more of the following, where the damage does not require the removal or replacement of any external or internal claddings or linings: • Door or window jams or swings, or • Movement of cornices, or • Movement at external or internal expansion joints.
R1 Very Minor Repair	One or more of the following, where the damage can be repaired by filling, patching or painting without the removal or replacement of any external or internal brickwork, claddings or linings: • Cracks in brick mortar only, or isolated cracked, broken, or loose bricks in the external façade, or • Cracks or movement < 5 mm in width in any external or internal wall claddings, linings, or finish, or • Isolated cracked, loose, or drummy floor or wall tiles, or • Minor repairs to any services or gutters.
R2 Minor Repair	One or more of the following, where the damage affects a small proportion of external or internal claddings or linings, but does not affect the integrity of external brickwork or structural elements: • Continuous cracking in bricks < 5 mm in width in one or more locations in the total external façade, or • Slippage along the damp proof course of 2 to 5 mm anywhere in the total external façade, or • Cracks or movement > 5 mm in width in any external or internal wall claddings, linings, finish, or • Several cracked, loose or drummy floor or wall tiles, or • Replacement of any services.
R3 Substantial Repair	One or more of the following, where the damage requires the removal or replacement of a large proportion of external brickwork, or affects the stability of isolated structural elements: • Continuous cracking in bricks of 5 to 15 mm in width in one or more locations in the total external façade, or • Slippage along the damp proof course of 5 to 15 mm anywhere in the total external façade, or • Loss of bearing to isolated walls, piers, columns, or other load-bearing elements, or

Repair Category	Extent of Repairs
	• Loss of stability of isolated structural elements.
R4 Extensive Repair	One or more of the following, where the damage requires the removal or replacement of a large proportion of external brickwork, or the replacement or repair of several structural elements: • Continuous cracking in bricks > 15 mm in width in one or more locations in the total external façade, or • Slippage along the damp proof course of 15 mm or greater anywhere in the total external façade, or • Re-levelling of building, or • Loss of stability of several structural elements.
R5 Re-build	Extensive damage to house where Tahmoor Coal and the owner have agreed to rebuild as the cost of repair is greater than the cost of replacement.

11.1.5 Existing Environment

Underlying Geology

Tahmoor Mine lies in the southern part of the Permo-Triassic Sydney Basin, within which the main coal bearing sequence is the Illawarra Coal Measures. The Illawarra Coal Measures contain multiple workable coal seams, the uppermost of which is the Bulli seam, which would be mined as part of the proposed development.

Three stratigraphic divisions overlie the Illawarra Coal Measures, being the Narrabeen Group (sandstone and claystone), Hawkesbury Sandstone Group (bedded sandstone) and Wianamatta Group (shales and siltstones). Sandstone units within these stratigraphic divisions dominate the study area and are evident at the surface, often exposed in river gorges and creeks. The Wianamatta Group units evident at the surface are generally limited to along the tops of ridgelines.

Coal exploration for the proposed development has identified a number of geological features within the study area, including two faults being the Nepean fault and the Central fault. The presence of these faults influenced the proposed mine layout as shown on **Figure 4.1**. Further detailed description of the underlying geology is provided in **Section 5.0**.

Groundwater

The proposed development is located within the Sydney Basin sedimentary rock groundwater system. The recognised aquifers/water bearing zones within the Groundwater Study Area are the:

- unconfined Quaternary and Tertiary alluvium/sediment aquifers;
- late Triassic Wianamatta Group minor aquifers and aquitards;
- middle Triassic Hawkesbury Sandstone aquifers;
- lower Triassic Narrabeen Group sandstone aquifers; and
- Permian Illawarra Coal Measures water bearing zones.

Aquifers or known groundwater resources identified within the SSA are detailed in **Section 11.3**.

Natural Surface Features

Natural surface features identified within the SSA are shown in **Figure 11.2** and include:

- catchment areas or declared Special Areas;
- State conservation areas;
- rivers and creeks, including Mermaid Pool;
- cliffs or pagodas;
- steep slopes;
- land prone to flooding or inundation;

- threatened or protected species; and
- natural vegetation.

Detailed descriptions of these natural features are included in the Geomorphology Technical Report (Fluvial Systems, 2013), Surface Water Baseline Study (HEC, 2018), Terrestrial Ecology Assessment (Niche Environment and Heritage Pty Ltd, 2018) and Aquatic Ecology Assessment (Niche Environment and Heritage Pty Ltd, 2018) and are summarised in **Sections 11.2, 11.4, 11.6** and **11.7**, respectively.

Although of anthropogenic significance, archaeological items of Aboriginal significance have been considered a natural surface feature as they are usually linked to landforms such as cliffs and streams (e.g. rock shelters). Archaeological items and sites of Aboriginal significance are described in **Section 11.8** and include a number of open camp sites, grinding groove sites, rock shelter sites, and a scarred tree.

Built Features

Built features identified within the SSA (refer to **Figure 11.3**) include:

- roads and railways, including the M31 Hume Motorway, Remembrance Driveway and Main Southern Railway;
- structures such as culverts, bridges and viaducts, including bridges over rivers (Nepean River, Bargo River) and bridges over the Main Southern Railway;
- dams, reservoirs and associated works (including Nepean Dam and Picton Weir);
- public amenity infrastructure such as schools, Bargo cemetery, shopping centres and ovals;
- farm land and facilities including farm buildings and sheds, irrigation systems, farm dams and fences;
- industrial, commercial and business establishments;
- residential establishments and houses; and
- significant Heritage sites.

Detailed descriptions of these features are included in the non-aboriginal heritage, traffic, social, and land use, agriculture and resources sections of this EIS (refer **Sections 11.9, 11.13**, **11.15, and 11.19** respectively). Key built features (above ground only) are shown in **Figure 11.3**.

Road and Rail

Road and rail infrastructure within the Project Area are shown in **Figure 11.3** and include:

- Main Southern Railway – a key national transport route that carries significant freight and passenger services between Brisbane, Sydney and Melbourne. The Main Southern Railway is maintained by the ARTC. The railway consists of a number of components (other than the track) including major and minor structures such as:
  - a railway viaduct over Bargo River;
  - several bridges, including road overbridges and rail overbridges;
  - Tahmoor overhead rejects conveyor, which crosses the railway;
  - culverts, cuttings, and embankments; and
  - signalling, electrical equipment and telecommunications equipment.
- M31 Hume Motorway – a highway road corridor, linking Sydney with Canberra and Melbourne. The highway is located approximately 520 m from the nearest longwall based on the proposed Mine Plan. The M31 Hume Motorway within the Project Area includes several components (other than the road pavement) that may be subject to subsidence impacts namely bridges, culverts, cuttings and embankments. The M31 Hume Motorway is maintained by RMS.

- Remembrance Driveway – the primary local road within the Project Area, and runs alongside the western side of the Main Southern Railway. Remembrance Driveway is maintained by Wollondilly Shire Council.
- other local roads – local roads are located throughout the Project Area, primarily linking with the Remembrance Driveway and M31 Hume Motorway. There are several local road bridges within the Project Area as part of the local road network including Bargo Road, Kader Street and Pheasants Nest Road bridges.

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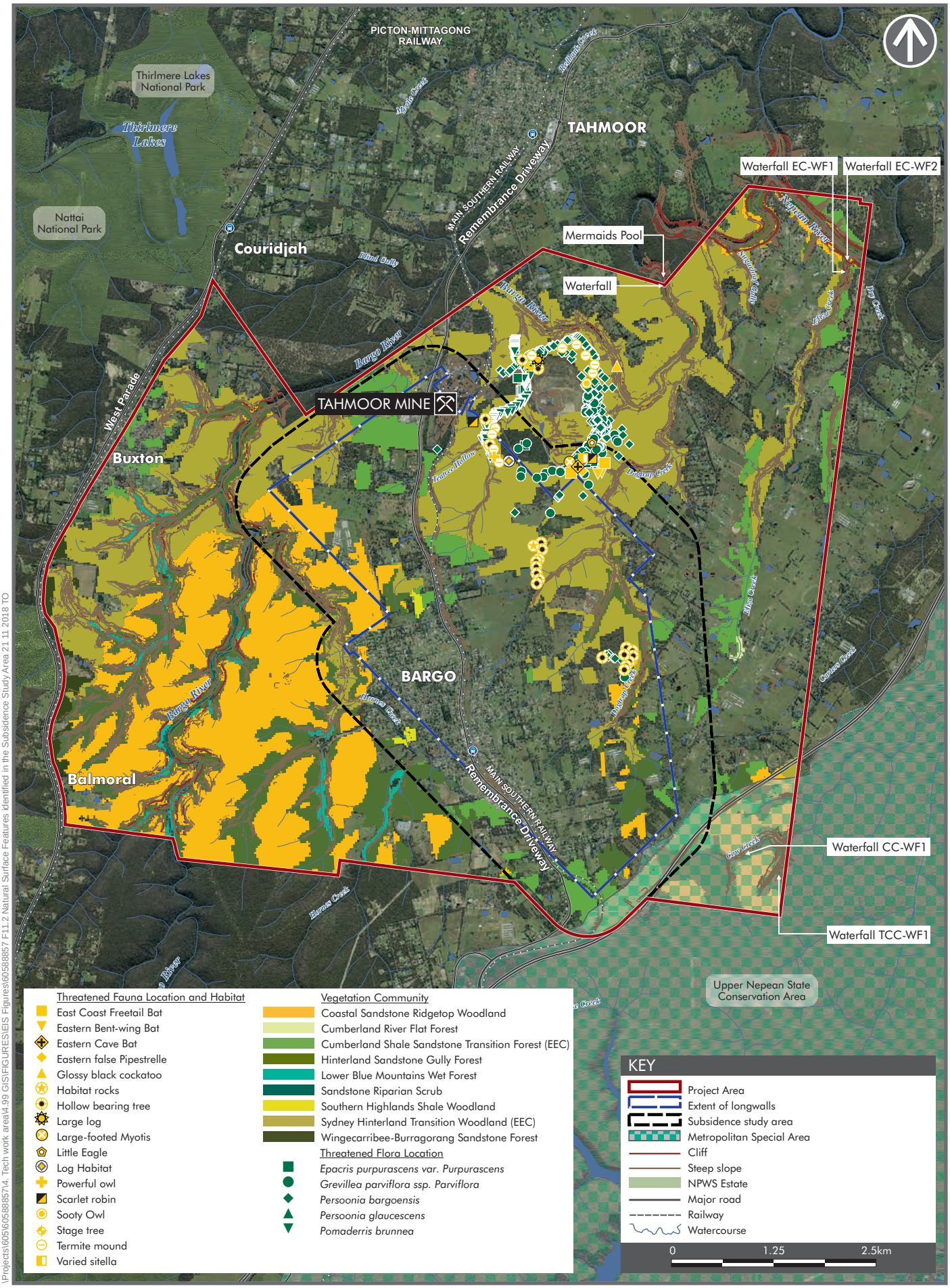

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NATURAL SURFACE FEATURES IDENTIFIED IN THE SUBSIDENCE STUDY AREA

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FIGURE 11.2

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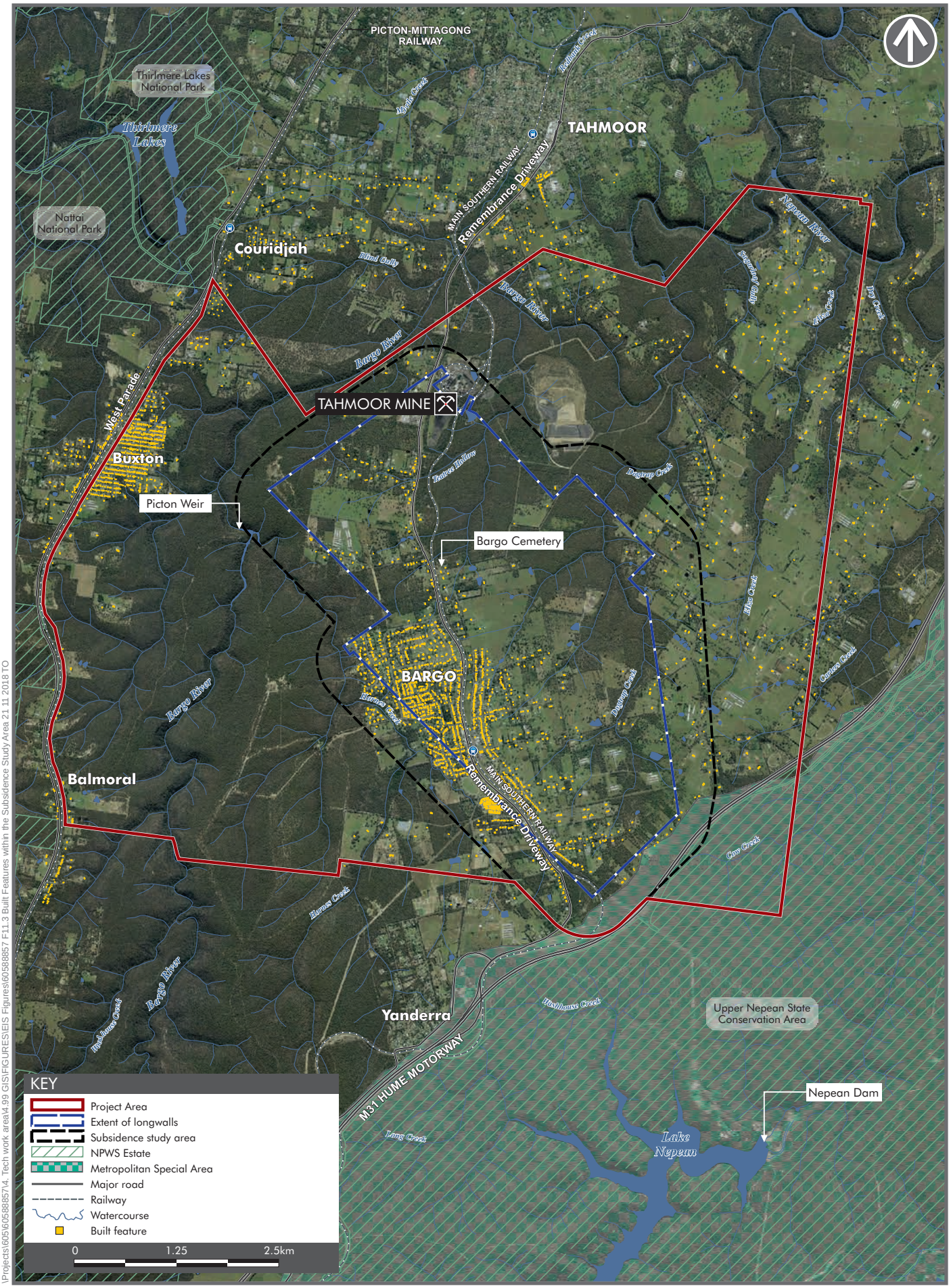

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SIMEC MINING

BUILT FEATURES WITHIN THE SUBSIDENCE STUDY AREA

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FIGURE 11.3

Utility Infrastructure and Services

Utility infrastructure and services within the Project Area are shown in **Figure 11.4** and include:

- potable water infrastructure – includes a rising main, water storage reservoir and distribution network owned and operated by Sydney Water;
- Bargo sewerage scheme - includes a pressure main along Remembrance Driveway and a consumer reticulation network along the local roads. The proposed sewerage system is being designed to accommodate mine subsidence movements and would be approved by the SA NSW prior to construction. The system would consist of polyethylene pipelines with diameters up to approximately 250 mm;
- Bargo Waste Management Centre (BWMC) – is operated by Wollondilly Council and is located on Anthony Road, Bargo. The BWMC would be located directly above the proposed longwall mining area;
- gas infrastructure – includes the Moomba to Sydney Gas Pipeline and the Gorodok Ethane Pipeline (high pressure pipelines) as well as the local gas reticulation network;
- electrical infrastructure – includes 66 kV, 11 kV and low voltage power lines (distribution only); and
- telecommunications infrastructure – includes copper cables, and optical fibre cables owned and operated by Telstra, Optus, AAPT and NextGen. A mobile phone tower is also located within the Project Area.

Public Amenity

Public amenities within the Project Area are located in or near the Bargo Township and include:

- two places of worship (Bargo District Baptist Church and St Paul's Anglican Church);
- two schools (Wollondilly Anglican College and Bargo Public School);
- a number of small shops in the Bargo township;
- one community centre (Bargo Community Centre);
- two bowling greens (both located at the Bargo Sports Club);
- two sportsgrounds which include ovals and tennis courts (Bargo Sportsground and grounds at Wollondilly Anglican College); and
- other public amenities including a preschool and three childcare centres, the Avon Caravan Village, Bargo Volunteer Bush Fire Brigade and Bargo Cemetery.

Houses

There are 1,458 houses within the SSA. These are shown in **Figure 11.5**. The majority of these houses are within the main township of Bargo and consist of single-storey residences with maximum plan dimensions less than 30 m, and are of brick or brick-veneer construction. Of the 1,458 houses, 751 (52%) are located directly above the proposed longwalls.

Within the SSA, the majority of houses are between 10 m and 30 m long with plan areas between 100 m^2 and 400 m^2. On average houses are around 18 m long with a plan area of 220 m^2. Analysis of historical aerial photographs indicates that the most houses were constructed between 1984 and 1994 and between 2002 and 2013.

The construction style of houses within the SSA is very similar to the distribution of styles within the Tahmoor Township, which have been subject to longwall mining by the Tahmoor Mine. The majority of the houses within the SSA are constructed of brick or brick veneer (75%), which is of a similar percentage (81%) to the construction style of houses affected by the mining of Longwalls 24 to 26 at Tahmoor North. As such, existing experience of subsidence impacts to houses depending on construction style from Tahmoor North would inform the management of subsidence impacts to houses within the Tahmoor South SSA.

Proposed development in mine subsidence districts requires SA NSW approval. SA NSW sets building and construction requirements to protect buildings and other surface improvements from subsidence damage; these requirements cover the nature and class of improvements, including height, type of building materials used and the construction method. Australian standards have been available for use in the design of structures since 1948. It is noted that the great majority of structures at Tahmoor and Thirlmere (approximately 80%) have been constructed after the declaration of the Bargo Mine Subsidence District in November 1975 (MSEC, 2018).

Subsidence Management and Consultation

Tahmoor Mine has been operating for over 30 years and has managed the impacts of mining operations on residences during mining at Tahmoor North using a range of communication and management tools. These tools would continue to be used to engage with the community during operation of the proposed development. These consultation and management tools include:

- **Resident Information Pack** distributed to residents in advance of any potential subsidence occurring at their properties. The resident information pack contains:
  - an overview of subsidence and the mining techniques used by Tahmoor Mine;
  - the rights and responsibilities as a home owner or tenant living in a Mine Subsidence District;
  - details of pre- mining inspections;
  - details of subsidence hazard inspections;
  - how to lodge a damage claim with the SA NSW; and
  - contact details for the relevant personnel at Tahmoor Mine including emergency contact details.
- **Monthly newsletter** containing up to date information on the current position of the longwall with local streets identified on the plan. The monthly newsletter assists residents to identify where they live in relation to current and future longwalls. The monthly newsletter also contains information on:
  - subsidence movements;
  - other major projects within the local area;
  - upcoming community information days; and
  - 24 hour contact numbers for Tahmoor Mine.

  The monthly newsletter is widely distributed in the community as follows:
  - via email to residents;
  - via posted mail to residents;
  - published on the Tahmoor Coal website- www.tahmoorcoal.com.au; and
  - posted to community notice boards in the Tahmoor Town Centre and at Community Links in Harper Close Tahmoor.
- **Community Information Days** held at least twice a year. The community information days are advertised in the Monthly Newsletter, Wollondilly Advertiser and on the Tahmoor Coal website. Representatives from Tahmoor Colliery and the SA NSW are available at each community information day to answer questions raised by community members. The purpose of the community information days is to provide the community with up to date information and the opportunity to talk to a Tahmoor Mine or SA NSW representative regarding a range of issues including:
  - mining updates and details of proposed mining operations at Tahmoor Mine;
  - information about mine subsidence and its impacts;
  - information regarding major projects at Tahmoor Mine;

- information regarding proposed control procedures, including monitoring programs;
- expert advice on specific housing and land issues within the area affected by mining;
- responses to queries about mining and subsidence;
- access to confidential counselling services; and
- community guides to mine subsidence and individual properties.

- **Subsidence monitoring** undertaken along the streets regularly to monitor the impacts. Tahmoor Coal has engaged a team of specialists to visually inspect, monitor and survey surface and below surface infrastructure to not only ensure there is no risk to public safety, but also monitor change and discuss any concerns residents may have regarding Tahmoor Coal operations.

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SIMEC MINING

UTILITIES WITHIN THE PROJECT AREA

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.4

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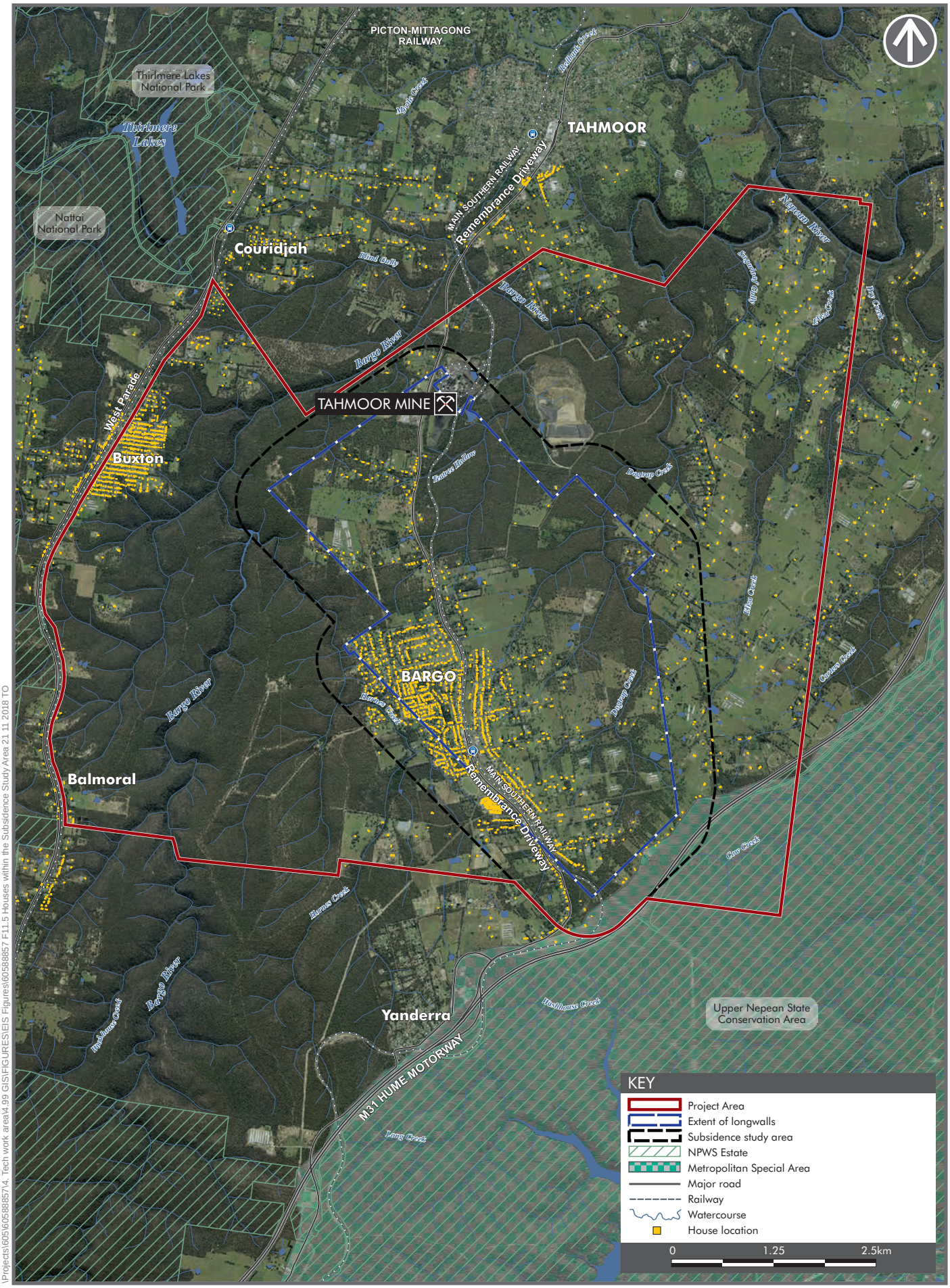


\Projects\605\605888574. Tech work area\4.99 GIS\FIGURES\EIS Figures\605888857 F11.5 Houses within the Subsidence Study Area 21 11 2018 TO

SIMEC MINING

HOUSES WITHIN THE SUBSIDENCE STUDY AREA

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.5

11.1.6 Impact Assessment

Longwall mining-induced subsidence can result in both subsurface and surface impacts. Potential subsurface impacts include impacts to groundwater and aquifers. Surface impacts include ground deformations such as surface cracking, heaving, buckling, humping and stepping of land at the surface. The extent and severity of these impacts are dependent on a number of factors, including the mine geometry, depth of cover, overburden geology, locations of natural jointing in the bedrock and the presence of near surface geological structures.

The Tahmoor South Project will involve longwall mining of nine panels (LW101-109). The mining geometry for each of the longwall panels is shown in **Table 11-3**.

Table 11-3 Mining geometry for proposed longwalls (MSEC, 2018)

Location	Longwall Widths (m)	Depths of Cover (m)	Width-to-Depth Ratios	Extraction Heights (m)
LW101 to LW108	285 & 305	370 ~ 415 (390 average)	0.70 ~ 0.82 (0.78 average)	2.05 ~ 2.85 (2.6 average)
LW109	305	380 ~ 410 (400 average)	0.74 ~ 0.80 (0.76 average)	2.1 ~ 2.4 (2.3 average)

Predicted Subsidence

Table 11-4 shows the maximum predicted conventional subsidence parameters resulting from the extraction of the proposed Longwalls 101 to 109 (MSEC, 2018). As shown, the maximum predicted subsidence for the proposed development is 1,900 mm after the completion of the proposed longwalls, which represents around 67% of the extraction height (MSEC, 2018). The maximum predicted total conventional tilt is 13 mm/m (i.e. 1.3 %), which represents a change in grade of 1 in 77 (MSEC, 2018). The maximum predicted total conventional curvatures are 0.19 km^{-1} hogging and 0.33 km^{-1} sagging, which represent minimum radii of curvature of 5 km and 3 km, respectively (MSEC, 2018).

As discussed in **Section 11.1.4**, the outer limits of the SSA was based on the predicted limit of vertical subsidence, taken as the 20 mm subsidence contour or a minimum of 600 m from the nearest edge of the proposed extent of longwalls (whichever was greater). The SSA boundary shown in **Figure 4.1** thereby shows the outer limits of subsidence impacts predicted to result from the proposed development.

Table 11-4 Maximum predicted total conventional subsidence, tilt and curvature resulting from the extraction of each proposed longwall area (MSEC, 2018)

Longwall	Maximum predicted total conventional subsidence (mm)	Maximum predicted total conventional tilt (mm/m)	Maximum predicted total conventional hogging curvature (km^{-1})	Maximum predicted total sagging curvature (km^{-1})
LW101 to LW108	1,900	12.0	0.19	0.33
LW109	1,000	8.0	0.09	0.24

Predicted Strain

The maximum predicted conventional strains, based on applying the maximum predicted conventional curvatures of 0.19 km^{-1} hogging and 0.33 km^{-1} sagging curvature and a factor of 15 to the maximum predicted curvatures, is approximately 3.0 mm/m tensile and 5.0 mm/m compressive for longwalls 101 to 109.

There can be considerable variation between observed and prediction strains. To account for this variability, a statistical approach was adopted for the strain analysis using data obtained from Tahmoor Mine and other collieries, adjusted to account for differences in mine geometry (refer to **Section 11.1.1**). The analysis identified that strains resulting from the extraction of the proposed longwalls would be, on average, around 30% to 50% greater than those previously experienced at Tahmoor Mine, Appin and West Cliff Collieries.

Potential for Increased Subsidence

As described in **Section 11.1.3** and **Appendix F**, Tahmoor Mine has experienced levels of subsidence greater than that which was predicted for previously extracted Longwalls 24A and 25 to 27. The likelihood for increased subsidence was assessed and it was concluded that while increased subsidence similar to that experienced for Longwalls 24A and 25 to 27 may be possible, the following conditions are different for the proposed development and these conditions would influence the potential for increased subsidence:

- the Nepean Fault is less defined in the Project Area for the proposed development compared to the existing Tahmoor North area;
- the proposed longwalls are located further away from major regional streams such as the Bargo River (the magnitude of subsidence generally decreased as distance from the river increased); and
- the groundwater gradients are less than those measured near Longwalls 24A to 26 (refer **Appendix F**).

If greater than predicted subsidence was to occur for the proposed longwalls, it is unlikely that the magnitude of this increased subsidence would be significantly greater than predictions for the following reasons:

- predicted maximum observed incremental subsidence represents 51% of the proposed extraction height. The maximum incremental subsidence for Longwalls 24A to 27 was around 55% of the extraction height;
- predicted maximum total subsidence represents 67% of the proposed extraction height. The maximum observed total subsidence for Longwalls 24A to 27 was around 62% of the extraction height;
- the higher levels of predicted subsidence at Tahmoor South are due to a combination of thicker extraction heights, slightly shallower depths of cover and wider proposed longwall panel widths. They are comparable to or just less than the observed increased subsidence above Longwalls 24A to 27 when expressed as a proportion of extraction height; and
- in the cases of Longwalls 25 and 24A, the observed relative increase in incremental subsidence was greater than predictions by between 2 and 2.34 times, respectively. This was partly because the panels were the first and second in a series of longwalls where reduced subsidence would normally have been expected to develop. Increasing the predicted levels of subsidence by factors of 2 to 2.34 would result in subsidence much greater than the proposed extraction height, which is extremely unlikely to occur.

The potential for increased subsidence resulting from barriers of unmined coal between proposed Longwall 101 and previously extracted Longwall 2 and between proposed Longwalls 101 to 105 and previously extracted Longwalls 14 to 19 has also been assessed. While it is possible that observed subsidence may exceed predictions in these zones, subsidence monitoring at Tahmoor Mine indicates that any increase is accompanied by relatively low systematic tilts, curvature and strains (less than 0.5 mm/m and usually within survey tolerance). Based on previous experience at Tahmoor North, similar observations are considered likely for the proposed development.

Predicted Horizontal Movements

Conventional horizontal movements observed for the Tahmoor Mine are within the normal range in the Southern Coalfield for similar depths of cover. Horizontal movements generally do not result in perceived impacts. However, differential horizontal movements can potentially result in impacts on sensitive features, such as long road and railway bridges. Predictions of absolute and differential far field horizontal movements have been provided for these features.

The far-field horizontal movements for the proposed development are predicted as being very small and accompanied by very low levels of strain, which are generally less than the order of survey tolerance (i.e. less than 0.3 mm/m). However, some far-field horizontal movements can be experienced by road and railway bridges. The potential impacts of far-field horizontal movements on the natural and built features within the vicinity of the proposed longwalls are not expected to be significant.

Impacts on Natural Features

Impacts to natural features have been assessed based on the maximum predictions of subsidence and strains, and observations and experiences gained during the extraction of previous longwalls adjacent to or directly beneath similar natural features. Detailed assessment is provided in the relevant specialist section of this EIS. However, a summary of the impacts is provided in **Table 11-5**.

Table 11-5 Potential impacts to natural features

Natural feature	Potential impacts	Mitigation
Groundwater and aquifers	Potential impacts may include fracturing of bedrock and drawdown of groundwater. Potential impacts to groundwater as a result of subsidence associated with the proposed development are considered further in **Section 11.3**, and in **Appendix I**.	A number of measures would be implemented to manage potential groundwater impacts, including: • a Groundwater Management Plan (GWMP) would be developed to define a groundwater monitoring strategy, groundwater level triggers, and a TARP; • the regional groundwater monitoring network would continue to be developed and maintained; and • Tahmoor Coal commits to implementing "make good" measures to effectively mitigate impacts to bore users. Refer to **Section 11.3.5** and **Appendix I** for the full list of measures that would be implemented to manage potential groundwater impacts.
Steep slopes, cliffs and rock formations	Potential impacts include fracturing and increased rock falls. Potential impacts to slopes, cliffs and rock formations as a result of subsidence associated with the proposed development are in **Section 11.2**, and in **Appendix H**.	Tahmoor Mine has previously developed Management Plans to manage the potential impacts on cliffs during the mining of longwalls. The management plans include consultation with landowners, visual inspections before and after mining and where the public may access the cliffs, erection of warning signs during periods of active mining. Similar management strategies would be developed in consultation with the nearby landowners to manage potential risks to the people who may be visiting or passing by cliffs within the SSA during periods of active mining. Tahmoor Mine has previously developed subsidence management plans for managing the potential impacts on steep slopes during the mining of Longwalls 22 to 27. These management plans include: • identification of all structures, dams and roads that lie in close proximity to steep slopes; • site investigation and landslide risk assessment of structures near slopes by a qualified geotechnical engineer; • site investigation and structural assessment of structures where recommended by the geotechnical engineer. This may include recommendations to mitigate against potential impacts; • monitoring, including ground survey and visual inspections; and • remediation if cracking or slippage occurs. Tahmoor Mine would continue to develop management plans consistent with existing measures to manage potential impacts on slopes during the mining of the proposed longwalls.

Natural feature	Potential impacts	Mitigation
Catchment areas, rivers and creeks	Potential impacts include fracturing resulting in loss of flow and surface deformation resulting in ponding. Potential impacts to surface water features are considered further in **Section 11.4**, and in **Appendix J**.	Tahmoor Mine would incorporate a number the measures listed in **Section 11.4.6** into the Extraction Plan for the proposed development. These measures would be consistent with the existing measures that have been implemented to effectively manage potential mining induced impacts to river channels for current operations as part of existing SMPs.
Threatened or protected species and natural vegetation	Potential impacts to vegetation and threatened flora as a result of subsidence are not anticipated to be significant given that impacts from subsidence on vegetation are considered to be localised and minor, and availability of water to vegetation would not be significantly altered. There are no sensitive heath and swamp communities within the SSA. Subsidence impacts to threatened fauna are primarily limited to aquatic species associated with potential impacts on rivers and creeks. Potential impacts to both terrestrial and aquatic flora and fauna are considered in further detail in **Section 11.6** and **11.7**, and in **Appendix K**.	Tahmoor mine would prepare and implement a Corrective Management Action Plan and TARP for potential impacts to pools and other aquatic habitat features identified in the Aquatic Ecology Assessment (**Appendix K**). Stream triggers would be developed using baseline data and anticipated subsidence effects, with specific triggers continuing to be developed as monitoring continues and refined in consultation with key stakeholders. An on-going monitoring program would be undertaken as part of the Biodiversity Management Plan. This program would include monitoring of potential flora and fauna impacts and would be implemented for as long as potential impacts could occur. Monitoring measures would include regular inspection, measures for response if impacts are detected, and monitoring of the success of mitigation. Refer to **Section 11.6.5**, **Section 11.7.5** and **Appendix K** for additional mitigation measures.

Natural feature	Potential impacts	Mitigation
Archaeology and Aboriginal heritage	Potential subsidence impacts to archaeological and Aboriginal heritage include increased rock fall or surface cracking that may damage items and their values and are discussed further in **Section 11.8** and **11.9**, and in **Appendix L**.	The Extraction Plan developed for the longwalls for the proposed development (refer to **Section 11.1.7**) would include the following for Aboriginal heritage: • A schedule for undertaking monitoring at nominated sites; • Appropriately detailed baseline and archival site recordings, including high resolution digital photographs and an impact Trigger and Action Response Plan TARP specific to each of the sites being monitored; - Archival site recordings would include three dimensional scans and digital rendering of rock shelters of high significance which would be provided for use to RAPs; and • Adaptive management techniques. Should monitoring detect the early development of potentially severe differential movements at these archaeological sites during the extraction of Longwalls 101 and 102, consideration would be given to shortening the commencing position of Longwall 103. A site specific Heritage Management Plan would be prepared for each heritage site of local and/ or State significance identified within the Project Area, including Wirrimbirra Sanctuary, Bargo Cemetery, Bargo Railway Bridges (South and North) and Tahmoor Mine. Each Heritage Management Plan would be developed in consultation with property owners/managers and the Wollondilly Shire Council prior to commencement of mining. Refer to **Section 11.8.5**, **Section 11.9.5** and **Appendix L** for additional mitigation measures.

Impacts to Built Features

Impacts to built features have been assessed based on the maximum predictions of subsidence and strains, and observations and experiences gained during the extraction of previous longwalls adjacent to or directly beneath similar built features. Detailed assessment is provided in sections below and a summary of the potential impacts is provided **Table 11-6**.

Table 11-6 Summary of potential impacts to built features

Built feature	Potential impacts	Mitigation
Roads and railways, including the M31 Hume Motorway, Remembrance Driveway and Main Southern Railway	Impacts include subsidence of up to 1,800 mm on the Main Southern Railway and Remembrance Driveway. The M31 Hume Highway would not be undermined and is located outside of the predicted limit of subsidence. Other local roads are located directly above the proposed longwalls and, therefore, could experience the full range of predicted subsidence movements. Potential impacts to roads and railways as a result of subsidence associated with the proposed development are discussed below.	Potential subsidence impacts to built infrastructure are manageable and can be controlled by the preparation and implementation of an Extraction Plan and a series of specific Extraction Plan sub-plans, similar to the SMPs which have already been developed and are being successfully implemented during mining at Tahmoor Mine. These management plans would be developed through consultation with the infrastructure owners and are approved by the relevant government agencies. Refer to **Section 11.1.7** for further detail.
Private properties	Potential impacts to private properties including houses are discussed below.	
Structures such as culverts, bridges and viaducts	For some less ductile structures, there is a possibility that those structures may fail in a brittle manner. Potential impacts to relevant structures as a result of subsidence associated with the proposed development have been considered further below.	
Public utilities such as water, gas or sewerage infrastructure, electricity transmission lines, and telecommunication services	The distribution network is located across the Study Area and, therefore, could experience the full range of predicted subsidence movements. Impacts could include leakage or breaks of water or gas pipes, or pole tilts for electrical (aboveground) infrastructure as discussed below. The main Telstra and Optus Sydney to Melbourne optical fibre cables and National Broadband Network cables follow the alignment of the M31 Hume Motorway and are outside the predicted limit of subsidence. The locations where key infrastructure is co-located would require careful management and would be addressed in the Extraction Plan.	
Varying land uses such as farm land, industrial and commercial establishments	Potential impacts are discussed below.	

Built feature	Potential impacts	Mitigation
Heritage sites	Possible impacts include damage to masonry or timber structures as a result of subsidence. Potential impacts to non-Aboriginal heritage features as a result of subsidence associated with the proposed development are considered further in **Section 11.9**, and in **Appendix L**.	Refer **Section 11.9.5** and **Appendix L.**

Impacts to Road and Rail

Table 11-7 shows the maximum predicted conventional subsidence parameters resulting from the extraction of the proposed longwalls in relation to the key road and rail infrastructure discussed in **Section 11.1.3**. The table shows that maximum predicted subsidence is highest for infrastructure that is located directly above longwall panels (such as the Main Southern Railway, Remembrance Driveway and local roads).

Table 11-7 Maximum predicted subsidence impacts for road and rail infrastructure

Infrastructure Item	Maximum predicted total conventional subsidence (mm)	Maximum predicted total conventional tilt (mm/m)	Maximum predicted total conventional hogging curvature (km^{-1})	Maximum predicted total sagging curvature (km^{-1})
Main Southern Railway	1,800 *(after LW108)*	8.5 *(after LW102 and 107)*	0.10	0.23
Remembrance Driveway	1,800 *(after LW108)*	8.0 *(after LW107)*	0.12	0.31
Local roads	1,900	12.0	0.19	0.33

Main Southern Railway

Potential impacts to the Main Southern Railway include the potential for:

- changes in track geometry (which could include vertical misalignment, horizontal misalignment, changes in track cant and track twist), changes in grades and changes in rail stress of the rail tracks; and
- cracking, damage or failure of associated structures (bridges and culverts), cuttings and embankments.

The ARTC *National Code of Practice for Track Geometry* provides allowable deviations in track geometry. An assessment of predicted conventional subsidence against this Code showed that that the predicted changes in track geometry are an order of magnitude less than the maximum allowable deviations. However, non-conventional movements could result in exceedances. Previous experience at Tahmoor Mine has demonstrated that potential risk to track safety can be managed through early detection via monitoring and early response through the implementation of triggered response plans. Tahmoor Mine and the Australian Rail Track Corporation (ARTC) previously developed a detailed risk management plan for managing potential mine subsidence impacts on the Main Southern Railway due to the extraction of Longwalls 25 to 32 at Tahmoor Mine and similar measures would be applied to the proposed development, to identify and manage impacts in accordance with ARTC requirements.

Mine subsidence would result in changes to rail stress unless preventive measures are implemented. The maximum predicted change in stress free temperature for the project is sufficient to warrant immediate preventative action on a track with concrete sleepers. If no action is taken, it is likely that the rails would become unstable as a result of the mining of the proposed longwalls. The combination of expansion switches and zero toe load clips has been successfully employed previously at Tahmoor Mine and at Appin Colliery to manage rail stress.

A series of predictions and assessments were also undertaken for each crossing of the Main Southern Railway, including bridges, Bargo viaduct and other crossings (such as Tahmoor Overhead Rejects Conveyor). Potential impacts to these structures include damage from cracking or failure due to their brittle nature. Previous bridge strengthening activities have been undertaken for Tahmoor Mine that would be similarly implemented for the proposed development. As such, potential impacts to these structures are considered to be minor in nature and manageable. Management and mitigation measures for potential subsidence as a result of the project are outlined in **Section 11.1.7** and include the preparation of the Extraction Plan that would be developed through consultation with the infrastructure owners and approved by the relevant government agencies.

M31 Hume Motorway

The M31 Hume Highway would not be undermined and is located outside of the predicted limit of subsidence and as such is not expected to be impacted by subsidence impacts.

M31 Hume Motorway bridges are all located outside the extent of the proposed longwalls. However some far-field horizontal movements may be experienced at the Avon Dam Road overbridge which is located 520m south of the extent of longwalls (noting that far field movements of up to 75mm have been observed up to 400m from previously extracted longwalls). As the remaining bridges are located at least 1.8 km from the proposed longwalls, they are unlikely to experience any measurable conventional subsidence impacts.

The Hume Highway and infrastructure associated with the Hume Highway are not predicted to be significantly impacted. Notwithstanding, management and mitigation measures for potential subsidence as a result of the project are outlined in **Section 11.1.7** and include the preparation of an Extraction Plan that would be developed through consultation with the infrastructure owners and would be approved by the relevant government agencies.

Remembrance Driveway and Local Roads

The Remembrance Driveway follows a similar alignment to the Main Southern Railway and as such is likely to experience similar subsidence movements. The remaining local roads within the SSA are located directly above the proposed longwalls and are likely to experience the full range of predicted subsidence movements. Potential impacts include cracking of the pavement, cracking of concrete culverts and drainage structures, and cracking of road cuttings and embankments. Previous experience of mining beneath roads and culverts indicates that the incidence of impacts is low and generally limited to cracking which can be readily remediated Longwalls 22 to 31 at Tahmoor Mine have mined directly beneath more than 28 km of local roads and a total of 52 impact sites have been observed. There is extensive experience of mining directly beneath local roads in the Southern Coalfield and with the implementation of suitable management strategies, impacts are considered to be manageable.

The most likely impacts of direct undermining of local road bridges could include cracking of the abutments and increased stresses on the decks and the compression heaving of pavements on approach to the bridges. The Tahmoor Mine has previously successfully undermined two local road bridges including undertaking strengthening and monitoring activities. These measures would inform the implementation of similar safeguards for the proposed development. As such, potential impacts to these structures are considered to be minor in nature and manageable. Management and mitigation measures for potential subsidence as a result of the project are outlined in **Section 11.1.7** and include the preparation of an Extraction Plan that would developed through consultation with the infrastructure owners and be approved by the relevant government agencies.

Impacts to Utility Infrastructure and Services

Table 11-8 shows the maximum predicted conventional subsidence parameters resulting from the extraction of the proposed longwalls in relation to the key utility infrastructure discussed in **Section 11.1.3**.

Longwall mining in the Southern Coalfield has occurred directly beneath water pipelines in the past and the subsidence impacts of the proposal are anticipated to be consistent with that observed to occur from previous longwall mining. Potential impacts to water infrastructure include localised leaks as a result of strain on pipes. These impacts are more likely to occur at stream crossings due to valley related movements. Previous experience at Tahmoor Mine indicates impacts to water infrastructure are minor in nature and readily remediated.

The Sydney to Moomba Gas Pipeline and the Gorodok Ethane Pipeline are considered to have reasonable flexibility to accommodate conventional subsidence movements. However, the pipeline may be impacted by localised non-conventional subsidence movements near the bases of streams. Previous experience in the Southern Coalfields has indicated that management measures are required to alleviate strain in these situations.

The local gas, sewerage, electrical and telecommunications infrastructure have the potential to experience the full range, or close to the full range, of predicted subsidence movements. The infrastructure is considered flexible and previous experience has demonstrated these assets are able to withstand the full range of subsidence experienced at Tahmoor Mine to date. Management measures are able to readily remediate minor impacts. Management and mitigation measures for potential subsidence as a result of the project are outlined in **Section 11.1.7** and include the preparation of an Extraction Plans that would be developed through consultation with the infrastructure owners and are approved by the relevant government agencies.

The Bargo Waste Management Centre (BWMC) is located on Anthony Road, Bargo directly above the proposed extent of longwalls. The BWMC is expected to experience the full range of predicted subsidence movements. Without the implementation of mitigation measures, mining directly beneath the BWMC may result in impacts on the slopes of the landfill and may result in cracking and potential leakage to groundwater for the surface water treatment ponds at the site. Storage containers at the site used to stored waste liquids such as engine oil are considered likely to be flexible and would tolerate subsidence movements.

Table 11-8 Maximum predicted subsidence impacts for utility infrastructure

Item	Maximum predicted total conventional subsidence (mm)	Maximum predicted total conventional tilt (mm/m)	Maximum predicted total conventional hogging curvature (km^{-1})	Maximum predicted total sagging curvature (km^{-1})
Potable water infrastructure	1,800	7.5	0.12	0.29
Sewer infrastructure	1800	8.0	0.12	0.31
Sydney-Moomba Gas Pipeline and Gorodok Ethane Pipeline	1,850	10.0	0.16	0.33
Local gas network	1,900	12.0	0.19	0.33
Electrical infrastructure	1,900	12.0	0.19	0.33
Telecommunications infrastructure (optical fibre cables)	1,900 (after LW103-108)	10.0	0.15	0.33
Telecommunications infrastructure (optical fibre cables that follow the Sydney-Moomba Gas Pipeline)	1,850	10.0	0.16	0.33
National Broadband Network (NBN) cables and copper cables	1800	10.0	0.15	0.33
Telstra Bargo Exchange	250	2.0	0.02	0.01

Impacts to Public Amenity

The assessment of public amenities considered amenities that:

- are located directly above the longwalls and therefore likely to experience the full range of subsidence predictions (refer **Section 11.1**); and

- are not located directly above the longwalls and therefore have been considered on a case by case basis (i.e. site specific predictions were undertaken, refer **Appendix F**).

Public amenities located directly above the longwalls may experience variable impacts depending on their structure including non-structural cracking of walls, floors or ceilings, tensile surface cracking and localised ground deformations. Some of these impacts may be experienced at public amenities not undermined by the proposed development. However, the nature and scale of impacts would be less than those directly above the longwalls.

Management and mitigation measures for potential subsidence related impacts as a result of the project are outlined in **Section 11.1.7** and include the preparation of an Extraction Plan that would be developed through consultation with the infrastructure owners to ensure all public amenities can be maintained in a safe and serviceable condition.

Impacts to Houses

Of the 1,458 houses identified within the SSA, 751 are located directly above one of the proposed longwalls (approximately 52%). Predicted movements and assessed impacts for each house within the SSA are included in Table D.03 of Appendix D of **Appendix F**.

Over the past thirteen years, Tahmoor Mine has subsided in the order of 1,890 houses above Tahmoor Longwalls 22 to 29, the majority of which experienced little if any damage from mine subsidence impacts. Of the 1,541 houses and buildings, a small percentage (7%) experienced more significant impacts (repair category R3 to R5 requiring substantial repair or rebuilding). These impacts have been rectified or continue to be repaired, replaced or otherwise satisfactorily addressed, by Tahmoor Mine in close working relationship with Subsidence Advisory New South Wales (SA NSW). Tahmoor Mine has been successfully managing subsidence impacts to houses and buildings from longwall mining at Tahmoor North for many years in accordance with an approved SMP and would continue to do so for Tahmoor South with an Extraction Plan for the proposed development.

Recent experience mining Longwalls 22 to 29 at Tahmoor Mine has indicated that residents have not been exposed to immediate or sudden safety hazards as a result of impacts that occur due to mining subsidence movements. Residents living within the active subsidence zone have often provided early feedback about impacts developing at their houses; with contact occurring before impacts develop to a level of severity sufficient to become a safety hazard. The community consultation and notification process is therefore critical to managing subsidence impacts, along with site specific investigations, regular surveys and inspections during mining and triggered response measures.

Potential impacts to houses include:

- changes to height above the flood level as a result of vertical subsidence;
- serviceability impacts (e.g. door swings, guttering and drainage) as a result of tilt; and
- amenity and structural impacts as a result of curvature and strain.

The range of predicted curvatures for the houses within the SSA is considered to be similar to those within the zone of increased subsidence observed above Tahmoor Longwalls 24A to 27. Subsidence impacts to houses within the zone of increased subsidence above Tahmoor Longwalls 24A to 27 involve a higher proportion of R3 to R5 repair category impacts (16%) to 69 out of 432 houses. This is compared to the overall proportion of R3 to R5 repair category impacts across all subsided houses above Tahmoor Longwalls 24A to 27 (7%, reflecting 131 of 1890 houses).

Within the Tahmoor South SSA, approximately 16% of houses directly above longwalls (126 of 751 houses) and 10% of all houses within the SSA (143 of 1,458 houses) are predicted to result in subsidence impacts in the R3 to R5 category. It is noted that the predictions also reflect the conservative nature of assumptions used in the assessment, where all houses were assigned the category of brick veneer on strip footings, noting that this type of construction has been observed to be more susceptible to subsidence impacts. The majority of predicted impacts (52% of houses directly above longwalls and 70% of all houses within the SSA) remain in the No Claim or R0 category (nil impacts or minor adjustment).

A summary of the assessed impacts to houses within the SSA is shown in **Table 11-9**.

Table 11-9 Assessment of likely impacts for the houses within the Study Area (MSEC, 2018)

Group	Repair Category			
	No Claim or R0	R1 or R2	R3 or R4	R5
All Houses (total 1,458)	**1,019 (70%)**	**296 (20%)**	**115 (8%)**	**28 (2%)**
Above proposed longwalls (total 751)	391 (52%)	234 (31%)	100 (21%)	26 (3%)
Above solid coal (total 707)	628 (89%)	62 (9%)	15 (2%)	2 (<0.5%)

Notes:
Nil/No Claim – No repairs required. No claims
R0 – Adjustment
R1 – Very Minor Repair
R2 – Minor Repair
R3 – Substantial Repair
R4 – Extensive Repair
R5 - Rebuild
Refer to **Table 11-2** for full definitions of repair classifications from MSEC, 2018.

An analysis was completed based on previous longwalls at Tahmoor Mine which suggests potential impacts are more likely to be experienced for:

- houses predicted to experience higher strains and curvatures;
- houses with masonry walls;
- masonry walled houses that are constructed on strip footings;
- larger houses; and
- houses with variable foundations, such as those with extensions.

The primary risk associated with undermining houses is public safety which is managed by the existing Tahmoor Mine operations through SMPs developed in consultation with SA NSW. Tahmoor Mine has extensive experience mining beneath urban areas and has developed and acted in accordance with a risk management plan to manage potential impacts on residential structures. Past mining experience has shown that residents have not been exposed to immediate and sudden safety hazards as a result of impacts from mine subsidence movements in the NSW Coalfields, where the depths of cover were greater than 350 metres, such as the case above the proposed longwalls. This includes the recent experience at Tahmoor Mine, which has affected more than 1,950 houses, and the experiences at Appin, Teralba, West Cliff and West Wallsend Collieries, which have affected around 500 houses (MSEC, 2018).

Management and mitigation measures for potential subsidence as a result of the project are outlined in **Section 11.1.7** and include the preparation of an Extraction Plan that would be developed through consultation with the infrastructure owners and would be approved by the relevant government agencies. In addition, owners of buildings or other surface improvements damaged by mine subsidence can lodge claims for compensation through SA NSW. SA NSW would facilitate compensation from mine operators where damage is the result of an active mining operation.

Impacts to Growth Areas

Wollondilly Shire Council has planned for future urban growth in and around Bargo in the order of an additional 2,000 houses prior to 2036 (as documented in the Council's Growth Management Strategy 2011). The majority of the urban growth is planned to occur to the east of Bargo township and above the longwalls of the proposed development. It should be noted that the additional houses envisaged by the strategy would be subject to development approval. The results of the assessment of potential subsidence impacts to potential future houses in Bargo described below would therefore be subject to change depending on what development is actually approved and constructed.

The Subsidence Impact Assessment in **Appendix F** included a simulation exercise to forecast the potential impacts of the proposed development on the future urban growth area around Bargo. For the purposes of the simulation exercise, 1,930 houses are forecast to be constructed within the SSA, and 1,603 would be located directly above the proposed longwall mining area.

The assessed impacts have been undertaken with all forecast houses assigned as brick veneer on strip footings. As noted before, this is a conservative approach as houses on strip footings have been observed to be more susceptible to impacts than other construction types. A summary of the assessed impacts for the additional 2,000 houses that form part of the future urban growth simulation exercise is provided in **Table 11-10**.

Table 11-10 Assessment of likely impacts for the houses included in the future urban growth simulation exercise

Group	Repair Category			
	No Claim or R0	R1 or R2	R3 or R4	R5
All future urban growth houses (total 2,000)	**1090 (55%)**	**560 (28%)**	**256 (13%)**	**96 (5%)**
Above proposed longwalls (total 1,603)	736 (46%)	528 (33%)	245 (15%)	94 (6%)
Above solid coal (total 397)	355 (89%)	32 (8%)	9 (2%)	1 (<0.5%)

The exercise indicates that of the 2,000 houses in the growth area, impacts to 55% of the houses would be classified as “no claim” or R0, 28% would be classified as R1 or R2 and 17% would be classified as R3 to R5 (MSEC, 2018).

Table 11-11 shows the overall distribution of assessed impacts where the proposed additional 2,000 houses assumed for the future urban growth simulation exercise are added to the existing houses within the SSA. The overall distribution of predicted impacts within the SSA would increase if the additional houses included in the simulation exercise are constructed in accordance with the current plans by Wollondilly Shire Council for future urban growth in this area. This is primarily due to there being a greater proportion of houses forecast to be located directly above the proposed longwall mining area within the SSA.

Table 11-11 Assessment of likely impacts for existing houses and additional houses assumed in the future urban growth simulation exercise

Group	Repair Category			
	No Claim or R0	R1 or R2	R3 or R4	R5
All additional houses (total 3,458)	**2,109 (61%)**	**856 (25%)**	**369 (11%)**	**124 (4%)**
Above proposed longwalls (total 2,354)	1,127 (48%)	762 (32%)	345 (15%)	120 (5%)
Above solid coal (total 1,104)	983 (89%)	94 (9%)	24 (2%)	3 (<0.5%)

Notwithstanding, the majority of houses (both existing and predicted to be constructed under Wollondilly Shire Council’s future urban growth plans around Bargo) are predicted to either not require adjustment or only require minor repair (around 61%), with the forecast incidence of substantial or extensive repair or in a worst-case, rebuild, forecast for around 15% of all houses within the SSA.

Management and mitigation measures for potential subsidence as a result of the project are outlined in **Section 11.1.7** and include the preparation of an Extraction Plan that would be developed through consultation with the infrastructure owners and are approved by the relevant government agencies. It is not anticipated that additional management or mitigation measures would be required if the additional houses proposed as part of the Wollondilly Shire Council's future urban growth plans are realised.

It is noted that proposed development (including new houses and other structures) in mine subsidence districts requires SA NSW approval. SA NSW sets building and construction requirements to protect buildings and other surface improvements from subsidence damage. These requirements cover the nature and class of improvements, including height, type of building materials used and the construction method and are consistent with the Australian Building Code. SA NSW has the power to issue stop work notices to prevent illegal construction in mine subsidence districts, and any improvements erected without SA NSW's approval, or contrary to an approval are not eligible for compensation (MSEC, 2018).

11.1.7 Management and Mitigation Measures

Extraction Plan

The Tahmoor Mine currently develops SMPs that incorporate each natural and built feature that would be impacted by subsidence. Existing subsidence monitoring and management at Tahmoor is described in **Section 3.2.9**.

From 1 July 2014 the former Subsidence Management Plan process was replaced by a consolidated Extraction Plan process to ensure that the mining industry meets strict contemporary standards. This provides for the joint regulation of mine subsidence under a single Extraction Plan. The proposed development would therefore manage potential subsidence under a single Extraction Plan, with component management plans developed to manage risks to specific built or natural features as described below.

While specific management measures for each natural feature is contained within the relevant technical section of this EIS, a series of management plans would also be prepared for the proposed development which would form part of the overarching Extraction Plan. These sub plans would be developed to manage the impacts of longwall mining on specific features which could potentially be impacted by subsidence. These features include:

- natural features (such as waterways and cliffs);
- heritage items;
- built features, including:
    - Council owned assets and infrastructure;
    - rail assets and infrastructure;
    - potable water assets and infrastructure;
    - sewer assets and infrastructure;
    - gas assets and infrastructure;
    - power assets and infrastructure;
    - communications assets and infrastructure; and
    - public, commercial and residential structures, which can also include specific sub-plans for large structures, such as bridges, retail complexes and industrial facilities.

The management plans would include details such as:

- proposed mining schedule and mine plan;
- performance measures and criteria for each feature;
- predictions and descriptions of impacts for each feature;

- monitoring requirements for each feature; and
- risk controls and Trigger Action Response Plan (TARP).

The Extraction Plan would consider the potential for increased subsidence impacts above predicted levels. The following actions would be undertaken:

- detailed pre-mining assessment of the potential impacts on surface infrastructure, including an assessment of potential impacts in the unlikely event that actual subsidence is greater than predicted subsidence. Pre-mining assessment would include pre-mining inspections at residential properties. Under SA NSW requirements, Tahmoor Coal is required to: identify properties that have the potential to be impacted by mine subsidence, provide this information (including likely timing of the subsidence) to SA NSW, and complete a pre-mining inspection (PMI) or arrange for a PMI to be completed prior to a property being influenced by mine subsidence. The PMI can be carried out by Tahmoor Coal (in accordance with SA NSW guidelines) or the details of the property can be forwarded to SA NSW to undertake the inspection. PMI's are carried out at no cost to the resident/landowner. The purpose of the inspection is to obtain an accurate record of the condition of the property prior to mining. When conducted, property owners receive a full, written report with photographs on their pre-mining inspection;
- monitoring of subsidence movements above and beyond the proposed mining footprint, including across the projected location of the Nepean Fault on the surface (the monitoring program would be capable of detecting vertical, horizontal and far-field subsidence movements);
- monitoring of the condition of surface infrastructure before, during and after the mining period;
- implementation of planned early response measures to further protect the safety and serviceability of surface infrastructure focussing on pre-determined trigger levels which are based on monitoring data; and
- if increased subsidence were to occur during the mining of a proposed longwall, amendments to the mine plan for future longwalls would be considered to avoid future increased subsidence.

For all infrastructure and housing, a Built Features Management Plan would be prepared which would:

- contain an assessment of the pre-mining condition of the infrastructure (e.g. bridges, road, gas network);
- provide mitigation measures to be implemented prior to mining (if any);
- describe monitoring systems to be installed, which are capable of detecting vertical, horizontal and far-field subsidence movements;
- set up processes for regular review and assess the monitoring data;
- provide timing for the conduct of regular visual inspections; and
- contain procedures for the implementation of planned responses if triggered by monitoring and inspections.

These plans would be developed in consultation with the relevant authority or owner, and SA NSW.

Prior to mining operations commencing for a new longwall, potentially affected residents would receive a Resident Information Pack which includes:

- longwall information;
- an explanation of subsidence and the potential effect of subsidence on houses and other structures;
- anticipated levels of subsidence for the longwall;
- a description of property inspections, surveys and monitoring;
- a description of rights and responsibilities relevant to subsidence; and
- emergency contact details.

Resident Information Packs are issued as part of the existing operations. Resident Information Packs for the proposed development would generally take the same form and structure of Resident Information Packs for existing operations.

Rehabilitation of Subsidence Impacts to Land

Rehabilitation of subsidence impacts to land relates primarily to the rehabilitation of two broad categories subsidence impacts:

- surface cracking; and
- impacts to watercourses and drainage lines.

Rehabilitations of Surface Cracking

Rehabilitation of surface cracks would be undertaken as soon as practical post-subsidence and would include:

- ripping and seeding of areas where required, followed by rehabilitation planting (if clearing was required to allow for ripping and seeding activities);
- seeding and/or planting of appropriate species of vegetation to achieve a land use commensurate to its pre-subsidence condition; and
- subsided areas to be regraded to control surface water flow and minimise erosion and sedimentation.

For areas where ripping is not feasible due to the width of cracks:

- topsoil would be stripped and stockpiled;
- clay, or another suitable, material would be used to fill and seal cracks; and
- topsoil would be respread once cracks have sealed and the area would be seeded with appropriate plant species.

Rehabilitations of Subsidence Impacts to Watercourses

Tahmoor Mine currently implements an approved SMP that considers potential impacts on streams due to mining activities, including monitoring and TARPs. An Extraction Plan would be prepared and implemented for the proposed development and would include specific measures for watercourses in the Project Area.

Rehabilitation of streams that generally have significant sediment accumulation would occur naturally and no further measures are proposed. However, for streams with lower sediment accumulation, it is proposed that fractures and voids would be sealed with grout. Potential impacts to streams and riparian vegetation that may require rehabilitation are discussed in **Section 11.2**.

General rehabilitation of the subsided riparian subsidence areas may involve:

- creating a stable substrate for revegetation of channel banks through topsoil and a weathered rock matrix;
- replacing sand across the channel bed;
- mitigation of erosion of channel banks through placement of timber groynes, woody debris and other measures;
- preventing the uncontrolled flow of runoff through suitable design of local drainage (e.g. diversion bunds);
- topsoiling and revegetation on banks; and
- targeted revegetation in areas where surface water patterns have been affected.

Rehabilitation of Subsidence Impacts to Built Infrastructure

The SSA is located within the Bargo Mine Subsidence District. The *Coal Mine Subsidence Compensation Act 2017* provides for the assessment and management of risks associated with subsidence resulting from coal mine operations and includes provisions for the compensation or repair services required to mitigate the damage caused by mine subsidence following underground coal mining (see **Section 8.1.4** for further details about the *Coal Mine Subsidence Compensation Act 2017* as it applies to the project).

SA NSW is the NSW Government agency responsible for administering the *Coal Mine Subsidence Compensation Act 2017*. SA NSW has two core functions:

1. to provide compensation or manage the provision of compensation where surface developments are damaged by mine subsidence following extraction of coal or shale in NSW; and
2. to regulate surface development within mine subsidence districts to reduce the risk of mine subsidence damage.

The owners of buildings or other surface improvements damaged by mine subsidence can lodge claims for compensation through SA NSW. A SA NSW Case Advisor would be allocated to the claim to support property owners throughout the assessment process and SA NSW would facilitate compensation from mine operators where damage is the result of an active mining operation.

Proposed development in mine subsidence districts requires SA NSW approval. SA NSW sets building and construction requirements to protect buildings and other surface improvements from subsidence damage; these requirements cover the nature and class of improvements, including height, type of building materials used and the construction method.

SA NSW has the power to issue stop work notices to prevent illegal construction in mine subsidence districts, and any improvements erected without SA NSW's approval, or contrary to an approval are not eligible for compensation.

11.1.8 Conclusion

The proposed Mine Plan was developed by Tahmoor Coal following a significant risk assessment process to avoid and minimise impacts to sensitive features including impacts to the Metropolitan Special Area (MSA) and incised bedrock creeks and rivers. Tahmoor Coal made a number of revisions to the original Mine Plan, including shortening Longwall 105 to 108 from the commencing ends so they do not encroach into the MSA and removal of mining in the eastern domain (see **Section 11.1.1**).

The maximum predicted subsidence impacts would impact on natural and built features within the SSA. These impacts are primarily related to surface cracking, localised water loss and ground deformations which can damage or reduce values of these features. Detailed assessment of each feature is provided in the relevant specialist section of this EIS. The assessment of potential subsidence impacts determined that 79% of the houses within the SSA would be unaffected or require minor adjustments only. Far field horizontal movements are predicted to occur. However, impacts experienced at sensitive features are not expected to be significant or measureable (i.e. less than 0.3 mm/m).

The overall findings of the assessments are that the levels of impact and damage to identified natural features and built infrastructure are manageable and can be controlled by the preparation and implementation of an Extraction Plan.

Tahmoor Mine has subsided in the order of 1,541 residential homes and commercial premises, the majority of which experienced little if any damage from mine subsidence impacts. A small percentage experienced more significant impacts which have been rectified or continue to be repaired, replaced or otherwise satisfactorily addressed by Tahmoor Mine in close working relationship with SA NSW. Tahmoor Mine has been successfully managing subsidence impacts to houses and buildings from longwall mining at Tahmoor North in accordance with an approved SMP and would continue to do so for Tahmoor South in accordance with the Extraction Plan for the proposed development. Extraction Plan sub-plans would be developed to manage potential impacts to specific features in consultation with affected stakeholders for approval by relevant government agencies. Specific management measures for natural and built features are described separately throughout **Section 11.0** of the EIS.

11.2 Geomorphology

A Geomorphology Technical Report (Fluvial Systems, 2013) has been undertaken to characterise the geomorphology of waterways and cliffs within the Project Area. The Geomorphology Technical Report is provided in **Appendix H**. A Subsidence Assessment (MSEC, 2018) was undertaken to quantify the potential subsidence impacts of the proposed development on natural features, including waterways and cliffs. The Subsidence Assessment is provided in **Appendix F**. The two assessments were undertaken collaboratively to determine the extent to which subsidence associated with the proposed development would impact on the geomorphology of waterways and cliffs within the SSA.

The Geomorphology Technical Report addressed the SEARs relevant to geomorphology impacts. These are listed in **Table 11-12**. Specific SEARs have not been issued for geomorphology however impacts to geomorphology are relevant for the assessment of potential impacts from subsidence on the natural environment including water resources.

Table 11-12 SEARs for the assessment of geomorphology impacts

Geomorphology SEARs	Section addressed
Subsidence – including a detailed assessment of the potential conventional and non-conventional subsidence effects, subsidence impacts and environmental consequences of the development on the natural and built environments, paying particular attention to features that are considered to have significant ecological, economic, social, cultural and environmental value, taking into consideration:	**Section 11.2.4**. Subsidence impacts are also assessed specifically in **Section 11.1** and **Appendix F**.
An assessment of the likely impacts of the development on aquifers, watercourses, swamps, riparian land, water supply infrastructure and systems and other water users;	**Section 11.2.4**.See also **Section 11.3** and **11.4** for assessment of potential groundwater and surface water impacts.

11.2.1 Background

The proposed development may impact on geomorphological features through the generation of subsidence movements that may alter geomorphological features on the surface. Geomorphic processes and forms are connected to aquatic ecological character and processes through the provision of physical habitat and the influence on water quality. As a result, the potential for the proposed development to create geomorphological changes may have an impact on aquatic ecology and water quality. "*Alteration of habitat following subsidence due to longwall mining*" is a Key Threatening Process listed under Schedule 4 of the *Biodiversity Conservation Act 2016* (BC Act).The Geomorphology Technical Report has focused on characterising the physical aspects of the Project Area that are known to contribute to aquatic and riparian habitat value.

The Geomorphology Technical Report for the Project was completed in 2013 and assesses an alternate mine plan under consideration at the time, which comprised a larger footprint (and associated SSA) to the current Tahmoor South project. The report is considered to present a conservative assessment characterising the geomorphic features within the broader Project Area including and beyond the current mine plan footprint and associated SSA (which has contracted since 2013). The report has been reviewed against the SEARs issued for the Project in 2017 and is considered to meet the requirements of the SEARs. Therefore, the report has not been updated. Mine plan revisions to reduce impacts to sensitive features are detailed in **Section 5.3.7** and **Section 6.2.4**.

The Geomorphology Technical Report characterised the physical environment of the Project Area and identified RMZs for significant or sensitive geomorphological features. The catalogue of geomorphologic features was used to define the existing environment within the Project Area and has been incorporated into other relevant impact assessments undertaken for the proposed development, including terrestrial ecology (**Section 11.6** and **Appendix K**), aquatic ecology (**Section 11.7** and **Appendix K**) and surface water (**Section 11.4** and **Appendix J**).

11.2.2 Methodology

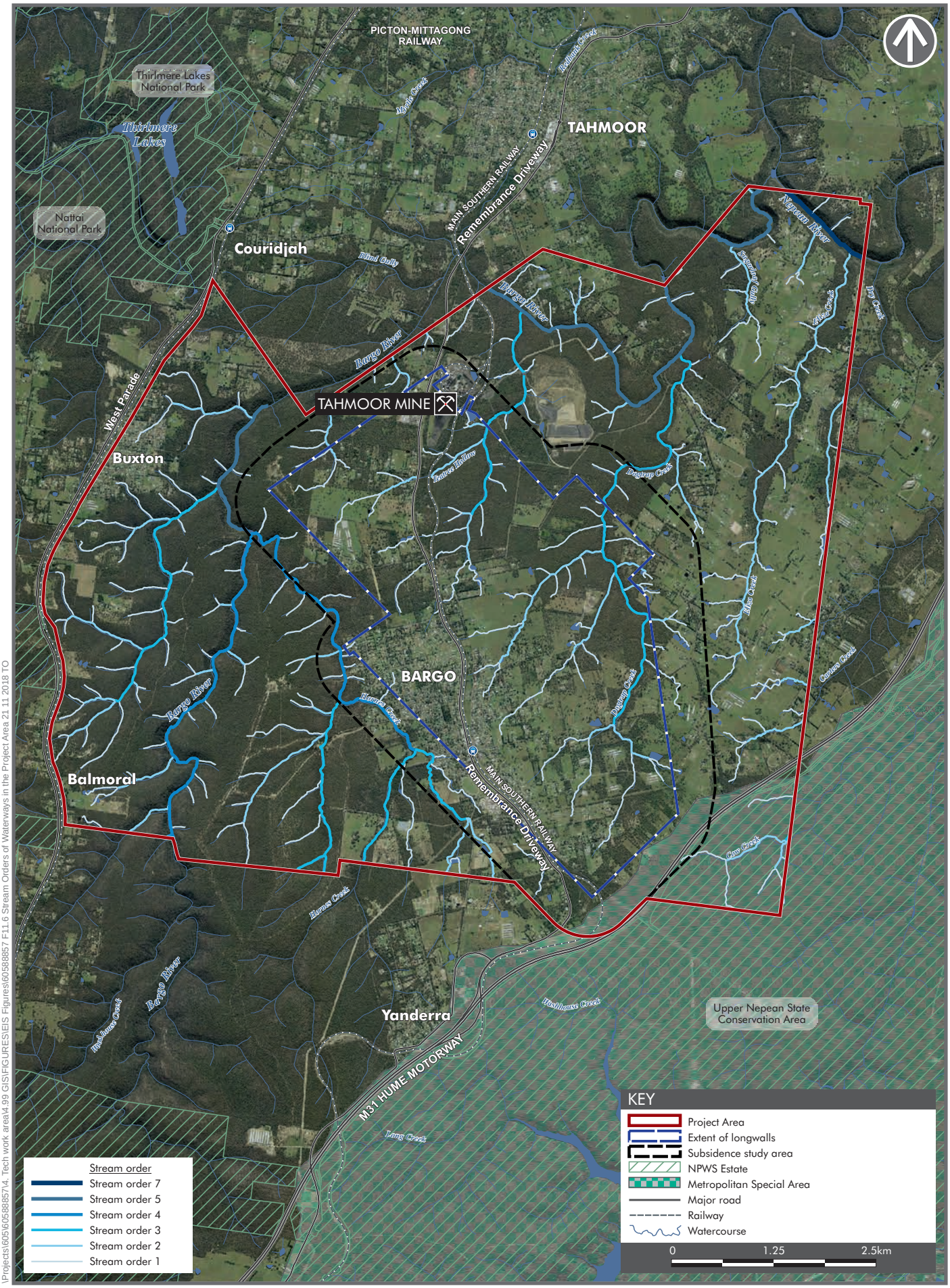
The risks to geomorphological features as a result of the proposed development have been described for the SSA where relevant. However, in order to provide a comprehensive baseline of geomorphological features, the existing geomorphological environment has been described for the entire Project Area.

The methodology for the assessment was undertaken as follows:

- identification of relevant geomorphological variables that would be sensitive to mine subsidence changes including:
  - landscape-scale variables - geology, soils, topography,
  - stream-reach and point-scale variables - stream geomorphic type and condition, riparian and in-channel vegetation including filamentous algae, in-channel bedrock features, in-channel pools, channel slope, channel dimensions, channel bed materials, knickpoints and characteristics of fractures in channel bedrock. Note: knickpoint refers to a local steep fall in channel bed elevation.
- desktop terrain analysis:
  - terrain analysis was performed using two different GIS applications: Global Mapper™ V14.2.2 July 2013 and SAGA (System for Automated Geoscientific Analyses) GIS in order to characterise landform within the Project Area including topography, stream network, slope and valley depth.
- a detailed field survey of the main waterways within the Project Area:
  - a field survey was undertaken over 18 days, during which geomorphic features present within waterway were logged and characterised in the Project Area.
  - due to the level of data captured for the waterways that were surveyed during the field survey, the representative character of the waterways that were not surveyed (for example those on private property) could be inferred through the comparison of landscape scale variables, derived from the desktop study. The field survey particularly focused on pools (a deeper section of a waterway that retains water), knickpoints and bedrock features that were large relative to the channel size to enable the capture of morphological variability of the Project Area at the habitat scale.
- geomorphological characterisation of waterways within the Project Area:
  - waterways in the Project Area were classified according to river type and geomorphic condition using an approach consistent with the River Styles process. The recovery potential of waterways depends on geomorphic condition, with undisturbed waterways close to a natural state more likely to be resilient and recover faster than those that are already degraded.
- impact assessment of geomorphological features:
  - the extent of subsidence predicted by the Subsidence Assessment (refer to **Section 11.1**) for the proposed development was used to determine the likely impacts on the geomorphology of waterways and other landforms.
  - existing and historical operations at Tahmoor Mine included longwall mining beneath Tea Tree Hollow, the Bargo River, Myrtle Creek and Redbank Creek. Records of the observed impacts of subsidence on these waterways were used to inform the prediction of impacts of the proposed development on the geomorphology of waterways within the Project Area.
- identification of RMZs:
  - the Southern Coalfields Inquiry recommends that RMZs be developed for:
    - all waterways classified as 3rd order and above in the Strahler stream order classification;
    - valley infill swamps not on a 3rd order or higher stream; and

- major cliff lines and overhangs not directly associated with watercourses.

- accordingly, RMZ's were identified for the Project Area. The length and mean slope of 2nd order streams and higher within the Project Area were measured using the 2m x 2m Lidar survey and the presence of pools, knickpoints and bedrock features within these waterways were identified in the field survey. The combined data from the terrain analysis and field survey of these waterways in the Project Area indicates that the 3rd order sections of Cow Creek, Dog Trap Creek and Dry Creek, as well as the 4th order section of Hornes Creek had a large number of pools, and also had relatively high number of bedrock features present. As a result of the high density of features such as pools and bedrock features which are sensitive to mining-related subsidence impacts, these waterways are considered to have the highest risk of their geomorphic character being altered by the proposed development.



\Projects\605\605888574. Tech work area\4.99 GIS\FIGURES\EIS Figures\605888857 F11.6 Stream Orders of Waterways in the Project Area 21 11 2018 TO

SIMEC MINING

STREAM ORDERS OF WATERWAYS IN THE PROJECT AREA

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.6

11.2.3 Existing Environment

The existing operations at Tahmoor North have undermined Myrtle Creek and Redbank Creek. As part of the SMPs for each longwall, each creek is monitored for impacts associated with subsidence movements. Impacts observed at the creeks are summarised below.

Myrtle Creek - between 2004 and 2014, longwalls 22 to 28 were mined beneath a three km section of the creek. Impacts observed along this creek included localised bed cracking in exposed sandstone areas, surface flow diversions in four locations over Longwalls 22, 23B and 25 as well as cracking in soil within the upper banks and flanks over Longwall 23B (MSEC, 2018). At times of low flow, pools were also observed to drain (MSEC, 2018).

Redbank Creek - since 2008 a two km section of Redbank Creek has been undermined by longwalls 25 to 31. Impacts observed along the creek included: cracks along most pools located directly above longwalls 25 to 31, draining of pools at times of low flow, subsurface flow diversion observed to re-emerge downstream of Longwall 30, and some adverse changes in water quality at times of low flow (MSEC, 2018, SIMEC, 2017).

Landscape-scale Geomorphological Characteristics of the Project Area

The Project Area is located in a region characterised by weakly developed soils on sandstone and shale which are highly susceptible to erosion by concentrated water flow. Waterways within the Project Area comprise:

- small headwater waterways on relatively low gradient plateaus; and
- waterways eroded into rocky gorges rimmed by relatively stable cliffs, with densely vegetated talus slopes below the cliffs.

Within the Project Area, land elevation ranges from between 95m to 448m AHD and the slope of the land ranges up to a maximum of 85.6°.The south-western section of the Project Area is heavily dissected with high elevation and high sloping land is present. Within the central portion of the Project Area, the landform is dissected and of mid elevation comprising undulating plateau land. Downstream of the Bargo Fault, there is a small section of land in the Project Area exhibiting a landform that is dissected and of low elevation.

Bargo and Nepean River

The Nepean and Bargo Rivers would not be directly undermined by the project. Early mine plan investigations ruled out longwall mining under the Bargo River taking into consideration sensitive environmental features including the Bargo River Gorge and Mermaid Pools (neither feature being within the SSA of the current mine plan).

Only a 165 metres long length of the Bargo River that is immediately upstream from the Picton Weir is located inside the SSA. This length of the river that is within the SSA is a 4th order perennial stream as defined by the Strahler Stream Order Method (MSEC, 2018). No part of the Nepean River is within the SSA.

Cliffs and Steep Slopes

Three hundred and sixteen (316) major cliff features were identified within the Project Area in the terrain analysis. Of these, a total of 24 cliffs are located within the SSA generally located within the valleys of the Bargo River, Dog Trap Creek and the lower reaches of Hornes Creek (MSEC, 2018).

In the terrain analysis, steep slopes were mostly identified along the Bargo and Nepean Rivers, which are deeply dissected drainage lines (Refer to Figure 15 of **Appendix H**). At the landscape-scale, cliffs within the Project Area appear to be relatively stable, with historical photographs of the Project Area not displaying any evidence of recent rock falls. It is likely that natural rock falls may be present at the local scale.

There has been extensive experience of mining beneath steep slopes in the Southern Coalfield including along the Cataract, Nepean, Bargo and Georges Rivers and streams such as Myrtle Creek and Redbank Creek above Tahmoor Mine Longwalls 22 to 31, and slopes on Redback Range above Tahmoor Mine Longwalls 26 and 27 (MSEC, 2018). No large-scale slope failures have been observed along these slopes even in the case of direct undermining of the slopes. Whilst, surface cracking and minor rock falls along clifflines or rock outcrops have been observed (e.g. mining of Appin Longwalls 301 and 302 adjacent to the Cataract River), no large-scale slope failures have been observed (MSEC, 2018).

An approximately 20 metres high waterfall on Eliza Creek (EC-WF2) was identified as being a significant topographical feature within the Project Area, however as Eliza Creek is not located within the SSA, impacts to this feature are not expected.

Other Waterways within the Project Area

Of the waterways identified within the Project Area, the following are located within the SSA for the proposed development (in addition to the section of Bargo River described earlier):

- Hornes Creek – 4th order creek, which would not be directly undermined.
- Dog Trap Creek - 3rd order creek. Approximately 3.1 km of this waterway would be undermined by the proposal.
- Tea Tree Hollow – 3rd order creek. Approximately 1.9 km of this waterway would be undermined by the proposal.
- Tributary to Tea Tree Hollow – 3rd order creek. Approximately 2.4 km of this waterway would be undermined by the proposal.
- Tributary 1 to Dog Trap Creek – 2nd order creek. Approximately 2.6 km of this waterway would be undermined by the proposal.
- Tributary 2 to Dog Trap Creek – 2nd order creek. Approximately 2.4 km of this waterway would be undermined by the proposal.

As a result of mine plan investigations including the ruling out of mining in the eastern domain and the shortening of commencement ends of longwalls, impacts have been minimised or avoided to other waterways identified within the Project Area (including Eliza Creek, Dry Creek, Sugar Loaf Gully, Carters Creek and Cow Creek), which would remain outside of the SSA.

Stream Reach and Point-scale Characteristics of the Project Area

Waterway Geomorphic Type

Within the extent of the Project Area, the Bargo and Nepean Rivers were identified as the Gorge-strong geomorphic type. Tributary streams and lower order streams from the Bargo and Nepean Rivers largely comprise headwater streams (weak, moderate and strong), as well as a smaller number of weak to moderate gorges.

Channel dimensions were measured during the field survey at 249 sites within the Project Area. The data from these measurements indicates that gorge type streams are larger than headwater type streams and strong type streams were larger than moderate and weak type streams.

The distribution of geomorphic types within the Project Area (refer to Figure 36 of **Appendix H**) corresponds to the spatial distributions of elevation, valley depth, landform class, steep slopes, dominant bed material and grass cover on the low flow channel.

Waterway Geomorphic Condition

Waterways within the Project Area are bedrock controlled and naturally resilient to geomorphic change with the majority of waterways in a stable, close to natural geomorphic condition. Several characteristics/factors present in waterways within the Project Area were identified as having potential relevance for the ecological condition within creeks, but do not strongly influence geomorphic condition. These factors include clearance of riparian trees, licensed discharges, incision, mobile knickpoints, and filamentous algae. Some waterways were affected by loss of water to the subsurface over short reaches, and others were impacted by ferruginous seeps and suspended colloids.

With the exception of Tea Tree Hollow and Eliza Creek, the majority of the surveyed sites along creeks within the Project Area were considered to be in good condition for the majority of their length. Of the 696 surveyed sites in the Project Area, 85% were considered to be in good condition. Fifteen percent (15%) of individual sites, including a length of Tea Tree Hollow to the east of the pit top and the middle reach of Eliza Creek were considered to be in moderate condition. Sites of moderate condition east of the existing pit top related to the impact of licensed discharges from existing mine operations into Tea Tree Hollow. Sites of moderate condition along the middle reaches of Eliza Creek related to fill tipped into the channel and evidence of a failed dam. The isolated survey sites of moderate condition were associated with the occurrence of minor culverts or track crossings and/or low riparian vegetation cover.

Channel Bed Profiles and Material Composition

Waterways of the Southern Coalfield, such as those within the Project Area that flow through sandstone and/or shale regularly have a significant proportion of their beds formed in exposed bedrock. Bedrock is typically visible as flat to gently sloping slabs of rock exposed along a bedding plane and elevated rock bars crossing a channel. Exposed rock is often associated with pools by forming a low permeability bed surface or by acting as a hydraulic control. Long profiles of major waterways flowing into and out of the Project Area (refer to Figure 34 of **Appendix H**) were plotted using Digital Elevation Model and topographic map data, revealing three types of stream profiles present:

- river mainstream with major profile variation, namely the Bargo and Nepean Rivers;
- tributary streams lacking a major fixed knickpoint near their junction with the river mainstream, including Hornes Creek, Tea Tree Hollow and Dog Trap Creek; and
- tributary streams with a major fixed knickpoint near their junction with the river mainstream, including Carters Creek, Cow Creek, Dry Creek, Eliza Creek, Sugarloaf Gully and several unnamed creeks (XA2, XB2, XC2, XD3, XE2, XI2, XJ2, and XM2) (Note: these waterways are outside of the SSA).

In tributary streams where there is no major knickpoint, the slopes of the stream profiles are slightly greater than that of the Bargo River into which they flow. The tributary streams that have a major fixed knickpoint close to their junction with the Bargo or Nepean River have fairly steep slopes.

A wide range of channel bed materials were observed throughout the Project Area during the field survey. Across the Project Area, channel bed material was identified as being spatially variable. Mud was the prevalent material in the headwaters of waterways, and along small waterways on the plateau. The other commonly dominant bed materials within the Project Area included boulders and bedrock material.

Lower Eliza Creek and Creeks XA and XB exhibited particularly frequent bedrock features. Dog Trap Creek, Cow Creek and Dry Creek all contained higher frequencies of bedrock features and in-channel pools. Carters Creek, Hornes Creek and Tea Tree Hollow displayed the least abundance of bedrock features (refer to **Figure 11.7**). Tea Tree Hollow also displayed a lower frequency of pools compared to other creeks in the Project Area. Bedrock fractures were present at 32% of the sites where exposed bedrock was located.

Bedrock Fractures

Bedrock fractures observed were considered to be natural characteristics of the rock, varying in density from 0.11 to 0.15 fractures per 10m and an average bedrock density of 2.3 fractures per 10m (refer to Figure 23 of **Appendix H**). Within the Project Area, Hawkesbury Sandstone is present as massive beds with widely spaced and roughly vertical joint sets. As a result, it is anticipated that natural fractures would be present in the bedrock within the Project Area which are very old in geological terms, and are a result of historical episodes of deformation and relief of stress.

Mining-induced fractures in waterway beds have a different appearance to historic, natural bedrock fractures. Based on circumstantial evidence (namely observations of creeks previously undermined as part of the current Tahmoor North operations), bedrock fractures observed at two locations (XA2-1 and XB2-1) were tentatively suggested as being a result of mining-related subsidence due to their distinctively different appearance to other fractures in the Project Area. Fractures have open, sharp, unweathered edges as well as evidence of some overriding of bedding slabs, consistent with the findings of *The Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield: Strategic Review* (NSW Department of Planning, 2008).

In-channel Pools

The dimensions of observed in-channel pools within the Project Area are variable. The largest pool observed was Mermaids Pool, along the Bargo River, with a reported depth of 12m (National Parks Association, Macarthur, 2006), which is not within the SSA or limits of subsidence (20mm subsidence contour) predicted. The hydraulic controls of pools within the Project Area include boulders (47%), rock bars (33%), high points of cohesive material (12%), gravel, cobble or sand bars (8%) and artificial material (1%). The spatial distribution of hydraulic controls within the Project Area was considered to be variable.

Knickpoints

Within the Project Area, 149 hard knickpoints and 44 soft knickpoints were observed. Soft knickpoints were mostly observed along small plateau waterways through cleared and uncleared land, ranging in height from 0.22m to 1.4m with an average height of 0.62m. Hard knickpoints were located largely along steeper waterways, with the highest observed knickpoint being 35m in height, located at the confluence of Eliza Creek and the Nepean River Gorge. Other high, steep hard knickpoints were also observed near Mermaids Pool and along Cow Creek, which are all outside of the SSA.

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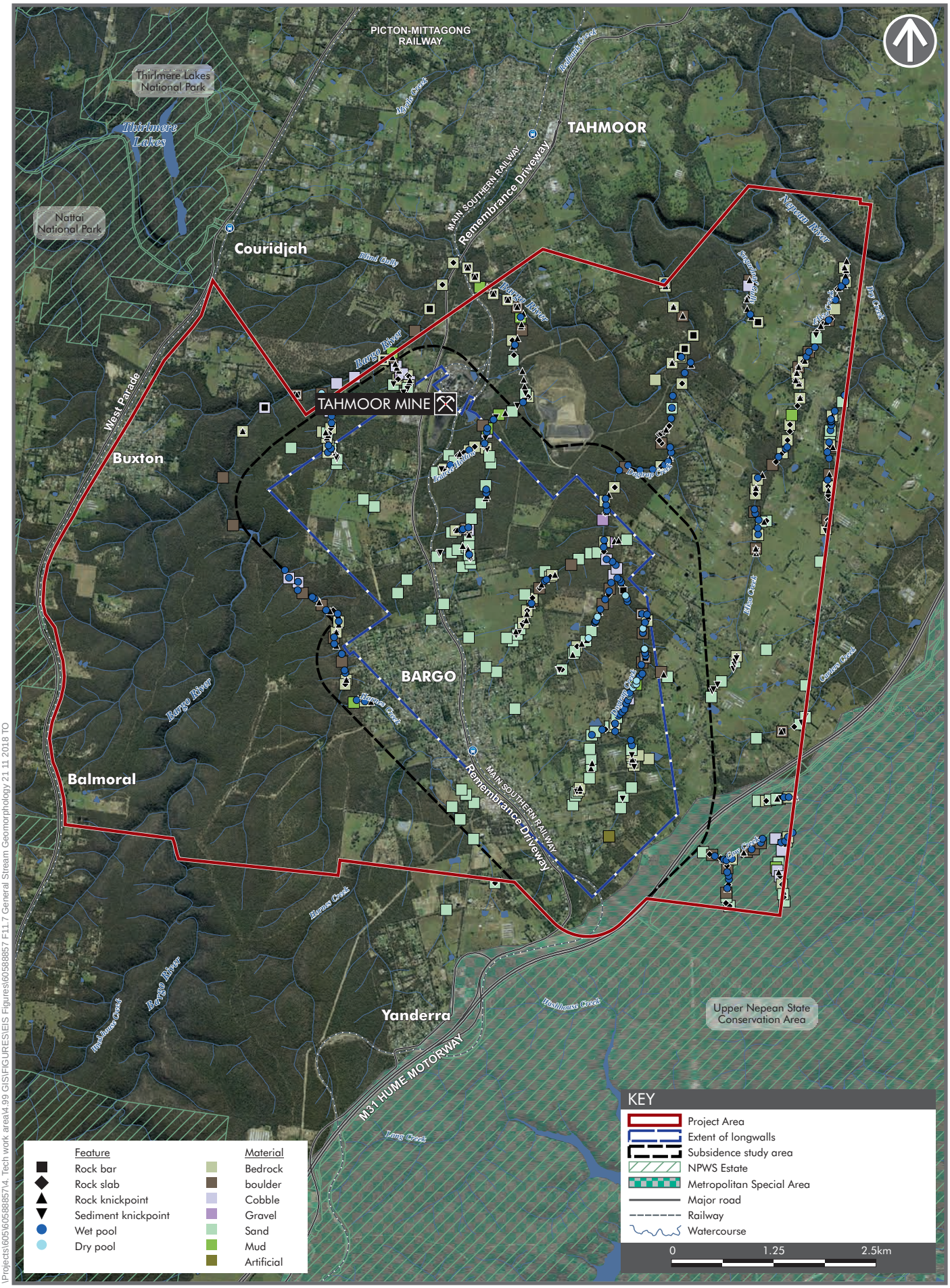

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GENERAL STREAM GEOMORPHOLOGY

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FIGURE 11.7

Riparian Vegetation

Geomorphic condition is strongly linked to the degree of naturalness and extent of cover of riparian vegetation (Outhet and Cook, 2004; Outhet and Young, 2004). The following was observed within the Project Area during the field survey:

- the width of riparian vegetation was greater than 50 m at more than 90% of surveyed sites on both banks of waterways;
- the continuity of vegetation within the Project Area was greater than 75% at more than 90% of the sites on both banks of waterways;
- riparian tree cover was considered to be generally high, with the greatest degree of tree cover tending to be located within dissected valleys and gorges, namely the Nepean and Bargo Rivers. A moderate level of riparian tree cover was within the natural range of undisturbed sites; and
- the Project Area generally exhibited a moderate to high riparian vegetation cover index, with 62% of sites having an index greater than 0.6. The lowest riparian vegetation cover index scores (8% of sites, with an index of 0.2-0.4) were associated with small plateau waterways that flow through cleared land.

It was considered that the presence of small areas of poor quality riparian width and vegetation continuity does not present a significant threat to the geomorphic stability of waterways in the Project Area.

Extensive grass cover on the bed of a low flow channel is indicative of a low energy headwater environment where the bed shear stress of high flows is inadequate to overcome the resistance of vegetation roots, and the baseflow is not deep or persistent enough to discourage grass growth. Grass cover was found on all of the small headwater waterways in the Project Area (refer to Figure 31 of **Appendix H**). With the exception of Dry Creek, grass cover was uncommon in 2nd order streams and higher (refer to Figure 31 of **Appendix H**).

Large woody debris is considered to contribute to the structural stability of streams. Large wood was present in 57% of waterways in the Project Area. Surveyed sites with low riparian tree cover (Figure 29 of **Appendix H**) tended to have a low frequency of large wood. The density of large wood was so variable within streams of the Project Area that is was not considered to be a reliable indicator of stream condition when considered in isolation.

11.2.4 Impact Assessment

Waterways confined within bedrock valleys, such as those within the Project Area, maintain a relatively stable position over time. However, the channel can widen, narrow, deepen (scour) or shallow (aggrade). These changes can occur in natural systems. However, mining-related subsidence has the potential to impact the rate and/or extent of such changes.

Impacts to geomorphology in the SSA as a result of the proposed development have been assessed qualitatively, and are described in **Table 11-13** and in further detail in the relevant technical specialist studies as referenced below. For the purposes of the qualitative impact assessment, the risks to the geomorphology within the SSA as a result of the proposed development have been separated into events where the risk is constant over the entire SSA and events where the risk is variable.

The mine has been designed in the first instance to avoid undermining major watercourses where feasible. Major water courses were identified as part of the development of RMZs which informed the development of the mine plant for the proposed development. Revisions undertaken to mine plans to avoid sensitive features including the Bargo River and the MSA are detailed in **Section 5.3.7** and **Section 6.2.4**.

A range of practical strategies to mitigate and remediate mining induced impacts to river channels are provided in **Section 11.2.5** and **Section 11.1.7**.

Table 11-13 Potential impacts to natural features

Natural feature	Potential impacts
Impacts to Headwater and Gorge Types	The Project Area comprises Headwater and Gorge types. These types are considered have a low fragility, meaning that the potential for change in type over management time scales (i.e. less than 100 years) is minimal. Changes in these types over such a time scale generally only comprise minor changes to bedform and the type never changes to another, regardless of the level of damaging impact. It is therefore considered unlikely that waterways within the Project Area would be exposed to a change in geomorphic type as a result of subsidence associated with the Project. If such an event was to occur, changes to type would be localised and more likely to occur in headwaters rather than gorges, with headwaters potentially being altered to Cut and Fill (Cook and Schneider, 2006). Such a change would be reversible with the application of appropriate and proactive management measures. Waterways within the Project Area are largely located within valleys, with beds and banks controlled by bedrock or hard regolith. This restricts the potential for the alignment of channels to be altered across the entire Project Area. It is unlikely that the proposed development would result in a change in channel alignment within the Project Area due to the highly incised nature of the waterway channels within the valleys.
Impacts to In-Channel Pools	In-channel pools are often a focus of habitat assessments due to their ability to act as a refuge when waterways stop flowing (Bond et al, 2008). In the Project Area, where in-channel pools are bedrock controlled, pools are likely to be found in association with rock bars, which are potentially at risk of fracturing due to mining-related subsidence. There is a high probability that at least part of the bed of most in-channel pools within the Project Area have been formed in bedrock. A reduction in the volume of existing in-channel pools as a result of the proposed development is dependent on the extent of fracturing that occurs on rock bars and rock slabs that form the bed of such pools. Pools within the SSA that have rock bars acting as the main hydraulic control (33%) would potentially hold water for shorter periods of the year if they are fractured as a result of the Project, assuming that the hydrology at this location remains unaltered. Differential subsidence across the SSA could potentially result in the formation of new in-channel pools, or could increase the depth of existing in-channel pools. The likelihood of this occurring depends on the spatial distribution and depth of subsidence within the SSA. Impacts to in-channel pools in waterways within the SSA have been assessed in **Section 11.4.4**.
Impacts to knickpoints	Under disturbance from mining-induced subsidence, or a significant increase in stream flow, hard knickpoints are assumed to be resilient to change, while existing soft knickpoints were assumed to be fragile, and thereby susceptible to the formation of new soft knickpoints. Soft knickpoints within the SSA occur in locations that have been disturbed through urbanisation and agricultural development, as well as in undisturbed and well vegetated waterways. Should knickpoints be located in small headwater waterways on the plateau area where differential subsidence could potentially occur, there is the potential for the natural rate of knickpoint migration to be accelerated, or new knickpoints could potentially be created. These locations are discussed further in **Appendix H** and provided on Figure 27 of **Appendix H**.

Natural feature	Potential impacts
Impacts to sedimentation processes in channels	Within the Project Area, accumulation of sediment appeared to be low. The headwater strong types in the Project Area are free of loose sediment, or contain boulders with less cobble gravel, sand and mud present in the channel-bed, suggesting that rock falls are rare and talus slopes are stable. This is evidenced by the field observations that the talus slopes observed were covered in dense vegetation. Mining-related subsidence could potentially increase the angle of talus slopes in the SSA, causing them to destabilise, resulting in an increase of sediment supply into channels within the Project Area as well as further downstream. Impacts to the geomorphology of the Project Area from a potential increase in sedimentation within waterways resulting from the destabilisation of talus slopes due to mining-induced subsidence are considered to be minor. Potential talus slopes within the Project Area are only located within the Bargo and Nepean systems, which are high energy and high flow waterways. The supply of additional sediment to these waterways would not impact on the sedimentation processes as the high energy environment would mean that sediment would be rapidly transported through the system. Potential downstream impacts associated with the settlement of additional sediment on existing aquatic ecology habitat are discussed in **Section 11.7**. Changes to bed slope due to mining-related subsidence has the potential to reduce stream power to below the sediment transport threshold. The field survey undertaken as part of the Geomorphology Technical Report found that waterways within the Project Area would likely exhibit high energy under high flow conditions. This is consistent with the results of a study undertaken by Nanson and Young (1983) which concluded that waterways within sandstone landscapes contain very little sediment storage. Therefore, the potential for mining related subsidence to reduce stream power to below the sediment transport threshold is low as bedslopes of waterways within the Project Area are already steep with little sediment accumulation occurring within the channels. Within the Project Area, sediment transport is considered to be efficient under existing conditions, and the majority of stream beds are not sensitive to sediment scouring as they are bedrock controlled with limited opportunity for scouring to occur. The steepening of the slope of a channel within the Project Area due to mining-related subsidence has the potential to increase stream power, and increase the rate of sediment scouring. The likelihood that sediment scouring in the Project Area is increased as a result of the proposed development is considered to be low due to the low sensitivity of bedrock controlled waterways to scouring. Further, the predicted changes in stream bed grade as a result of subsidence from the proposed development are typically less than one percent (1%) from current grade. The predicted maximum increase in stream bed grade of 1.2% is relatively small compared to natural gradients and is not anticipated to significantly increase the potential for scouring.
Impacts to Channel-bed Vegetation	The potential impacts to channel bed vegetation would occur as a result of increased scour and surface fracturing within channel beds. However, the predicted maximum increase in stream bed grade is relatively small compared to natural gradients and is not anticipated to significantly increase the potential for scouring. Further changes to waterway velocities and flooding also have the potential to impact channel bed vegetation. Potential impacts to channel bed vegetation as a result of mining-induced subsidence are discussed further in **Section 11.7**.

Natural feature	Potential impacts
Impacts to rock fall frequency	The majority of cliffs within the Project Area including those along the Nepean River, Bargo Rivers and Hornes Creek would not be directly undermined as part of the proposed development. It is possible that isolated rock falls could occur, particularly at those cliffs located closest to the proposed long walls. Impacts are expected to represent less than 0.5% of the total face area of cliffs within the Project Area. The Subsidence Impact Assessment notes that while cliffs within the SSA would potentially experience very low levels of vertical subsidence, it is unlikely that cliffs beyond the extent of this would experience large instabilities (refer to **Appendix F**). The likelihood of a significant increase in the rate of rock falls from cliffs and talus slopes in the Project Area as a result of mining-related subsidence is considered low.

Impact Summary

Based on the above assessment, the impacts of the proposed development on geomorphological features within the Project Area are summarised below.

- **Headwater and Gorge Types** – it is considered unlikely that subsidence from the proposed development would change the geomorphic type of waterways within the Project Area or alter channel alignment due to the highly incised nature of the waterway channels within the valleys.
- **Channel Pools** – subsidence related fracturing could reduce the volume of in-channel pools or potentially result in pools holding water for shorter periods. Differential subsidence across the SSA could potentially result in the formation of new in-channel pools, or could increase the depth of existing in-channel pools.
- **Knickpoints** - subsidence impacts on small headwater waterways (in plateau areas where differential subsidence could occur) have the potential to accelerate the natural rate of knickpoint migration, or create new knickpoints.
- **Sedimentation processes in channels** - changes to stream bed grades as a result of subsidence are predicted to be relatively small (typically less than one percent compared to the current grade) and therefore are not anticipated to significantly increase the potential for in-channel scouring. Furthermore, given the low sensitivity of bedrock controlled waterways to scouring, the potential for increased channel scouring in the Project Area is considered to be reduced.
- **Channel-bed vegetation** – vegetation along waterways has the potential to be impacted by subsidence related changes to in-channel process including changes to pool holding capacity, flooding velocities and inundation. Risks to vegetation from significant increases to scour and sedimentation have been assessed as low.
- **Rock fall frequency** - The majority of cliffs within the Project Area would not be directly undermined and the likelihood of a significant increase in the rate of rock falls from cliffs and talus slopes in the Project Area as a result of mining-related subsidence is considered to be low. Tahmoor Coal would incorporate mitigation measures to manage potential subsidence impacts to natural features described above into the Extraction Plan for the proposed development. This would include trigger action response plans, detailed pre-mining assessments, monitoring of subsidence, monitoring of the condition of geomorphological features during and after the mining period; and the consideration of amendments to the mine plan for future longwalls if higher than expected subsidence were to occur during the mining of a proposed longwall.

Refer to **Section 11.2.5** for further discussion on the measures that would be implemented to mitigate impacts on geomorphology.

11.2.5 Management and Mitigation Measures

Risk Management Zones

As part of the Geomorphology Technical Report, relevant high value features were identified as being all waterways classified as 3rd order and above in the Project Area (refer to **Figure 11.6**) in accordance with the recommendation of the Southern Coalfields Inquiry, and major cliffs within the Project Area. RMZs were identified as 400 m wide buffers around these features. When these risk areas were compared with the mine plan for the Project, it was identified that detailed monitoring and management during mining is required in the following locations:

- upper Tea Tree Hollow; and
- upper Dog Trap Creek.

The RMZs for the Project and the location of the abovementioned relevant features are shown on **Figure 11.8**.

Remediation Measures

There are a range of practical strategies to mitigate and remediate mining induced impacts to river channels as outlined within *Damage Criteria and Practical Solutions for Protecting River Channels* (SCT Operations Pty Ltd, 2009), a research project undertaken by the Australian Coal Association Research Program (ACARP Project C12016). The three primary strategies suggested for managing impacts on river systems, without unnecessarily sterilising valuable coal resources, include:

- avoid mining within proximity of river channels through mine design, to limit the potential subsidence impacts on specific river systems to levels that can be estimated with reasonable confidence;
- provide open space within the rock mass at the base of a river channel to absorb valley closure movements or implement an artificial barrier that forces the hydraulic gradient to the surface. A thin, flexible, impermeable barrier installed across a rock bar has the potential to act as an effective barrier to subsurface flow; and
- actively fill fractures in the subsurface fracture network with introduced material to accelerate the natural remediation process, whereby the mining induced fracture network is filled with sand, silt and clay materials, gradually increasing hydraulic resistance. This strategy involves filling of the subsurface fracture network with fill material such as cementitious grouting, sand or polyurethane resin.

Management Measures

Tahmoor would incorporate the measures listed below into the Extraction Plan for the proposed development. These measures would be consistent with the existing measures that have implemented to effectively manage potential mining induced impacts to river channels for current operations as part of existing SMPs.

- develop and implement an Extraction Plan prior to mining to manage the potential impacts of the proposed development on the geomorphological features of waterways within the SSA as a result of longwall mining. The Extraction Plans would require:
    - triggered action response plans to provide adaptive management strategies that provide specific mitigation measures for natural features that have been identified as potentially affected by the proposed development;
    - detailed pre-mining assessment of the potential impacts on geomorphological features, including an assessment in the unlikely event that increased subsidence occurs;
    - monitoring of subsidence movements above and beyond the proposed mining footprint, including across specific geological features such as faults;
    - monitoring of the condition of geomorphological features during and after the mining period; and

  - if increased subsidence were to occur during the mining of a proposed longwall, amendments to the mine plan for future longwalls would be considered to avoid future increased subsidence.

- undertake pre, during and post mining photographic surveys and visual inspections of geomorphological features for each longwall. Annual photographic surveys of sensitive geomorphic features would be undertaken at 10 headwater photographic sampling locations to monitor mining-induced subsidence impacts of the proposed development over time; and
- prepare an annual report on the results of the photographic survey. The assessment and report would:
  - provide data for baseline geomorphic conditions of waterways in the Project Area; and
  - be repeated annually within areas that have been undermined to identify potential impacts to geomorphology as a result of subsidence.
- undertake a pre and post mining catchment-wide survey, assessment and report for waterway geomorphological conditions. The survey would include a sample of randomly distributed headwater sites on headwater waterways. Headwater sampling would be undertaken to confirm the assessment that the risk to geomorphological character within the Project Area as a result of mining-related subsidence is insignificant;
- for each longwall monitor risk of knickpoint formation and implement appropriate controls to prevent knickpoint formation. This would include:
  - regular monitoring to detect if there is potential for knickpoint formation;
  - an assessment of the potential consequences of any identified knickpoint formation locations; and
  - the implementation of appropriate controls to prevent knickpoint formation such as rock grade control structures and/ or large wood structures. The most appropriate form of control for each location would be determined on a case-by-case basis.

11.2.6 Conclusion

The Geomorphology Technical Report characterised the geomorphology of the Project Area and identified RMZs for significant streams and major cliffs. Waterways within the Project Area consist of two main types; headwater or gorge, and range in stream order from 2nd order to 7th order streams. The waterways are bedrock controlled, and as a result are resilient to geomorphological change. The majority of streams were considered to be in a stable and close to natural geomorphic condition.

The qualitative assessment of geomorphology found that the overall risk of geomorphic change as a result of mining-induced subsidence was minor. Waterway types within the Project Area were assessed to be resilient and generally in good condition. Should the proposed development result in subsidence related changes to creek geomorphology, it is considered that subject to appropriate monitoring and management the geomorphology of waterways would be able to recover.

Providing that the mitigation and management measure are implemented, the proposed development is not anticipated to present a significant risk of change in the geomorphic character of waterways in the Project Area.

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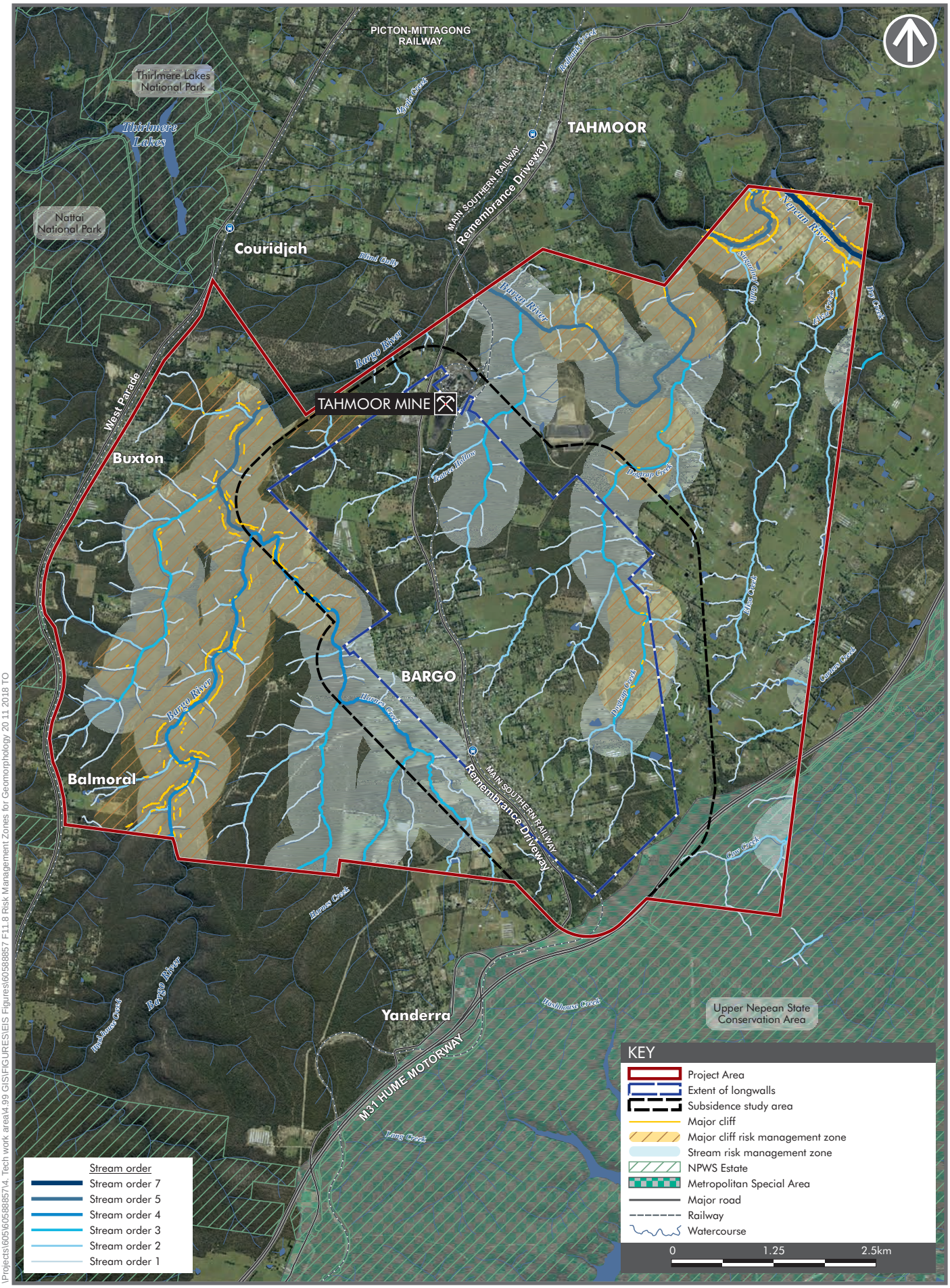

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RISK MANAGEMENT ZONES FOR GEOMORPHOLOGY

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FIGURE 11.8

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11.3 Groundwater

A Groundwater Assessment for the proposed development was undertaken by HydroSimulations (2018). The Groundwater Assessment included the development of a conceptual model and numerical groundwater model to represent the historical behaviour of groundwater at Tahmoor Mine, and to predict impacts to groundwater behaviour as a result of the proposed development.

The Groundwater Assessment was peer reviewed by Prathapar & Associates (November, 2018). The peer review considered the Groundwater Assessment to be robust, technically appropriate and consistent with:

- *Australian Groundwater Modelling Guidelines* (Barnett et al. 2012);
- the requirements of the *NSW Aquifer Interference Policy* (NSW Government, 2012); and
- the *Information guidelines for Independent Expert Scientific Committee advice of coal seam gas and large mining development proposals* (IESC, October 2015).

Both the Groundwater Assessment for the proposed development and the peer review report are provided in **Appendix I**.

The Groundwater Assessment addressed the SEARs and Supplementary SEARs relevant to groundwater impacts. These are listed in **Table 11-14**. Impacts relating to surface water, flooding and aquatic ecology are addressed in **Sections 11.4** and **11.7** of this EIS. Where relevant, pertinent information from the Surface Water Impact Assessment (HEC, 2018) prepared for this EIS has been referenced in this section.

Table 11-14 SEARs for the assessment of water resource impacts

Water Resource SEARs	Section addressed
Water Resources – including:	
• an assessment of the likely impacts of the development on the quantity and quality of surface and groundwater resources, having regard to EPA's, CL&W's (i.e. DI Water's) and WaterNSW's requirements and recommendations;	• Surface Water - **Section 11.4.4**, **Section 11.5.4** and **Appendix J** (Surface Water Impact Assessment – Sections 5, 7,8, 9, 10,12) • Groundwater - **Section 11.3.4**, **Section 11.5.4** and **Appendix I** (Sections 4-6)
• an assessment of the likely impacts of the development on aquifers, watercourses, swamps, riparian land, water supply infrastructure and systems and other water users;	• Surface Water - **Section 11.4.4**, **Section 11.5.4** and **Appendix J** (Surface Water Baseline Study, Surface Water Impact Assessment – Sections 5, 7,8, 9, 10,12) • Groundwater - **Section 11.3.4**, **Section 11.5.4** and **Appendix I** (Sections 3-6) • Surface water features are also described and assessed in **Sections 11.2** and **Appendix H** (Geomorphology) and **Section 11.7** and **Appendix K (**Aquatic Ecology).
• an assessment of any drinking water catchment losses from mining, and whether the development can be operated to achieve a neutral or beneficial effect on water quality in the Sydney Drinking Water Catchment, consistent with the provisions of *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011*;	• Surface Water - **Section 11.4.4** and **Appendix J** (Surface Water Impact Assessment – Section 13)

Water Resource SEARs	Section addressed
• a detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply and transfer infrastructure and water storage structures;	• **Section 11.4.5** and **Appendix J** (Water Balance Report)
• a detailed description of the proposed water management system (including sewerage), beneficial water re-use program and all other proposed measures to mitigate surface water and groundwater impacts;	• **Section 11.4.5** and **Appendix J** (Water Balance Report, **Section 11.4.6** (Surface water mitigation measures) and **Section 11.3.5** (Groundwater mitigation measures)
• The proposed surface water and groundwater monitoring regime, which should include a comprehensive array of shallow and deep piezometers and extensometers across the underground mining area which are capable of detecting fluctuations in groundwater levels and the influence of fracture networks on regional groundwater resources; and	• **Appendix J** (Surface Water Baseline Study), **Appendix I** (Section 3.8), **Section 11.4.6** (Surface water mitigation measures) and **Section 11.3.5** (Groundwater mitigation measures)
• an assessment of the potential flooding impacts of the development.	• **Section 11.4.4** and **Appendix J** (Flood Study)
Water Resource Supplementary SEARs	
Water resource, in relation to coal seam gas development and large coal mining development	
• The EIS should provide a description of the location, extent and ecological characteristics and values of the identified water resource potentially affected by the project.	• Surface Water - **Section 11.4.4** and **Appendix J** (Surface Water Baseline Study, Surface Water Impact Assessment – Section 3) • Groundwater - **Section 11.3.4** and **Appendix I** (Sections 3) • Surface water features are also described and assessed in **Sections 11.2** and **Appendix H** (Geomorphology) and **Section 11.7** and **Appendix K (**Aquatic Ecology).
• The assessment of impacts should include information on:	
- Any substantial and measurable changes to the hydrological regime of the water resource, for example a substantial change to the volume, timing, duration or frequency of ground and surface water flows;	- Surface Water - **Section 11.4.4** and **Appendix J** (Surface Water Impact Assessment – Sections 5, 7,8, 9, 10,12) - Groundwater - **Section 11.3.4** and **Appendix I** (Sections 4-6)
- The habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the water resource being seriously affected; and	- **Sections 11.6** (Terrestrial Ecology) and **11.7** (Aquatic Ecology) and **Appendix K**

Water Resource SEARs	Section addressed
- Substantial and measurable change in the water quality and quantity of the water resource – for example a substantial change in the level of salinity, pollutants or nutrients in the wetland or water temperature that may adversely impact on biodiversity, ecological integrity, social amenity or human health.	- Surface Water - **Section 11.4.4** and **Appendix J** (Surface Water Impact Assessment – Sections 10) - Groundwater - **Section 11.3.4** and **Appendix I** (Sections 4-6) - Aquatic Ecology – **Section 11.7.4** and **Appendix K**
• The EIS must provide adequate information to allow the project to be reviewed by the Independent Expert Scientific Committee of Coal Seam Gas and Large Mining Development, as outlined in the *Information Guideline for Independent Expert Scientific Committee advice of coal seam gas and large mining development proposals* (IESC, October 2015).	• **Sections 1-4, 11.1**, **11.2**, **11.3**, **11.4**, **11.5**, **11.6** and **11.7** • **Appendix F**, I, **H**, **J**, **K** • The requirements of the IESC guideline have also been specifically assessed in **Appendix I.**
• The proponent should ensure that a comprehensive and scientifically rigorous water monitoring program and adaptive management program is put in place to ensure Thirlmere Lakes are not being impacted by the proposed action. The listed studies should be considered by the Proponent when assessing the impacts of the proposed action on ground water and surface water.	• **Appendix J** (Surface Water Impact Assessment – Sections 8, 11), **Appendix I** (Section 6-7), **Section 11.4.6** (Surface water mitigation measures) and **Section 11.3.5** (Groundwater mitigation measures) and **Section 11.5** (Thirlmere Lakes). • The studies considered by the assessments are listed in the reference sections of each specialist report.

11.3.1 Background

Longwall mining removes large rectangular panels of coal from a coal seam which results in the overburden caving into the void, creating stresses that propagate upwards, and outward, through the overlying strata. It is generally understood, based on experience of monitoring and modelling groundwater impacts in the Southern Coalfields, that fracturing and deformation of the overlying strata results in some changes, from very large to no change, in the permeability and water storage properties of this caved and deformed overburden (HydroSimulations, 2018).

In NSW, impacts to groundwater resources are regulated consistent with water sharing plans (WSPs) enacted under the *Water Management Act 2000* (WM Act) and the *NSW Aquifer Interference Policy* (NSW Government, 2012).

Water Sharing Plans

The relevant groundwater WSP for the proposed development is the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 (GMRGS Plan). The GMRGS Plan comprises several groundwater sources or 'Groundwater Management Areas' which are used to manage the average long-term annual volume of water extracted. The Groundwater Management Area relevant to the proposed development is 'Sydney Basin - Nepean Sandstone'. The Sydney Basin – Nepean Sandstone Groundwater Management Area is further subdivided into Management Zones. The proposed development lies within Zone 2 of the Sydney Basin – Nepean Sandstone Groundwater Management Area.

The relevant WSP for the proposed development, in terms of surface water, is the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011. Particularly relevant to the proposed development is the Upper Nepean River source, which is segmented into management zones. The proposed development is covered by the Pheasants Nest Weir to Nepean Dam management zone, the Stonequarry Creek management zone and the Maldon Weir management zone.

NSW Aquifer Interference Policy

The *NSW Aquifer Interference Policy* (NSW Government, 2012) requires estimation of the volume of water that is likely to be taken from any water source as a result of an activity. The *NSW Aquifer Interference Policy* also requires that an assessment be undertaken to predict the impacts generated by the activity. The estimation is to be based on a "complex modelling platform" for any mining activity not subject to the Gateway process, where the model makes use of available baseline data that has been collected at an appropriate frequency and scale and over a sufficient period of time.

Development proposals for mining and coal seam gas projects on Biophysical Strategic Agricultural Land (BSAL) are subject to assessment by a Gateway Panel prior to lodgement with DPE. The NSW Government has mapped strategic agricultural land across NSW at a desktop level and the Project Area is not located within an area mapped as BSAL. As discussed in **Section 8.1.3**, Tahmoor Coal has applied for and received a Site Verification Certificate from DPE on 23 October 2018 confirming that the Project Area is not located on BSAL land. Therefore, the proposed development is not subject to the Gateway process, and a “complex modelling platform” is required to inform the groundwater impact assessment for the proposed development.

The *NSW Aquifer Interference Policy* provides the framework for the assessment of impacts of a proposed development on aquifers in NSW. The policy categorises groundwater sources as either “highly productive” or “less productive” depending on salinity and aquifer yield.

Zone 2 of the Sydney Basin – Nepean Sandstone Groundwater Management Area (where the Project Area is located) is defined by the *NSW Aquifer Interference Policy* as being ‘highly productive’. As a result, the groundwater resource is subject to the minimal impact considerations for highly productive groundwater as stipulated by the policy. These considerations relate to thresholds for water table and groundwater pressure drawdown, and changes in groundwater and surface water quality. The minimal impact considerations for highly productive groundwater are listed in **Table 11-19**.

The ‘highly productive’ categorisation within the *NSW Aquifer Interference Policy* does not distinguish vertically between the higher-yielding Hawkesbury Sandstone groundwater system and the low-yielding Narrabeen Group groundwater system, or the Permian (and deeper) groundwater systems lying at depth. However, most groundwater exploited for human or environmental purposes in this area comes from the Hawkesbury Sandstone, and only a small fraction from the Narrabeen Group or underlying Coal Measures. Hence the focus of the Groundwater Assessment has been on the potential impact that can propagate to the shallower stratigraphic units, most importantly the more utilised Hawkesbury Sandstone.

The groundwater impact assessment for the proposed development has been undertaken in line with the requirements outlined by the *NSW Aquifer Interference Policy*.

Licences

Dewatering operations at Tahmoor Mine are governed by groundwater licence 10WAl18745 with an annual total of less than or equal to 1,642 ML. Water entering the mine is collected into sumps, pumped to the Surface Facilities Area and either treated at the recycled water treatment plant or discharged via LDP1 to Tea Tree Hollow in accordance with EPL 1389.

The proposed development would operate under the existing groundwater licence and EPL as discussed in **Section 4.0**. The existing groundwater entitlement volume currently held by Tahmoor Coal is 1,642 ML/a. An additional groundwater licence would be required to be secured to account for increased groundwater inflows for the proposed development, as discussed further in **Section 11.3.4**.

Independent Expert Scientific Committee

The Independent Expert Scientific Committee (IESC) on coal seam gas and large coal mining development is a statutory body established under the EPBC Act. The Commonwealth Minister for the Environment is required to seek the advice of the IESC on coal seam gas or large coal mining developments that have the potential to significantly impact water resources.

In 2012, the Commonwealth Government entered into the National Partnership Agreement on Coal Seam Gas and Large Coal Mining Development with the NSW, Victorian, Queensland, South Australian and Northern Territory Governments. Under the Agreement, the Commonwealth Government and signatory states agreed to seek advice from the IESC at appropriate stages in the assessment and approvals process for coal seam gas and large coal mining development proposals that are likely to have a significant impact on water resources.

The proposed development was declared a controlled action under the provisions of the EPBC Act by the DoEE in January 2018, due to the potential for significant impacts on matters of national environmental significance, including water resources. Accordingly, the groundwater assessment has been carried out considering the Information Guidelines formulated by the IESC (2015). The requirements of the IESC guideline have also been specifically assessed in **Appendix I**. As previously noted in **Section 1.6.4**, the DoEE referral and Controlled Action determination of the proposed development was based on an earlier mine plan layout, which included mining in both the Central and Eastern domains. As discussed in **Section 6.2.4**, subsequent mine planning has led to a revised mine plan involving mining in the Central Domain only (current proposed development), and is anticipated to result in reduced overall impacts to water resources.

11.3.2 Methodology

In order to determine the extent of impact of the proposed development on groundwater resources, the Groundwater Assessment included:

- an analysis of data inputs including baseline monitoring data from Tahmoor Coal's groundwater monitoring program;
- establishing a groundwater assessment study area;
- the development of a hydrogeological conceptual model; and
- numerical modelling to assess impacts of mine development.

Baseline Monitoring

The groundwater monitoring network at Tahmoor Mine is used for operational monitoring of the Tahmoor North Mine, as well as providing baseline data for the Tahmoor South Project. Various bores have been operational since 2008 for multiple years as shown in Figure 3-7 of HydroSimulations, 2018. Baseline monitoring of surface and groundwater resources has been undertaken in the vicinity of the proposed development to inform the conceptual model and to establish trigger response values for the ongoing monitoring and management of these resources during mining. Surface water monitoring sites are presented and discussed in **Section 11.4**. Groundwater monitoring data used to inform the assessment were obtained from the following sources, also shown on **Figure 11.9**:

- five bore installations within the Existing Tahmoor Approved Mining Area, each with between six and eight vibrating wire piezometers installed at different locations within the stratigraphic sequence;
- multiple piezometers installed in bore TBF040c, located above longwall 10A of the existing operations;
- nine shallow bores within the Hawkesbury Sandstone above the existing operations, labelled as piezometers P1 to P9 on **Figure 11.9**. Of these P5 and P6 are no longer active;
- four DI Water monitoring bores at Thirlmere Lakes that monitor the shallow Hawkesbury Sandstone and/or alluvium;
- thirty monitoring bores installed across the Project Area, 17 with dual piezometer installations and 13 with multi piezometer installations;

- a bore census (survey) of standing water levels and geochemistry from 23 private, DI Water registered bores located across the Project Area and six Tahmoor Coal monitoring bores (GeoTerra, 2013a);
- a deep horizon water sampling bore (TBC035) for EC, oxygen, deuterium and tritium isotope sampling; and
- two piezometers monitoring groundwater at the REA: TGW5 (up-gradient) and TGW4 (down-gradient).

Monitoring bores provide information regarding groundwater levels and also provide information regarding groundwater pressure where piezometers are installed within the monitoring bores.

Groundwater quality data for the Study Area was sourced from publicly available data from the NSW government Groundwater Works/Pinneena database, Dendrobium Mine, and from the bore census conducted by GeoTerra (2013a). Water quality sampling has been carried out at 29 local bores since early 2013, 6 of which are Tahmoor Coal monitoring bores and the remainder being private landowner bores (see GeoTerra, 2013a). Additionally, there is monitoring of water quality within deeper horizons of the stratigraphic sequence. This is done via sampling of TBC035 (see GeoTerra, 2013a) and also monthly sampling, since January 2012, of the water pumped out of the mine, which is primarily groundwater.

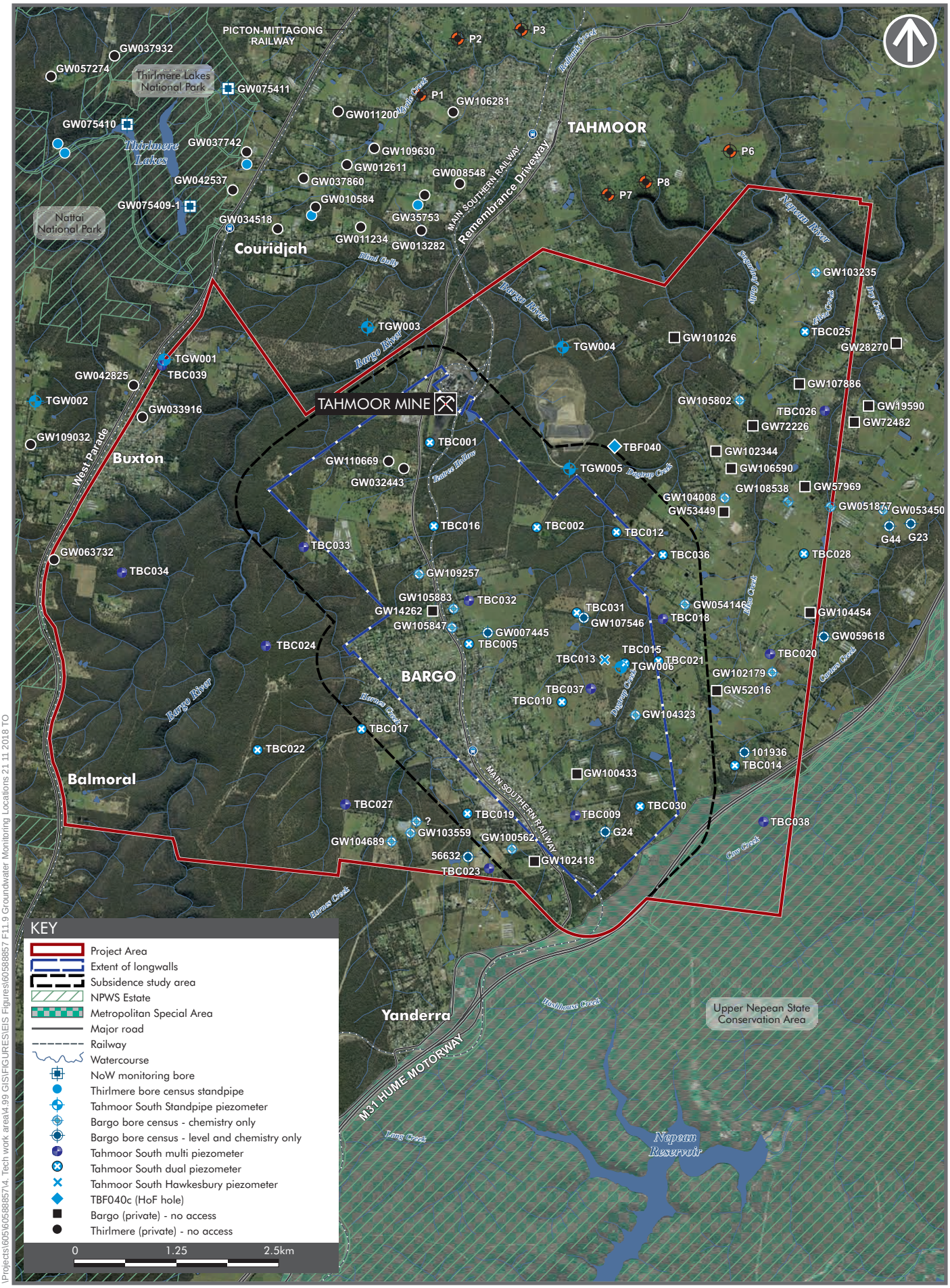
Groundwater Assessment Study Area

A groundwater assessment study area was established to encompass the geological and hydrological features that might be important to the proposed development and to the numerical model built for the purpose of impact assessment. The groundwater assessment study area is centred on the Tahmoor Mine, extending beyond Lake Burragorang to the west, past Wollongong to the south east, beyond the Illawarra Escarpment in the east, and into the suburbs of Sydney in the north and north east (refer to Figure 1-1 of HydroSimulations, 2018).

Conceptual Model

A review of literature and data was carried out as a basis for the development of the conceptual model. This included review of available information on geology, rock mass hydraulic properties, neighbouring mine workings and strata geometry for the area interpreted stratigraphy bore logs from the Tahmoor Lease area (MBGS, 2013), and modelling techniques for considering potential effects of longwall mining on the overlying strata. In particular, previous investigations commissioned by Tahmoor Coal at Tahmoor Mine were reviewed, comprising predicted changes to permeability in the goaf and overburden via geotechnical modelling (SCT, 2013) and down-hole investigations into fracturing above a longwall (SCT, 2014). The SCT (2014) report on the ‘Height of Fracturing’ (HoF) hole is particularly important in the development of the conceptual model of this process at Tahmoor because it shows in situ behaviour of groundwater levels in response to mining at Tahmoor at a location that is only a few hundred metres from the proposed Tahmoor South longwalls.

Cross-sections of the stratigraphy within the Tahmoor Lease Area (based on the regional conceptual model) are shown in **Figure 11.10**.



\Projects\605\605888574. Tech work area\4.99 GIS\FIGURES\EIS Figures\605888857 F11.9 Groundwater Monitoring Locations 21 11 2018 TO

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GROUNDWATER MONITORING LOCATIONS WITHIN THE PROJECT AREA

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FIGURE 11.9

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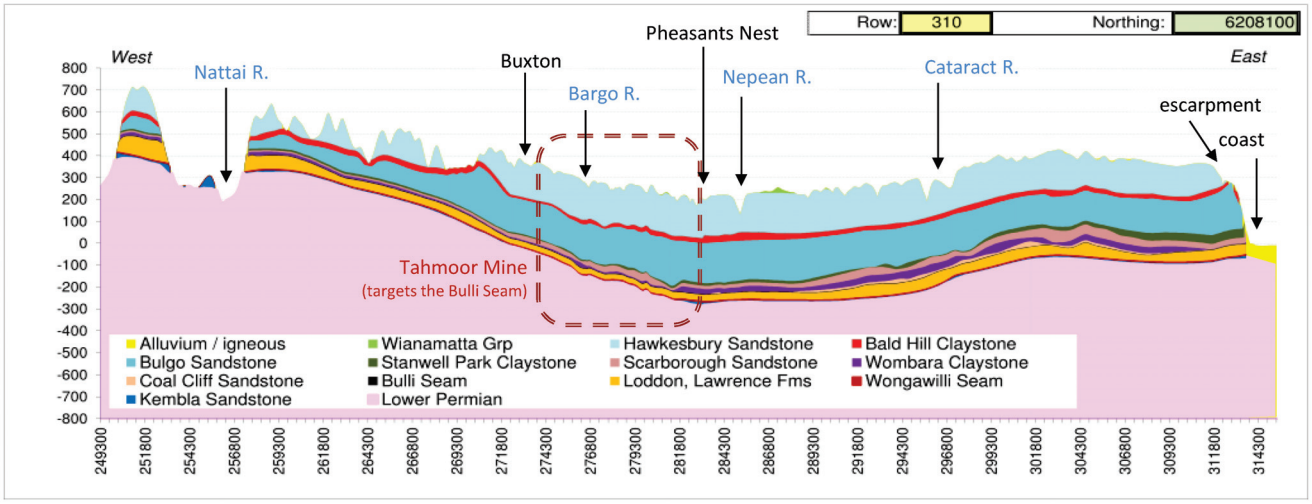

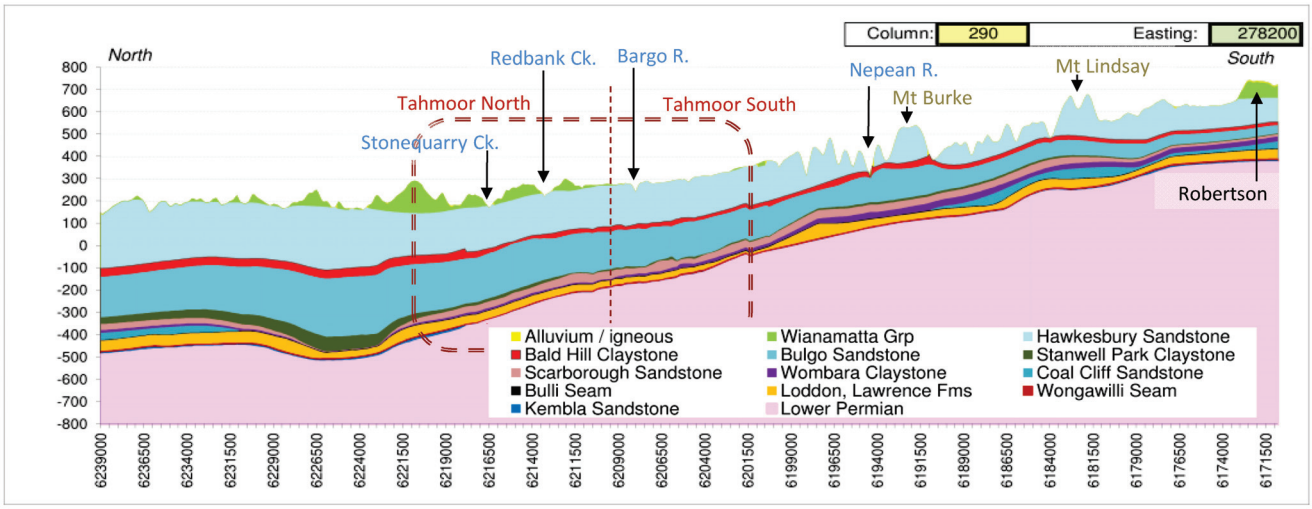

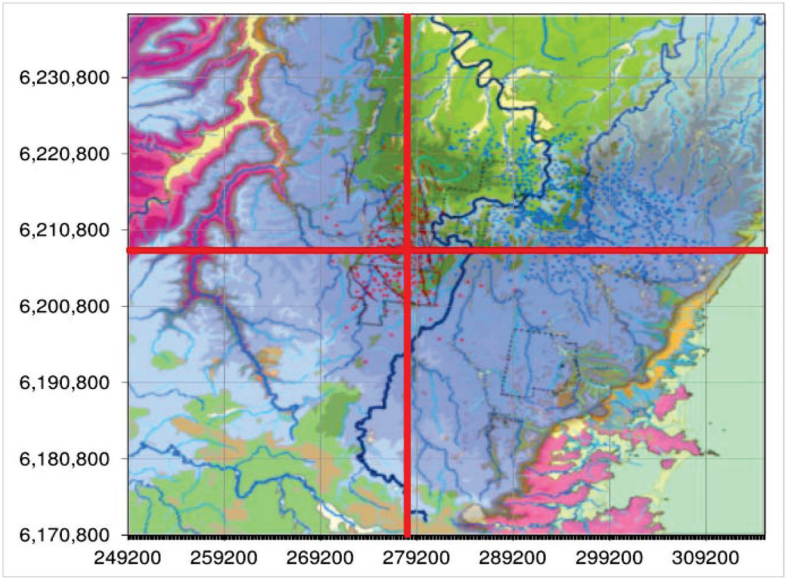

Red lines denote position of East-West section (upper) and North-South section (lower section).

\Projects\605\605888571\4. Tech work area\4.99 GIS\FIGURES\EIS Figures\605888571 F11.10 Cross Sections of the Stratigraphic Units in the Project Area 2018 TO

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CROSS-SECTIONS OF THE STRATIGRAPHIC UNITS IN THE PROJECT AREA

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Source: Hydrosimulations (2018)

FIGURE 11.10

Numerical Model

The numerical model was developed in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al., 2012), which build on the Murray-Darling Basin Commission Groundwater Flow Modelling Guideline (MDBC, 2001). The model was developed to assess the proposed development meets a 'Class 2' confidence level under the Barnett et al (2012) guide, which is equivalent to a 'medium' model complexity classification under MDBC (2001). This level of model complexity is deemed by the guidelines to be suitable for predicting the impacts of the proposed development.

Numerical modelling has been undertaken using MODFLOW-USG, which is distributed by the United States Geological Survey (USGS). MODFLOW-USG is a relatively new version of the popular MODFLOW code (McDonald and Harbaugh, 1988) developed by the United States Geological Survey (USGS). MODFLOW is the most widely used code for groundwater modelling and has long been considered an industry standard. USG allows finer grid scale to focus on sensitive areas (such as the Thirlmere lakes) and allows the inclusion of localised layers.

The model complexity is adequate for simulating contrasts in hydraulic properties and hydraulic gradients that may be associated with changes to the groundwater system as a result of the proposed development. This is based on the availability of groundwater level data, mine inflow data and stream flow/baseflow data, and the use of this to calibrate the numerical model while constraining the input hydraulic properties (namely hydraulic conductivity) with the packer and core testing datasets.

The following modelling approach was adopted:

- development of a steady state calibration model representing hypothetical, un-impacted or natural (pre-mining) condition using average climate and no mine stresses;
- development of a transient calibration model that simulated mining stresses from Tahmoor Mine and neighbouring mines for the period 1980 until October 2017;
- development of a transient predictive model extending through the end of the Tahmoor North operations (~2022), then through the operation of Tahmoor South (2023-2035), and the simulation of post-mining recovery through to 2500 (i.e. >450 years of recovery); and
- implementation of a sensitivity analysis to test the impacts of various hydrogeological features and behaviours including:
    - testing the possibility that the barrier faults are 'weaker' (more permeable) than simulated in the baseline model;
    - testing the possibility that faults in the project area act as hydraulically conductive features;
    - testing the potential impact of increasing the height of fracturing above the coal seam; and
    - testing the inclusion of enhanced groundwater storage parameters in the groundwater model.

The potential impacts of the development were assessed by making comparisons between the predictive scenarios summarised in **Table 11-15**.

Table 11-15 Summary of modelled scenarios

Scenario	Description	Mining – proposed development	Mining – other
Scenario A	Scenario A is the 'null' run as described in the Australian Groundwater Modelling Guidelines (Barnett et al., 2012) and otherwise known as a hypothetical 'natural' or non-impacted scenario whereby all aquifer interference activities were removed from simulation. In Scenario A the hydrological environment was created without any of the existing mines, longwall/ subsidence impacts on strata and no groundwater extraction from bores.	Not included	Not included

Scenario	Description	Mining – proposed development	Mining – other
Scenario B	Scenario B represents the existing environment with all mining activities simulated, except for the proposed development. The existing longwall mining operations (Tahmoor mine and other mines) modelled in this scenario are detailed in Figure 2-3 of HydroSimulations, 2018.	Not included	Included (existing operations at Tahmoor North and others)
Scenario C	Scenario C represents the proposed scenario with all mining activities occurring. This is the same as Scenario 'B' but with the proposed development also operating.	Included	Included (existing operations at Tahmoor North and others)

Modelling these scenarios allowed the net impact of the proposed development on the hydrogeological environment to be evaluated separately from the other processes. When Scenarios B and C are compared, the difference between the two represents the impact of the operation of the proposed development. When Scenarios A and C are compared, the difference between the two represents the cumulative impact of all the mining activities in the area.

Groundwater extraction bores were not simulated in Scenarios B or C given the uncertainty around actual extraction versus entitlement, as well as due to the possible presence of unregistered bores.

A schematic of the 'post-mining' groundwater conceptual model is provided in **Figure 11.11**.

Thirlmere Lakes

A discussion of the assessment of groundwater impacts to the Thirlmere Lakes is provided in **Section 11.5**.

11.3.3 Existing Environment

The existing environment of the groundwater assessment study area is described below and forms the conceptual model for the Groundwater Assessment.

Physical Environment

Topography and Surface Drainage

The elevation of the groundwater assessment study area ranges from 100 m to 370 m Australian Height Datum (m AHD) due to the highly incised nature of the watercourses. The topography is dominated by the Illawarra Escarpment which is both the regional high point and also the high rainfall area. The escarpment acts as a divide with most rivers and creeks flowing west into the Nepean catchment. The Nepean River is perennial and flows from the south through Lake Nepean, to the east of the Tahmoor South Project, and up to the north through Camden toward Penrith.

The Avon and Cordeaux Rivers are the largest tributaries to the Nepean River, with the confluence of these lying to the east of the Project Area. Bargo River flows through the middle of the Tahmoor leases, before flowing into the Nepean River. Other notable topographic features include the Nattai River valley and Lake Burragorang to the west of the Project Area.

Natural surface features identified within the groundwater assessment study area, and related to the Groundwater Assessment, include:

- the Thirlmere Lakes, to the west along the upper reaches of Blue Gum Creek. In order from upstream to downstream, the lakes comprise: Lake Gandagarra, Lake Werri Berri, Lake Couridjah, Lake Baraba and Lake Nerrigorang;
- catchment areas or declared Special Areas which include five major water storage reservoirs operated by WaterNSW (**Table 11-16**); and
- waterways and high value features including Mermaid Pool (as detailed in **Section 11.4**).

Table 11-16 Major water storage reservoirs (Hydrosimulations, 2018)

Reservoir[1]	Surface area (approx.) (km^2)	Full storage level (approx.) (m AHD)
Lake Burragorang (Warragamba Dam)	72	117
Lake Nepean	3	317
Lake Avon	9.5	320
Lake Cordeaux	7.5	304
Lake Cataract	8.5	290

[1] The locations of the lakes are shown in **Figure 1.1**

Streamflow monitoring indicates that the Bargo River, the Nepean River (Maldon Weir) and Hornes Creek are baseflow-fed streams. The monitoring data and flow duration curves suggest that waterways in the east of the Project Area, Eliza, Dry and Carters Creeks, have the lowest flows. Carters Creek and Dry Creek also have the steepest flow duration curves suggesting baseflow discharge is a less significant process at low flows in these catchments. While some creeks appear to have only a minor contribution from baseflow, there is no evidence for complete disconnection between streams and groundwater.

No significant springs or soaks have been identified within the Project Area, either by published data or the Shallow Groundwater Assessment commissioned by Tahmoor Coal as part of the feasibility investigations for the proposed development (GeoTerra, 2013). However, there are likely to be some localised springs and soaks due to the presence of saturated and perched aquifers within the Permo-Triassic strata, especially the Hawkesbury Sandstone, resulting in some groundwater discharge at surface before flowing into local creeks and rivers.

Climate

Topography in the region influences rainfall distribution so that rainfall decreases with distance from the Illawarra Escarpment (over 1,600 mm per annum) to the Lake Burragorang in the west (750-800 mm per annum). The long-term trend in rainfall in the Nepean catchment comprises a long period of lower than average rainfall between 1890-1950, with multiple year droughts occurring in around 1900 ('Federation Drought') and 1936-45 ('WWII Drought') (Verdon-Kidd and Kiem, 2009). This period of lower than average rainfall was followed by a sustained period of above average rainfall that continued until the early 1990s, and was followed by the 'Millennium Drought' (1997-2011).

The annual average 'Area Actual Evapotranspiration' (Bureau of Meteorology) is approximately 680 mm per year at Tahmoor. The Bureau of Meteorology defines Area Actual Evapotranspiration as that evapotranspiration that actually takes place, under the condition of existing water supply, from an area so large that the effects of any upwind boundary transitions are negligible and local variations are integrated to an area average.

Designated Areas

National Parks, State Forests and WaterNSW Special Areas (drinking water catchments) are present within the groundwater assessment study area. These include:

- Thirlmere Lakes National Park and the Warragamba 'Special Area with Restricted Entry' zone (managed by WaterNSW) to the west of the proposed development;
- Upper Nepean;
- Bargo; and
- the MSA immediately to the south-east of the extent of proposed longwalls.

Groundwater Dependent Ecosystems

Groundwater dependent ecosystems in the region that are listed on the GMRGS Plan as high priority are:

- Thirlmere Lakes, located approximately 3.5 km from the proposed development at its nearest proposed longwalls;
- O'Hares Creek located more than 23 km to the east of the proposed development; and
- Macquarie Rivulet Estuary located more than 29 km south east of the proposed development.

Potential impacts to Thirlmere Lakes are assessed and discussed in **Section 11.5**. O'Hares Creek and Macquarie Rivulet are beyond the boundaries of the impact assessment model. The proposed development is unlikely to impact these features due to their distance from the proposed development. Other GDEs are limited to North Pole Swamp which is located 21 km south of the proposed development.

The High Priority Endangered Ecological Vegetation Communities, as listed on the GMRGS Plan that exist within the groundwater assessment study area are:

- Temperate Highland Swamps on Sandstone, approximately 20-25 km to the south of the proposed development; and
- Cumberland Plain Woodland (Cumberland Plain Shale Woodlands and Shale- Gravel Transition Forest) mapped to the north of the proposed development.

No upland swamp communities or Cumberland Plain Woodland is identified in the Terrestrial Ecology assessment (Niche, 2018), as occurring within the proposed development area. Further discussion of these communities is provided in **Section 11.6**.

Underlying Geology

The proposed development is located in the southern part of the Permo-Triassic Sydney Basin, within which the main coal bearing sequence is the Illawarra Coal Measures. The Illawarra Coal Measures contain multiple workable seams, the uppermost of which is the Bulli Seam, and this seam is targeted for extraction by the proposed development.

Three stratigraphic divisions overlie the Illawarra Coal Measures, being the Narrabeen Group (sandstone and claystone), Hawkesbury Sandstone Group (bedded sandstone) and Wianamatta Group (shales and siltstones). Sandstone units within these stratigraphic divisions dominate the study area and are evident at the surface, often exposed in river gorges and creeks. The Wianamatta Group units evident at the surface are generally limited to along the tops of ridgelines.

Exploration has identified a number of geological features within the study area, including two major faults being the Nepean fault and the Central fault. These faults are included in the conceptual groundwater model. Further detailed description of the underlying geology is provided in **Section 5.0**.

Groundwater Flow Systems

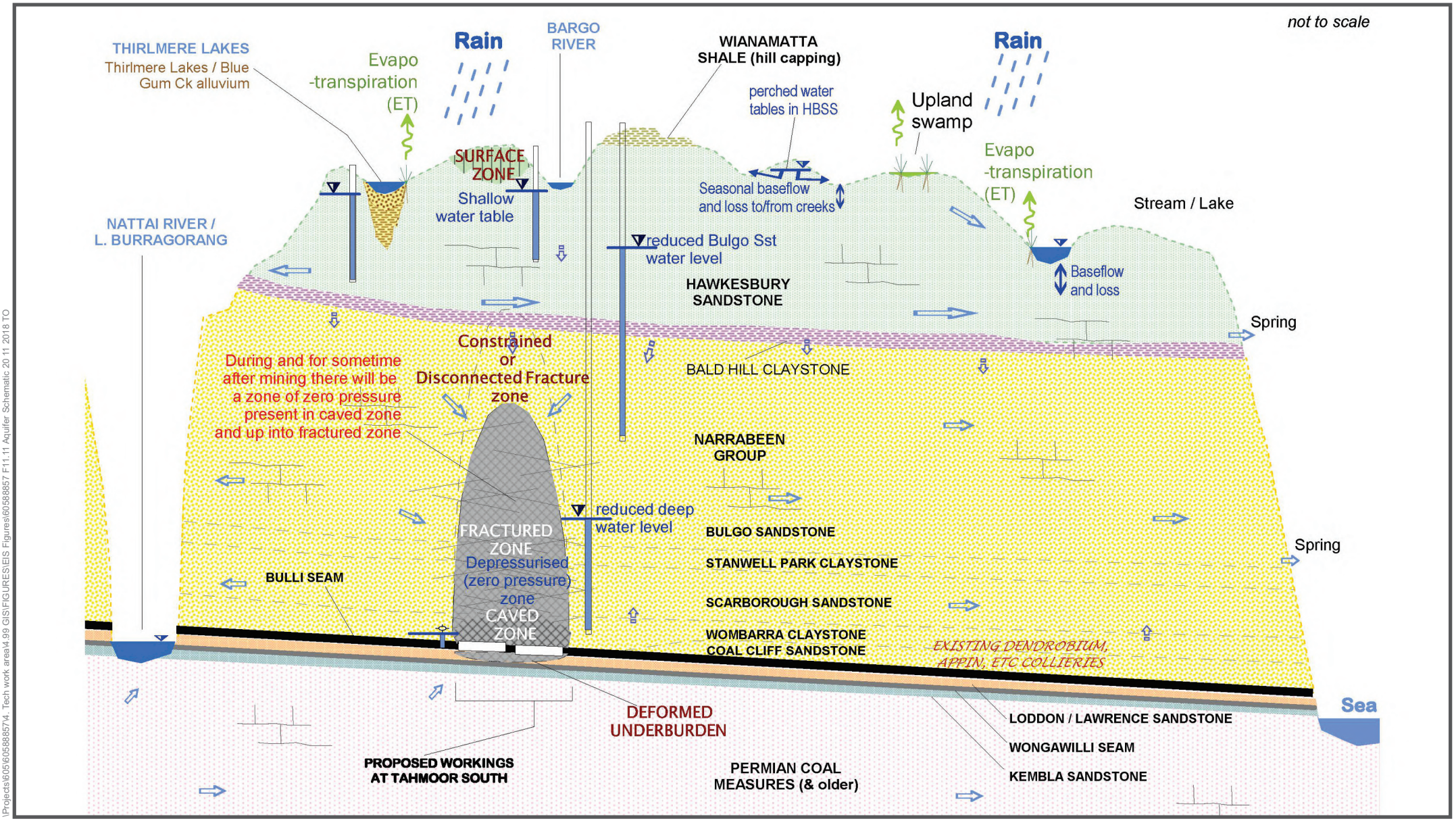
The major hydrostratigraphic units within the groundwater assessment study area are the Sydney Basin Permian and Triassic rock units, which form a porous and fractured rock aquifer (**Figure 11.11**). The Sydney Basin Permian and Triassic rock units are classified within the Nepean Groundwater Management Area as 'Highly Productive'. The primary aquifer within this grouping is the Hawkesbury Sandstone, although smaller quantities of water can be extracted from parts of the Narrabeen Group (such as the Bulgo Sandstone) and from the Illawarra Coal Measures. The geological sequence comprises interlayered sandstone, claystone (including Bald Hill Claystone), siltstone and, within the Permian strata, coal seams, to depths of 400-500 m.

Minor hydrostratigraphic units within the groundwater assessment study area include:

- Thirlmere Lakes alluvium: an alluvial aquifer, attributed as being Cretaceous in age, associated with Blue Gum Creek. It primarily comprises clayey sands and sandy clays, reaching a maximum thickness of 40-60 m or more, although restricted to a thin valley (only a hundred or a few hundred m wide); and

- Wianamatta Formation shales: poorly permeable, with typically poor water quality. This unit is typically present around the northern part of the Tahmoor lease as hill cappings, and has been eroded from above the Hawkesbury Sandstone to the south of the lease.

Inter-aquifer flow rates between the hydrostratigraphic units are likely limited by the contrasting permeability differences between these units. Consequently, the majority of groundwater flowing through the alluvium is likely to have been derived from rainfall recharge and river leakage directly into the alluvials, and is likely to primarily discharge out of the alluvium directly rather than draining into underlying rock strata. Groundwater flow through the porous (and fractured) rock aquifer, and out of it via the alluvium, creeks and evapotranspiration, would probably occur at significantly slower rates than in the alluvium, even considering the clay-rich nature of the Thirlmere Lakes alluvium.



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SUBSIDENCE SCHEMATIC

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FIGURE 11.11

Hydraulic Properties

Across all formations, with the exception of the Bulli Seam, the hydraulic conductivity measurements from the Project Area indicate that permeability has a general trend of decreasing with depth. The trend indicates two broad groups with regards to permeability:

- decreasing permeability from the Hawkesbury Sandstone down to the Wombarra Claystone, an apparent increase in permeability between the Wombarra Claystone and the Bulli Seam; and
- a further decreasing trend in strata underlying the Bulli Seam.

Most of the faults in the area are thought to act as barriers to flow (hydraulic barriers), noting that this does not mean they are impermeable, just less permeable than most of the surrounding rock mass. In contrast, water inflows to the longwalls at Tahmoor North were observed to be higher than normal at a point where the mine workings intersected the Nepean fault zone. For this reason the Nepean Fault is believed to be a conductive fault that is more permeable than the surrounding geology. However, calibration of the hydraulic zones as part of the conceptual model involved consideration of the Nepean Fault as conductive and as a barrier to understand the overall influence of the fault for both scenarios (refer to **Appendix I** for further information).

Groundwater Recharge and Discharge

The regional recharge is stated by DI Water (2010) to be 6% of the long term average rainfall. However, the analysis in the Groundwater Assessment suggests that recharge to the consolidated Hawkesbury Sandstone and Wianamatta Formation is likely to be approximately 2-3% of long term average rainfall in the area around Tahmoor and Bargo.

The higher average rate stated in DI Water (2010) might apply across the Nepean Groundwater Source as a whole, as it encompasses areas of higher rainfall to the south (Southern Highlands) and east (Illawarra escarpment) of Tahmoor. The Groundwater Assessment conceptual model has adopted the lower rate of 10-20 mm per year or 2-3% of long term average rainfall for recharge to the Hawkesbury Sandstone. Recharge to this aquifer is predominantly from rainfall recharge with some recharge from stream leakage. This is consistent with the close calibration of the model with water levels in the local piezometer network.

Recharge, including rainfall recharge as well as stream leakage, to alluvium in the region is likely to be occurring at higher rate, in the order of 10-20% of long term average rainfall.

Groundwater discharge is primarily to streams with some evapotranspiration occurring from shallow groundwater in lower lying areas via outcrops of fractured rock. A small portion of groundwater is extracted for anthropogenic use by production bores. Discharge from alluvium is primarily via baseflow to the lakes and watercourses, as well as evapotranspiration from shallow water table areas.

Groundwater Quality

Publicly available data from the NSW government Groundwater Works/Pinneena database, and from the bore census conducted by GeoTerra (2013a) indicates the following with regard to groundwater quality for hydrogeological units within the Study Area:

- Hawkesbury Sandstone: This hydrogeological unit shows a range of salinities, from fresh through to saline, with an approximate median value of around 500 mg/L, based on the usually qualitative entries in the NSW bore database. The average salinity from the 23 samples in the Tahmoor bore census was 1,050 mg/L.
- Alluvium and Wianamatta Formation: Groundwater is also of mixed quality. It is likely that evaporative concentration of salts could occur in alluvial aquifers, especially in clayey facies. The marine origin and low permeability of the Wianamatta Shales tends to lead to higher salinities in this unit.
- Narrabeen Group or Illawarra Coal Measures: There is little available data for these units. Older units such as the Shoalhaven Group exhibit a range of salinities from fresh to saline.

Publicly available water quality data from surrounding mines were also reviewed, including from the Dendrobium Mine 12 km to the south east. A summary of groundwater quality at Dendrobium Mine indicated:

- fresher conditions in the Hawkesbury Sandstone, with a median salinity of 80 mg/L;
- a median salinity of 280 mg/L for the Bulgo Sandstone; and
- median salinities for the mine goaf, i.e. the Permian Coal Measures, including the Wongawilli Seam and possibly the Bulli Coal Seam), in three different mine areas of approximately 500, 650 and 900 mg/L.

Publicly available data from AGL's Camden Gas Project indicated an average Total Dissolved Solids (TDS) of about 380 mg/L for Hawkesbury Sandstone groundwater (Parsons Brinckerhoff, 2013). An average TDS of 11000 mg/L and a range 3200-27500 mg/L was reported for groundwater from the Illawarra Coal Measures, which includes the Bulli Coal seam.

The Reject Emplacement Area (REA) located within the surface infrastructure area has been operated by Tahmoor for most of the period of historical mining. It is located on outcropping Hawkesbury Sandstone, just south of the Bargo River. A review of water quality monitoring around the REA suggests there is no adverse effect from the rejects within the REA on local groundwater quality.

Groundwater Extraction

Private Bores

Database searches identified 982 registered groundwater bores within the groundwater Study Area on the NSW government PINNEENA database. Based on a search of the NSW Water Access Licence register, 791 of the 982 bores returned matches to Water Access Licences amounting to a licensed groundwater entitlement of 3,272 ML of water per year for private or small scale government use within the groundwater assessment study area. There is some additional 981,000 ML of water per year associated with unregulated river licences held by government agencies, although these licences are also associated with licensed groundwater works. In addition, there is approximately 1,000 ML of water per year of unlicensed groundwater use for stock and domestic purposes (assuming that use for these purposes is 1 - 2 ML of water per year).

Most of the groundwater usage in the region is from the Hawkesbury Sandstone or from surficial alluvium and basalt aquifers (about 89% of the total), with about 10% from the Bulgo Sandstone. The disparity between use from the Hawkesbury Sandstone and the Bulgo Sandstone is suspected to be due to generally lower yields, poorer water quality, and increased drilling costs for accessing the deeper Bulgo Sandstone (HydroSimulations, 2018).

Mine Inflows

Inflows into the mine workings following mining create a vertical gradient in the surrounding aquifers and add to the discharge of groundwater from the system. Mine inflows at the existing operations of Tahmoor Mine come from the deeper aquifers in the Narrabeen and Permian strata. Mine inflows range between 1 and 4.5 ML of water per day. In the last 4-5 years, the total water make has been fairly steady at around 3-4 ML of water per day (HydroSimulations, 2018).

Existing Mining Operations

The Southern Coalfield includes a number of currently operational coal mines as shown on **Figure 2.1**. The nearest mines to the proposed development form part of the existing groundwater environment due to the cumulative impact that coal mining has had on groundwater pressure in the region. The nearest mining operations to the proposed development are identified in **Table 2.1** and are shown in **Figure 2.1**.

The majority of the existing mines in the Southern Coalfield mine the Bulli Seam. However, some also mine other seams within the Illawarra Coal Measures including the Wongawilli Seam. The numerical model assessed the cumulative impacts of the proposed development in the context of the nearest mining operations identified in **Figure 2.1**.

Investigation into Fracturing Above Longwalls

Longwall mining typically removes large rectangular panels of coal from a coal seam, often 100-400 m wide and up to 6-8 km long and 2-4.5 m high. In the case of Tahmoor South, the longwalls are proposed to be 285 and 305 m wide (most 305 m), and the mined thickness would be up to 2.85 m. The removal of a panel of coal then results in the overburden caving into the void, resulting in stresses propagating upward, and outward, through the overlying strata. Fracturing and deformation of these strata then results in some changes, from very large to no change, in the permeability and aquifer storage properties of this overburden.

The conceptual model of the impacts of mining on the permeability of caved and deformed overburden has been based on experience of monitoring and groundwater modelling gained at Tahmoor and in other locations, combined with the recent research available for subsidence impacts on aquifer materials.

Tahmoor Coal commissioned SCT to carry out investigative drilling and analysis of a variety of methods (SCT, 2014) of the conditions above Tahmoor Longwall 10A. The analysis identified that mining-induced fractures occur from around 75-80 m above the mined seam in the area. The analysis also showed that at shallow depths fracturing was not connected in a vertical sense, nor permeable enough in a horizontal sense to result in significant changes to the groundwater pressures within the local geology (Hawkesbury sandstone). At greater depths (closer to the seam), the degree of permeability enhancement increased, particularly in the vertical direction, resulting in significant loss of groundwater pressure. Further information is provided in **Appendix I**.

11.3.4 Impact Assessment

Impacts of longwall mining on the groundwater regime arise from changes in bulk rock mass permeability caused by the fracturing associated with longwall subsidence, and the pumping out of groundwater that enters the mine as a consequence. The caving of the overburden and the subsequent extraction of groundwater, impacts the hydrogeological system during and after mining operations. The extent to which the proposed development is likely to result in the following impacts is presented below:

- **Aquifer Interference** - inflow of water to the underground mine and the management of that mine water;
- **Baseflow** - impacts of baseflow capture on surface waterways during and after mining;
- **Drawdown** - impacts on groundwater levels during and after mining; and
- **Groundwater quality** - impacts on groundwater quality via mining-induced mixing of groundwater from different strata.

Impacts of the proposed development on groundwater have also been assessed against the criteria for minimal impact considerations specified by the *NSW Aquifer Interference Policy* (NSW Office of Water, 2012) which relates to:

- **Aquifer Interference** - licensable takes of water (and their partitioning);
- **Drawdown** - water table and pressure head drawdown; and
- **Groundwater quality**.

Aquifer Interference

The mine inflow rates for the proposed development are predicted to average approximately 4.7ML of groundwater per day for the life of the proposed development; with peaks in 2029-30 and 2032 of around 7.5-8 ML per day (HydroSimulations, 2018).

In annual terms, the inflows equate to an average of 1,700 ML of water per annum over the period of mining for the proposed development. The peak annual flows are predicted to be approximately 2,850ML in 2029 and 2,600 ML of water in 2032.

The existing groundwater entitlement volume currently held by Tahmoor Coal is 1,642 ML/a, meaning a short fall of a maximum of 1,208 ML/a (based on the maximum predicted inflow of 2,850 ML in 2029). Additional groundwater licence(s) would need to be secured to account for the increased groundwater inflows for the proposed development. The Nepean Sandstone Groundwater Source has an annualised limit on entitlement of 99,568 ML (HydroSimulations, 2018) with a current entitlement of 28,841 ML (based on the WaterNSW Water Register). Whilst current Unassigned Water volumes are not published on the Water Register, the most recent Report Card for the Sydney Basin Nepean Groundwater Source (NOW, 2011a), identified that there was 37,303 ML/a of Unassigned Water (equivalent to 102.2 ML/d) available. Therefore it is considered that there would be available water to increase the entitlement held by Tahmoor Coal. Tahmoor Coal would purchase additional groundwater allocations as required in consultation with DI Water.

Sensitivity testing of the numerical model suggests that mine inflows could be higher than predicted by the 'base case' model. That is, average inflows of 4.7-5.5 ML per day (1,700 to 2,000 ML/a) and peak inflows during 2029 and 2032 of up to 2,850 and 3,700 ML/a in a 12 month period for the proposed development.

However, the Groundwater Assessment demonstrated a high degree of correlation between the modelled inflows, for the calibrated historical model, with the observed inflows. Therefore, the high inflows from the sensitivity test are considered overly conservative for licensing annual rates of groundwater extraction (HydroSimulations, 2018). Periodically, the model predictions would be compared with measured data and if there are any inconsistencies the model (and where required licence allocations) would be updated accordingly.

As noted in **Section 11.3.1,** the Tahmoor South Project is subject to the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* (GMRGS Plan), which is divided into a number of groundwater sources. The proposed development is located within the *Sydney Basin – Nepean Sandstone* groundwater source (Management Zone 2). The proposed development is located some 10-11 km from the nearest part of the *Sydney Basin – Nepean Sandstone* Management Zone 1 and still further from other groundwater sources under the GMRGS Plan such as the *Sydney Basin - Central* (10km) and *Sydney Basin – South* (15-20km).

The groundwater modelling for the proposed development included consideration of groundwater 'take' (inter-zone fluxes) from other groundwater sources. The modelling indicated that on average, only interzone fluxes for *Sydney Basin – Nepean Sandstone* Management Zone 1 and *Sydney Basin– Central* would be affected by Tahmoor South, and only in the post-closure phase as it takes time for the drawdown to propagate. The modelling predicted that the proposed development would result in increased groundwater influxes as follows:

- *Sydney Basin – Nepean Sandstone* Management Zone 1: Average of <1 ML/a; Max of 2 ML/a; and
- *Sydney Basin – Central*: Average of <1 ML/a; Max of 1 ML/a.

It is considered that the predicted influxes do not represent a significant component of these groundwater resources.

Baseflow Impacts

Waterways

'Baseflow capture' is the process of inducing leakage from a creek or river into the aquifer via a downward gradient, or weakening an upward gradient from the aquifer into the watercourse and thereby reducing the rate at which baseflow occurs. Baseflow impacts determined by the conceptual model have informed the surface water impact assessment which is described in **Section 11.4**.

Baseflow impacts predicted to result from the proposed development and the cumulative case are summarised in **Table 11-17** below.

Table 11-17 Predicted baseflow reductions to watercourses

Watercourses	Proposed Development (Estimated max ML/d)	Cumulative Case (Estimated max ML/d)	Impacts as % of mean flow (project-only and cumulative)
Eliza Creek (SW-18)	0.0	0.003	0.0% - 0.5%
Carters Creek (SW-23)	0.0	0.004	0.0% – 0.4%
Dog Trap Creek (SW-15)	0.26	0.28	5.3% – 5.7%
Tea Tree Hollow (SW-22)	0.11	0.13	3.7% – 4.5%
Cow Creek (SW-24)	0.005	0.022	0.2% – 0.9%
Stonequarry Creek (212053)	0.06	0.29	0.4% - 1.9%
Bargo River (SW-1)	0.0013	0.17	0.3% - 3.6%
Bargo River (SW-13)	0.01	0.30	0.4% - 1.3%
Bargo River (SW-14)	0.54	0.83	1.7% - 2.6%
Hornes Creek (SW-9)	0.01	0.1	0.4% - 3.8%
Nepean River (SW-21 – Maldon Weir)	0.59	1.3	1.2% - 2.7%

The modelling indicates that baseflow impacts from the proposed development would likely be greatest at Dog Trap Creek (peak reductions up to 5.3% – 5.7% of mean flow), Tea Tree Hollow (peak reductions up to 3.7% – 4.5% of mean flow) and Bargo River (peak reductions up to around 2% of mean flow). These impacts are anticipated to occur at different times (e.g. 2024 at Bargo River, SW1 and 2035 at Dog Trap Creek), including in some cases after the operational life of the proposed development (e.g. 2041 at Bargo River, SW13 and 2043 at Hornes Creek and Cow Creek).

For the cumulative scenario, the modelling indicates typically greater impacts, which in most cases is the result of the impacted watercourses such as Stonequarry Creek and Blue Gum Creek, being located in closer proximity to existing approved mining operations (i.e. Tahmoor North longwalls).

The Surface Water Baseline Study undertaken by HEC (2018) indicates that baseflows make up a relatively small contribution of mean flows at watercourses in proximity to the proposed development (i.e. baseflow index of 0.1) (HEC, 2018).

Given this, the impacts of baseflow reduction on total stream flow are expected to be relatively small. This is demonstrated in the groundwater assessment results summarised in **Table 11-17** which indicates that the percentage of mean flow reduction (as a result of baseflow changes) for all waterways would be less than 3.8% under the proposed development and less than 4.9% under the cumulative scenarios.

The reductions in baseflow would likely be most noticeable during periods of low flow which would normally be dominated by baseflow (HEC, 2018). Furthermore, reductions in baseflow at Tea Tree Hollow would likely be offset by on-going licensed discharge from LDP1 (HEC, 2018). Baseflow impacts and other subsidence induced impacts to watercourses are further discussed in **Section 11.4.4**.

Surface Water Sharing Plans

As discussed in **Section 11.3.1**, the proposed development is also subject to the following (surface) water sharing plan: *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*. Within the WSP, the proposed development is located within the Upper Nepean River source. The proposed development (including other mining as part of the cumulative impact assessment) would result in a reduction in baseflow in three management zones (MZs) in the Nepean River Water source:

- Pheasants Nest Weir Nepean Dam MZ, which is predicted to experience baseflow depletion of around 0.04 ML/d (Tahmoor South), 0.5 ML/d (cumulative mining effect);
- Stonequarry Creek MZ, which is predicted to experience baseflow depletion of around 0.06 ML/d (Tahmoor South), 0.29 ML/d (cumulative mining effect); and
- Maldon Weir MZ, which is predicted to experience baseflow depletion of around 0.6 ML/d (Tahmoor South), 1.3 ML/d (cumulative mining effect).

The highest baseflow losses are predicted at the Nepean River, Maldon Weir MZ (up to 1.3 ML/d – cumulative effect). However, as identified in **Table 11-17,** this is equivalent to an overall reduction in mean flow rates within the Nepean River of up to 1.2% (under the proposed development) and up to 2.7% (under the cumulative scenario), which is not considered to be significant.

Water Storage Reservoirs

There are five WaterNSW water storage reservoirs partly or wholly within the groundwater model domain. The predicted leakage rates for the closest reservoirs associated with the proposed development are up to around 0.007 ML per day for Lake Nepean and 0.006 ML/d from Lake Avon. The predicted leakage rates associated with the Tahmoor South Project are considered to be small given the total capacity of the reservoirs (around 70 ML for Lake Nepean and 214,360 ML for Lake Avon).

The NSW Dam Safety Committee specifies tolerable limits for induced leakage from these reservoirs. For Lake Nepean and Lake Avon this is 1 ML/d. The predicted leakage rates for the Tahmoor South Project (0.007 ML per day for Lake Nepean and 0.006 ML/d from Lake Avon) are much less than this level.

Special Areas

The change in water balance for the MSA and Warragamba Special Area was calculated from groundwater model results.

The proposed Mine Plan was developed by Tahmoor Coal following consultation risk assessment process and included consideration of predicted subsidence impacts on the MSA and associated built and natural features. Tahmoor Coal made a number of revisions to the original Mine Plan, including shortening Longwall 105 to 108 from the commencing ends so they do not encroach into the MSA and no longer proposing mining within the eastern domain. The proposed development is predicted to result in less than 0.05 ML per day (less than 18 ML per year) decline in baseflow in the MSA and this impact would peak around the year 2100. A large proportion of the MSA catchment flows out through Maldon Weir. Average daily flow at the weir is approximately 180 ML/d, so the predicted flow depletion is about 0.1% of mean daily flow.

Cumulative impacts on the MSA would primarily include the reduction of baseflow and evapotranspiration from shallow groundwater. Baseflow is predicted to decline by a maximum of 0.16 ML per day (60 ML per year) in around 2070-2100. The impact to baseflow would decrease over the period following the year 2100, although it would never fully recover. This is due to the cumulative impact of the proposed development adjacent the MSA and historical, current and proposed workings at Russell Vale, Cordeaux, and Dendrobium mines. Licensed and registered bores may also account for further cumulative effects on baseflow and reduced evapotranspiration.

For the Warragamba Special Area, impacts to baseflow are predicted to be less than 0.005 ML per day (less than 2 ML per year) and less than <0.001% of the mean flow for the area. Cumulative impacts, including from the existing Tahmoor Mine, on the Warragamba Special area are predicted to include a reduction in baseflow of 0.005 ML per day (2 ML per year), which peaked at 0.1 ML per day (35 ML per year) in the 1980-90s. The (un-modelled) effects of bore pumping are likely to be greater in this area than in the MSA, given the bore use to the northwest of Tahmoor Mine.

Given that predicted flow depletion is expected to be around 0.1% and <0.001% of mean daily flow for the MSA and the Warragamba Special Area respectively, impacts are considered to be very minor.

Drawdown

Over the life of the proposed development, mine inflows would total around 21 GL. In annual terms, the groundwater take averages around 1,700 ML per year over the period of longwall mining. Mine inflows would result in a consequent decline in groundwater levels or 'drawdown'.

Drawdown is predicted to be strongest in the mined coal seam (with a peak of 350 m drawdown) and becoming less pronounced in the overlying stratigraphy. Moving upward through the sequence, drawdown is predicted as follows: Bulgo Sandstone - more than 250 m drawdown, Hawkesbury Sandstone - approximately 25 m drawdown and upper Hawkesbury - within one m of natural levels.

The model suggests that in the proposed mining footprint most of the recovery would be complete about 150 years after the cessation of the proposed development. Within the Central Domain longwall areas, recovery of water levels in the deeper layers (e.g. Bulli Seam, Scarborough Sandstone) is predicted to be incomplete, with a drawdown of 10-20 m in the lower Bulgo Sandstone and 20-30 m in the Bulli Seam predicted in 2500. Residual drawdown in 2500 is predicted to be much less in the upper layers.

To the east and southwest of the proposed development, recovery is predicted to be quicker than to the north (100 years rather than 150 years) as these areas are up-gradient of Tahmoor South, rather than downgradient.

At some locations and in some units there is predicted to be final recovery to beyond the natural level. Final recovery beyond natural levels is predicted to occur in these layers due to subsidence and fracturing causing greater vertical and horizontal connectivity through the strata around and above the underground mine and connecting areas with naturally higher levels to those with lower levels, resulting in recovery to an 'average' level.

Groundwater Dependent Ecosystems

The numerical groundwater model was used to generate estimates of drawdown in shallow groundwater beneath high priority GDEs for the proposed development. Estimates of drawdown impacts on GDEs were then used to inform the predicted impacts on surface water features.

The connection between shallow groundwater (water table aquifers) and surface water features is governed by the permeability of the aquifer material and of any surficial sediments (lake bed materials) as well as any head separation between the water body and the underlying aquifer.

Also, there may be no predicted decline in groundwater levels at or beneath a feature. However, a decline in water levels further up-gradient may result in a loss of baseflow or stream flow to that feature. This could cause a decline in surface water levels in that feature without any perceptible decline in groundwater levels at that point.

The numerical model was used to assess the impacts from the proposed development on the water table elevation at or beneath various high priority GDEs. Cumulative impacts to GDEs were also assessed. A discussion of impacts to the Thirlmere Lakes (listed as a high priority GDE) is provided in **Section 11.5**.

Other potential impacts to GDEs are limited to North Pole Swamp which is the closest of the upland swamps, located 21 km south of the proposed development. Modelling identified that the North Pole Swamp would not experience drawdown or baseflow impacts as a result of the proposed development.

Bore Users

The *NSW Aquifer Interference Policy* sets the threshold for acceptable impacts of proposed developments on bore users at less than 2 m of drawdown. Bore users within the study area were identified from the 2013 bore survey commissioned by Tahmoor Coal (GeoTerra, 2013) and by reviewing NSW Government Groundwater Works/Pinneena database and Water Register. The numerical model was used to assess the impacts of the proposed development on the 791 bore users identified within the groundwater assessment Study Area.

The Groundwater Assessment predicts that a total of 30 registered bores and three unregistered bores would experience drawdown of greater than 2 m as a result of the proposed development (refer to **Table 11-18**). Of the 30 bores affected beyond 2 m, 14 are predicted to experience greater than 5 m maximum drawdown, and 4 to experience greater than 10 m.

Accounting for cumulative impacts of the existing operations at Tahmoor North and other mines within the groundwater model, the number of impacted bores with >2m drawdown would increase to 94 registered bores and eight unregistered bores.

Table 11-18 Registered bores where predicted impacts exceed the 2 m drawdown threshold

Degree of impact (m)	Number of bores exceeding threshold		
	Base case model		Sensitivity analysis (maximum drawdown)
	Proposed development	Cumulative	Additional bores affected
>2 m	30	94	+28
Total bores in model area	791		

Tahmoor Coal would manage potential bore impacts through the existing process to 'make good' on impacted users' water sources. Groundwater would be monitored during mining using manual and data logger based standing water level monitoring. Tahmoor Coal has been operating this process during the life of Tahmoor North. In addition, the process allows for bore owners to apply to Tahmoor Coal if they believe the level or water quality has declined in their groundwater bore. If it is deemed that the mine in responsible, then remedial actions could involve deepening and/or replacing bores and wells, and/or providing an alternative water source to affected users. Tahmoor Coal has committed to continue this 'make good' process through the operation of the proposed development (refer to **Section 11.3.5** for further information).

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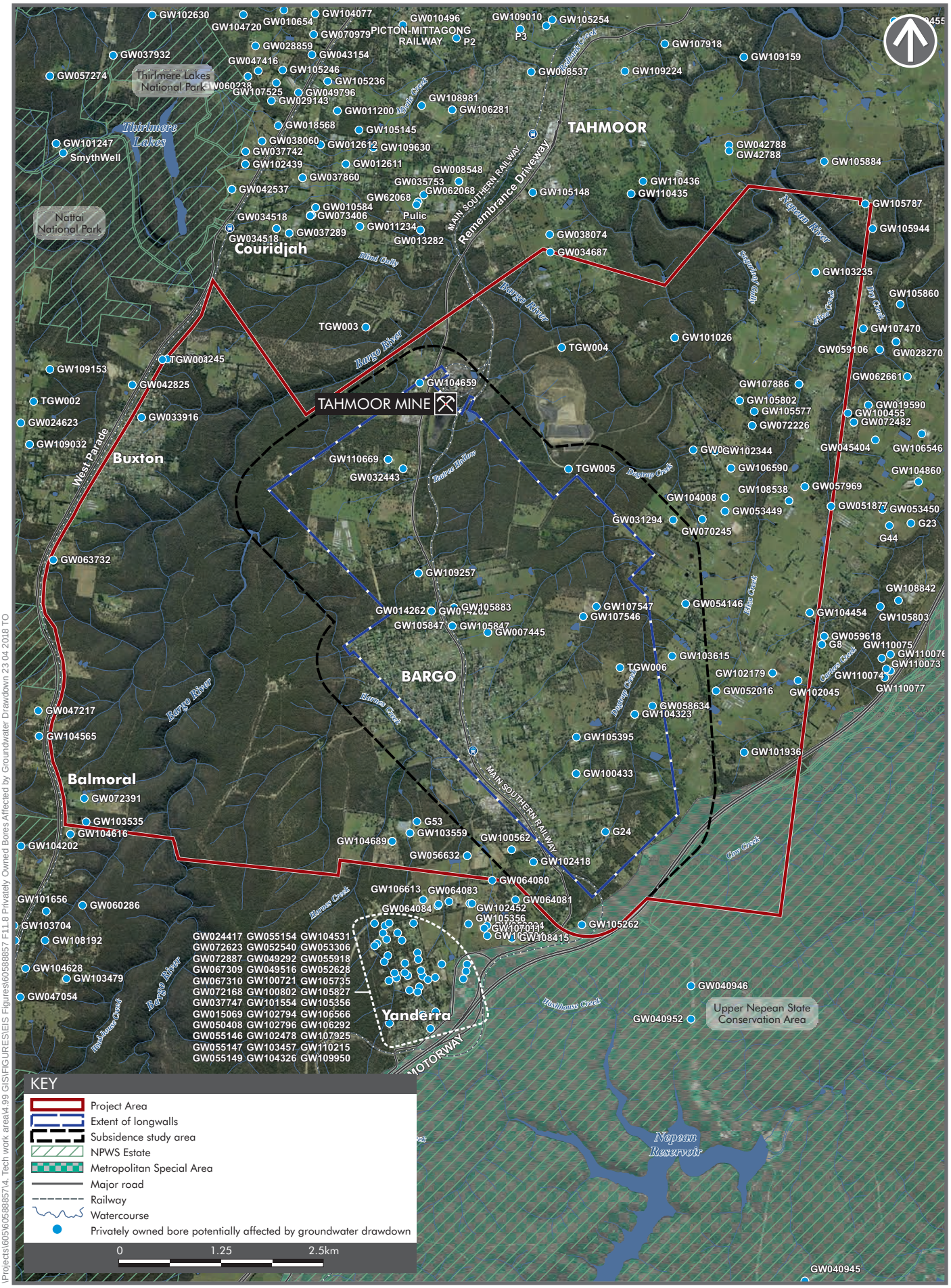

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SIMEC MINING

PRIVATELY OWNED BORES POTENTIALLY AFFECTED BY GROUNDWATER DRAWDOWN

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.12

Groundwater Quality

Mining-induced changes to the hydraulic properties and depressurisation of the strata in the mined area would result in mixing of potentially chemically different groundwater between overlying and underlying units. Initially, the strong head gradients would mean that water from shallower aquifers would likely be unaffected, while groundwater in the deeper units and coal seams would be mixed with water flowing laterally and vertically toward the mine void. During the recovery phase the head gradients into the mine void would slowly weaken, and movement and mixing of water from the deeper layers into shallower units may occur.

Electrical conductivity data for the groundwater in the Southern Coalfield indicates a general trend of increasing salinity with depth (with the Wianamatta Formation being one exception to this generalisation). As such, it is considered that mining-induced mixing of groundwater would result in changes to the salinity of the Hawkesbury Sandstone and Bulgo Sandstone, the two most commonly utilised aquifers. Changes are expected to be more likely in the Bulgo Sandstone, which is not as heavily utilised by bore users due to existing natural hydraulic gradients from the Illawarra Coal Measures into the lower Bulgo Sandstone. Any changes in salinity or specific nutrients (e.g. iron, manganese) are unlikely to alter or impact on the beneficial uses of groundwater in the Permo-Triassic rock aquifers in or around the mine lease. The risk of these impacts decreases with distance from the active mining area and enhanced rock mass deformation and fracturing. There are no anticipated risks of reduced beneficial uses of the Nepean Ground Water Management Area (GMA) porous rock aquifer as a result of the Tahmoor South mine.

As described above, Tahmoor Coal would 'make good' any impacts to the groundwater quality of groundwater bore users (refer to **Section 11.3.5** for further information).

Summary of Aquifer Interference Policy Assessment

The implications of the predicted impacts of the proposed development on groundwater are summarised in **Table 11-19** against the minimal impact considerations under the *NSW Aquifer Interference Policy*. Given the simulated potential cumulative impact on the water table at Thirlmere Lakes (refer to **Section 11.5**), as well as on existing groundwater users' bores within the Permian and Triassic strata, the proposed development is classified as Level 2 within the minimal impact considerations of the *NSW Aquifer Interference Policy*. A detailed discussion on the potential impacts to Thirlmere Lakes is provided in **Section 11.5**.

Mining Near/under Alluvial Water Sources

The proposed development would not take place beneath designated alluvial Water Source and would be three to four km away from the nearest mapped body of alluvium lying along the Thirlmere Lakes and Blue Gum Creek. No alluvial floodplains were identified in the Project Area as identified in **Appendix H**. Consequently, the *NSW Aquifer Interference Policy* requirements for mining activity beneath or near to alluvial water sources do not apply to the proposed development.

Table 11-19 Summary of Aquifer Interference Policy Assessment – Permo-Triassic Porous Rock (HydroSimulations, 2018)

Aquifer	**Sydney Basin Porous Rock (Nepean Groundwater Source, Management Zone 2)**
Category	**Highly productive**
Minimal Impact Consideration	**Assessment**
Water Table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40 m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan; or A maximum of a 2 m water table decline cumulatively at any water supply work.	There are three high-priority GDE in the groundwater assessment study area. Thirlmere Lakes: There is a risk of groundwater drawdown in the alluvium underlying the lakes of < 0.03m from the proposed development and a peak of 0.05m as a result of cumulative impacts. The cumulative impact groundwater drawdown is close to or above the 10% threshold criterion (refer **Section 11.5** for assessment of impacts on Thirlmere Lakes). Other listed GDEs: O'Hares Creek and Macquarie Rivulet are beyond the boundaries of the impact assessment model. There were no Culturally Significant Sites in the study area listed in the WSP. Hence there are no known risks of mine development to such sites. Probable risk of drawdown in excess of the water supply work drawdown criterion within the Permo-Triassic strata. **Level 2 minimal impact consideration classification**.
Water pressure A cumulative pressure head decline of not more than a 2 m decline, at any water supply work.	Probable risk of drawdown in excess of the criterion within the Permo-Triassic strata. **Level 2 minimal impact consideration classification.**
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity.	Mining-induced changes to the hydraulic properties and depressurisation of the strata in the mined area would result in mixing of potentially chemically different groundwater between overlying and underlying units. However, it is considered unlikely that this would result in changes to the beneficial uses of groundwater in the Permo- Triassic rock units. The risk of such impacts decreases with distance from the mine footprint. **Level 1 minimal impact consideration classification.**

11.3.5 Management and Mitigation Measures

The proposed development is classified as Level 2 within the minimal impact considerations of the *NSW Aquifer Interference Policy*. Consequently, the proposed development would require risk mitigation, prevention or avoidance strategies to be implemented so that groundwater impacts are managed and minimised. Tahmoor Coal would implement the following strategies in order to manage groundwater impacts:

- the existing Tahmoor Mine Groundwater Management Plan (GWMP) would be updated for the proposed development to define a groundwater monitoring strategy, groundwater level triggers, and include a TARP;

- the regional groundwater monitoring network would continue to be developed and maintained, including specific monitoring of Thirlmere Lakes (refer to **Section 11.5**) and to existing users' water supply. Monitoring sites would be reviewed and sites requiring repair, replacement or augmentation to improve confidence would be addressed in the next revision of the GWMP. This would include consideration of additional bores to sample groundwater quality from the mid/lower Hawkesbury Sandstone and Bulgo Sandstone within the project area and ongoing groundwater monitoring at the REA;
- additional reviews of groundwater monitoring data would be conducted on an annual basis in order to compare actual groundwater drawdown levels to those predicted by the numerical model;
- monitoring in longwall centre-lines of pre- and post-mining conditions would be conducted to assist in defining a profile of fracturing and depressurisation above longwalls;
- the volumetric take (total mine inflow) metering method, including improved monitoring of inflows to the drift and different areas within the underground mine, would continue to be employed. The data from this monitoring would be periodically used, in conjunction with the regional monitoring network data, to verify the numerical modelling and the potential risks of mining activity identified in this assessment. This would include revision of the modelling and identified risks as required; and
- Tahmoor Coal commits to the implementation of appropriate "make good" measures to mitigate and/or remediate impacts to bore users. This could involve deepening and/or replacing bores and wells, and/or providing an alternative water source to affected users. Prior to commencement of mining all water works identified as being potentially adversely affected in the Groundwater Assessment (HydroSimulations, 2018) and the Subsidence Impact Assessment (MSEC, 2018) would be surveyed for their existence, location, use, and construction details. Subsequent to this, remedial action can be planned and undertaken as required.

11.3.6 Conclusion

A numerical groundwater model was developed using information from a review of the data, literature and conceptual hydrogeology associated with current operations at Tahmoor, as well as other mines in the area, and other hydrogeological studies. The model was peer reviewed and was determined to be technically appropriate and consistent with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012).

The results of the numerical groundwater model indicate that the impacts of the proposed development on groundwater resources include inflows into the mine, drawdown, water quality and changes to stream baseflow.

Additional groundwater licence volumes would need to be secured to account for increased groundwater inflows as a result of the proposed development. Based on the most recent Report Card for the Sydney Basin Nepean Groundwater Source (NOW, 2011a), there was 37,303 ML per annum of Unassigned Water (equivalent to 102.2 ML/d). Therefore it is considered that there is available water to increase the entitlement held by Tahmoor Coal, and Tahmoor Coal would purchase additional groundwater allocations as required.

The groundwater modelling indicated that proposed development and cumulative modelling would result in reductions to baseflow within surrounding waterways, however that these reductions would comprise only a small proportion of total mean flow rates.

Potential impacts to Thirlmere Lakes are described in **Section 11.5**. Other GDEs in the region, such as O'Hares Creek and Macquarie Rivulet, are beyond the boundaries of the impact assessment model. The proposed development is unlikely to impact these features due to their distance from the proposed development.

The assessment determined that changes in groundwater salinity are unlikely to alter or impact on the beneficial uses of groundwater in the Permo-Triassic rock aquifers in or around the mine lease. There are no anticipated risks of reduced beneficial uses of the Nepean GMA porous rock aquifer as a result of the Tahmoor South mine. Tahmoor Coal would 'make good' any impacts to the groundwater quality of groundwater bore users.

It is predicted that a total of 30 registered bores and three unregistered bores would experience drawdown of greater than 2 m as a result of the proposed development. Tahmoor Coal would mitigate and manage potential impacts on these bore users through the implementation of appropriate ‘make good’ measures, as it currently does for operations at Tahmoor North.

Tahmoor Coal would continue to develop and maintain its established regional groundwater monitoring network to monitor potential drawdown risks to existing users’ bores and groundwater resources.

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11.4 Surface Water

Hydro Engineering & Consulting Pty Ltd (2018) has undertaken an assessment of surface water impacts for the proposed development. The surface water assessment comprises four components (provided in **Appendix J**):

- Surface Water Baseline Study;
- Water Management System and Site Water Balance Report;
- Flood Study; and
- Surface Water Impact Assessment.

The surface water assessment addressed the SEARs relevant to surface water impacts. These are listed in **Table 11-20**.

Table 11-20 SEARs for the assessment of water resource impacts

Water Resource SEARs	Section addressed
Water Resources – including:	
• an assessment of the likely impacts of the development on the quantity and quality of surface and groundwater resources, having regard to EPA's, DI Water's and WaterNSW's requirements and recommendation;	• Surface Water - **Section 11.4.4**, **Section 11.5.4** and **Appendix J** (Surface Water Impact Assessment – Sections 5, 7,8, 9, 10,12) • Groundwater - **Section 11.3.4**, **Section 11.5.4** and **Appendix I** (Sections 4-6)
• an assessment of the likely impacts of the development on aquifers, watercourses, swamps, riparian land, water supply infrastructure and systems and other water users;	• Surface Water - **Section 11.4.4**, **Section 11.5.4** and **Appendix J** (Surface Water Baseline Study, Surface Water Impact Assessment – Sections 5, 7,8, 9, 10,12) • Groundwater - **Section 11.3.4**, **Section 11.5.4** and **Appendix I** (Sections 3-6) • Surface water features are also described and assessed in **Sections 11.2** and **Appendix H** (Geomorphology) and **Section 11.7** and **Appendix K (**Aquatic Ecology).
• an assessment of any drinking water catchment losses from mining, and whether the development can be operated to achieve a neutral or beneficial effect on water quality in the Sydney Drinking Water Catchment, consistent with the provisions of *State Environmental Planning Policy (Sydney Drinking* • *Water Catchment) 2011*;	• Surface Water - **Section 11.4.4** and **Appendix J** (Surface Water Impact Assessment – Section 13)
• a detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply and transfer infrastructure and water storage structures;	• **Section 11.4.5** and **Appendix J** (Water Balance Report)
• a detailed description of the proposed water management system (including, sewerage), beneficial water re-use program and all other proposed, measures to mitigate surface water and groundwater impacts;	• **Section 11.4.5** and **Appendix J** (Water Balance Report, **Section 11.4.6** (Surface water mitigation measures) and **Section 11.3.5** (Groundwater mitigation measures)

Water Resource SEARs	Section addressed
• the proposed surface water and groundwater monitoring regime, which should include a comprehensive array of shallow and deep piezometers and extensometers across the underground mining area which are capable of detecting fluctuations in groundwater levels and the influence of fracture networks on regional groundwater resources; and	• **Appendix J** (Surface Water Baseline Study), **Appendix I** (Section 3.8), **Section 11.4.6** (Surface water mitigation measures) and **Section 11.3.5** (Groundwater mitigation measures)
• an assessment of the potential flooding impacts of the development.	• **Section 11.4.4** and **Appendix J** (Flood Study)
Water Resource Supplementary SEARs	
Water resource, in relation to coal seam gas development and large coal mining development	
• The EIS should provide a description of the location, extent and ecological characteristics and values of the identified water resource potentially affected by the project.	• Surface Water - **Section 11.4.4** and **Appendix J** (Surface Water Baseline Study, Surface Water Impact Assessment – Section 3) • Groundwater - **Section 11.3.4** and **Appendix I** (Sections 3) • Surface water features are also described and assessed in **Sections 11.2** and **Appendix H** (Geomorphology) and **Section 11.7** and **Appendix K (**Aquatic Ecology).
• The assessment of impacts should include information on:	
- Any substantial and measurable changes to the hydrological regime of the water resource, for example a substantial change to the volume, timing, duration or frequency of ground and surface water flows;	• Surface Water - **Section 11.4.4** and **Appendix J** (Surface Water Impact Assessment – Sections 5, 7,8, 9, 10,12) • Groundwater - **Section 11.3.4** and **Appendix I** (Sections 4-6)
- The habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the water resource being seriously affected; and	• **Sections 11.6** (Terrestrial Ecology) and **11.7** (Aquatic Ecology) and **Appendix K**
- Substantial and measurable change in the water quality and quantity of the water resource – for example a substantial change in the level of salinity, pollutants or nutrients in the wetland or water temperature that may adversely impact on biodiversity, ecological integrity, social amenity or human health.	• Surface Water - **Section 11.4.4** and **Appendix J** (Surface Water Impact Assessment – Sections 10) • Groundwater - **Section 11.3.4** and **Appendix I** (Sections 4-6) • Aquatic Ecology – **Section 11.7.4** and **Appendix K**
• The EIS must provide adequate information to allow the project to be reviewed by the Independent Expert Scientific Committee of Coal Seam Gas and Large Mining Development, as outlined in the Information Guideline for Independent Expert Scientific Committee advice of coal seam gas and large mining development proposals (IESC, October 2015).	• **Sections 1-4, 11.1**, **11.2**, **11.3**, **11.4**, **11.6** and **11.7** • **Appendix F**, I, **H**, **J**, **K** • The requirements of the IESC guideline have also been specifically assessed in **Appendix A.**

Water Resource SEARs	Section addressed
• The proponent should ensure that a comprehensive and scientifically rigorous water monitoring program and adaptive management program is put in place to ensure Thirlmere Lakes are not being impacted by the proposed action. The listed studies should be considered by the Proponent when assessing the impacts of the proposed action on ground water and surface water.	• **Appendix J** (Surface Water Impact Assessment – Sections 8, 11), **Appendix I** (Section 6-7), **Section 11.4.6** (Surface water mitigation measures), **Section 11.3.5** (Groundwater mitigation measures) and **Section 11.5** (Thirlmere Lakes). • The studies considered by the assessments are listed in the reference sections of each specialist report.

11.4.1 Background

The 2012 Southern Coalfields Inquiry placed particular focus on the potential for longwall mining to impact surface water systems. Key recommendations of the Southern Coalfields Inquiry relevant to the surface water assessment for the proposed development include:

- waterways classified under the Strahler stream classification as being 3rd order or higher are to be managed within an RMZ;
- a minimum of two years of baseline data, collected at appropriate frequency and scale should be provided for significant natural features; and
- an understanding and predicting impacts on valleys and their rivers and significant streams. Coal mining companies should focus on the prediction of valley closure in addition to local upsidence.

To satisfy these recommendations, the surface water assessment has relied upon data from:

- the Tahmoor South Surface Water Monitoring Program, which was undertaken between February 2012 and June 2015. The monitoring program was set up with the aim of providing at least two years of baseline data for all surface water sources within and adjacent to the proposed development;
- the Subsidence Impact Assessment undertaken for the proposed development (MSEC, 2018) (**Appendix F**) – the assessment predicted subsidence impacts to watercourses within the Project Area and has been used as a basis for the Surface Water Impact Assessment. The Subsidence Impact Assessment considered previous predictions and monitoring data in its assessment, as well as comparisons with impacts recorded at other collieries within the Southern Coalfields; and
- the Groundwater Assessment undertaken for the proposed development (HydroSimulations, 2018) (**Appendix I**). The assessment predicted impacts to groundwater resources as a result of the proposed development and has been used to assess potential impacts to surface water flows as a result of changes to groundwater baseflow.

11.4.2 Methodology

The methodology for the surface water assessment of the proposed development included four separate assessments as follows:

Surface Water Baseline Study

The Surface Water Baseline Study for watercourses in the Project Area included:

- review and assessment of rainfall data from mine site climate stations, local climate stations operated by the Bureau of Meteorology (BoM) and long term synthetic rainfall and evaporation records obtained from the SILO Data Drill[1] system for the Project Area;
- identifying and characterising watercourses within the Project Area identifying both baseline and impact sites;

[1] The SILO Data Drill is a system which provides synthetic data sets for a specified point by interpolation between surrounding point records held by the BoM. Refer https://www.longpaddock.qld.gov.au/silo/datadrill/

- monitoring of surface water at gauging stations shown in **Figure 11.13** (covering impact and baseline sites), including monitoring of:
  - flow of selected watercourses; and
  - water quality for comparison against the ANZECC guidelines.
- catchment modelling of surface water using the *Australian Water Balance Model* (Broughton, 2004) to simulate surface runoff and baseflow processes. The model was run for Bargo River (upstream), Dog Trap Creek (downstream) and Eliza Creek catchments. Streamflow characteristics for Cow Creek and Carter Creek catchments were estimated based on the modelling for Eliza Creek and Dog Trap Creek catchments, respectively, which were found to have closely similar hydrology. **Table 11-21** below summarises the location of these waterways in terms of impact or baseline sites.

The surface water monitoring program was designed to provide an adequate dataset to inform the baseline hydrological and water quality characteristics of watercourses in and around the Project Area. In order to provide an adequate dataset, the design of the monitoring program took into account the proposed extent of longwall mining when identifying suitable monitoring locations to ensure that:

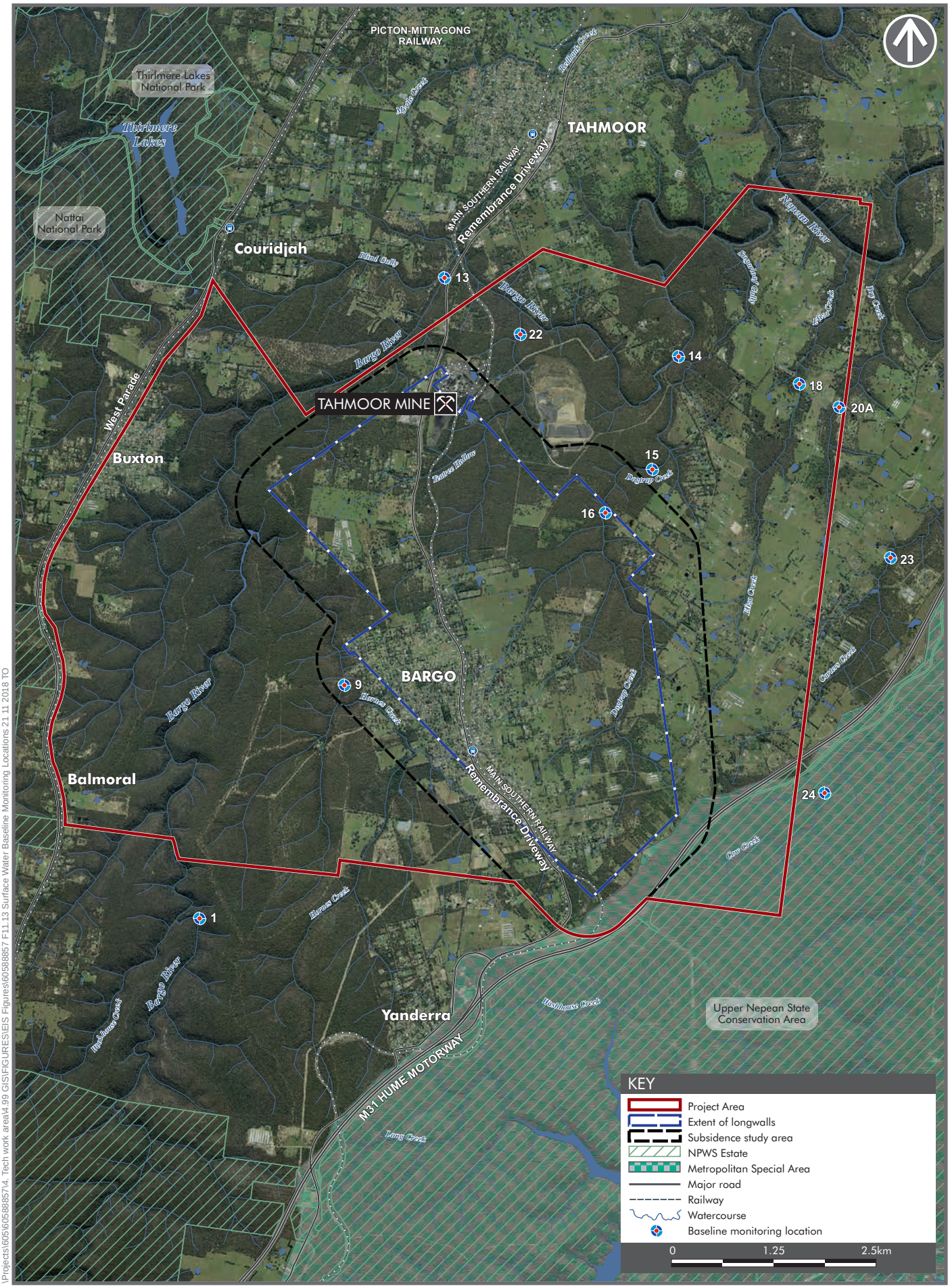
- monitoring locations are located upstream and downstream of areas likely to be impacted by subsidence;
- the locations selected include watercourses that would be undermined and some that would not be undermined so that potentially impacted sites and control sites could be established; and
- sensitive watercourses have been included in the monitoring program.

The Tahmoor South Surface Water Monitoring Program was undertaken between February 2012 and June 2015. The monitoring period has provided a robust dataset that accommodates seasonality and variations in precipitation. Surface water monitoring is also undertaken as part of existing operations at Tahmoor North.

The surface water monitoring locations are summarised in **Table 11-21** below and shown in **Figure 11.13**.

Table 11-21 Summary of surface water monitoring locations

Site ID on Figure 11.13	Site ID in Baseline Study (HEC, 2018)	Site Description	Category
1	SW-1 / 300061 Bargo River	Long pool with flat hydraulic control	Control site
9	SW-9 / 300062 Hornes Creek	Rock bar and pool	Control site
13	SW-13 / 300010A Bargo River Upstream Bargo	Rock bar and pool	Baseline/impact site
14	SW-14 / 300011A Bargo River Downstream Rockford Road Bridge	Rock bar and pool	Baseline/impact site
15	SW-15 / 300063 Dog Trap Creek Downstream	Long rock bar and pool	Baseline/impact site
16	SW-16 / 300064 Dog Trap Creek Upstream	Rock/mud bar and large pool	Baseline/impact site
18	SW-18 / 300073 Eliza Creek	Rock bar and pool	Baseline
20A	SW-20A / 300074 Dry Creek	Rock bar and large deep pool	Baseline
21	SW-21 / 300065 Nepean River at Maldon Weir	Pool behind weir	Baseline/impact site
22	SW-22 / 300056 Tea Tree Hollow	Rock bar	Baseline/impact site
23	SW-23 / 300076 Carters Creek	Rock bar	Baseline
24	SW-24 / 300075 Cow Creek	Rock bar	Baseline site



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SIMEC MINING

SURFACE WATER BASELINE MONITORING LOCATIONS

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.13

Water Management System and Site Water Balance Report

A water management and site water balance report was prepared for the Project which describes:

- the existing water management system;
- the proposed changes to the site water management system for the Project;
- the results of a water balance model simulation of the proposed water management system over the life of the Project including;
  - water supply efficiency and site water reuse;
  - controlled releases and storage overflows; and
  - stored water volume in underground water storage.
- the adequacy of the current discharge licence to Tea Tree Hollow to manage the release of water as per the EPL; and
- the risk of overflows under a wide range of climatic conditions.

Flooding Assessment

A flood study was conducted to assess the likelihood and scale of flooding as a result of the proposed development. This assessment involved:

- hydrological modelling using the RORB modelling software to simulate flood hydrographs for the Project Area;
- hydraulic modelling using the 2D hydrodynamic model Tuflow^{4TM} to estimate affected areas;
- hydrologic and hydraulic modelling to predict flood levels for flood events up to the Probable Maximum Flood (PMF) level in areas affected by mine subsidence before and after mining. The effects of subsidence on flooding within the Project Area has been assessed during 50%, 10%, 1% (1:100), 0.5% (1:200), 0.2% (1:500) Annual Exceedance Probability (AEP) flood events and a Probable Maximum Flood (PMF) event; and
- identifying where flooding risks would change as a result of subsidence, and an assessment of the likely effects of subsidence on surface stormwater management infrastructure in the urban areas of the Bargo township.

Surface Water Impact Assessment

The surface water baseline monitoring data, subsidence predictions undertaken by MSEC (**Appendix F**) and the groundwater assessment undertaken by HydroSimulations (**Appendix I**), were used to assess the extent to which the proposed development could impact on surface water catchments and watercourses within the Project Area. The assessment investigated potential impacts to flow rate, changes to the hydraulic characteristics and associated impacts to the physical stability of the watercourses, and impacts to the water quality characteristics of watercourses.

Thirlmere Lakes

A discussion of the assessment of potential surface water impacts to the Thirlmere Lakes is provided separately in **Section 11.5**.

11.4.3 Existing Environment

Regional Catchments and Watercourses

The existing Tahmoor Mine and the Project Area are located within the Bargo River catchment. From its headwaters near the townships of Hill Top and Yerrinbool, the Bargo River flows in a generally north-easterly direction through incised valleys and gorges to its confluence with the Nepean River, near the Pheasants Nest Weir. The lower 4 km of the river pass through the Bargo River Gorge, which is characterised by steep rock faces up to 110 m high. The river consists of a sequence of pools, glides and rock bars across sandstone bedrock, with occasional boulder fields and cobblestone riffles. The Bargo River drains a total catchment of some 130 square kilometres (km^2) at its confluence with the Nepean River, which has a catchment area of approximately 710 km^2 at this point.

The Bargo River has intermittent flow in its upstream reaches. In its upper reaches flows are, to some degree, regulated by the Picton Weir which is located approximately 14 km upstream of the Nepean River confluence. Downstream of the Tahmoor Mine pit top (i.e. downstream of the Tea Tree Hollow confluence) flow is perennial due to persistent licensed discharges from Tahmoor Mine. The Bargo River flows into the Nepean River 9 km downstream of the Tea Tree Hollow confluence.

The Nepean River rises in the Great Dividing Range to the west of the Project Area. Its headwaters also lie in the coastal ranges to the east of the Project Area. Flows in the upper reaches of the Nepean River are highly regulated by the Upper Nepean Water Supply Scheme, operated by WaterNSW, which incorporates four major water supply dams on the Cataract, Cordeaux, Avon and Nepean Rivers. The Nepean Dam is situated some 18 km upstream of the Bargo River confluence, while the Pheasant's Nest Weir is located approximately 7 km upstream of the confluence. Flows in the Nepean River near and downstream of the Project Area (downstream of the Peasant's Nest Weir) are not part of a WaterNSW Drinking Water Catchment Area.

The Nepean River flows into the Warragamba River near Wallacia, downstream of which it is referred to as the Hawkesbury-Nepean River. The Hawkesbury- Nepean catchment is one of the largest coastal catchments in NSW with an area of some 21,400 km^2 at its mouth in Broken Bay on the northern side of the Sydney Metropolitan area.

The Project Area is also within and adjacent to the Sydney Drinking Water Catchment, with major drinking water catchments in the areas to the east, surrounding Lake Nepean, Lake Avon, Lake Cordeaux and Lake Cataract located within the MSA. Notably, the Project Area is downstream of these areas, mostly within the Bargo catchment and contributing to the Nepean Catchments downstream of the MSA. Importantly, no longwall panels, nor surface infrastructure, are proposed in the MSA. The proposed development has been specifically designed to avoid extending longwall panels into the MSA as described in **Section 5.3.7** and **Section 6.2.4**.

Water Sharing Plan

DIP – Water implements water regulation according to the *Water Management Act 2000*. A primary objective is the sustainable management and use of water resources, balancing environmental, social and economic considerations. Water Sharing Plans (WSPs) have been developed for much of the State and these establish rules for sharing and trading water between the environment town water supplies, basic landholder rights and commercial uses. The Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011 (the WSP) is the relevant plan for surface waters for the proposed development.

The proposed development would involve continued use of water for coal processing within the existing facilities at Tahmoor, and for the control of dust emissions from the REA. The water used in these operations is sourced from the underground operations and from water captured within the existing site water management system – principally at the coal handling and REA areas. Some water is also supplied under agreement with Sydney Water. None of these activities involve extraction of water or water sharing from sources covered by the WSP.

Project Area Catchments and Watercourses

The watercourses and catchment within and adjacent to the Project Area are described by HEC 2018, as follows:

- the Project Area is predominantly drained by Tea Tree Hollow and Dog Trap Creek which flow generally north and eastward toward the Bargo River;
- a small area on the south western side of the proposed longwall panels is drained by headwater tributaries of Hornes Creek which flows into the Bargo River at Picton Weir;
- the eastern portion of the Project Area is predominantly drained by Eliza Creek which flows generally northward to the Nepean River;
- a small part of the eastern portion of the Project Area is also drained by Carters Creek which flows north-eastward to the Nepean River; and
- Cow Creek, which is within the MSA, lies to the east of the Project Area and is a tributary of the Nepean River upstream of Pheasant's Nest Weir.

A summary of watercourses within the Project Area is provided in **Table 11-22** and are shown in **Figure 11.6**. As part of the baseline monitoring program for the proposed development, surface water monitoring locations were established at a number of stream locations both upstream of the proposed development (control sites) and at locations that would be directly undermined by the proposed development as shown on **Figure 11.13** and described in **Table 11-21**.

Table 11-22 Watercourses within the project Area

Watercourse	Strahler Stream Order	Description in relation to proposed longwalls
Nepean River	7th order	River is not located within the SSA.
Bargo River	5th order	River would not be directly mined beneath and is located 975m from the nearest longwall (LW102). Only a 165 metres long length of the Bargo River that is immediately upstream from the Picton Weir is located inside the SSA. This length of the river that is within the SSA is a 4th order perennial stream.
Hornes Creek	4th Order	Not directly mined beneath and located 360 metres south-west of proposed LW108.
Carters Creek	3rd order	Creek is not located within the SSA.
Cow Creek	3rd order	Creek is not located within the SSA.
Dry Creek	3rd order	Creek is not located within the SSA.
Dog Trap Creek	3rd Order	Located directly above proposed LW101 to LW109, with a total length of 3.1 kilometres directly mined beneath.
Tea Tree Hollow	3rd order	Located directly above proposed LW101 to LW105, with a total length of 1.9 kilometres directly mined beneath.
Tributary to Tea Tree Hollow	3rd Order	Located directly above the proposed LW101 to LW106, with a total length of 2.4 kilometres directly mined beneath
Eliza Creek	2nd order	Creek is not located within the SSA.
Sugarloaf Gully	2nd order	Creek is not located within the SSA.
Tributary 1 to Dog Trap Creek	2nd order	Located directly above the proposed LW101 to LW107, with a total length of 2.6 kilometres directly mined beneath
Tributary 2 to Dog Trap Creek	2nd order	Located directly above the proposed LW101 to LW107, with a total length of 2.4 kilometres directly mined beneath

Catchment modelling of surface water based on baseline data was undertaken to simulate surface runoff and baseflow processes which are discussed below. A description of the fluvial geomorphology for each stream is contained within **Appendix H**, and was relied upon for the modelling and assessment.

Analysis of rainfall data found that on average, annual rainfall is highest (940 mm/annum) in the south eastern part of the Project Area and reduces further north and west to about 850 mm/annum near the existing surface facilities and 790 mm in Thirlmere. The average annual rainfall yield (percent of average annual catchment rainfall) was consistent for most streams (between 11 and 18%) in the Project Area. However, flow volumes and velocities were variable based on stream geomorphology. The results of surface water catchment modelling are summarised below.

Within the SSA

- Bargo River (upstream) is a consistently high flow stream (23.9 ML per day);
- Dog Trap Creek is a stream with moderate flow (4.95 ML per day), and flow is highly variable. Flow velocity is high due to the relatively steep bed gradient (max velocity 3.3m/s). However, lower velocities occur in the upper reaches of the creek where the channel is flatter; and
- Tea Tree Hollow is a stream with consistently moderate flow (6.3 ML per day) due to the release of water in accordance with EPL 1389 from Tahmoor Mine. In the absence of mine discharge via LDP1, Tea Tree Hollow would consist of an ephemeral creek environment, flowing only after rainfall. Flow velocity is high due to the relatively steep bed gradient (maximum velocity of 3.5m/s). However, lower velocities occur in the upper reaches of the creek where the channel is flatter.

Outside of the SSA

- Carters Creek is a stream with very low flow (0.44 ML per day), and flow is highly variable. Flow velocities are generally low in the upper reaches and increase downstream with steeper bed gradient (maximum velocity of 2.1m/s);
- Cow Creek is a stream with consistently low flow (1.19 ML per day). Flow velocity is generally high due to the steep confined channel geometry (max velocity 4 m/s); and
- Eliza Creek is a stream with consistently low flow (0.95 ML per day). Flow velocities are generally low in the upper reaches (less than 0.5m/s) and increase downstream (max velocity 2.5m/s).

Increased shear bed stress is usually associated with higher relative velocities and therefore for most watercourses occurs in the upper reaches of streams.

Water quality parameters were monitored at each of the monitoring locations identified in **Table 11-21**. The monitoring locations are broadly representative of three categories:

- sites undermined/affected by existing Tahmoor Mine operations and likely to be impacted by Tahmoor South:
  - SW-13 – Bargo River upstream of Tea Tree Hollow,
  - SW-14 – Bargo River Rockford Bridge downstream of Tea Tree Hollow,
  - SW-15 – Dog Trap Creek downstream, and
  - SW-22 – Tea Tree Hollow.
- sites not undermined/affected by existing Tahmoor Mine operations and likely to be affected by Tahmoor South Project:
  - SW-16 – Dog Trap Creek upstream
  - SW-21 – Nepean River Maldon Weir,
- sites unlikely to be impacted (control or baseline sites):
  - SW-1 – Bargo River upper reaches,
  - SW-9 – Hornes Creek,
  - SW-18 – Eliza Creek,
  - SW-20A – Dry Creek,
  - SW-23 – Carters Creek, and
  - SW-24 – Cow Creek.

Exceedances of ANZECC (2000) guideline values for aquatic ecosystems and recreational users were recorded at the various monitoring sites as summarised in **Table 11-23**.

The results of the water quality monitoring indicate that:

- all monitored watercourses recorded samples with elevated levels of aluminium, zinc, cadmium and iron and of pH outside of the water quality range. Observations of water quality data over the monitoring period indicated variability of water quality in watercourses that span the majority of the Project Area (HEC, 2018);
- the two sites downstream of the Tahmoor Mine licensed discharge point LDP 1 (SW-22 Tea Tree Hollow and SW-14 Bargo River Rockford Bridge) displayed similar water quality profiles including elevated levels of bicarbonate, sodium and barium which was not identified at other locations; and
- with the exception of the two locations directly downstream of licensed discharge point LDP 1, the water quality at creeks affected by subsidence from Tahmoor Mine (SW-13, SW-15) remained broadly similar to the water quality of un-impacted creeks including baseline/ reference sites upstream, both in terms of the range and incidence of exceedances of water quality parameters. This indicates that in terms of mining processes, discharge water from LDP1 is a key controlling factor of water quality for the affected streams.

Table 11-23 Number of recorded exceedances of ANZECC 2000 guidelines at water quality monitoring locations

Monitoring Location	pH		Aluminium (milligrams per litre (mg/L))		Zinc (mg/L)		Copper (mg/L)		Cadmium (mg/L)		Iron (mg/L)		Selenium (mg/L)		Lead (mg/L)		Arsenic (mg/L)	
	ANZECC[1]	ANZECC[2]	ANZECC[1]	ANZECC[2]	ANZECC[1]	ANZECC[2]	ANZECC[1]	ANZECC[2]	ANZECC[1]	ANZECC[2]	ANZECC[1]	ANZECC[2]	ANZECC[1]	ANZECC[2]	ANZECC[1]	ANZECC[2]	ANZECC[1]	ANZECC[2]
Sites undermined/affected by existing Tahmoor Mine operations and likely to be impacted by Tahmoor South																		
SW-13 Bargo River (upstream of SW-22)[a]	11		23	14	35	-	5	-	6	6	-	15	-	-	1	-	1	1
SW-14 Bargo River Rockford Bridge (down-stream of SW-22)[b]	31	-	32	13	35	-	14	-	6	6	-	8	21	21	4	-	20	13
SW-15 Dog Trap Creek downstream[c]	2	-	25	23	22	-	6	-	1	1	-	7	-	-	-	-	-	-
SW-22 Tea Tree Hollow[b,c]	28	-	23	6	26	-	20	-	7	7	-	1	26	26	8	-	26	23
Sites not undermined/affected by existing Tahmoor Mine operations but likely to be affected by Tahmoor South Project operations																		
SW-16 Dog Trap Creek upstream[c]	5	-	34	32	31	-	9	-	3	3	-	9	-	-	-	-	-	-
SW21 Nepean River Maldon Weir[c]	10	-	23	11	30	-	8	-	6	5	-	4	1	1	4	-	1	-
Sites unlikely to be impacted (control or reference sites)																		
SW-1 Bargo River upper reaches	13	-	15	5	14	-	-	-	7	6	-	27	1	1	-	-	-	-
SW-9 Hornes Creek[c]	16		30	17	37	-	8	-	5	4	-	16	4	4	-	-	-	-
SW-18 Eliza Creek[c]	14	-	13	12	34	-	17	-	7	7	-	29	10	10	4	-	-	-
SW-20A Dry Creek[c]	9	-	27	18	27	-	9	-	2	2	-	4	-	-	2	-	-	-
SW-23 Carters Creek[c]	5	-	29	19	29	-	9	-	1	1	-	3	-	-	-	-	-	-
SW-24 Cow Creek	10	-	29	19	20	-	3	-	2	2	-	3	-	-	-	-	-	-

ANZECC[1] – ANZECC Aquatic Ecosystems Guideline Value
ANZECC[2]– ANZECC Recreational User Guideline Value
[a]SW-13 also recorded single exceedances of ANZECC[2] values for barium (mg/L) and mercury (mg/L)
[b] SW-22 and SW-14 also recorded exceedances of ANZECC[2] values for bicarbonate alkalinity ($CaCO_3$ mg/L), sodium (mg/L) and barium (mg/L). SW-22 further recorded exceedances of ANZECC[1] values for electrical conductivity (micro siemens per centimetre (µS/cm))
[c] These monitoring locations also recorded exceedances of ANZECC[1] and/ or ANZECC[2] values for Turbidity (NTU)

Existing Tahmoor Mine

A summary of the existing water management system at Tahmoor Mine, including an overview of the existing surface water demand, water discharge, surface water infrastructure and water storage structures, is provided in **Section 3.3.6**. Existing approvals held by Tahmoor Coal under the *Water Management Act 2000* are discussed in **Section 8.0** and the existing discharges and water management for the Tahmoor Mine are outlined in the water balance presented in **Section 11.4.5**.

Surface water discharge from the Tahmoor Mine is licenced under Environmental Protection Licence (EPL) 1389, which limits discharge volumes at LDP1 to 15.5 ML per day and places the following 100th Percentile concentration limits for discharge water quality:

- pH: 6.5-9.0
- Electrical conductivity (EC) (µS/cm): 2600
- Arsenic (microgram per litre (µg/L)): 200
- Nickel (µg/L): 200
- Zinc (µg/L): 300
- Turbidity (NTU): 150
- Total Suspended Solids (mg/L): 30
- Oil and grease (mg/L): 10

A series of PRPs aimed at managing water quality have been implemented at Tahmoor Mine since 2005. **Table 11-24** below provides a summary of current and completed PRPs relevant to managing water quality at the existing Tahmoor Mine.

Surface water discharge from licensed discharge point (LDP1) is monitored monthly for the water quality criteria listed under EPL 1398. Tahmoor has demonstrated a significant reduction in historical non-compliances with EPL water conditions, with the performance improvement attributed to the implementation of the water management PRPs outlined in **Table 11-24**. Surface water monitoring in 2017 indicated that existing surface water discharges at Tahmoor Mine are compliant with the volumetric discharge limit and discharge water quality criteria for LDP1 under EPL 1389.

Table 11-24 PRPs relevant to managing water quality at the existing Tahmoor Mine

PRP No.	Year completed	Description
5	2005	These two PRPs investigated: • Improving the quality of mine water discharged into the Bargo River catchment; • Increasing the re-use of mine water and minimising the use of potable water in mine operations; and • Reducing pollutant loads discharged from the site.
7		
10	2006	Implementation of a pilot scale water treatment plant to test the effectiveness in meeting the water quality goals for discharges from LPD1.
11	2006	To implement improvements to surface water management resulting from investigations made in PRP 7, and subsequent additional investigations into improving discharge water quality at LOPs 3, 4 and 5.
15	2011	Construction of the Stormwater Improvement Project.
20	2012	Construction of the Water Recycling Plant.
21	2013	Consolidation of Mine discharges into LDP1.

PRP No.	Year completed	Description
22	Ongoing	Development and commissioning of a water treatment plant to reduce the concentrations of arsenic, nickel and zinc in mine water released from LDP1. The WWTP was constructed in June 2015 to treat up to 6 ML/d of mine water to achieve the following metal concentration limits: • Arsenic: 0.013 mg/L • Nickel: 0.011 mg/L • Zinc: 0.008 mg/L The WWTP was constructed at Tahmoor Underground Mine in June 2015 as part of PRP22 to improve the quality of water discharged from LDP1. Following modifications, detailed commissioning of the WWTP occurred during September to November 2018. PRP22 on EPL 1389 for the WWTP has been extended until November 2018.
23	2016	Research and investigation program in Tea Tree Hollow and the Bargo River to define site specific trigger values for electrical conductivity at LDP1. This investigation was completed and did not recommend any changes to existing discharge licence limits to EC/ salinity and is further discussed in **Section 11.7.4** (Aquatic Ecology).
26	Ongoing	An aquatic health assessment in Tea Tree Hollow and the Bargo River within nine months following WWTP recommissioning to determine any changes to aquatic health (refer **Section 11.7.5**).

11.4.4 Impact Assessment

Subsidence Predictions

Subsidence predictions for watercourses within the SSA were determined by MSEC (2018) and are provided in **Table 11-25**.

Table 11-25 Maximum Predicted Total Subsidence, Upsidence and Closure for Watercourses within the Subsidence Study Area

Watercourse	Maximum Predicted Subsidence (mm)	Maximum Predicted Upsidence (mm)	Maximum Predicted Closure (mm)
Bargo River	<20	<20	<20
Dog Trap Creek	1850*	550*	425*
Hornes Creek	50	30	50
Tea Tree Hollow	1400*	400*	275*
Tributary 1 to Dog Trap Creek	1850	750	725
Tributary 2 to Dog Trap Creek	1800	525	450
Tributary to Tea Tree Hollow	1700	475	400

* Note: downstream sections of Dog Trap Creek and Tea Tree Hollow have been previously mined beneath by LW12 and LW13 and by LW1 and LW2, respectively, at Tahmoor Mine. The maximum predicted parameters provided in the above table include those resulting from the extraction of these earlier longwalls.

Watercourses that lie directly over the longwalls (Dog Trap Creek and Tea Tree Hollow) are predicted to experience a greater range of subsidence impacts. Impacts to stream bed grade are likely to occur as a result of tilt and curvature. MSEC (2018) predicted that changes in stream bed grade would be typically less than one percent of the existing grade. The predicted maximum increase in stream bed grade is 1.2 %, which is considered relatively small compared to the natural gradients.

Based on the previous experience at Tahmoor Mine, it is likely that fracturing and surface flow diversions would occur in the sandstone bedrock along the streams, particularly for streams that are located directly above the proposed longwalls (MSEC, 2018). Potential impacts to watercourses are further discussed below.

Impacts to Watercourses

Overview

Potential impacts to surface waters are likely to occur as a result of mining induced subsidence from the proposed development and surface water discharges from the expansion and operation of the REA and the Surface Facilities Area. These include:

- impacts to flow rate or the quantity of flow, which can occur as a result of flow diversion or loss;
- changes to the hydraulic characteristics and associated impacts to the physical stability of the watercourses, which can occur as a result of shear stress and changes to the stream bed; and
- impacts to the water quality characteristics of watercourses, which can occur as a result of changes to or increasing in scour, mine discharge and/or gas release.

The impacts are discussed further below. These potential impacts may also have indirect implications for hydrological and other values such as landscape, heritage or ecological values (such as riparian land). These matters have been addressed in other sections of this EIS (Refer **Sections 11.6** to **Section 11.9**). Measures to manage potential impacts to watercourses caused by subsidence are outlined in **Section 11.1.7**.

Impacts to Flow

Impacts to flow in watercourses have the potential to occur due to:

- reduced flows due to reduction in catchment size;
- loss of flow to subsidence induced fracturing;
- loss of flow to baseflow reduction;
- reduced flows due to trapping runoff in subsidence depressions; and
- increased flows due to controlled discharges and overflows from the water management system.

The potential for each of these to occur as a result of the proposed development are discussed below.

Reduced flow is likely to occur in areas immediately impacted by the expansion of the REA. This is as a result of reduction of the catchment in this location, in particular sections of the Tea Tree Hollow and Bargo River catchments. In contrast, increased flow is likely to be experienced for Tea Tree Hollow and Bargo River immediately downstream of the REA, as a result of increases in controlled discharge via LDP1 (although within the current discharge limits of the licence). This would offset the reductions to catchment area associated with the REA expansion from the proposed development.

Localised reduced flow is likely to be experienced by watercourses due to subsidence induced fracturing. Cracking is likely to occur along stream beds and there is potential for some diversion of surface water and drainage of pools at some locations. Considering the predicted subsidence and upsidence for watercourses, it is considered that Tea Tree Hollow and Dog Trap Creek are at greatest risk of impacts resulting in losses of surface water to groundwater and localised diversion of surface water, including reduced water holding capacity of pools, decreased frequency of overflow and loss of interconnection between pools. Based on MSEC (2018) observations relating to valley closure impacts on rock-bar controlled pools in watercourses, the surface water impact assessment identified a number of pools that would be at risk of flow holding capacity impacts, as follows:

- two of the approximately 14 mapped pools in Tea Tree Hollow were identified to be at moderate risk; and
- 14 of the over 70 mapped pools in Dog Trap Creek were identified to be at moderate to high risk.

Baseflow reduction is the process of inducing leakage from a creek or river into the aquifer via a downward gradient or weakening an upward gradient from the aquifer into the watercourse and reducing the rate at which baseflow occurs.

HydroSimulations (2018) have made predictions of baseflow reductions for local and regional streams including Bargo River, Tea Tree Hollow and Dog Trap Creek. The maximum predicted reduction in flow at each watercourse is relatively small in terms of mean daily flow (0.4-5.3%) but represents a significant percentage of the average estimated baseflow at Dog Trap Creek (52.5%) and a small to moderate percentage at the Bargo River (4.2%) and Tea Tree Hollow (3.1%). The reduction in flow in Tea Tree Hollow (downstream) would be offset by on-going licensed discharge from LDP1. It is expected that reduction in baseflow would be most noticeable during periods of low flow which would normally be dominated by baseflow. The surface water impact assessment identified the following potential effects to low flows as a result of baseflow reductions:

- Bargo River – the probability that flow would be greater than 0.1 ML/day would reduce from 99% to 97% of days, which is considered imperceptible compared to natural variability and therefore negligible;
- Dog Trap Creek – the probability that flow would be greater than 0.1 ML/day would reduce from 87% to 45% of days, which is considered to be distinguishable from natural variability and therefore significant; and
- Tea Tree Hollow – downstream impacts would be offset by discharge from LDP1 and therefore negligible. However, upstream impacts are likely to be similar to Dog Trap Creek given the similarity of catchments and therefore detectable and significant during periods of low flow.

Therefore, perceptible impacts to flow are only predicted to occur in Dog Trap Creek and upstream of LDP1 in Tea Tree Hollow. It is unlikely that there would be any net loss of water from the catchment overall since any redirected flow is unlikely to intercept any flow path that would allow the water to be diverted into deeper strata.

Pool water and low flow levels at Tea Tree Hollow and Dog Trap Creek would be monitored prior to and during mining to confirm any mining related impacts and formulate appropriate remediation where required (refer **Section 11.4.6**). Measures to remediate subsidence impacted watercourses are outlined **Section 11.1.7**.

Impacts to Watercourse Hydraulics and Stability

Modelled scenarios for impacts to flow velocity and shear bed stress are presented in **Appendix J**. The findings identified that for all watercourses peak flow velocities decrease in some areas and increase in others. Generally watercourses demonstrated no significant changes to pattern or distribution in shear bed stresses. However, localised increases in bed shear stress were identified in isolated sections of Dog Trap Creek and Tea Tree Hollow. Changes to flow velocity and bed shear stress have the potential to cause localised increased erosion, depending on the specific nature of the bed materials. Suggested management and mitigation measures are provided in **Section 11.4.6**.

The potential for increased scouring in streams as a result of the proposed development would not be significant, as the maximum increase in bed grade would be 1.2% (MSEC, 2018) which is relatively small compared to natural gradients. Localised changes in ponding are anticipated to be minor, also due to the minimal changes to stream bed grade predicted (up to a maximum of 1.2%).

Stream stability can be indirectly impacted by loss of vegetation resulting from subsidence induced fracturing and changes to groundwater drainage. However, previous experience at Tahmoor Mine and the Southern Coalfields has not reported such impacts to date with no significant changes to riparian vegetation observed along waterways within areas subjected to subsidence. It is considered that riparian vegetation associated with streams overlying the Project Area is unlikely to be sensitive to minor changes in drainage patterns. Refer **Sections 11.6 and 11.7** for further assessment of riparian and aquatic ecology impacts.

Impacts to Water Quality

Potential impacts to water quality can occur as a result of:

- discharge or spill of contaminants from mine infrastructure, including the pit top, to watercourses;
- liberation of contaminants from subsidence induced fracturing in watercourses;
- changes to chemical composition of surface flows due to increased or decreased groundwater baseflow contribution to watercourses; and
- drainage and expression of strata gas through surface water.

The results of predictive modelling of the proposed water management system over the remaining mine life indicate that total discharges from the pit top of the combined existing Tahmoor operation and the Project are unlikely to increase above current LDP1 volume limits. It is therefore expected that the Project would not result in additional water quality impacts due to releases and overflows from the site water management system compared to the existing situation. The upgraded WWTP would control heavy metal concentrations from LDP1 for the proposed development and would continue to meet licensed water quality limits.

Accidental spills could also occur which could result in transient impacts to water quality. The risk of accidental spills is not likely to increase as a result of the Project and would be managed as part of the site EMS, as it is now.

Subsidence fracturing of bed rock is predicted to occur and upsidence related buckling of stream beds is predicted along some sections of creeks. Based on past experience in the Southern Coalfields, including experience at the existing Tahmoor operation, it is expected that upsidence induced fracturing may lead to releases of aluminium, iron, manganese and zinc (HEC, 2018). It is likely that there may be transient, localised spikes in metal concentrations at Tea Tree Hollow, Dog Trap Creek and downstream watercourses, while subsidence is active. The extent of these impacts is expected to be similar to impacts observed in similar streams in the Southern Coalfields (refer to **Appendix J** for further information).

Measures to manage potential subsidence fracturing are outlined in **Section 11.4.6** and **Section 11.1.7** including measures to actively fill fractures in the subsurface fracture network with introduced material to accelerate the natural remediation process.

While there have been some occurrences of gas release within the Southern Coalfields, studies have shown that gas flows do not impact water quality due to the low solubility of methane and the short residence time in the water column. However, there have been rare instances reported of vegetation die back which could impact stream stability. This is unlikely to occur for the proposed development and is further assessed in **Section 11.6**.

Neutral or Beneficial Effects (NorBE)

Under the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* all development in the Sydney drinking water catchment is required to demonstrate a NorBE on water quality. The Project would involve mining adjacent to but not beneath the MSA. Longwall panels for the Project have been specifically reduced in length so that they do not extend into the MSA. Cow Creek is located within the MSA and was included in the impact assessment; however this watercourse would not be impacted by the Project and is located outside of the project SSA. Therefore the Project would not trigger NorBE requirements.

Cow Creek, which is located within the MSA is located approximately one km from the nearest Project longwall. At this distance, the maximum predicted subsidence upsidence and closure are less than 20 mm and the potential for localised impacts on Cow Creek, such as fracturing and surface water flow diversion, are at extremely low levels.

It is therefore highly unlikely that there would be any identifiable water quality impacts to flow in Cow Creek as longwall mining is sufficiently remote from the creek, meaning that the potential for fracturing is extremely low. In the unlikely event that fracturing was to occur, it would not result in a detectable change to water quality in Cow Creek. This is consistent with the definition of a neutral effect on water quality (“no identifiable potential impact”) in accordance with guidelines published by NSW Water (2015) for assessing compliance with NorBE criteria of a development on water quality.

Cumulative Impacts

There has been significant past development in both the immediate and downstream catchment areas of the Project Area, including widespread agricultural and urban development. Cumulative effects of this previous development are inherently incorporated into the baseline monitoring results of surface water resources for the Tahmoor South Project.

HydroSimulations (2018) has assessed cumulative impacts to baseflow capture due to the combined effects of the proposed development and the effects of other existing mining operations, primarily Tahmoor North.

In general, the predicted maximum cumulative baseflow capture rates are similar to the maximum baseflow capture rates due to the Project alone. The largest predicted increases in baseflow capture rates are at Dog Trap Creek and the Bargo River.

At Dog Trap Creek, the probability of flows being greater than 0.01 ML/day would reduce from 87% to 45% of days as a result of baseflow reductions from the project alone and down to 43% of days as a result of cumulative baseflow reductions. The negligible additional impact under the cumulative scenario indicates that the Tahmoor South Project (proposed to directly undermine up to 3.1 km of Dog Trap Creek) would have the most influence on this watercourse in contrast to the existing operations (Tahmoor North) where the longwalls extend to the north and west further away from this creek.

At Bargo River, the probability of flows being greater than 0.01 ML/day would reduce from 99% to 97% of days as a result of base flow reductions from the project alone and down to 90% of days as a result of cumulative base flow reductions. The lesser influence of the Tahmoor South Project in comparison to the cumulative scenario is reflective of the Tahmoor South workings progressing away from the Bargo River. The existing operations impose a stronger influence (although still relatively small) on the Bargo River due to its closer proximity. It is noted that this level of change would not be detectable during normal periods of low flow and would likely be indistinguishable from natural variability in catchment conditions.

Flooding

Flooding of Catchments

The flood study (**Appendix J**) identified that the upper reaches of catchments are more likely to be susceptible to flood inundation due to the flatter terrain and low capacity drainage channels in these areas. The effect of culverts and other constructed constrictions in the more urbanised upland areas also have the potential to increase the extent of flooding in these areas. Flooding in the lower reaches is confined by steep, incised channel geometry (HEC, 2018).

The flood study modelled peak flood inundation under pre-subsidence and post-subsidence conditions to determine if the proposed development is likely to increase flooding. The results are shown in **Appendix J** and summarised in **Table 11-26** below. Localised increases of inundation during flood events are predicted for Tea Tree Hollow (upstream) at Remembrance Driveway near Caloola Road which is near an urbanised area in the Bargo township. Drainage enhancement works, including provision of additional drainage culverts or pipes are proposed under Remembrance Drive, to reduce the impacts associated with the predicted increased flood inundation at this location.

Negligible changes to flooding are predicted at other locations. Notably, changes to peak flood inundation were considered to be minor or negligible for these catchments.

Table 11- 26 Predicted Effects of Subsidence on increasing flood inundation

Watercourse		1% AEP Flood Event	50% AEP Flood Event
Dog Trap Creek	Upstream (Southern)	Increases to inundation confined to small areas on the edges of the floodplains overlying longwalls 106 and 107. Flood inundation increases are close to the resolution of the model i.e. +/- 3m.	Impacts would be less than the larger 1% AEP event and inundation increases confined to the same areas as the 1% AEP event.
	Downstream (Northern)	No detectable increase in inundation and no new areas inundated. Flooding contained within the main channel.	No detectable increase in inundation and no new areas inundated. Flooding contained within the main channel.
Tea Tree Hollow	Upstream (Southern)	The effects of subsidence would increase areas subject to flood inundation on the western side of Remembrance Driveway, with the largest increase in the area overlying longwall 103. Drainage enhancement works, including provision of additional drainage culverts or pipes under Remembrance Driveway, are proposed to reduce the impacts associated with the predicted increased flood inundation at this location.	The predicted effects of subsidence on increasing flood inundation are minor and at the limit of the model resolution.
	Downstream (Northern)	No detectable increase in inundation. Flooding contained within the main channel.	No detectable increase in inundation. Flooding contained within the main channel.

Localised Flooding in Bargo

Consideration of the potential for subsidence to increase local flooding in Bargo focused on the location of overland flow paths in the township. This was based on identifying where overland flow paths intersect the gate roads between longwall panels, which would form relatively elevated areas in the post subsidence topography (for example areas over remaining pillars which would not subside relative to areas directly over the goaf) and potentially increase local flooding. Overland flow path locations identified in the flood study are presented in **Appendix J** and the outcomes of the flood assessment are summarised in **Table 11-27**.

The results show that flooding is unlikely to be increased in the Bargo Township as a result of the proposed development, with the exception of minor localised flooding at Dymond Road and Wattle Street. This flooding extent would not impact surrounding residential developments. Given the minor nature of predicted flood impacts the project would have no impact on existing flood emergency management procedures (such as evacuation and emergency services procedures and notifications).

Table 11-27 Potentially affected overland flow paths in Bargo Township

Location	Predicted flood risk
Overland Flow Path 1 – Wellers Road	The average slope of overland flow path in the area is predicted to reduce from about 2.8% to 2.2% due to predicted subsidence. This slope change would result in about a 10% increase in normal flow depth, equivalent to the effect of natural vegetation changes (such as the length of grass) on flow depth. Predicted change in slope represents minor change in gradient and flow depth and is unlikely to pose a significant risk of increased flooding outside the immediate timbered area.
Overland Flow Path 2 – Hambridge Road	The average slope of overland flow path in the area is predicted to reduce from about 5.6 to 5.4% due to predicted subsidence. This slope change would result in about a 2% increase in normal flow depth, which is considered to be negligible. Due to the small upslope catchment size the risk of significant overland flow and flooding is minor. Predicted change in slope would result in negligible changes to flow depth.
Overland Flow Path 3 – Remembrance Driveway	The average slope of overland flow path in the area is predicted to reduce from about 8.9 to 8.8% due to predicted subsidence. This slope change would result in about a 2.3% increase in normal flow depth, which is considered to be negligible. Due to the small upslope catchment size, the risk of significant overland flow and flooding is low. Predicted change in slope would result in negligible changes to flow depth.
Overland Flow Path 4 – Hawthorne Road	The average slope of overland flow path in the area is predicted to reduce from about 3.3% to 3.1% due to predicted subsidence. This slope change would result in about a 3.6% increase in normal flow depth, which is minor and less than the effect of natural vegetation changes on flow depth. Predicted change in slope represents a relatively small change in gradient and flow depth and is unlikely to pose a significant risk of increased flooding outside the immediate open area.
Overland Flow Path 5 - Bargo Road	The average slope of overland flow path in the area is predicted to reduce from about 3.2 to 3% due to predicted subsidence. This slope change would result in about a 4% increase in normal flow depth, which is minor and less than the effect of natural vegetation changes on flow depth. Due to the small upslope catchment size, the risk of significant overland flow and flooding is low. Predicted change in slope represents a relatively small change in gradient and flow depth and is unlikely to pose a significant risk of increased flooding outside the immediate open area.
Overland Flow Path 6 – Wellers Road and Hogans Drive	The average slope of overland flow path in the area is predicted to reduce from about 2.6 to 2.2% due to predicted subsidence. This slope change would result in about a 7.4% increase in normal flow depth, which is small and less than the effect of natural vegetation changes on flow depth. Predicted change in slope represents a relatively minor change in gradient and flow depth and is unlikely to pose a significant risk of increased flooding outside the immediate treed area.
Overland Flow Path 7 - Hogans Drive	The average slope of overland flow path in the area is predicted to reduce from about 4.8 to 4.3% due to predicted subsidence. This slope change would result in about a 5% increase in normal flow depth, which is small. Predicted change in slope represents a relatively minor change in gradient and flow depth and given the extensive open area and relatively elevated level of the surrounding area, the changes are considered unlikely to pose a significant risk of increased flooding outside the immediate open area.

Location	Predicted flood risk
Overland Flow Path 8 - Great Southern Road	The average slope of overland flow path in the area is predicted to reduce from about 4.4 to 3.9% due to predicted subsidence. This slope change would result in about a 5.5% increase in normal flow depth, which is small. The predicted change in slope is minor and is unlikely to pose a significant risk of increased flooding outside the immediate area.
Overland Flow Path 9 – Hawthorne Road	The average slope of overland flow path in the area is predicted to reduce from about 3 to 2.5% due to predicted subsidence. This slope change would result in about an 8% increase in normal flow depth, which is comparable to the effect of natural vegetation changes on flow depth. Predicted change in slope represents a relatively small change in gradient and flow depth and is unlikely to pose a significant risk of increased flooding outside the immediate open area.
Overland Flow Path 10 – Dymond Road and Wattle Street	The average slope of overland flow path in the area is predicted to reduce from about 1.6 to 1% due to predicted subsidence. Predicted change in slope would result in an approximate 19% increase in normal flow depth. As a result minor localised flooding may occur in the immediate open area. However, it is unlikely to increase flooding within the surrounding developed areas.
Overland Flow Path 11 – Dymond Road	The average slope of overland flow path in the area is predicted to reduce from about 2.5 to 2.1% due to predicted subsidence. This slope change would result in about a 7.8% increase in normal flow depth, which is small. Predicted change in slope represents a relatively minor change in gradient and flow depth and is unlikely to pose a significant risk of increased flooding outside the immediate area.

11.4.5 Water Balance

Existing Water Management System

The existing water management system for Tahmoor Mine involves management of the following site components:

- Surface Facilities Area;
- ventilation shaft sites;
- REA; and
- underground mine workings.

The existing management water system is shown in **Figure 3.4**, **Figure 3.5** and **Figure 3.6.**

Discharge Points

There is one licensed discharge point for controlled releases (LDP1). The REA has three sedimentation ponds which overflow at three licensed overflow discharge points (LOP 3, 4 and 5) from the existing Tahmoor Mine as shown on **Figure 3.4**, **Figure 3.5** and **Figure 3.6**. All discharge points release water into Tea Tree Hollow.

Proposed Water Management System

Tahmoor Coal has an existing water management system which effectively manages water in accordance with the EPL. This system would continue to be used with minor modifications as described below to allow for the proposed development:

- development and expansion of the stormwater drainage management and runoff control for the planned staged expansion of the REA, including:
  - the construction and commissioning of Dam S11 and S12 at the start of the Project. Water from dams S11 and S12 would be pumped (via open drains) to dam S9. Any overflow from dam S11 would flow into the Bargo River and any overflow from Dam S12 would flow into Tea Tree Hollow; and

  - the decommissioning of Dam S7, S7a, S7b, S8 and S10 which would either be covered with rejects within the expanded REA or left to overflow passively to Tea Tree Hollow.

- upgrading of existing water supply and water reticulation infrastructure to handle increased coal throughput and coal handling facilities;
- changes to underground mine water supply and mine dewatering reticulation needed to service the Tahmoor South operations;
- development of an underground storage within goafed areas of the Tahmoor North underground, in order to store water pumped from sediment dam M3 at times when inflow to dam M3 is in excess of the WWTP capacity. At times of lower inflow, water could be recovered from the underground storage, treated within the WWTP and released via LDP1. The underground storage would be formed within the void space of the mined longwall panels up to and including LW30. A storage capacity of 4,751 ML has been estimated within this area. Water would be pumped into and out of the storage via the existing drift and no new surface infrastructure is envisaged outside the pit top area; and
- upgrade of the sewage treatment plant at the pit top to treat sewage on site for additional proposed bathhouses.

A schematic of the proposed water management system is provided in **Figure 11.14**.

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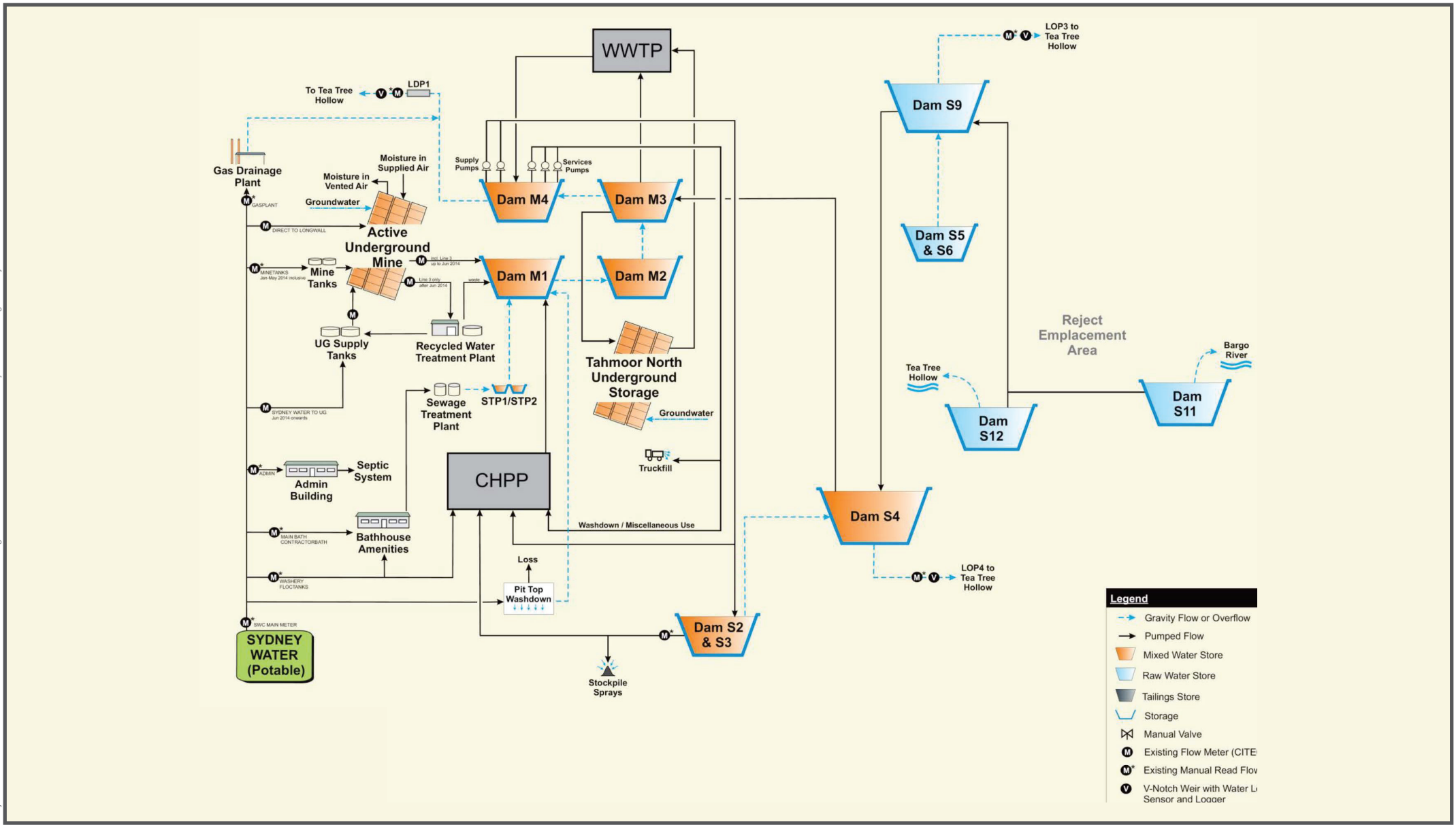

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SIMEC MINING

SCHEMATIC OF PROJECT WATER MANAGEMENT SYSTEM

Tahmoor South Project
Environmental Impact Statement

Source: Hydro Engineering & Consulting (2018)

FIGURE 11.14

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Site Water Balance

Inputs and Outputs

The major inputs and outputs of water into the site water cycle are detailed in **Table 11-28**.

Table 11-28 Simulated average water balance (over project life) (HEC, 2018)

Source	ML per annum	% of Total flow
Inflows		
Runoff	373	14
Sydney Water Supply (for use in CHPP flocculation, CHPP make-up water, pit top washdown, surface amenities, gas drainage plan, underground mine use)	485	18
Groundwater inflow to underground mine	1,693	63
Ventilation moisture (in)	136	5
Total inflows	2,687	100
Outflows		
Evaporation	56	2
Discharge via LDP1	2,135	82
Discharge via LOPs	58	2
CHPP make-up water supply	76	3
Haul road dust suppression	11	<1
Stockpile sprays (dust suppression)	26	1
Pit top washdown water	14	1
Ventilation moisture (out)	224	9
Totals outflows	2,600	100

Performance

In assessing performance of water management on site, consideration was given to the following:

- the average water balance which provides an overall (i.e. high level) understanding of the magnitude of different components of the water balance;
- water supply efficiency - the capacity of the water management system to satisfy the various water demands from recycling and reuse of water on site; and
- capacity to contain water on site and capacity to manage off-site releases within conditions of the EPL.

The objective of water supply management at Tahmoor Mine is to minimise the reliance on Sydney Water for supply and enable greater re-use.

Existing operations incorporate water efficiency measures to minimise water import requirements from Sydney Water and these measures would continue to be applied to the proposed development. The CHPP is a major water user at the mine; however a significant proportion of the water used is internally recycled via the use of a tailings belt filter press. Make-up water requirements for the CHPP are met by recycled water from dam M4 (in the first instance) with a small additional raw water demand for pump glands, flocculation and reagent dosing supplied by Sydney Water.

Water from dam M4 is also used for dust suppression on the haul road to the REA and on the REA itself. Water for dust suppression on the product coal stockpile area is drawn from dams S2/S3.

The underground mining operation currently uses water for non-potable uses (dust suppression on the coal face, drilling, wash down and other miscellaneous) and potable use (in the longwall machine), which is supplied by Sydney Water. A Recycled Water Treatment Plant was constructed in 2012 to treat a proportion of the water recovered from the underground mine and to recycle it back underground for non-potable uses.

The water balance model concluded that a high level of water supply efficiency would be maintained for the proposed development by on site recycling with 55% of water demand for underground operations met by water recycled from the mine. A portion of water recovered from underground mining operations would continue to be treated in the Recycled Water Treatment Plant at the surface to be reused for non-potable underground mining purposes. The remainder of recovered mine water would be pumped to dam M1 as per existing practices. However, ongoing supply from Sydney Water would still be required to meet water supply requirements, which would account for approximately 18% of system inflows over the life of the proposed development.

While efforts are made to contain water on site, the water balance identified the on-going need for controlled releases of treated water to Tea Tree Hollow via LDP1 of around 2,200 ML per annum over the life of the Project. Simulated releases were all compliant with EPL daily volumetric release limits. Other offsite releases included overflows from sediment dams predicted by the model, including:

- overflow releases to Tea Tree Hollow (LPD1) via the LOPs are predicted to occur during higher rainfall climatic conditions. The maximum annual simulated overflow from all Tea Tree Hollow overflow points was 325 ML; and
- small overflows from dam S11 to the Bargo River during higher rainfall climatic conditions. The maximum simulated annual overflow was 116ML per annum.

The 6 ML/day capacity WWTP (refer to **Section 3.3.6**), in combination with the proposed 4,751 ML capacity underground water storage, would be adequate to ensure continued treatment of water discharged via LDP1 at least until 2031. Thereafter a WWTP capacity upgrade of between 1.5 to 3 ML/day is likely be required, depending on actual conditions experienced. The WWTP can be scaled to process up to 9 ML/day if required.

11.4.6 Management and Mitigation Measures

The following mitigations and management measures would be implemented for the various stages of the proposed development.

Risk Management Zones

Refer to **Section 11.2.5** for discussion regarding RMZs.

Baseline Monitoring

The existing network of streamflow monitoring (gauging stations) and water quality monitoring sites would be maintained. In addition:

- an additional gauging station would be installed on Tea Tree Hollow at a suitable location downstream of the predicted subsidence impact zone and upstream of the LDP 1. The station would be established at least 2 years prior to commencement of longwall mining in the central domain; and
- the gauging station at Dog Trap Creek (downstream) (SW-15) would be incorporated with enhanced low flow control weirs in order to reliably record low flows. In addition a new gauging station (which would also include a low flow weir) would be established upstream of LDP1 at Tea Tree Hollow.

A continuous pool water level monitoring network would be established. The network would be established prior to commencement of longwall mining at Tahmoor South and include the following sites:

- Dog Trap Creek; and
- Tea Tree Hollow.

Flood Remediation Measures

The flood assessment concluded that an upgrade of the capacity of the Remembrance Driveway culvert crossing of Tea Tree Hollow near Caloola Road would be required. Details of this would be included in the Extraction Plan for the proposed development. Tahmoor Mine has previously successfully upgraded culvert and flood drainage infrastructure around road and rail infrastructure.

Operational Monitoring

Prior to the commencement of longwall mining in each domain, an adaptive monitoring and management plan would be developed as part of the Extraction Plan and in consultation with the relevant authorities and infrastructure owners. The following surface water elements would be incorporated into the plan:

- action response triggers for water quality exceedances based on recommended approaches in ANZECC (2000) and in particular schemes which incorporate both baseline and control monitoring data;
- action response trigger for unexpected flow loss based on analysis of baseline (i.e. pre-subsidence) streamflow data, post-subsidence streamflow data and contemporaneous data from control sites. Catchment flow modelling would also be used in the analysis;
- action response trigger for unexpected loss of pool water holding capacity based on analysis of baseline (i.e. pre-subsidence) pool water level data, post-subsidence pool water level data and contemporaneous data from control pool sites. Pool water balance modelling would also be used in the analysis particularly during unusual climatic/hydrological conditions;
- periodic inspections, photographic reconnaissance and field based water quality monitoring in watercourse(s) when longwall mining is within 200 m of any watercourse, at sites upstream and downstream of the potentially affected area. Water quality samples would be collected and analysed monthly and if weekly field monitoring results indicate a change from background (e.g. exceedance of 80th percentile value). Results of monitoring would be analysed in relation to action response triggers on a monthly basis when longwall mining is within 200 m of a watercourse; and
- a monitoring program to monitor the erosional stability and nature of bed and banks in the areas identified by HEC, 2018 as likely to experience significant increase in bed shear. In the event of scour /instability which exceeds that observed at control sites, develop and implement a restoration plan specific to the location and the bed and bank material.

Site Water Management

The Water Management System and Site Water Balance Report indicated that the proposed water management system would have capacity to contain water on site and capacity to manage off-site releases within conditions of the EPL 1389 until at least 2031.

The performance of the water management system would be assessed by comparing the monitored water balance with water balance model predictions. Revision to the water management plan would be undertaken if the performance review indicates the water management system has, or is likely to be, unable to meet its regulatory performance requirements. The water management plan revision would document the measures to be implemented and their effectiveness in meeting regulatory requirements.

In order to maintain treatment of water to be discharged via LDP1, it is anticipated that the capacity of the WWTP would need to be upgraded at some stage after 2031. The WWTP would be upgraded as required to meet mine water treatment demand post 2031 to ensure that licence discharge limits at LDP1 are met.

PRP 22 - Mine Water Treatment Plant – upgrade of the waste water treatment plant to reduce the concentrations of arsenic, nickel and zinc in mine water released from LDP1. PRP 22 is scheduled to be completed during November 2018.

Post Mining Monitoring

Monitoring of streamflow, pool water levels and water quality would continue in accordance with the Extraction Plan following cessation of longwall subsidence related movement in a watercourse or following completion of any stream/pool remediation. Monitoring data would be reviewed at annual intervals over this period. Reviews would involve assessment against long term performance objectives which would be based on the pre-mine baseline conditions or an approved departure from these.

Contingency Measures

Potential contingency measures in the event of unforeseen impacts or impacts in excess of those predicted would include:

- the conduct of additional monitoring (e.g. increase in monitoring frequency or additional sampling) to inform the proposed contingency measures;
- the implementation of stream remediation measures to reduce the extent and effect of subsidence fracturing;
- the implementation of revegetation measures to remediate impacts of vegetation loss due to subsidence;
- the provision of a suitable offset(s) to compensate for the reduction in the quantity of water resources/flow; and/or
- the implementation of adaptive management measures – e.g. reducing the thickness of the coal seam extracted, narrowing of the longwall panels and/or increasing the setback of the longwalls from the affected area.

11.4.7 Conclusion

The surface water assessment considered baseline monitoring data to inform the identification and assessment of potential impacts.

Subsidence predictions identified that watercourses that lie directly over the longwalls are exposed to a greater range of subsidence impacts than those that do not directly overly the longwalls. The maximum predicted reduction in baseflow due to subsidence for watercourses represents a significant percentage (52.5%) of the average estimated baseflow at Dog Trap Creek and a small to moderate percentage at the Bargo River (4.2%) and Tea Tree Hollow (3.1%). It is expected that reduction in baseflow would be most noticeable during periods of low flow which would normally be dominated by baseflow.

Management measures would include further monitoring during mining, remediation measures and post-mining monitoring programs. TARPs would be prepared for the proposed development, focusing on water quality exceedances, unexpected flow loss, and unexpected loss of pool water holding capacity. Over the past 13 years, PRPs have been effectively implemented by Tahmoor Coal to manage potential water quality impacts (refer to **Table 11-24**).

The assessment of flooding identified that minor localised increases of flooding are predicted at Tea Tree Hollow (upstream). Flood inundation upstream of the Remembrance Driveway culvert crossing of Tea Tree Hollow near Caloola Road could impact an urbanised area of Bargo Township, however the flood study has identified that subsidence related inundation increases would be minor at this location (compared to existing) and can be mitigated through improvements to culvert capacity. Flooding is unlikely to be increased in the Bargo Township as a result of changes to overland flow paths from the proposed development (refer **Appendix J**).

The water balance for the Project identified that a high level of water supply efficiency is provided by on site recycling. However, ongoing supply from Sydney Water is still required to meet water supply requirements. Controlled releases of treated water to Tea Tree Hollow via LDP1 would continue to be required for the proposed development.

11.5 Thirlmere Lakes

11.5.1 Background

The Thirlmere Lakes are located to the west of the existing Tahmoor Mine, in the upper reaches of Blue Gum Creek, which ultimately flows to Lake Burragorang (Warragamba Dam) – Sydney's main water supply storage. The Thirlmere Lakes lie within the Thirlmere Lakes National Park which is part of the Greater Blue Mountains World Heritage Area.

The Lakes are a series of five interconnected lakes including (in order of upstream to downstream):

- Lake Gandangarra;
- Lake Werri Berri;
- Lake Couridjah;
- Lake Baraba; and
- Lake Nerrigorang.

The Thirlmere Lakes are approximately 3.5 km from the proposed development at its nearest proposed longwalls. Given previous community concern about potential impacts to the Thirlmere Lakes as a result of nearby mining operations (see **Section 5.3**), a separate impact assessment of Thirlmere Lakes is provided in this chapter for the proposed development.

Thirlmere Lakes Inquiry

As described in **Section 5.3**, the Thirlmere Lakes Inquiry was undertaken in 2011 in response to community concern about water level decline in the Thirlmere Lakes.

The inquiry found that variations in climate such as droughts and floods were the primary influence on water level changes in Thirlmere Lakes; however identified that other factors may be involved in the present low levels. The Inquiry found evidence of groundwater leakages from the Lakes towards the east and north-east within the Hawkesbury Sandstone Aquifers and towards the west and down Blue Gum Creek. The Inquiry did not find any direct evidence of longwall mining impacting on lake water levels or breaching geologic containment structures underneath the lakes.

Consideration of Thirlmere Lakes During the Design of the Proposed Development

As described in **Section 5.3.7**, groundwater beneath Thirlmere Lakes was identified as a significant natural feature within the Project Area. Consideration of significant natural features informed the development of RMZ for the development of the proposed mine plan for the Project. The proposed development would involve longwall mining to the south east of the Bargo River and therefore away from the Thirlmere Lakes (located to the west of the Bargo River and 3-4 km away). The Thirlmere Lakes would not be undermined by the proposed development and are located outside of the development area, and well outside the area anticipated to experience mine subsidence as a result of the proposed development (the 20mm subsidence contour which remains to the east of the Bargo River).

Modifications undertaken to the mine plan to avoid or minimise impacts to other significant or sensitive items and natural features is outlined in **Section 6.2.4**.

11.5.2 Methodology

Potential impacts to the Thirlmere Lakes have been assessed throughout the technical assessments prepared for the proposed development including the:

- Groundwater Assessment prepared by HydroSimulations (2018) (**Appendix I**);
- Surface Water Baseline Study and Surface Water Impact Assessment prepared Hydro Engineering & Consulting Pty Ltd (2018) (**Appendix J**);
- Terrestrial Ecology Assessment prepared by Niche Environment and Heritage Pty Ltd (2018) (**Appendix K**); and
- Aquatic Ecology Assessment prepared by Niche Environment and Heritage Pty Ltd (2018) (**Appendix K**).

The methodology for the assessment of potential impacts to the Thirlmere Lakes is described below.

Groundwater and Surface Water

A groundwater assessment study area was established to encompass the geological and hydrological features that might be important to the proposed development and to the groundwater model built for the purpose of impact assessment. The assessment area included the Thirlmere Lakes.

Baseline monitoring of groundwater resources was undertaken in the vicinity of the proposed development to inform the groundwater model and to establish trigger response values for the ongoing monitoring and management of these resources during mining. Baseline monitoring included four DI Water monitoring bores at Thirlmere Lakes that monitor the shallow Hawkesbury Sandstone and/or alluvium.

Groundwater modelling was undertaken using MODFLOW-USG which allows finer grid scale to focus on sensitive areas such as the Thirlmere lakes. Refer to **Section 11.3.2** for further information regarding the groundwater model and methodology for the groundwater assessment.

A water balance model of the Thirlmere Lakes was developed in order to simulate the potential impacts of the Project on the behaviour of the Thirlmere Lakes as part of the Surface Water Impact Assessment (**Appendix J**). Surface water baseline monitoring data, subsidence predictions (**Appendix F**) and the outcomes of the Groundwater Assessment (**Appendix I**) were used in the Surface Water Impact Assessment to assess the extent to which the proposed development may impact on surface water catchments and watercourses, including the Thirlmere Lakes. The assessment included an investigation into whether impacts to lake water levels could occur as a result of the project.

Terrestrial and Aquatic Ecology

The Terrestrial Ecology Assessment and Aquatic Ecology Assessment considered the findings of the Groundwater Assessment and Surface Water Impact Assessment to predict the potential for impacts to terrestrial and aquatic ecology at the Thirlmere Lakes. The Thirlmere Lakes are located outside of the Project Area and would not be subject to surface disturbance and therefore detailed assessment of potential impacts to terrestrial ecology at the Thirlmere Lakes was not required.

11.5.3 Existing Environment

As described in **Section 11.5.1**, the Thirlmere Lakes are a series of five interconnected lakes located to the west of the existing Tahmoor Mine, in the upper reaches of Blue Gum Creek. The Thirlmere Lakes lie within the Thirlmere Lakes National Park which is part of the Greater Blue Mountains World Heritage Area.

The catchment of the Thirlmere Lakes is estimated at approximately five km^2 with the largest portion of the catchment comprised of Lake Gandangarra (39%). The total catchment area of the lakes is relatively small and therefore the volume of water in the lakes varies significantly with climate.

The surface geology within the catchment of Thirlmere Lakes is dominated by areas of Hawkesbury Sandstone which outcrop on the valley sides and ridges. There is significant topographic relief within the catchment of the Thirlmere Lakes. Surface elevations vary from approximately 350 m Australian Height Datum (AHD) to approximately 300 m AHD.

Catchment ground cover primarily comprises undisturbed eucalypt woodlands with some cleared land located along the eastern and north-western boundaries. The lakes generally comprise dense fringing vegetation around their perimeter around water level with sedges and grasses within the inundation area.

A significant depth (around up to 50 m) of alluvium has accumulated below the Thirlmere Lakes. Groundwater within this alluvium forms a perched system above the deeper water table within the bedrock. Alluvial groundwater is connected to the ponded water within the Lakes. Surface water – groundwater interactions within the Lakes and alluvial systems are an important component of the water balance of the Thirlmere Lakes. Perched groundwater within the alluvium recharges the deeper bedrock water table and the Thirlmere Lakes are therefore considered a naturally ‘losing’ system (whereby water outputs from evaporation/evapotranspiration and leakage to groundwater are greater than inputs from rainfall).

The water balance model determined that the most significant outflow component from the Thirlmere Lakes is evaporation/evapotranspiration, comprising approximately two-thirds of outflows. Groundwater recharge by contrast comprises approximately a quarter of outflows. The Project would only affect the groundwater recharge component.

The Thirlmere Lakes are listed as a High Priority GDE in the Water Sharing Plan (WSP) for the Metropolitan Groundwater Sources 2011, and specifically for the Sydney Basin – Nepean Groundwater Source. The dependence of the Thirlmere Lakes on groundwater has been investigated as part of the Thirlmere Lakes Inquiry and the Groundwater Assessment for the proposed development.

As part of the Thirlmere Lakes Inquiry, the following conclusions were made in Heritage Computing (2012b):

- the Thirlmere Lakes appear to act as a naturally 'losing' system under both dry and wet conditions;
- rainfall trend analysis shows that the district has been experiencing drought conditions dating from 1992 of a severity similar to the 1935-1949 depression/war drought;
- temperature trend analysis shows an unprecedented change in behaviour since 2000 with coincident steady rises in both maximum and minimum [rainfall] residual masses.

As described above and in the Groundwater Assessment, leakage from streams to shallow aquifers is considered to be a significant groundwater recharge mechanism for the Thirlmere Lakes, which acts as a naturally 'losing' system. It is therefore considered that there is limited dependence on groundwater for the water levels and associated ecosystems of the Thirlmere Lakes.

11.5.4 Impact Assessment

Groundwater and Surface Water

The numerical groundwater model was used to generate estimates of drawdown in shallow groundwater beneath the Thirlmere Lakes for the proposed development. Estimates of drawdown impacts were then used to inform the predicted impacts on surface water features.

The groundwater drawdown estimates, as opposed to reductions in surface water level, expected to occur as a result of the proposed development are presented in **Table 11-29** for the Thirlmere Lakes.

Table 11-29 Proposed development groundwater drawdown at high priority GDEs

GDE		Predicted Maximum Drawdown (m)	Predicted time to water level recovery
Thirlmere Lakes	Gandangarra	0.02	150 years post-mining
	Werri Berri	0.01	
	Couridjah	0.03	
	Baraba	0.02	
	Nerrigorang	0.02	n/a

The estimates for groundwater drawdown expected to occur as a result of the proposed development and other mines (cumulative scenario) are presented in **Table 11-30** for the Thirlmere Lakes.

Table 11-30 Cumulative impacts - groundwater drawdown at high priority GDEs (HydroSimulations, 2018)

GDE		Predicted Maximum Drawdown (m)	Predicted time to water level recovery
Thirlmere Lakes	Gandangarra	0.05	150 years post-mining
	Werri Berri	0.03	
	Couridjah	0.05	
	Baraba	0.05	
	Nerrigorang	0.05	

Based on the baseflow reductions outlined above, potential impacts to Thirlmere Lakes were analysed in the Surface Impact Assessment Study prepared by HEC (2018).

The HEC (2018) assessment indicated a modelled 330 ML (or 2.6 ML/year average) increase in groundwater recharge as a result of the Project and a 107 ML (or 0.8 ML/year average) decrease in discharge to Blue Gum Creek (from Lake Nerrigorang). This level of change would be very small compared to natural variability in downstream catchment conditions, and in the context of the potential impacts on inflow to downstream Lake Burragorang (Warragamba Dam), it would be imperceptible. The predicted impacts are close to the limit of accuracy of the model.

Over the modelled 129 years, it is anticipated that water levels in the Thirlmere Lakes would decrease by between 0.01 m and 0.06 m on average. The predicted average number of weeks per decade that the Lakes would be without any discernible ponded water increases by between 3 and 5.2 weeks. These levels of change would be imperceptible and very small compared to natural variability and are therefore considered negligible.

As the groundwater assessment (HydroSimulations, 2018) indicates eventual recovery of water levels over time, it is anticipated that consequent impacts to surface water at Thirlmere Lakes would also decrease over time with the completion of mining.

Terrestrial and Aquatic Ecology

Based on the relatively imperceptible impacts to the Thirlmere Lakes identified in the Groundwater Assessment and Surface Water Impact Assessment it was determined that:

- it is highly unlikely that the terrestrial biodiversity values of the Thirlmere Lakes system would be impacted in a manner that would result in loss of vegetation and habitat, or die back of vegetation. Compared to natural variability, any change would be minor to negligible; and
- it is unlikely that the minor impacts to surface water and groundwater relative to natural variability would affect aquatic flora or fauna.

Summary of Aquifer Interference Policy Assessment

The implications of the predicted impacts of the proposed development on groundwater (including the Thirlmere Lakes) are summarised in **Table 11-19** of **Section 11.3** against the minimal impact considerations under the *NSW Aquifer Interference Policy*. Given the simulated potential cumulative impact on the water table at Thirlmere Lakes as well as on existing groundwater users' bores within the Permian and Triassic strata, the proposed development is classified as Level 2 within the minimal impact considerations of the *NSW Aquifer Interference Policy*. Impacts to groundwater are assessed in detail in **Section 11.3**.

11.5.5 Management and Mitigation Measures

The groundwater mitigation and monitoring measures outlined in **Section 11.3.5** would be implemented to manage and monitor the impacts of the proposed development including in relation to Thirlmere Lakes.

11.5.6 Conclusion

Based on available information, including the investigations undertaken as part of the Thirlmere Lakes Inquiry, the Thirlmere Lakes appear to act as a naturally 'losing' system under both dry and wet conditions. Therefore, there is limited dependence on groundwater for the water levels and associated ecosystems of the Thirlmere Lakes.

The water balance model determined that the most significant outflow component from the Thirlmere Lakes is evaporation/evapotranspiration, comprising approximately two-thirds of outflows. Groundwater recharge by contrast comprises approximately a quarter of outflows. The Project would only affect the groundwater recharge component, albeit to a minor extent.

It has been determined that the proposed development would have negligible groundwater and surface water impacts on the Thirlmere Lakes that would be comparable to levels of natural variability (i.e. changes to lake levels of 0.01 m and 0.06 m on average) and would be imperceptible in many circumstances. Potential impacts to terrestrial and aquatic ecology within the Thirlmere Lakes were also determined to be minor to negligible.

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11.6 Terrestrial Ecology

A Terrestrial Ecology Assessment was prepared for the proposed development by Niche Environment and Heritage Pty Ltd (2018), and is provided in **Appendix K**.

The ecology assessment has addressed the SEARs and Supplementary SEARs relevant to terrestrial biodiversity impacts. These requirements are listed in **Table 11-31**. SEARs relating to aquatic ecology have been addressed in **Section 11.7.**

Table 11-31 SEARs for the assessment of biodiversity impacts

Biodiversity SEARs	Section addressed
Biodiversity – including:	
• an assessment of the likely biodiversity impacts of the development, including impacts to terrestrial and aquatic species and habitats, in accordance with the Framework for Biodiversity Assessment, by a person accredited in accordance with s142(B)(1)(c) of *the Threatened Species Conservation Act 1995*, and having regard to OEH's requirements; and	**Section 11.6** (terrestrial), **Section 11.7** (aquatic) and **Appendix K**.
• a strategy to offset any residual impacts of the development in accordance with the NSW Biodiversity Offsets Policy for Major Projects.	**Section 11.6.5** and **11.7.5** and **Appendix K.**
Biodiversity Supplementary SEARs	
• The EIS must identify each EPBC Act listed threatened species and community likely to be impacted by the action. For any species and communities that are likely to be impacted, the proponent must provide a description of the nature, quantum, and consequences of the impacts. For species and communities potentially located in the project area or in the vicinity that are not likely to be impacted, provide evidence why they are not likely to be impacted.	**Section 11.6.3, 11.6.4, 11.7.3** and **11.7.4** and **Appendix K**

Biodiversity SEARs	Section addressed
• For each of the EPBC listed threatened species and communities likely to be impacted by the action the EIS must provide a separate: • description of the habitat (including identification and mapping of suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice and recovery plans; • details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Australian Government guidelines and policy statements; • description of the relevant impacts of the action having regard to the full extent of the species or community's range; • description of the specific proposed avoidance and mitigation measures to deal with relevant impacts of the action; • Identification of significant residual adverse impacts likely to occur after the proposed activities to avoid and mitigate all impacts are taken into account; • A description of any offsets proposed to address residual adverse significant impacts and how these offsets will be established; • Details of how the current published NSW Framework for Biodiversity Assessment (FBA) has been applied in accordance with the objects of the EPBC Act to offset significant residual adverse impacts; and • Details of the offset package to compensate for significant residual impacts including details of the credit profiles required to offset the action in accordance with the FBA and/ or mapping and description of the extent and condition of the relevant habitat and/ or threatened communities occurring on proposed offset sites.	**Section 11.6.3, 11.6.4, 11.7.3** and **11.7.4** and **Appendix K**
• Any significant residual impacts not addressed by the FBA may need to be addressed in accordance with the EPBC Act Environmental Offset Policy.	Residual impacts to ecology were not identified for the proposed development
• The Department of the Environment's Reporting Tool (ERT) identifies that threatened species and communities may occur in the vicinity of the proposed action. Based on the information in the referral documentation, the location of the action, species records and likely habitat present in the area, there are likely to be significant impacts to: • Shale/ Sandstone Transition Forest (SSFT) ecological community – Critically Endangered; • Bargo Geebung (*Persoonia bargoensis*) – Vulnerable; • Small-flower Grevillea (*Grevillea parviflora subsp. Parviflora*)– Vulnerable; and • Rufous Pomaderris (*Pomaderris brunnea*) – Vulnerable.	**Section 11.6.3, 11.6.4** and **Appendix K**

Biodiversity SEARs	Section addressed
• There is some risk that there may be significant impacts on the following matters and the level of impact should be further investigated: • Turpentine-Ironbark Forest of the Sydney Basin Bioregion – Critically Endangered; • Woronora Beard-heath (*Leucopogon exolasius*) – Vulnerable; • Koala (*Phascolarctos conereus*) – Vulnerable; • Macquarie Perch (*Macquaire australasica*) – Endangered; and • Greater Glider (*Petauroidies volans*) – Vulnerable.	**Section 11.6.3, 11.6.4, 11.7.3** and **11.7.4** and **Appendix K**

11.6.1 Background

The proposed development has the potential to impact on terrestrial ecology through the clearing of vegetation as part of the expansion of the REA, construction of ventilation shafts (and associated service infrastructure), and car park extension, as well as through the generation of subsidence movements as a result of longwall mining. The purpose of the Terrestrial Ecology Assessment was to identify terrestrial flora and fauna likely to occur within the ecology study area (refer **Section 11.6.2**), assess potential impacts of the proposed development on terrestrial ecology, and recommend mitigation measures where appropriate. The assessment has utilised available public information, including threatened biodiversity records and vegetation mapping.

The Project Area has been subject to several previous monitoring and ecological survey efforts in order to obtain sufficient baseline data and to inform the footprint of the proposed development. Previous studies and surveys include:

- several Reviews of Environmental Factors for the Bargo Exploration Program (2010-13), which involved ecological assessment and survey for several seismic survey lines and exploration boreholes within CCL 747 and CCL 716;
- Tahmoor South Terrestrial Ecology Pilot Study (2010-11), which involved a detailed literature review and field survey of the broader CCL 747 area. The outcomes of this study informed the detailed baseline monitoring program; and
- Tahmoor South Terrestrial Ecology Monitoring Program (2012-14), which involved collecting two years of baseline data on amphibian and riparian vegetation in order quantify those ecological values which may be sensitive to subsidence impacts. This program has been completed and the data have been used to inform the impact assessment for the proposed development, as well as monitor impacts during and after mining of the proposed development.

As described in **Section 11.6.2** additional survey assessments were completed in 2013, 2017 and 2018 for the proposed development within the ecology study area.

As discussed in **Section 8.1.4**, the *Biodiversity Conservation Act 2016* (BC Act) replaced the *Threatened Species Conservation Act 1995* (TSC Act) on 25 August 2017. However, the proposed development is subject to transitional provisions under the *Biodiversity Conservation (Savings and Transitional) Regulation 2017* (clauses 27 (1)(b) and 28 of Part 7) as it meets the definition of a '*pending or interim planning application*', being a development for which an application would be submitted within 18 months of the commencement of the BC Act (i.e. by February 2019), will be accompanied by an EIS (this document), and the original SEARS were issued prior to the commencement of the BC Act (i.e. 9 June 2017). As such, in accordance with Clause 28, Part 7 of the Regulation '*Former planning provisions*' (being the provisions of the EP&A Act that were in force if that Act had not been amended by the BC Act) '*continue to apply to pending or interim planning applications*'. Prior to its amendment by the BC Act, the EP&A Act (Clause 5A) required assessment of threatened species, populations, ecological communities or their habitat under the TSC Act and as per the transitional provisions of the BC Act, this required under the TSC Act continues to apply to the proposed development. As such the proposed development has been assessed under the Framework for Biodiversity Assessment (FBA) method under the TSC Act. The assessment has used the BioBanking Credit Calculator (BBCC) Version 4 and the Major Project module for all development calculations.

Avoidance

The proposed development has, in the first instance, avoided biodiversity impacts where possible. Avoidance of impacts to biodiversity has been achieved through:

- designing the extent of longwall mining to avoid the Bargo and Nepean River valleys to maximise protection and reduce potential for impacts to the biodiversity values associated with these rivers;
- the longwalls in the south of the Project Area have been re-designed to be stand back from the Metropolitan Special Area (MSA), which comprises a water catchment area managed by WaterNSW. This avoids impacts to the MSA, as well as the Upper Nepean State Conservation Area and Cow Creek, located within its bounds. This will also avoid impacts to the Giant Burrowing Frog which was recorded during previous surveys along Cow Creek;
- removal of previously proposed mining within the 'Eastern Domain' thereby avoiding undermining and subsidence impacts including to Eliza Creek; and
- redesigning the REA (reducing the overall footprint) to avoid greater impacts to SSTF, *Persoonia bargoensis* and *Grevillea parviflora* subsp. *parviflora,* and to move the REA away from Tea Tree Hollow and the population of *Pomaderris brunnea*.

The adopted REA design takes into consideration a balance of environmental impacts relating to dust, noise and visual impacts to surrounding properties, as well as potential impacts on biodiversity. This included a cost benefit analysis of the design options considering biodiversity impacts and offset requirements associated with the options. Consideration was given to raising the northern section of the existing REA which has been rehabilitated; however this increased the number of impacted properties from dust and noise, and hence was not included in the proposed final design. The southern section of the REA is proposed to be increased in height as this change does not increase the number of potentially affected properties. Further information on REA design and the options considered is provided in **Section 6.2.6**.

Refer to **Section 5.0** and **Section 6.0** for further information regarding mine design constraints and alternatives considered for the proposed development.

11.6.2 Methodology

The Terrestrial Ecology Assessment was prepared by Niche Environment and Heritage Pty Ltd (2018) and included:

- a study area for the ecological assessment that comprised:
  - the SSA as per MSEC (2018) for subsidence related impacts; and
  - the extent of the proposed REA extensions and proposed surface infrastructure including ventilation shaft sites and carpark extension for surface vegetation clearance.
- a desktop review of background information, including:
  - a search of public databases including EPBC Act Protected Matters Search Tool (10 km search area), the OEH Atlas of NSW Wildlife, and the OEH BioBanking Threatened Species Profiles Database; and
  - review of previous studies within and surrounding the study area including studies undertaken by Niche Environment and Heritage Pty Ltd as part of the Tahmoor two year baseline monitoring program.
- defining potentially impacted species by considering the likelihood of occurrence and likelihood of impacts for each species that were identified through database and literature review, as potently occurring within the study area. Five categories of likelihood of occurrence were evaluated (Refer **Table 11-32**) with the species classified as 'Moderate', 'High' or 'Known' considered further.

Table 11-32 Likelihood of occurrence criteria

Likelihood rating	Threatened flora criteria	Threatened and migratory fauna criteria
Known	The species were observed within the study area.	The species were observed within the study area.
High	It is likely that a species inhabits or utilises habitat within the study area.	It is likely that a species inhabits or utilises habitat within the study area.

Likelihood rating	Threatened flora criteria	Threatened and migratory fauna criteria
Moderate	Potential habitat for a species occurs on the site. Adequate field survey would determine if there is a 'high' or 'low' likelihood of occurrence for the species within the study area.	Potential habitat for a species occurs on the site and the species may occasionally utilise that habitat. Species unlikely to be wholly dependent on the habitat present within the study area.
Low	It is unlikely that the species inhabits the study area.	It is unlikely that the species inhabits the study area. If present at the site the species would likely be transient visitor. The site contains only common habitat for this species which the species would not rely on for its on-going local existence such as limited breeding habitat resources.
None	The species has not been recorded within the study area and habitat within the study area is unsuitable for the species.	The species has not been recorded within the study area and habitat within the study area is unsuitable for the species.

- Field surveys were undertaken in accordance with the Framework for Biodiversity Assessment methodology. The assessment utilised information from previous surveys within the Project Area and current surveys for the proposed development as follows:
  - Pilot study (2011-2012) - terrestrial ecology pilot study was conducted over four days from the 5 to 8 December 2011, and 11 and 16 April 2012 to determine ecological values that would require consideration during EIS for the Project. The survey involved habitat based flora assessment and opportunistic threatened flora survey;
  - Riparian Monitoring (2012-2013) - A riparian monitoring project was implemented for two monitoring years to gain baseline floristic data at 42 permanent monitoring sites along riparian areas within the Project Area, and within a number of Control sites. BioBanking plots were completed at each monitoring site. The data would be used in a Before-After-Control Impact Assessment (BACI) for the Project. The first year of riparian vegetation monitoring was conducted from 18 to 27 June 2012, and again from 5 to 13 December 2012. The second year of riparian vegetation monitoring was conducted between 3 June and 15 June 2013. The two different survey periods were aimed at targeting any potential seasonal differences in species presence;
  - REA detailed survey (2013) - The proposed REA expansion and surrounding vegetation was investigated from November 2012 to January 2013. The assessment included detailed vegetation mapping and threatened flora survey. The survey resulted in the collection of over 53 BioBanking plot/transects, rapid survey points, and targeted threatened flora survey and population counts for *Grevillea parviflora subsp. parviflora, Persoonia bargoensis*, and *Pomaderris brunnea*. With respect to fauna, the survey effort included camera traps, koala searches, spotlighting, stag watching, call playback, remote bat detectors, harp traps, arboreal cage traps, hair tubes, reptile spotlighting and reptile habitat searching/ rock turning, diurnal bird searches and habitat searches;
  - Previously proposed ventilation shaft sites and associated haul road and transmission lines (2013) - These sites were investigated over five days in June 2013 and one day in September 2013. The assessment included detailed vegetation mapping and threatened flora survey. The survey of these areas involved habitat assessment, and BioBanking plot collection, quadrats and random meanders, as well as spotlighting and camera traps. Whilst these ventilations sites and associated infrastructure are no longer proposed the surveys provided baseline information of vegetation and habitat within the Project Area;
  - Amphibian monitoring at a total of 39 locations along the following watercourses: Dog Trap Creek, Cow Creek, Carters Creek, Tea Tree Hollow, Hornes Creek, Eliza Creek, Dry Creek, Bargo River and tributaries of Bargo River during spring and autumn in 2012 and in 2013. The monitoring surveys at the sites included nocturnal aural and visual searches, nocturnal playback and tadpole searches;

- Detailed survey 2017 - An update of the previous survey assessments was completed in September 2017. The purpose was to inspect the condition of the vegetation, re-count flora populations, and gain additional floristic plot data. During the assessment an additional four BioBanking plots/transects were completed to accompany the 53 plots/transects completed during the 2013 survey. Targeted threatened flora surveys were undertaken across the disturbance areas, along with a population count for *Grevillea parviflora* subsp. *parviflora*. With respect to fauna the survey effort included camera traps, call playback, spotlighting/ stag watching, diurnal bird surveys, koala searches, amphibian searches (Dog Trap Creek, Tea TreeHollow Creek, Eliza Creek and Dry Creek), Cumberland Land Snail searches and reptile habitat searches; and

- Ventilation shafts, Hornes Creek and car park (2018) - Survey assessments were completed on 12-19 September 2018 to validate the vegetation mapping within the ventilation shaft sites and carpark and complete threatened flora survey and counts within these areas. During the assessment an additional seven BioBanking plots/transects were completed and targeted threatened flora surveys were undertaken across the disturbance areas, along with a population count for *Grevillea parviflora* subsp. *parviflora* and *Persoonia bargoensis*. The surveys also included a small portion of Hornes Creek in the north-west of the study area to confirm potential impacts from subsidence. With respect to fauna, the survey effort included camera traps, koala searches, spotlighting/ stag watching, call playback, diurnal bird searches and Cumberland Land Snail searches.

- The survey methods included:
  - vegetation verification, in particular native vegetation attributes such as coverage and species richness;
  - targeted searches for threatened flora species with the potential to occur within the study area, including those identified in the SEARs;
  - targeted searches for threatened fauna species with the potential to occur within the study area. The targeted surveys focused on species identified in the SEARs as well as 'species-credit species' which unlike 'ecosystem-credit species' cannot be assumed to be present based on habitat surrogates; and
  - habitat based assessment and opportunistic bird survey.
- assessment of potential impacts to affected vegetation communities and threatened species within the study area. This included calculating areas of vegetation disturbed as a result of surface activities and consideration of riparian vegetation impacted as a result of subsidence impacts to watercourses;
- recommendations for avoidance, mitigation and offsets for potential impacts on terrestrial ecology; and
- assessment of significance for Commonwealth listed species where it is determined that an impact to that species is likely to occur as a result of the proposed development.

11.6.3 Existing Environment

The existing environment has been characterised in forms of vegetation communities, threatened flora and fauna species, and State Conservation Areas and National Parks.

Vegetation Communities

Vegetation within the study area has been mapped as part of the *Native Vegetation of Southeast NSW* mapping project (Tozer *et al* 2006) and also as part of the Cumberland Plain Mapping Project (OEH, 2013). The mapped vegetation communities (OEH, 2013) are shown on **Figure 11.15**. Five vegetation communities have been mapped as occurring within the study area, of which two are considered to constitute EECs, as identified below. Vegetation communities verified through site surveys are shown in **Figure 11.16**.

- *Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin*. This plant community was considered to align with the Shale Sandstone Transition Forest (SSTF) threatened ecological community (TEC) listed as critically endangered under both the BC Act and EPBC Act. Verification surveys have confirmed the presence of this community within the proposed REA extension and ventilation shaft sites. This community has also been mapped within the subsidence limits of the study area. Within the study area approximately 308.2 ha of the community is mapped as being of 'moderate/ good' condition, 11.8 ha as 'moderate/ good-medium' condition and 5.6 ha as 'moderate/ good-derived' condition;

- *Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion.* This plant community aligns with the Cumberland Plain Woodland threatened ecological community listed as critically endangered under both the BC Act and EPBC Act. Verification surveys did not identify this vegetation community within the footprint of proposed surface infrastructure (REA, ventilations shafts or car park). Given the expanse of the study area within private property, survey was limited to accessible areas. As such, it is possible that Cumberland Plain Woodland may occur as small patches within some private properties throughout the study area. Approximately 9 ha of this community has been mapped within the subsidence limits of the study area.
- *Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin* (Upper Georges River Sandstone Woodland vegetation community). This community is not listed as a TEC or EEC. This community is mapped within the subsidence limits of the study area (approximately 493.8 ha), and verification surveys have confirmed the presence of this community within the REA;
- *Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest in gullies of western Sydney, Sydney Basin sandstone* (Hinterland Sandstone Gully Forest vegetation community). This community is not listed as a TEC or EEC. This community is mapped within the subsidence limits of the study area (approximately one ha), however mapping and verification surveys indicates that this community does not occur within the surface infrastructure areas (REA, ventilation shaft sites and car park); and
- Plantings – 0.1 ha of plantings were identified through verification surveys within the proposed car park and 0.2 ha within the subsidence limits of the study area. This community type does not fit with any of the mapped plant community types and *Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin* was used in the vegetation mapping as a surrogate.

Upland Swamps are thought to be particularly susceptible to the impacts from mining induced subsidence and were therefore considered in the assessment. Upland Swamps include Montane Peatlands and Swamps of the New England Tableland, (listed as endangered under the BC and EPBC Acts) and Coastal Upland Swamps in the Sydney Basin Bioregion (listed as endangered under the BC and EPBC Acts). However, Upland Swamps are not mapped within the study area and were not recorded during field surveys. In addition, aerial photography interpretation has not identified any potential upland swamps.

Turpentine Ironbark Forest in the Sydney Bioregion was identified by DoEE (2018) as a TEC that could potentially be impacted by the proposed development. However, this TEC was not recorded during field surveys, nor has it been previously mapped as occurring within the study area by Tozer et al (2006) and OEH (2013). The Project Area occurs predominately within the Wollondilly LGA which is not an LGA listed in the Scientific Determination for the Sydney Turpentine Ironbark Forest. Whilst a similar form of Sydney Turpentine Ironbark Forest occurs more widely in the Wollondilly and Hawkesbury areas, based on the results of the field survey, and existing vegetation mapping, no similar communities to Sydney Turpentine Ironbark Forest have been identified. As such, it is considered highly unlikely that Sydney Turpentine Ironbark Forest occurs within the study area (Niche, 2018).

Landscape Features

The FBA requires landscape features to be considered and entered into the BioBanking Credit Calculator (BBCC) so that features such as landscape setting, connectivity and native vegetation cover can be taken into account.

The following Mitchell landscapes occur across the study area: Picton – Razorback Hills, Woronora Plataea, Nattai Plateau, and Upper Nepean Gorges. As the Picton – Razorback Hills occupies the majority of the study area it was entered into the BBCC.

The key landscape features of the study area are concentrated around the watercourses; namely Tea Tree Hollow Creek, Dog Trap Creek and Hornes Creek. Vegetation corridors along each of these watercourses are more prominent toward the far west of the study area near the Bargo River. This area is typically away from rural and residential lands. As per the FBA, the study area was classed as occurring within a strategic (connectivity) location as it contains riparian buffers that are of a 4th order or higher Strahler level (Bargo River– western edge of study area).

Two Assessment Circles (15, 000 ha and 1,500 ha) were placed over the study area and percentage native vegetation cover was estimated using GIS interrogation. Percentage native vegetation cover was determined to remain within the same class (71-75%), before and after the proposed development at both the 15,000 ha and 1,500 ha scales.

Based on the above inputs the BBCC calculated landscape score for the development is 21.0.

Threatened Flora

A total of 47 threatened flora listed under the BC Act and/or EPBC Act have been recorded or have potential habitat within 10 km of the study area. Of these, seven species have been recorded within or in close proximity to the study area during recent and/or previous surveys. These included: *Acacia bynoeana, Epacris purpurascens var. purpurascens, Grevillea parviflora subsp. parviflora, Persoonia hirsuta, Persoonia glaucescens var. glaucescens, Persoonia bargoensis,* and *Pomaderris brunnea.* Threatened flora species identified through surveys are shown on **Figure 11.17**.

Of these, three species (*Grevillea parviflora subsp. parviflora, Persoonia bargoensis,* and *Pomaderris brunnea*) have been recorded near the proposed surface infrastructure works, including the REA and ventilation shaft sites (refer **Table 11-33**).

Table 11-33 Records of threatened flora within the study area

Flora Species	Records	BC Act Listing	EPBC Act Listing
Acacia bynoeana	Not recorded during recent surveys undertaken for the proposed development and no records of the species by OEH occur within the study area. Approximately 20 individuals were recorded during surveys to the west of the study area along the entrance to a Fire Road off Ashby Close in land owned by Tahmoor Coal. The plants were recorded within plant community type *Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux, Sydney Basin* which does not occur within the surface infrastructure disturbance areas of the study area.	Vulnerable	Vulnerable
Epacris purpurascens var. *purpurascens*	Recorded along either side of Anthony Road, Bargo, and within Crown Land immediately to the north of Anthony Road. The population at this location consists of more than 500 individuals. Nil individuals recorded within the surface infrastructure areas of the study area (REA, ventilations shafts, car park).	Vulnerable	-
Grevillea parviflora subsp. *parviflora*	This species was recorded extensively during field surveys at the following areas: • REA Areas 1 and 2; • Ventilation shaft sites; • Outside of the REA development footprint to the east of Charlies Point Road; • Within the Anthony Road property owned by Tahmoor Coal; • Along Fire Road 5 in the Upper Nepean State Conservation Area; and • Within land owned by Tahmoor Coal off Ashby Close Bargo. An estimated 2,324plants occur within the core and outer habitat areas within the footprint of the surface infrastructure.	Vulnerable	Vulnerable
Persoonia bargoensis	Recorded within the surface infrastructure areas. A total of 692 individuals were recorded, the bulk of which occurs in the REA Area 2. Approximately 96 plants would be affected by the REA and four plants by the ventilation shaft sites.	Endangered	Vulnerable

Flora Species	Records	BC Act Listing	EPBC Act Listing
Persoonia hirsuta	Not recorded during recent surveys undertaken for the proposed development. A single OEH Bionet database recording occurs to the far west of the study area (outside of the surface infrastructure areas) within private property, which could not be verified. The records coincide with Dry Sclerophyll Forest vegetation located away from riparian zones within the Study Area. In addition, during surveys, a large population of the species was recorded outside of the study area in Tahmoor Coal owned land.	Endangered	Endangered
Persoonia glaucescens	Was not recorded during surveys of the surface infrastructure areas and riparian areas of the study area despite targeted surveys. One OEH Bionet databased record occurs within the REA Area 2, however no evidence of this species was identified during surveys of the REA. Other records for this species occur in private property, away from the surface infrastructure and riparian areas of the project. The records coincide with Dry Sclerophyll Forest vegetation located away from riparian zones within the study area. During survey, scattered individuals of this species were recorded outside of the study area in land owned by Tahmoor Coal.	Endangered	Vulnerable
Pomaderris brunnea	Recorded along Tea Tree Hollow Creek, immediately to the west of (but outside) the REA footprint. A population of 300 individuals were recorded at this location.	Vulnerable	Vulnerable

Threatened Fauna

A total of 74 threatened fauna listed on the BC and/ or EPBC Acts have previously been recorded or are predicted to have habitat within 10 km of the study area. Of these, 22 were identified as species-credit species that cannot be determined based on habitat surrogates.

A total of 78 fauna species were recorded within the Project Area during surveys, including eight amphibians, 45 birds, 17 mammals and eight reptiles. Of these 12 threatened fauna listed under the BC Act (nil listed under the EPBC Act) were recorded within the Study Area within, or immediately adjacent to the proposed surface infrastructure disturbance footprint. These comprised:

- 10 Ecosystem-credit species: Glossy Black Cockatoo *(Calyptorhynchus lathami),* Little Eagle *(Hieraaetus morphnoides),* Powerful Owl *(Ninox strenua),* Scarlet Robin *(Petroica boodang),* Sooty Owl *(Tyto tenebricosa),* Varied Sittella *(Daphoenositta chrysoptera)*, Eastern Free-tail Bat *(Mormopterus norfolkensis),* Large-footed Myotis *(Myotis macropus)*, Eastern Cave Bat *(Vespadelus troughtoni)* and Eastern False Pipistrelle *(Falsistrellus tasmaniensis)*;
- one species-credit species: Red-crowned Toadlet *(Pseudophryne australis)*; and
- one Ecosystem-credit/ species-credit species: Eastern Bentwing Bat *(Miniopterus schreibersii oceanensis*).

Two threatened amphibians were recorded during the Amphibian Monitoring Program in 2013: the Red-crowned Toadlet (*Pseudophryne australis*) as identified above and the Giant Burrowing Frog (*Heleioporus australiacus*). The Giant Burrowing Frog was recorded outside of the study area, within Cow Creek, whilst the Red-crowned Toadlet was recorded within the study area at Hornes Creek.

Threatened fauna species recorded near the proposed surface infrastructure works (including the REA and ventilation shaft sites) are shown on **Figure 11.18**.

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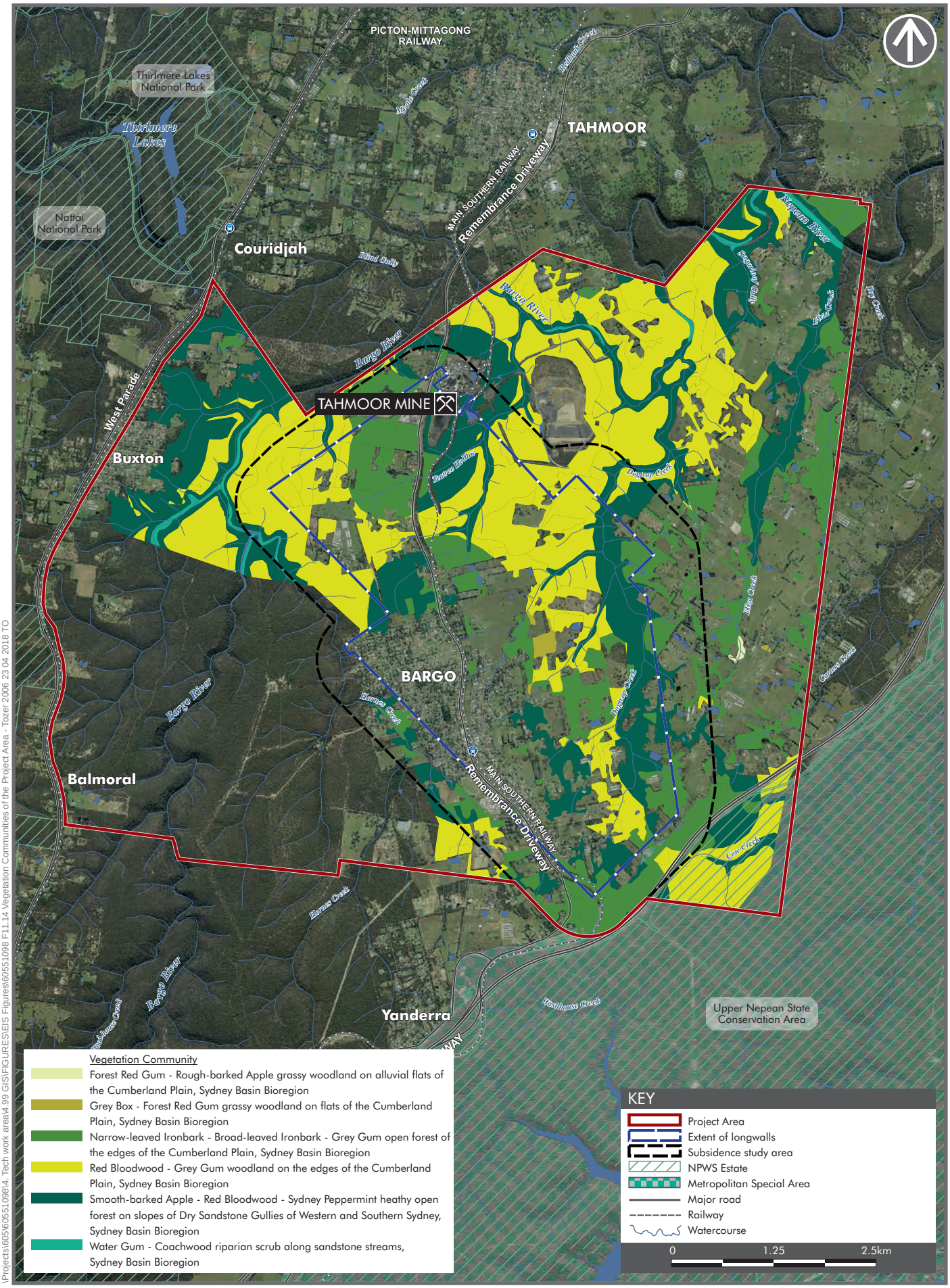

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SIMEC MINING

VEGETATION COMMUNITIES OF THE PROJECT AREA (OEH, 2013)

Tahmoor South Project
Environmental Impact Statement

Source: Niche Environment and Heritage (2013)

FIGURE 11.15

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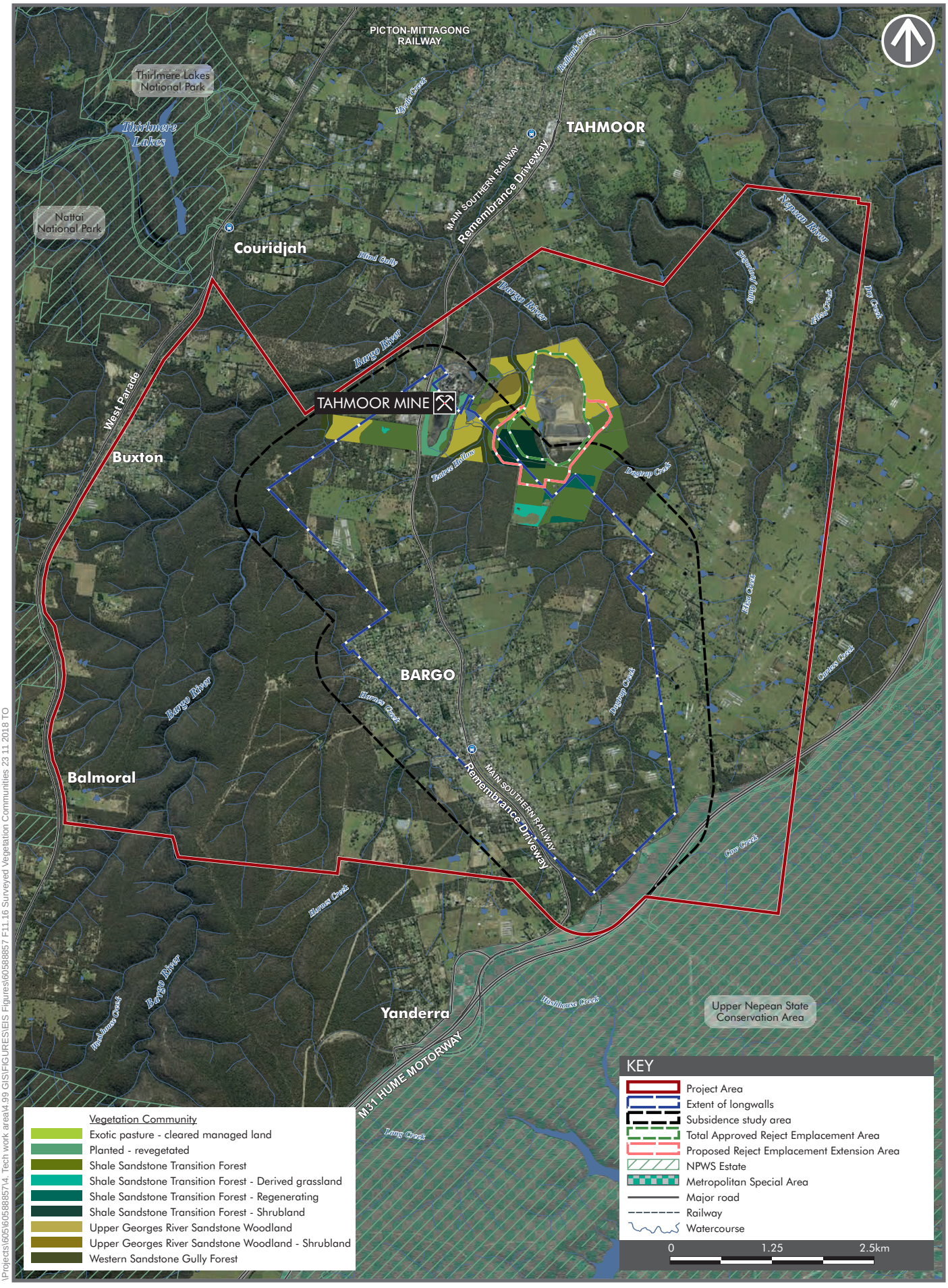

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SIMEC MINING

SURVEYED VEGETATION COMMUNITIES

Tahmoor South Project
Environmental Impact Statement

Source: Niche Environment and Heritage (2018)

FIGURE 11.16

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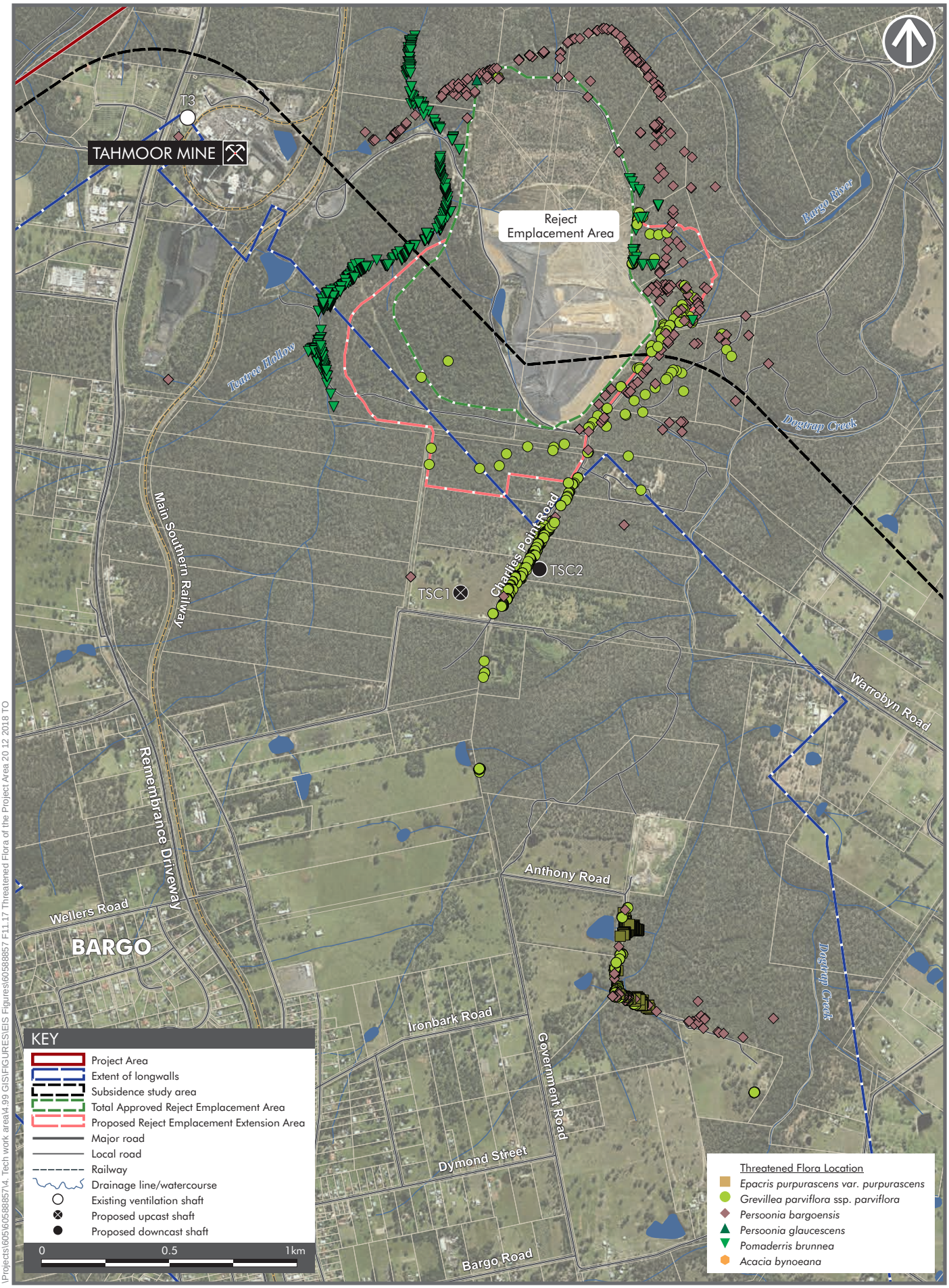

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SIMEC MINING

THREATENED FLORA OF THE PROJECT AREA

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.17

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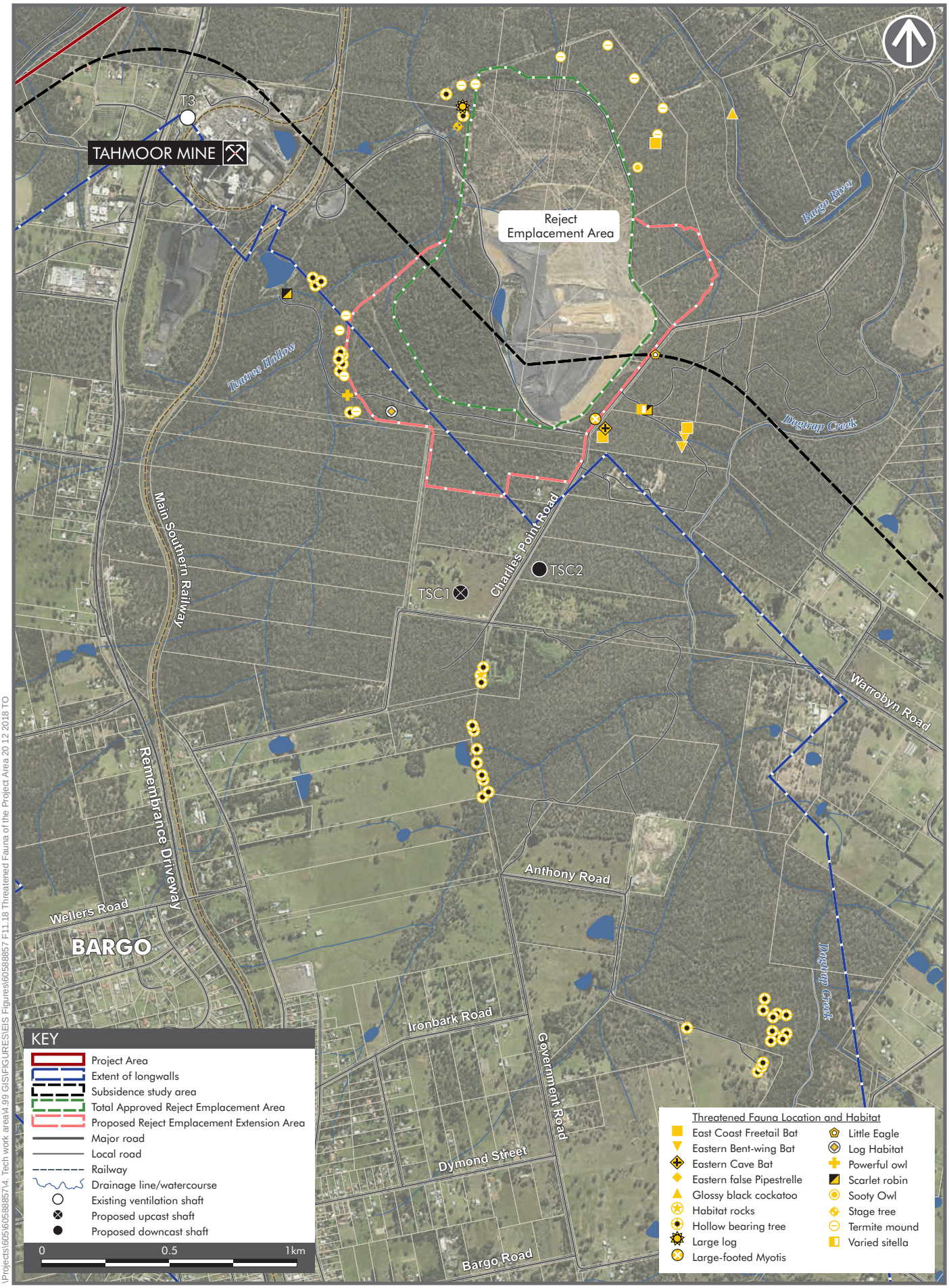

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SIMEC MINING

THREATENED FAUNA SIGHTINGS WITHIN THE PROJECT AREA

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.18

State Conservation Areas and National Parks

A number of State Conservation Areas and National Parks are located surrounding or partially within the Project Area as shown on **Figure 2.3**. Of these, the Upper Nepean State Conservation Area within the MSA comprises the only conservation area to be located within the study area along the south eastern boundary of the predicted subsidence limit. A summary of existing biodiversity records for these areas is provided in **Table 11-34**.

Table 11-34 Threatened communities and species within surrounding conservation areas

State Conservation Area or National Park	Known threatened communities, flora, fauna and habitat recorded within the conservation area (as noted in the Plans of Management for each area)
Upper Nepean State Conservation Area	- SSTF EEC; - *Grevillea parviflora subsp. Parviflora*; - *Epacris purpurascens var. purpurascens*; and - Potential habitat for the Red-crowned Toadlet and Giant Burrowing Frog.
Bargo State Conservation Area	- SSTF EEC; - Southern Highlands Shale Woodlands (SHSWs) EEC; - Grevillea parviflora subsp. Parviflora; - Persoonia hirsuta; - Persoonia glaucescens; - Gang-gang cockatoo; - Scarlet Robin; - Sooty Owl; - Koala; and - Potential habitat for the Broad-headed snake. It is also noted that the Bargo State Conservation Area is an integral part of the Bargo Linkage, a fauna habitat corridor in the Greater Southern Sydney Region which facilitates the movement of migratory species, nomadic species and other species that use sandstone habitat between the Woronora Plateau and Nattai Plateau, and ultimately the southern Blue Mountains.
Thirlmere Lakes National Park	- Australasian Bittern; and - Japanese Snipe (Gallinago hardwickii). Over 140 species of bush and water birds occur within the Park.
Nattai National Park	Over 22 listed threatened species have been recorded in the Park.

11.6.4 Impact Assessment

The impact assessment included consideration of potential construction and operational impacts which may result in direct or indirect impacts to vegetation communities and threatened species, such as clearing and subsidence related impacts. Key threatening processes likely to occur have been identified, and some Key Threatening Processes may be increased as a result of the proposed development.

A description of how the proposed development has been designed to avoid impacts to biodiversity where practicable is provided in **Section 11.6.1**.

Key Threatening Processes

The following Key Threatening Processes listed under Schedule 3 of the TSC Act most relevant to the proposed development (refer to **Appendix K**) are:

- alteration of habitat following subsidence due to longwall mining (resulting in potential impacts to threatened flora and fauna habitat and TECs);
- alteration to the natural flow regimes of rivers, streams, floodplains and wetlands (as a result of subsidence impacts);
- bush rock removal (as a result of all surface works);
- clearing of native vegetation (as a result of all surface works);
- loss of hollow-bearing trees (as a result of all surface works); and
- removal of dead wood and dead trees (as a result of surface works).

Vegetation Communities

Potential direct impacts to vegetation would occur as a result of the following:

- vegetation clearing for surface works including the expansion of the REA, construction of new ventilation shaft locations, and construction of the proposed car park; and
- subsidence impacts at the ground surface including surface cracking and impacts to watercourses and flow regime.

Vegetation Clearing

The proposed development will result in the clearance of a total of 49.2 ha of native vegetation. The majority of this vegetation consists of Shale Sandstone Transition Forest (SSTF) EEC (43.4 ha) as well as 5.7 ha of Upper Georges River Sandstone Woodland and 0.1 ha of planted vegetation that does not align to a mapped plant community type.

Most of the SSTF to be cleared is in a highly resilient and intact condition. This comprises: 26 ha classed as 'moderate/ good' and 11.8 ha classed as 'moderate/ good-medium'. The SSTF would be cleared for the REA expansion (34 ha) and ventilation shaft construction (9.4 ha).

Credits required to offset vegetation clearing impacts (comprising 43.4 ha of SSTF EEC and 5.7 ha of non-listed native vegetation) have been calculated using the BBCC and estimated at 2,246 credits for the SSTF and 287 credits for the Upper Georges River Sandstone Woodland community.

Subsidence Impacts

Subsidence from the Project may result in the following impacts to native vegetation:

- vegetation die-back around strata gas emission/drainage sites within creeks;
- changes to the floristic composition of vegetation communities immediately adjacent to creeks/ponds where fracturing may result in changes to water flow and water retention periods; and
- destruction/smothering of vegetation/tree fall by rock falls and/or slippage of earth and rocks down steep slopes.

Previous experience of mining in the Southern Coalfields indicates that vegetation dieback as result of gas emissions is a rare event. It has occurred previously on one occasion at the Tower Mine, over small areas at the base of the Cataract Gorge that had been directly mined beneath by Longwalls 10 and 14. These impacts were short term and limited to small areas of vegetation, local to the points of emission, and when the gas emissions declined, the affected areas were successfully restored. No similar impacts have been reported during the mining of Tahmoor North.

Plant communities that occur along the riparian zones of the study area include the Upper Georges River Sandstone Woodland and Hinterland Sandstone Gully forest communities. It is possible that some localised die back from gas emissions may occur to these communities where plants occur immediately above or adjacent to the point of gas emission. Given that the subsidence assessment has not predicted any significant gas emission releases along any of the water courses within the study area, it is expected that any impacts to plant communities would be limited in extent and temporal in nature. In addition, as for the sites previously affected by gas emissions, if it was to occur, the vegetation would be expected to regenerate once the gas emissions declined. As such, it is unlikely that gas emissions from subsidence would result in a decrease in the extent of plant communities and habitat within the study area.

With respect to changes to riparian vegetation from fracturing related water flow and water retention impacts at watercourses, to date, no impacts to riparian vegetation have been observed at Tahmoor Mine. The creeks within the study area are all ephemeral in nature with many being consistently dry throughout the years of survey. It is considered likely that the vegetation along the watercourses is accustomed to periodically dry conditions. Given that the vegetation is not solely reliant upon groundwater for its survival, and the dry conditions currently experienced by riparian vegetation along watercourses within the study area, should water diversion occur as a result of subsidence, it is considered unlikely to result in significant alterations to the composition of the community or vegetation die back.

There is extensive experience of mining beneath steep slopes in the Southern Coalfield. These include steep slopes along the Cataract, Nepean, Bargo and Georges Rivers and streams such as Myrtle Creek and Redbank Creek above Tahmoor Colliery Longwalls 22 to 27. No large-scale slope failures have been observed along these slopes, even where longwalls have been mined directly beneath them. Minor rock falls along cliff lines or rock outcrops have been observed, for example, during the mining of Appin Longwalls 301 and 302 adjacent to the Cataract River. These have resulted in minor and localised rock collapses. Furthermore, rock falls can occur as natural events following major weather events and through natural stresses. Based on the above, it is considered likely that any impacts to vegetation as a result of earth and rock-face instability will be highly localised and relatively minor in nature. Large-scale impacts to vegetation as a result of largescale slope failures are highly unlikely based on subsidence predictions.

Based on the above, significant subsidence related impacts are not considered likely on any vegetation community occurring within the subsidence limits of the study area, including the mapped EEC, SSTF. It is noted that this community was not identified within riparian vegetation mapped within the study area and as such would be of low risk from subsidence related water course changes or gas releases.

As noted in **Section 11.6.3**, it is possible that (previously unmapped) Cumberland Plain Woodland EEC may occur as small patches within some private properties throughout the study area outside of the verified surface infrastructure areas. However, the potential for direct impacts to this EEC from subsidence related changes are considered to be low given that this EEC occurs away from riparian areas, is not specifically groundwater dependant and as subsidence related vegetation changes have been assessed as being minor and localised. Any surface soil cracking within the EEC should it occur, is unlikely to result in any significant floristic or structural change to the community.

Indirect Impacts
Indirect impacts to vegetation include:

- introduction of weeds or introduction of native species into areas where they did not previously exist;
- introduction of diseases such as the introduced plant pathogen *Phytophthora cinnamomi*;
- dust, erosion and sedimentation of soils during construction which has the potential to reduce habitat quality;
- alteration of vegetation and habitat through increased fire risks during construction and operation of surface infrastructure (including the REA); and
- increased fragmentation, edge effects and loss of connectivity as a result of vegetation clearance.

The greatest risk for the potential spread of weeds as a result of the proposed development is associated with the expansion of the REA, which is located in relatively undisturbed vegetation. Weeds are not currently common in these areas and may be spread as a result of creating new access to these areas and from the use of machinery from more disturbed areas of the mine site or areas subject to agricultural land use (southern areas). This also has the potential to introduce/ spread disease. Weed and disease management measures would be incorporate into the Biodiversity Management Plan for the project to minimise and control the spread of weeds during construction and operation.

Construction activities for the expansion of the REA, ventilation shafts and surface facilities have the potential to increase dust generation, erosion and sedimentation which may impact habitat quality. Subsidence may also, to a lesser extent, contribute to increased erosion as a result of changes to slope, surface cracking and other deformations, in particular where these impacts may occur in watercourses. In addition operational activities including activities within the expanded REA would result in dust and noise generation that have the potential to impact on surrounding habitat and fauna. Impacts would be managed in accordance with relevant management plans to minimise nuisance emissions and comply with relevant project standards.

The construction and operation of surface activities may increase the risk of fire ignition and potential for bushfire. Bushfires are a natural occurrence to the ecosystem and are unlikely to significantly change habitat patterns in the long-term. However, consideration of increased risks from the proposed development suggests that risks are adequately managed within the existing Tahmoor Bushfire Management Plan.

Much of the habitat within the study area maintains a high level of connectivity. The proposed development has the potential to impact on connectivity due to fragmentation and edge effects as a result of direct vegetation clearance proposed for the expansion of the REA and construction of ventilation shafts and car park. Edge effects have been incorporated within the disturbance footprint and surface infrastructure would be progressively rehabilitated as mining progresses to minimise disturbance areas.

Threatened Flora

As a result of direct impacts to native vegetation communities, direct impacts to two threatened species previously recorded in the study area (refer **Section 11.6.3**) would occur as outlined in **Table 11-35**.

In addition, the subsidence related impacts discussed above are generally centred on habitat types along riparian areas, immediately above and below cliff lines and steep slopes. Vegetation and habitat that occurs on the flat terrain of the study area are located away from these areas. Of the threatened flora recorded within the study area, only *Pomaderris brunnea* was recorded within a gully habitat of the study area and potential subsidence related impacts are considered for this species in **Table 11-35**. The remainder of the recorded threatened flora were located away from the subsidence sensitive areas. Credits required to offset threatened flora impacts have been calculated using the BBCC and are included in **Table 11-35.**

Table 11-35 Direct impacts to threatened species

Species	Impacts of the proposed development	Credits required to offset
Grevillea parviflora subsp. parviflora	Removal of approximately 2,324 individuals for the surface infrastructure comprising: 2,312 from the core habitat area and a further 12 scattered plants outside of the core habitat area.	32,536
Persoonia bargoensis	Removal of approximately 100 plants for the REA and four plants from the ventilation shaft sites.	7,700
Pomaderris brunnea	No direct clearance of habitat. Subsidence related impacts are considered unlikely due to: - the section of Tea Tree Hollow Creek where the species was recorded being dry during much of the survey and monitoring period, indicating that the species can withstand natural drying events. This would indicate that changes to standing water levels as a result of subsidence is unlikely to result in significant die-back of this species; - the low likelihood of subsidence related gas emissions and the position of the plants away from the lowest point in the topography (should gas emissions occur), which would protect the species at the location from significants die-back; and - the low likelihood of major rock falls and there being no cliffs within this portion of Tea Tree Hollow.	None

Threatened Fauna

Potential impacts to threatened fauna include:

- death or injury of individuals;
- loss or disturbance of limiting foraging resources; and
- loss or disturbance of limiting breeding resources.

Based on previous recordings, survey results, literature reviews and habitat assessments, 55 threatened and migratory fauna were attributed a moderate to high likelihood of occurrence within the study area. A number of species were identified as having potential habitat within the study area. The majority of these species are highly mobile species (such as threatened birds and microbats) that are likely to use the study area on an intermittent basis and would not be solely dependent upon the habitat features within the area to be disturbed by the surface infrastructure works.

Of the 55 fauna species with a moderate to high likelihood of occurrence, the Red-crowned Toadlet, Large-eared Pied Bat, Large-footed Myotis, Eastern Cave Bat and Koala are considered the only species-credit fauna likely to occur within the study area.

The Project has been determined to have the following impacts to the following species-credit fauna:

- Koala (*Phascolarctos conereus*): Whilst not detected during the field survey, the Koala was assigned a high likelihood of occurrence given nearby records in the locality. Koala feed trees are associated with the vegetation communities to be cleared as part of the project. As such, the 43.5 hectares, comprising of the 'moderate/good' and 'moderate/good-medium' condition classes of SSTF and Upper Georges River Sandstone Woodland proposed to be cleared for surface infrastructure would require a biodiversity offset for this species. Given the localised and minor nature of subsidence related vegetation impacts, it was considered unlikely that Koala habitat or feed trees would be significantly impacted by subsidence;
- Red-crowned Toadlet (*Pseudophryne australis*): This species would not be impacted by direct clearing associated with the Project. The species was recorded within Hornes Creek which occurs on the far western portion of the study area. Based on subsidence predictions, there is a low likelihood that subsidence may reduce the number or holding capacity of pools within Hornes Creek, particularly since the creek would not be directly mined beneath. Given the low likelihood for impact, no offsets are proposed for this species;
- Large-eared Pied Bat (*Chalinolobus dwyeri*): Whilst this species was not detected during the site surveys, records for the species exist along the Nepean River outside the study area. It is likely given the proximity of records, that the species may utilise the study area for foraging habitat. Within the area proposed to be cleared for surface infrastructure, no breeding habitat features (such as caves, rocky crevices, old mine workings) would be removed. Based on past experience of mining within the Southern Coalfields, large scale rock instabilities are unlikely and as such subsidence related impacts to cliff lines used for roosting or breeding habitat are unlikely to be significant;
- The Large-footed Myotis (*Myotis macropus):* This species was recorded within the surface area footprint of the REA during targeted surveys. The Large-footed Myotis is regarded as a species-credit species given its dependence on habitat surrounding waterways for roosting. Hollow-bearing trees, bridges, caves or artificial structures within 200 m of a riparian zone are considered areas of important habitat for the species. Portions of the proposed REA contain hollow-bearing trees that are within 200 m of Tea Tree Hollow Creek. The portion of habitat within 200 m of a riparian zone that would be removed as part of the development is 7.4 ha and this area of habitat would require offsetting. Based on subsidence predictions, changes to water capacity could occur at standing pools at Dog Trap Creek and Tea Tree Hollow, which could affect foraging habitat for this species. However, not all pools would be affected and subsidence could also generate ponding which could create foraging habitat for the Large-footed Myotis. Given this subsidence related changes are considered unlikely to disrupt the life cycle of the species such that the population would decline; and
- The Eastern Cave Bat (*Vespadelus troughtoni*): This species was recorded within the surface area footprint during targeted surveys (one recording on a single night). If a breeding colony was nearby, a greater detection of the species on the Anabat recorders would be likely. As such, it is considered unlikely that the vegetation to be cleared for the surface works contains important foraging or breeding habitat for the species. As with the other bat species discussed above, significant subsidence impacts are considered unlikely.

Credits required to offset threatened fauna impacts have been calculated using the BBCC and estimated as being 163 credits for the Large-footed Myotis and 1,131 credits for the Koala.

No fauna species listed under the Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA) and/or Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA) are likely to be significantly impacted by the proposed development.

State Conservation Areas and National Parks

Subsidence related impacts are not predicted to occur within Bargo State Conservation Area, Thirlmere Lakes National Park and Nattai National Park. Based on the relatively imperceptible impacts to the Thirlmere Lakes (compared to natural variability) concluded in the groundwater and surface water assessments (Hydrosimulations, 2018 and HEC, 2018), it is considered highly unlikely that the terrestrial biodiversity values of the Thirlmere Lakes system would be impacted in a manner that would result in loss of vegetation and habitat or die back of vegetation. As such, impacts to the biodiversity values of the Thirlmere Lakes National Park are not anticipated.

As discussed in **Section 6.2.4** changes to the Mine Plan layout have significantly reduced the potential subsidence impacts to the Sydney MSA and Upper Nepean State Conservation Area. Further assessment and survey of sensitive heritage, geomorphological and ecological surface features was undertaken as part of baseline monitoring and preparation of this EIS. The results of this assessment have fed into an analysis of the risk of potential impacts to these sensitive surface features due to subsidence, and into the mine planning process, resulting in modification to the extent of longwalls and the location of ventilation shafts in these areas compared to previous versions of the Mine Plan.

Minimal subsidence impacts are predicted within the MSA and Upper Nepean State Conservation Area, which is located at the limits of subsidence predictions. No cliffs or watercourses are contained within the small portion of the conservation area within the subsidence limits of the study area. Cracking of soil within dry sclerophyll forest and woodland habitat is unlikely to result in any adverse impacts to flora or vegetation structure and as such, it is considered highly unlikely that the proposed development would result in any impact to conservation areas due to subsidence.

Matters of National Environmental Significance (MNES)

The proposed development was referred to the DoEE on 20 October 2017 (EPBC 2017/8084) for consideration as a controlled action, based on potential impacts to listed threatened species and communities, and water resources. It is noted that the referred proposal comprised the previously considered mine plan layout which included the Eastern Domain and additional mine ventilation shafts, which are no longer proposed (refer **Section 5.0** and **6.0**). The proposed development was determined to be a controlled action by DoEE on 12 January 2018, on the basis that it may impact the following MNES:

- Shale/Sandstone Transition Forest (SSTF) - a Critically endangered ecological community (CEEC) under the EPBC Act, identified within the surface facilities footprint including the proposed REA expansion area;
- Bargo Geebung (*Persoonia bargoensis*) - listed as vulnerable under the EPBC Act, which has also been identified within the footprint of the proposed REA expansion area;
- Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*) - listed as vulnerable under the EPBC Act, which has also been identified within the footprint of the proposed REA expansion area;
- Rufous Pomaderris (*Pomaderris brunnea*) - listed as vulnerable under the EPBC Act; and
- impacts to groundwater resources as a result of longwall mining (Water Trigger) (refer to **Section 11.3**).

In addition, the DoEE identified that there is some risk of significant impacts on the following matters and the levels of impact should be further investigated:

- Turpentine-Ironbark Forest of the Sydney Basin Bioregion – Critically Endangered;
- Woronora Beard-heath (*Leucopogon exolasius*) – Vulnerable;
- Koala (*Phascolarctos conereus*) – Vulnerable;
- Macquarie Perch (*Macquaria australasica*) – Endangered; and
- Greater Glider (*Petauroides Volans*) – Vulnerable.

A summary of the assessment of the MNES is provided in **Table 11-36**. Refer to **Appendix I** for further detail.

Table 11-36 Assessment of MNES

MNES	Assessment
Shale/Sandstone Transition Forest	An Assessment of Significance was undertaken (refer to Appendix 8 of **Appendix K**) which concluded a significant impact was likely. An offset has been provided (refer to **Section 11.6.5**).
Bargo Geebung (*Persoonia bargoensis*)	An Assessment of Significance was undertaken (refer to Appendix 8 of **Appendix K**) which concluded a significant impact was likely. An offset has been provided (refer to **Section 11.6.5**).
Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*)	An Assessment of Significance was undertaken (refer to Appendix 8 of **Appendix K**) which concluded a significant impact was likely. An offset has been provided (refer to **Section 11.6.5**).

MNES	Assessment
Rufous Pomaderris (*Pomaderris brunnea*)	An Assessment of Significance was undertaken (refer to Appendix 8 of **Appendix K**) which concluded that the proposed development would avoid direct impacts to the species.
Turpentine-Ironbark Forest of the Sydney Basin Bioregion	The ecological community does not occur within the study area.
Woronora Beard-heath (*Leucopogon exolasius*)	The species does not occur within the study area. An Assessment of Significance was undertaken (refer to Appendix 8 of **Appendix K**) which concluded a significant impact was unlikely.
Koala (*Phascolarctos conereus*)	The Koala was not recorded despite a targeted survey. An Assessment of Significance was undertaken (refer to Appendix 8 of **Appendix K**) which concluded a significant impact was unlikely. Regardless, an offset has been provided (refer to **Section 11.6.5**).
Macquarie Perch (*Macquaire australasica*)	An aquatic ecology impact assessment was completed for the Macquarie Perch (refer to **Section 11.7**).
Greater Glider (*Petauroides Volans*) – Vulnerable	The Greater Glider was not recorded despite a targeted survey. An Assessment of Significance was undertaken (refer to Appendix 8 of **Appendix K**) which concluded a significant impact was unlikely.

In addition to the species listed in the controlled action decision, Niche has also undertaken assessments of significance for additional Commonwealth listed species that have the potential to occur within the study area including: birds (Regent Honey eater Fork-tailed Swift, Great Egret, Cattle Egret and Rainbow Bee-eater, Satin Flycatcher, Swift Parrot), Large-eared Pied Bat, Broad-headed Snake, Grey-headed Flying Fox, *Acacia bynoeana, Persoonia glaucescens,* and *Persoonia hirsute*. The assessment of significance under the EPBC Act for each of these species is provided at Appendix 8 of the Biodiversity Assessment Report (refer to **Appendix K**).

11.6.5 Management and Mitigation Measures

In accordance with the NSW Biodiversity Offsets Policy for Major Projects and the FBA the proposed development has firstly utilised the principle hierarchy for impact avoidance and mitigation:

1) Avoid – unnecessary biodiversity impacts must be avoided where possible;

2) Minimise – where biodiversity impacts cannot be avoided by design or other preventative measures, then the impact must be minimised through mitigation measures and environmental safeguards; and

3) Offset – after all feasible measures have been undertaken to avoid or minimise impacts, offsets are to be used to compensate for any remaining impacts.

Avoidance

The proposed development has, in the first instance, avoided biodiversity impacts where possible. Avoidance of impacts to biodiversity has been achieved through:

- designing the extent of longwall mining to avoid the Bargo and Nepean River valleys to maximise protection of the natural features within these rivers and reduce potential for impacts to the biodiversity values associated with these rivers;
- the longwalls in the south of the study area have been re-designed to stand back from the Metropolitan Special Area (which includes the Upper Nepean State Conservation Area), and avoid impacts to Cow Creek, located within the Special Area. This will also avoid impacts to the Giant Burrowing Frog which was recorded during previous surveys along Cow Creek;
- no longer proposing longwall mining within the Eastern Domain resulted in the avoidance of potential subsidence impacts, including at Eliza Creek; and
- redesigning the REA (reducing the overall footprint) to avoid greater impacts to SSTF, *Persoonia bargoensis* and *Grevillea parviflora* subsp. *parviflora,* and to move the REA away from Tea Tree Hollow and the population of *Pomaderris brunnea.*

Mitigation

In order to minimise impacts to biodiversity as a result of the proposed development, impacts would be mitigated through the preparation and implementation of a Biodiversity Management Plan for the proposed development. The Biodiversity Management Plan would contain:

- native vegetation clearing protocol to:
  - define where clearing of native vegetation is to be undertaken or where native vegetation is to be retained;
  - specify methods of clearing of native vegetation, including approach for hollow-bearing trees; and
  - detail methods for pre-clearance surveys to identify biodiversity to be protected (including any threatened species) and allow fauna to escape.
- threatened species management measures including a map, list and description of all threatened species recorded in the vicinity of the surface infrastructure sites;
- weed management and disease prevention protocols; and
- other measures such as fire management and progressive rehabilitation of the REA to minimise fragmentation of vegetation.

An on-going monitoring program would be undertaken as part of the Biodiversity Management Plan for the proposed development. This program would include monitoring of potential flora and fauna impacts and would be implemented for as long as potential impacts could occur. Monitoring measures would include regular inspection, measures for response if impacts are detected, and monitoring of the success of mitigation.

In addition to the Biodiversity Management Plan, Tahmoor Coal will continue to implement a detailed ground disturbance permit procedure. Ground disturbance permits form part of Tahmoor Coal's EMS used to manage and reduce environmental impacts of activities covered by Tahmoor Mine's development consents, including impacts to flora and fauna. A ground disturbance permit is required for any surface disturbance work undertaken at Tahmoor Mine including slashing, tree lopping, removal of topsoil, clearing and access to rehabilitation areas. A ground disturbance permit requires approval from Tahmoor Coal's environment and community representative prior to works taking place.

Offset

The residual impacts of the proposed development will be offset in accordance with the proposed Tahmoor South Project – Biodiversity Offset Strategy (**Appendix K**). The Offset Strategy aims to develop an offset that satisfies both NSW and Commonwealth requirements. The package will:

- meet OEH's Principles for the use of biodiversity offsets in NSW;
- identify the conservation mechanisms to be used to ensure the long term protection and management of the offset sites; and
- include an appropriate management plan (such as vegetation or habitat) that has been developed as a key amelioration measure to ensure any proposed compensatory offsets, retained habitat enhancement features within the development footprint and/or impact mitigation measures (including proposed rehabilitation and/or monitoring programs) are appropriately managed and funded.

The Tahmoor South Project would impact on flora and fauna listed under both the BC Act and the EPBC Act, specifically with regards to:

- SSTF, listed as an EEC under the BC Act and EPBC Act (direct clearing of up to 43.4 ha);
- *Grevillea parviflora subsp. Parviflora* (Small-flower Grevillea), listed as Vulnerable under the BC Act and EPBC Act (removal of up to 2,324 individual plants);
- *Persoonia bargoensis* (Bargo Geebung), listed as Endangered under the BC Act and Vulnerable under the EPBC Act (removal of up to 100 individual plants);
- Large-footed Myotis listed as Vulnerable under the BC Act (removal of 7.4 ha of potential habitat); and
- Koala listed as Vulnerable under the BC Act (removal of 43.5 ha of potential habitat).

An Offset Strategy is proposed to achieve a long-term conservation gain for State and Commonwealth biodiversity, to offset residual significant impacts as a result of the Tahmoor South Project.

Not all impacts as a result of the proposed development would occur at once.

As vegetation clearing for the development would be staged, it is proposed that offsets be secured in a staged manner shown in **Table 11-37**.

Table 11-37 Staged offset credit requirements

Community or species	Credit Accruement		
	Stage 1 – Year 0	Stage 2 – Year 7	Total
SSFTF Shale Sandstone Transition Forest (Moderate/Good)	570	867	1,437
SSFTF Shale Sandstone Transition Forest (Moderate/good_medium)	-	599	599
SSFTF Shale Sandstone Transition Forest (Moderate good_derived)	210	-	210
Upper Georges River Sandstone Woodland community (Moderate/good)	-	287	287
Grevillea parviflora subsp. Parviflora	22,775	9,761	32,536
Persoonia bargoensis	7,392	308	7,700
Koala	403	728	1,131
Large-footed Myotis	-	163	163

Five sites have been identified to date within Tahmoor Coal landholdings which have potential to be offset sites. Detailed information on the sites is provided in **Appendix K**. These sites have been surveyed in accordance with BioBanking methodology to determine likely credits that would be generated, as summarised in **Table 11-38**.

Table 11-38 Credits generated from potential offset sites

Community or species	Potential for credits generated by Offset Sites							
	Credits Required	Pit Top	Rockford Road	Ventilation shaft No 2	Bargo Colliery	Anthony Road	Total	Credit Shortfall
Shale Sandstone Transition Forest EEC (*Narrow-leaved Ironbark - Broad-leaved Ironbark – Broad-leaved Ironbark -Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion*)	2,246	26	238	68	-	67	399	1,847

Community or species	Potential for credits generated by Offset Sites							
	Credits Required	Pit Top	Rockford Road	Ventilation shaft No 2	Bargo Colliery	Anthony Road	Total	Credit Shortfall
Upper Georges River Sandstone Woodland (*Red Bloodwood - Grey Gum woodland on the edges of the Cumberland Plain, Sydney Basin Bioregion*)	287	247	-	-	-	-	247	40
Smooth-barked Apple - Red Bloodwood - Sydney Peppermint heathy open forest on slopes of dry sandstone gullies of western and southern Sydney, Sydney Basin Bioregion	0	57	49	-	242	-	348	0
Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	0	-	-	-	3,873	-	3,873	0
Acacia bynoeana	0	-	-	-	227	-	227	0
Epacris purpurascens var. purpurascens	0	36	-	-	-	-	36	0
Grevillea parviflora subsp. parviflora	32,536	149	-	71	226,611	-	226,831	0
Persoonia bargoensis	7,700	547	-	7	1,193	-	1,747	5,953
Persoonia glaucescens	0	-	-	-	398	-	398	0
Persoonia hirsuta	0	-	-	-	1,030	-	1,030	0
Pomaderris brunnea	0	1,001	-	-	320	-	1,321	0
Large-footed Myotis	163	212	-	-	213	-	425	0
Red-crowned Toadlet	0	-	-	-	19	-	19	0
Koala	1,131	212	-	-	1,917	-	2,129	0

Based on credits generated by the sites, there would be a shortfall of credits for the development as follows:

- shortfall of 1,847 credits for SSFTF;
- shortfall of 40 credits for Upper Georges River Sandstone Woodland community; and
- shortfall of 5,953 credits for *Persoonia bargoensis*.

A final decision on which combination of sites (and the extent of land) to be offered as part of the land-based component of the Offset Strategy, would be made by Tahmoor Coal. Offset sites would continue to be identified and refined during the approval process. Following the approval of the proposed development, the following actions would be undertaken by Tahmoor Coal:

- purchase credits that are available on the public register. Note: in order to satisfy the Commonwealth offset requirement for SSFT, only credits that meet the threshold criteria for the TEC as defined under the EPBC Act would be purchased;
- final layout of offset areas would be defined by Tahmoor Coal and formally established as a BioBank site(s), in consultation with OEH and DoEE regarding application, management actions and variation criteria (if required); and
- payment into the Biodiversity Conservation Fund if required in consultation with OEH and DoEE.

In relation to credit availability, a search of the BioBanking public register on 17 December 2018 shows that:

- there are 3,001 credits issued and a further 883 pending for SSTF (HN556);
- there are 1,131 credits issued and a further 221 pending for the Upper Georges River Sandstone Woodland community (HN564); and
- there are no credits available at present for Persoonia bargonensis.

11.6.6 Conclusion

The Terrestrial Ecology Assessment undertaken for the proposed development identified that potential impacts to terrestrial vegetation throughout the study area are not anticipated to be significant as a result of subsidence. Riparian vegetation is more susceptible to subsidence impacts. However, impacts are considered to be manageable.

Impacts to native vegetation (including SSTF EEC) will occur as a result of clearing necessitated by the expansion of the REA and the construction of other surface infrastructure. An Offset Strategy has been proposed to compensate for impacts to the SSTF EEC as impacts cannot be avoided. The Offset strategy would incorporate the following credits:

- 2,246 ecosystem-credits for the 43.4 ha of clearing impacts to SSTF;
- 287 ecosystem-credits for the 5.7 ha of clearing impact to the Upper Georges River Sandstone Woodland community;
- 7,700 species-credits for the removal of 100 *Persoonia bargoensis* plants;
- 32,536 species-credits for the removal of 2,324 *Grevillea parviflora subsp. parviflora plants*;
- 163 species-credits for the removal of 7.4 ha of potential habitat for the Large-footed Myotis; and
- 1,131 species-credits for the removal of 43.5 ha of potential Koala habitat.

Impacts to threatened species within the study area will be mitigated and managed through the implementation of a Biodiversity Management Plan and an on-going monitoring program.

11.7 Aquatic Ecology

An Aquatic Ecology Assessment was prepared for the proposed development by Niche Environment and Heritage Pty Ltd, and is provided in **Appendix K**. The Aquatic Ecology Assessment addressed the SEARs and Supplementary SEARs relevant to aquatic biodiversity impacts. These are listed in **Table 11-37**. SEARs relating to terrestrial ecology have been addressed in **Section 11.6**.

Table 11-37 SEARs for the assessment of aquatic biodiversity

Biodiversity SEARs	Section addressed
Biodiversity – including:	
• an assessment of the likely biodiversity impacts of the development, including impacts to terrestrial and aquatic species and habitats in accordance with the Framework for Biodiversity Assessment, by a person accredited in accordance with s142(B)(1)(c) of the *Threatened Species Conservation Act 1995*, and having regard to OEH's requirements.	**Section 11.6** (terrestrial), **Section 11.7** (aquatic) and **Appendix K**
• a strategy to offset any residual impacts of the development in accordance with the NSW Biodiversity Offsets Policy for Major Projects.	**Section 11.6.5** and **11.7.5** and **Appendix K**
Biodiversity Supplementary SEARs	
Biodiversity	
• The EIS must identify each EPBC Act listed threatened species and community likely to be impacted by the action. For any species and communities that are likely to be impacted, the proponent must provide a description of the nature, quantum, and consequences of the impacts. For species and communities potentially located in the project area or in the vicinity that are not likely to be impacted, provide evidence why they are not likely to be impacted.	**Section 11.6.3, 11.6.4, 11.7.3** and **11.7.4** and **Appendix K**
• For each of the EPBC listed threatened species and communities likely to be impacted by the action the EIS must provide a separate: • description of the habitat (including identification and mapping of suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice and recovery plans; • details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Australian Government guidelines and policy statements; • description of the relevant impacts of the action having regard to the full extent of the species or community's range; • description of the specific proposed avoidance and mitigation measures to deal with relevant impacts of the action; • Identification of significant residual adverse impacts likely to occur after the proposed	**Section 11.6.3, 11.6.4, 11.7.3** and **11.7.4** and **Appendix K**

Biodiversity SEARs	Section addressed
activities to avoid and mitigate all impacts are taken into account; • A description of any offsets proposed to address residual adverse significant impacts and how these offsets will be established; • Details of how the current published NSW Framework for Biodiversity Assessment (FBA) has been applied in accordance with the objects of the EPBC Act to offset significant residual adverse impacts; and • Details of the offset package to compensate for significant residual impacts including details of the credit profiles required to offset the action in accordance with the FBA and/ or mapping and description of the extent and condition of the relevant habitat and/ or threatened communities occurring on proposed offset sites.	
• Any significant residual impacts not addressed by the FBA may need to be addressed in accordance with the EPBC Act Environmental Offset Policy.	Residual impacts to ecology were not identified for the proposed development
• There is some risk that there may be significant impacts on the following matters and the level of impact should be further investigated: • Macquarie Perch (*Macquaria australasica*) – Endangered.	**Section 11.7.3** and **11.7.4** and **Appendix K**
Water resources, in relation to coal seam gas development and large coal mining development	
• The EIS should provide a description of the location, extent and ecological values of the identified water resources potentially affected by the project.	**Section 11.4.3, 11.6.3, 11.7.3** and **Appendix K**
• The assessment of impacts should include information on:	
• The habitat or life cycle of native species, including invertebrate fauna and fish species, dependent upon the water resource being seriously affected.	**Section 11.6.3, 11.6.4, 11.7.3** and **11.7.4** and **Appendix K**

11.7.1 Background

The Southern Coalfields Inquiry placed particular emphasis on aquatic ecosystems. Key recommendations of the Inquiry relevant to aquatic ecological investigations include:

- streams of 3rd order or above within the mine subsidence area should be considered as RMZs;
- a minimum of two years of baseline data, collected at appropriate frequency and scale should be provided for significant natural features; and
- monitoring of mine subsidence impacts should allow for back analysis and comparison of actual versus predicted effects and impacts, in order to review the accuracy and confidence levels of the prediction techniques used (i.e. the use of Before, After, Control, Impact design ecological studies (Underwood 1981)).

The Project Area has been subject to several previous monitoring and ecological survey efforts in order to obtain sufficient baseline data to inform the footprint of the proposed development. Previous studies and surveys include:

- Tahmoor South Pilot Study (2010-11), which involved a detailed literature review and field survey of the broader CCL 747 area. The outcomes of this study informed the detailed baseline monitoring program; and

- Tahmoor South Aquatic Ecology Monitoring Program (2012-13), which involved collecting two years of baseline data on aquatic habitat (including riparian vegetation), macroinvertebrates and fish in order quantify those ecological values which may be sensitive to subsidence impacts. This program has been completed and the data was used to inform the impact assessment for the proposed development, as well as monitor impacts during and after mining of the proposed development.

The aim of the Aquatic Ecology Assessment was to assess the potential impacts of the proposed development on stream ecology and aquatic threatened species, populations, communities or their habitats. The assessment addresses the impacts of subsidence from underground coal mining as well as discharge generated from the REA and surface facilities.

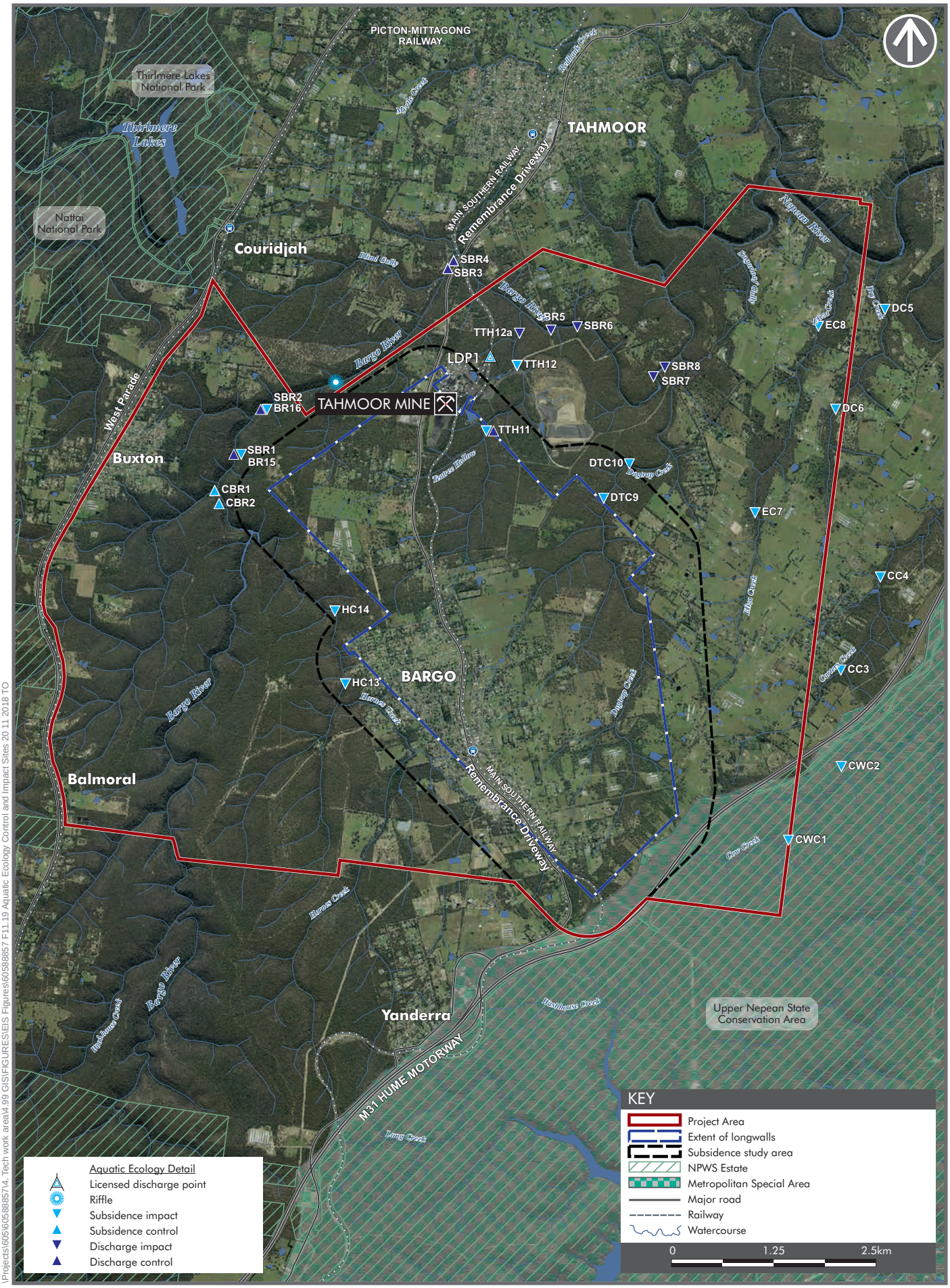
11.7.2 Methodology

The Aquatic Ecology Assessment was prepared by Niche Environment and Heritage Pty Ltd (2018) and included:

- Desktop review of background information, including:
  - A search of public databases including EPBC Act Protected Matters Search Tool (10 km search area), the OEH Bionet Atlas of NSW Wildlife (10 km search), and the Department of Primary Industries (DPI) threatened and protected species records viewer and spatial data portal (Hawkesbury-Nepean CMA and Wollondilly LGA) for species listed under the *Fisheries Management Act 1994* (FM Act); and
  - Review of previous studies within and surrounding the Project Area, including studies undertaken by Niche Environment and Heritage Pty Ltd as part of the Tahmoor two year baseline monitoring program.
- Defining subject species and affected species for further assessment.
- *Subject species* are defined as threatened species, populations or ecological communities which have been recorded or are considered to have important habitat features within 10 km of the Project Area as defined by the EPBC Act Protected Matters Search Tool, the Atlas of NSW Wildlife or DPI records viewer;
- *Affected species* are defined as subject species (including populations or ecological communities) which are known to occur or have a reasonable likelihood of occurrence and which may be impacted by the proposed development; and
- Five categories for 'likelihood of occurrence' (None, Low, Moderate, High, Known) were attributed to subject species to determine *affected species* after consideration of criteria such as known records, presence or absence of important habitat features on the subject site, and results of the field surveys. Species considered further in formal assessments of significance pursuant to relevant legislation were those in the 'Known' to 'Moderate' categories and where impacts for the species could reasonably occur from the development.
- Identifying monitoring sites (control and impact sites) for baseline monitoring. For the purpose of aquatic ecological assessment, monitoring points were selected in streams of 2rd order or above, as 1st order waterways within the Project Area were observed to have relatively small catchments, lower energy (and sediment transport), few pools (if any) and fewer areas of exposed bedrock features and therefore of low geomorphic and aquatic biota risk. The control sites and impact sites identified for monitoring and survey are shown on **Figure 11.19** and further details of monitoring locations are provided in Section 3.4 of **Appendix K**:
- Subsidence impact monitoring locations: Four potential impact watercourses within the Project Area (Dog Tap Creek, Tea Tree Hollow, Hornes Creek, Bargo River) and eight ecologically comparable creeks within and outside of the Project Area (control locations) (Cow Creek, Carters Creek, Dry Creek, Eliza Creek, Bargo River tributary, Moore Creek, Cedar Creek, Stonequarry Creek) were selected for monitoring, with two sampling sites at each location; and
- Discharge monitoring locations: two downstream potential impacts locations and two upstream control locations were monitored at Tea Tree Hollow and Bargo River.
- Field survey was undertaken in accordance with the *Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual* (Turak et al 2004) and to address the recommendations of the Southern Coalfields Enquiry (refer **Section 11.7.1**). Surveys and monitoring were undertaken over a two year period in 2012/13. The surveys undertaken for the proposed development included:
  - Habitat assessment based on description of each survey site including description of topography, presence, extent and condition of riparian and aquatic vegetation, presence of fish habitat, stream level and width, instream features and stream substrate. A photo was taken at each site;

- Riparian, Channel and Environmental Inventory assessment (Chessman et al., 1997) of each survey site. This involved producing a score for each site based on a series of observations relating to the natural characteristics and degree of disturbance evident at each site, including recording changes to these characteristics;
- Surface water quality sampling to measure temperature, conductivity, pH, oxidation-reduction potential, dissolved oxygen and turbidity. Sampling results were compared to ANZECC guidelines (2000);
- Fish, macrophyte and aquatic macroinvertebrate sampling. Fish sampling using bait traps was undertaken at subsidence and surface works monitoring sites. In addition, any fish captured as part of the macroinvertebrate sampling were recorded. The presence/absence of macrophytes within a 100 m reach at each sample site was recorded and identified to species level. Aquatic macroinvertebrates were collected using both the AUSRIVAS protocol for NSW streams (Turak et al.2004), and quantitative method for surveying macroinvertebrates. (Note: AUSRIVAS utilises modelled reference stream for comparison of macroinvertebrate fauna, and as such the control watercourse monitoring sites were not utilised for the purposes of AUSRIVAS monitoring). Macroinvertebrate samples were analysed using the AUSRIVAS spring and autumn models for NSW pool edge habitat to identify the species expected to occur at the sites based on observed habitat conditions in the absence of environmental stress, such as pollution or habitat degradation; and
- Targeted surveys were undertaken for the threatened Sydney Hawk Dragonfly (*Austrocordulia leonardi*) on 24 - 26 July and 31st July - 2 August, 2013. The survey primarily targeted tributaries of the Bargo River and Nepean River, since Austrocorduliidae (the Sydney Hawk dragonfly family) were observed in Eliza Creek in baseline monitoring samples. Potential habitat for the species was determined based on geomorphology mapping (Fluvial Systems, 2013) and GIS modelling.

- Assessment of potential impacts to aquatic habitat and biota including threatened aquatic species within the Project Area as a result of subsidence impacts to watercourses and mine water discharge, including an Assessment of Significance for potential impacts to the Sydney Hawk dragonfly;
- Assessment of potential impacts to stygofauna (groundwater) and hyporheic fauna (streams) in a Stygofauna Assessment (provided in **Appendix K**). Risks and potential impacts to stygofauna and hyporheic fauna as a result of the proposed development were assessed in accordance with the *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (Serov *et al*, 2012), and included sampling of 26 sites (separated into 13 bores and 13 hyporheic sites) (Refer **Figure 11.20**). GDEs listed on the *Water Sharing Plan for the Greater Metropolitan Regional Groundwater Sources 2011* are assessed in **Section 11.3.4**; and
- Recommendations for avoidance, mitigation and offsets for potential impacts on aquatic ecology.



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SIMEC MINING

AQUATIC ECOLOGY - CONTROL AND IMPACT SITES

Tahmoor South Project
Environmental Impact Statement

Source: Niche Environment and Heritage (2013)

FIGURE 11.19

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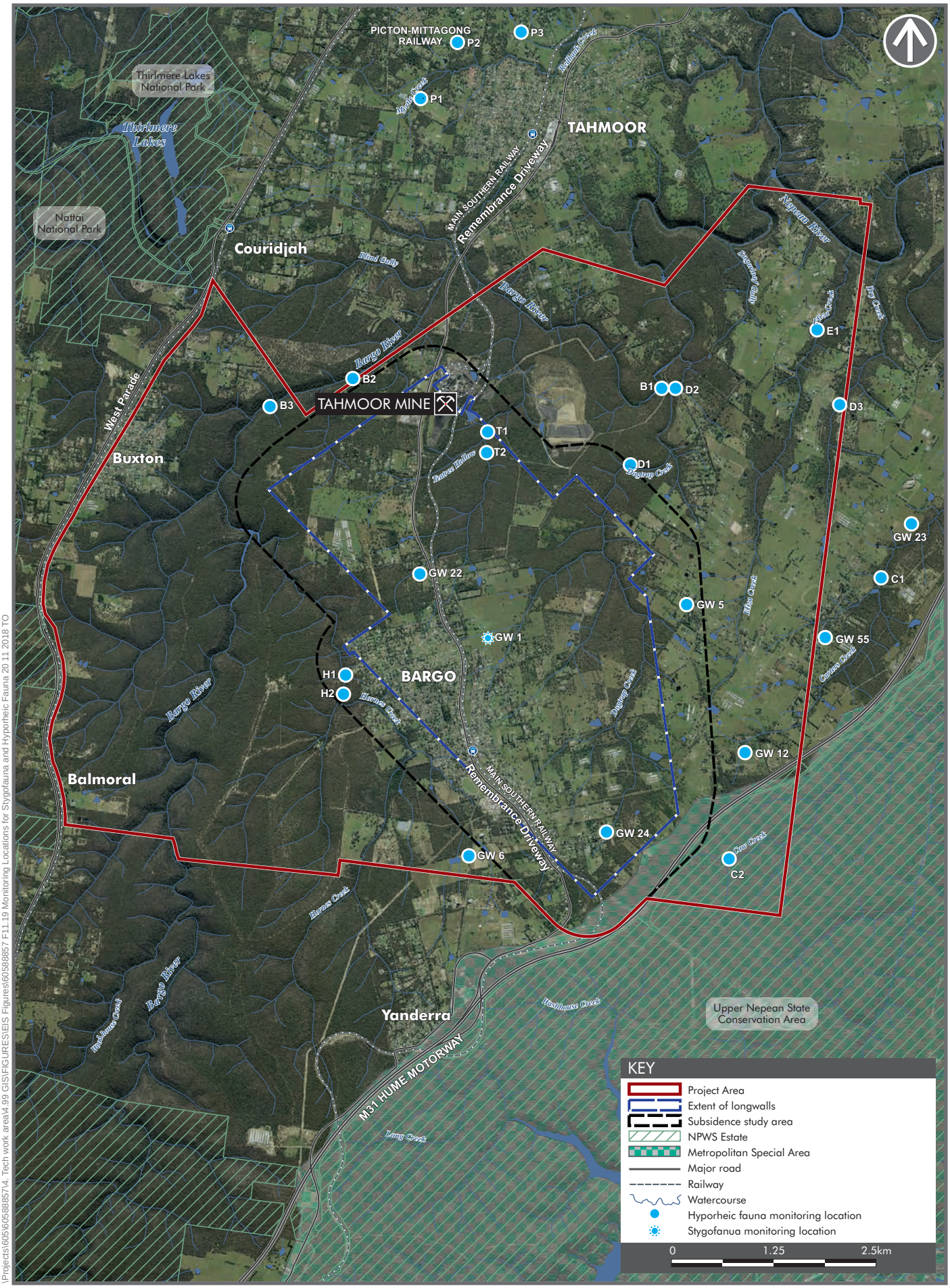

\Projects\605\605888574. Tech work area\4.99 GIS\FIGURES\EIS Figures\605888857-F11.19 Monitoring Locations for Stygofauna and Hyporheic Fauna 20 11 2018 TO

SIMEC MINING

MONITORING LOCATIONS FOR STYGOFAUNA AND HYPORHEIC FAUNA

Tahmoor South Project
Environmental Impact Statement

Source: Niche Environment and Heritage (2013)

FIGURE 11.20

11.7.3 Existing Environment

The geomorphology of watercourses within the Project Area is described in **Section 11.2** (and **Appendix H**), and the surface water impact assessment is described in **Section 11.4** (and **Appendix J**). These sections provide the background to the stream environment within which aquatic species and habitat may exist. The presence of riparian vegetation, aquatic habitat and aquatic species are reliant on varying stream features (e.g. pools, rock bars) and substrates (e.g. cobble, gravel, mud), as well as water quality (e.g. turbidity, pH, etc.). Geomorphological features of relevance to the aquatic environment are shown on **Figure 11.7**.

Riparian Vegetation

The riparian vegetation around Bargo River is dominated by Hinterland Sandstone Gully Forest. This vegetation community also occurs around Hornes Creek, Dog Trap Creek and Cow Creek. Cumberland SSTF is mapped along parts of Eliza Creek, Dry Creek and Carters Creek, while areas of Sydney Hinterland Transition Woodland occur predominantly along Eliza Creek and Dog Trap Creek (Tozer 2010).

Lomandra longifolia extensively colonises the low-level areas of all potential impact streams within the Project Area. Potential impacts of the proposed development on riparian vegetation are discussed in **Section 11.6.4**.

Aquatic Habitat and Biota

Streams within the Project Area are base flow GDEs and contain both surface and hyporheic (below river surface) habitats (**Appendix K**). It is considered that pools and riffle sections common to 1st and 2nd order creeks are likely to provide important macroinvertebrate habitat and fish refuge, whereas higher order streams are typically broader and are likely to provide habitat for larger fish species (NSW DoP, 2008). There are eight named creeks within the Project Area, ranging in order from 1st order to 4th order creeks (based on the Strahler river classification system) as identified in **Table 11-22** of **Section 11.4**. Descriptions of the aquatic habitat and habitat condition of these eight creeks ascertained through the field monitoring and survey is provided in **Appendix K**.

The majority of the creeks within the Project Area have a high percentage of bedrock and boulders instream. Habitat attributes within these creeks included pools with bank overhang and trailing bank vegetation, rock bars, small waterfalls and sections of dry bed dominated by *L. longifolia* and boulders. Hornes Creek and Tea Tree Hollow exhibited orange discolouration of the water, iron flocs and algae. Macrophytes were uncommon and many of the creeks contained freshwater yabbies *Cherax destructor*, freshwater shrimp *Paratya australiensis* and Mosquito Fish *Gambusia holbrooki*. Crofton Weed *Ageratina adenophora*, which is a Class 4 noxious weed under the NSW *Noxious Weeds Act 1993*, was present at Carters Creek and Tea Tree Hollow.

Macrophytes

Macrophytes are aquatic plants that provide food and shelter for fish, aquatic invertebrates and water birds. Submerged and floating macrophytes generally require permanent water; however they can, in time, recolonise dry areas if and when water levels return. At potential impact monitoring sites, sedges and rushes such as Spiny-head Mat-rush, *S. melanostachys*, Saw Sedge *G. clarkei, C. appressa* and *C. gracilis* were common and in some cases very dominant along creeks. However, the overall abundance, diversity and distribution of macrophytes recorded during aquatic monitoring surveys in the Project Area was low. Macrophytes recorded during surveys for the proposed development included:

- Spiny head Mat Rush;
- *S.melanostachys*;
- Saw Sedge *G. clarkei*;
- *C. appressa*;
- *C. gracilis*;
- Floating pond weed *Potamogeton sulcatus*;
- *Typha orientalis* and *Typha domingensis*;
- Slender knotweed *Persicaria decipiens*;
- Tall Spikerush *Eleocharis sphacelata*; and
- Jointed twig rush *Baumea articulate*.

Fish

A number of common and exotic fish species are present within the Project Area. Those recorded during the monitoring and survey of watercourses within the Project Area included:

- Mosquito Fish (*Gambusia holbrooki*) which was recorded in all waterways surveyed except Cow Creek;
- Firetail Gudgeon (*Hypseleotris galii*) which was recorded in Dry Creek;
- Common Jollytail (*Galaxias maculatus*) which were recorded in Hornes Creek and Eliza Creek;
- Australian Smelt (*Retropinna semoni*) which were recorded in Bargo River;
- Mountain Galaxias (*Galaxias olidus*) which was recorded in Hornes Creek;
- Freshwater crayfish (*Euastacus spinifer*) which were recorded in Hornes Creek;
- Freshwater Yabbies (*Cherax destructor)* which were recorded in all creeks within the Project Area; and
- Common freshwater shrimp (*Paratya australiensis)* which were recorded in all creeks within the Project Area.

Key Fish Habitat

Based on Key Fish Habitat mapping prepared for LGAs including Wollondilly (DPI, 2013c), sections of the following waterways within the Project Area (3rd order streams and above) have been mapped as Key Fish Habitat:

- Bargo River;
- Hornes Creek;
- Tea Tree Hollow;
- Dog Trap Creek;
- Eliza Creek;
- Carters Creek; and
- Cow Creek.

The Project Area has 3rd order streams and above which contain both:

- highly sensitive Key Fish Habitat (Type1) - “Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 m in length, or native aquatic plants” (DPI 2013a); and
- minimal Key Fish Habitat (Type 3) - “Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation” (DPI 2013a).

Macroinvertebrates

Macroinvertebrate fauna recorded at subsidence monitoring sites within the Project Area were generally comparable to AUSRIVAS modelled reference sites (Band A). However, at times, Bargo River, Tea Tree Hollow, Hornes Creek and Dry Creek scores lowered to Band B, possibly indicating impairment to macroinvertebrate communities at given times. The majority of sampling points at Bargo River indicated significantly impairment (Band B).

Watercourses within the Project Area generally recorded scores equivalent to moderate to severe pollution. It is noted that the scores are reflective of the dominance of pollutant tolerant species and can occur with the absence of pollution, if the waterway is subject to natural environmental stressors such as low rainfall/flow. Watercourses consistently recording high AUSRIVAS scores include Bargo River, indicating moderate pollution.

The dominant Macroinvertebrates recorded in watercourses within the Project Area include *Leptophlebiidae* (may fly) and *Chironomidae*, *Tanypodinae*, *Othocladinae* (non-biting midges), *Oligochaeta* (worm) larvae and *Leptoceridae* (caddis fly).

Threatened Aquatic Species

Database searches identified four threatened aquatic species with the potential to occur within 10 km of the Project Area (**Table 11-38**). Of these, only the Sydney Hawk dragonfly is considered to have potential habitat within the Project Area. However, the Sydney Hawk dragonfly was not recorded during targeted surveys conducted in July / August 2013.

Table 11-38 Threatened aquatic species recorded within the locality and likelihood of occurrence within the Project Area

Scientific Name	Common Name	Status	Likelihood of occurrence
Austrocordulia leonardi	Sydney Hawk dragonfly	Endangered (FM Act)	Moderate. Potential habitat occurs in the Bargo/Nepean River. Not recorded in targeted surveys.
Archaeophya adamsi	Adam's Emerald dragonfly	Endangered (FM Act)	Low. Only one potential riffle habitat located which will not be impacted by the proposal.
Petalura gigantea	Giant Dragonfly	Endangered (BC Act)	Low. No suitable habitat.
Macquaria australasica	Macquarie perch	Endangered (EPBC Act, FM Act)	Low. Potential habitat occurs in the Bargo/Nepean River outside of the Project Area only (barrier to fish passage at Mermaid Falls).

Stygofauna

Stygofauna (groundwater) and hyporheic fauna (streams) exist in small isolated populations within the Project Area (**Figure 11.20**):

- Stygofauna (hyporheic fauna) were recorded at seven of the stream sampling sites from the 13 sampled. Hyporheic fauna were recorded at all river sites that were supported by a perennial base flow but were low in diversity and abundance. Fauna recorded was dominated by surface macroinvertebrates, but also included ostracods and worms associated with aquifer environments; and
- Stygofauna were recorded at only one groundwater bore site (GW1 on Great Southern Road) from the 13 sampled.

Upland swamp complexes are known to support habitat for abundant levels of stygofauna. The nature of the geology, sediments and lack of fracture zones; as well as the hilly/sloping topography of the Project Area reduces the occurrence of upland swamp complexes (no upland swamps were identified in the Terrestrial Ecology Assessment, **Section 11.6**). It is considered that the limited diversity and abundance of stygofauna in the Project Area is due to the limited available stygofauna habitat associated with upland swamps. Further, in addition to the limiting geomorphology characteristics, the Stygofauna Assessment concluded that the diversity of the stygofauna composition is also limited by stream and groundwater water chemistry (i.e. very low levels of groundwater dissolved oxygen, high levels of dissolved iron, lower pH levels ranging from approximately 6-4 pH units), and the small, transient, disconnected nature of the riverine hyporheic zone habitats.

11.7.4 Impact Assessment

Potential impacts typical of longwall mining relevant to aquatic ecology relate to changes to stream geomorphology and hydrology and include the following:

- fracturing and surface water flow diversion;
- increased levels of ponding;
- changes to water quality as a result of:
  - subsidence induced fracturing; and
  - mine water discharge impacts.

Significant subsidence movements are not predicted at the Nepean River (outside the SSA) and the Bargo River (4^{th} order, 165 m section within the SSA) and these rivers would not be undermined, indicating that the quality and quantity of available aquatic habitat is unlikely to be impacted. However, potential impacts to aquatic habitat within the creeks located within the Project Area may occur as a result of subsidence impacts on surface water, as described in the sections below.

Fracturing, Surface Water Diversion and Draining of Pools

Fracturing resulting in surface water flow diversion is considered likely to occur for streams that are directly mined beneath by the proposed development. This fracturing also has the potential to drain or change levels in pools along creeks. It is not possible to predict the precise locations where fracturing would occur due to the proposed development or the flow capacity of subsurface fracture networks. However, analysis of past observations by MSEC (2018) indicates that some of the main factors that contribute to the fracturing of pools relate to the characteristics of the valley that the pool is located within including:

- pre-existing levels of stress in the valley floor;
- depth and shape of the valley;
- presence of rock bars and perennial pools and the presence and mobility of alluvium; and
- the geological characteristics of the valley.

A risk assessment for the potential fracturing of pools was undertaken based on the preliminary relationship between valley characteristics and potential fracturing that has been established by MSEC (2018). Areas within the Project Area identified as medium to high risk of impacts to pools include portions of Tea Tree Hollow and Dog Trap Creek. Mapped pools within these watercourses and potential subsidence impacts to these pools are listed below:

- Tea Tree Hollow: There were 14 mapped pools in Tea Tree Hollow and most of these pools are located in areas where there is a low risk of impact to pool levels. Two pools are located within an area of moderate risk of impact; and
- Dog Trap Creek: There were over 70 pools mapped in Dog Trap Creek. The majority are located in areas of low risk of impact to pool areas and 14 pools are located in areas of either moderate or high risk.

Overall, the assessment indicates that there would be a moderate or high risk (of losing water holding capacity) to around 19% of the mapped pools within these watercourses (MSEC, 2018). However, it should be noted that experience has shown that over time, pools tend to recover naturally from fracturing due to sealing by deposited fine sediment (Tahmoor Colliery, 2004, Centennial Tahmoor, 2005, Centennial Coal, 2006, Centennial Coal, 2007, Xstrata Coal, 2008).

Sudden drainage of pools or rapid drops in stream flow can result in changes to abundance, richness, and diversity of aquatic biota and possibly mortality of macroinvertebrates and native fish. Streams with soft sediment banks which retain moisture are likely to prolong survival (through protection from desiccation) compared to streams with bedrock substrate with limited natural refugia.

There is capacity for recovery of some stream biota, particularly macroinvertebrate fauna, as most taxa identified within the Project Area are able to adapt to drying conditions and have the potential to recruit back to pools once re-established. However, fauna with limited distribution and poor dispersal are not as adaptable and would be most impacted. Fish may be limited in their capacity to re-establish if river connectivity is reduced; however connectivity is likely to be re-established in periods of higher flow, allowing fish movement. Submerged and floating macrophytes generally require permanent water; however can, in time, recolonise dry areas when water levels return. It is noted that no threatened aquatic species have been identified as likely to be impacted within the Project Area and this is further discussed below. Should long term drainage impacts occur (where pools become permanently dry or reduce holding capacity), permanent changes to stream biota within the pools could occur as well as restrictions to the recovery of aquatic species that depend on stream connectivity (e.g. fish). Mitigation measures to monitor long term impacts and rehabilitate affected streams should impacts occur are outlined in **Section 11.7.5**.

For invertebrates, while there will be loss of habitat in sections of streams, and changes to invertebrate composition, density and family richness where these impacts occur; at a sub-catchment to catchment scale changes to overall assemblage and family richness are unlikely to be measurable.

A variety of possible remediation options would be considered when surface water diversion and draining of pools have the potential to have a substantial impact on aquatic ecology, as discussed further in **Section 11.7.5**. These could include one or a combination of the following:

- allowing natural sealing to occur over time;
- mechanical grouting of cracks and voids to promote surface flow; and
- the addition of sealers and/or binders to water flow to seal cracks and voids.

Increased Ponding

While the potential for increased scouring is not expected to be significant within the Project Area, there is a predicted reversal of grade along a naturally flat section of Dog Trap Creek, upstream of the tailgate of LW103, which results in increased potential for ponding in an area which is estimated to be up to 0.2 m deep and 150 m long. Increased ponding would provide a localised increase in available habitat for aquatic macroinvertebrates. Should an increase in ponding occur, and these ponds maintain connectivity to the streams, there may also be increased localised habitat for fish and macrophytes.

Changes to Water Quality

Changes to water quality may also impact the quality of aquatic habitat. Potential impacts to water quality could result from the liberation of contaminants from surface fractures causing localised increases in iron and other minerals. Scouring may also increase turbidity and suspended solids. These subsidence-related impacts could affect biota in Tea Tree Hollow and Dog Trap Creek and downstream watercourses. Impacts may be observed through a reduction in abundance, richness and changes to invertebrate community composition such as *Leptophlebiidae* (Mayfly). However, potential impacts to aquatic fauna are likely to be localised, and fauna are able to recover from transient spikes in concentrations (Niche, 2018).

Mine water discharge has the potential to elevate concentration levels of dissolved salts and metals and can pose environmental risks to aquatic biota. Elevated concentrations in metals can reduce abundance and diversity of macroinvertebrates. Barium precipitate was observed at the Tea Tree Hollow discharge point, which is thought to impact on benthic macroinvertebrates by smothering substrate and thereby limiting habitat and the availability of food resources. It is noted that the potential effect of discharges decrease with increasing distance from the source and would be diluted during periods of high flow.

As described in **Section 3.4.3** a waste water treatment plant (WWTP) was constructed at Tahmoor Underground Mine in June 2015. The purpose of the plant is to treat up to 6 ML/d of mine water to reduce the concentrations of Arsenic, Nickel and Zinc in the water discharged from the mine from the LDP1, with the treatment objectives set by a Pollution Reduction Program (PRP 22) on the EPL. During commissioning of the WWTP, it was found that the complex water chemistry of the underground mine waters was buffering chemical reactions in the treatment processes preventing the effective removal of metals. As such a range of upgrades to the WWTP were proposed and are currently being implemented. The PRP 22 was extended until November 2018.

Increases in heavy metals in mine water discharge are not predicted from the proposed development and it is expected that the commissioning of the upgraded WWTP (as part of PRP 22) will reduce concentrations of heavy metals from mine water discharge and also reduce barium precipitation. Completion of the program would most likely result in enhanced water quality in Tea Tree Hollow and the Bargo River downstream and thus improved habitat for primary producers and aquatic fauna. Within nine months of the WWTP recommissioning, an aquatic health assessment would be undertaken at Tea Tree Hollow and the Bargo River to confirm aquatic health in accordance with the requirements of PRP 26.

An investigation was undertaken by Cardno (2016) as part of PRP 23 to evaluate potential impacts to aquatic ecology from electrical conductivity (EC)/ salinity levels at the licensed discharge point at Tea Tree Hollow. The PRP 23 investigation found localised effects to aquatic ecology at Tea Tree Hollow and Bargo River, downstream of the licensed discharge point, comprising a reduction in pollution sensitive invertebrates and an increase in pollution tolerant invertebrates. The study found the effects of the discharge to be localised within a few km downstream of the discharge point and not excessive in the context of a system modified by other anthropogenic land uses. Whist EC levels at LDP1 were found to be elevated, the PRP investigation considered the levels to not be excessive and within the reported tolerances of many aquatic biota present in Tea Tree Hollow and the Bargo River. Additionally, EC levels at the Bargo River were found to be more influenced by background levels of EC and flow levels at the Bargo River compared to EC levels from discharge at LDP1. Based on the PRP investigation, changes to the existing licence limit for EC / salinity were not considered beneficial with respect to aquatic health.

The Water Management System and Site Water Balance Report indicated that the proposed water management system would have capacity to contain water on site and capacity to manage off-site releases within conditions of the EPL 1389 until at least 2031.

In order to maintain treatment of water to be discharged via LDP1, it is anticipated that the capacity of the WWTP will need to be upgraded at some stage after 2031. The WWTP would be upgraded as required to meet mine water treatment demand post 2031 to ensure that licensed discharge limits at LDP1 are met (see **Section 11.4.6** for further information).

Mine discharge water from the proposed development would be subject to existing EPL discharge limits with respect to EC/salinity. As such impacts to downstream water quality and aquatic ecology beyond existing levels are not expected to occur.

Key Fish Habitat

As identified in **Sections 11.1 – 11.4**, the proposed development has the potential to impact on waterways within the Project Area through subsidence related changes to stream processes and changes to stream flow, with consequent impacts to aquatic habitat. This includes sections of waterways mapped as Key Fish Habitat within the Project Area, particularly in areas along Dog Trap Creek and Tea Tree Hollow. Monitoring programs would be implemented to identify stream changes and undertake remediation measures where required. If monitoring indicates impacts to sections of waterways mapped as Key Fish Habitat, DPI Fisheries would be consulted to identify appropriate habitat rehabilitation measures and/or if environmental compensation (such as habitat replacement measures) are required. Any conditions will be incorporated into the monitoring and management of the waterways and key fish habitat. As part of the development of the required Extraction Plan and associated management plans for the Project, a TARP will be prepared, which will incorporate appropriate triggers, monitoring regimes and appropriate actions for key fish habitat in the Project Area.

Threatened Aquatic Species

The Sydney Hawk dragonfly was assessed as having a moderate likelihood of occurrence as potential habitat may occur within the Bargo and Nepean River. This species was subject to targeted survey. All pools with a predominantly boulder and/or cobble substrate were defined as containing potential habitat for this species and based on geomorphic mapping, a total of 29 potential habitat sites were identified within the Project Area. These sites were surveyed with two of the sites found to be dry and the remaining 27 sampled. No specimens of Sydney Hawk dragonfly were recorded during the site survey. Whilst specimens of the family *Austrocorduliidae* (to which the Sydney Hawk dragonfly belongs) were recorded at Eliza Creek, these were confirmed as the non-listed *Austrocorduliidae refracta* species. *A. refracta* can inhabit smaller streams whereas the Sydney Hawk Dragonfly is thought to be restricted to larger streams in coastal areas (Theischinger 2013). Therefore the presence of *A. refracta* does not necessarily indicate suitable habitat for the Sydney Hawk dragonfly. Larger watercourses within the Project Area, such as the Bargo and Nepean River, which could provide potential habitat for this species, are unlikely to be impacted by subsidence. An Assessment of Significance was undertaken for the Sydney Hawk dragonfly and determined the proposed development is unlikely to have a significant impact on this species.

The EPBC Act protected matters search tool reported the Macquarie Perch within a 10 km radius of the Project Area. The creeks within the Project Area have been assessed as having 'None' to 'Low' likelihood of containing Macquarie Perch habitat, based on available habitat being highly fragmented with rock bars and other barriers to fish movement, and the ephemeral nature of the 1st and 2nd order streams within the Project Area. The creeks also lack suitable spawning habitat. Whilst there are some sections on the Bargo River within the Project Area that contain suitable habitat for Macquarie Perch, they occur above Mermaid Falls and below Picton Weir. It is considered unlikely that a viable population of Macquarie Perch exists in this limited range and there are no recorded occurrences of this species within this section of the Bargo River despite surveys being conducted as part of this assessment and surveys by NSW DPI. As such, impacts to this species are considered unlikely.

Stygofauna

The Stygofauna Assessment concluded that the ecological value of the stygofauna community across the SSA is low, with 'hotspots' of biodiversity with potentially a high degree of endemism. The survey sites with the highest total number of recorded stygofauna individuals included B2 and B3 along the Bargo River, C2 along Cow Creek and GW 1 along Great Southern Road (refer **Figure 11.19**).

Subterranean ecosystems both in the aquifers and the river systems were identified to exist, although none are currently listed as endemic, relictual, rare, or endangered biota (fauna or flora) populations or communities as listed under the TSC Act, FM Act or the Commonwealth EPBC Act or identified by an acknowledged expert Taxonomist/Regional Ecologist as being important.

The risk assessment undertaken for the Stygofauna Assessment determined that the ecological value of the hyporheic sites across the SSA is mostly low, with only the site at Cow Creek (C2) assessed as being moderate, although there was connectivity between the shallow aquifers and the associated rivers. The assessment found moderate to low potential impacts to the subterranean ecosystems as a result of the proposed development. This was attributed to the separation of the shallow aquifers that support these ecosystems from the deeper aquifers, and also that most of the hyporheic sites are at lower risk from subduction from the project.

11.7.5 Management and Mitigation Measures

In accordance with the OEH NSW Biodiversity Offsets Policy for Major Projects and DPI *Policy and guidelines for fish habitat conservation and management* (2013), the proposed project has used the principle hierarchy for impact avoidance and mitigation:

1) Avoid – unnecessary biodiversity impacts must be avoided where possible;

2) Minimise – where biodiversity impacts cannot be avoided by design or other preventative measures, then the impact must be minimised through mitigation measures and environmental safeguards; and

3) Offset – after all feasible measures have been undertaken to avoid or minimise impacts, offsets are to be used to compensate for any remaining impacts.

Avoidance

The proposed development has, in the first instance, avoided biodiversity impacts where possible. Direct impacts during construction are forecast to be minimal as the project would not require works to occur within waterways. Indirect impacts on receiving waters may occur as a result of run-off effects, however these would be managed appropriately through the implementation of erosion and sediment controls (refer to **Section 11.18**).

The proposed Mine Plan was developed by Tahmoor Coal following extensive risk assessment process and included consideration of predicted subsidence impacts on the MSA and associated built and natural features including Cow Creek. Tahmoor Coal made a number of revisions to the original Mine Plan, including shortening Longwall 105 to 108 from the commencing ends of the longwalls such that they do not encroach into the MSA and Cow Creek and no longer proposing mining in the Eastern Domain to avoid impacts to Eliza Creek.

Early mine plans for the proposed development included longwalls beneath the Bargo River in the west and south of the mining lease areas. However, due to the environmental and social significance of this river, the initial mine plan underwent a revision to avoid longwall mining directly under these sensitive surface features. Subsequent stages of the mine planning process investigated the longwall extraction of coal adjacent to the Bargo River and beneath Hornes Creek. The current mine plan avoids undermining the Bargo River and Hornes Creek and the project's SSA does not extend to: Carters Creek, Cow Creek, Dry Creek, Eliza Creek and Sugar Leaf Gully.

Refer to **Section 5.3.7** for further information regarding how potential impacts have been minimised for the proposed Mine Plan.

Mitigation

In order to minimise impacts to aquatic ecology as a result of the proposed development, impacts would be mitigated through:

- an aquatic ecology monitoring program to monitor aquatic heath downstream of the discharge from the proposed development, focusing on precipitates and impacts to benthic macroinvertebrates including in-situ quantitative sampling;
- monitoring of macroinvertebrates for a baseline period of two years prior to longwall extraction. The monitoring program may require adding or relocating monitoring sites according to the final mine plan, and using the same sampling methods as used in the aquatic monitoring conducted to date;
- a BACI (Before After Control Impact) designed monitoring program to compliment the baseline information collected and to assess monitoring impacts in an adaptive management framework;
- appropriate stream rehabilitation measures applied to areas that undergo significant impacts due to subsidence; and
- preparation and implementation of a Creek Remediation Action Plan and TARP for potential impacts to pools and other aquatic habitat features identified in the Aquatic Ecology Assessment (**Appendix K**). Stream triggers would be developed using baseline data and anticipated subsidence effects, with specific triggers continuing to be developed as monitoring continues and refined in consultation with key stakeholders. Where a trigger is exceeded, the cause and effect would be investigated. In the instance that the cause is directly related to mining, a corrective management action plan would be developed. The mitigation or remediation plans would outline methods to reduce ongoing impacts to levels below the impact assessment criteria as quickly as possible. This could include stream grouting and use of other engineering works.

Key Fish Habitat

The Project may affect habitat that has been mapped as key fish habitat in a number of locations, particularly in areas along Dog Trap Creek and Tea Tree Hollow (see **Section 11.7.4**), and therefore some remediation measures may be required. If monitoring indicates this is the case, DPI Fisheries will be required to be consulted to determine the appropriate habitat rehabilitation measures or if environmental compensation is required. Any conditions will be incorporated into the monitoring and management of the waterways and key fish habitat. Further, as part of the development of the required Extraction Plan and associated management plans for the Project, a TARP will be prepared, which will incorporate appropriate triggers, monitoring regimes and appropriate actions for key fish habitat in the Project Area.

11.7.6 Conclusion

The Subsidence Impact Assessment (refer to **Section 11.1**) identified that subsidence impacts would impact on natural and built features within the SSA. These impacts are primarily related to surface cracking, localised water loss and ground deformations which can damage or reduce values of these features. The Aquatic Ecology Assessment identified that aquatic habitats of streams within the SSA may be impacted by subsidence related impacts to surface water in Tea Tree Hollow, Dog Trap Creek and downstream watercourses, such as changes to stream beds, altering surface water flows and ponding, and changes to water quality.

The Aquatic Ecology Assessment determined:

- significant subsidence movements are not predicted at the Nepean and Bargo Rivers and these rivers would not be undermined, indicating that the quality and quantity of available aquatic habitat is unlikely to be impacted;
- only one listed threatened aquatic species is considered to have potential habitat within the Project Area (Sydney Hawk dragonfly). It was determined that the proposed development is unlikely to have a significant impact on this species; and
- there would be moderate to low impacts to stygofauna and hyporheic sites as a result of the proposed development.

Rehabilitation of subsidence impacts to land, including rehabilitation of surface cracking impacts to watercourses and drainage lines, would be undertaken for the proposed development as described in **Section 11.1.7**.Specific impacts to areas of Key Fish Habitat would be mitigated by the measures outlined in **Section 11.7.5** and residual impacts would be offset in negotiation with DPI (as required).

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11.8 Aboriginal Cultural Heritage

An Aboriginal Cultural Heritage Assessment (ACHA) was prepared for the proposed development by Niche Environment and Heritage and is provided in **Appendix L**.

The Aboriginal heritage assessment addressed the SEARs relevant to Aboriginal heritage impacts. These are listed in **Table 11-39**. Aboriginal parties who hold cultural knowledge relevant to determining the cultural significance of Aboriginal objects and/or places in the area of the proposed development were registered as part of the consultation process and were consulted throughout the EIS process. A detailed description of consultation with indigenous stakeholders carried out for the project is provided in **Section 11.8.2**.

Aboriginal site names, locations and photographs have been excluded from this public document at the request of the Knowledge Holders as they have been deemed culturally sensitive by local Registered Aboriginal Parties (RAPs).

Table 11-39 SEARs for the assessment of heritage impacts

SEARs	Section addressed
Heritage – including:	
• An assessment of the likely Aboriginal and historic heritage (cultural and archaeological) impacts of the development, having regard to OEH's requirements (see below).	**Section 11.8** and **11.9**, and **Appendix L**
OEH's requirements are reproduced below. The EIS must provide a heritage assessment including but not limited to an assessment of impacts to *State and local heritage* including conservation areas, natural heritage areas, places of Aboriginal heritage value, buildings, works, relics, gardens, landscapes, views and trees. Where impacts to State or locally significant heritage items are identified, the assessment shall:	**Section 11.8** and **11.9**, and **Appendix L**
- Outline the proposed mitigation and management measures (including measures to avoid significant impacts and an evaluation of the effectiveness of the mitigation measures) generally consistent with the NSW Heritage Manual (1996);	**Section 11.8.5** and **11.9.5**
- Be undertaken by a suitably qualified heritage consultant (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria),	The assessment in **Appendix L** was undertaken by Niche Environment and Heritage.
- Include a statement of heritage impact for all heritage items (including significance assessment);	**Section 11.8.3, 11.8.4, 11.9.3** and **11.9.4**
- Consider impacts including, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, landscapes and vistas, and architectural noise treatment (as relevant); and	**Section 11.8.4, 11.9.4** and **11.10.4**.
- Where potential archaeological impacts have been identified develop an appropriate archaeological assessment methodology, including research design, to guide physical archaeological test excavation (terrestrial and maritime as relevant) include the results of these test excavations.	**Section 11.8.2**. Test excavations were not required as part of the survey methodology for the assessment.

11.8.1 Background

As described in **Section 2.3**, the Project Area comprises a gently undulating landscape with generally low relief and slight slopes and is within the traditional area of the Tharawal people. Topography becomes steeper nearer to the valleys of the Bargo and Nepean Rivers that are generally associated with a deeply incised sandstone landscape forming steep sided valleys, gorges and cliffs. The landscape presents a range of landforms that may have been utilised by traditional Aboriginal groups.

Subsidence predictions for the proposed development were prepared by MSEC (2018) and are summarised in **Section 11.1**. The assessment of potential subsidence identified natural surface features that are sensitive to subsidence movements including streams and valleys, which are known for providing areas for focused occupation for the Aboriginal community, including art and occupation sites in rock shelters. Consequently, the ACHA for the proposed development considered the potential effects of subsidence on these features.

Tahmoor Coal has consulted with RAPs and individuals regarding the proposed development and has sought their views about cultural significance of the area. As part of the development of the mine plan, a risk assessment process was undertaken to identify RMZs as detailed in **Chapter 5**. Heritage values were determined from consultation with indigenous stakeholders and through the preparation of the ACHA, the outcomes of which were used in the subsidence risk workshops. At the workshop, rock shelters were identified as being of high significance and project archaeologists and subsidence engineers therefore delineated RMZs to manage impacts on these heritage items.

Representatives from the Tharawal Local Aboriginal Land Council and Cubbitch Barta Native Title Claimants participated in the field survey undertaken for 16 days in 2013. Additional site surveys undertaken over three days in October 2017 were accompanied by a representative from Cubbitch Barta Native Title Claimants. As a result of consultation with RAPs and individuals, it was determined that all of the archaeological heritage sites hold cultural significance for the RAPs. Further, the consultation also determined specific sites of high significance including along Dog Trap Creek.

Longwall 102 and Longwall 103 have been designed to avoid mining beneath rock shelter sites along Dog trap Creek with artwork that is of high cultural and archaeological significance. The surface infrastructure for the proposed development would also avoid all grinding grooves and rock shelters, and therefore there would be no potential surface disturbance impacts to archaeological sites with moderate or high scientific significance. The mine plan has also been amended to avoid impacts to archaeological heritage sites and sensitive water features in the south east section of the Project Area south of the Hume Highway.

11.8.2 Methodology

The ACHA was undertaken in accordance with the following guidelines:

- *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (NSW Department of Environment, Climate Change and Water (DECCW), 2010a) (the Code);
- *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (OEH, 2011);
- *The Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW* (NSW OEH, 2011);
- *Draft Guidelines for Aboriginal Cultural Heritage Assessment and Community Consultation* (DEC, 2005);
- *The Aboriginal cultural heritage consultation requirements for proponents 2010* (the ACHCRs) (DECCW, 2010b); and
- *The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance* (Australia International Council on Monuments and Sites, 2013).

The following methodology was used to complete the ACHA:

- Review of background information, including:
    - Review of previous heritage assessments within and surrounding the Project Area;
    - A search of the AHIMS database; and
    - A search of other public heritage registers including: the National Heritage List and Commonwealth Heritage List (via the Australian Heritage database), State Heritage Register, S170 Heritage and Conservation Registers and the National Trust Register.

- Predictive modelling of the Project Area to establish a theoretical model for site location and distribution within the Project Area. The predictive model for the proposed development was based on a review of geologic, geomorphic, hydrologic and archaeological data obtained during a review of background studies.
- Field survey of sensitive landforms within the Project Area, in particular creeks and associated landforms identified in the predictive model including:
    - Areas designated within the Project Area that would be disturbed by surface infrastructure;
    - Rivers, creek lines and large sandstone rock platforms that have the potential to be affected by subsidence within the Project Area; and
    - Previously registered sites that fall within the potential subsidence zone (SSA) of the proposed longwalls, in order to verify their location and condition, as well as to complete a more systematic archaeological assessment of these areas.
- Consultation with Aboriginal communities in accordance with the ACHCRs, including:
    - Notifying the Aboriginal community of the proposed development (through advertisement and letters) and inviting local Aboriginal parties to register their interest for further consultation;
    - Presenting the proposed development to those Aboriginal parties who registered an interest;
    - Gathering information regarding cultural significance from the RAPs regarding the protocol for sourcing and holding cultural information, and their views on potential management options;
    - Enabling the RAPs to attend the field assessment component; and
    - Enabling the RAPs to review and provide comments on the assessment methodology and draft ACHA report.
- Preparation of statements of significance for the Project Area, prepared in consideration of comments received from the RAPs during the consultation process; and
- Formulation of recommendations based on the:
    - Scientific significance of the Aboriginal heritage sites;
    - The assessment of potential impacts; and
    - The suggested management and mitigation measures for potential impact on Aboriginal cultural heritage.

11.8.3 Existing Environment

Predictive Model

Predictive modelling aims to establish a theoretical model for site location and distribution within a given area. The predictive model for the proposed development was based on a review of geologic, geomorphic, hydrologic and archaeological data obtained during a review of background studies.

The predictive model for the proposed development determined that:

- open lithic sites (artefacts scatters and isolated artefacts) are the most likely site type to occur, and are most likely to occur in association with water-related landforms and gentle slopes less than 100 m from natural watercourses. Site sizes and densities are generally expected to increase with decreasing distance to natural watercourses;
- scarred trees may occur in the areas which feature native bush which has not been previously cleared;
- Aboriginal burials are unlikely to occur due to the lack of suitable soils landscapes;
- no Aboriginal places have been declared within the Project Area (November 2011) or listed on AHIMS;
- potential exists for bedrock exposure, consequently increasing the potential for sites such as axe grinding grooves or quarries; and
- the geological characteristics of the Project Area are consistent with those required for sandstone shelters. Previously unidentified sandstone shelters are likely to occur along Dog Trap, Eliza and Dry Creeks as well Tea Tree Hollow as systematic assessment has previously not occurred at these locations.

Registered Sites

A search of the AHIMS database was undertaken on 31 January 2013 and identified 37 previously recorded Aboriginal archaeological or cultural sites within the Project Area. An updated search of the AHIMS database was undertaken on 11 October 2018 and identified 40 previously recorded Aboriginal archaeological or cultural sites within the area (39 archaeological sites and one Aboriginal dream time story). Of the 39 Aboriginal archaeological sites registered in the Project Area, 27 were confirmed during the assessment. The remaining twelve artefact sites in the form of isolated stone artefacts and open camp sites have not been reassessed as part of this assessment because of access restrictions to the sites and due to the fact that mine subsidence would not harm these types of sites. AHIMS sites are shown in the ACHA in **Appendix L**. Descriptions of the previously recorded sites, as well as newly recorded sites, are also provided in **Appendix L**.

The most common site types recorded in the Project Area comprised of rock shelters with art and stone artefacts sites.

The location of registered Aboriginal archaeological or cultural sites is considered to be culturally sensitive information and so mapping of these sites is not provided as part of this EIS. However, the location of these sites has been considered and the mine plan has been amended to minimise impacts to aboriginal cultural heritage. As described in **Section 11.8.1**, the mine plan was redesigned to avoid mining directly under rock shelters with artwork that is of high cultural and archaeological significance identified with the Project Area around Dog Trap Creek. Archaeological sites of high cultural and archaeological significance are not located in areas proposed for surface infrastructure for the proposed development.

Dog Trap Creek

Dog Trap Creek features a high concentration and diversity of site types, in particular rock shelters with art. The majority of the sites recorded are associated with moderately steep slopes along the creek line. Dog Trap Creek is considered to be a significant archaeological and culturally significant complex due to the distinctive and representative assemblage of anthropomorphic motifs, and art assemblages that are locally notable for the number of stencils and motifs present. Factors that have contributed to the Dog Trap complex is the creek line itself, the existing sandstone geology which has allowed the formation of shelter sites suitable for habitation, and the surrounding topography (Niche, 2018).

11.8.4 Impact Assessment

A significance assessment of the Aboriginal cultural heritage sites and values of the Project Area was undertaken in accordance with the relevant guidelines and considered two main themes:

- cultural/social significance of Aboriginal objects and/or places to Aboriginal people as identified in consultation with RAPs; and
- scientific (archaeological) significance (the potential to provide information about the past through archaeological investigation).

The consideration of the themes described above was undertaken in consultation with RAPs and other individuals by appropriately qualified heritage professionals.

Cultural

The natural heritage and environmental features of the landscape hold landscape value in terms of Aboriginal cultural heritage. In addition, specific local features and places are considered to hold some Aboriginal cultural landscape value to local community groups.

Tahmoor Coal has consulted with RAPs and individuals regarding the proposed development and has sought their views about cultural significance of the area. Representatives from the Tharawal Local Aboriginal Land Council and Cubbitch Barta Native Title Claimants participated in the field survey undertaken for 16 days in 2013. Additional site surveys undertaken over three days in October 2017 were accompanied by a representative from Cubbitch Barta Native Title Claimants. As a result of consultation with RAPs and individuals, it was determined that all of the archaeological heritage sites hold cultural significance for the RAPs. However, the consultation also determined specific sites of high significance, including along Dog Trap Creek. The mine plan has been designed to minimise impacts to these sites as described below. Specific comments from the RAPs are included in the ACHA in **Appendix L**.

As described in **Section 11.8.1**, assessment and survey of sensitive heritage features along Dog Trap Creek have been undertaken as part of baseline monitoring and preparation of this EIS. The results of this assessment have fed into an analysis of the risk of potential impacts to these sensitive surface features due to subsidence,

and into the mine planning process, resulting in modification to the extent of longwalls and the location of ventilation shafts in these areas. Longwall 102 and Longwall 103 have been designed to avoid mining beneath four rock shelter sites along Dog Trap Creek with artwork that is of high cultural and archaeological significance.

Archaeological

Of the 40 Aboriginal heritage sites identified within the Project Area, one comprises a cultural site (Bandibong – Aboriginal dream time story) and the remaining 39 comprise archaeological sites.

The scientific significance of the archaeological sites was assessed based on research potential, representativeness and rarity criteria.

The findings of the archaeological significance assessment undertaken for the 39 archaeological items recorded within the Project Area identified the following:

- two sites (shelters with art, including one with axe grinding groves, both at Dog Trap Creek) were assessed to be of moderate-local archaeological or scientific significance (52-2-1524 and 52-2-1527);
- four sites (shelters with art, including some with axe grinding grooves, artefacts and deposits, at Dog Trap Creek) were assessed to be of high-local archaeological or scientific significance (52-2-1523, 52-2-1525, 52-2-1528 and 52-2-1529); and
- The 33 remaining archaeological sites were considered to be of low archaeological significance.

Rock shelter sites 52-2-1523, 52-2-1524, 52-2-1525, 52-2-1527, 52-2-1528 and 52-2-1529 were identified as moderate to high scientific significance due to their location, high density of art, high intactness of art, evidence of chronology provided by motifs, motif representation and the rarity of these motifs/ art technique within the region.

The remaining sites were assessed as low significance as they were considered to be a commonly representative Aboriginal site or Aboriginal object type exhibiting low research potential, and where many more similar examples can be confidently predicted to occur within the Project Area, and in the region. The mine plan has been designed to avoid direct impacts to the archaeological heritage sites along Dog Trap Creek and avoid direct impacts to archaeological heritage sites in the south east section of the Project Area south of the Hume Highway.

Summary of Potential Impacts to Archaeological Sites

Table 11-40 provides a summary of the potential impacts of the Project on Aboriginal heritage sites within the Project Area, including the type of potential impact on each site (i.e. surface impacts, subsidence impacts or no impacts).

Of the 40 Aboriginal heritage sites identified:

- no impacts are predicted to the cultural site (Bandibong – Aboriginal dream time story);
- one archaeological site (Charles Point Road – open camp site) has the potential to be impacted by surface disturbance works and subsurface works (i.e. direct impacts); and
- 26 archaeological sites have the potential to be impacted by subsidence impacts (i.e. indirect impacts).

The mine plan has been designed to avoid direct (undermining) impacts to the rock shelter with art archaeological heritage sites identified along Dog Trap Creek and to avoid impacts to archaeological heritage sites in the south east section of the Project Area south of the Hume Highway.

Table 11-40 Assessment of potential impacts to Cultural and Archaeological sites

No.	AHIMS	Site Name	Site Type	Scientific Significance	Impact	Type of impact	Degree of impact
1	52-2-1599	Bandibong	Aboriginal dreaming story	Low	None	Indirect	None
2	52-2-1520	Dog Trap Creek	Sandstone shelter with art	Low	Potential subsidence	Indirect	Partial
3	52-2-1521	Dog Trap Creek	Sandstone shelter with art	Low	Potential subsidence	Indirect	Partial
4	52-2-1522	Dog Trap Creek	Sandstone shelter with art	Low	Potential subsidence	Indirect	Partial
5	52-2-1523	Dog Trap Creek	Sandstone shelter with art and deposit	High	Potential subsidence	Indirect	Partial
6	52-2-1524	Dog Trap Creek	Sandstone shelter with art and axe grinding grooves	Moderate	Potential subsidence	Indirect	Partial
7	52-2-1525	Dog Trap Creek	Sandstone shelter with art	High	Potential subsidence	Indirect	Partial
8	52-2-1526	Dog Trap Creek	Sandstone shelter with art	Low	Potential subsidence	Indirect	Partial
9	52-2-1527	Dog Trap Creek	Sandstone shelter with art	Moderate	Potential subsidence	Indirect	Partial
10	52-2-1528	Dog Trap Creek	Sandstone shelter with art	High	Potential subsidence	Indirect	Partial
11	52-2-1529	Dog Trap Creek	Sandstone shelter with art and axe grinding grooves	High	Potential subsidence	Indirect	Partial
12	52-2-1530	Dog Trap Creek	Modified tree	Low	Potential subsidence	Indirect	Partial
13	52-2-1532	Dog Trap Creek	Sandstone shelter with art	Low	Potential subsidence	Indirect	Partial
14	52-2-1533	Dog Trap Creek	Sandstone shelter with art	Low	Potential subsidence	Indirect	Partial
15	52-2-1534	Dog Trap Creek	Sandstone shelter with art and deposit	Low	Potential subsidence	Indirect	Partial
16	52-2-1538	Bargo	Sandstone shelter with art and deposit	Low	Potential subsidence	Indirect	Partial
17	52-2-1539	Bargo	Sandstone shelter with art and axe grinding groove	Low	Potential subsidence	Indirect	Partial
18	52-2-1540	Bargo	Sandstone shelter with art	Low	Potential subsidence	Indirect	Partial
19	52-2-3872	Bargo Sports Ground-AFT001	Isolated find	Low	Potential subsidence	None	None
20	52-2-3921	Dog Trap Creek AGG-1	Axe Grinding Grooves	Low	Potential subsidence	Indirect	Partial
21	52-2-3922	Dog Trap Creek IA-1	Isolated find	Low	None	None	None
22	52-2-3938	Eliza Creek OAS 1	Open camp site	Low	None	None	None

No.	AHIMS	Site Name	Site Type	Scientific Significance	Impact	Type of impact	Degree of impact
23	52-2-3944	Dry Creek GG 1	Axe Grinding Groove	Low	None	None	None
24	52-2-3942	Dry Creek OAS 1	Open camp site	Low	None	None	None
25	52-2-3943	Dry Creek IA 1	Isolated find	Low	None	None	None
26	52-2-3968	Remembrance Driveway 2013.1	Isolated Find	Low	Potential subsidence	None	None
27	52-2-3969	Eliza Creek 2013.3	Sandstone shelter with art	Low	Potential subsidence	Indirect	Partial
28	52-2-3970	Eliza Creek 2013.2	Sandstone shelter with art and deposit	Low	Potential subsidence	Indirect	Partial
29	52-2-3971	Dog Trap Creek 2013.2	Sandstone shelter with art	Low	Potential subsidence	Indirect	Partial
30	52-2-3972	Dry Creek 2013.1	Isolated find	Low	None	None	None
31	52-2-3960	Dog trap Creek 2013.1	Shelter with art	Low	Potential subsidence	Indirect	Partial
32	52-2-4194	BDTC-GG01	Axe grinding groove	Low	Potential subsidence	Direct	Partial
33	52-2-4195	BDTC-AS01	Open Camp Site	Low	Potential subsidence	None	None
34	52-2-4034	SW Corner Bargo Sportsground	Isolated find	Low	Potential subsidence	None	None
35	52-2-4395	Government Road AGG-1	Axe grinding groove	Low	Potential subsidence	Direct	Partial
36	52-2-3975	Bargo Artefact Scatter 3	Open Camp Site	Low	Potential subsidence	None	None
37	52-2-3976	Bargo Isolated Find 1	Isolated Find	Low	Potential subsidence	None	None
38	52-2-4471	Tea Tree Hollow 2013.1	Shelter with art and deposit	Low	Potential subsidence	Indirect	Partial
39	52-2-4473	Eliza Creek 2013.1	Shelter with deposit	Low	None	None	Partial
40	52-2-TBC	Charlies Point Road	Open Camp Site	Low	Surface disturbance	Direct	Total loss

Management measures have been developed in accordance with the hierarchy of controls to avoid impacts where possible in the first instance, and then mitigate where avoidance is not possible. Impacts have initially been avoided through the design of the mine plan. Longwall 102 and Longwall 103 have been designed to avoid mining beneath four rock shelter sites along Dog Trap Creek with artwork that is of high cultural and archaeological significance. The surface infrastructure for the proposed development would also avoid all grinding grooves, rock shelters and therefore there would be no potential surface disturbance impacts to archaeological sites with moderate or high scientific significance.

The mine plan has been amended to avoid impacts to archaeological heritage sites in the south east section of the Project Area south of the Hume Highway. Sites that have been avoided include:

- one axe grinding groove site (AHIMS site 52-2-3358);
- one axe grinding groove and shelter with art site (AHIMS site 52-2-2048); and
- three isolated artefact find sites (AHIMS sites 52-2-3359, 52-2-3360, 5-5-3371).

As described above the exact location of the sites listed above is considered to be culturally sensitive information by the RAPs and so mapping of these sites is not provided as part of this EIS.

Where impacts cannot be avoided, mitigation measures have been provided to manage these impacts as described in **Section 11.8.5**. Mitigation measures would be included in a Heritage Management Plan (HMP).

Surface Infrastructure Impacts

Direct harm is not predicted for 39 of the identified archaeological or cultural sites as a result of surface infrastructure disturbance from the ventilation shafts or REA. One archaeological site (an open camp site, AHIMS site 52-2-TBC) falls within the footprint of a proposed ventilation shaft and may be impacted. This site was assessed as having low scientific significance as the site was comprised of three artefacts only. This site should be avoided by the final footprint. However in the event that direct impact to this site is required and cannot be avoided, further management should be undertaken in consultation with a suitably qualified archaeologist and in accordance with an Aboriginal Heritage Management Plan (AHMP).

Indirect impacts could occur to some archaeological items within proximity to ventilation shaft sites and ancillary infrastructure, due to the partial loss of site context from the clearing of vegetation at the surface infrastructures sites.

The location of all ancillary infrastructure, such as transmission lines and gas pipelines, would be finalised during detailed design to avoid identified Aboriginal heritage sites, as far as practicable. If direct impacts cannot be avoided in the location of surface infrastructure, further management would be undertaken in consultation with the RAPs and a suitably qualified archaeologist in accordance with the HMP. During construction appropriate measures such as fencing would be considered for inclusion in the HMP to avoid impacts to identified items.

Subsidence Impacts

The ACHA identifies the following potential impacts to sites as a result of subsidence impacts:

- scarred tree - From past longwall experience, the incidence of impacts on trees is extremely rare. Impacts on trees have been previously observed where the depths of cover were extremely shallow, in the order of 50 m or less, or on very steeply sloping terrain, in the order of 1 in 1 grade or greater. The scarred tree within the Project Area is located 150 m east of the nearest longwall and is unlikely to be affected by the proposed mining;
- artefact scatters and isolated finds - Open camp sites can potentially be affected by cracking of the surface soils as a result of mine subsidence movements. However it is unlikely that scattered artefacts or isolated finds would be significantly harmed by such surface cracking;
- axe grinding grooves – Based on maximum predicted subsidence movements for the proposed development, it is possible that fracturing could occur in the bedrock in the vicinity of grinding groove sites as a result of proposed mining. Minor and isolated fracturing has been observed in streams up to around 400 m outside previously extracted longwalls in the Southern Coalfield. Two axe grinding groove sites on sandstone platforms are located directly above longwalls (Site 52-2-4395 above longwall 103 and 52-2-4194 above longwall 104) and have the potential to be impacted;

- sandstone shelters - The likelihood of shelters becoming unstable as a result of subsidence movements is dependent on a number of factors. These factors include jointing, inclusions, weaknesses within the rock mass, groundwater pressure and seepage flow behind the rock face. Subsidence impacts to the four rock shelter sites that have been given a high significance rating (52-2-1523, 52-2-1525, 52-2-1528 and 52-2-1529) are predicted to experience between 125 and 175 mm of vertical subsidence due to the extraction of the proposed longwall 102. However, given the setback distances of the proposed longwalls to the sites (Refer Table 32 of **Appendix L**) it is considered that the likelihood of impacts is low. The experience from the Southern Coalfield indicates that the likelihood of significant physical impacts on rock shelters within the area (as a result of subsidence) is relatively low.

11.8.5 Management and Mitigation Measures

Management measures have been developed in accordance with the hierarchy of controls to avoid impacts where possible in the first instance, and then mitigate where avoidance is not possible. Impacts have initially been avoided through the design of the mine plan. Longwall 102 and Longwall 103 have been designed to avoid mining beneath rock shelter sites along Dog Trap Creek with artwork that is of high cultural and archaeological significance. One of the archaeological sites identified within the Project Area occurs within the direct footprint of the surface facilities; this site was assessed as having a low scientific significance. The surface infrastructure for the proposed development would avoid all grinding grooves and rock shelters and therefore there would be no potential surface disturbance impacts to archaeological sites with moderate or high scientific significance. The mine plan has been amended to avoid impacts to archaeological heritage sites in the south east section of the Project Area south of the Hume Highway.

A HMP would be prepared for the proposed development in consultation with RAPs to include specific background information and mitigation measures proposed by this EIS and the ACHA (Niche, 2018), including:

- mine plan layout;
- mapping to indicate the location of known Aboriginal heritage sites;
- site specific management measures, including buffer zones and barriers where appropriate;
- protocols that describe the involvement of the RAPs in cultural heritage works conducted under the HMP, focusing on members of the RAPS identified during the ACHA consultation process;
- a communications protocol that describes clear methods of communication, including expectations of suitable notification and response time, between Tahmoor Coal and the RAPs;
- a protocol to allow for reasonable access to identified significant Aboriginal heritage sites;
- procedures to establish, maintain and update a current GIS database of Aboriginal heritage sites identified within the Project Area (i.e. the Project Sites Database);
- a protocol for the discovery and management of human remains, including stop work provisions and notification protocols;
- procedures for the management and reporting of previously unknown Aboriginal heritage sites that may be identified during the life of the proposed development; and
- protocols for heritage awareness training to be incorporated into mine site inductions for employees and sub-contractors who may be conducting works that have the potential to impact on any Aboriginal heritage sites.

The final locations of all ancillary infrastructures (e.g. transmission lines, gas pipelines etc.) would be confirmed during detailed design with the aim of avoiding identified Aboriginal sites as far as possible. This would include, systematic survey of the relevant area(s) (in consultation with the RAPs) if the area has not already been surveyed. Any previously unidentified sites would be managed in accordance with the management measures described in the HMP and in consultation with the RAPs. If impacts to any existing (or newly identified) sites cannot be avoided, additional management, mitigation and archival recording measures would be determined in consultation with the RAPs and statutory agencies.

A subsurface test excavation program in consultation with the RAPs would be implemented at the TSC 2 ventilation shaft and fan site, after the confirmation of its final location. Should any new Aboriginal objects be identified these would be managed in consultation with RAPs and statutory agencies.

The Extraction Plan developed for the longwalls for the proposed development (refer to **Section 11.1.7**) would include:

- a schedule for undertaking monitoring at nominated sites;
- appropriately detailed baseline and archival site recordings, including high resolution digital photographs and an impact Trigger and Action Response Plan TARP specific to each of the sites being monitored;
- archival site recordings would include three dimensional scans and digital rendering of rock shelters of high significance which would be provided for use to RAPs; and
- adaptive management techniques for sites 52-2-1523, 52-2-1525, 52-2-1528 and 52-2-1529. Should monitoring detect the early development of potentially severe differential movements at these archaeological sites during the extraction of Longwalls 101 and 102, consideration would be given to shortening the commencing position of Longwall 103.

11.8.6 Conclusion

The ACHA identified that the majority of potential impacts on cultural heritage sites are limited to potential subsidence impacts, in particular to rock shelters which are more likely to experience adverse impacts that could result in harm such as increased rock falls and cracking. One archaeological site of low scientific significance (an open camp) falls within the footprint of a ventilation shaft and may be impacted directly.

Impacts to Aboriginal heritage have initially been avoided through the design of the mine plan. Tahmoor Coal has consulted with RAPs and individuals regarding the proposed development and has sought their views about cultural significance of the area. As a result of consultation with RAPs and individuals, it was determined that all of the archaeological heritage sites hold cultural significance for the RAPs. However, the consultation also determined specific sites of high significance including along Dog Trap Creek.

Heritage values were determined from consultation with indigenous stakeholders and through the preparation of the ACHA, the outcomes of which were used in the subsidence risk workshops. At the workshop, rock shelters were identified as being of high significance and therefore project archaeologists and subsidence engineers delineated RMZs to manage impacts on these heritage items.

Longwall 102 and Longwall 103 have been designed to avoid mining beneath rock shelter sites along Dog Trap Creek with artwork that is of high cultural and archaeological significance. The mine plan has been amended to avoid impacts to archaeological heritage sites in the south east section of the Project Area south of the Hume Highway.

One cultural site (Bandibong – Aboriginal dream time story) and a total of 39 archaeological sites were identified within the Project Area during the assessment (including previously recorded and newly recorded sites). Of the 39 archaeological sites, four are considered to be of high significance and two are considered to be of moderate significance. Twenty six (26) archaeological sites have the potential to be impacted by subsidence impacts, and one archaeological site has been identified as having potential to be directly impacted by the surface infrastructure. During detailed design and construction planning care would be taken to site surface infrastructure (including power lines and gas infrastructure) to avoid disturbance of identified archaeological sites, as far as practicable. If direct impacts cannot be avoided in the location of surface infrastructure, further management would be undertaken in consultation with the RAPs and a suitably qualified archaeologist, as part of a HMP.

Mitigation and management for potential impacts to cultural heritage includes the preparation and implementation of a HMP for the proposed development. The HMP will include all sites identified as having the potential to be impacted, including both previously recorded and newly recorded sites. Should monitoring detect the early development of potentially severe differential movements at these archaeological sites during the extraction of Longwalls 101 and 102, adaptive management techniques would be applied.

11.9 Non-Aboriginal Heritage

A Historical Heritage Assessment was prepared for the proposed development by Niche Environment and Heritage Pty Ltd, and is provided in **Appendix L**.

The Historic Heritage Assessment addressed the SEARs relevant to historic heritage impacts. These are listed in **Table 11-41**.

Table 11-41 SEARs for the assessment of heritage impacts

SEARs	Section addressed
Heritage – including:	
• an assessment of the likely Aboriginal and historic heritage (cultural and archaeological) impacts of the development, having regard to OEH's requirements (see below).	**Section 11.8** and **11.9**, and **Appendix L**
OEH's requirements are reproduced below. The EIS must provide a heritage assessment including but not limited to an assessment of impacts to *State and local heritage* including conservation areas, natural heritage areas, places of Aboriginal heritage value, buildings, works, relics, gardens, landscapes, views and trees. Where impacts to State or locally significant heritage items are identified, the assessment shall:	**Section 11.8** and **11.9**, and **Appendix L**
- Outline the proposed mitigation and management measures (including measures to avoid significant impacts and an evaluation of the effectiveness of the mitigation measures) generally consistent with the NSW Heritage Manual (1996);	**Section 11.8.5** and **11.9.5**
- Be undertaken by a suitably qualified heritage consultant (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria),	The assessment in **Appendix L** was undertaken by Niche Environment and Heritage.
- Include a statement of heritage impact for all heritage items (including significance assessment);	**Section 11.8.3, 11.8.4, 11.9.3** and **11.9.4**
- Consider impacts including, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, landscapes and vistas, and architectural noise treatment (as relevant); and	**Section 11.8.4, 11.9.4,** and **11.10.4**.
- Where potential archaeological impacts have been identified develop an appropriate archaeological assessment methodology, including research design, to guide physical archaeological test excavation (terrestrial and maritime as relevant) include the results of these test excavations.	**Section 11.9.2**. Test excavations were not required as part of the survey methodology for the assessment.

11.9.1 Background

The Bargo area was first explored by Europeans in the late 1790s and was occupied from the early 1800s. Since its initial settlement in 1815, the Bargo township and surrounding area was developed to include farming and early road and creek crossings (including the Great Southern Road and Rockford crossing), homesteads, commercial and public buildings (including the Bargo Hotel and Bargo post office), public spaces (such as the Bargo Cemetery) and road and railway infrastructure. The land to the east and south east of Bargo Township was identified as a possible State Coal Mine Reserve in 1917. However, mining in the area was not commissioned until 1979 when the existing Tahmoor Mine commenced operations.

The Historic Heritage Assessment considered the potential physical effects on historic heritage items within the SSA, anticipated as a result of the proposed development. Subsidence predictions for the proposed development were prepared by MSEC (2018) to inform the assessment (refer **Appendix F**).

11.9.2 Methodology

The Historical Heritage Assessment for the proposed development was undertaken as follows:

- desktop review of background studies including:
  - review of Commonwealth, State and Local Government heritage lists and databases including the Australian Heritage Database (comprising the National Heritage List, Commonwealth Heritage List, and the non-statutory Register of the National Estate archive), State Heritage Register, State Heritage Inventory, State Government agency S170 Registers, Wollondilly LEP, and the National Trust Register;
  - review of existing heritage studies relevant to the Project Area and surrounding areas; and
  - review of available baseline data from Tahmoor Coal, such as previous environmental studies and other relevant data.
- field survey of identified historic heritage items, which included an initial survey in 2014 and subsequent survey on 28 September 2017. The surveys were undertaken to inspect items identified during the desktop review (including items listed on heritage registers, heritage studies and Schedule 5 (Environmental heritage) of the Wollondilly LEP), and in particular those heritage items anticipated to be most impacted by the proposed development;
- assessment of potential impacts on identified heritage items through consideration of the value of each item and the maximum predicted subsidence at those sites, based on the findings of the Subsidence Impact Assessment (**Appendix F**); and
- recommendation of management measures for heritage items which may experience potential impacts as a result of subsidence.

11.9.3 Existing Environment

The database searches and desktop review identified 22 existing historical heritage items within the SSA. Of these historic heritage items within the SSA:

- one item ('Tahmoor Colliery') is not registered or listed on any heritage register. However, the item has been identified as having historical values in local and regional heritage studies. This item was identified as a heritage item of local significance in the *Macarthur Heritage Study 1986* (JRC Planning Services, 1986). It is noted that one other item of historical value (Anderson's Inn) was identified through research and previous studies. However, the item is no longer present, likely to have been demolished during residential redevelopment and is therefore not considered further in the assessment or in the item count;
- 21 items are locally listed on the Wollondilly LEP, including:
  - one item which is also listed on the State Heritage Register: Wirrimbirra Sanctuary (listing number 01508);
  - one item which is also listed on a State (S170) Heritage and Conservation Register - Bargo Railway Station Toilet Block);
  - two items which are also listed on the Register of the National Estate (RNE) which is a non-statutory Commonwealth, public archive - Wirrimbirra Sanctuary (Place ID 3302, natural heritage place), and Bargo Railway Station (Place ID 101967); and
  - one item which is also listed with the National Trust of Australia (NSW) - Wirrimbirra Sanctuary; and
- no items are listed on the Commonwealth or National Heritage Lists.

In addition to the above one new heritage item (Great Southern Road, Bargo) was identified by the current Historic Heritage Assessment through historical research and field survey.

The 23 historic heritage items in total identified within the SSA are listed in **Table 11-42** and are shown on **Figure 11.21**. Of these historical heritage items, 19 are situated directly above the proposed longwall mining area.

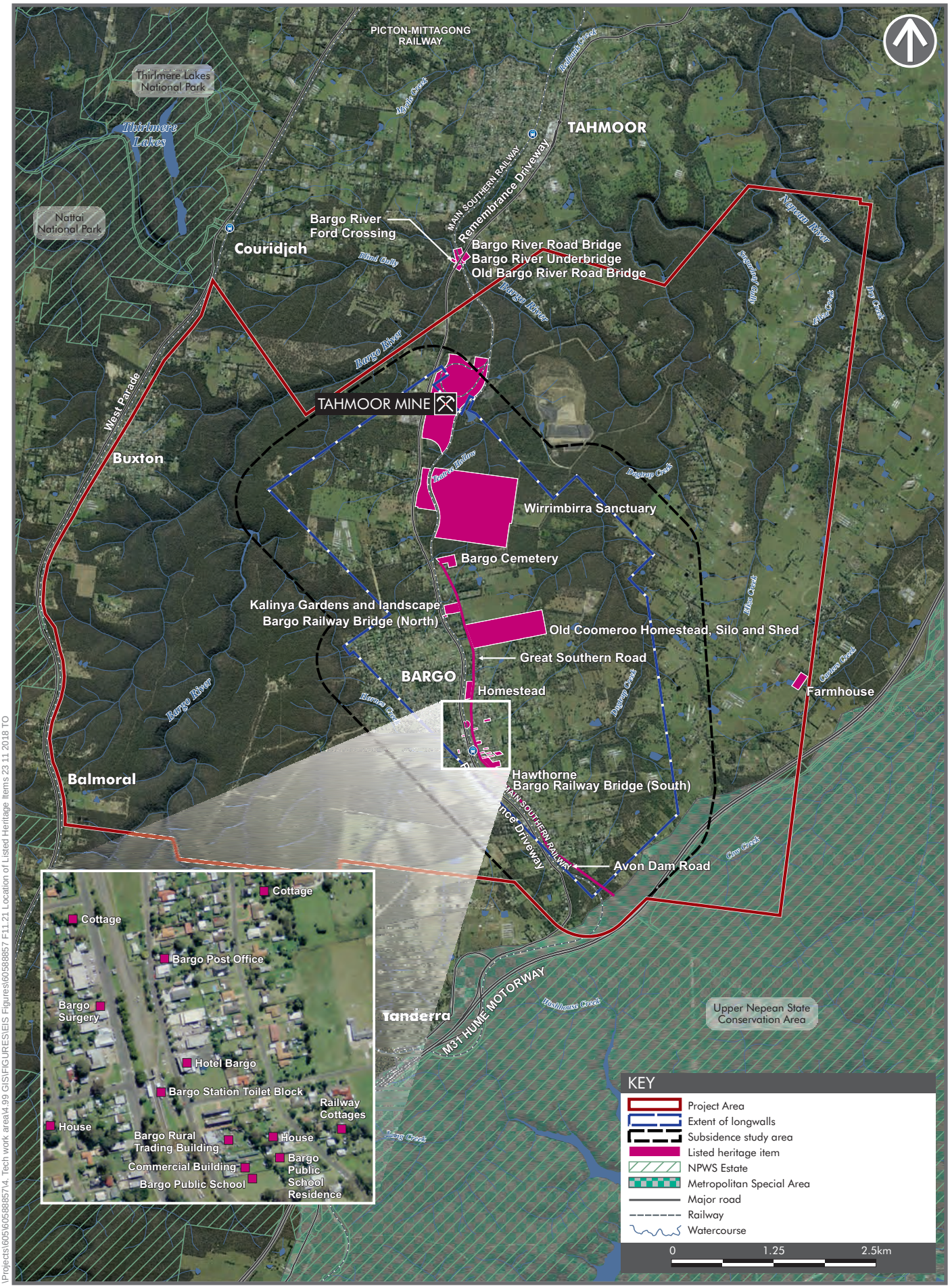
Condition and integrity assessments were undertaken for each of the identified items. The overall condition of the buildings or archaeological relics were categorised as Good, Fair, or Poor, depending on how well-maintained or degraded the fabric of the items were. Integrity assessments evaluated the degree of retained original fabric within the heritage item. Each item was assessed as having High, Medium or Low integrity, with the items assigned the highest integrity ratings retaining the most original features, such as windows or doors. Items assigned low integrity rating were those with replaced fittings or additions to the original item. The condition and integrity ratings of the items are summarised in **Table 11-42** below, along with the heritage significance of the items, based on their statutory listing / or previous assessed significance (for previously recorded items), or assessed significance under the current study (for the newly identified site).

Table 11-42 Summary of historical heritage items within the SSA

Ref #	Item Name	Location in relation to nearest longwall (LW)	Assessment of Condition / Integrity	Significance	Listing[1]
Listed historic heritage items					
1	Bargo Cemetery	Directly above LW mining area	Fair / High	Local	LEP
2	Kalinya Gardens and landscape	Directly above LW mining area	Good / High	Local	LEP
3	Old Coomeroo Homestead, silo, shed	Directly above LW mining area	Poor / Low to Medium	Local	LEP
4	Homestead 170 Great Southern Road	Directly above LW mining area	Good / Medium	Local	LEP
5	Bargo Post office	Directly above LW mining area	Fair / Medium	Local	LEP
6	Hotel Bargo	Directly above LW mining area	Good / Low	Local	LEP
7	Bargo Rural Trading Building	Directly above LW mining area	Poor / Low	Local	LEP
8	Commercial Building	Directly above LW mining area	Fair / Medium	Local	LEP
9	Bargo Public School	Directly above LW mining area	Fair / Medium	Local	LEP
10	Cottage, 91 Hawthorne Road	Directly above LW mining area	Good / Low to Medium	Local	LEP
11	House, 118 Hawthorne Road	Directly above LW mining area	Good / Medium	Local	LEP
12	Bargo Public School Residence	Directly above LW mining area	Good / High	Local	LEP
13	Railway Cottages	Directly above LW mining area	143 – Fair / High 145 – Fair / Low 147 – Good / Medium	Local	LEP
14	Hawthorne	Directly above LW mining area	Fair to Good / High	Local	LEP
15	Bargo Railway Station Toilet Block	Directly above LW mining area	Fair / Medium	Local	RNE S170

Ref #	Item Name	Location in relation to nearest longwall (LW)	Assessment of Condition / Integrity	Significance	Listing[1]
					Register LEP
16	House, 8 Noongah Street	~130m from LW mining area	Good / Medium	Local	LEP
17	Bargo Surgery (74 Railside Ave)	Directly above LW mining area	Fair / High	Local	LEP
18	Cottage, 121 Railside Ave	~80m from LW mining area	Poor / Medium	Local	LEP
19	Wirrimbirra Sanctuary	Directly above LW mining area	N/A / High	Local, State	RNE National Trust of Australia (NSW) State Heritage Register LEP
20	Bargo Railway Bridge (road over rail) (South)	~100m from LW mining area	Good / High	Local	LEP
21	Bargo Railway Bridge (road over rail) (North)	Directly above LW mining area	Good / High	Local	LEP
Items of Historical Value (Not listed)					
24	Tahmoor Colliery	Centre of surface facilities ~500m from LW mining area	Good / Medium	Local	N/A
25	Anderson's Inn	The exact location of the Inn is unclear based on historical records. However, the land parcels on which the Inn was likely situated are located directly above the LW mining area	N/A Not Located. (The Inn no longer exists. It was likely demolished during residential development, and has not been included in the heritage item count.)	None	N/A
Newly identified historic heritage items					
29	Great Southern Road, Bargo	Directly above LW mining area	Poor / Low	Local	N/A

[1] LEP = *Wollondilly Local Environmental Plan 2011* Heritage Schedule



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SIMEC MINING

HISTORIC HERITAGE WITHIN THE SUBSIDENCE STUDY AREA

Tahmoor South Project
Environmental Impact Statement

Source: Niche Environment and Heritage (2018)

FIGURE 11.21

11.9.4 Impact Assessment

The potential impacts of the proposed development on historical heritage could relate to:

- direct impacts at Tahmoor Mine (Tahmoor Colliery), due to upgrades of the existing surface infrastructure facilities, expansion of the REA and construction of additional ventilation shafts; and
- indirect impacts to all heritage items resulting from subsidence of the ground surface following longwall extraction of coal.

Direct impacts include physical disturbance associated with clearing, earthworks and other construction activities required during the upgrade of the surface infrastructure area, expansion of the REA and new ventilation shafts. Based on an analysis of design drawings for these works, there would be very little impact on the CHPP and other items of historical value at Tahmoor Mine. No other heritage items are located in proximity to these upgrade works. Direct impacts to heritage items are therefore not expected to occur as a result of the proposed development.

Potential indirect impacts from subsidence to built structures include cracking of internal linings, dislodgement of external weatherboards (for timber structures) and cracking of brickwork and chimneys. Masonry structures are considered to be more susceptible to impacts than timber based structures, experiencing greater impacts ranging from minor cracking to substantial cracking of walls. If impacts are left untreated, there is the potential for reduction of the heritage values associated with that item. Similarly, if restoration works or repairs are poorly undertaken, heritage values can also be diminished.

An assessment of potential subsidence related impacts to each heritage item identified within the SSA was undertaken and determined that there would be a nil to low likelihood of severe impacts to any built structure (refer Table7 of **Appendix F**). Impacts to the heritage values of these items would therefore be nil to minor, particularly if subsidence related damage is corrected through repair or restoration. It is noted that should damage occur and is left untreated, overtime the condition could deteriorate, potentially resulting in severe impacts. Table 7 of **Appendix L** provides further detail on potential impacts for each heritage item identified.

Further discussion on potential impacts to State Heritage items in the subsidence study area are provided below.

Impacts to State Heritage

One item listed on the National Trust of Australia (NSW), State Heritage Register and State (S170) Heritage and Conservation Register is located within the SSA: Wirrimbirra Sanctuary. In addition a second item listed in the State (S170) Heritage and Conservation Register is also located within the SSA: Bargo Railway Station Toilet Block.

Wirrimbirra Sanctuary

Access to the Wirrimbirra Sanctuary was limited during the field survey for the assessment and detailed inspection of the historical ruins within the Sanctuary was not possible (due to access restrictions), however based on historical research it is understood that they are in poor condition.

The Historical Heritage Assessment considered potential subsidence related impacts to Wirrimbirra Sanctuary, including potential impacts to stone hut foundations and the remains of low stone walls. It is likely that the proposed development would result in the fracturing of the rock bed at Tea Tree Hollow, within the Wirrimbirra Sanctuary. Potential associated surface water impacts such as diversion of surface water and the draining of pools may impact on the natural heritage values of the Sanctuary.

However overall, impacts to heritage features within the sanctuary due to subsidence have been assessed to be nil to minor (Niche, 2018; **Appendix L**).

Whilst impacts to the Wirrimbirra Sanctuary have been assessed to be nil to minor; in consideration of its State heritage significance additional assessment including a detailed site inspection would be undertaken at Wirrimbirra Sanctuary prior to the commencement of mining. The assessment would include a detailed site inspection to assess the condition and structural integrity of the historic items within the sanctuary and the contribution of these items to the overall significance of Wirrimbirra Sanctuary. The results of the assessment would inform the preparation of a site-specific Heritage Management Plan and Statement of Heritage Impact for Wirrimbirra Sanctuary. The site-specific Heritage Management Plan would form part of the Extraction Plan for the relevant longwalls in the vicinity of the Sanctuary, and would identify specific measures to manage potential subsidence related impacts to Wirrimbirra Sanctuary. The Statement of Heritage Impact would be prepared in consultation with approved guidelines, the landowner (National Trust of Australia) and the NSW Heritage Council or its delegate.

Bargo Railway Station Toilet Block

Longwall mining would occur under the Bargo Railway Station Toilet Block. Based on the predicted subsidence impacts, nil to minor impacts are predicted to the structures of this heritage item, including potential damage to the face brickwork and the brick water closet. There is potential for the platforms to slightly move apart and a low chance that they would move closer together, which could encroach on platform clearances. To manage subsidence impacts pre-mining inspections would be carried out, along with monitoring measures during longwall mining to identify and guide restoration measures should minor damage occur. With the implementation of mitigation measures, adverse impacts to the heritage values of the site are not anticipated.

11.9.5 Mitigation Measures

The existing Cultural Heritage Management Plan (CHMP) for the Tahmoor Mine incorporates management of both Aboriginal heritage and historic heritage. The CHMP would be updated for the proposed development to include relevant information from the Historic Heritage Assessment (Niche, 2018; **Appendix L**).

In addition, the following mitigation measures would be implemented by Tahmoor Coal and included in the updated CHMP:

- a site specific Heritage Management Plan would be prepared for each heritage site of local and/ or State significance identified within the SSA, including: Wirrimbirra Sanctuary, Bargo Railway Station and Toilet Block, Bargo Cemetery, Bargo Railway Bridges (South and North) and Tahmoor Mine. Each Heritage Management Plan would form part of the Extraction Plan for the longwalls relevant to each item, and would be developed in consultation with property owners/managers and the Wollondilly Shire Council prior to commencement of mining. The Heritage Management Plans would include:
  - assessment of the pre-mining condition of the heritage item;
  - mitigation or strengthening measures prior to mining such as structural reinforcement;
  - monitoring measures such as the monitoring of ground movements and building movements through regular visual inspections; and
  - measures such as remedial or repair works.
- measures to manage direct and indirect construction impacts (including construction vibration) to structures of heritage value within the Tahmoor Mine and the SSA during the upgrade of surface infrastructure facilities and associated ancillary works;
- Heritage Management Plans or other measures (including pre-mining inspection) for the Bargo Railway Station and Bridges (South and North) would be prepared in consultation with Transport for NSW; and
- as described in **Section 11.9.4**, additional assessment, including a detailed site inspection, would be undertaken for Wirrimbirra Sanctuary. The results of the assessment would inform the preparation of a site-specific Heritage Management Plan and Statement of Heritage Impact prepared in consultation with the landowner (National Trust) and the NSW Heritage Council, or its delegate. The Heritage Management Plan and Statement of Heritage Impact for the Sanctuary would be finalised as part of the Extraction Plan for the longwalls relevant to the Sanctuary.

The undertaking of pre-condition assessment and the preparation of a Heritage Management Plan for the identified heritage items is consistent with the conservation principles of the Burra Charter and ensures an understanding of the significance of the items and makes use of techniques available to conserve the place.

11.9.6 Conclusion

The Historic Heritage Assessment identified that potential impacts on heritage items are primarily limited to subsidence associated impacts. Potential impacts include cracking of internal lining, dislodgement of external weatherboards (if the structure is timber), cracking of brickwork and brick chimneys. Masonry structures were considered as more susceptible to these impacts and were prioritised in the assessment. In most instances restoration works will mitigate impacts to heritage values of affected items.

A total of 23 historical heritage items were identified during the assessment, with 19 located directly above the proposed longwall mining area. The assessment concluded that there was nil to low likelihood of physical impacts to all masonry or timber heritage items, and that any impacts are predicted to be minor. Mitigation measures have been identified to manage potential impacts, including the preparation and implementation of a site specific Heritage Management Plan for each heritage site of State/ local significance identified within the SSA.

Heritage values of Wirrimbirra Sanctuary, which is listed on the State Heritage Register, are not expected to be reduced by the proposed development. However, additional assessment of the Sanctuary would be undertaken prior to mining and would inform the preparation of a site specific Heritage Management Plan and Statement of Heritage Impact in consultation with approved guidelines, the landowner (National Trust of Australia) and the NSW Heritage Council or its delegate.

11.10 Noise and Vibration

A Noise and Vibration Impact Assessment (NVIA) was prepared by EMM Consulting Pty Ltd (EMM) for the Tahmoor South project (EMM, 2018) which assessed the potential noise and vibration impacts of the proposed development in the context of the existing mine noise and acoustic environment. This included assessment of construction noise and vibration, sleep disturbance and operational noise impacts including road traffic noise and rail noise. The NVIA is provided in **Appendix M**.

The NVIA addressed the SEARs relevant to noise and vibration impacts, listed in **Table 11-43**.

Table 11-43 SEARs for the assessment of noise and vibration impacts

Noise and Vibration SEARs	Where addressed
Noise and Vibration – including:	
• an assessment of the likely operational, rail "wheel squeal" and construction noise impacts of the development under the NSW Industrial Noise Policy (as may be updated or replaced), paying particular attention to the obligations in chapters 8 and 9 of the policy, and the Voluntary Land Acquisition and Mitigation Policy (DPE);	**Section 11.10.1** and **11.10.4**
• if a claim is made for specific construction noise criteria for certain activities, then this claim must be justified and accompanied by an assessment of the likely construction noise impacts of these activities under the Interim Construction Noise Guideline;	**Section 11.10.4**
• an assessment of the likely road noise impacts of the development under the NSW Road Noise Policy; and	**Section 11.10.4**
• an assessment of the potential vibration and low frequency noise impacts of the development.	**Section 11.10.4**

11.10.1 Background

Tahmoor Mine has been operating since 1979. Since its original development, numerous changes have occurred that are relevant to the consideration and assessment of operational noise, in particular the encroachment of residential and other development in the vicinity of the mine and the increasing amount of traffic on Remembrance Driveway, which borders the mine surface infrastructure area. There have also been significant changes to government policy relating to the management of noise since development consent was originally approved for the mine, including the introduction of the EPA's *Industrial Noise Policy* (INP) in 2000, and the *Noise Policy for Industry* (NPfI) in 2017 which supersedes the INP.

The most recent development consent relating to existing operations at Tahmoor Mine and which includes operational noise criteria is the 1994 development consent. The Tahmoor mine is also regulated by an Environmental Protection Licence (EPL 1389), however the licence does not contain noise limits relevant to the site nor requirements to monitor noise emissions. However, it has in the past included a number of noise related Pollution Reduction Programs (PRPs). Extensive work has subsequently been undertaken at the site to implement the PRPs, as described further in **Section 11.10.5,** and Section 4.2 of **Appendix M**. The success of these PRPs is demonstrated by the significant reduction in noise related complaints at the site, which have reduced from around 100 complaints in 2010, to only one in 2018.

Noise Policy

In 2017 the NSW EPA released the *Noise Policy for Industry*, which replaced the INP for the assessment of new developments. At the time that the SEARs were issued, the project fell within the transitional arrangements for noise assessments, so that the INP still applies to the assessment of noise and vibration for the project. This approach was confirmed by the NSW EPA at a meeting on 16 November 2017.

In 2018, the NSW EPA released the revised *Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments* (VLAMP). This policy outlines how acquisition and mitigation rights are assigned to landholders in relation to State significant resource projects in NSW. Once the rights are established they may be voluntarily triggered by landholders at any time. The noise assessment for the proposed development has been undertaken with consideration of this policy.

11.10.2 Methodology

Noise modelling

Noise modelling was based on three-dimensional digitised ground contours of the surrounding land and surface infrastructure for the existing mine operations, as well as the construction and operational phases of the proposed development. Noise predictions were carried out using the Brüel & Kjær Predictor software.

A summary of the operational noise sources and associated sound power levels used in the noise model are provided in Table 7.1 and Table 7.3 of **Appendix M**. The equipment items and numbers of each item are based on the current operations at the mine and largely based on noise measurements of existing activities at the site. Where this was not possible, sound power data has been obtained from an EMM database of similar plant and equipment.

Applying the INP to existing sites – Operational Noise

Section 10 of the INP describes how the policy is to be applied to existing industrial premises with legacy noise issues, in particular those sites where existing noise emissions are above noise levels that would apply based on the current noise policy, as is the case at Tahmoor Mine (refer to **Section 11.10.3**).

Accordingly, the following steps were taken in the assessment of operational noise emissions from the Tahmoor Mine, consistent with those outlined in Section 10 of the INP:

1. Measure and determine existing background and ambient noise levels.
2. Measure and predict noise levels produced by the existing infrastructure at Tahmoor Mine, having regard to meteorological effects such as from wind and temperature inversion.
3. Determine project-specific noise levels (PSNL) based on intrusive and amenity noise criteria.
4. Compare the measured and/or predicted noise levels from the site with the PSNL.
5. Where the PSNL are exceeded, assess feasible and reasonable noise mitigation strategies.
6. Determine achievable noise limits for the site. Describe the noise reduction measures to be implemented and their proposed timing.

Existing Noise Monitoring Program

Noise at the mine is monitored through quarterly attended night-time surveys (at locations M1 to M10), and by two continuous real-time noise monitors which operate 24 hours per day 7 days per week. The continuous real-time noise monitor located onsite has been programmed with pre-defined alarm trigger levels, which are linked to the site's control room and Citect control system, for monitoring night-time operational noise. The system allows the site to proactively manage noise levels during night-time hours (the most sensitive noise period), with the intent of managing identified elevated noise levels as they occur, ultimately reducing the number of community complaints.

Attended noise monitoring was also completed in November 2017 and January 2018 to measure night-time L_{Aeq} one-third octave band centre frequency levels (10-160 Hz), low frequency noise (LFN) threshold levels and C-A weighted levels.

Quarterly noise compliance monitoring and attended noise monitoring locations are shown on **Figure 11.22**. The results of the monitoring are discussed in **Section 11.10.3**.

Background Noise Monitoring

For the purposes of the current assessment, long term noise loggers and short-term operator-attended noise monitoring were used to quantify the existing background noise environment, including any existing industrial noise where present. Unattended noise monitoring was completed by EMM at five locations surrounding the site from 16 to 29 May 2018. Operator-attended noise monitoring was also completed by EMM at the same five locations and four additional off-site locations surrounding the site. Consideration has also been given to the existing quarterly noise compliance monitoring locations (QM1 to QM10) and previous unattended noise monitoring undertaken by Atkins Acoustics in 2012. Noise assessment monitoring locations are provided on **Figure 11.22**. The results of the monitoring are discussed in **Section 11.10.3**.

Meteorology

During certain weather conditions such as high winds, mine noise emissions may increase or decrease. A conservative approach has been selected for the consideration of potentially noise-enhancing weather conditions in accordance with Section 5 of the INP. Noise emissions from the mine have been predicted for both calm and worst-case noise-enhancing conditions as provided in **Appendix M**.

Assessment locations

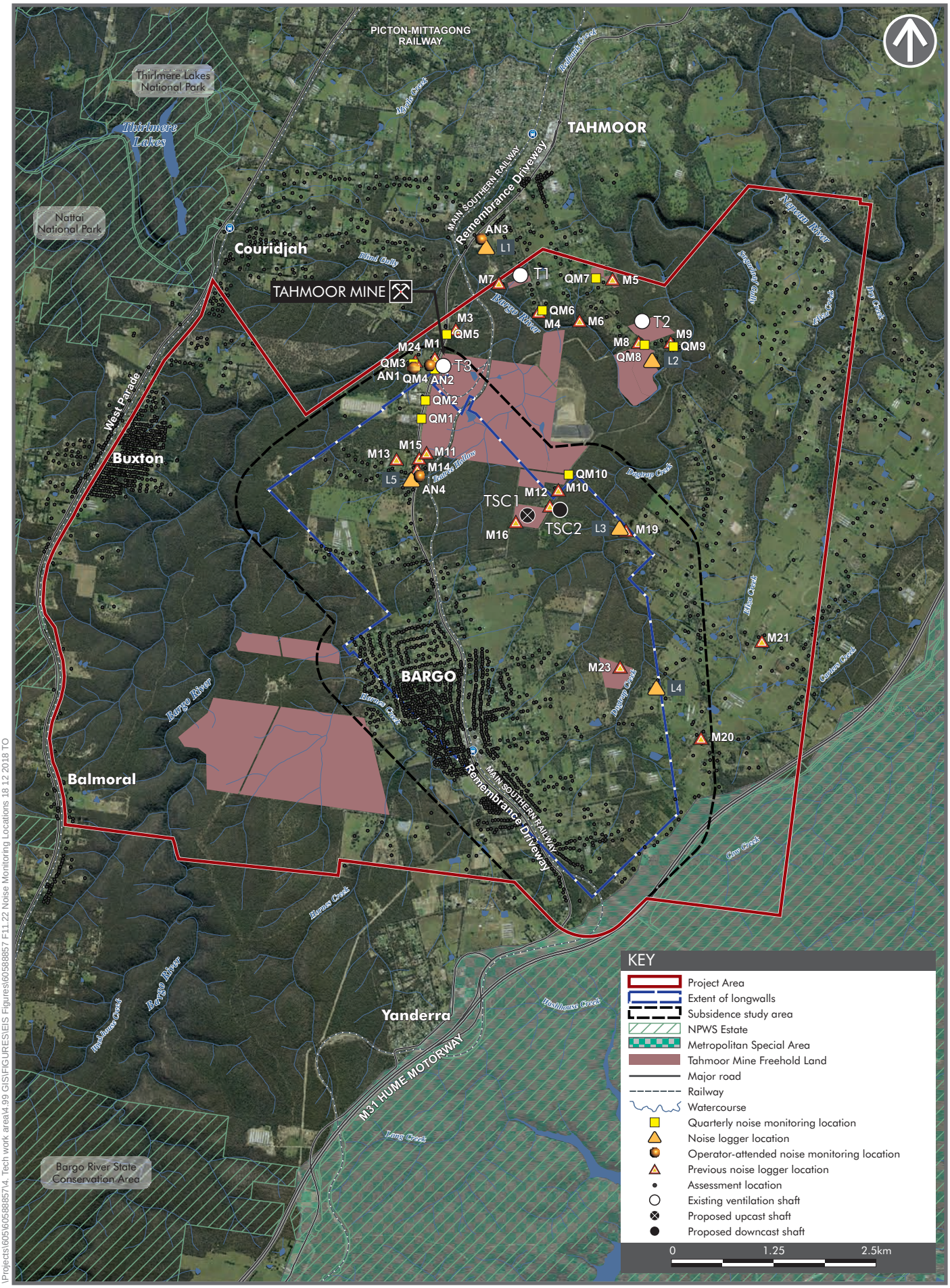
Sensitive receptors, including private dwellings and other noise-sensitive developments (e.g. Wollondilly Anglican Church and College), have been identified near the site and are referred to as assessment locations. Assessment locations have been categorised into nine noise catchment areas (NCA) based on similar ambient acoustic environments. NCAs including corresponding assessment locations (represented as black dots) are shown on **Figure 11.23.**

A description of the NCAs, and the relevant monitoring locations for each catchment, are outlined in **Table 11-44**.

Table 11-44 Noise Catchment Areas

NCA	Description and relation to Noise Monitoring
1	This is the area located within 100 m of Remembrance Driveway and is represented by the ambient noise levels recorded at logger location 5 (L5) which was located 70 m from Remembrance Driveway. It was found that ambient noise levels measured here were generally consistent (within 2 dB) with those measured at other similar locations by Atkins Acoustics (i.e. M11, M14 and M15).
2	This is the area located within 200 m of Remembrance Driveway and is represented by the ambient noise levels recorded at L1.
3	This is the area located south-east of the mine toward the Hume Motorway and is represented by the ambient noise levels recorded at L4. Ambient noise levels measured at L4 were generally lower than those measured at other similar locations by Atkins Acoustics (i.e. M20, M21 and M23) however the lower levels have been utilised for this assessment and provides a conservative approach for the determination of PSNLs in this area.
4	This area is representative of all other typically rural locations within the project study area. Ambient noise levels in this area are consistent with the minimum level provided in the INP and consistent with those measured at locations L2, L3, M10, M12 and M16.
5	This area is located north-east of the mine and represents most residences located on this northern section of Rockford Road, Tahmoor. It is represented by ambient noise levels measured at M5 and M6.
6	This area is located north-east of the mine and represents most residences located on Stratford Road, Tahmoor. It is represented by ambient noise levels measured at M4 and M7.
7	This area contains three residential dwellings adjacent to the service station north of the mine on Remembrance Driveway. It is represented by the ambient noise levels recorded at M3.

NCA	Description and relation to Noise Monitoring
8	This area is relevant to the western end of Olive Lane and is represented by the ambient noise levels recorded at M2.
9	This area is located south-west of the mine and represents most residences located on Caloola Road and Yarran Road, Bargo. It is represented by the ambient noise levels recorded at M13.



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NOISE MEASUREMENT LOCATIONS

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.22

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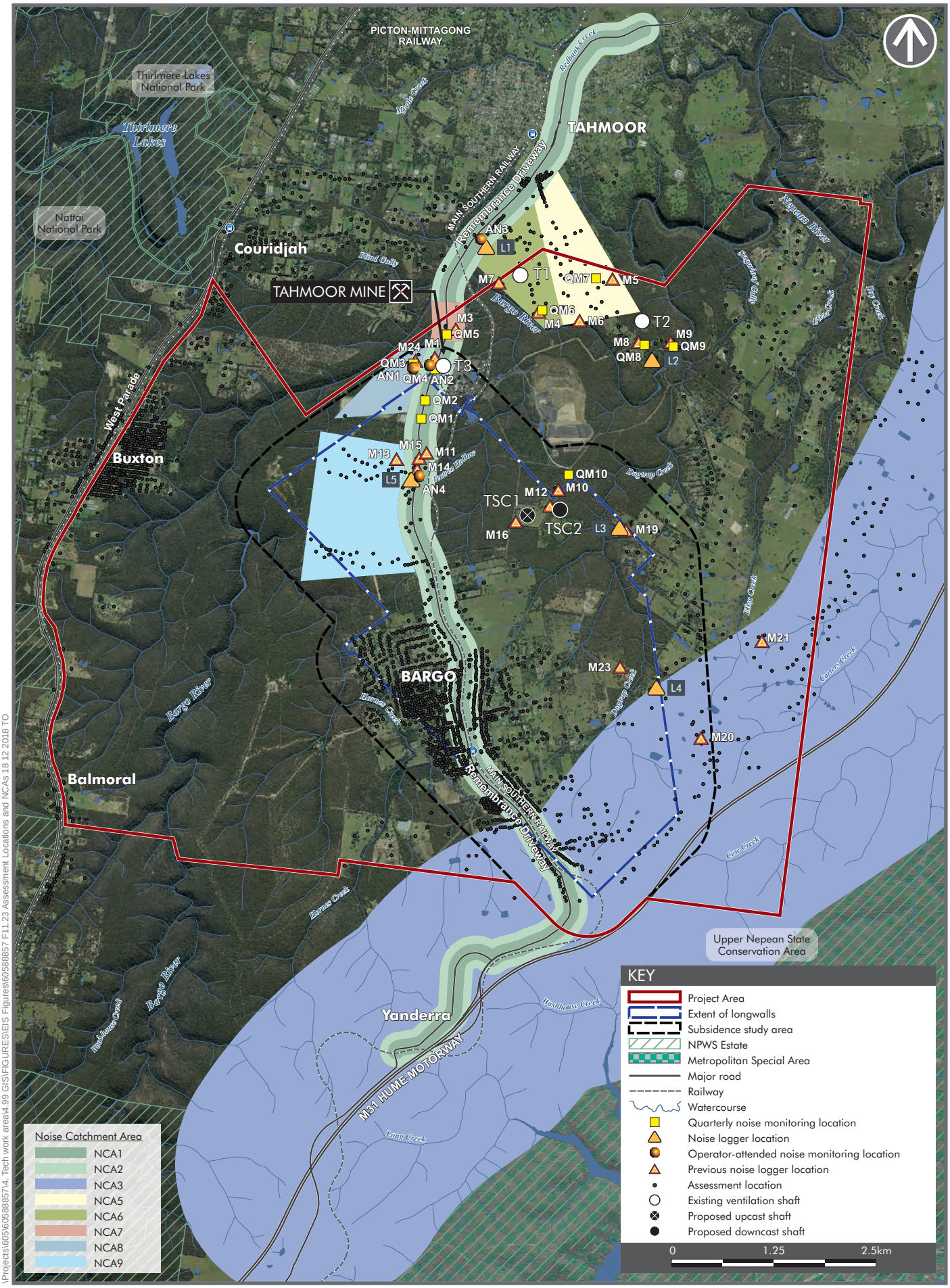

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ASSESSMENT LOCATIONS AND NOISE CATCHMENT AREAS

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.23

Noise and Vibration Criteria

Operational Noise

Project specific noise limits (PSNLs) were determined for the proposed development. As per normal INP practice, these limits are generally taken as equal to the lower of the derived intrusiveness and amenity criteria.

The intrusiveness criterion is equal to the rating background level (RBL) plus 5 dB(A), which means that the equivalent continuous noise level of the source should not be more than 5 dB(A) above the measured background level.

The RBL for each NCA (as determined from noise monitoring described in **Section 11.10.2**), and the associated intrusive noise criteria are provided in **Table 11-45**. Where the RBL for the evening or night period is higher than day period RBL, the lower RBL for the day period has been adopted as the evening and night period in accordance with the INP Application Notes.

Table 11-45 Intrusive noise criteria

NCA (representative logger location)	Adopted RBL, dB			Intrusive criteria, $L_{Aeq,15min}$, dB		
	Day	Evening	Night	Day	Evening	Night
1 (L5)	44	37	30	49	42	35
2 (L1)	39	37	30	44	42	35
3 (L4)	33	33	30	38	38	35
4 (L2, L3)	30	30	30	35	35	35
5 (M5, M6)	32	30	30	37	35	35
6 (M4, M7)	34	32	32	39	37	37
7 (M3)	41	37	34	46	42	39
8 (M2)	41	40	32	46	45	37
9 (M13)	39	38	30	44	43	35

Amenity noise criteria are provided by the INP and are specific to land uses and activities. The criteria relate only to industrial-type noise and do not include road, rail and/or community noise. Assessment locations within NCA1, 2, 7, 8 and 9 have been categorised as per the INP as suburban amenity (i.e. an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry). All other assessment locations have been categorised as per the INP as rural amenity category (i.e. an area with an acoustical environment that is dominated by natural sounds and generally characterised by low background noise levels). Due to the lack of other existing or proposed (approved and not yet built) industry in the area, no adjustment to the acceptable amenity levels was required.

The INP amenity criteria relevant to the proposed development are provided in **Table 11-46.**

Table 11-46 Operational noise amenity criteria

NCA	Indicative area	Recommended 'acceptable' noise, $L_{Aeq,period}$, dB			Recommended 'maximum' noise, $L_{Aeq,period}$, dB		
		Day[1]	Evening	Night	Day	Evening	Night
1	Suburban	55	45	40	60	50	45
2	Suburban	55	45	40	60	50	45
3	Rural	50	45	40	55	50	45
4	Rural	50	45	40	55	50	45
5	Rural	50	45	40	55	50	45
6	Rural	50	45	40	55	50	45
7	Suburban	55	45	40	60	50	45
8	Suburban	55	45	40	60	50	45
9	Suburban	55	45	40	60	50	45
College[2] (internal)	All	$L_{Aeq(1hour)}$ 40	-	-	$L_{Aeq(1hour)}$ 45[3]-	-	-
Place of worship (internal)	All	$L_{Aeq(1hour)}$ 40	$L_{Aeq(1hour)}$ 40	$L_{Aeq(1hour)}$ 40	$L_{Aeq(1hour)}$ 45	$L_{Aeq(1hour)}$ 45	$L_{Aeq(1hour)}$ 45

1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; evening: 6 pm to 10 pm; night: all remaining periods.
2. The recommended acceptable noise amenity level for an existing school affected by existing industrial noise sources has been established as per Note 10 to Table 2.1 of the INP. Amenity criteria for the College applies "when in use" – it has been assumed the College operates during the day period only.
3. It has been inferred that the recommended maximum amenity noise level for an existing school affected by existing industrial noise sources is 5 dB higher than the recommended acceptable level, consistent with all other receiver types listed in Table 2.1 of the INP.

The PSNLs for the project were determined as the lowest of the intrusive criteria and the amenity criteria. For all receivers the intrusive criteria were lower and have therefore determined the PSNLs for the proposed development and are shown in **Table 11-47** below.

Table 11.47 Project specific noise levels

NCA	Intrusive criteria, $L_{Aeq,15min}$, dB			Amenity criteria, $L_{Aeq,period}$, dB			PSNL, $L_{Aeq,15min}$, dB		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
1	**49**	**42**	**35**	55	45	40	**49**	**42**	**35**
2	**44**	**42**	**35**	55	45	40	**44**	**42**	**35**
3	**38**	**38**	**35**	50	45	40	**38**	**38**	**35**
4	**35**	**35**	**35**	50	45	40	**35**	**35**	**35**
5	**37**	**35**	**35**	50	45	40	**37**	**35**	**35**
6	**39**	**37**	**37**	50	45	40	**39**	**37**	**37**
7	**46**	**42**	**39**	55	45	40	**46**	**42**	**39**
8	**46**	**45**	**37**	55	45	40	**46**	**45**	**37**
9	**44**	**43**	**35**	55	45	40	**44**	**43**	**35**
College (internal)	**-**	**-**	**-**	$L_{Aeq(1hour)}$ 40	-	-	$L_{Aeq(1hour)}$ 40	**-**	**-**
Church (internal)	**-**	**-**	**-**	$L_{Aeq(1hour)}$ 40	$L_{Aeq(1hour)}$ 40	$L_{Aeq(1hour)}$ 40	$L_{Aeq(1hour)}$ 40	$L_{Aeq(1hour)}$ 40	$L_{Aeq(1hour)}$ 40

Low Frequency Noise

The modifying factor adjustments outlined in Fact Sheet C of the NPfI (EPA 2017) have been used when assessing the characteristics of a noise source. As a result of the guidance in Fact Sheet C, 2 dB or 5 dB positive adjustments have been made depending on the tonal characteristics of the noise.

Construction Noise

The proposed development will involve a period of construction to establish site facilities (such as ventilation shafts) before staged longwall mining can commence. The Interim Construction Noise Guideline (ICNG) quantitative methodology, which is suited to major construction projects with a typical duration of more than three weeks, is appropriate for construction associated with the proposed development and hence has been adopted for this assessment. This method requires noise emission predictions from construction activities at the nearest assessment locations and assessment against ICNG recommended noise levels.

Noise management levels (NMLs) for residential sensitive receptors as outlined in the ICNG are reproduced in **Table 11-48**. NMLs were used to assess potential noise impacts on construction receptors during standard and non-standard construction hours.

Table 11-48 ICNG construction noise management levels for residential land uses.

Time of day	Management level $L_{Aeq(15\ minute)}$	Application
Recommended standard hours: Monday to Friday 7 am to 6 pm, Saturday 8 am to 1 pm, No work on Sundays or public holidays	Noise-affected RBL + 10 dB	The noise-affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq(15\text{-}min)}$ is greater than the noise-affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB	The highly noise-affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: i. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); ii. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Time of day	Management level $L_{Aeq(15\ minute)}$	Application
Outside recommended standard hours	Noise-affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise-affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see Section 7.2.2 of the ICNG.

Sleep Disturbance

The existing mine and proposed development include 24 hour operations and as such an assessment of sleep disturbance was undertaken. In addition, sleep disturbance was considered in relation to construction noise, as construction works outside of standard hours (i.e. night time works) are proposed.

While absolute criteria for sleep disturbance is not available, the INP Application Notes suggests that a site-related $L_{A1(1min)}$ or L_{Amax} level of 15 dB above the RBL is a suitable screening criterion for sleep disturbance for operation in the night-time period (10pm-7am).

For residential receivers the accepted noise attenuation of 10 dB for the facade of a residential building of standard construction with a partially open window has been adopted.

Sleep disturbance criteria for operation of the proposed development, as derived from the INP, are provided in **Table 11-49**.

Table 11-49 Sleep disturbance screening criteria

NCA	Adopted RBL, dB	Sleep disturbance screening criteria, L_{Amax} (dB)
1	30	45
2	30	45
3	30	45
4	30	45
5	30	45
6	32	47
7	34	49
8	32	47
9	30	45

Road Noise

Traffic routes for construction and operational traffic related to the proposed development comprise Remembrance Driveway (north and south of the mine entrance), Rockford Road and Charlies Point Road. These are all categorised as either arterial or sub-arterial roads as per the categories provided in the RNP.

The relevant RNP road traffic noise assessment criteria for noise sensitive receptors are reproduced in **Table 11-50**.

Table 11-50 Road traffic noise assessment criteria for residential land uses

Receiver type	Road category	Type of project/development	Assessment criteria – dB Day (7 am to 10 pm)	Night (10 pm to 7 am)
Residence	Freeway/ arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments.	$L_{Aeq,15hr}$ 60 (external)	$L_{Aeq,9hr}$ 55 (external)
School	Any	Proposed road projects and traffic generating developments	$L_{Aeq,1hr}$ 40 (internal) when in use	-
Place of worship	Any	Proposed road projects and traffic generating developments	$L_{Aeq,1hr}$ 40 (internal) when in use	$L_{Aeq,1hr}$ 40 (internal) when in use

Additionally, the RNP states that where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2 dB.

The RNP states that any assessment location experiencing an increase in total traffic noise levels above those presented in **Table 11-51** should be considered for mitigation.

Table 11-51 Road traffic relative increase criteria for residential land uses

Road category	Type of project/development	Total traffic noise level increase – dB	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Freeway/arterial/sub-arterial roads and transit ways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic $L_{Aeq(15\text{-}hr)}$ + 12 (external)	Existing traffic $L_{Aeq(9\text{-}hr)}$ + 12 (external)

Construction and Operation Vibration - Human Comfort

Humans can detect vibration levels which are well below those causing any risk of damage to a building or its contents. The actual perception of vibration depends on a range of individual factors. The accepted degrees of perception of vibration for humans are outlined in German Standard DIN 4150 Part 2 1975 (**Table 11-52**).

Table 11-52 Peak vibration levels and human perception to motion

Approximate vibration level	Degree of perception
0.10 mm/s	Not felt
0.15 mm/s	Threshold of perception
0.35 mm/s	Barely noticeable
1.00 mm/s	Noticeable
2.20 mm/s	Easily noticeable
6.00 mm/s	Strongly noticeable
14.00 mm/s	Very strongly noticeable

The NSW guideline for the assessment of vibration *Environmental Noise Management – Assessing Vibration: a technical guideline* (DEC 2006) presents preferred and maximum vibration values for the use in assessing human responses to vibration. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended that the operator negotiate directly with the affected community.

The guideline defines three vibration types and provides direction for assessing and evaluating the applicable criteria. The three vibration types are continuous vibration, impulsive vibration and intermittent vibration.

Intermittent vibration is representative of construction activities such as impact hammering, rolling or general excavation work. Intermittent vibration is assessed using the vibration dose concept which relates to vibration magnitude and exposure time. Calculation of Vibration Dose Values (VDV) and acceptable VDV values are outlined in Section 3.9.1 of **Appendix M**.

It is expected that consideration of transient vibration provides a worst-case scenario in terms of potential human-comfort vibration impacts. Continuous vibration has not been considered given the transient nature of operations and the relative separation to vibration-sensitive receptors. Impulsive vibration can be caused by blasting which is not applicable to the general operations or construction phase of the proposed development.

Construction and Operation Vibration – Structural Effects

The assessment of the project's potential to affect buildings and other structures has been based on BS 7385 Part 2-1993 'Evaluation and measurement for vibration in buildings Part 2'. This standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated.

The recommended limits (guide values) for transient vibration to manage the risk of cosmetic damage to structures are presented numerically in **Table 11-53**.

Table 11-53 Transient vibration guide values for minimal risk of cosmetic damage

Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s	50 mm/s
Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Under certain circumstances, the criteria values have been reduced in line with the recommendations of the standard. However, the BS 7385 states that a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.

11.10.3 Existing Environment

Existing Mine Noise

A summary of the quarterly noise monitoring results for the period between Q1 2014 and Q1 2018 is provided in Table 4.1 of **Appendix M**. These results indicate that noise levels from the mine are generally in compliance with the existing noise limits (i.e. within 2 dB) at the relevant residential monitoring locations. These results also show that existing mine noise emissions from the site at the eastern end of Olive Lane (M4) are in the order of 47 to 50 dB during calm conditions. However, location M4 is not a residence, so the exceedance would not result in impacts at this location. Modelled existing mine noise contours are provided in **Figure 11.24**.

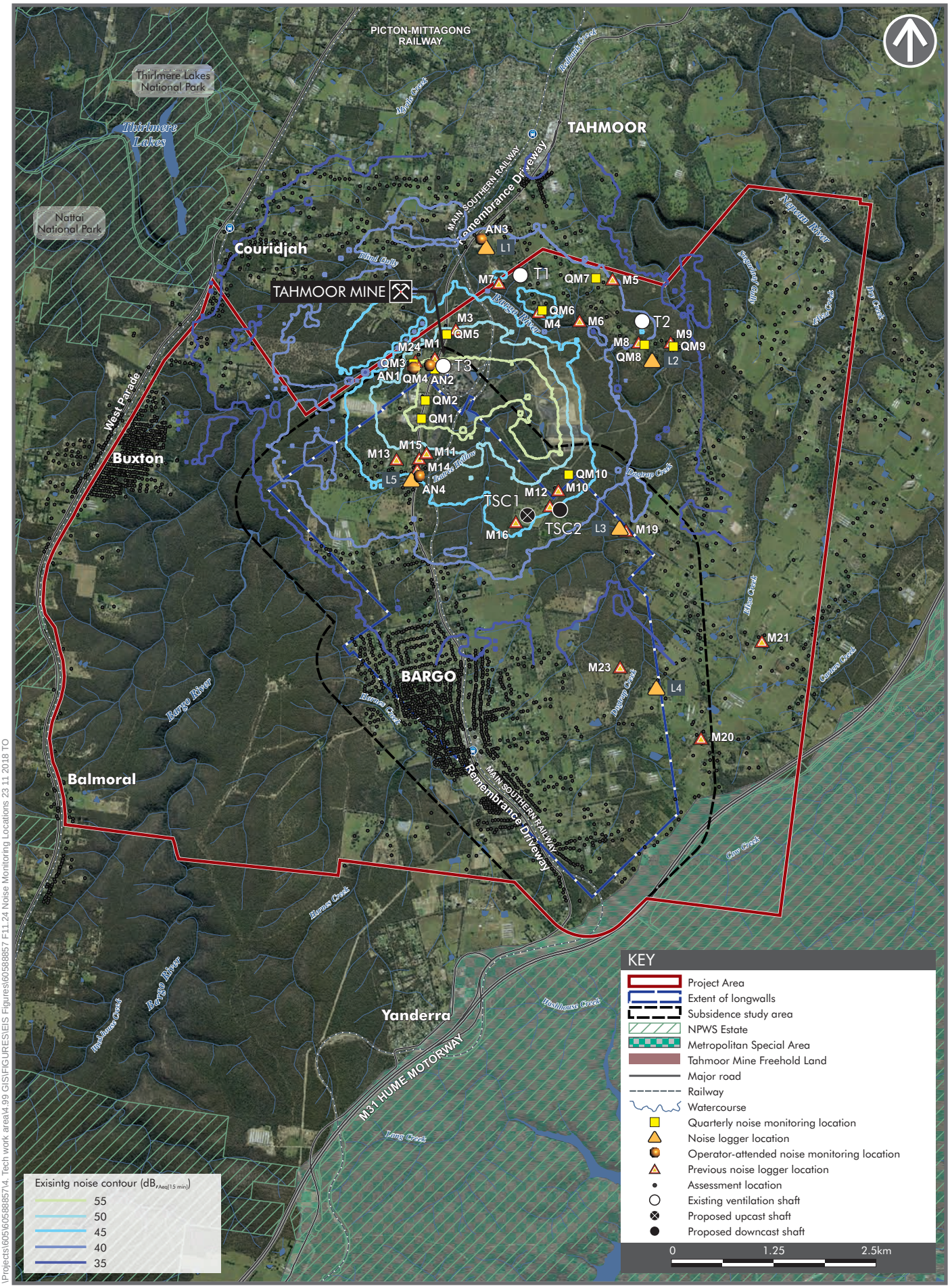
Attended noise monitoring undertaken between November 2017 and January 2018 (**Table 4.2** and Table 4.3 of **Appendix M)** indicate that low frequency noise above the relevant thresholds as a result of operation of the CHPP is present in the vicinity of Olive Lane (M3 and M4) and the Wollondilly Anglican Church and College (M2). Low frequency noise impacts as part of the operation of the mine have been assessed in **Section 11.10.4**.

Existing Acoustic Environment

In addition to the quarterly noise monitoring undertaken around the mine site and previous unattended noise monitoring undertaken by Atkins Acoustics in 2012, EMM conducted attended and unattended noise monitoring at five locations surrounding the site in May 2018 to characterise the existing background noise environment for the purposes of the current assessment.

A summary of the noise monitoring results is provided in Table 5.1 and Table 5.2 of **Appendix M**.

The results of noise monitoring conducted around the site show that, with the exception of the area west of the mine in Olive lane, the existing noise environment surrounding the Tahmoor mining operation is dominated by sources other than the mine. The existing noise environment west of the site, in Olive Lane, is dominated by noise from Tahmoor mine and traffic on Remembrance Driveway. North of the site the existing noise environment is dominated by local traffic and some commercial activity with some contribution from Tahmoor mine. Noise levels at residences south of the site are dominated by traffic noise from Remembrance Driveway and trains. Noise levels in residential areas west of the site are dominated by typically rural sounds and local traffic.



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EXISTING MINE NOISE CONTOURS

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FIGURE 11.24

11.10.4 Impact Assessment

Construction Noise

Of the construction activities required to be undertaken for the proposal, construction of the ventilation shaft site(s) have been modelled as the representative, worst-case construction activities for the proposal.

Site establishment and construction activities associated with the ventilation shafts (other than drilling) would be undertaken between 7am and 6pm Monday to Friday, and 7am to 1pm Saturday, and therefore consistent with the ICNG standard hours. Ventilation shaft drilling would be continuous 24 hours a day, 7 days a week.

TSC1 is proposed to be constructed over a period of approximately two years; 18 months of site establishment and developing site access followed by fan installation over approximately six months. Construction of TSC2 will follow immediately after TSC1 is complete and over a similar timeframe.

Mobilisation for each site would include delivery of approximately forty standard and two wide semitrailer loads of drill rig components, auxiliary drill rig items, storage containers, temporary site amenities and construction equipment. The plant and equipment likely to be used during the site establishment works include excavators, dozer, tippers, trucks, graders, vibratory rollers, compactor, asphalt pavers and water carts. In addition to the drilling rig and gantry itself, associated drilling plant and equipment comprises excavator, loader, crane, compressor, welding machines and water pumps. Plant and equipment items, sound power levels and quantities adopted in the noise modelling are summarised in Table 10.1 of **Appendix M.**

Predicted noise levels over a typical worst case 15-minute scenario were modelled and assessed for comparison against the relevant NMLs. Noise predictions were undertaken assuming calm and noise-enhancing meteorological conditions.

A summary of predicted construction noise emissions for ventilation shaft construction is provided in **Table 11-54** for select representative assessment locations. The assessment locations nearest the proposed construction site are all located within NCA 4 and are all representative of typically rural locations. Hence, minimum construction noise NMLs have been applied.

Table 11-54 Predicted ventilation shaft construction noise – noise enhancing conditions

Location	Predicted ventilation shaft construction noise, $L_{Aeq,15min}$, dB					
	Ventilation ShaftTSC1			Ventilation Shaft TSC2		
	Site Est. (Standard hours)	Drilling (Standard hours)	Drilling (Outside standard hours)	Site Est. (Standard hours)	Drilling (Standard hours)	Drilling (Outside standard hours)
215 Charlies Point Rd	58	48	39	62	52	44
185 Charlies Point Rd	67	57	44	66	56	50
80 Charlies Point Rd	52	42	<35	51	41	<35
Nearest on Great Southern Rd	45	35	<35	42	<35	<35
70 Warrobyn Rd	48	38	<35	52	42	<35
Nearest on Ironbark Rd	42	<35	<35	41	<35	<35
Nearest on Remembrance Driveway	46	36	<35	43	<35	<35
NML ($L_{Aeq,15\ minute}$, dB)	**40 75 highly affected**	**40 75 highly affected**	**35**	**40 75 highly affected**	**40 75 highly affected**	**35**

Construction noise levels are predicted to exceed the NMLs but would be below the highly noise affected level for all works during standard construction hours. Given that the predictions assume noise-enhancing conditions as well as simultaneous operation of plant and equipment, it is likely that actual construction noise levels would be less than those predicted most of the time. Notwithstanding, noise mitigation measures and application of good practice noise management have been considered. Noise mitigation and management measures are discussed below.

Construction noise levels outside of standard hours are predicted to exceed the NML at two locations only: the two nearest privately-owned residences on Charlies Point Road. Tahmoor Coal has commenced negotiations with the owners of both of these properties. Noise from the out-of-hours activity will generally be continuous in nature. Therefore, given the magnitude of predicted L_{Aeq} construction noise levels, the maximum noise level (ie L_{Amax}) from out-of-hours drilling is likely to be below relevant sleep disturbance screening criteria at all nearby assessment locations.

Due to the significant separation between the construction sites and the nearest non-residential sensitive receptors (e.g. Wollondilly Anglican Church and College), potential construction noise impacts at these locations would be negligible.

Operational Noise

Three scenarios were modelled for the operational noise assessment:

- existing mine operations;
- unmitigated proposed development operations; and
- mitigated proposed development operations.

All sources were assumed to operate continuously during all periods (day, evening and night) for both the existing and unmitigated proposed development scenarios to assess a worst case scenario.

Operational noise predictions for Wollondilly Anglican Church and College are presented as internal values. This accounts for a 25 dB reduction in noise at the façade and assumes the affected façade does not have any open windows or doors.

The results of the existing and unmitigated modelling scenarios showed that noise levels from the existing mine and the proposed development exceed the PSNLs. This is despite noise levels generally being in compliance with current noise criteria and is a reflection of changes in both noise policy and the surrounding environment that have occurred since the mine began operation almost 40 years ago.

In consideration of the noise modelling results for the existing and unmitigated scenarios, feasible and reasonable mitigation measures were then considered in accordance with the guidance provided in the INP, so as to minimise noise impacts on sensitive receivers. The proposed development was then modelled with the measures considered reasonable and feasible in place (i.e. the mitigated scenario). A description of these noise mitigation measures is provided in **Section 11.10.5**.

In relation to LFN, tonality corrections were applied to noise levels predicted at the Olive Lane residences and Wollondilly Anglican Church and College, based on the results of the quarterly noise compliance monitoring.

Results for the unmitigated and mitigated operation of the proposed development are presented in the NVIA (**Appendix M**) and illustrated in **Figure 11.25** and **Figure 11.26** below.

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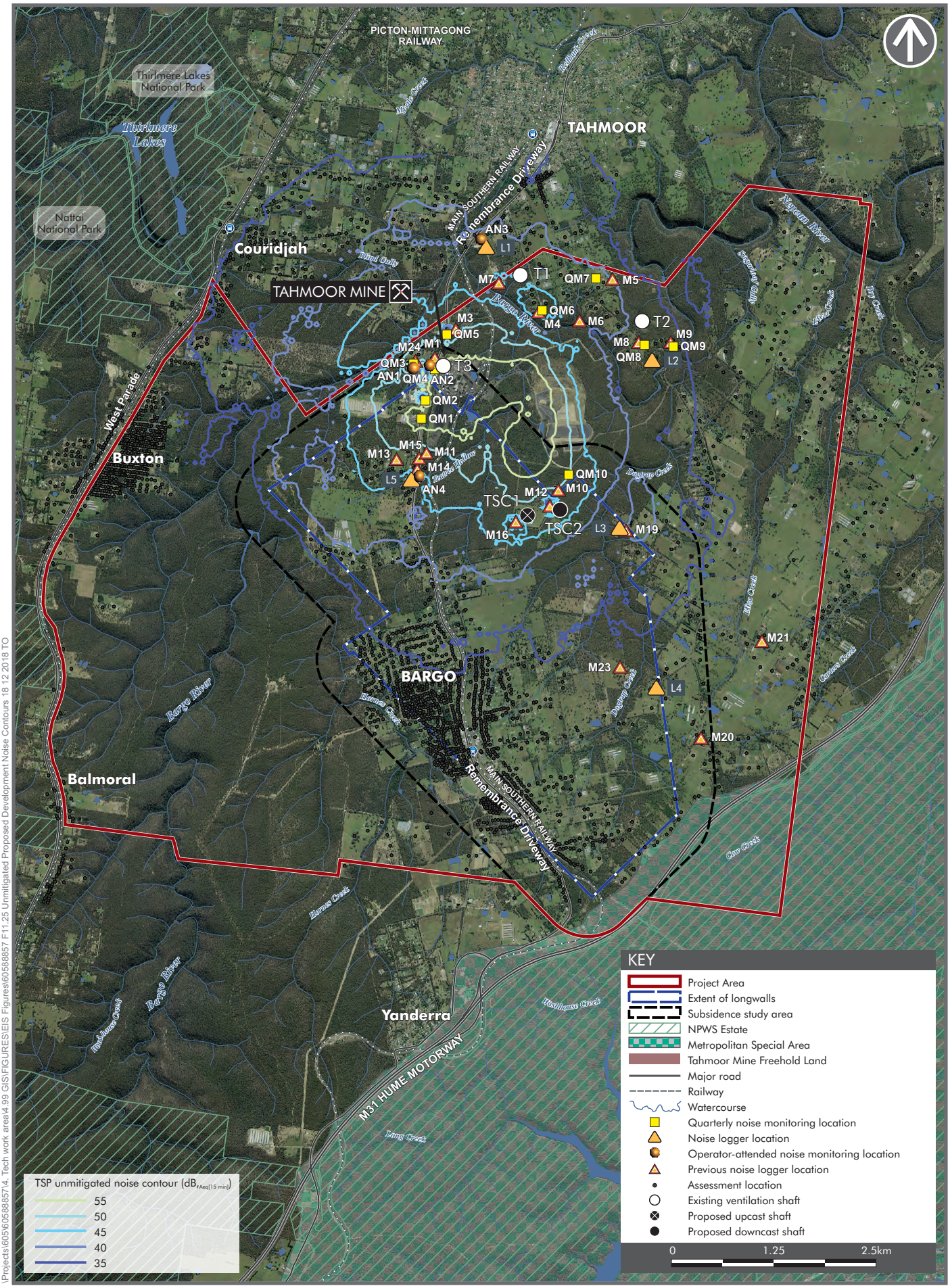

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UNMITIGATED PROPOSED DEVELOPMENT NOISE CONTOURS

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FIGURE 11.25

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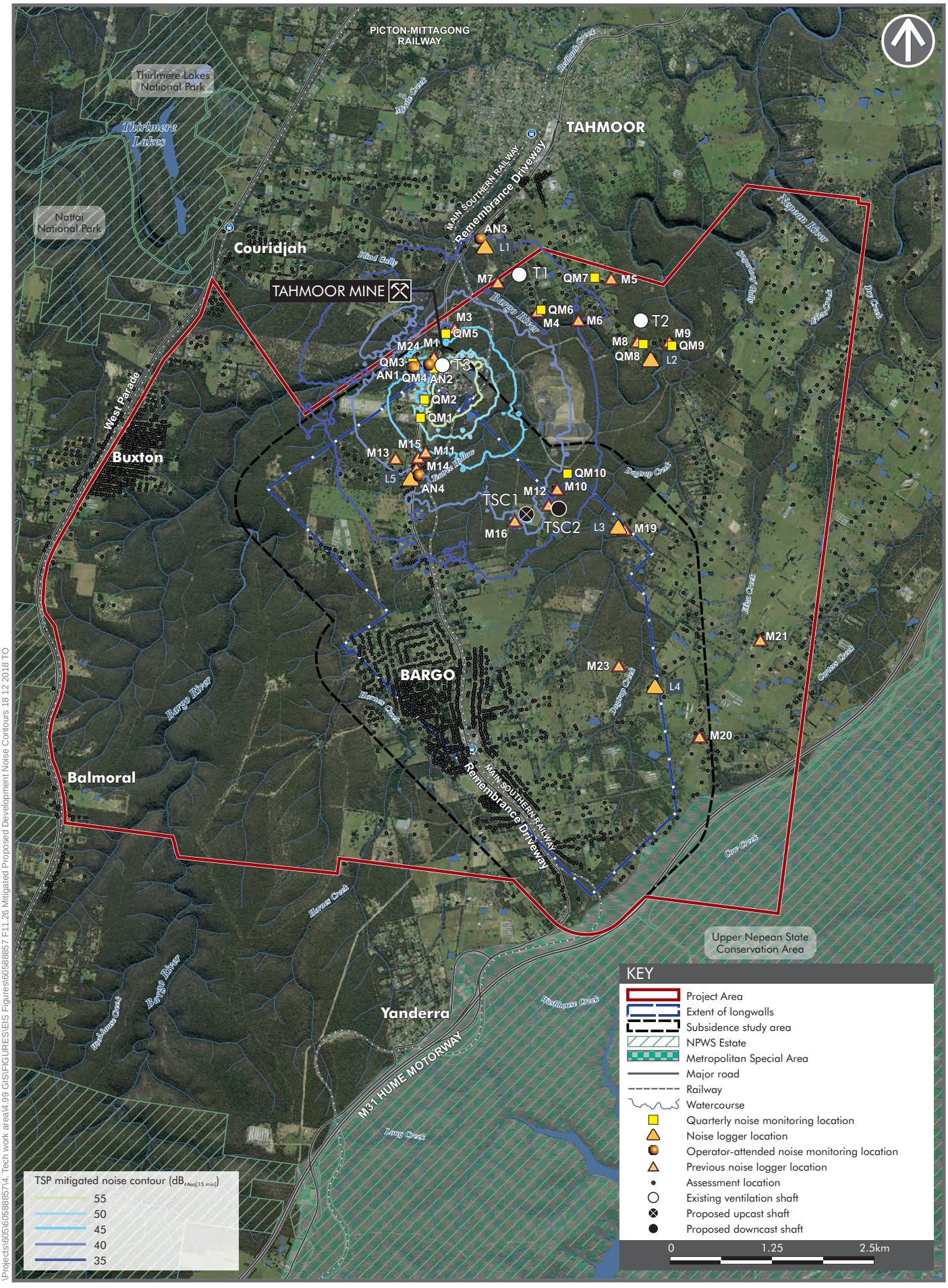

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MITIGATED PROPOSED DEVELOPMENT NOISE CONTOURS

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FIGURE 11.26

Table 11-55 provides a summary of the number of assessment locations for each operational scenario (existing, unmitigated and mitigated proposed development) where predicted noise emissions are in the following categories:

- no more than 2 dB above PSNL;
- 3-5 dB above PSNL; and
- more than 5 dB above PSNL.

Table 11-55 Number of assessment locations compared to PSNLs

Category	Existing Tahmoor mine			The project unmitigated			The project mitigated		
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night
Noise-enhancing meteorological conditions									
No more than 2 dB above PSNL	2,585	2,556	2,464	2,585	2,553	2,460	2,683	2,657	2,716
3-5 dB above PSNL	128	133	172	124	129	167	70	70	28
More than 5 dB above PSNL	50	74	127	54	81	136	10	36	19
Calm meteorological conditions									
No more than 2 dB above PSNL	2,697	2,675	2,619	2,700	2,675	2,610	2,749	2,721	2,743
3-5 dB above PSNL	58	67	86	55	68	95	12	35	12
More than 5 dB above PSNL	8	21	58	8	20	57	2	7	7

The key outcomes of the operational noise assessment are summarised as follows:

- the mitigated proposed development will result in a significant reduction in the number of privately-owned dwellings affected by night-time mine noise emissions that are more than 5 dB above the relevant PSNL; 19 for operation of the mitigated Tahmoor South Project compared to 127 for existing Tahmoor mine operations.
- mine noise associated with the mitigated Tahmoor South Project is expected to reduce at all assessment locations during the night-time period compared to existing levels by at least 2 dB and up to 9 dB.
- mine noise during the day and evening periods associated with the mitigated Tahmoor South Project is expected to reduce by up to 6 dB compared to existing levels at all but two assessment locations. The exceptions are the residences at 185 and 215 Charlies Point Road (south of the REA) where noise levels are predicted to increase by 3 dB compared to existing mine levels as a result of the southern extension to the REA and the new ventilation fans. Predicted night-time noise levels at these two properties are 40 dB and 39 dB (ie 5 dB and 4 dB above PSNLs, respectively). Negotiations with these two properties have commenced, as described in **Section 11.10.5**.
- mine noise at the Anglican Church and school are predicted to achieve the relevant internal amenity noise levels.

Where a proposal is predicted to exceed the PSNLs, the INP describes the process for the negotiation of what represents the best achievable level that is practicable for a development. In the event that a negotiation process is an outcome of this assessment, predicted 'achievable' noise levels at locations around the mine have been provided in Table 7.6 of **Appendix M.**

As identified in **Section 11.10.1** the VLAMP (NSW Government, 2018) outlines how acquisition and mitigation rights are assigned to landholders in relation to State significant resource projects in NSW where PSNLs are exceeded. A summary of the number of assessment locations in each noise impact category, in accordance with Table 1 of the VLAMP are illustrated on **Figure 11.27** and summarised in

Table 11-56. These categories are: significant, moderate, marginal or negligible, consistent with VLAMP definitions.

The characterisation of noise impacts outlined in the VLAMP is generally based around human perception to changes in noise levels. For example, a change in noise level of 1 to 2 dB is typically indiscernible to the human ear. The characterisation of a residual noise impact of 0 to 2 dB above the PSNL is therefore considered negligible. This characterisation of residual noise impacts is outlined further in Table 3.2 of **Appendix M**.

In some cases, locations categorised as significant are relatively further from the mine than those with a moderate or marginal impact category. This is due to several factors including rounding of noise predictions, local topographical features and the relative criteria for these locations (with respect to amenity as per Table 1 of the VLAMP).

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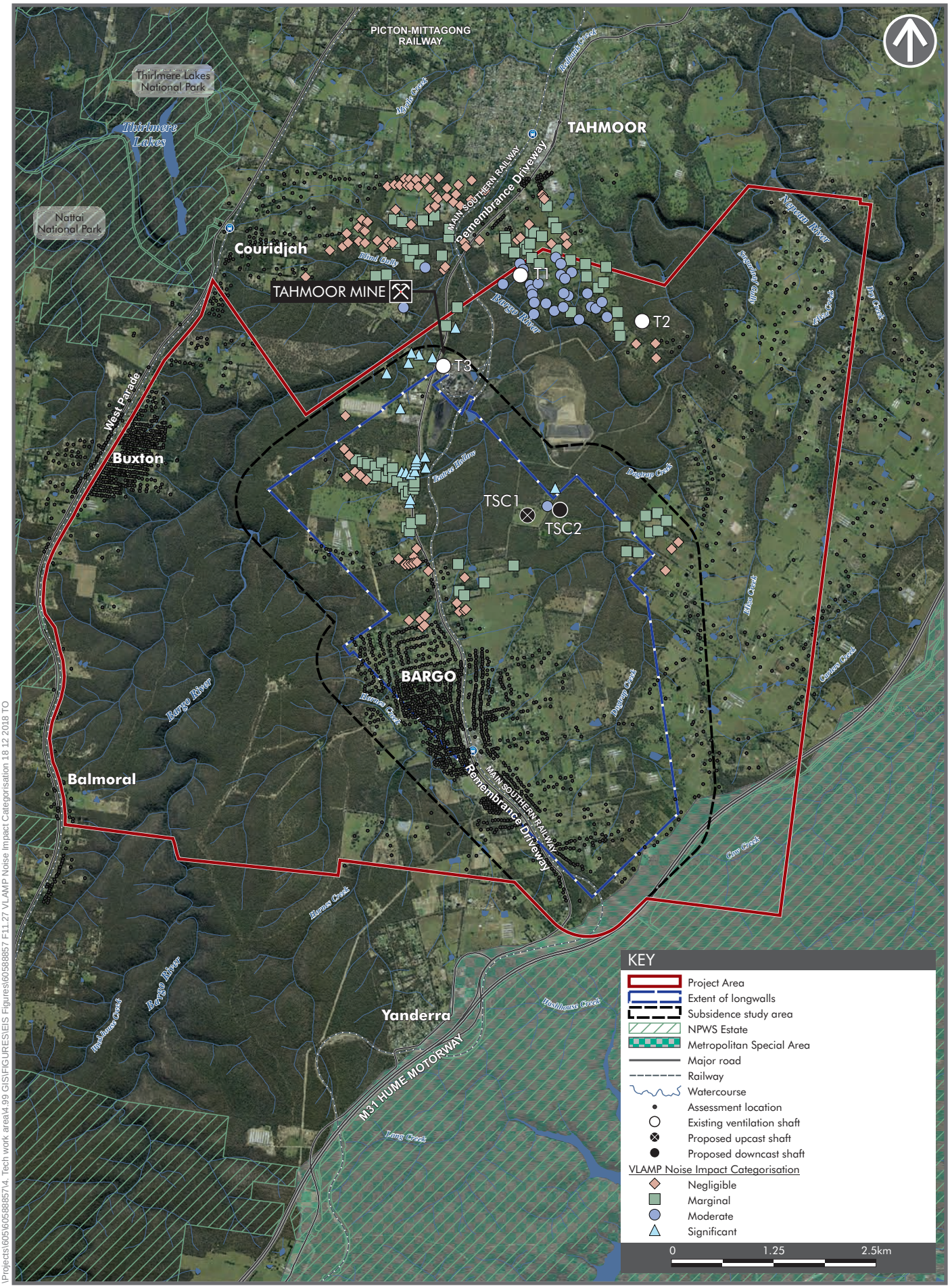

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VLAMP NOISE IMPACT CATERIGISATION

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FIGURE 11.27

Table 11-56 Number of assessment locations in each noise impact category for mitigated proposed development

Satisfies PSNL	Negligible	Marginal	Moderate	Significant
2,538	93	83	28	20

As described in **Section 11.10.5**, Tahmoor Mine will progress negotiations where required with properties predicted to be marginally, moderately or significantly affected by the proposed development, with the aim of achieving negotiated agreements as per the VLAMP. If voluntary mitigation or acquisition rights were to be applied, then mitigation rights could be applied to those properties predicted to experience impacts categorised as marginal or moderate (i.e. 111 properties), and voluntary acquisition rights could be applied to properties where impacts are categorised as significant (i.e. 20). Notwithstanding, and as described above in this section, the proposed development will have a beneficial outcome in relation to noise impacts at a site which has legacy noise issues, in that it will reduce noise levels from the mine at all nearby properties during the night-time and all but two during the day. Accordingly, achievable noise limits are presented in **Appendix M** for the proposed development.

Sleep Disturbance

Based on the results of operator-attended noise surveys undertaken by EMM in Olive Lane, existing maximum noise levels from Tahmoor Mine are in the order of L_{Amax} 53 dB from general dozer activity or loading coal into wagons. Based on a partially open window providing 10 dB of sound reduction this would equate to an approximate internal noise level of L_{Amax} 43 dB. Although this external level is above the relevant screening criteria, the calculated internal noise levels are well below those that are likely to cause awakening reactions.

Maximum noise levels from existing operations have previously been the subject of a PRP. Engineered mitigation controls have been effectively implemented as part of the Tahmoor Mine's PRPs to reduce and control maximum noise events. In addition, the noise reduction measures proposed as part of the proposed development (refer to Section 11.10.5) will also have the effect of further reducing maximum noise levels from site. It is expected that both the frequency and level of maximum noise events from the proposed development will be lower compared to the existing operation due to the mitigation measures to be implemented as part of the proposed development. Operation of the proposed development during the night-time is likely to result in maximum noise events below those likely to cause awakening reactions and satisfy the relevant maximum noise level screening criteria. A noise monitoring program would continue to be implemented at the mine to verify operational noise levels from the mine including maximum noise events during the night time (refer **Section 11.10.5**).

Road Traffic Noise

The nearest sensitive receptors potentially affected by an increase in road traffic volumes as a result of the proposed development are primarily located on Remembrance Driveway, north and south of the site access road. Road traffic movements associated with some of the proposed construction activities (i.e. TSC1 and TSC2 ventilation shaft construction) will require the use of additional roads surrounding the site including Rockford Road (from Remembrance Driveway north of the site access road) and Charlies Point Road. Hence, the potential for road traffic noise impact has also been considered at the nearest sensitive receptors along these roads during the TSC1 and TSC2 ventilation shafts construction.

Existing traffic volumes were referenced from the *Traffic Impact Assessment for Tahmoor South Project* prepared by Transport and Urban Planning Pty Ltd (TUP), November 2018. Peak period traffic counts corresponding to the shift change periods at the site were undertaken by TUP in August 2017. Road traffic volumes have been based on the traffic surveys and are summarised in **Table 11-57**. This assessment of road traffic noise has been based on existing average daily traffic (ADT) volumes.

Table 11-57 Existing traffic volumes

Road	Road section	ADT (2017)	% Heavy vehicle
Remembrance Driveway	North of site access road	9,467	7.3
Remembrance Driveway	South of site access road	8,866	7.5
Rockford Rd	North of Charlies Point Rd	2,762	6.2
Charlies Point Rd	North of TSC1/TSC2	119	7.5

Site employee (operational) traffic volumes are expected to increase between approximately 2019 and 2020 (peak in 2020) as a result of the proposed development. Construction generated traffic would also occur between approximately 2020-2024 with equipment deliveries continuing till approximately 2027. Given peak operational traffic generation in 2020, overlapping construction and operational traffic volumes for 2020 have been considered as the worst-case year in this assessment for predicting road traffic noise and is considered to be conservative. Site traffic for the construction of TSC1 and TSC2 will travel north from the site access road then on to Rockford Road and Charlies Point Road.

Road traffic noise levels predicted at the nearest sensitive receivers to the relevant roads for the proposed development are shown in **Table 11-58.**

Table 11-58 Road traffic noise results

Road	Road section	Receiver type (distance from road)	Existing (2017) noise levels $L_{Aeq,period}$, dB		Future[1] (2020) noise levels $L_{Aeq,period}$, dB		Criteria $L_{Aeq,period}$, dB		Increase between existing and future, dB	
			Day	Night	Day	Night	Day	Night	Day	Night
Remembrance Driveway	North of Rockford Rd	Residence (10 m)	63	58	63	58	60	55	<1	<1
	Between site and Rockford Rd	Residence (14 m)	61	55	61	56	60	55	<1	<1
	South of site	Residence (18 m)	62	57	62	57	60	55	<1	<1
		School/ Church[1,2]	48 (internal)	N/A	48 (internal)	N/A	40 (internal)	N/A	<1	N/A
Rockford Rd[3,4]	North of Charlies Point Rd	Residence (15 m)	63	58	64	58	60	55	<1	1
Charlies Point Rd[3,4]	North of TSC1/ TSC2	Residence (40 m)	46	41	53	49	60	55	7	8

Notes: 1. Levels for this receiver are $L_{Aeq,1hr}$ internal noise levels, where an external-to-internal reduction of 10 dB has been applied for partially opened windows.
2. Internal $L_{Aeq,1hr}$ criterion applies when in use.
3. Existing site generated traffic volumes on this road are generally very low.
4. Site related traffic on this road are only for TSC1 and TSC2 construction.

Existing (2017) road traffic noise levels currently exceed or are equal to the relevant RNP criteria at the nearest affected receivers along Remembrance Driveway and Rockford Road. At receivers along Charlies Point Road, the existing (2017) level of road traffic noise is calculated to be well below the relevant criteria.

The proposed development (peak) traffic volumes are predicted to marginally increase (by up to 1 dB for the relevant periods) the future (2020) road traffic noise levels at the nearest sensitive receptors on Remembrance Driveway and Rockford Road. Such an increase is considered negligible and satisfies the RNP 2 dB allowance increase following all feasible and reasonable mitigation measures.

At receivers along Charlies Point Road, future (2020) road traffic noise levels are predicted to increase by up to 7 dB and 8 dB compared to the existing (2017) levels of road traffic noise calculated for day and night. However, this is below the RNP road traffic relative increase criteria ($L_{Aeq,period}$ + 12 dB) for residential land uses and overall road traffic noise levels that are predicted to be below the relevant day and night-time criteria. Therefore, the proposed development is not expected to result in significant road traffic noise impacts at the nearest potentially affected sensitive receptors. It is noted that traffic volumes (and associated noise) would be expected to reduce after 2020.

Rail Noise

Tahmoor Mine currently has four allocated train paths per day between the site and Port Kembla. This allocation is equivalent to the transport of approximately 4 million tonnes of product coal per annum and is sufficient to accommodate the full life of the proposed development. Hence no increase in rail capacity between Tahmoor Mine and Port Kembla will be required for the proposed development. As the existing rail infrastructure and the number of allowable train movements would remain unchanged, an assessment of off-site rail traffic noise was not considered necessary.

The current rail movements to and from Tahmoor Mine were described in the EIS for the current Tahmoor North operations, and were subsequently approved as part of the 1994 Tahmoor North Consent (Reference number: D47-0029). The Tahmoor North EIS noted that productivity increases associated with the Tahmoor North project would result in an average of 3.5 trains per day, with peaks of eight trains per day. The Tahmoor South Project would continue to operate at a similar capacity of an average of four trains per day.

The existing on-site rail loop design is configured with two radii of approximately 170 m and 200 m. Wheel squeal from trains on the Tahmoor Mine rail loop has never been the subject of noise complaints. Further, investigations during on-site and off-site routine monitoring audits have not identified rail “wheel squeal” as a component of the noise from coal trains entering or leaving the rail loop. The main component of train noise on this loop has been identified as locomotive engine noise. This noise source has been modelled as part of the operational noise assessment for the proposed development.

Construction Vibration

As a guide, safe working distances for typical items of vibration intensive plant are listed in **Table 11-59**. The safe working distances are quoted for both “cosmetic damage” and “human comfort” as defined in British Standard BS 6472-1. The safe working distances are indicative and will vary depending on the particular item of plant and local geotechnical conditions.

In relation to human comfort (response), the safe working distances relate to continuous vibration and apply to residential receivers. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels than those listed under the human response in **Table 11-59**, occurring over shorter periods are allowed.

Based on the safe working distances for typical plant items and the location of surrounding sensitive receptors, it is unlikely that human response vibration criteria will be exceeded. Most of the assessment locations are greater than 170 m away from any likely construction activity, which is greater than the maximum safe working distance of 100 m for an 18 tonne (or greater) vibratory roller. Human response criteria are more stringent than cosmetic damage criteria; therefore cosmetic damage criteria would be satisfied at privately owned sensitive receptors.

The exception to this is the privately owned sensitive receptor at 185 Charlies Point Road; vibration intensive construction plant may operate within approximately 30 m of this residence when site establishment activities occur for TSC1. Cosmetic damage thresholds would be met and site establishment would be during standard hours only. Tahmoor Coal has commenced consultation with the resident at 185 Charlies Point Road.

Table 11-59 Recommended safe working distances for vibration intensive plant

Plant item	Rating/Description	Safe working distance	
		Cosmetic damage (BS 7385)	Human response (BS 6472)
Vibratory roller	<50kN (Typically 1-2 tonnes)	5 m	15 to 20 m
	<100kN (Typically 2-4 tonnes)	6 m	20 m
	<200kN (Typically 4-6 tonnes)	12 m	40 m
	<300kN (Typically 7-13 tonnes)	15 m	100 m
	>300kN (Typically 13-18 tonnes)	20 m	100 m
	>300kN (>18 tonnes)	25 m	100 m
Small hydraulic hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium hydraulic hammer	(900 kg - 12 to 18t excavator)	7 m	23 m
Large hydraulic hammer	(1600 kg - 18 to 34t excavator)	22 m	73 m
Vibratory pile driver	Sheet piles	2 m to 20 m	20 m
Pile boring	≤ 800 mm	2 m (nominal)	4 m
Jackhammer	Hand held	1 m (nominal)	2m

Operational Vibration

Vibration from operational activity is not expected to change and given the separation distance between the site and the nearest residence (>200m), ground-borne vibration from equipment operating at the pit-top is not expected to be perceptible.

11.10.5 Management and Mitigation Measures

Construction Noise and Vibration

The ICNG recommends the following where NMLs are predicted to be exceeded:

- application of feasible and reasonable work practices to minimise noise;
- inform potentially affected residents of the nature of the works to be carried out, expected noise levels and duration and relevant contact details; and
- negotiation with the community where noise from work outside standard hours is predicted to exceed the relevant NML by more than 5 dB.

Tahmoor Coal would manage construction noise from the site by adopting work practices such as:

- constructing during ICNG standard hours only, excluding drilling of ventilation shafts;
- selection of lower noise emitting equipment where feasible and reasonable;
- regular reinforcement with construction staff (such as at toolbox talks) of the need to minimise noise and vibration;
- avoiding the use of portable radios, public address systems or other methods of site communication that may unnecessarily impact upon residents;
- parking of vehicles in locations that minimise noise;
- minimising the need for vehicle reversing for example, by arranging for one-way site traffic routes (largely achieved by site layout design);
- use of broadband audible reverse alarms on vehicles and elevated work platforms used on site; and

- minimising the movement of materials and plant and unnecessary metal-on-metal contact.

Tahmoor Coal will manage construction noise levels where exceedances of NMLs have been identified. The construction noise management methods will be detailed in a construction noise and vibration management plan which will be developed prior to commencement of construction activities and include, but not be limited to, the following:

- a detailed assessment of feasible and reasonable work practices that will be implemented to minimise noise and vibration impacts;
- strategies to promptly deal with and address noise and vibration complaints; and
- procedures for notifying nearby residents of forthcoming works that are likely to produce noise and vibration impacts.

Tahmoor Coal has commenced negotiations with the owners of the two properties on Charlies Point Road that are predicted to exceed construction NMLs during non-standard (night-time) construction hours.

Existing Mine Noise

Noise mitigation and management measures that are currently implemented at the Tahmoor Mine include the following:

- enclosure of acoustically significant fixed plant such as the Coal Handling and Preparation Plant (CHPP), transfer and processing buildings and conveyor galleries;
- broadband reversing alarms on all surface mobile equipment;
- acoustic barriers such as the earth bund adjacent to the rail loop and on the western side of the clean coal stockpile area; and
- concrete coal storage bins.

Tahmoor Mine has been the subject of numerous pollution reduction programs (PRPs) in relation to noise, the outcomes of which have been accepted by the EPA and evidenced by a significant reduction in noise complaints over time. Noise mitigation works undertaken as part of PRPs included the following:

- use of a Programmable Logic Controller (PLC) to control the operation of the main surface shaker screen at the CHPP;
- GPS tracking installed in REA haul trucks to monitor speed and truck movements;
- secondary acoustic treatments to the Ventilation Shaft 2;
- decommissioning of the Shaft 3 ventilation system;
- acoustic treatments to the head of the drift conveyor to reduce the airborne noise and vibration transfer impacts from processing product coal;
- dampening of product deflector plates, external insulation and cladding of the reject bin; and
- replacement of building cladding and closing of openings in buildings.

Other works implemented as a result of the PRPs specifically targeted at reducing maximum noise events from the site include the following:

- laminated transfer chutes at conveyor transfer points;
- lagging of the reject stone bin;
- limit switches to ensure the stone bin levels are maintained at not less than 30% full;
- replacement of mobile plant reversing alarms with low level, broad-spectrum alarms (colloquially referred to as “quackers”); and
- a real-time noise monitoring network and alarm reporting system.

The Tahmoor South Project - Operational Noise

The main operational noise sources at the site are the CHPP and dozers. Other significant sources that contribute to off-site noise emissions include rail loading activity (locomotives and loading coal into wagons), compressors and the reject haul truck. These activities would continue as part of the proposed development. Mitigation strategies have been considered in the following hierarchical approach:

1. control of noise at the source;
2. once the feasible and reasonable controls at the source are exhausted, controlling the transmission of noise; and
3. once feasible and reasonable controls are exhausted for source and transmission, consider mitigation measures at the noise-sensitive receivers.

Mitigation measures determined to be reasonable and feasible for the proposed development (and therefore included in the noise modelling and assessment) include:

- at-source controls:
  - close openings on CHPP facades (reduction of CHPP noise emissions up to 10 dB);
  - improved cladding and insulation for CHPP roof (reduction of CHPP noise emissions up to 10 dB);
  - improved cladding and insulation for north, east and western facades of the CHPP (reduction of CHPP noise emissions up to 10 dB);
  - noise suppression kit for dozer (4 dB reduction to dozer sound power level);
  - use of only one dozer at night (either on the ROM or stockpile area);
  - restrict night time dozer operation to northern section of stockpile area;
  - restrict activity in the REA to day and evening only – no haulage or dozer operation in REA at night;
  - improve feed chute into rail wagons (5 dB reduction to activity sound power level); and
  - improvement to enclosure of compressors (8 dB reduction to compressor sound power level).
- transmission noise control:
  - barrier around coal stockpile area, in the form of 3 shipping containers stacked; and
  - improve performance (increase height) of bund to shield northern section of rail loop.
- at receptor control:
  - receptor mitigation at two receptors (185 and 215 Charlies Point Road), where mitigation measures depend on the outcome of commenced negotiations with the receptors.

All the feasible and reasonable noise mitigation measures identified above, with the exception of at receiver controls, were modelled in the mitigated proposed development scenario and will be completed within three years of operational commencement of the Project.

Tahmoor Coal will continue to investigate options for further noise mitigation into the future including, but not limited to, the following:

- mitigation for the CHPP; and
- consideration of noise mitigation initiatives in the purchase and/or design of all new equipment as well as any new site buildings and access roads.

Sleep Disturbance

Additional noise reduction measures considered as reasonable and feasible and therefore committed to as part of the proposed development that will have the effect of further reducing maximum noise levels from site include the following:

- increased height of the barrier adjacent to the north-western side of the rail loop;
- improvements to feed chute into rail wagons to reduce impact noise when loading of coal commences into each wagon (5 dB reduction to activity sound power level);
- additional cladding and insulation on the CHPP building (reduction of CHPP noise emissions up to 10 dB);
- noise-suppression kit for dozer (4 dB reduction to dozer sound power level); and
- no activity (haulage or dozer) will occur in the REA during the night time.

11.10.6 Conclusion

Significant work has been undertaken at Tahmoor over recent years to mitigate noise emissions from the mine, and existing mine noise emissions are generally in compliance with the current noise criteria for the site. However, operational noise emissions from the existing Tahmoor mine were found to be above the relevant PSNLs in accordance with contemporary EPA noise policy at a number of assessment locations. Accordingly, a detailed investigation has been undertaken into the feasible and reasonable mitigation measures that could be applied to further reduce noise emissions from the proposed development, in consideration of contemporary noise criteria.

A number of mitigation measures determined to be feasible and reasonable have been committed to by Tahmoor Mine and incorporated into the operational noise model for the proposed development. Subsequently, the noise emissions from the proposed development are predicted to reduce compared to existing Tahmoor Mine operational noise emissions at almost all noise-sensitive receptors during the day and evening periods and, importantly, most significantly during the night-time period at all noise-sensitive receptors. Under noise-enhancing weather conditions it is predicted that up to 19 properties would be affected by noise emissions more than 5 dB above the PSNL during the night-time period, which is a significant reduction from 127 for existing Tahmoor mine operations.

Night-time noise associated with the proposed operational mine (with mitigation applied) is expected to be lower than existing noise levels by at least 2 dB (and up to 9 dB) at all assessment locations. During the day and evening periods mitigated operational noise is expected to be lower by up to 6 dB compared to existing levels at all but two assessment locations; residences at 185 and 215 Charlies Point Road. These residences would experience minor increases as a result of the southern extension to the REA and the operation of the new ventilation fans. Predicted noise levels at these two properties are 40 dB and 39 dB (i.e. 5 dB and 4 dB above PSNLs, respectively). Negotiations between Tahmoor Coal and the owners of the two residences have commenced, for the purpose of acquiring the two properties. Mine noise at the Wollondilly Anglican Church and College is predicted to achieve the relevant internal amenity noise levels for these facilities.

It is expected that both the frequency and level of maximum noise events from the proposed development will be lower compared to the existing operation due to the mitigation measures to be implemented as part of the proposed development. Operation of the proposed development during the night-time is likely to result in maximum noise events below those likely to cause awakening reactions and satisfy the relevant maximum noise level screening criteria.

Road traffic noise associated with construction and operation of the project is predicted to satisfy the requirements of the RNP. Hence, the project is not expected to generate significant road traffic noise impacts at the nearest potentially affected receivers.

Construction noise levels are predicted to exceed the relevant NML at some locations but would remain below the highly noise affected level for all works during standard construction hours at all assessment locations. Construction noise levels outside of standard hours are predicted to exceed the NML at the two nearest sensitive receptors on Charlies Point Road. Noise from out-of-hours construction activity would generally be continuous in nature and given the magnitude of predicted L_{Aeq} construction noise levels, the maximum noise level is likely to be below the sleep disturbance screening criteria at all nearby assessment locations.

Based on the safe working distances for construction related vibration from typical plant items and the location of surrounding sensitive receptors, it is unlikely that human response vibration criteria will be exceeded. Since human response criteria are more stringent than cosmetic damage criteria, cosmetic damage criteria would be satisfied for most receptors. The exception to this is the residence at 185 Charlies Point Road, with whom negotiations have commenced for the purpose of acquiring the property. Vibration from operational activity is not expected to change, with ground-borne vibration from equipment operating at the pit-top not expected to be perceptible.

Tahmoor Coal will continue to monitor and actively manage noise and vibration as part of the proposed development, and will continue to investigate options for further operational noise mitigation into the future.

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11.11 Air Quality

The Air Quality Impact Assessment (AQIA) prepared by ERM (2018) to inform this EIS assessed the potential air quality impacts of the proposed development, in the context of existing background levels, including the ongoing operation of the Tahmoor Mine's Surface Facilities Area and other local pollutant sources. The complete AQIA is provided in **Appendix N** of this EIS.

The AQIA addressed the SEARs relevant to air quality impacts. These are listed in **Table 11.60**. The EPA's requirements relating to the assessment of air quality impacts, including where they are addressed in the EIS, are listed in **Appendix A**.

Table 11-60 SEARs for the assessment of air quality impacts

Air Quality SEARs	Where addressed
Air Quality – including:	
• an assessment of the likely air quality impacts of the development in accordance with the Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW, having regard to EPA's requirements (see Attachment 2);	**Section 11.12.5**
• an assessment of the likely greenhouse gas impacts of the development; and	**Section 11.13.3**
• an odour assessment of the ventilation shafts in accordance with the Technical Framework – Assessment and Management of Odour from Stationary Sources in NSW.	**Section 11.12.5**

11.11.1 Background

Particulate Matter

The emission of dust and Particulate Matter (PM) are the key air quality issues associated with mining. Odour can also be an issue. PM is formed when a particulate becomes entrained in the atmosphere by the turbulent action of wind, by the mechanical disturbance of materials, or through the release of particulate-rich gaseous emissions from combustion sources. PM is generated at mines from a number of activities including vegetation stripping and removing topsoil, the removal and handling of coal rejects, the abstraction and handling of coal, heavy vehicle movements and wind erosion from stockpiles and exposed surfaces. Particle size is an important factor which influences the dispersion and transport of PM in the atmosphere, and its potential effects on human health. Typically, the size of suspended particles ranges from 0.005 to 100 micrometres (µm) and is often described by the aerodynamic diameter of the particle. Common particulate size ranges include:

- TSP: total suspended particulate matter refers to all suspended particles in the air. The upper size range is typically 30µm to 50µm;
- PM_{10}: all particles with an equivalent aerodynamic diameters of less than 10µm;
- $PM_{2.5}$: all particles with equivalent aerodynamic diameters of less than 2.5µm, often referred to as fine particles. Fine particles are derived primarily from combustion processes such as vehicle emissions, wood burning for power generation and natural processes such as bushfires. Fine particles also include secondary organic aerosol from volatile organic compound (VOC) emissions, and sulphate and nitrate particles; and
- $PM_{2.5-10}$: the difference between PM_{10} and $PM_{2.5}$ mass concentrations, often described as coarse particles. Coarse particles are derived mainly from mechanical processes resulting in the suspension of dust, soil or other materials from roads, farming, mining and dust storms, pollen, mould, spores and plant parts.

Reviews of the health effects of particulate matter have generally identified that the smaller PM are of greater health concern as these particles can penetrate further into the respiratory tract.

In addition to health impacts, airborne dust also has the potential to cause nuisance effects by depositing on surfaces, including native vegetation and crops. Larger particles do not tend to remain suspended in the atmosphere for long periods of time and will deposit relatively close to source. Dust fallout can soil materials and generally degrade aesthetic elements of the environment and are assessed for nuisance or amenity impacts. Mining-related dust is likely to be comprised predominantly of coarse PM and larger.

The key pollutants released from flaring of coal seam methane are oxides of nitrogen NOx (comprised of nitric oxide (NO) and nitrogen dioxide (NO_2)), Carbon Monoxide and Volatile Organic Compounds (VOCs). Concern with nitric oxide is related to its transformation to nitrogen dioxide and its role in the formation of photochemical smog. Carbon monoxide and VOCs can be harmful to health.

Odorous discharge can occur from mine ventilation shafts of return air, for example when longwall mining exposes odorous shale oil within mine workings. There are no instrument-based methods that can measure an odour response in the same way as the human nose. Therefore “dynamic olfactometry” is typically used as the basis for odour management and regulation. Dynamic olfactometry is the measurement of odour by presenting a sample of odorous air diluted to the point where a trained panel of assessors cannot detect a change between the odour free air and the diluted sample. The concentration is then doubled until the difference is observed with certainty. The units for odour measurement using dynamic olfactometry are “odour units” (ou).

Air quality is influenced by a number of environmental factors, including local topography, and local climate conditions such as seasonal wind patterns, rainfall and the occurrence of temperature inversions.

11.11.2 Criteria

Air Quality

Air Quality criteria are intended to protect the community against the adverse effects of air pollutants and generally reflect the current Australian Standards for the protection against nuisance effects and health.

The EPA’s *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (EPA, 2016) (Approved Methods) specifies the air quality assessment criteria relevant for assessing impacts from air pollution. The air quality assessment criteria for dust include consideration of background dust levels and relate to the total dust burden in the air and not just the dust attributable to the proposed development. These criteria are consistent with the National Environment Protection Measures for Ambient Air Quality (Ambient Air NEPM) (NEPC, 1998). The air quality concentrations adopted for the AQIA are summarised in **Table 11.61**.

Table 11-61 Air Quality Impact Assessment Criteria for the proposed development

Pollutant	Averaging Period	Standard/Criteria	Agency
TSP	Annual mean	90µg/m^3	National Health and Medical Research Council (NHMRC)
PM_{10}	24-hour maximum	50µg/m^3	EPA impact assessment criteria; Ambient Air NEPM reporting goal, allows five exceedances per year
	Annual mean	25µg/m^3	EPA impact assessment criteria
$PM_{2.5}$	24-hour maximum	25µg/m^3	Ambient Air NEPM
	Annual mean	8µg/m^3	

Airborne dust is assessed for nuisance or amenity impacts. The maximum acceptable increase in dust deposition above the existing dust levels from an amenity perspective are detailed in **Table 11.62**, and are set by the EPA (2016) to protect against nuisance impacts.

Table 11-62 Criteria for dust fallout

Pollutant	Averaging Period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 grams per square m per month	4 grams per square m per month

Development consent conditions for the existing Tahmoor Mine include air quality criteria as shown in **Table 11.63**. The current criteria for TSP and PM_{10} exclude extraordinary events such as bushfires and dust storms. The total impact referred to in **Table 11.63** includes the impacts of the mine and all other sources. Incremental impact refers to the impact of the mine considered in isolation. The assessment criteria applying to the Tahmoor South Project are the criteria outlined in the EPA 2016 Approved Methods.

Table 11-63 Air Quality Criteria for the existing Tahmoor Mine

Pollutant	Criterion	Averaging Period	Application
TSP	90 µg/m^3	Annual mean	Total impact
PM_{10}	50 µg/m^3	24-hour average	Total impact
	25 µg/m^3	Annual mean	Total impact
Deposited dust	2 grams per square m per month	Annual mean	Incremental impact
	4 grams per square m per month	Annual mean	Total impact

Nitrogen Oxides, Carbon Monoxide and Volatile Organic Compounds

EPA prescribed ambient impact assessment criteria for NO_2 and CO are detailed in **Table 11.64**.

Table 11-64 Ambient air quality goals for nitrogen dioxide and carbon monoxide

Pollutant	Averaging Period	Goal	
		Parts Per Million (ppm)	Micrograms per cubic metre
Nitrogen Dioxide	1 hour	0.12 ppm	246 µg/m^3
	Annual	0.03 ppm	62 µg/m^3
Carbon Monoxide	8 hour	9 ppm	10 mg/m^3
	1 hour	25 ppm	30 mg/m^3
	15 minute	87 ppm	100 mg/m^3

VOCs result from the flaring of coal seam methane. Organic hydrocarbons comprise a collection of various hydrocarbons, several of which may be toxic, including BTEX and methane. Organic hydrocarbons also include reactive organic compounds which can also contribute to the formation of photochemical smog, and can be hazardous to human health. There are no impact assessment criteria for total VOCs. Modelling predictions can however be compared to impact assessment criteria for individual organic pollutants that may be present in the extracted gas.

Odour Criteria

Odour Concentration

The detectability of an odour is a sensory property that refers to the theoretical minimum concentration that produces an olfactory response or sensation. The theoretical minimum concentration is referred to as the odour threshold or one odour unit (OU). An OU of less than one means there is theoretically no odour present.

The determination of odour goals and the way in which they should be applied with dispersion models is guided by the EPA, although it is recognised as a difficult topic in air pollution science. The level of exposure is used to reflect the fact that odour impacts are determined by several factors including the frequency, intensity, duration and offensiveness of the odour, as well as the location of the odour source.

Whether or not an individual considers an odour to be a nuisance depends on these factors. Although it is possible to derive formulae for assessing odour annoyance in a community, the response of any individual to an odour is still unpredictable and odour goals need to consider these factors. Odour goals need to consider what level of exposure to odour is acceptable to meet current community standards in NSW and how dispersion modelling can be used to determine if a source of odour meets the goals which are based on this acceptable level of exposure.

Compliance with odour goals is often determined through the use of dispersion modelling, which is typically only able to directly predict concentrations over a one hour averaging period or greater. However, the human nose responds to odour over periods of the order of a second or so. Odour levels can fluctuate significantly within a one hour period depending on the nature of the source. To predict the variation that may be experienced, the peak-to-mean or P/M ratio; which is the ratio between one second peak concentrations and longer period average concentrations is used for various odour sources. The application of P/M ratios in NSW is shown in Table 3.6 of the AQIA at **Appendix N**.

Complex Mixtures of Odorous Pollutants

The EPA's Approved Methods (2016) include ground level concentrations for complex mixtures of odorous air pollutants which are shown in **Table 11.65**. The ground level concentrations odour criteria must not be exceeded more than one percent of the time for different population densities. The difference between odour criteria is based on considerations of risk of odour impact. For a given odour level there will be a wide range of responses in the population exposed to the odour. For instance, in a densely populated area there will be a greater risk that some individuals within the community will find the odour unacceptable than in a sparsely populated area. Given the proximity of the new upcast shaft to nearest sensitive receptors, an impact assessment ground level concentration (glc) criterion of 7 OU is appropriate for this area (refer to **Figure 11.28** for sensitive receiver locations).

Table 11-65 Odour performance criteria for the assessment of odour (EPA, 2016)

Population of affected community	Criterion for complex mixtures of odorous air pollutants (99th percentile) (OU)
Equal to or less than two	7
10	6
30	5
125	4
500	3
Urban area (2000) and/or schools and hospitals	2

11.11.3 Methodology

The methodology for the AQIA was undertaken in accordance with the EPA's Approved Methods (2016).

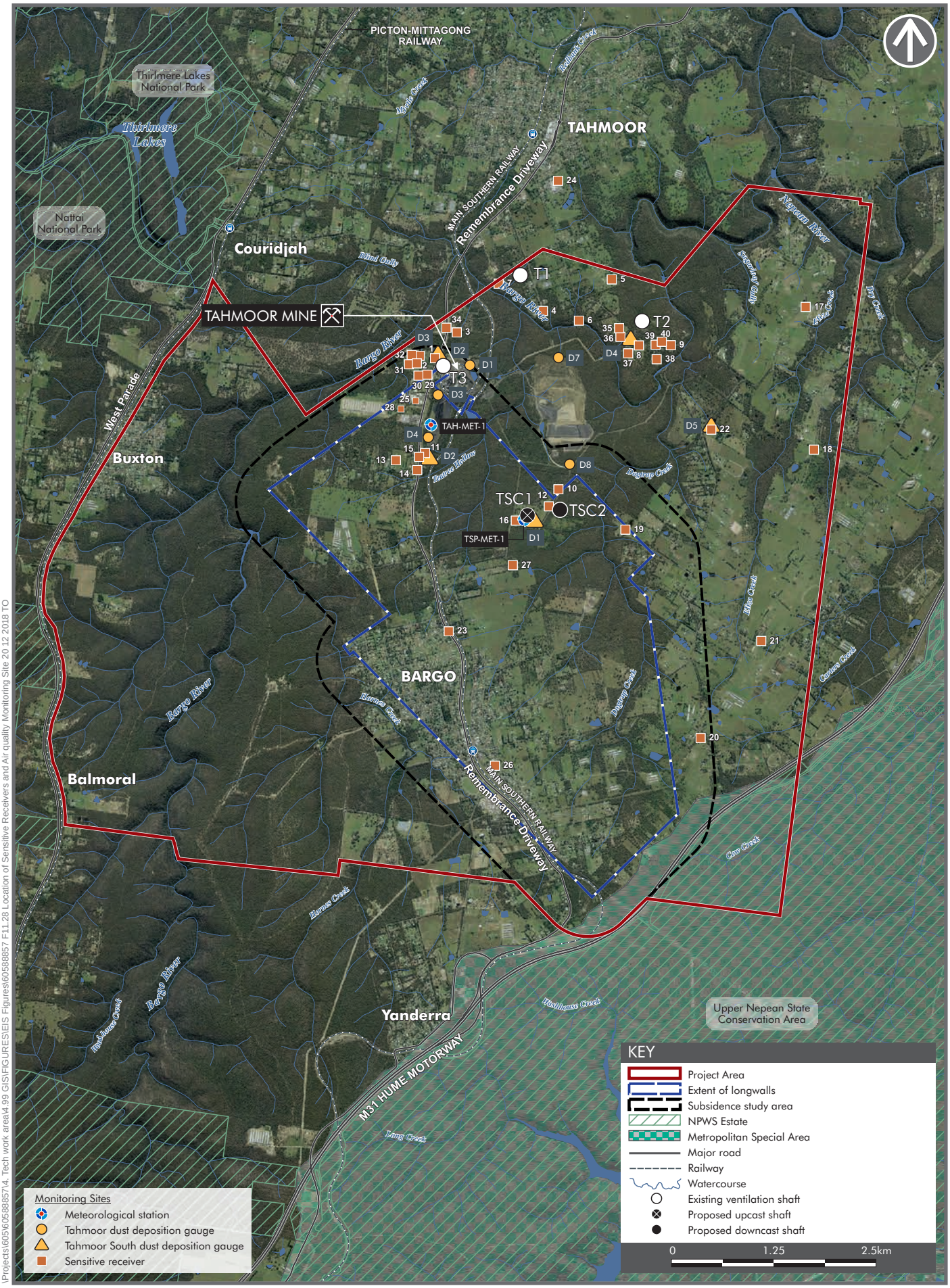
Sensitive Receptors

Sensitive receptors within the vicinity of the proposed development that have been assessed as part of this AQIA are detailed in **Table 11.66** below and shown in **Figure 11.28**.

Table 11-66 Air quality impact assessment sensitive receptors

Receptor ID	Address
1	2 Olive Lane
2	4 Olive Lane
3	2897 Remembrance Driveway
4	130 Stratford Road
5	7 Hodgson Grove
6	20 Dietrich Road
7	84 Stratford Road
8	250 Rockford Road
9	11 Kammer Place
10	215 Charlies Point Road
11	3085 Remembrance Driveway
12	185 Charlies Point Road
13	30 Caloola Road
14	3092 Remembrance Driveway
15	3076 Remembrance Driveway
16	115 Charlies Point Road
17	60 Lyrebird Road
18	45 Knox Road
19	70 Warrobyn Road
20	70 Hinkler Avenue
21	105 Dwyers Road
22	10 Pheasants Nest Road
23	Edge of Bargo Township closest to site
24	Edge of Tahmoor Township closest to site
25	Wollondilly Anglican College – Remembrance Driveway
26	Bargo Public School 245-261 Great Southern Road
27	80 Charlies Point Road
28	3030 Remembrance Driveway
29	1 Olive Lane
30	5 Olive Lane
31	7 Olive Lane
32	6 Olive Lane
33	4 Olive Lane (b)
34	2900 Remembrance Driveway
35	230 Rockford Road (a)
36	230 Rockford Road (b)

Receptor ID	Address
37	260 Rockford Road
38	280 Rockford Road
39	285 Rockford Road
40	5 Kammer Place



\Projects\605\605888574. Tech work area\4.99 GIS\FIGURES\EIS Figures\605888857 F11.28 Location of Sensitive Receivers and Air quality Monitoring Site 20 12 2018 TO

SIMEC MINING

SENSITIVE RECEIVERS AND AIR QUALITY MONITORING SITES

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.28

Construction Air Quality Impacts

An emissions inventory was prepared for construction activities associated with the proposed development. Estimated PM_{10} emissions were then compared with emissions during mining.

Operational Air Quality Modelling Approach

The air quality assessment was undertaken based on the use of CALPUFF, a multi-layer, multi-species non-steady state puff dispersion model that can simulate the effects of time and space, varying meteorological conditions on pollutant transport, transformation and removal (ERM, 2018).

Local meteorology was modelled using a combination of the CSIRO's TAPM modelling (The Air Prediction Model) and the CALMET models. CALMET is a meteorological pre-processor that includes a wind field generator containing objective analysis and parameterised treatments of slope flows, terrain effects and terrain blocking effects (ERM, 2018). Output from TAPM, plus data from the Tahmoor South weather station were entered into CALMET, which was then used to compile a representative meteorological dataset suitable for use in the plume dispersion model CALPUFF.

Dispersion model predictions were made for one scenario, involving the development of Area 2 of the REA. The REA is expected to have the most impact when it is moving closer to the southern residences during construction of Area 2. The year with high production rates during construction of Area 2 of the REA was therefore selected for the air assessment. Dispersion modelling for this scenario is considered to be representative of the worst case scenario for the proposed development at any sensitive receptor.

Modelling was used to determine the impact of the proposed development on sensitive receivers with regards to annual average PM_{10}, annual average $PM_{2.5}$, annual average TSP, annual average dust deposition, 24-Hour Average PM_{10} and 24-hour average $PM_{2.5}$. Contour plots of particulate concentrations and deposition levels are shown in Figure 10.1 to Figure 10.6 of **Appendix N**. CALPUFF modelling was also used to predict the impact of emissions of Carbon Monoxide and Nitric Oxides from flaring at the site.

Cumulative 24-hour Average PM10

The use of dispersion modelling to accurately predict cumulative 24-hour PM_{10} concentrations is difficult due to daily variability in the intensity, duration and location of mining activities, weather conditions and dust levels, as well as the spatial and temporal variation in other anthropogenic activities and natural events such as agricultural activities and bushfires. Cumulative 24-hour PM_{10} impacts have been evaluated using a Monte Carlo statistical approach that focuses on representative receptors in the vicinity of the mine which were modelled as having 24-hour PM_{10} concentrations greater than 35µg/m^3 as a result of Project-only contributions. Additional receptors downwind of the predominant wind direction and receptors away from operations were also selected to provide an overview of the potential cumulative 24-hour average PM_{10} impacts.

Additional detail regarding the modelling approach for cumulative 24-hour PM_{10} concentrations is provided in Section 10.4 of **Appendix N**.

Odour

Odour dispersion modelling was undertaken using both dispersion modelling and computational fluid dynamics (CFD) modelling for the ventilation shafts associated with the proposed development, which generated a 99th percentile glc odour contour plot. Odour modelling for the proposed development was undertaken using in-stack measurements from existing ventilation shafts during shale oil operations in May 2010 (AECOM, 2010).

11.11.4 Existing Environment

Topography

The proposed development is located in a gently undulating landscape with generally low relief and small slopes. The topography becomes steeper towards the valleys of the Bargo and Nepean Rivers in the north and western portions of the Project Area.

Land use within the Project Area comprises semi-rural and partly forested landscapes, along with a mix of rural and environmental land uses as well as the existing facilities associated with current

Tahmoor Coal mine. Rural uses include small-scale agricultural activities such as farming produce, poultry, cattle grazing and horse studs. The Project Area also extends underneath the residential, semi-rural and agricultural areas of Buxton, Bargo, Balmoral and Pheasants Nest.

Meteorological Data

Meteorological data is collected at the Tahmoor South meteorological station. Annually, the most common winds are from the south-west and south-south-west (refer to Figure 5.2 of **Appendix N** for seasonal wind roses), with the exception of summer, when the predominant winds are from the north-east. The average wind speed is 1.6m/s and calm wind conditions (less than or equal to 0.5m/s) are present about 24% of the time.

Climatic data from the Bureau of Meteorology is collected from the Picton Council Depot Automatic Weather Station (approximately 6 km from the proposed development). The annual average maximum and minimum temperatures were recorded as 23.4°C and 8.8°C respectively. On average, January is the hottest month, July is the coldest month and February is the wettest month.

Existing Air Quality Monitoring Network

An air quality monitoring network was established for the proposed Tahmoor South project in 2012 to evaluate existing air quality conditions and inform assessment. The monitoring network consists of the following:

- one High Volume Air Sampler (HVAS), which measures TSP concentrations for 24 hour periods on a one-in-six day run;
- one Tapered Element Oscillating Microbalance Instrument (TEOM), which measures PM_{10} on a continuous basis at five minute intervals;
- five dust monitoring gauges; and
- one meteorological station.

The Tahmoor South monitoring locations are in addition to the six dust deposition gauges and meteorologic station established at the existing Tahmoor Mine (refer to **Figure 11.28**).

In addition to the monitoring data collected on-site, data from a number of NSW EPA monitoring stations has been analysed. There are five monitoring stations in South West Sydney, comprising:

- Bargo (Silica Road) located approximately 6 km south of the proposed development;
- Oakdale (Ridge Road) located approximately 23 km northwest of the proposed development;
- Macarthur (UWS Campbelltown Campus) located approximately 27 km northeast of the proposed development;
- Campbelltown West (Campbelltown TAFE) located approximately 28 km northeast of the proposed development; and
- Camden (aerodrome) located approximately 24 km north of the proposed development.

Data from these EPA monitoring sites between 2007 and 2017 have been used to provide an indication of existing ambient air quality for the area. The on-site data is considered to be more representative of the nearest receptors (such as Wollondilly Anglican College) but regional data is useful to demonstrate the levels in the wider area.

Existing Ambient Air Quality

Background air quality data from the Tahmoor Mine and EPA monitoring stations shows that the ambient air quality does not generally exceed the relevant criteria. Although the average measurements are shown to meet criteria, there were isolated recorded incidences where exceedances were experienced. These were attributed to dry weather, dust events, bushfires or isolated local incidents. The background ambient air quality compared to the relevant criteria is summarised in **Table 11.67**.

Table 11-67 Background ambient air quality

Ambient Air Quality Measurement	Period of data collection	Source of data	Average	Criteria	Comment
TSP	9 Mar 2012 to 26 July 2013 and 6 Dec 2014 to 29 July 2017	Tahmoor South HVAS	18.3 µg/m^3	90 µg/m^3	
PM_{10}	Jan 2012 to July 2013 and Jan 2015 to August 2017	Tahmoor South TEOM	12.6 µg/m^3	25 µg/m^3 – annual average	
			N/A	50 µg/m^3- 24-hour average	Exceedance of criteria on 6 days*
	2007 to 2013	EPA monitoring stations	14.3 µg/m^3	25 µg/m^3 – annual average	
			N/A	50 µg/m^3- 24-hour average	Exceedances at all locations
$PM_{2.5}$	December 2012 to 2017*	EPA Monitoring Station - Camden	6 µg/m^3	8 µg/m^3	
Dust Deposition	April 2012 to May 2013 and Dec 2015 to June 2017	Tahmoor South Dust Deposition Gauges (5)	1.4 grams per square metre per month	4 grams per square metre per month	Dust deposition gauges within proposed development area
	2008 to Aug 2017	Tahmoor Mine Dust Deposition Gauges (6)	1.2 grams per square metre per month	4 grams per square metre per month	Dust deposition gauges within existing Tahmoor Mine area
NO_2	2004 to 2017	EPA monitoring stations (Bargo, Camden, Macarthur and Campbelltown West)	N/A	246 µg/m^3	All four monitoring stations well below criteria. Maximum concentration of 166 µg/m^3
CO	2005 to 2017	EPA Monitoring Stations (Camden, Macarthur and Campbelltown West)	N/A	10 mg/m^3 – 8-hour maximum	All monitoring stations well below criteria. Maximum concentration of 2.3 mg/m^3

**PM_{10} measured at the TEOM exceeded the criteria on 31 October and 1 November 2012, 6 May 2015, and on 25 March, 7 May and 22 May 2016 which may be associated with dry weather and a number of bushfires/hazard reduction burns.*

Based on an evaluation of air quality data from Tahmoor South, the existing Tahmoor Mine, and surrounding EPA monitoring stations, the following background air quality levels were adopted for the purposes of assessment (taken from the either the on-site monitoring station or closest station to the site with over one year of data available, whichever is relevant for each pollutant):

- Annual Average PM_{10} – 12.6 µg/m^3
- 24-hour PM_{10} – varies daily
- Annual Average TSP – 18.3 µg/m^3
- Annual Average $PM_{2.5}$ – 5 µg/m^3
- Dust deposition – 1.4 g/m^2/month.

11.11.5 Impact Assessment

Construction

Construction of the two mine ventilation shafts and the expanded rejects emplacement area has the potential to result in dust deposition, visible dust plumes, elevated PM_{10} concentrations from dust generating activities and emissions from diesel-powered construction equipment. Sensitive receptors close to construction areas would be most sensitive to construction dust; however, these impacts would be short term and temporary in nature. Management and mitigation measure to minimise these impacts are provided in **Section 11.11.6** below.

Construction of the proposed development would be across several separate areas and construction is unlikely to occur simultaneously. As shown in **Table 11.68**, estimated PM_{10} emissions from construction of the proposed development as a whole would be significantly less than the estimated emissions for operational mining activities.

Table 11-68 Estimated PM10 emissions for construction and operational scenarios

Activity	Estimated PM_{10} Emissions (kilograms per year)
Construction	
Construction of ventilation shaft (per ventilation shaft)	3,980
Construction of REA	2,105
Upgrades to surface facilities	5,386
Operation	
Development of Area 2 of the REA	84,219

Operation

TSP and Deposited Dust

There are no predicted exceedances of the air quality criteria as a result of the proposed development only, or when other sources are also considered, for annual average TSP or annual average deposited dust.

Particulate Matter

Annual Average $PM_{2.5}$

There are no predicted exceedances of the annual average $PM_{2.5}$ Ambient Air NEPM standard as a result of the proposed development only, or when other sources are also considered.

Project-only 24-hour $PM_{2.5}$

Contour plots for the predicted 24-hour average $PM_{2.5}$ concentrations as a result of emissions from the proposed development only are shown in **Figure 11.30**. There are no predicted exceedances of the 24-hour advisory reporting standard for $PM_{2.5}$ at any private receptors due to the project alone.

Annual Average PM_{10}

Emissions at sensitive receptors are not predicted to exceed the annual average PM_{10} criterion of 25 µg/m^3. The highest project only prediction is at R29 with an annual average PM_{10} concentration of 9.1 µg/m^3. Once background concentrations are taken into account, the cumulative concentration at R29 is 21.7 µg/m3, which remains below the criterion. The results are considered to be conservative as the modelling incorporated a background annual average PM_{10} concentration of 12.6 µg/m^3, which accounts for 50% of the annual average PM_{10} criterion of 25 µg/m^3. The results indicate the relatively low contribution of the project to cumulative PM_{10} concentrations.

Project-only 24-hour PM_{10}

Only one receptor (R10) is predicted to experience maximum 24-hour average PM_{10} concentrations above the criterion of 50 µg/m^3 as a result of the proposed development (project-only). Contour plots for the predicted 24-hour average PM_{10} concentrations as a result of emissions from the proposed development only are shown in **Figure 11.29**.

R10 is in close proximity to the REA (refer to **Figure 11.28**). Notably, the exceedance (51 µg/m^3) is predicted to occur at this receptor on only one day during the year due to the proposed development operations alone. Measures to manage potential air quality impacts are outlined in **Section 11.11.6**.

Cumulative 24-hour PM_{10}

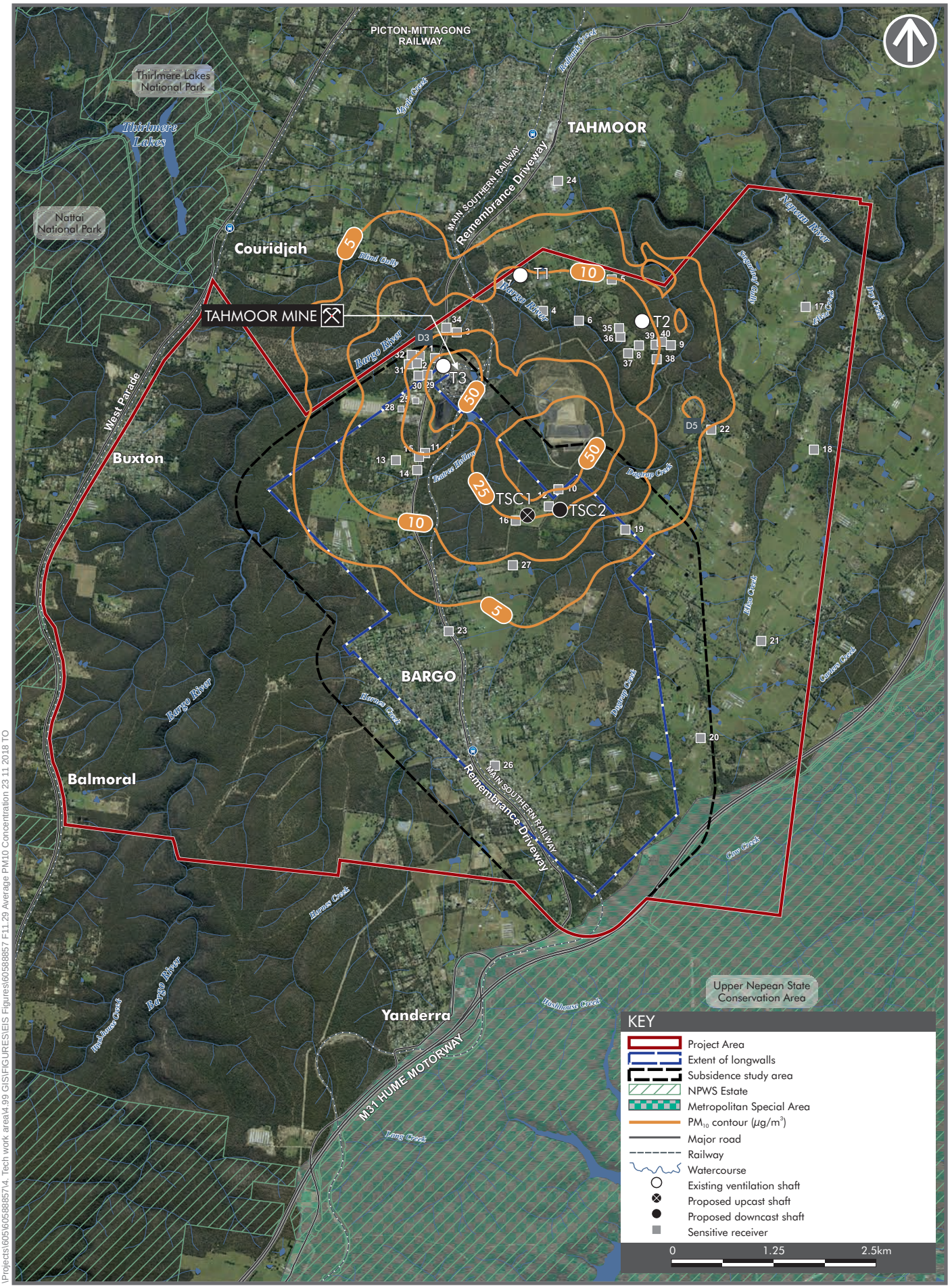
Due to the difficulty of accurately predicting cumulative 24-hour PM_{10} concentration using dispersion modelling, cumulative air quality impacts have been evaluated using a statistical approach (Monte Carlo Simulation). This approach is considered appropriate to characterise cumulative 24-hr average concentrations from coal mines.

Table 11-69 presents a summary of the number of days that the 24-hour PM_{10} concentration would exceed the relevant criteria as a result of the operation of the mine only and cumulative scenarios. The actual number of exceedances per year from cumulative impacts cannot be predicted precisely and would depend on actual mine activities, other nearby dust generating activities, weather conditions as well as the implementation of real-time controls.

The analysis predicted that when cumulative impacts are considered, the probability of a 24-hour PM_{10} exceedance is between one and nine days during a year. The highest prediction of exceedances is at receptor 10, where up to 9 days of exceedances are predicted. The analysis also shows that due to background concentrations alone, the 24-hour average PM_{10} criterion would likely be exceeded on approximately one day per year.

Table 11-69 Exceedances of 24-hour PM10 concentrations for mine alone and cumulative scenarios

Receptor	Maximum predicted 24-hr PM_{10} Concentration (mine alone) Criteria = 50µg/m^3	Predicted days over 50µg/m^3 (mine alone)	Predicted days over 50µg/m^3 (background)	Predicted days over 50µg/m^3 (cumulative)
1	47	0	1	5
2	29	0	1	2
10	51	1	1	9
12	30	0	1	2
25	30	0	1	3
30	36	0	1	3
33	28	0	1	2



\Projects\605\605888574. Tech work area\4.99 GIS\FIGURES\EIS Figures\605888857 F11.29 Average PM10 Concentration 23 11 2018 TO

SIMEC MINING

PREDICTED 24 HOUR AVERAGE PM_{10} CONCENTRATION

Tahmoor South Project
Environmental Impact Statement

Source: Pacific Environment Limited (2018)

FIGURE 11.29

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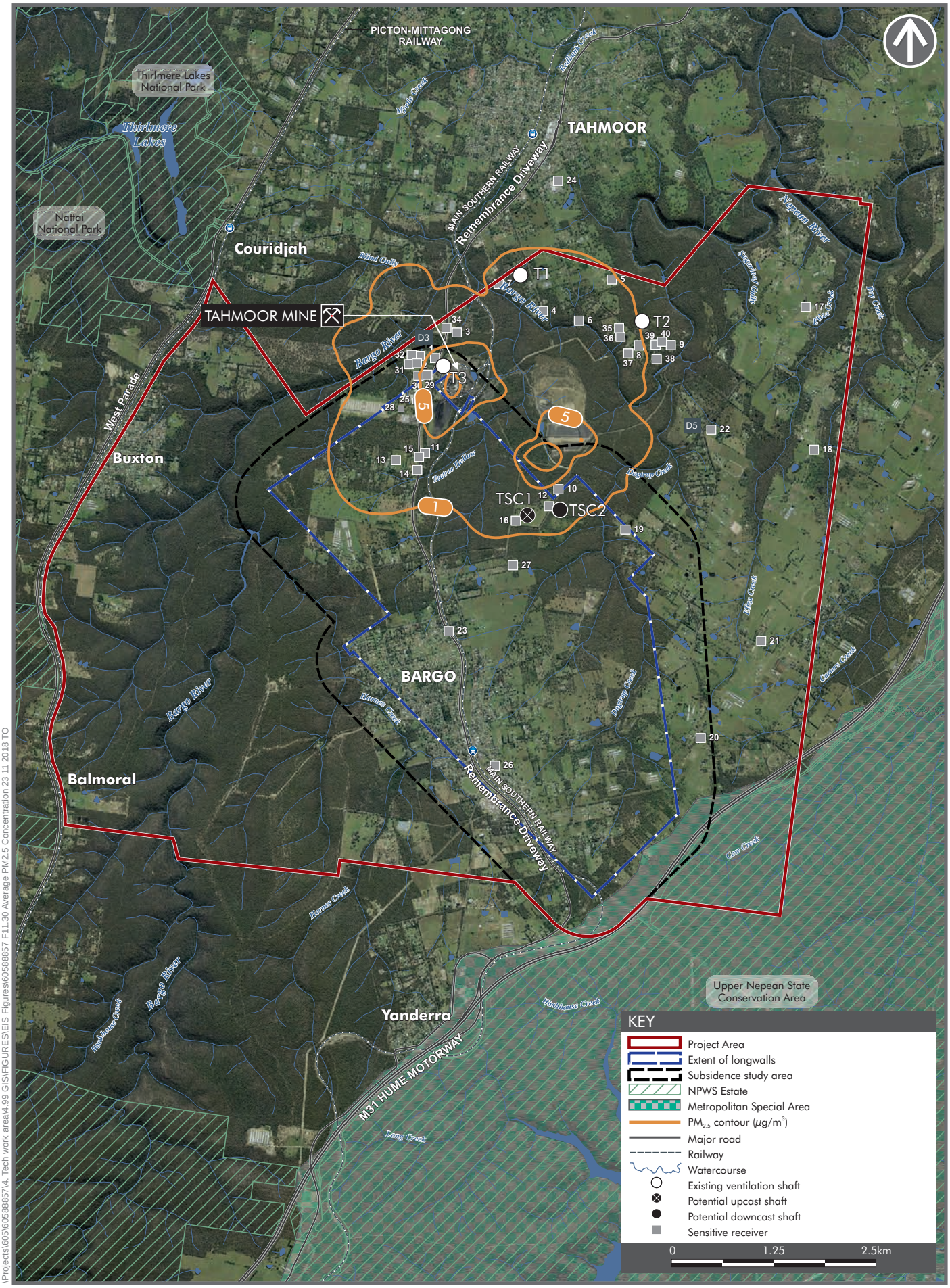


\Projects\605\605888574. Tech work area\4.99 GIS\FIGURES\EIS Figures\605888857 F11.30 Average PM2.5 Concentration 23 11 2018 TO

SIMEC MINING

PREDICTED 24 HOUR AVERAGE $PM_{2.5}$ CONCENTRATION

Tahmoor South Project
Environmental Impact Statement

Source: Pacific Environment Limited (2018)

FIGURE 11.30

Odour

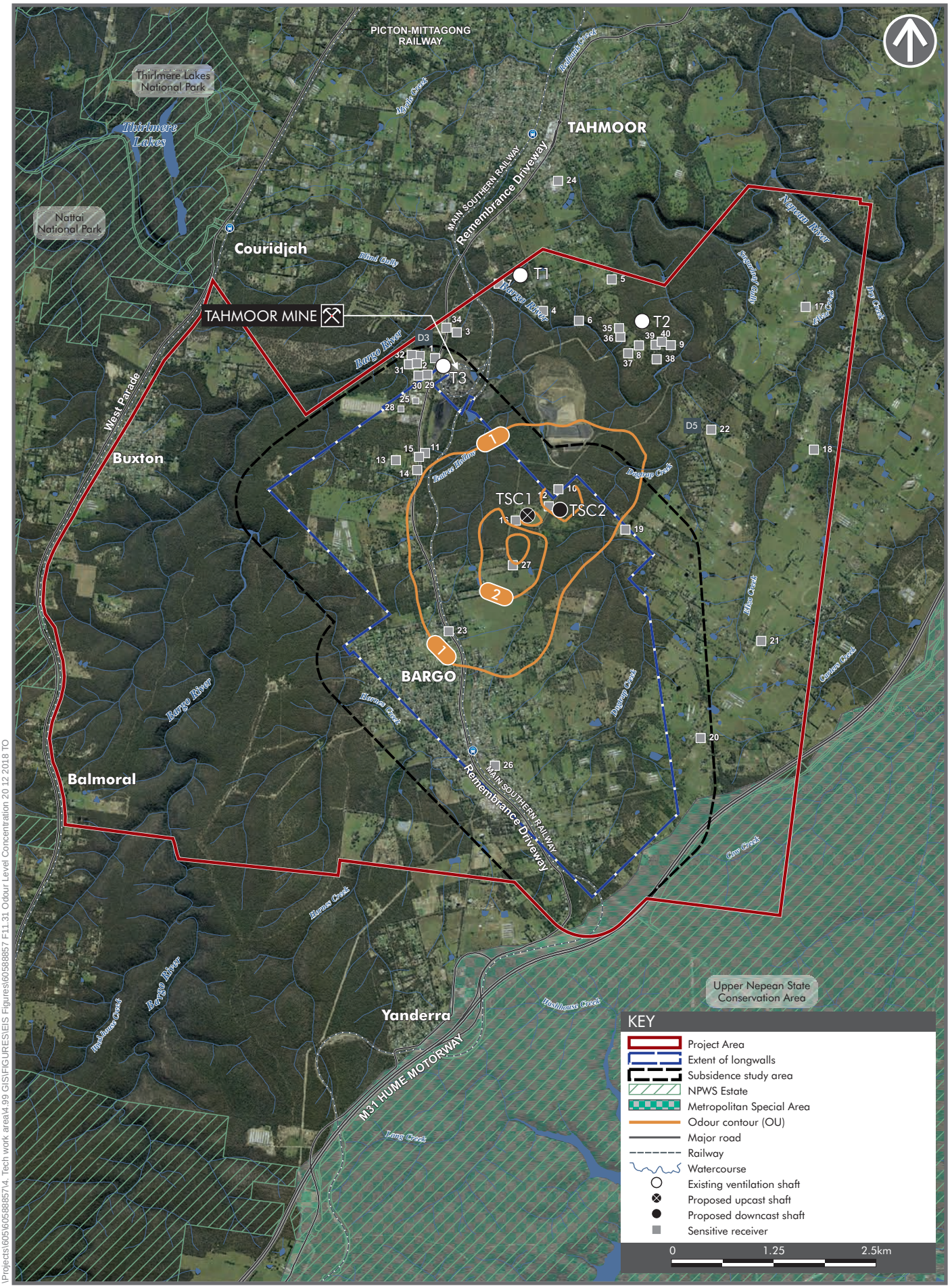
The 99th percentile odour concentration is predicted to remain below the relevant criterion of 7OU at nearby residences, and 2OU at schools (R25 - Wollondilly Anglican College and R26 – Bargo public school) (refer to **Table 10.8** of **Appendix N**). The contour plot for the predicted 99th percentile nose response average ground level odour concentrations are shown on **Figure 11.31**.

There may be instances throughout the year where some residences in close proximity to ventilation shafts (refer to **Figure 11.28**) experience concentrations above 7OU (refer to **Table 11-68**).

Due to a history of odour complaints from local residences, in 2012 significant odour modelling work was undertaken for the existing T2 shaft to better understand the conditions that cause occasional spikes in odour levels. Modelling determined that ground level odour concentrations could be reduced by increasing the height of the ventilation shaft, and by increasing the velocity at which ventilation air is emitted. Ventilation Shaft T2 does not form part of this assessment as it will only be operated as a backup during times when TSC1 is not available, such as during maintenance periods.

Table 11-70 Odour dispersion modelling – receptors which exceed Criterion

Receptor ID	Odour Level (OU) 99th percentile criteria – 7OU (2 OU for schools)
1	0
2	0
3	0
8	0
9	0
11	0
13	0
14	0
15	1
25 - School	2
26 - School	1
29	2
30	1
31	1
32	1
33	1
35	0
36	0
37	1
38	0
39	0
40	1



\Projects\605\605885714. Tech work area\4.99 GIS\FIGURES\EIS Figures\605885857 F11.31 Odour Level Concentration 20 12 2018 TO

SIMEC MINING

Source: Pacific Environment Limited (2018)

PREDICTED 99th PERCENTILE NOSE RESPONSE AVERAGE GROUND LEVEL ODOUR CONCENTRATIONS

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.31

Carbon Monoxide, Nitric Oxide and VOC Impacts from Flaring

CALPUFF modelling was used to predict the impact of emissions from flaring at the site. The predicted 1-hour and 8-hour average for CO were well below their respective EPA criterion of 10 mg/m^3 and 30 mg/m^3. Similarly, the predictions for 1-hour average and annual average oxides of nitrogen (NOx) were below the respective criterion of 246 $\mu g/m^3$ and 62 $\mu g/m^3$, respectively, even with predicted NO_x concentrations assumed to be 100% NO_2, which is very conservative.

With respect to VOCs, the US EPA provides speciation of emissions from flaring of natural gas and the emissions consist of 30% ethane, 20% formaldehyde, 20% methane and 30% propane (US EPA, 2013). The highest predicted hydrocarbon concentration is at receptor 35 of 52 $\mu g/m^3$. Assuming that 20% is formaldehyde (US EPA, 2013), the predicted concentration of 10.4 $\mu g/m^3$ is well below the EPA 1-hour average formaldehyde criterion of 20 $\mu g/m^3$.

The predicted air quality results for these pollutants are provided in Table 10.9 of **Appendix N**.

11.11.6 Management and Mitigation Measures

Construction

A Construction Air Quality Management Plan would be developed and implemented as part of the CEMP for the proposed development. The construction AQMP would include management and mitigation measures to minimise dust generation as a result of the proposed development as much as possible, including:

- disturbed areas would be stabilised as soon as practicable to prevent or minimise wind-blown dust;
- unsealed roads would be watered and sealed where possible;
- unsealed trafficable areas would be kept damp to minimise dust generation;
- construction activities would be modified or stopped during periods of high wind;
- stockpiles would be maintained in a condition that minimises windblown or traffic generated dust;
- waterways, sprinklers and water carts would be used as required to adequately dampen stockpiles, work areas and exposed soils to prevent the emission of dust from the site;
- all equipment would be maintained for dust control by keeping it in good operation condition; and
- erosion and sediment control structures would be regularly maintained to ensure silt does not become a source of dust.

Operation

Tahmoor Coal implements a reactive and predictive Air Quality Control System to manage dust impacts. The system would continue to be implemented during operation of the proposed development and would include daily alerts for site personnel of meteorological conditions and predicted daily dust risk over the proposed development and at nominated receptors around the Project Area. The existing Air Quality and GHG Management Plan would be updated to align with the operation of the proposed development and would include the dust control measures currently implemented and shown in **Table 11.71**.

Table 11-71 Existing general dust management measures which would continue to be implemented

Management Measure	Unsealed Roads	Sealed Roads	Exposed Areas	Stockpiles (ROM, product and topsoil)
Daily watering with a water truck with increased frequency during adverse weather conditions	✓	✓	✓	✓
Application of chemical dust suppressant at least once per month	✓		✓	
Obsolete roads would be ripped and revegetated;	✓			
Transport of loads by heavy vehicles would be covered if material being hauled has less than 10% moisture content	✓	✓		
Operators avoid overloading and minimise spillage	✓	✓		
Spillages regularly cleared off roads	✓			
Visual inspection at the start of each shift to determine if additional dust controls are required	✓	✓	✓	✓
Speed limits of plant and vehicle reduced to suit road conditions and around stockpiles	✓	✓		✓
Minimise haulage distances as much as possible	✓	✓		
Utilise road sweeper as required		✓		
Unutilised exposed areas would be sealed and/or revegetated			✓	
Revegetation of topsoil stockpiles based on a risk based approach.				✓
Automatic water sprays are triggered by wind speed monitoring at the on-site Weather Station linked back to CHPP Control. If wind is in excess of 5m/s they are automatically triggered. The CHPP Control Room also has the ability to manually override them so that they may be switched on at any time as required by conditions				✓

In addition to the ongoing implementation of the measures outline above:

- Tahmoor Coal would implement a TARP relating to meteorological triggers for dust generation;
- for receptors in close proximity to the Surface Facilities Area, a dust management plan will be developed in consultation with the landowner to manage and reduce potential dust impacts and an additional real-time PM_{10} monitor would be implemented to monitor impacts and enable adaptive real-time management of air quality impacts;
- an odour management plan will be developed and implemented to monitor, manage and mitigate potential odour impacts at receptors where maximum odour levels are predicted as having the potential to exceed the odour criteria; and
- the proposed ventilation stack design would incorporate odour modelling recommendations to reduce ground level odour concentrations. This includes increasing the height of the ventilation shaft, and increasing the velocity at which ventilation air is emitted.

Action for Air

Action for Air, a 25 year air quality management plan for Sydney, Wollongong and the Lower Hunter was implemented by the NSW Government in 1998 (DECCW, 2009). The plan seeks to provide long-term ongoing emission reductions, meet the national air quality standards for six pollutants as identified in the Ambient Air NEPM and reduce the population's exposure to air pollution, and the associated health costs.

The six pollutants in the Ambient Air NEPM include CO, NO_2, SO_2, lead, ozone (O_3) and PM_{10}. The main pollutant from the proposed development that is relevant to the Action for Air is PM_{10}. Action for Air aims to reduce air emissions to enable compliance with the Ambient Air NEPM targets with a focus on motor vehicle emissions.

The proposed development is located within the area relevant to the Action for Air plan and generally addresses the aims of the Action for Air Plan in the following ways:

- air quality emissions potentially associated with the proposed development have been quantified;
- dispersion modelling has been conducted by ERM to predict the impact of these emissions on nearby receptors and assess these emissions against the Ambient Air NEPM goals; and
- potential mitigation measures have been identified for the proposed development.

11.11.7 Conclusion

The AQIA for the proposed development assessed the worst case air quality impact, involving the preparation of detailed emission inventories and dispersion modelling to predict the ground level concentrations for relevant pollutants.

Construction of the proposed development has the potential to result in dust deposition, visible dust plumes, elevated PM_{10} concentrations from dust generating activities and emissions from diesel-powered construction equipment. Sensitive receptors close to construction areas would be most sensitive to construction dust; however, these impacts would be short term and temporary in nature. Estimated PM_{10} emissions from construction of the proposed development as a whole would be significantly less than the estimated emissions for operational mining activities.

Operation of the proposed development is not predicted to result in exceedances of air quality criteria for annual average $PM_{2.5}$, annual average PM_{10}, annual average TSP or annual average deposited dust under the worst case scenario, when considering project only contributions or when including cumulative (background) contributions.

No sensitive receptors are predicted to exceed the maximum 24-hour $PM_{2.5}$ criterion of 25 µg/m^3 as a result of the proposed development (project-only contributions).

One private receptor near the REA (R10) is predicted to experience maximum 24-hour average PM_{10} concentrations above the criterion of 50 µg/m^3, due to the proposed development's operations alone. This receptor is predicted to exceed the 24-hour average impact assessment criterion on only one day of the year as a result of emissions from the proposed development.

Assessment of cumulative PM_{10} 24-hour impacts concluded that there was a probability that the selected receptors may exceed the EPA criterion of 50 µg/m^3 when impacts are considered cumulatively. Receptor (R10) had the highest estimated number of days exceeding the 24-hour average PM_{10} criterion (up to 9 days per year). However, with the incorporation of the TARP and other dust management practices, these exceedances would be well managed.

11.12 Greenhouse Gas

This section provides an assessment of the predicted greenhouse gas emissions associated with the proposed development and is supported by the Tahmoor South Project Greenhouse Gas Assessment (ERM, 2018). The Greenhouse Gas Assessment is provided in **Appendix O**.

The greenhouse gas assessment addressed the SEARs relevant to greenhouse gas impacts. These are listed in **Table 11-72**.

Table 11-72 Secretary's Environmental Assessment Requirements (SEARs)

Greenhouse Gas SEARs
Air – including an assessment of the likely greenhouse gas impacts of the development.

11.12.1 Background

The proposed development will generate greenhouse gas through the creation of Scope 1, 2 and 3 emissions. Consequently, a Greenhouse Gas Assessment has been undertaken to:

- quantify the potential Scope 1, 2 and 3 greenhouse gas emissions generated by the proposed development;
- assess the potential impacts of these emissions on the environment; and
- determine reasonable and feasible measures to minimise greenhouse gas emissions and ensure energy efficiency.

11.12.2 Methodology

The Greenhouse Gas Assessment was undertaken in line with the methods outlined in the following documents and guidance material:

- The World Resources Institute/World Business Council for Sustainable Development Greenhouse Gas Protocol *The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard Revised Edition* (GHG Protocol) (2004);
- National Greenhouse and Energy Reporting (NGER) (Measurement) Determination 2008; and
- The National Greenhouse and Energy Reporting Scheme Measurement. Technical Guidelines for the Estimation of Greenhouse Gas Emissions by Facilities in Australia (the NGER Guidelines) (DoEE, 2016b).

In accordance with the GHG Protocol, greenhouse gas emissions were categorised into three different scopes (Scope 1, Scope 2 and Scope 3). Categorising emissions enables the delineation of direct and indirect emission sources, improves transparency, and provides a degree of flexibility for individual organisations to report based on their organisational structure, business activities and business goals. The three scopes of greenhouse gas emissions as defined by the GHG Protocol are as follows:

- Scope 1 emissions: direct greenhouse gas emissions occurring from sources owned or controlled by the company, such as vehicle fleet, fuel combustion and fugitive emissions. Any negative emissions (sequestration) are also included as Scope 1;
- Scope 2 emissions: indirect greenhouse gas emissions from purchasing electricity or heat from other parties; and
- Scope 3 emissions: indirect emissions which occur due to the company's business activities, but from sources not owned or controlled by the company, such as emissions from the production of purchased material, product use, outsourced activities, contractor owned vehicles, waste disposal, employee business-related air travel etc. The principal Scope 3 emission associated with the proposed development would be the combustion of the product coal that would be produced.

The Greenhouse Gas Assessment has calculated emissions for two scenarios; where the WCMG Power Plant (as described in **Section 3.2.2**) is, and is not operational at Tahmoor Mine.

All greenhouse gas calculations undertaken for the proposed development have used equations and emissions factors given within the NGER Measurement Determination. The equations were undertaken using the following data provided by Tahmoor Coal:

- consumption data for fiscal years 2009/2010, 2010/2011, 2011/2012 and 2012 to March 2013 in the form of NGER Scheme declarations; and
- ROM and product coal values for the years that consumption data was provided, as well as projections for the life of the project (approximately 2019 to 2035).

Projections for future years consumption data was undertaken using intensity factors of consumption per tonne of ROM coal. The derivation of these intensity factors is provided in Table 4-1 of the Greenhouse Gas Assessment at **Appendix O**. A summary of these intensity factors is provided in **Table 11-73**.

Table 11-73 Intensity factors for consumables used for Scope 1 emissions calculations

Year	Diesel (kL)	Petrol (kL)	Oils (kL)	Lubricants (kL)	Electricity (MWh)	SF6 (CO_2-et/t)
Intensity Factor (Usage per kt ROM)	0.44	0.008	0.0001	0.095	36.9	0.12

11.12.3 Impact Assessment

Scope 1 Emissions

The major Scope 1 emission sources associated with the proposed development are anticipated to comprise:

- ROM coal extracted from gassy underground mine (including post-mining);
- collection and venting/flaring of pre-drained gas and goaf gas (post drainage);
- venting of mine ventilation return air;
- diesel oil combustion;
- petrol combustion;
- post-mining activities; and
- the potential use of sulfur hexafluoride (SF_6).

Estimates of Scope 1 emissions from fugitive methane were provided by Tahmoor Coal. The projections assumed that pre-gas drainage Scope 1 emissions would occur from 2020, and would then continue for the remainder of the proposed development.

Commercial agreements are in place between Tahmoor Coal and EDL for the WCMG Power Plant to operate until 2020. If the WCMG Power Plant is not operated, the gas will be diverted to the Tahmoor Mine Flare Plant, which has sufficient design capacity to accommodate this additional gas. The Greenhouse Gas Assessment considered two scenarios; one in which the WCMG Power Plant operates at Tahmoor Mine, and one without the WCMG Power Plant operating where gas will be sent to the Tahmoor Mine Flare Plant.

For the purposes of this assessment GHG emissions are reported as tonnes of carbon dioxide equivalent (t CO_2-e).

A summary of the types of Scope 1 emissions that these activities generate is provided in **Table 11.74**.

Table 11-74 Activities that will generate Scope 1 greenhouse gas emissions

Emission source type	Activities that will generate emissions
Fugitive Methane	Mine ventilation, pre-gas drainage, post-drainage, flaring and third party power generation (use of the WCMG Power Plant, if available).
Diesel	Exploration and drilling, underground coal extraction and coal handling activities.
Unleaded Petrol	Mining support services at the Surface Facilities Area.
Oils and lubricants	Not considered further*.
Sulfur hexafluoride gas (SF_6)	Potentially emitted through use of SF_6 in insulated switch gear and circuit breaker applications.
Post-mining activities	ROM coal extraction and processing.

**NGER reported oils and lubricants data is used only in terms of characterising the associated energy consumption, as opposed to greenhouse gas emission. This is because typically, such oils and lubricants are consumed below their temperature of combustion, whereby while energy is consumed there is no associated emission and they are deemed 'consumed but not combusted'. As a result, oils and lubricants are not considered further in the scope of this greenhouse gas assessment.*

The Greenhouse Gas Assessment estimates that over the life of the proposed development, approximately 13.5 million tonnes of CO_2-e Scope 1 emissions would be generated with the WCMG Power Plant operating at Tahmoor Mine (refer to **Table 11-75**). Fugitive methane emissions are the major source of Scope 1 emissions, accounting for 93.5% of direct (Scope 1) emissions that would be generated by the proposed development (with the WCMG Power Plant operating at Tahmoor Mine), followed by post-mining activities, which would generate 6.0% of total Scope 1 emissions (refer to **Table 11-75**). The estimated Scope 1 greenhouse gas emissions intensity of the proposed development is about 0.35 t CO_2-e/t saleable coal, which is comparable with the emissions intensity of existing gassy underground mines in Australia (Deslandes, 1999).

The proposed development's contribution to climate change and the associated impacts would be in proportion with its contribution to global greenhouse gas emissions. Average annual Scope 1 emissions from the proposed development (0.84 million tonnes CO_2-e) would represent about 0.19% of Australia's commitment under the Paris Agreement (431 Mt CO_2-e), and a very small portion of global greenhouse emissions given that Australia contributed approximately 1.5% of global GHG emissions in 2005 (Commonwealth of Australia, 2011).

Without the operation of the WCMG Power Plant, total estimated Scope 1 Emissions for the proposed development would be 17,375,791 tonnes CO_2-e/t.

Scope 2 Emissions

The only source of Scope 2 greenhouse gas emissions associated with the proposed development would be electricity consumption. Over the life of the proposed development, electricity consumption is anticipated to generate 1,463,663 tonnes CO_2-e (refer to **Table 11-75**).

Scope 3 Emissions

The GHG Protocol provides that the reporting of Scope 3 emissions is optional. Typically, only major sources of Scope 3 emissions are accounted for and reported, which for the proposed development is the burning of product coal. Notably, the GHG Protocol notes that reporting Scope 3 emissions can result in double counting, as these emissions are reported as direct emissions by the facility using the coal. Further, the Protocol recognises that compliance regimes are more likely to focus on point of release emissions (i.e. direct emissions) and/or indirect emissions from the purchase of electricity. Notwithstanding, for completeness Scope 3 emissions from the burning of coal are reported in the Greenhouse Gas Assessment for the proposed development.

The burning of product coal over the life of the proposed development is anticipated to generate about 104.5 million tonnes CO_2-e of Scope 3 emissions.

Table 11-75 Summary of estimated Scope 1, Scope 2 and Scope 3 greenhouse gas emissions CO2-e (tonnes)

Year	Scope 1 Emissions (t CO_2-e) (With WCMG Power Plant Operating)						Scope 2 Emissions (t CO_2-e)	Scope 3 Emissions (t CO_2-e)
	Diesel	Unleaded Petrol	Fugitive Methane	SF_6	Post-mining Activities	Total	Electricity	Energy Production
2020	375	6	253,700	0.3	5,330	259,412	9,613	618,071
2021	1,284	22	248,207	1.2	18,246	267,760	32,909	2,145,039
2022	3,289	56	255,826	3.0	46,750	305,924	84,318	5,341,094
2023	4,250	72	652,940	3.9	60,414	717,681	108,963	7,274,286
2024	4,150	70	625,918	3.8	58,993	689,135	106,399	7,654,222
2025	4,231	72	740,259	3.9	60,146	804,712	108,478	8,076,159
2026	4,310	73	723,693	4.0	61,265	789,345	110,497	8,121,181
2027	4,670	79	931,985	4.3	66,383	1,003,121	119,727	8,871,963
2028	4,380	74	1,368,976	4.0	62,258	1,435,692	112,287	8,119,980
2029	4,042	69	1,403,072	3.7	57,449	1,464,636	103,615	7,409,838
2030	4,527	77	1,436,056	4.2	64,348	1,505,012	116,057	8,772,232
2031	4,199	71	1,072,983	3.9	59,689	1,136,946	107,654	7,810,812
2032	4,211	71	1,180,287	3.9	59,862	1,244,435	107,966	8,259,963
2033	4,727	80	479,393	4.4	67,196	551,401	121,194	8,236,845
2034	3,110	53	489,559	2.9	44,211	536,936	79,739	5,438,160
2035	1,336	23	735,991	1.2	18,988	756,339	34,247	2,403,145
Total	**57,094**	**968**	**12,598,845**	**53**	**811,527**	**13,468,487**	**1,463,663**	**104,552,988**

The estimated Scope 1 greenhouse gas emissions provided in **Table 11-75** are based on the WCMG Power Plant operating at Tahmoor Mine. As noted above, the total estimated Scope 1 emissions for the proposed development would be 17,375,791 tonnes CO_2-e/t without the WCMG Power Plant operating.

11.12.4 Management and Mitigation Measures

A number of options were evaluated to determine reasonable and feasible measures to minimise Greenhouse Gas emissions from the proposed development. The reduction of fugitive methane emissions by flaring and the diversion of waste mine gas to the WCMG Power Plant (if available) are considered to be best practice methane management measures for underground coal mines.

Management and mitigation measures will be incorporated into the various stages of the proposed development in order to reduce the volume of greenhouse gas emissions and the resultant impact of the proposed development on the environment. These management and mitigation measures are listed below.

General Operations

- implement the following fugitive methane emissions abatement measures:
  - flaring at the Tahmoor Mine Flare Plant;

  - methane recycling through the use of third party power generation (WCMG Power Plant, if available); and
  - use of ventilation control devices in sections of the mine not in use enabling them not to be ventilated (unless required for safety purposes), thereby reducing fugitive emissions.
- an electric winder will continue to be used for the drift and man and materials winder in ventilation shaft 3, instead of diesel powered; and
- longwall panels will be sealed to reduce methane emissions from the goaf into the return ventilation where it is not feasible to capture.

Monitoring

- use real-time gas (methane and carbon dioxide), temperature, pressure and associated volumetric flow monitoring at the upcast ventilation shafts to allow accurate measurement of ventilation (including methane and carbon dioxide) emissions, which will then allow further feasibility assessment of reuse options. A Continuous Emission Monitoring (CEM) system such as this is currently in place at the Tahmoor Mine. A similar system will be installed for the Tahmoor South Project which would meet the monitoring requirements of Method 4 as described within Part 1.3 of the NGER Measurement Determination (refer to Section 8.2.1 of the Greenhouse Gas Assessment at **Appendix O**).

Recording

- maintenance, calibration and record keeping will be undertaken on the main ventilation shaft and fans to allow calculation of greenhouse gas emissions; and
- records of monthly electricity use and ROM coal production will be maintained to enable greenhouse gas emissions calculations.

Management Plans

In accordance with the Guidelines for Energy Savings Action Plans (DEUS, 2005), an Energy Savings Action Plan would be prepared and implemented. The Energy Savings Action Plan would include Standards to minimise energy use and greenhouse gas emissions from the operation of the proposed development. The Energy Savings Action Plan would be incorporated into the OEMP and would include objectives, commitments, procedures and responsibilities for:

- assisting in general industry research and promoting low emission coal technologies;
- improving energy use and efficiency;
- considering of the use of alternative fuels where economically and practically feasible;
- review of mining practices to minimise double handling of materials and ensuring that materials haulage is undertaken using the most efficient routes;
- ongoing scheduled and preventative maintenance to ensure that diesel and electricity powered plants operate efficiently;
- the development of targets for greenhouse gas emissions and energy use, as well as monitoring and reporting against these to input to the National Greenhouse and Energy Reporting scheme;
- implementation of a detailed energy monitoring programme, including monitoring electricity and diesel usage on-site to identify main sources of greenhouse gas emissions and provide a baseline of energy use to apply appropriate reduction mechanisms where possible;
- regular maintenance of diesel powered equipment to ensure operation at peak efficiency; and
- assessing lighting plant efficiency.

11.12.5 Conclusion

The proposed development will generate an annual average of 0.84 million tonnes CO_2-e of Scope 1 emissions, equating to approximately 13.5 million tonnes CO_2-e over its life. Without the WCMG Power Plant operating, the proposed development will generate approximately 17.4 million tonnes CO_2-e/t over its life. Importantly, average annual Scope 1 emissions would represent a very small portion of Australia's commitment under the Paris Agreement, at about 0.19%. In addition, the proposed development will generate approximately 1.5 million tonnes CO_2-e of Scope 2 emissions and approximately 104.5 million tonnes CO_2-e of Scope 3 emissions over its life. Management and mitigation measures will be incorporated into the proposed development to reduce Scope 1 and 2 emissions where feasible and practical.

11.13 Traffic

A Traffic Impact Assessment (TIA) was undertaken by Transport & Urban Planning Pty Ltd to assess the potential traffic impacts of the proposed development.

The TIA is provided in **Appendix P** and summarised in the following sub-sections.

The traffic assessment addressed the SEARs relevant to road traffic impacts. These are listed in **Table 11.76**. Impacts on rail and port capacity are addressed in **Section 11.14**.

Table 11-76 Amended SEARs

Traffic & Transport SEARs
Traffic & Transport – including:
• Transport – including an assessment of the likely transport impacts of the development on the capacity, condition, safety and efficiency of the rail network and the local and State road network.

11.13.1 Methodology

Overview

The TIA was undertaken to provide:

- an overview of existing traffic and transport conditions, including existing operational performance of local roads, including Remembrance Driveway, Avon Dam Road, and Tahmoor Mine Access Road, and key intersections such as the Tahmoor Mine Access Road/Remembrance Driveway and Avon Dam Road/Remembrance Driveway intersections;
- transport appraisal of the proposed Tahmoor Mine Access Road/Remembrance Driveway intersection upgrade with reference to the existing and proposed volumes of traffic;
- an assessment of traffic impacts for different stages of the proposed development including the peak stages of construction and operation;
- an assessment of increased transport of product coal and rejects from the mine by road transport up to 200,000 tpa; and
- management measures developed to mitigate the impact of the potential traffic and transport issues identified.

Traffic Counts and Modelling

Traffic counts were undertaken to establish existing traffic volumes and vehicle classifications on the local road network between 17 and 23 October 2018. Traffic count locations included: Remembrance Driveway at several locations, Avon Dam Road Rail Overbridge and Avon Dam Road, Rockford Road and Charlies Point Road. Daily volume and classification counts were also undertaken in the Tahmoor Mine Access Road.

In addition, weekday AM and PM peak period intersection counts were undertaken on 15 August 2017 between 6.00am and 9.30am and 2.00pm and 6.00pm at the principal intersections of Remembrance Driveway/Tahmoor Mine Access Road and Remembrance Driveway/Avon Dam Bridge Road.

Traffic modelling scenarios took into account:

- an assessment of a future timeframe of 10 years (as recommended by RMS);
- an assessment of existing conditions in the AM and PM periods including mine peak hours;
- projected employee numbers in 2020, as this is the anticipated peak year for employment levels for the proposed development;
- shift work hours for peak traffic generation; and
- future scenarios based on dates for construction and operation.

Intersection Performance Modelling

Traffic modelling has been undertaken to determine the potential impact of additional traffic volumes, generated by the proposed development, on critical intersections along Remembrance Driveway. Intersection performance has been evaluated using SIDRA Intersection 6, a computer-based modelling package designed for calculating isolated intersection performance. The main performance indicators used in SIDRA 6 include:

- Degree of Saturation – a measure of the ratio between traffic volumes and lane/approach capacity at the intersection. A degree of saturation below 1.0 suggests that the intersection operates with spare capacity, whereas a degree of saturation of over 1.0 results in increasing delays and vehicle queue lengths;
- Average Delay – duration, in seconds, of the average vehicle delay at an intersection; and
- Level of Service (LoS) – a measure of the overall performance of an intersection, with LoS A to C being good to satisfactory, LoS D being near capacity and LoS E being at or above capacity. Detailed descriptions of the different LoS can be found in **Appendix P**.

Detailed outputs of the SIDRA Intersection 6 modelling results are provided in **Appendix P**.

11.13.2 Existing Environment

The principal road network that services the Tahmoor Mine is shown in **Figure 11.32** and includes:

- The Hume Highway;
- Remembrance Driveway;
- Avon Dam Road; and
- Tahmoor Mine Access Road and other local roads that provide access to the eastern side of the Tahmoor Mine site.

Hume Highway

The Hume Highway is a national road that links Sydney, Canberra and Melbourne, forming the high speed connection between Sydney and the Southern Highlands.

Between Campbelltown and the Southern Highlands, the Hume Highway is known as the M31 Hume Motorway and comprises a four lane road with a divided carriageway, and has a posted speed limit of 110 km/hour.

Local Road Network

The principal road network that services the Mine and the surrounding local area includes Remembrance Driveway and Tahmoor Mine Access Road which provide access to the Mine site's Surface Facilities Area. Avon Dam Road provides a link between Remembrance Driveway and the M31 Hume Motorway. The local road network, including the key local roads identified in this section, is shown on **Figure 11.32**.

Key intersections within the local road network include:

- Tahmoor Mine Access Road/Remembrance Driveway - Tahmoor Mine Access Road forms a T-junction with Remembrance Driveway. The intersection is characterised by an auxiliary right turn lane treatment and auxiliary left turn treatment channelisation and priority control on Tahmoor Mine Access Road;
- Olive Grove Lane/Remembrance Driveway – Olive Grove Lane forms a minor T-junction with Remembrance Driveway, approximately 95 m north of the Tahmoor Mine Access Road and is characterised by a basic left turn and basic right turn treatment. An auxiliary through lane exists for the southern approach to allow through vehicles to pass a right turn vehicle at this location;
- Wollondilly Anglican College Access Road - Wollondilly Anglican College Access Road forms a T-junction with Remembrance Driveway, approximately 330 m south of the Tahmoor Mine Access Road. It is characterised by a channelized right treatment/lane and auxiliary left turn lane treatment and priority control on the school access road;

- Avon Dam Road/Remembrance Driveway intersection - A rail overbridge links Remembrance Driveway to Avon Dam Road at Bargo and provides the most direct route to the M31 Hume Motorway for travel to and from Sydney. At this intersection, Avon Dam Road forms a T Junction and railway crossing with a basic left turn and basic right turn treatment and priority control on the rail crossing; and
- Wellers Road/Remembrance Driveway intersection - A rail overbridge provides an alternative or second rail crossing at Wellers Road north of Avon Dam Road at Bargo. Wellers Road forms a cross junction intersection with a basic left turn and basic right turn treatment and stop sign control.

The sight distances at all intersections above are considered satisfactory.

Existing Traffic Volumes

Average Daily Traffic Volumes

Table 11.77 presents the five day weekday average daily traffic and the seven day average daily traffic on the local road network, as well as the proportion of heavy vehicles.

Table 11-77 Five Day Average and Seven Day Average Traffic Volumes (Transport & Urban Planning, 2018)

Location	5 Day Average (Weekday)				7 Day Average (Average Daily Traffic)			
	North-bound	South-bound	Total	% Heavy Vehicles	North-bound	South-bound	Total	% Heavy Vehicles
1	4,376	4,413	8,789	11.2%	4,060	4,076	8,136	10.4%
2	4,192	4,256	8,448	8.0%	3,896	3,937	7,833	7.0%
3	4,559	4,354	8,913	8.6%	4,284	4,023	8,307	7.6%
4	2,248	2,236	4,484	14.1%	2,129	2,152	4,282	12.6%
5	2,442	2,505	4,947	9.3%	2,250	2,296	4,546	8.5%
6	2,016	2,015	4,032	17.7%	1,820	1,824	3,634	16.5%
Location	**East-bound**	**West-bound**	**Total**	**% Heavy Vehicles**	**East-bound**	**West-bound**	**Total**	**% Heavy Vehicles**
7	383	383	766	10.2%	313	313	626	9.3%

Note – 1: Remembrance Driveway, north of Tahmoor Mine Access Road; 2: Remembrance Driveway, south of Wollondilly Anglican College Access Road; 3:Remembrance Driveway, North of Avon Dam Road Rail Bridge; 4:Remembrance Driveway, South of Marshalls Avenue; 5:Avon Dam Road Rail Bridge, East of Remembrance Driveway; 6:Avon Dam Road, North of Arina Road; 7:Tahmoor Mine Access Road.

Weekday AM and PM Peak Hour Traffic Volumes

AM Peak

The AM peak period at the principal intersections of the Tahmoor Mine Access Road intersection and the Remembrance Driveway/Avon Dam Road intersection occur between 7.45am – 8.45am and 7.30am – 8.30am respectively. The highest traffic generation of Tahmoor Mine in the AM peak period does not coincide with the peak period at these principal intersections.

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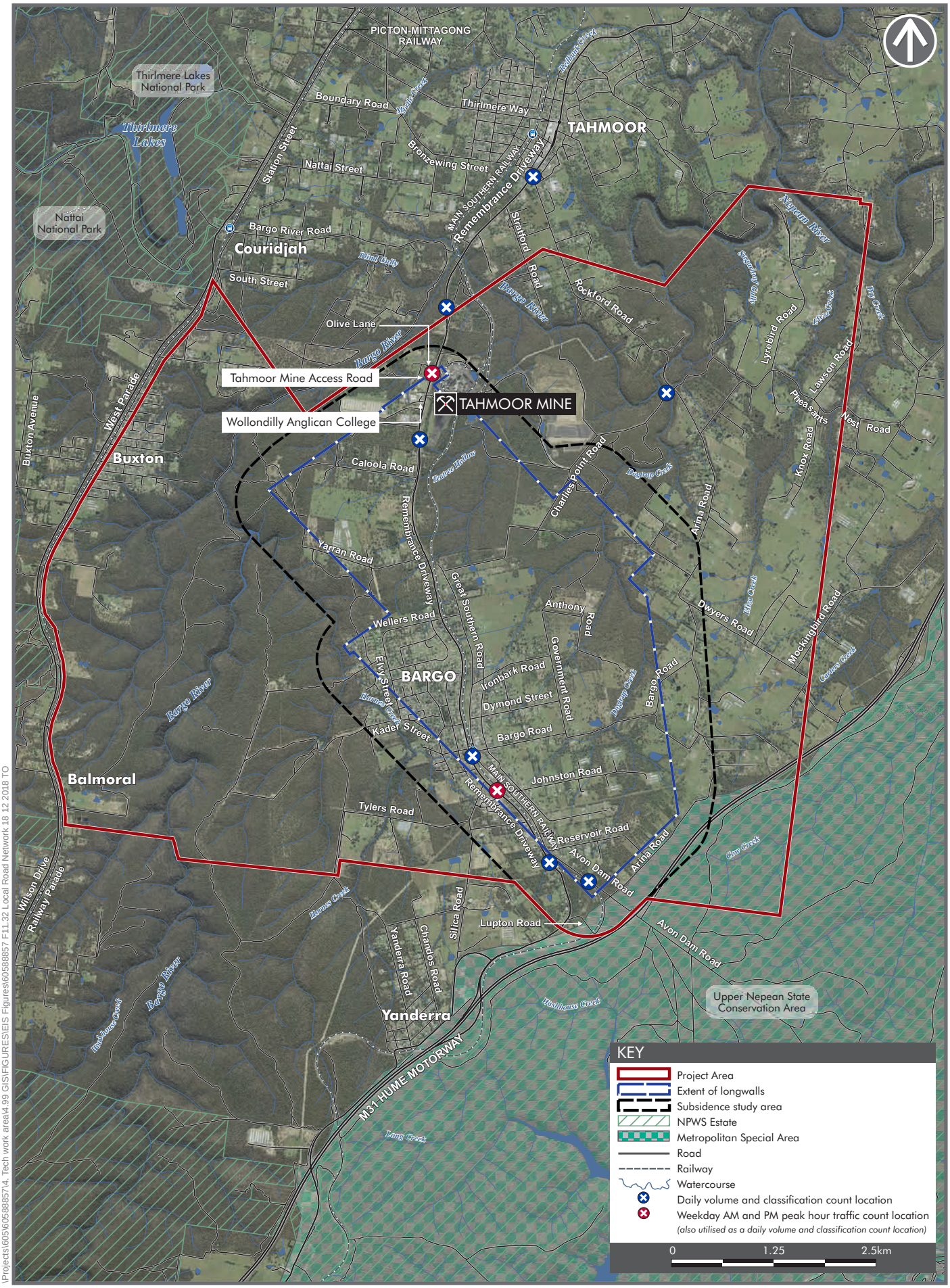

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SIMEC MINING

LOCAL ROAD NETWORK

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.32

During the AM peak (7.45am-8.45am) at the Tahmoor Mine Access Road intersection:

- Traffic volumes using Remembrance Driveway totalled 342 vehicles per hour (vph) travelling northbound and 365 vph travelling southbound; and
- The entry and exit movements to and from Tahmoor Mine were 19 vph and 53 vph respectively.

During the AM peak (7.30am – 8.30am) at the Remembrance Driveway and Avon Dam intersection:

- Traffic volumes using Remembrance Driveway totalled 135 vehicles per hour (vph) travelling northbound and 234 vph travelling southbound;
- The left and right turn movements into Avon Dam Road Rail Bridge were 172vph and 32vph respectively; and
- The left and right turn movements out of Avon Dam Road Rail Bridge were 34vph and 105vph respectively.

PM Peak

The PM peak period for the principal intersections, occurs between 3.30pm and 4.30pm. In this period:

- Northbound and southbound through volumes at the Remembrance Driveway/Tahmoor Mine Access Road intersection were 362vph and 313vph respectively;
- Entry and exit movements from Tahmoor Mine were 6vph and 79vph respectively. The left turn out of the Mine Access Road was the highest movement at 50vph;
- Northbound and southbound through volumes at the Remembrance Driveway/Avon Dam Road Rail Bridge intersection accounted for 197vph and 130vph respectively;
- The left and right turn into Avon Dam Road Rail Bridge were 165vph and 35vph respectively; and
- The left and right turn out of Avon Dam Road Rail Bridge were 36vph and 249vph respectively.

The peak traffic generation of Tahmoor Mine in the PM peak period occurs before the commuter peak hours.

Existing Tahmoor Mine Traffic Generation

The existing Tahmoor Mine operation (based on 2018 traffic counts) generates some 39 two way heavy vehicle movements per day on weekdays (i.e. 39 in/39 out). The majority of these vehicles are rigid trucks with up to two semi-trailers per day.

The existing Tahmoor Mine operation generates on average 344 light vehicle movements per day on weekdays (i.e. 344 in/344 out).

Road Safety

A review of RMS accident statistics for Remembrance Driveway and Avon Dam Road was undertaken for the five year period between 1 October 2011 and 30 September 2016. A summary of these statistics is provided in the following sections. Seventeen of the accidents occurred in proximity to intersections on Remembrance Driveway.

Remembrance Driveway

Between 2011 and 2016, a total of 39 accidents were recorded along Remembrance Driveway between the M31 Hume Motorway, Yanderra, and Thirlmere Way, Tahmoor. Of the 39 accidents, there was one accident, which involved a fatality, 20 injury-related accidents, and 18 non-casualty accidents involving damage to property only.

At the intersection of Remembrance Driveway and Tahmoor Mine Access Road, there were a total of three accidents. These included one head on fatal accident 200 m south of the intersection, as well as two injury accidents involving a northbound car on Remembrance Driveway colliding with a right turning vehicle waiting to turn into Tahmoor Mine. The proposed upgraded channelisation to provide a dedicated right turn bay in the southern approach of Remembrance Driveway (refer to **Section 11.13.4**) would reduce the potential for accidents at this intersection.

The remaining intersection accidents were spread over a number of intersections along Remembrance Driveway including at Wellers Road, (three accidents) Avon Dam Road (two accidents) and Yarran Road (two accidents). However, the data does not indicate an identifiable accident pattern at the intersections.

The reduction of the speed limit in recent years from 100km/h to 80km/h in the section of Remembrance Driveway near Tahmoor Mine should result in an improvement in road safety outcomes on Remembrance Driveway.

Avon Dam Road

A total of 12 accidents were recorded along Avon Dam Road, between Remembrance Driveway, Bargo, and the M31 Hume Motorway at Pheasant Nest, for the five year period between 2011 and 2016. Of the 12 accidents, there were three injury-related accidents, and nine non-casualty accidents involving damage to property. Of the 12 accidents, seven occurred within proximity of an intersection.

All seven intersection accidents (non-fatal) were recorded at the intersection of Anna Road/Avon Dam Road/Lupton Road. Four of the total, were cross intersection accidents and the three remaining accidents included a vehicle overtaking and two single vehicle accidents.

It is noted that a roundabout has been constructed at this intersection in recent times and that the speed limit in the section of Avon Dam Road between the M31 Hume Highway and the edge of the township has been reduced to 60km/h. These measures would assist in reducing the number of crashes in this section of Avon Dam Road.

Car Parks

Tahmoor Mine currently has three car parks with a total of 278 car spaces. As part of the proposed development, a new car park would be constructed which would incorporate another 150 parking spaces, providing a total car parking capacity of 428 spaces.

Public Transport

Bus services operate along Remembrance Driveway between Picton and Bargo/Yanderra on weekdays and Saturdays. Picton Bus Lines operates seven services per day on weekdays and two services on Saturdays. County Transport also operates bus services between Picton and Bargo, with four services provided on weekdays and two on Saturdays. No bus services are provided on Sundays.

11.13.3 Impact Assessment

Construction Activities

Traffic volumes associated with the construction of the proposed development are defined in terms of a number of construction activities. These include:

- construction of the underground mine workings between 2020 and 2024;
- delivery of equipment between 2024 and 2027;
- construction of additional surface infrastructure and upgrades to existing infrastructure within the Surface Facilities Area, between 2020 and 2024;
- upgrade of the Remembrance Driveway/Mine Access Road intersection between 2020 and 2021; and
- ventilation shaft construction, one at a time, between 2021 and 2024.

As shown in **Table 11.78**, the upgrade to the Surface Facilities Area (including mine access upgrade) and construction of the two ventilation shafts are likely to generate the greatest construction impact on the local road network.

Table 11-78 Summary table of construction traffic volumes by construction activity

Activity	Year of development	Light vehicles	Heavy vehicles
Underground mine workings	2020 to 2024	-	2-3 semi-trailer deliveries per month (approx. 1 per week in and out).
Delivery of equipment	2024 to 2027	-	5-8 semi-trailer deliveries per month (1-2 per week in and out).
Surface Facilities Area Remembrance Driveway/Mine Access Road intersection	2020 to 2024	30 construction workers in 6am – 7am 30 construction workers out 5pm – 6pm	On average 10-15 large rigid truck and articulated semi-trailer deliveries per month (2-3 per week in/2-3 per week out) Note – during construction of the new parking area and internal road and Remembrance Driveway intersection up to 15 heavy vehicles per day may be required to deliver materials to site (15 movements in and out) Additional heavy vehicle movements would also occur associated with delivery of materials, concrete pours, asphalting etc., although these would spread over the day.
Ventilation shafts (x2) TSC1 - Upcast TSC2 - Downcast	2021 to 2024	13 construction worker trips 5.30am – 6.30am 13 construction worker trips 5.30pm – 6.30pm	Site establishment works – 40 semi-trailer loads over three weeks for each shaft location. Construction of ventilation shafts – 1-2 heavy vehicle deliveries per day (1-2 in/1-2 out) for the 18 months to two year construction period except for heavy concrete pours when up to an additional 13 deliveries per day (approx. 1-2 per hour). Demobilisation works – 40 semi-trailer loads over three weeks for each shaft location. Note: Ventilation shafts would be constructed one at a time.

Surface Facilities Area and Mine Access Upgrade

While an increase in vehicles is anticipated for construction of the proposed development, the order of this increase is less than the proposed additional peak traffic generated in the operational phase. In addition, construction traffic would be generated at different times than operational traffic and primarily outside of the AM and PM peak hours on the road network. On this basis, the potential construction impacts are considered satisfactory in the context of the overall proposed development.

Ventilation Shafts

As shown in **Table 11.78**, two ventilation shafts will be constructed between 2021 and 2024. Construction vehicle access to TSC1 and TSC2 would be via Rockford Road and Charles Point Road. The existing weekday traffic on these roads is between 1,576-1,607 vehicles per day (vpd) (12.2-13.2% heavy vehicles) and 131-135vpd (6.8-7.8%heavy vehicles), respectively. The additional 26 light vehicle trips and 14-16 heavy vehicle trips (worst case) generated by the construction of TSC1 and TSC2 are not considered to impact the capacity of these roads.

Operation

The employment at Tahmoor Mine (i.e. employees and contractors) is expected to vary from current levels, with the peak year for employment occurring in 2020. After 2020 employment levels are anticipated to reduce. At the request of RMS, traffic volumes generated by the Tahmoor Mine have been considered for the existing situation (2017/2018) and the future timeframe of 10 years (2028). In addition, the peak employment scenario (2020) has been assessed. As employment levels are expected to decrease post 2020, the 2020 scenario represents the most conservative assessment for the operational phase.

The increase in employment as a result of the proposed development (compared to 2017) will be proportional across all the shifts worked at Tahmoor Mine and therefore the increase in the traffic generation over the day including at peak times (i.e. shift changeover times) would also be expected to be proportional. Weekdays have the highest number of employees and traffic generation from Tahmoor Mine. Based on anticipated employment trends the existing and projected traffic impacts during operation are shown in **Table 11.79**.

Table 11-79 Existing and future traffic at Tahmoor Mine during weekday AM and PM peak hour (Transport and Urban Planning, 2018)

Hourly period	2017 (existing)		2020 (peak employment)		Increase from 2017 volumes		2028 (future)		Increase from 2017 volumes	
	In	Out	In	Out	In	Out	In	Out	In	Out
7.45am – 8.45am	19	53	27	74	+8	+21	22	61	+3	+8
3.30pm – 4.30pm	6	79	9	110	+3	+31	8	91	+1	+12

Traffic Generation

As noted in **Table 11.79**, the peak traffic volumes generated by the proposed development will occur in 2020 during the 7.45am-8.45am period and the 3.30pm – 4.30pm period on weekdays. Figures 11 and 12 in **Appendix P** show the additional volumes and directional splits assigned to the road network during these periods based on the existing traffic patterns. In summary:

- during the 7.45am-8.45am period the increase in traffic volumes due to the proposed development would be:
  - a 14 vph increase in Remembrance Driveway north of Tahmoor Mine Access Road with 9 northbound vehicles and 5 southbound vehicles;
  - a 31 vph increase south of Tahmoor Mine Access Road with 11 northbound vehicles and 20 southbound vehicle;
  - a 15 vph increase on Remembrance Driveway south of Avon Dam Road; and
  - a 16 vph increase on Avon Dam Road.
- during the 3.30pm – 4.30pm period the increase in traffic volumes due to the proposed development would be:
  - a 13 vph increase on Remembrance Driveway north of Tahmoor Mine Access Road with 11 northbound vehicles and 2 southbound vehicles;
  - a 37 vph increase on Remembrance Driveway south of Tahmoor Mine Access Road with 9 northbound vehicle and 28 southbound vehicles;
  - a 18 vph increase on Remembrance Driveway south of Avon Dam Road; and
  - a 19 vph increase on Avon Dam Road.

The impact of additional traffic on both Remembrance Driveway and Avon Dam Road is considered relatively minor in terms of midblock capacity.

The transportation of the 200,000 tpa of coal and other products by road would generate on an average day an additional 16 truck loads (i.e. 16 in/16 out) and a maximum of 79 truck loads per day (using trucks and quad dog articulated vehicle) on a campaign basis (i.e. 79 in/79 out). This would add (at maximum) an additional 8 truck loads per hour (i.e. 8 in/8 out) in the AM and PM peak hours.

Operational Performance of Intersections

Traffic modelling using SIDRA examined the impacts of additional traffic movements from the proposed development on critical intersections on Remembrance Driveway.

The TIA considered the future operational performance of the Remembrance Driveway/Mine Access Road intersection (refer to **Section 11.13.4** for further information) for the existing traffic volumes (2017) and for the 2020 scenario with traffic generated by the proposed development and a lineal background traffic growth rate of 3.3 percent per year. A summary of the intersection performance is provided in **Table 11-80** for the existing 2017 and forecast 2020 traffic flows (further details of the SIDRA results are in Tables 4.4 to 4.7 in **Appendix P**).

Table 11-80 Intersection performance

Scenario (all vehicles)	Existing (2017)		Future Conservative (2020) with Operation of Proposed Development	
	Degree of Saturation	Level of Service	Degree of Saturation	Level of Service
Remembrance Driveway/Tahmoor Mine Access Road during the AM Tahmoor Mine Peak Hour	0.193	A	0.216	B
Remembrance Driveway/Tahmoor Mine Access Road during the PM Tahmoor Mine Peak Hour	0.165	A	0.216	B
Remembrance Driveway/Avon Dam Road during the AM Tahmoor Mine Peak Hour	0.317	A	0.338	B
Remembrance Driveway/Avon Dam Road during the PM Tahmoor Mine Peak Hour	0.561	B	0.733	B

Note: For the Remembrance Driveway/Tahmoor Mine Access Road intersection, the modelling adopted the existing channelisation for 2017 (and the proposed upgraded channelisation with the right turn bay in 2020.
At Remembrance Driveway/Avon Dam Road (Rail Bridge) intersection, the existing traffic management has been used for the 2017 and 2020 models.

Table 11-80 shows that all intersections will maintain a satisfactory to good level of service (Level of Service B) in the 2020 scenario. The assessment predicts small increases in vehicle delay for the right hand turn movement of the Remembrance Driveway/Tahmoor Mine Access Road interchange from 13.8 to 16.5 seconds per vehicle in the AM peak and 12.8 to 15.4 seconds in the PM peak (less than 3 seconds in each case). Similar small increases in vehicle delays (less than 2 seconds per vehicle) are predicted at the Remembrance Driveway/Avon Dam Road intersection during the morning peak in 2020. Whilst an increase in delays of between six and seven seconds per vehicle is predicted for the PM peak, the overall operation of the intersection is predicted to remain satisfactory at a Level of Service B.

The above two critical intersections were also modelled for the 10 year future scenario, comparing the 2028 base case without the proposed development (assuming background traffic growth of 3.3% lineal average) and the 2028 scenario with the proposed development plus background traffic growth (Refer Tables 4.8 to 4.11 of **Appendix P**). The intersection modelling indicates that the Remembrance Driveway/Tahmoor Mine Access Road interchange would retain a satisfactory to good operation in 2028 with the proposed development, compared to the 2028 base case, with a predicted Level of Service of B in both the AM and PM peak periods. The delays for the right turn out of the Mine Access Road increases by around 1 second per vehicle with the proposed development as compared to the 2028 base case, which is a minimal impact.

With respect to the Remembrance Driveway/Avon Dam Road intersection, the modelling indicates a satisfactory to good Level of Service (B) during the AM peak in 2028 with the proposed development in place. Only a small increase in vehicle delay of 1-2 seconds is predicted for the right turn out of Avon Dam Road Rail Bridge compared to the 2028 base case, which is considered minor.

In the PM peak, the background traffic growth over the 10 year period to 2028 (if realised) will increase the vehicle delay for right turns out of Avon Dam Rail Bridge Road to 51.9 seconds per vehicle (the equivalent of a Level of Service D operation). With the proposed development in place the delay to the right turn movement will increase to 67.4 seconds per vehicle (the equivalent of a Level of Service E operation). However the proposed development will only generate an additional 24 vehicle trips at this intersection in the PM peak hour in 2028, as compared to the background 2017 volumes and would therefore only account for a very small proportion of the increase in the overall traffic volumes predicted to use this intersection in 2028. As such, the proposed development's contribution to the intersection performance when compared to predicted existing traffic volumes in 2017 is considered to be relatively small. It is noted that the traffic generated by the proposed development would reduce from its peak in 2020 and by 2023 the increases associated with the Project will be 50% less than in 2020. From 2023 to 2035 employment levels at the mine will be the same as the employment level in 2011. The only additional traffic will be eight truck loads per hour (i.e. 8 in/8 out) associated with the road transport of coal products, which would only occur on a campaign basis where required.

Parking

As part of the upgrade works to the existing surface infrastructure of the Mine, additional parking facilities would be provided to accommodate the increased number of employees.

Parking surveys undertaken for a week in February 2013 found that the maximum parking demand at Tahmoor Mine at the time was 262 vehicles which occurred in the morning. This included all vehicles parked in the car parks, plus adjacent the frontage of the Tahmoor Mine site. This represents a maximum demand parking rate of 0.70 cars/spaces per employee (based on 378 employees in 2013). Adopting this parking rate for 510 employees (peak employment in 2020) indicates a parking requirement of 357 spaces. However, due to the arrival of workers prior to shift handover additional car parking spaces would likely be required and these additional spaces have been allowed for in the project description. As noted above, Tahmoor Mine will have a total of 428 spaces with the additional 150 car spaces and therefore will have adequate parking to accommodate its peak parking demand including additional parking spaces for shift handover.

11.13.4 Management and Mitigation Measures

Potential impacts on the local road network as a result of traffic generated by the proposed development are anticipated to be minor. However, mitigation and management measures would be implemented to avoid, minimise or manage potential traffic impacts, where possible.

The proposed development incorporates a number of measures as part of the proposed development designed to minimise potential impacts to traffic, and to improve road safety and performance, including:

- upgrade to the Remembrance Driveway/Mine Access Road intersection to improve the performance and safety of the intersection, particularly with regard to reducing the incidence of rear end collisions between vehicles turning right onto Mine Access Road at the southbound approach to the intersection and northbound vehicles on Remembrance Driveway. The intersection will be designed and constructed in accordance with relevant Austroads standards and relevant RMS supplementary documents, where appropriate;
- staging of construction of the proposed ventilation shafts, with one ventilation shaft constructed at a time. A benefit of this approach is that it will reduce the cumulative impact of heavy and light vehicle movements on the local road network and reduce the overall traffic volume generated by the proposed development; and
- construction of a new car park at the Surface Facilities Area to accommodate the increased number of employees and contractors. No offsite parking is anticipated to be required.

Construction

Upgrade to the Tahmoor Mine Access Road / Remembrance Driveway Intersection

Upgrade of the Tahmoor Mine Access Road/Remembrance Driveway intersection would improve potential road safety issues associated with the incidence of rear end collisions between vehicles turning right onto Mine Access Road at the southbound approach to the intersection and with northbound vehicles on Remembrance Driveway. The Project is not expected to have any negative impacts on road safety.

The proposed upgrade is shown on **Figure 11.33**, and will include:

- a channelised right hand turning bay for the southern approach of Remembrance Driveway (i.e. for vehicles travelling northbound), together with a separate northbound lane so that northbound vehicles may pass vehicles turning right onto Mine Access Road in a safe manner;
- a dedicated left turn lane from Remembrance Driveway onto Olive Grove Lane for vehicles travelling northbound, so that northbound traffic may pass vehicles turning left onto Olive Grove lane in a safe manner;
- an auxiliary left hand turning lane in the northern approach of Remembrance Driveway, so that southbound traffic, particularly heavy vehicles associated with the Mine, may turn left into Mine Access Road and reduce potential congestion for southbound traffic; and
- a painted median between northbound and southbound traffic on the northern approach of Remembrance Driveway Widening of Mine Access Road to provide two approach lanes at the intersection. This will allow greater movement of vehicles, reducing delays for vehicles turning left southbound on Remembrance Driveway and avoiding congestion associated with vehicles turning right northbound on Remembrance Driveway. The upgrade of Mine Access Road will also provide access to the new parking facilities constructed within the Surface Facilities Area.

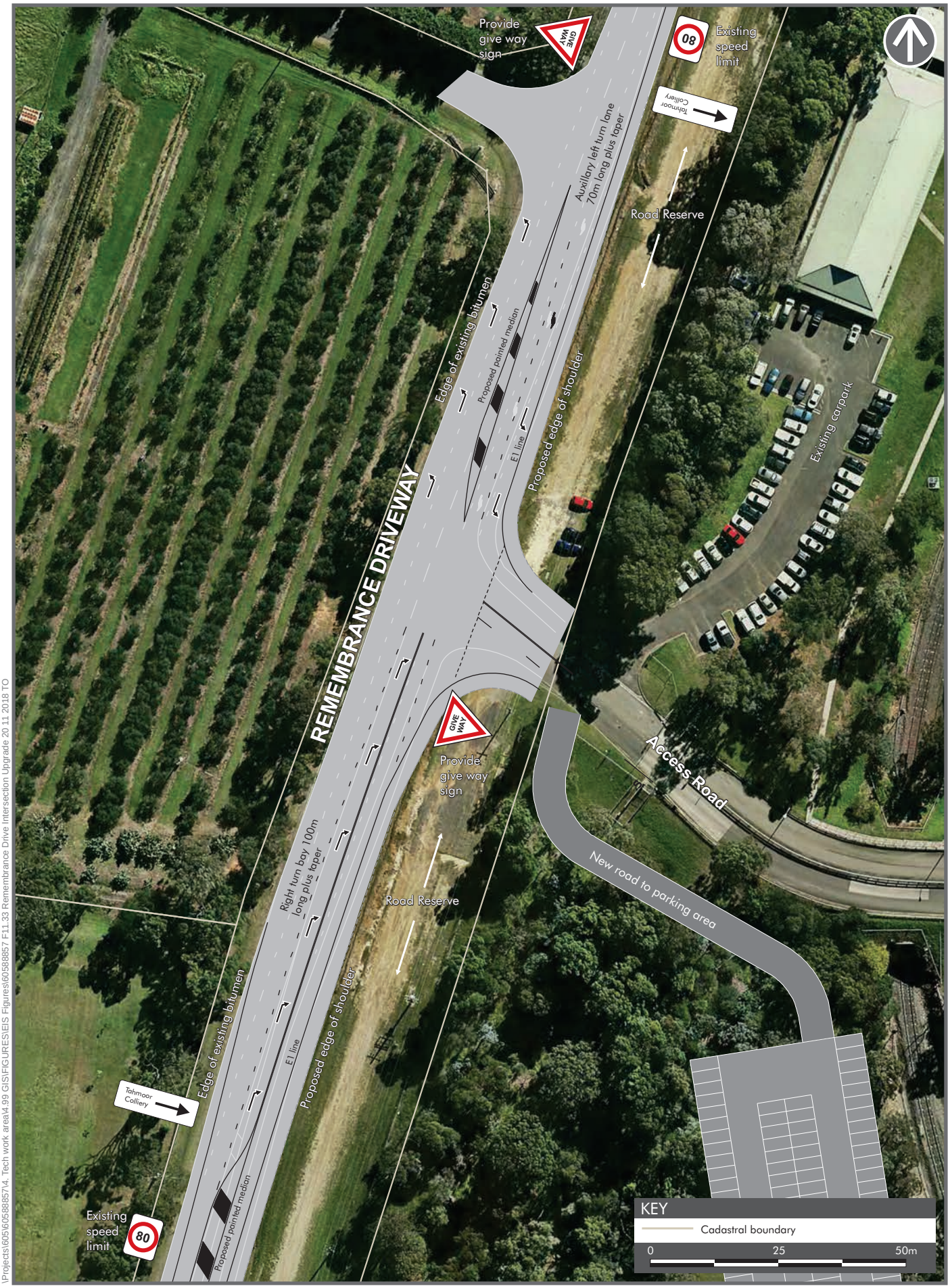
The intersection will be designed for a design speed greater than 80 km per hour in accordance with Austroads Standards, and has been designed to accommodate a 19 m articulated vehicle turning into and out of Mine Access Road. The available sight distance at the intersection is satisfactory and meets Austroad requirements for sight distance for the posted speed limit and the estimated vehicle operating speeds in Remembrance Driveway.

Construction Traffic Management Plan

A Construction Traffic Management Plan (CTMP) will be prepared prior to construction of the proposed development. The CTMP will provide mitigation measures to be implemented to address potential impacts on local road users during construction, with specific management measures developed in consultation with RMS and Wollondilly Shire Council.

Potential traffic impacts resulting from construction of the proposed Remembrance Driveway/Mine Access Road intersection upgrade will be managed through a separate CTMP, which will be prepared in consultation with RMS and Wollondilly Shire Council, prior to the commencement of the upgrade works. The CTMP will include details of any staging requirements and will include Traffic Control Plans to manage traffic at the intersection under the changed traffic conditions.

Prior to construction, an additional CTMP will be prepared and implemented to manage potential impacts of construction traffic for each proposed ventilation shaft. The CTMP would include details of the proposed works, transport routes required for access to the ventilation shaft sites and for the delivery of construction materials and equipment, as well as any upgrades to local roads required to accommodate heavy vehicles. The CTMP will be prepared in consultation with RMS and Wollondilly Shire Council.



\Projects\605\605885714. Tech work area\4.99 GIS\FIGURES\EIS Figures\605885857-F11.33 Remembrance Drive Intersection Upgrade 20 11 2018 TO

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CONCEPTUAL REMEMBRANCE DRIVEWAY INTERSECTION UPGRADE

Tahmoor South Project
Environmental Impact Statement

Source: Traffic and Urban Planning (2018)

FIGURE 11.33

Potential impacts on local traffic during the construction phase would be managed and mitigated onsite by the construction contractor, in accordance with the CTMPs. Traffic management measures likely to be included in the CTMPs would include:

- dilapidation surveys and 'make good' commitments;
- appropriate signage and implementation of temporarily reduced speed limits in proximity to construction activities, particularly for the upgrade of the Mine Access Road/Remembrance Driveway intersection;
- restriction of heavy vehicle movements to designated haulage routes and access points to minimise the impacts to residents and the local road network;
- transportation of oversized construction equipment and machinery in accordance with the RMS guidelines for oversized movements; and
- notification to the local community.

Operation

Operational traffic volumes generated by the proposed development are anticipated to be managed in line with current traffic management for the existing operations, and any existing management measures or procedures would be updated accordingly.

Tahmoor Coal will prepare and implement a Driver's Code of Conduct for traffic movements required during both construction and operation of the proposed development, with particular reference to heavy vehicle movements along local roads, such as Charlies Point Road to access the proposed ventilation shafts TSC1 and TSC2. The Code of Conduct will be used to reinforce best practice measures and behaviour in terms of light and heavy vehicle movements to minimise potential impacts to other road users and to maintain road safety.

11.13.5 Conclusion

The Traffic Impact Assessment for the proposed development identified existing and future traffic volumes on the local road network. Anticipated traffic volumes for the construction and operation of the proposed development were identified and show that the operational phase will result in a greater increase in traffic (when employment is at its peak) than the construction phase. While an increase in construction and operational traffic is anticipated as a result of the proposed development, given the capacity of the existing road network this increase is considered minor.

The upgrade of the mine access intersection with Remembrance Driveway in accordance with Austroads standards is expected to improve road safety at this intersection. SIDRA traffic modelling undertaken for the intersection indicates that it will have a satisfactory to good operation in terms of vehicle delay when the proposed development reaches its peak employment (and therefore its peak traffic generation).

The potential impacts of the proposed development would be managed through the implementation of Construction Traffic Management Plans which will be prepared in consultation with both RMS and Wollondilly Shire Council.

11.14 Rail and Port Capacity

A Rail and Port Assessment was undertaken by Jacobs (2017) to assess the capacity of the rail and port network, with regard to the strategic objectives for both passenger and freight transport, and to assess the impacts of the proposed development on this network. This section provides a summary of the assessment, which is provided in **Appendix P.**

The SEARs relevant to transport and rail network impacts are listed in **Table 11-81**. Impacts on road traffic are addressed in **Section 11.13**.

Table 11-81 Amended SEARs

Rail and Port SEARs
Transport – including:
• Transport – including an assessment of the likely transport impacts of the development on the capacity, condition, safety and efficiency of the rail network and the local and State road network; and

11.14.1 Background

The proposed development would utilise existing rail and port infrastructure in order to transport product coal to Port Kembla for export. As a result, an assessment was undertaken in order to determine whether sufficient capacity exists within the existing rail and port infrastructure to cater for the proposed development.

11.14.2 Methodology

To determine the existing capacity within the port and rail network, an analysis of data from the ARTC regarding rail movements along the Main Southern Railway Line and Moss Vale to Unanderra Line within ARTC's jurisdiction was undertaken. Jacobs then examined the results of rail network modelling previously undertaken by Tahmoor Coal.

The capacity of alternative rail paths was considered, along with the potential for the receipt, storage and shipping of product coal through Port Kembla Coal Terminal. An investigation was then undertaken to identify potential future rail paths and upgrades which may be required to transport product coal from the proposed development to Port Kembla Coal Terminal.

Rail Network Modelling

Rail network modelling was undertaken by Tahmoor Coal using the following assumptions:

- four rail paths would be utilised per day;
- minimum annual product coal transported to Port Kembla Coal Terminal: 1.8 Mtpa;
- average annual product coal transported to Port Kembla Coal Terminal: 2.6 Mtpa; and
- maximum annual product coal transported to Port Kembla Coal Terminal: 3.1 Mtpa.

11.14.3 Existing Environment

Rail Transport Infrastructure

The railway system utilised by the existing Tahmoor Mine comprises the Tahmoor Mine Balloon Loop, Main Southern Railway Line and the Moss Vale to Unanderra Line for rail haulage to Port Kembla. The total distance travelled from the Tahmoor Mine to Port Kembla is approximately 113 km. Tahmoor Coal also rails product coal to Newcastle Port Waratah from time to time.

The Tahmoor Mine currently uses Class 82 locomotives and coal wagons with a nominal gross load of 100 tonnes. The trains are about 796m long comprising two locomotives; one at either end, and 45 wagons. Each coal wagon currently carries 70 tonnes of product each, equating to an average loaded train capacity of 3,150 tonnes for a 45 wagon train.

Analysis undertaken as part of the Rail and Port Assessment indicates that the average travel time in each direction is about 3.5 hours. The total cycle time, including unloading of product coal at Port Kembla Coal Terminal is a minimum of eight hours.

Tahmoor Mine Balloon Loop

The Tahmoor Mine Balloon Loop is a 1.3 km long rail loop located at the Tahmoor Mine Junction and is used to load coal from the existing Tahmoor Mine onto trains for transport to Port Kembla. The coal loading process at the Tahmoor Mine Balloon Loop takes a minimum of about two hours. Trains that are used for transport of coal from the existing Tahmoor Mine travel along the Main Southern Railway Line from the south and pass the Tahmoor Mine Balloon Loop, where they then stop, reverse and travel backwards through the Tahmoor Mine Balloon Loop for loading. Product coal is loaded onto trains via the rail load out bin located between the CHPP and product coal stockpile area. Once loaded, trains enter back onto the Main Southern Railway Line and travel south along the Main Southern Railway Line.

Train movements along the Main Southern Railway Line are blocked for 12 minutes at a time as a result of the complex manoeuvres required for trains to enter and exit the Tahmoor Mine Balloon Loop. Owing to the configuration of the Tahmoor Mine Balloon Loop and the complex manoeuvres required by trains to enter and exit, the maximum train length that can be accommodated at the existing Tahmoor Mine is about 900m, limiting the opportunity for longer trains to be utilised.

The scheduled arrival and departure times for trains to the Tahmoor Mine Balloon Loop is summarised in **Table 11-82**. The actual arrival and departure times largely depend on the availability of train path segments and congestion within the network.

Table 11-82 Existing Tahmoor Mine arrival and departure schedule

Train ID	Weekday Arrival	Weekday Departure	Weekend Arrival	Weekend Departure
TM71/TM72	08:37	10:44	08:10	11:00
TM81/TM82	11:39	14:00	11:39	14:00
TM93/TM94	21:30	23:25	20:46	23:25
TM97/TM98	23:47	01:50	23:39	01:50

Main Southern Railway Line

The Main Southern Railway Line is part of the north-south rail corridor between Sydney and Melbourne. It is leased by ARTC and is utilised for both passenger and freight traffic. The rail loop at the Tahmoor Mine connects to the Main Southern Railway Line, with locomotives travelling along this route until the Moss Vale junction, where trains turn east and continue along the Moss Vale to Unanderra Line towards Port Kembla (refer to **Figure 11.34**).

Moss Vale to Unanderra Railway

The Moss Vale to Unanderra Line is an east-west rail corridor which is operated by ARTC for the purposes of freight traffic. It is a duplicated line between Unanderra and Dombarton. However, the remainder of the rail corridor is single line with four passing loops or sidings. From Unanderra, the Moss Vale to Unanderra Line is operated by NSW TrainLink. At Unanderra there is a rail junction where freight trains wait for clearance to proceed to Port Kembla (refer to **Figure 11.34**).

The Moss Vale to Unanderra Line currently has a capacity of 16 to 17 train paths per day, with a peak utilisation of about 13 paths per weekday. There are therefore three to four train paths available per day on the Moss Vale to Unanderra Line. The existing Tahmoor Mine utilises four (31%) of the available train paths per day (during peak utilisation) along the Moss Vale to Unanderra Line, with the remaining paths used for the transport of grain, flour, limestone and mineral ore. There is potential for the capacity of the Moss Vale to Unanderra Line to be enhanced in the future by extending the existing passing loops.

Alternative Rail Path – Illawarra South Coast Line

The Illawarra South Coast Line runs from Sutherland to Bomaderry via Wollongong as part of the Sydney metropolitan train network and is used by a mixture of passenger and freight trains. Passenger trains have priority over freight movements with no freight trains permitted to impact on passenger services arriving at Central station in the morning (6am to 9am) and afternoon (4pm to 6pm) peak.

There is potential for rail traffic from the Tahmoor Mine Balloon Loop to travel north along the Main Southern Railway Line towards Sydney, where trains could travel through the Metropolitan Freight Network and then from Marrickville, travel south along the Illawarra South Coast Line to Port Kembla. There is minimal capacity along the Illawarra South Coast Line as detailed in **Table 11-83**.

Table 11-83 Available train paths on the Illawarra South Coast Line

Hour	Spare Paths from Sydney towards Port Kembla	Spare paths from Port Kembla towards Sydney
00:00 – 00:59	1	0
02:00 – 02:59	1	0
03:00 – 03:59	1	0
10:00 – 10:59	2	0
11:00 – 11:59	0	1
12:00 – 12:59	1	0
13:00 – 13:59	0	1
19:00 – 19:59	0	1
22:00 – 22:59	0	1

Potential Future Rail Paths – Maldon to Dombarton Line

The proposed Maldon to Dombarton Line would potentially provide an alternative link between the Tahmoor Mine and Port Kembla if it were more economical than current arrangements. The use of the Maldon to Dombarton Line would be considered if the rail project is completed and this route provides greater economic or operational benefits than the current rail routes available.

The Maldon to Dombarton Line would connect with the Main Southern Rail Line near Picton and finish at Dombarton, about 15 km from Port Kembla. Construction of the Maldon to Dombarton Line commenced in 1983, but the proposed development was cancelled in 1988 when a significant number of coal mines that were potential users of the Maldon to Dombarton Line were closed and there was a change in government. At the time of cessation of construction of the Maldon to Dombarton Line, two thirds of earthworks and entry cuts to the tunnel portals and access roads to the tunnel area had been completed.

Port Infrastructure

Port Kembla Coal Terminal is the major coal intermodal facility in southern NSW for the transfer of coal from road and rail to ship. Port Kembla Coal Terminal enables the receipt, assembly and loading of coal from the Southern and Western NSW Coalfields for transport by ship to both Australian and international markets. It is located on the northern side of the Port Kembla Inner Harbour and has two bulk handling facilities, with Berth 102 (high capacity coal berth) utilised for the handling and loading of coal.

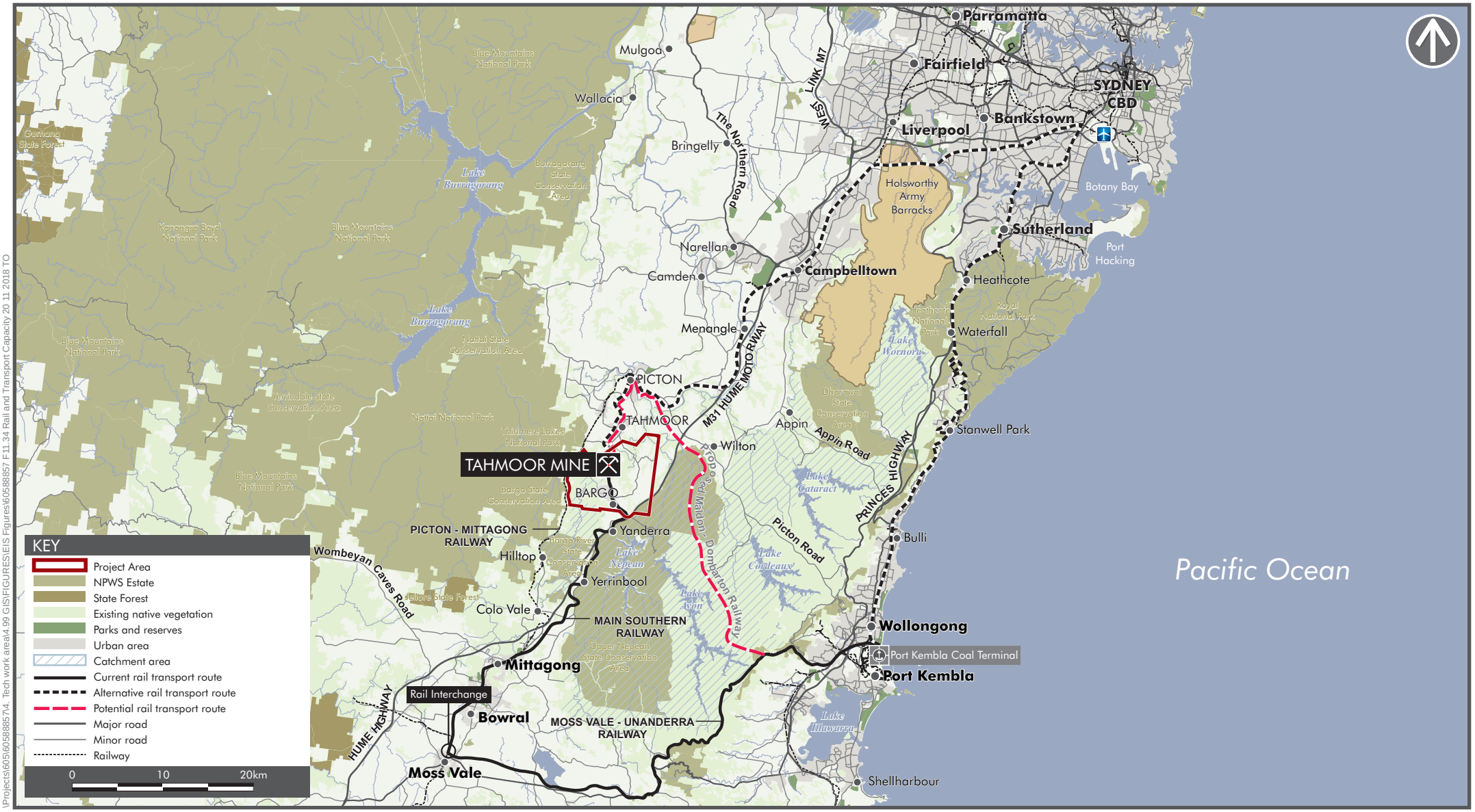
Trains enter the port from the main line at Coniston. Here the rail line branches and proceeds around a loop in a clockwise direction, unloading coal from wagons within the receival terminal before leaving the site. Coal is unloaded from the train wagons through the bottom doors while moving around a balloon rail loop at a speed of about 0.9 km per hour. Port Kembla Coal Terminal receives up to 16 trains of coal product a day, with each train taking about one hour to unload. Conveyor belts transport coal from the receival sheds to the stockyard where it is assembled in preparation for vessel loading. The stockyard has a capacity to store 850,000 tonnes of coal in two storage pads.

The capacity of the Port Kembla Coal Terminal has a rated capacity of 18 Mtpa and a throughput of around 8 Mtpa to 10.5 Mtpa in recent years (2015-2016, 2016-2017 reporting periods), indicating that there is about 7.5 Mtpa of spare capacity. About 60% of coal product transported to the Port Kembla Coal Terminal is received by rail. The terminal typically receives 23,100 tonnes of product per day at a nominal rate of 3,700 tonnes per hour. In the 2016/2017 financial year, 8,058,430 tonnes of coal was shipped through the terminal. Coking coal comprised 78% (6,311,450 tonnes) of this product, and steaming coal made up the remaining 22% (1,746,980 tonnes). Of the coal product received and transported by ship at the terminal, about 93% is exported and seven percent is transported for use in the Australian market.

Ongoing capacity of the Port Kembla Coal Terminal

As outlined in *Navigating the Future: NSW Ports' 30 Year Masterplan* (NSW Ports, 2015), Port Kembla's role in supporting NSW mining industry (as well as other industries such as agriculture, manufacturing and construction) will grow and strengthen over the next 30 years.

The Port Kembla Outer Harbour Development would provide additional land for operational facilities and future berth construction and to provide for future throughput needs. Approval for the development of Port Kembla's Outer Harbour was granted in March 2011 and Stage 1A of the development has been completed which has provided 6.9 hectares of additional port land suitable for further development to allow storage and handling and processing of bulk cargoes.



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SIMEC MINING

RAIL AND TRANSPORT CAPACITY

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.34

11.14.4 Impact Assessment

Capacity of the Existing Rail Transport Path

Rail network modelling undertaken by Tahmoor Coal determined that the maximum available rail system capacity within the limit of the existing approved four train paths per day is 4.6 Mtpa. The proposed development would produce up to 4 Mtpa ROM coal and the Tahmoor Mine Balloon Loop has sufficient capacity to accommodate the expected range of annual product coal from the proposed development. To transport the anticipated 4 Mtpa of product coal by rail, four train paths per day would be required between the Tahmoor Mine and Port Kembla. This is consistent with the existing approved rail transport for the operation of Tahmoor Mine and as a result, no impact on rail transport infrastructure is anticipated.

Rail Network Modelling determined that the transport of coal product via the Main Southern Rail Line and Moss Vale to Unanderra Line (as per current arrangements) was the most efficient solution for the Tahmoor Mine to transport the anticipated amount of product to Port Kembla using the four existing train paths a day. The use of the existing Main Sothern Rail Line and Moss Vale to Unanderra Line would not require any modification of existing infrastructure and the train paths could be used immediately at the commencement of the proposed development. As the proposed development would not modify the frequency of rail movements, it is not anticipated to impact on the existing rail transport path between Tahmoor Mine and Port Kembla.

Other nearby proposed developments such as The Hume Coal Project and the Russell Vale Colliery Underground Expansion Project would not significantly impact the capacity of the rail system between the Tahmoor Mine and Port Kembla. The Hume Coal Project would transport coal via a new rail loop as part of the Berrima Rail project and would only utilise the Main Southern Rail Line during off-peak periods in the existing timetable and would have a minimal effect on the overall line capacity (EMM, 2017). The Russel Vale Colliery Underground Expansion Project would not transport coal via rail.

Use of Alternative and Potential Future Rail Paths

Following the feasibility study undertaken in 2010 to 2011 to inform decision making on the Maldon to Dombarton Rail Line proposal, the Federal Government contributed $25.5 million to the preparation of detailed design work to support future construction of the Maldon to Dombarton Rail Line. It was determined that construction of the line is not feasible for financial reasons and that the existing infrastructure is sufficient to manage rail capacity in the short to medium term. As construction of the Maldon to Dombarton Rail Line is not planned, it has not been considered as an alternative rail path to the existing movement of trains between the Tahmoor Mine and Port Kembla. However, if completed the Maldon to Dombarton Rail Line would provide a shorter route for trains. If completed, Tahmoor Coal would consider the commercial benefits of utilising the Maldon to Dombarton Rail Line as an alternative to the Moss Vale to Unanderra route.

Safety of the rail network

As the proposed development is not anticipated to modify rail path movements there would be no impact to the safety of the rail network.

Capacity of Port Kembla Coal Terminal

Between 8 Mtpa and 10.54 Mtpa of product coal has been shipped from Port Kembla Coal Terminal in recent years (2015-2016, 2016-2017 reporting periods), indicating that there is about 7.5 Mtpa of spare capacity, with the terminal having an approved throughput of about 18 Mtpa.

Port Kembla Coal Terminal has the capacity to continue to receive four train paths per day of product coal from the Tahmoor Mine. The volume of coal to be produced from the proposed development would be able to be accommodated within the 7.5 Mtpa of spare capacity that exists at the terminal. It is therefore considered the proposed development would not significantly alter the existing impacts that Tahmoor Mine has on port and rail capacity other than the prolongation of utilising this infrastructure.

Management and Mitigation Measures

As the proposed development is not anticipated to modify rail path movements and is highly unlikely to impact on the current and potential future capacity of Port Kembla Coal Terminal, no management and mitigation measures are considered necessary.

11.14.5 Conclusion

The generation of product coal from the proposed development would be accommodated within the four rail paths that are currently utilised for the operation of the existing Tahmoor Mine.

The use of the Illawarra South Coast Line as an alternative route to the Main Southern Rail Line and Moss Vale to Unanderra Line should these rail lines reach capacity is not considered favourable when considering the existing constraints for rail movements, particularly for freight purposes along this rail line. As the proposed development would not require additional rail paths or increase the frequency of pass-byes, the development is not expected to pose additional constraint on the current Main Southern Rail Line and Moss Vale to Unanderra Line route.

Port Kembla Coal Terminal has the capacity to receive four train paths of coal product per day from the proposed development, and has the capacity to store and handle the product coal that the proposed development would generate.

It is therefore considered the proposed development would not significantly alter the existing impacts that Tahmoor Mine has on port and rail capacity other than the prolongation of utilising this infrastructure.

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11.15 Social

The Social Impact Assessment (SIA) (AECOM, 2018) undertaken for the proposed development is attached as **Appendix Q**.

The social assessment addressed the SEARs relevant to social impacts. These are listed in **Table 11-84**. SEARs relevant to economic impacts are addressed in **Section 11.16**.

Table 11-84 SEARs for the assessment of social impacts

Social & Economic SEARs	Section Addressed
Social & Economic – including an assessment of the:	
• A detailed assessment of the likely social impacts of the development on the local and regional community in accordance with the *Social impact assessment guideline for State significant mining, petroleum production and extractive industry development* (2017); and; and	**Section 11.15.1** to **11.15.6** and **Appendix Q**
• an assessment of the likely economic impacts of the development, paying particular attention to: - the significance of the resource; - the costs and benefits of the development, identifying if it would result in a net benefit to NSW, including consideration of fluctuation in commodity markets and exchange rates; and - the demand for the provision of local infrastructure and services.	**Section 11.15.4**, **Section 11.16** and **Appendix R**

11.15.1 Background

The proposed development has the potential to affect various individuals and groups within the community in both positive and negative ways. The role of the SIA for the proposed development is to determine how potential adverse impacts can be addressed to minimise the effects of a proposal on the social environment and to identify how potentially beneficial impacts associated with the proposed development can be further enhanced to support the local area.

The objectives of the SIA undertaken for the proposed development were:

- to identify and assess the potential social impacts associated with the proposed development in accordance with the methodology outlined in *Social impact assessment guideline for State significant mining, petroleum production and extractive industry development* (DPE, 2017) (SIA Guideline);
- to provide an understanding of the community context within which the proposed development would be undertaken, including consideration of community perception and the recognition that the interests and values of stakeholders are diverse; and
- to develop appropriate mitigation measures to respond to the social impacts identified.

The SIA for the proposed development was completed in accordance with the SIA Guideline with consideration to the types of social impacts identified in Section 1.1 of the Guideline, as listed below:

- **way of life**, including:
  - how people live, for example, how they get around, access to adequate housing;
  - how people work, for example, access to adequate employment, working conditions and/or practices;
  - how people play, for example, access to recreation activities; and
  - how people interact with one another on a daily basis;
- **community**, including its composition, cohesion, character, how it functions and sense of place;

- **access to and use of infrastructure, services and facilities**, whether provided by local, state, or federal governments, or by for-profit or not-for-profit organisations or volunteer groups;
- **culture**, including shared beliefs, customs, values and stories, and connections to land, places, and buildings (including Aboriginal culture and connection to country);
- **health and wellbeing**, including physical and mental health;
- **surroundings**, including access to and use of ecosystem services, public safety and security, access to and use of the natural and built environment, and its aesthetic value and/or amenity;
- **personal and property rights**, including whether people's economic livelihoods are affected, and whether they experience personal disadvantage or have their civil liberties affected;
- **decision-making systems**, particularly the extent to which people can have a say in decisions that affect their lives, and have access to grievance and remedy mechanisms; and
- **fears and aspirations** related to one or a combination of the above, or about the future of their community.

11.15.2 Existing Environment

The Project Area is located on the outer south-western peri-urban fringe of Sydney primarily within the Wollondilly LGA with a small portion extending into the Wingecarribee LGA. Within the Project Area, the proposed development (including all longwall mining and surface infrastructure) would be confined to the Wollondilly LGA only. The region is characterised by a mixture of village residential, rural residential, market gardens, agricultural and conservation areas. The region is located within the Greater Sydney Basin and encompasses areas of land dedicated to conservation and the protection of drinking water catchments.

The Project Area (refer to **Figure 1.3**) is bounded by the incised gullies associated with the Bargo and Nepean Rivers. Land within the Project Area comprises forested land, rural-residential development and Crown land, Government authority or corporation owned land. Forested land is largely located in the south-eastern section of the Project Area and along the Bargo River.

Rural residential areas are generally clustered around the town centres of Bargo, Tahmoor and Buxton, and the villages of Yanderra, Pheasants Nest, Couridjah and Balmoral. These areas are separated by a semi-rural and partially forested landscape.

The Project Area is located in a region with a long history of agricultural land use which has resulted in large areas of flat and low gradient slopes in the Project Area being subject to large scale vegetation clearance for agricultural and other activities including farming practices, poultry, cattle grazing, trotting horse training, greyhound training and horse studs.

Community Identity and Profile

The population of the outer south-western region has increased over the five years between 2011 and 2016. Larger townships in the Project Area have also been subject to increased population growth. However, the, smaller villages have been experiencing a population decline. Regional and local population growth is anticipated to continue (DPE, 2016) with regional growth projected to be greater than local growth due to the development of the south-west growth centre within the Campbelltown and Liverpool LGAs. Local population growth is anticipated to reflect natural growth associated with births and deaths, as well as a net migration of people moving into the local area. The local population is ageing as a result of an increase in people aged over 65 relocating into the area's multiple new senior's living developments and outwards migration of people aged 18 to 34 as a result of limited tertiary education opportunities, for more diverse employment opportunities and to experience a 'city' lifestyle (Wollondilly Shire Council, 2011).

The local area has an above-average proportion of family households, with the number of single parent households lower than the State average. At the time of the 2016 census, the proportion of Aboriginal and Torres Strait Islander people living within the local area is higher than the State average of 3%. The number of people living in the local area that were born overseas and that speak a language other than English is significantly lower than the State average.

More than 90% of housing in the Wollondilly and Wingecarribee LGAs comprises detached houses, reflecting the primary rural-residential nature of the area, as does the lower than State average percentage of rental properties. Tahmoor has the highest proportion of rental properties (29%) which aligns with the State average. Vacancy and occupancy rates of dwellings in the local areas align with those of the remainder of the State.

The *Wollondilly Growth Management Strategy* (2011) notes that 7,500 additional dwellings are required over the next 25 years to accommodate the population growth that is projected for the local area. The Growth Management Strategy has identified a target of 4,000 dwellings across Picton, Tahmoor and Thirlmere and 2,000 in the Bargo area.

Accessibility of individuals to material and social resources, and their ability to participate in society broadly defines the socio-economic advantage or disadvantage of an area. All LGAs and suburbs in the State are provided with a socio economic indices. The lowest scoring 10% of areas are given a decile of one indicating these areas are the most disadvantaged and the highest 10% of areas are given a decile of 10, representing areas that are the least disadvantaged in the state. The Wollondilly and Wingecarribee LGAs have a decile of nine, indicating that they are not greatly disadvantaged as a whole. However, within the Project Area, Tahmoor is ranked as being relatively disadvantaged with a decile value of three, indicating that as a township Tahmoor is more disadvantaged than 70% of other suburbs in the state.

As detailed in Section 3.2.4 of **Appendix Q**, there are a number of early childhood and primary school facilities in the Project Area, whilst high schools are located at some distance from the local area. One tertiary educational facility (Illawarra TAFE Moss Vale campus) is located in the Wingecarribee LGA. A higher proportion of advanced diploma qualifications were recorded in the 2016 census in the Wollondilly and Wingecarribee LGAs compared to the rest of the State. However, the number of bachelor and post graduate degree qualifications was lower than the State average, reflecting the limited accessibility to tertiary educational facilities in the local area. This aligns with the trends in employment within the two LGAs, with the highest proportion of the labour force comprising the manufacturing, construction, retail trade, health care and social assistance sectors. The 2011 census reported that the employment rate of the two LGAs was lower than NSW as a whole.[1]

The Sydney Trains Southern Highlands Line passes through the Project Area, connecting the Project Area to the Sydney metropolitan area via Campbelltown. Weekday services generally travel through Bargo on an hourly basis, with services every one to two and a half hours on weekends. There are also two bus routes which provide public transport along Remembrance Driveway between Yanderra / Bargo and Picton on weekdays and on Saturdays.

A number of diverse sport and recreational facilities in the Project Area provide areas of open space and a sense of community and place.

The Role of Tahmoor Mine in the Community

The Tahmoor Mine has been operational for over thirty five years, during which time the mine has developed a relationship with the local community through supporting local events, making contributions to community partnerships and employing most of its staff from within the local area. In 2013, the largest proportion of personnel employed at Tahmoor Mine resided within the Wollondilly LGA (199 employees or 46%). Remaining employees travel to the Tahmoor Mine from nearby LGAs including Wollongong and Shellharbour (30%), Wingecarribee (8%), and Campbelltown (16%). The Tahmoor Mine also has an Apprentice Engagement Program which employs on average two apprentices from the local area each year.

In addition to mandatory contributions from royalties and taxes, Tahmoor Coal also contributes to community partnerships and initiatives through its Corporate Social Involvement (CSI) program. The CSI program provides for local contributions as part of the targeted Tahmoor Community Support Program and other local programs (refer to Section 3.3 of **Appendix Q** for additional detail).

[1] Data for the 2016 Census was not yet available at the time of preparation of this SIA.

Open dialogue and the dissemination of information between mine operators, management, key stakeholders and the community is facilitated by the TCCCC. Tahmoor Coal maintains a database of complaints received by the Tahmoor Mine to allow it to understand issues as they arise in the community. Tahmoor Coal actively engages with the community to resolve issues and complaints raised.

11.15.3 Methodology

SIA Guideline

The SIA Guideline applies to applications for development consent for State significant resource projects where the SEARs are issued after the date of publication of the guideline in September 2017. The SIA Guideline includes the following transitional arrangements for State significant resource projects for which SEARs have already been issued but are not expecting to lodge an EIS until six months or more following publication of the SIA guideline (i.e. after March 2018):

The Department, in consultation with the applicant, will re-issue the Secretary's Environmental Assessment Requirements (SEARs) to require the social impact assessment component of the environmental impact statement to be prepared in accordance with this guideline.

This situation applies to the Tahmoor South project for which SEARs were originally issued on 9 June 2017 prior to the publication of the SIA Guideline.

In accordance with the transitional arrangements of the SIA Guidelines, supplementary SEARs were issued for the Tahmoor South Project by DPE on 20 June 2018 as identified in **Table 11-84**.

This SIA has been prepared to meet the objectives and requirements of both the SIA Guideline and the supplementary SEARs.

Assessment Steps

The methodology for the SIA has followed the assessment steps of the SIA Guideline as outlined below. Further details of the methodology followed for the Baseline Study (Step 1) and the Identification and Evaluation of Impacts (Steps 2 and 3) are also outlined below.

- **Step 1** - Preparing a Social baseline study, which has involved:
    - identifying the area of social influence within which the proposed development may result in potential social impacts;
    - identifying the social indicators, against which social impacts will be assessed and monitored;
    - undertaking a desktop review of social indicators and other relevant data in order to create a baseline profile of the community;
    - undertaking community and stakeholder engagement to seek direct feedback on community views, concerns and social impacts; and
    - considering the overall sensitivity of different stakeholders and how they are likely to respond (based on knowledge of the community profile, their values, fears and aspirations, previous projects etc.);
- **Step 2**- Predicting and analysing the extent and nature of potential social impacts, which has involved:
    - identifying and describing project components or activities that may result in potential social impacts (against baseline conditions), both positive and negative;
    - liaising with other technical specialists to identify any potential social implications of, for example, impacts from subsidence, traffic, noise, air quality, and landscape and visual amenity; and
    - taking into consideration factors such as the spatial extent, duration, severity, and sensitivity of receptors in characterising potential social impacts;

- **Step 3** - Evaluating the significance of potential social impacts without mitigation and with mitigation (to determine residual impacts) based on likelihood and consequence ratings, as per the social risk matrix approach in the SIA Guideline. This includes consideration of potential cumulative social impacts and the timing of impacts; and
- **Steps 4 & 5** - Recommending measures for the avoidance, reduction, mitigation, management and/ or monitoring of potential social impacts and any residual impacts.

Baseline Study

Area of Social Influence

The Area of Social Influence was determined for the SIA based on the following factors:

1. the activities proposed as part of the development, comprising the surface disturbance activities and longwall mining within the Project Area. The development would utilise the existing rail loop and rail network to transport coal to Port Kembla and from time to time to Port Waratah. However, this would not involve any change to existing train movements, train loading capacity or frequencies. As there would be no change to operations or impacts along the train haulage route(s) (compared to existing), the area of social influence for the SIA does not include broader rail network haulage routes to Port Kembla or Port Waratah;
2. the likely scale and extent of impacts – the severity and spatial and temporal extent of impacts identified in other specialist assessments within this EIS has informed the area of influence of the SIA. For example economic and employment opportunities created by the proposed development are considered likely to have far-reaching effects for the south west Sydney region, and NSW more broadly. However, impacts upon amenity values are anticipated to occur largely within close proximity to the proposed development, generally limited to the Wollondilly Shire LGA;
3. cumulative impacts – the specialist studies carried out for the proposed development have included consideration and modelling (where relevant) of cumulative impacts from other mines and other known and/or proposed developments within the Southern Coalfields;
4. the natural, land use and social characteristics of the areas likely to be affected by the development, including proposed future land use and growth, based on a review of baseline and publicly available data.
5. the community and stakeholder groups most likely to be affected by the kinds of impacts predicted, based on the consultation activities carried out for the proposed development.

Based on the above, the area of social influence (referred to hereafter as the study area) for the assessment of social impacts includes a broad consideration of the statistical areas of Wollondilly, Wingecarribee, Camden, Campbelltown and Wollongong LGAs, with comparison to broader NSW provided for context.

An assessment of local level social impacts for the proposed development are provided for the localities of Tahmoor, Bargo, Yanderra, Pheasants Nest, Buxton and Couridjah within the Wollondilly Shire LGA. These localities have been chosen based on their proximity to the proposed development, the results of specialist assessments and the availability of baseline data.

Identification of Social Indicators

Social indicators were identified in terms of their potential for social change as a result of the proposed development. Social indicators were selected to be reflective of key social issues for the study area and included population demographics, health and wellbeing in the community in terms of its potential relative disadvantage, housing, educations, employment and income, availability and access to community services and community identity including the shared values and customs, as well as community cohesion.

Collection of baseline data

Statistical and other relevant data was collected and reviewed to create a baseline community profile. Baseline data collection included the following:

- database searches obtained from sources such as the Australian Bureau of Statistics (ABS) for the relevant statistical areas. Database searches are detailed in Table 2.1 of **Appendix Q**;

- a review of current Major Projects listed on the DPE website to identify major developments relevant to the proposed development in order to assess cumulative impacts on the community, particularly with regards to workforce requirements and timeframes; and
- a review of relevant government inquiries, namely the Southern Coalfields Inquiry and the Thirlmere Lakes Inquiry, as well as relevant Council and community interest submissions made as part of the inquiries to provide context for the assessment of the proposed development.

Consultation and Engagement

The results of consultation and engagement activities undertaken by Tahmoor Coal were reviewed to provide an understanding of the community perception and values about the environment, community, the operation of the existing Tahmoor Mine and the proposed development. Consultation and engagement materials that were reviewed included:

- Tahmoor Coal independent stakeholder survey 2012;
- Tahmoor community survey 2012;
- Tahmoor South Project community information days survey and feedback (2013, 2014, 2017 and 2018);
- records of complaints and enquiries received, as well as the implementation of activities guided by the CSI Plan;
- records of 15 June 2017 Tahmoor Coal Community Consultative Committee (TCCCC) meeting;
- records of meeting with Wollondilly Shire Council project update on 7 September 2017;
- records of meetings held with other specialist stakeholders and groups including: Wollondilly Anglican College, Wirrimba Flora and Fauna Sanctuary, Bargo Dingo Sanctuary, Emergency Services and the Bargo Progress Association; and
- Aboriginal heritage consultation undertaken as part of the ACHA.

Identification and Evaluation of Impacts

Negative Social Impacts

Potential negative social impacts were identified and evaluated based on the framework outlined in the SIA Guidelines as summarised in **Figure 11.35** below.

Potential negative social impacts were identified through the following means:

- impacts identified in the Tahmoor South Project SIA Scoping Report (June 2018). This report was prepared to support the seeking of supplementary SEARs for the proposal in relation to social impacts and was prepared utilising the SIA Scoping Tool component of the SIA Guideline;
- additional impacts identified in the EIS by other technical studies; and
- ongoing feedback from community engagement activities.

To determine the likely significance or ‘Social Risk Rating’ of the social impact, the ‘likelihood’ and ‘consequence’ of the identified negative social impacts were then evaluated based on the risk matrix provided in the SIA Guideline as shown in **Figure 11.36** below. Each impact was evaluated without mitigation and again with mitigation to determine any residual impacts.

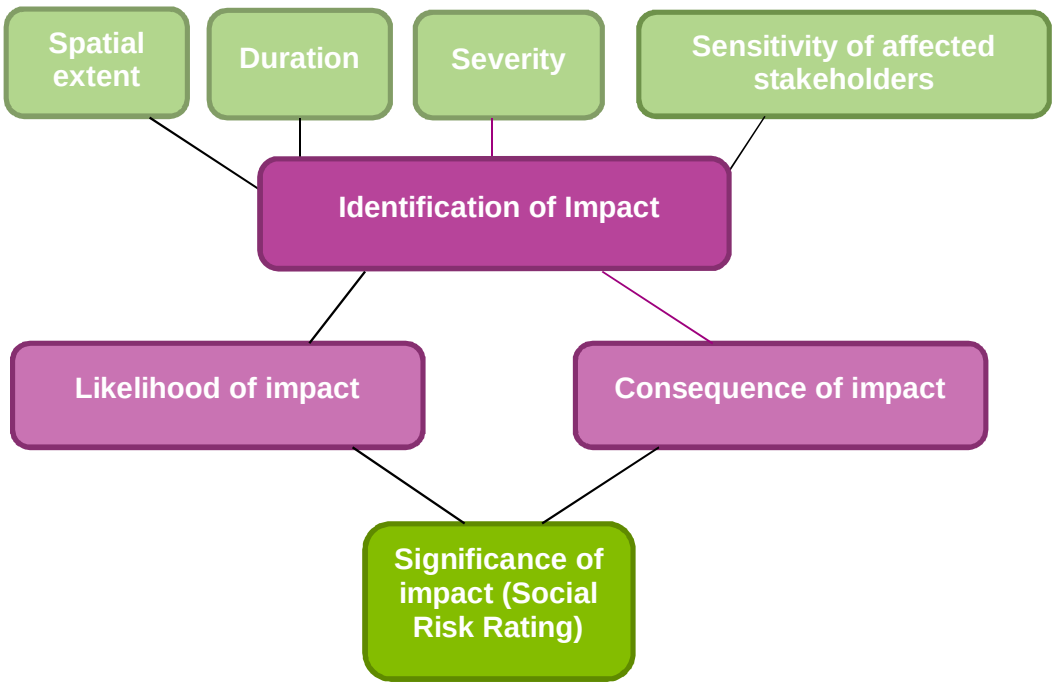

Figure 11.35 Assessment framework for determining risk rating of social impacts

			Consequence Level				
			1	2	3	4	5
			Minimal	Minor	Moderate	Major	Catastrophic
Likelihood Level	A	Almost certain	A1	A2	A3	A4	A5
	B	Likely	B1	B2	B3	B4	B5
	C	Possible	C1	C2	C3	C4	C5
	D	Unlikely	D1	D2	D3	D4	D5
	E	Rare	E1	E2	E3	E4	E5
Social Risk Rating							
	Low		Moderate		High		Extreme

Figure 11.36 Social Risk Matrix (SIA Guideline, DPE, 2017)

The evaluation criteria for "likelihood" are shown in Figure **11.36** and comprise: *almost certain, likely, possible, unlikely,* or *rare*. The evaluation criteria for "consequences" as identified in the SIA Guideline are listed below:

Minimal

- No discernible positive or negative changes caused by the impact

Minor

- small change caused by the impact;
- generally temporary or short term in duration;
- impacts confined to a small number of receivers within the proposed development locality; and
- able to be mitigated or managed such that impacts are deemed to be low.

Moderate

- moderate change caused by the impact;
- generally temporary or short to medium term in duration;
- spatial extent of impacts may vary across the affected LGAs; and
- able to be mitigated or managed such that impacts are deemed to be moderate.

Major

- large change caused by the impact;
- generally medium to long term in duration;
- spatial extent of impacts may vary across the affected LGAs, or the broader region or State; and
- negative impacts would require extensive mitigation and consultation with affected stakeholders.

Worst Case

- very large change caused by the impacts;
- likely to be long-term in duration;
- spatial extent of impacts may vary across the affected LGAs, or the broader region or State; and
- negative impacts would require extensive mitigation and consultation with affected stakeholders.

Positive Social impacts

Consistent with the guidance provided in the SIA Guideline, positive social impacts were evaluated qualitatively with consideration to the following factors:

- level of interest by stakeholders;
- the scale of improvement or benefit; and
- the importance placed on the benefit and the equity of distribution.

The social risk matrix approach identified in the SIA Guideline as discussed above was adopted to assess the significance of positive social impacts considering the likelihood of benefits and the scale of the improvement or benefit (replacing 'consequence level').

11.15.4 Impact Assessment

The assessment of potential impacts associated with the proposed development included consideration of direct and indirect impacts, with direct impacts being those that would cause change to the existing community as measured through the use of social indicators, and indirect as those impacts which relate to community values and sense of place. In addition the SIA considered cumulative social impacts resulting from the proposal.

Surroundings –Amenity Impacts and Natural Features

Table 11-85 summarises the potential impacts of the proposed development on amenity and natural features. The primary amenity impacts associated with the proposed development is the continuation of existing types of impacts associated with existing mining operations (such as noise, air quality, subsidence and visual impacts). However, over the life of Tahmoor Mine, Tahmoor Coal has developed an extensive understanding of the local environment which it operates within and this has informed the effective management of potential amenity impacts.

Table 11-85 Amenity Impacts of the Proposed Development

Aspect	Impacts
Noise	The noise assessment predicts exceedances of Noise Management Levels (NMLs) during standard and non-standard construction hours at nearby receivers and a range of reasonable and feasible mitigation measures are proposed to be implemented as part of a Noise Management Plan to minimise impacts. Mitigation would focus particularly on sensitive night time hours in order to minimise the potential for sleep disturbance. In addition, acquisition negotiations have commenced with the two receptors predicted to experience exceedances of noise levels outside of standard hours. Social amenity impacts from construction noise would be temporary and consistent with construction projects of a similar scale. With the implementation of mitigation measures, it is considered that impacts can be managed so as to not significantly impact on social amenity. The likelihood of construction noise impacts is considered to be *likely* and the consequence of impact is considered to be *moderate* resulting in a significance/ risk rating of *high*. With the implementation of mitigation the consequence of impact is likely to reduce to *minor* however the residual post-mitigation significance/ risk rating would remain *high*. The operational noise assessment undertaken for the proposal identifies that that with the implementation of reasonable and feasible mitigation measures as part of surface facility upgrades for the Tahmoor South Project, the Tahmoor Mine surface facilities would result in noise emission reductions compared to the existing scenario. Noise emissions are predicted to reduce compared to the existing operations at almost all noise-sensitive receptors during the day and evening periods and, importantly, most significantly during the night-time period at all noise-sensitive receptors. As such the proposed development would lead to significantly improved noise and social amenity outcomes compared to the existing situation. Tahmoor Coal would implement negotiated noise agreements and voluntary acquisition in accordance with the NSW Government VLAMP, for residual noise impacts above project specific noise levels. The likelihood of operational noise impacts is considered to be *possible* and the consequence of impact is considered to be *moderate* resulting in a significance/ risk rating of *high*. With the implementation of measures including real time noise monitoring and reactive management to trigger noise levels during surface facility and REA operations, it is considered that the consequence of impacts can be reduced to *minor* resulting in a residual post-mitigation significance/ risk rating of *moderate*. Further details regarding noise and vibration impacts are discussed in **Section 11.10**.

Aspect	Impacts
Air Quality and Odour	There are no predicted exceedances for most of the air quality criteria assessed as a result of the proposed development. Exceedances of the 24-hour average PM_{10} criteria would occur at up to seven sensitive receivers however are predicted to occur over a limited number of days per year and would be able to be managed with the implementation of on-site controls. No exceedance of odour criteria are predicted. Stakeholders in the Southern NSW Coalfields rate Tahmoor Coal's current efforts to improve air quality as below satisfactory (ACCSR, 2016) and increased air quality and odour impacts would be perceived negatively by the community. The likelihood of air quality and odour impacts is considered to be *unlikely* and the consequence of impacts is considered to be *minor*, resulting in a significance/ risk rating of *low*. With the implementation of mitigation measures, the consequence of impact is likely to reduce to *minimal*, resulting in residual post-mitigation significance/ risk rating of low. The residual risk rating is expected to remain substantially unchanged (at *low*) with the implementation of mitigation measures. Details of the impacts to sensitive receptors with regards to air quality and odour, as well as how they are managed are discussed in detail in **Section 11.11**.
Visual Impacts	The proposed development is considered as having negligible visual effects on the landscape character of the area, views from private dwellings, publicly accessible areas and community facilities, as existing and established tree cover, coupled with the gently undulating and low ridgeline landforms, provide screening of the REA and surface infrastructure facilities. The proposed development would introduce limited visual elements in addition to the existing infrastructure at the mine which has been included as part of the landscape for over 30 years. Based on this, the likelihood of visual amenity impacts is considered to be *unlikely* and of *minor* consequence, resulting in significance/ risk rating of *low*. With the implementation of mitigation measures, the consequence of impacts could be further reduced to *minimal* resulting in a residual post-mitigation significance/ risk rating of *low*. Visual impacts of the proposed development are discussed further in **Section 11.17**.
Traffic	Construction and operation of the proposed development would increase traffic movements within the local road network; however due to the local road network capacity, impacts are considered to be minor. An upgrade to the intersection of the mine access road with Remembrance Driveway would improve road safety in this area. The likelihood of traffic impacts is considered to be *possible* and the consequence of impact is considered to be *moderate,* resulting in significance/ risk rating of *high*. With the inclusion of standard traffic control measures, the consequence rating can be reduced to *minor*, resulting in a residual post-mitigation significance/ risk rating of *moderate*. Traffic impacts are discussed further in **Section 11.13**.

Aspect	Impacts
Land Use	Land use within the Project Area has been identified as predominately rural with some urban townships. There is no mapped BSAL in the Project Area. The nearest area of mapped BSAL is located between Douglas Park and Camden, approximately 20 km to the north-east of the Project Area. Approximately 43 hectares of potential agricultural land, comprising 37 hectares of Land and Soil Capability (LSC) Class 4 land, and 5.5 hectares of LSC Class 6 land, would be reduced to Class 7 land and therefore permanently removed from potential agricultural production as a result of the REA expansion. This land is not currently used for agricultural production and would be returned to bushland as part of the rehabilitation of the site following mine closure. Landholders were identified as having a low perception of the mine operator, particularly with regard to issues of land use. The likelihood of impacts to land use is considered to be *possible* and the consequences of impacts is considered to be *minimal*, resulting in a significance/ risk rating of *low*. The residual risk rating is considered unlikely to change with the inclusion of mitigation measures (landform rehabilitation). Impacts of the proposed development on land use in the proposed development are discussed further in **Section 11.19** and **Section 11.1**.
Subsidence and Groundwater	Subsidence and water resources were consistently identified as important issues for stakeholders across the Southern NSW Coalfields demonstrating the high sensitivity of affected stakeholders. The overall findings of the subsidence assessments undertaken by MSEC are that the levels of potential impact to all identified natural features and built infrastructure are able to be mitigated and can be controlled by the preparation and implementation of Extraction Plans, many of which have already been developed and are being successfully implemented as part of current mining activities at the Tahmoor Mine. Similarly, Tahmoor Coal would continue to implement its existing policy of 'making good' for any affected private bore users to mitigate impacts to groundwater quality or quantity from longwall mining. The likelihood of subsidence and groundwater bore impacts are considered to be *likely* with *major* consequences of impact without mitigation, resulting in a significance/ risk rating of *extreme*. Based on the outcomes of the specialist assessments, it is considered that with the implementation of project specific mitigation measures the consequence of impacts can be reduced to *moderate* resulting in a residual post-mitigation significance/ risk rating of *high.* Further discussion regarding subsidence and groundwater is provided in **Sections 11.1** and **11.3**.

Aspect	Impacts
Surface Water	A key community concern relates to the potential impacts of underground mining on natural water courses, and the perception that environmental effects on watercourses may affect the ecological value of the local area and the potential to recognise economic gains associated with tourism. During the mine planning process, a constraints analysis, risk assessment and preliminary fieldwork investigations were undertaken to identify sensitive natural surface features and to develop risk management zones for the proposed development. Following the risk assessment the proposed longwall layout was modified to reduce subsidence impacts to these natural features. Specifically mining is no longer proposed in the Eastern Domain and the commencement ends of longwalls have been shortened to minimise and avoid impacts to the Metropolitan Special Area including Cow Creek and the Upper Nepean State Conservation Area located within its bounds. The mine planning process has avoided direct undermining of sensitive environmental features including the Bargo and Nepean Rivers, Bargo River Gorge, Mermaid Pools and of several waterways including Eliza Creek, Dry Creek, Sugar Loaf Gully, Carters Creek and Cow Creek, which would remain outside of the SSA for the proposal. Similarly, the Thirlmere Lakes are located 3.5 km from the nearest longwalls and outside the SSA for the proposal. The surface water impact assessments undertaken for the proposal indicates that the proposed development is likely to result in minor localised changes, diversions and ponding to surface water. Management of these potential impacts would include further baseline monitoring, monitoring during mining and post-mining and Trigger Response Action Plans. Given the level of community value and concern raised relating to the potential impacts of the proposed development on local watercourses, the sensitivity of potentially affected stakeholders is considered to be high. The likelihood of impacts to waterways is considered to be *likely* with *major* consequences of impact without mitigation, resulting in a significance/ risk rating of *extreme*. Based on the outcomes of the specialist assessments, it is considered that with the implementation of project specific mitigation measures the consequence of impacts can be reduced to *moderate* resulting in a residual post-mitigation significance/ risk rating of *high*. Further discussion regarding surface water is provided in **Section 11.4**.

Way of Life

The proposed development is considered to have the following social impacts with respect to population and way of life.

Negative

- demographic change and housing shortages – As the proposal would continue its existing policy of employing locally the likelihood of an influx of workers for the proposed development is considered to be *unlikely* and the consequence of such an influx on housing shortages, would be *minor*, resulting in a *low* significance/ risk rating. With the implementation of existing mitigation (policy of employing locally), there would be no change to the significance/ risk rating post-mitigation; and

- cessation of employment at mine closure – without mitigation, the likelihood of job losses for up to 422 employees (existing plus new, post 2020) at the end of the mine life is considered *almost certain* which could lead to potential *major* impacts in relation to a portion of population leaving the local area to find alternate employment (and associated impacts to the local economy, business, community infrastructure and services). This would result in an *extreme* significance/ risk rating. With the implementation of mitigation in the form of a Social Involvement Policy including employment transitioning to help employees find alternate employment and appropriate mine closure planning, the likelihood of net employment losses can be reduced to *likely* and the consequence of impacts to the population can be reduced to *moderate*. As such, the residual significance/risk rating would be reduced post-mitigation to *high*.

Positive

- employment – the proposal would maintain employment for the existing 390 employees at the mine and employ an additional 50-175 people at peak employment. The likelihood of the proposed development generating and maintaining employment in the local and regional area during the mine life is considered *likely*. The beneficial consequences for the local and regional population (with respect to employment and associated benefits to the local economy, business, community infrastructure and services) is considered *moderate*, resulting in an overall *high* positive social impact rating. With the implementation of the existing policy of sourcing mine employment from the local area and region, there would be no change to the post-mitigation beneficial significance rating.

Community Identity and Cohesion

The proposed development is considered likely to result in the following social impacts with respect to community identity and cohesion.

Negative

- use of Existing Mine Facilities - the proposed development would not change Tahmoor Mine's existing character, function and role within the landscape and therefore have minimal impacts to community identity and sense of place in this regard. The likelihood of impact is considered *unlikely* and the consequence of impact *minor*, resulting in a *low* significance/ risk rating. No mitigation measures are proposed and the residual significance/ risk rating would remain unchanged.
- access - the proposed development would not create an access barrier or physical divide between communities. Any temporary disruptions to access during construction would be localised and mitigated with the implementation of standard construction measures. The likelihood of impact is considered *unlikely* and the consequence of impact *minor*, resulting in a *low* significance/ risk rating. The post mitigation significance/ risk rating is expected to remain the same.
- New Infrastructure – the introduction of new surface infrastructure have a *possible* likelihood of impacting on landscape character and certain receptor's sense of place with localised *minor* consequences in terms of amenity and disturbance impacts, resulting in a *moderate* significance/ risk rating. With appropriate facility design the consequence rating can be reduced to *minimal* resulting in a residual post mitigation significance/ risk rating of *low*;
- natural features – there is the potential for the project to affect local natural features, resulting in impacts upon the community's sense of place. This impact is considered *possible*, with the consequences without mitigation being *moderate*. As such the overall significance is considered to be *high*. With the implementation of mitigation measures including monitoring, Trigger action Response Plans and remediation of damage, the consequence of impacts can be reduced to *minor* resulting in a residual post mitigation significance/ risk rating of *moderate*; and
- employment and Demographics – *unlikely* likelihood and *minor* consequence to overall demographic composition and associated effects on social cohesion, as employment would be primarily sourced locally, thereby resulting in a *low* significance/ risk rating. With the implementation of existing policy to employ locally, the post mitigation significance/ risk rating is expected to remain the same; and

- consistency with the Wollondilly CSP – A *possible* likelihood and *moderate* consequence of effects to the local strategic community direction should mitigation measures not be integrated into all stages of the proposal consistent with the CSP objectives, resulting in a *high* significance/ risk rating. The measures proposed as part of the proposal (including local employment, implementation of a Social Involvement Policy, road upgrades to the mine entrance at Remembrance Driveway to improve road safety and mine planning with consideration to risk management zones) are consistent with the CSP objectives of: looking after the community and building a strong local economy, managing the road network and improving road safety and caring for the environment. With the implementation of the proposed mitigation, the consequence of impacts to the local strategic direction would reduce to *minor* resulting in a residual post mitigation significance/ risk rating of *moderate*.

Positive

- community Contributions– the ongoing operation of the mine would include the continuation of Tahmoor Coal's provision of ongoing community contributions and support for the local community as part of its Social Involvement Plan. The likelihood of this occurring would be *almost certain*, with a *moderate* beneficial consequence, resulting in an *extreme* beneficial significance rating. With the implementation of ongoing community contributions there would be no change to the post-mitigation beneficial significance rating.

Access to, and use of, infrastructure, services and facilities

The proposed development is considered to have the following social impacts on access to, and use of, infrastructure, services and facilities.

Negative

- subsidence impacts – the likelihood of subsidence impacts on infrastructure is considered to be *likely* with *moderate* consequences on disruption to services and infrastructure, resulting in a significance/ risk rating of *high* (without mitigation). With the implementation of subsidence management and remediation measures the consequence rating can be reduced to *minor*, however the residual post mitigation significance/ risk rating would remain at *high*;
- construction damage – a *possible* likelihood of damage and disruption to services/ infrastructure during construction activities with *minor* consequences as any damage would likely be localised and easily rectified resulting in a significance/ risk rating of *moderate*. With the implementation of standard construction practice and mitigation such as due diligence dial-before-you-dig searches and remediation in the case of damage, it is expected that the consequence of impact can be reduced to *minimal*. Therefore, the residual post-mitigation significance/ risk rating would be *low*;
- resources – the likelihood of requiring additional potable water supplies and construction material is considered to be *likely*, with *minimal* consequences on existing services and resource availability as these resources are considered to be readily available, resulting in a significance/ risk rating of *low*. Given the low significance of impact specific mitigation measures are not proposed and there would be no change to the residual risk rating; and
- Workforce – *unlikely* likelihood of influx of construction workforce (as employment to be sourced locally) with *minor* consequences on community facilities and services, resulting in a significance/ risk rating of *low*. With the implementation of existing policy to employ locally, the post mitigation significance/ risk rating is expected to remain the same. Currently 45% of permanent employees at Tahmoor Mine are local. Assuming a similar percentage for the Project, there would be 14-15 additional local and 16-17 additional other permanent full time equivalent workers after the transition period. It is assumed that other employees would live in the region and be able to commute to work (i.e. from the Wollongong to Sydney area). Therefore, no additional infrastructure or serviced demand is anticipated for the additional workers.

Positive

- royalties – an *almost certain* likelihood of royalties from the proposed development being available to Government with *moderate* beneficial consequences for the funding of community infrastructure and facilities resulting in an overall significance rating of *extreme benefits*. With the implementation of royalty arrangements as per government requirements there would be no change to the post-mitigation beneficial significance rating.

Culture

The ACHA (Niche, 2018) carried out for the proposed development identified that subsidence related impacts (indirect impacts) have the potential to affect 26 of the 40 Aboriginal cultural heritage sites identified within the SSA. In addition, one of the 40 heritage sites are predicted to be directly impacted by surface disturbance for surface infrastructure works. Detailed consultation with Aboriginal heritage stakeholders were conducted as part of the ACHA preparation and the cultural importance of all of the recorded sites were emphasised by the Aboriginal stakeholders. Importantly, the mine plan has been designed to avoid direct undermining of archaeological heritage sites along Dog Trap Creek, which include sand shelter sites with artwork of high significance, to avoid potential impacts and preserve the heritage values for future generations. Detailed mitigation measures have been proposed to manage, monitor and mitigate subsidence impacts to Aboriginal heritage sites.

Based on the above, the likelihood of negative impacts to Aboriginal cultural heritage have been rated as *possible* with *moderate* consequences resulting in a significance/ risk rating of *high*. With the implementation of project specific mitigation measures, the consequence of impacts can be reduced to *minor* resulting in a residual post-mitigation significance/ risk rating of *moderate*.

The Historic Heritage Assessment (Niche, 2018) carried out for the proposed development identified that potential impacts on heritage items are primarily limited to subsidence associated impacts. A total of 23 historical heritage items were identified during the assessment, with 19 located directly above the proposed longwall mining area. Impacts to historic heritage items may result in changes to the way in which the community interacts with and values heritage items and the extent to which heritage is available for future generations. The assessment concluded that there was nil to low likelihood of significant impacts to any of the built structures of heritage value identified in the project area, as such it is considered that the proposed development would have minimal impacts to historic cultural values.

Negative impacts to historical cultural heritage have been rated as *unlikely* with *moderate* consequences resulting in a significance/ risk rating of *moderate*. With the implementation heritage management and monitoring measures in relation to subsidence impacts and ongoing consultation with affected stakeholders it is considered that the consequence level can be reduced *minor* resulting in a residual post-mitigation significance/ risk rating of *low*.

Health and Wellbeing

Longwall mining related subsidence impacts to private properties and structures (including farm infrastructure such as farm dams and fences) have the potential to increase anxiety and stress in the community, including in relation to the timing, duration and process for accessing any reparations for subsidence. Tahmoor Coal has extensive experience to-date in successfully managing subsidence related impacts from the Tahmoor Mine, including in investigating and closing out subsidence claims sensitively and expeditiously in accordance with Subsidence Advisory NSW's (SA NSW) requirements. Tahmoor Coal would apply the same process for the proposed development in consultation with affected receivers with the aim of minimising stress and anxiety associated with the process as far as possible.

There is the potential for environmental emissions associated with the proposed development including air quality (particulates and odour), noise, surface water discharge and groundwater intrusion (affecting bore water quality) to raise concerns and anxiety within the community regarding health impacts (actual or perceived). Such stress and anxiety could occur at any stage of the proposed development from the development assessment stage, to construction, mine operation and closure and post-closure stages (in regards to residual impacts of the development).

Specialist technical assessments have been completed for all key impacts associated with the proposed development against current NSW assessment standards and requirements to ensure that the environmental impacts of the proposal can be managed within acceptable limits so as not to pose unacceptable risks or impacts to surrounding receivers. In addition a range of mitigation and management measures have been proposed as part of the technical assessments to manage the environmental impacts of the proposal.

Based on the above negative social impacts in relation to health and wellbeing are considered *possible* but likely to be of *minor* consequence (as impacts are likely to localised to specific receivers with concerns), resulting in a significance/ risk rating of *moderate*. It is considered that with the implementation of mitigation measures the likelihood of increased anxiety and health impacts (perceived and actual) can be reduced to *unlikely*, resulting in a residual post-mitigation significance/ risk rating of *low*.

Personal and property rights

Access to private property for the purposes of construction activities would be subject to landholder access agreements to identify access arrangements and management measures to avoid impacts to private property during project related activities. Any impacts to private bore users (groundwater quality or quality) would be subject to make good provisions by Tahmoor Coal. Similarly subsidence related property claims would be subject to reparation in accordance with SA NSW's requirements. Environmental impacts of the mine would be managed in accordance with regulatory requirements to ensure acceptable limits are met at nearest receptors. Impacts to personal and property rights are considered to be *possible* but *minimal* in consequence, resulting in a significance/ risk rating of *low*. With the implementation of mitigation measures the likelihood of impacts on personal and property rights would reduce to *unlikely*, resulting in a residual post-mitigation significance/ risk rating of *low*.

Decision making systems

Environmental regulation at the mine would be governed by its development consent and associated environmental management framework which would include complaint handling mechanisms to address and remedy issues raised by the community. Subsidence related property claims would be handled in accordance with the SA NSW's requirements and would be overseen by that agency in the case of dispute or advice. Tahmoor Coal would continue to engage with the community and affected stakeholders through its mine community consultative committee and other mechanisms to ensure affected receptors are aware of their rights under the development consent and are aware of and have the opportunity to provide feedback on the mine's activities and environmental management. Impacts to individual's decision making abilities are considered to be *possible* but *minimal* in consequence, resulting in a significance/ risk rating of *low*. With the implementation of mitigation measures the likelihood of impacts on individual's decision making abilities would reduce to *unlikely*, resulting in a residual post-mitigation significance/ risk rating of *low*.

Fears and Aspirations

Opposition to coal mining projects in general (on the basis of greenhouse gas and climate change impacts), and concern regarding the cumulative impacts of mining in the Southern Coalfields on landscape features such as Thirlmere Lakes are concerns raised by the broader public and regional receivers in submissions on similar development projects. The Tahmoor South Project has been developed with specific consideration to the recommendations of the Southern Coalfield Inquiry, and based on the precautionary and robust assessment approach of developing RMZs in the first instance to avoid and minimise impacts to significant natural features. In addition, the assessment of the proposed development has been based on significant technical studies (including the assessment of greenhouse gas emissions) and significant consultation between specialist to ensure interconnections between impacts are identified and appropriate mitigation measures developed.

Tahmoor Coal will continue to engage with community members through the mine community consultative committee and other mechanisms (including the mine website) to ensure accurate and up-to-date information on the project's impacts assessment, environmental management and monitoring results are made available for public viewing and feedback.

Impacts of the proposed development on individual's fears and aspiration are considered to be *possible* but *minimal* in consequence, resulting in a significance/ risk rating of *low*. With the implementation of mitigation measures it is considered that the risk rating would remain similar.

Cumulative Impacts

The proposed development is considered to have the following cumulative social impacts.

- workforce - The likelihood of cumulative projects generating additional employment and economic opportunity is considered to be *possible* with a likely *minor* beneficial consequence (given its temporary and localised nature), resulting in a moderate significance rating. As this would comprise a community benefit no mitigation measures are proposed and the residual significance rating would remain unchanged.
- other mining development (amenity) - Given the distance separation, the likelihood of surface amenity and traffic impacts from other mining operations in the area is considered to be *unlikely* and the consequence of impact *minor*, resulting in a significance/ risk rating of *low*. Mitigation measures implemented at the mine to manage project specific surface amenity impacts would reduce contributions to cumulative impacts, however given the distance between nearest mining operations, the risk rating is likely to remain unchanged.
- other mining development (environmental) - The likelihood of contributing to cumulative environmental impacts to receivers and the natural landscape (groundwater, surface water and subsidence) is considered *likely* and the consequences of impacts to be *moderate*, resulting in a significance/ risk rating of *high*. With the implementation of project specific mitigation measures contributions to cumulative impacts would be reduced and is likely to reduce the consequence of impact to *minor*. However, the residual post mitigation significance/ risk rating would remain *high*.

Residual Impacts

The significance of social impacts without and with mitigation (residual impacts) are summarised in **Table 11-86** below.

The assessment of social risk indicates that with the implementation of mitigation measures the likelihood and/ or consequences of impact can be reduced. Whilst a number of issues retain a residual social risk rating of 'high' under the risk matrix (subsidence, groundwater and surface water including cumulative impacts) this reflects the key nature of these issues for longwall mining projects in general and within the Southern Coalfields in particular. In recognition of the key nature of these issues, the impacts have been subject to significant technical assessment including specific consideration of the recommendations of the Southern Coalfield Inquiry, and significant consultation between specialist to ensure interconnections between impacts are identified and appropriate mitigation measures developed. Refer **Sections 11.1**, **11.3**, **11.4** and **11.5**. Construction noise has also retained a high residual risk rating, however this impact would be temporary and is consistent with impacts associated with other major construction works. Management and mitigation measures would be implemented to ensure impacts do not significantly impacts on receiver amenity during the construction period (refer **Section 11.10**)

Potential impacts to population from the loss of employment at the end of mining also retained a high residual risk rating. However the matrix indicates an expected reduction in impacts (compared to risks without mitigation) with the implementation of appropriate mitigation and contingency measures. The assessment shows that with the implementation of mitigation and management measures in the form of a Social Involvement Policy including employment transitioning to help employees find alternate employment and appropriate mine closure planning, the likelihood and consequence of impacts to the population can be reduced.

With the implementation of the proposed management, mitigation and monitoring regime, it is considered that residual social impacts of the proposed development are unlikely to be significant and would be outweighed by the social benefits of the proposed development.

The SIA has identified significant benefits of the proposal including:

- employment – the proposal would prolong the life of Tahmoor Mine, which in turn would enable the direct employment of the existing 390 employees and an additional 50 to 175 employees at peak employment. The retention of employment would enable the existing workforce (and their families) to continue to support the local economy and social and community services/ infrastructure in the area. With the development of other mining development in the area there is also the potential for cumulative beneficial employment generation.

- royalties - the economic assessment and cost-benefit analysis carried out for the proposed development (Refer **Section 11.16** and **Appendix R**) indicates net economic benefits accruing from the proposal including:
  - royalties estimated around $149.1 million to the NSW Government;
  - increase in gross regional income in the Wollondilly Region by between $3,288 million and $3,561 million (in NPV terms), depending on labour market responsiveness; and
  - increase in NSW's gross state product by between $4,692 million and $5,055 million (in NPV terms) depending on labour market responsiveness.

  The economic benefits from the proposed development represent additional public funds available to State and (indirectly) to local governments to spend on community infrastructure and facilities.

- community Contributions – the Tahmoor South Project would facilitate Tahmoor Coal's ongoing role in supporting the local community, through ongoing contributions to community partnerships and initiatives through Tahmoor Coal's Corporate Social Involvement (CSI) program, for a further 13 years.

Based on the identified impacts of the proposed development and the experience of managing such impacts over 30 years of mining in the Southern Coalfields it is considered that the proposed development would not result in significant adverse social outcomes, provided that the recommended mitigation, management and monitoring measures outlined in **Section 12.0** of the EIS are implemented. With the implementation of the identified measures, the social benefits of the proposed development are considered to outweigh the predicted residual impacts.

Table 11-86 Summary of Assessment of Significance

Impact Category		Likelihood	Consequence (Negative) or Scale of Benefit (Positive)	Rating (Before mitigation)	Likelihood	Consequence (Negative) or Scale of Benefit (Positive)	Rating (After mitigation)
Surroundings - Natural features and Amenity	Surface Water	B	4	B4 (Extreme Impact)	B	3	**B3 (High Impact)**
	Subsidence	B	4	B4 (Extreme Impact)	B	3	**B3 (High Impact)**
	Groundwater	B	4	B4 (Extreme Impact)	B	3	**B3 (High Impact)**
	Acoustic - operation	C	3	C3 (High Impact)	C	2	C2 (Moderate Impact)
	Acoustic - construction	B	3	B3 (High Impact)	B	2	**B2 (High Impact)**
	Particulate matter	D	2	D2 (Low Impact)	D	1	D1 (Low Impact)
	Odour	D	2	D2 (Low Impact)	D	1	D1 (Low Impact)
	Visual	D	2	D2 (Low Impact)	D	1	D1 (Low Impact)
	Traffic	C	3	C3 (High Impact)	C	2	C2 (Moderate Impact)
	Land use	C	1	C1 (Low Impact)	C	1	C1 (Low Impact)
Population and way of life	Housing	D	2	D2 (Low Impact)	D	2	D2 (Low Impact)
	Mine Closure	A	4	A4 (Extreme Impact)	B	3	**B3 (High Impact)**
	Employment	B	3	B3 (High Benefit)	B	3	B3 (High Benefit)

Impact Category		Likelihood	Consequence (Negative) or Scale of Benefit (Positive)	Rating (Before mitigation)	Likelihood	Consequence (Negative) or Scale of Benefit (Positive)	Rating (After mitigation)
Community (composition, cohesion, character, function, sense of place)	Use of Existing Mine facilities	D	2	D2 (Low Impact)	D	2	D2 (Low Impact)
	Barrier/ Access	D	2	D2 (Low Impact)	D	2	D2 (Low Impact)
	New Facilities	C	2	C2 (Moderate)	C	1	C1 (Low Impact)
	Natural features	C	3	C3 (High Impact)	C	2	C2 (Moderate Impact)
	Employment and Demographics	D	2	D2 (Low Impact)	D	2	D2 (Low Impact)
	Wollondilly CSP	C	3	C3 (High Impact)	C	2	C2 (Moderate Impact)
	Community contributions	A	3	A3 (Extreme Benefit)	A	3	A3 (Extreme Benefit)
Access to and use of infrastructure, services and facilities	Subsidence Impacts	B	3	B3 (High Impact)	B	2	**B2 (High Impact)**
	Construction impacts	C	2	C2 (Moderate Impact)	C	1	C1 (Low Impact)
	Natural resource use	B	1	B1 (Moderate Impact)	B	1	B1 (Moderate Impact)
	Workforce	D	2	D2 (Low Impact)	D	2	D2 (Low Impact)
	Royalties	A	3	A3 (Extreme Benefit)	A	3	A3 (Extreme Benefit)
Culture	Aboriginal cultural	C	3	C3 (High Impact)	C	2	C2 (Moderate Impact)
	Historic Heritage	D	3	D3 (Moderate Impact)	D	2	D2 (Low Impact)

Impact Category		Likelihood	Consequence (Negative) or Scale of Benefit (Positive)	Rating (Before mitigation)	Likelihood	Consequence (Negative) or Scale of Benefit (Positive)	Rating (After mitigation)
Health and Well being	Subsidence	C	2	C2 (Moderate Impact)	D	2	D2 (Low Impact)
	Other environmental impacts	C	2	C2 (Moderate Impact)	D	2	D2 (Low Impact)
Other	Fears and Aspirations	C	1	C1 (Low Impact)	C	1	C1 (Low Impact)
	Personal and property rights	C	1	C1 (Low Impact)	D	1	D1 (Low Impact)
	Decision-Making Systems	C	1	C1 (Low Impact)	D	1	D1 (Low Impact)
Cumulative Impacts	Workforce	C	2	C2 (Moderate Benefit)	C	2	C2 (Moderate Benefit)
	Other mining operations	D	2	D2 (Low Impact)	D	2	D2 (Low Impact)
	Environmental impacts	B	3	B3 (High Impact)	B	2	**(B2 (High Impact)**

11.15.5 Management and Mitigation Measures

The proposed development is anticipated to generate impacts to social amenity and surroundings including subsidence and groundwater, surface water, noise, air quality and odour, traffic, visual impacts, and land use. Tahmoor Coal has a 40 year history of working with the local community and managing social amenity impacts generated by its mining operations. Amenity impacts would be minimised in accordance with the recommended management and mitigation measures outlined in **Sections 11.1**-**11.23**.

Community engagement activities undertaken by Tahmoor Coal would be reviewed regularly to ensure that the information and mechanisms for providing information to key community and government stakeholders are appropriate. The Tahmoor Colliery Community Consultative Committee (TCCCC) would continue to facilitate open dialogue and dissemination of information between mine operators, management, key stakeholders and the community. Complaints received by Tahmoor Mine from the local community would be addressed as quickly as possible.

Tahmoor Coal would implement measures to monitor potential social impacts on the community for the duration of the project. An annual community survey would be conducted and Tahmoor Coal would continue to hold bi-annual open days which would allow feedback from the community. In addition to managing impacts associated with the proposed development, Tahmoor Coal would continue to provide ongoing community support measures, identified through consultation with the local community. The existing Social Investment Plan would be updated to allow for the continuation of mining proposed as part of the Tahmoor South Project, and would provide a framework for ongoing contributions to community partnerships and initiatives through Tahmoor Coal's Corporate Social Involvement (CSI) program. As outlined in **Table 9.1**, discussions with the Wollondilly Shire Council regarding a Voluntary Planning Agreement have commenced. Tahmoor Coal commit to continuing these discussions with the Wollondilly Shire Council, with the Voluntary Planning Agreement to be resolved before determination.

To ensure appropriate planning for eventual mine closure, Tahmoor Coal would implement its Social Involvement Policy, which requires a social impact assessment to be conducted as a component of mine closure planning, no later than five years prior to the end of the mine life. This planning would involve consultation with local and regional stakeholders to explore the employment generating potential of future land uses of the Surface Facilities Area and employment transitioning to help employees find alternate employment.

11.15.6 Conclusion

Social impacts of the proposed development have been assessed with consideration of the local and regional context of the Project Area. The proposed development is likely to continue to generate social impacts in line with those already experienced by the community, rather than to generate new impacts or significantly exacerbate social impacts within the local area and region.

The social impacts of the proposed development have been minimised as much as possible by utilising the existing surface infrastructure facilities where reasonable and feasible and through appropriate mine planning to avoid and minimise impacts to sensitive environmental, built and cultural heritage features.

Social impacts would be minimised and mitigated through the implementation of measures that have been informed by over 30 years of mining in the Southern coalfields and significant experience gained in successfully managing impacts in consultation with the community. Ongoing community consultation and engagement procedures would be implemented to keep the community informed of mine activities, respond to complaints and concerns and seek feedback. In addition, Tahmoor Coal would implement a Social Involvement Policy to provide for mine closure planning and transitioning of employment to minimise the future impacts of mine closure.

The proposed development would allow for the continued use of existing infrastructure, providing benefits by way of continuation of employment for the existing, established workforce for a further 13 years. This would provide ongoing employment for the existing 390 employees as well as generate an additional 50 to 175 jobs at peak employment. The proposed development would generate significant economic benefits, including royalties and net income to the Wollondilly region and State, and would allow for community contributions for a further 13 years.

11.16 Economic

An Economic Impact Assessment was prepared by Cadence Economics (2018) for the proposed development and is contained in **Appendix R**.

The Economic Impact Assessment addressed the SEARs relevant to economic impacts. These are listed in **Table 11.87**.

Table 11-87 Secretary's Environmental Assessment Requirements

Social & Economic SEARs
Social & Economic – including an assessment of the -likely economic impacts of the development, paying particular attention to:
• the significance of the resource;
• the costs and benefits of the development, identifying if it would result in a net benefit to NSW, including consideration of fluctuation in commodity markets and exchange rates; and
• the demand for the provision of local infrastructure and services.

11.16.1 Background

The Project Area is primarily situated within the Wollondilly LGA. Data obtained from the 2016 census (ABS, 2017) for the LGA provides a background of the social and economic conditions within the locality, and is further detailed in **Appendix R**. The economic assessment for the proposed development (**Appendix R**) presents a detailed assessment of the incremental costs and benefits of the proposed development, relative to a baseline, 'business as usual' case (with the existing Tahmoor Mine scheduled for completion in around 2022) (base case), an analysis of whether the proposed development would result in a net benefit for the NSW community, as well as a local effects analysis of economic benefits to the Wollondilly region.

The analysis has drawn on information provided by Tahmoor Coal, and the findings of this EIS and associated technical studies for the proposed development.

11.16.2 Methodology

The economic assessment for the proposed development included the following:

- A review of existing operational activity, costs and revenue for the Tahmoor Mine, as well as a review of other relevant economic information for the locality and region (refer **Appendix R**);
- A Cost-Benefit Analysis (CBA) of the proposed development. The analysis included an assessment of direct benefits, indirect benefits and indirect costs to NSW. A sensitivity analysis of the CBA was also undertaken to provide a range of possible outcomes given varying pricing scenarios (e.g. fluctuating coal price);
- A Local Effects Analysis (LEA) of the proposed development including assessment of the net economic impacts to the local community and a sensitivity analysis of the LEA; and
- A Computable General Equilibrium (CGE) modelling framework, which modelled the economic impacts of the proposed development flowing through the wider economy over the proposed development life cycle (from mine development to completion of coal extraction). Modelling was undertaking using a CGE model of the Wollondilly region ((Australian Bureau of Statistics Statistical Area 3 (SA3) - Wollondilly) and the NSW (including Wollondilly region) economies.

The economic assessment for the proposed development was prepared having consideration of the NSW Government (2015) *Guidelines for the economic assessment of mining and coal seam gas proposals* (the Guidelines).

11.16.3 Cost Benefit Analysis

For the purposes of the CBA and in accordance with the Guidelines, a baseline case and a proposed development - central case have been defined as follows to measure the net benefits to the NSW community.

Baseline case

The baseline scenario considered all costs and benefits if the proposed development does not proceed. Tahmoor currently has approval to mine resources in the Northern Domain, and therefore the economic benefits and costs associated with extraction of coal within the existing operation were excluded from the assessment.

Project case (proposed development)

The proposed development is seeking to extend mining activity at Tahmoor Mine beyond 2022 to 2035. The proposed development is detailed in **Section 4.0**, and forms the 'Project case' for the economic assessment.

The economic, environmental and social costs and benefits considered in the analysis are shown in **Appendix R** including the value assigned for each of those costs and benefits. Hard coking coal (HCC) and thermal coal price forecasts were developed by Cadence Economics, drawing on the latest coal price forecasts. In contrast, a monetary value could not always be applied to non-priced externalities including some environmental considerations. Further details on how these costs and values were derived are provided in **Appendix R**.

The findings of the CBA identified that the total net benefit of the proposed development is estimated at $699.5 million in NPV terms. This includes both direct and indirect benefits as explained further below.

Direct benefits

Based on the Guidelines, the direct benefits to NSW of the proposed development are derived from three sources:

- The net producer surplus generated by the proposed development that is attributable to NSW;
- The share of company tax payments that are attributable to NSW; and
- Other tax payments such as royalties and payroll tax that are paid to the NSW and local government.

In this case, the net producer surplus that is attributable to NSW is assumed to be zero. This is because Tahmoor Coal Pty Ltd is 100 per cent owned by SIMEC Mining, part of the Gupta Family Group Alliance (GFG Alliance) which is a private foreign-owned company based in London.

Consistent with the Guidelines, company tax is attributable to NSW based on the State's share of population which is 32 per cent.

Under the proposed development, various payments would be made to NSW Government and the Wollondilly Shire Council to extract and process coal in the State. These are made up of three types of payments: coal mining royalties and payroll tax paid to the NSW Government and council rates paid to the Wollondilly Shire Council.

The Tahmoor South Project is expected to generate an operating surplus of $916.7 million in Net Present Value (NPV) terms; of this $307.1 million in NPV terms is payable in the form of corporate taxes, leaving a net producer surplus of $609.6 million in NPV terms.

It is estimated the proposed development would generate $1,023.8 million in taxable profit in NPV terms over its operational life (this is an estimate of the accounting profit from which company taxes are calculated). At a company tax rate of 30 percent, the company tax estimate is $307.1 million in NPV terms, of which $98.3 million is attributable to NSW.

Over the life of the proposed development, a total of $177.7 million in payments would be made, in NPV terms. This is made up of $149.1 million of royalty payments and $21.7 million in payroll tax. A further $7.0 million would be paid in the form of council rates.

Indirect benefits

Based on the Guidelines, the indirect benefits to NSW of the proposed development are derived from three sources:

- The net economic benefit to workers in NSW;
- The net economic benefit to suppliers in NSW; and
- Any land owner premiums attributable to the proposed development.

Consistent with the Guidelines, a key factor in determining the benefits to workers are defined as the:

- Wages earnt in the mine;
- Minus the opportunity cost of labour for working in the mining sector, that is compared to working in non-mining sectors (or being unemployed); and
- Minus the wage difference due to skills and the disutility to work in the mining industry.

To determine the opportunity cost compared to the non-mining sector, Cadence Economics (2018) compared the average wage for mining employment to the average wage paid in NSW. This implies that should the proposed development not go ahead, those who would have been employed at Tahmoor find alternative work at the average wage paid in NSW.

In terms of supplier benefits, the producer surplus estimates were based on Type I multipliers by Cadence Economics which limit the benefit to direct value added generated by NSW suppliers. This methodology does not account for second round, nor induced consumption, effects that are captured within the CGE modelling. Using this relatively conservative technique, the total supplier benefits are estimated to be $211.4 million in NPV terms.

Indirect costs to NSW

Consistent with the Guidelines, a project's indirect costs are classified as the net public infrastructure costs, the estimated loss of surplus to other industries and the net environmental, social and transport-related costs. The proposed development's indirect costs include some costs that have been internalised by Tahmoor Coal including the biodiversity and subsidence impacts and costs that have been assessed qualitatively, such as visual amenity. In total indirect costs are estimated to be $42.3 million in NPV terms over the life of the proposed development, which includes $0.1 million of incremental costs that are not internalised by Tahmoor Coal (i.e. GHG, air quality and noise related impacts).

A summary of the net benefits of the proposed development is presented in **Table 11.88**.

A sensitivity analysis was undertaken and considered all key areas of the CBA, particularly coal prices, key costs (both capital expenditure and operating costs) and worker benefits. Where there were considered to be higher levels of uncertainty with the figures, a range of plus/minus 25 per cent was used. In areas where the figures were deemed more certain, a range of plus/minus 10 per cent was used. Variation of the CBA inputs was undertaken for the following scenarios:

- Revenue sensitivity:
  - Higher price assumptions, where coal prices are increased by 25 per cent over the central case assumptions for the life of the proposed development; and
  - Lower price assumptions, where coal prices are decreased under the central case assumptions by 25 per cent.
- Cost-base sensitivity:
  - Higher operational expenditure (increased by 10 per cent over the central case);
  - Lower operational expenditure (decreased by 10 per cent under the central case);
  - Higher capital expenditure (increased by 10 per cent over the central case); and
  - Lower capital expenditure (decreased by 10 per cent under the central case).
- Worker and supplier assumptions:

- Increased disutility of mining wage premium by 25 per cent on central case assumptions; and
- Reduced supplier benefits of 10 per cent from central case assumptions.

- Higher environmental costs (increased by 10 per cent); and
- Discount rate sensitivity, using a 4% and a 10% real discount rate.

In addition, upper and lower bound estimates were undertaken which assume:

- 'Worst-case' scenario: the coal price is reduced by 25 per cent, operational and capital expenditure are increased by 10 per cent, the disutility of the mining wage premium is set to 25 per cent and supplier benefits are lowered by 10 per cent compared with central case assumptions; and
- 'Best case' scenario: the coal price is increased by 25 per cent, operational and capital expenditure are decreased by 10 per cent, the disutility of the mining wage premium is set to zero and supplier benefits are increased by 10 per cent compared with central case assumptions.

The results are detailed in **Appendix R** and show that the estimated net benefits are robust in the sense that they remain strongly positive after testing all key assumptions underpinning the analysis. The lower bound, or worst-case, estimate of net benefits, which takes the most pessimistic assumptions around coal prices, capital expenditure, operational expenditure as well as worker, environmental impacts and supplier benefits, yields an estimated net benefit of $497.7 million in NPV terms. The upper bound, or best-case, estimate, based on the most optimistic assumptions, is $859.1 million in NPV terms.

Table 11-88 Central case – estimated net benefits of the proposed development ($ Million[1])

Benefits	NPV[2]	Costs	NPV[2]
Direct Benefits		***Direct Costs***	
1. Net producer surplus attributed to NSW	-		
2. Royalties, payroll tax and Council rates	177.7		
3. Company income tax apportioned to NSW	98.3		
Total direct benefits	**276.0**	**Total direct costs**	**-**
Indirect Benefits		***Indirect Costs***	
1. Net economic benefit to landholders	0.0	1. Air quality	-
2. Net economic benefit to NSW workers	212.2	2. Greenhouse gas emissions	0.1
3. Net economic benefit to NSW suppliers	211.4	3. Visual amenity	-
		4. Transport impact	-
		5. Net public infrastructure cost	-
		6. Surface water impact	-
		8. Residual value of land	-
		7. Biodiversity impact[3]	19.6
		8. Noise impact	10.7
		9. Loss of surplus to other industries	-
		10. Water	-
		11. Aboriginal cultural and Historical heritage	-
		12 Subsidence[3]	11.8

Benefits	NPV[2]	Costs	NPV[2]
Total indirect benefits	**423.6**	**Indirect Costs**	**42.3**
Total Project economic benefit	**699.6**	**Incremental Indirect Cost**	**0.1**
NPV of project - ($m)	**699.5**		

Source: Cadence Economics estimated based on information from various sources.
[1] Real 2017 Australian dollars
[2] NPV in 2017 Australian dollars based on a 7 per cent real discount rate
[3] Incorporated into operating costs

11.16.4 Local Effects analysis

In accordance with the Guidelines, the local effects analysis (LEA) uses a similar framework to the CBA but assesses the net economic impacts to the local community. The Guidelines refer to the local area as being consistent with the relevant Statistical Area (SA3) as defined by the Australia Bureau of Statistics. In the case of this project the Wollondilly SA3 area is used for the LEA.

The LEA accounts for the economic benefits to the Wollondilly SA3 area only. It does not include any economic benefits that may accrue to adjacent major regional centres such as the Illawarra region and Sydney.

The LEA was developed based on the following assumptions:

- no net producer surplus accrues to the region;
- no company income tax accrues to the Wollondilly SA3 region;
- 45 per cent of the workforce requirement of the proposed development and 12.9 per cent of intermediate inputs would be supplied from the SA3 region; and
- the incremental indirect costs associated with the proposed development is $674.9 million, global greenhouse gas costs apportioned to the local area.

The LEA found that the proposed development would generate indirect benefits to local suppliers of $29.5 million through increased demand for the provision of local infrastructure and services, and $95.5 million in NPV terms to local employees over the baseline case, as outlined in **Table 11.89.**

Based on these assumptions, the proposed development is estimated to confer a net benefit on the Wollondilly SA3 region of $132.0 million in NPV terms.

A sensitivity analysis was undertaken for the LEA, testing the same assumptions outlined in the CBA. The results are detailed in **Appendix R** and identify that the benefits of the proposed development exceed the costs in all scenarios, indicating that the estimated net benefits are robust. The main drivers for the regional impact are the supplier and employee benefits. Those sensitivities that change the supplier benefits through lower operational costs, lower supplier benefit or employee benefit have the greatest impact on the regional net benefit.

The lower bound, or worst-case, estimate of net benefits, which takes the most pessimistic assumptions around coal prices, capital expenditure, operational expenditure as well as worker and supplier benefits, yields an estimated net benefit of $103.4 million in NPV terms. The upper bound, or best-case, estimate, based on the most optimistic assumptions, is $139.5 million in NPV terms.

Table 11-89 Estimated Local Effects Analysis of the proposed development ($ million[1])

Benefits	NPV[2]	Costs	NPV[2]
Direct Benefits		***Direct Costs***	
1. Net producer surplus attributed to NSW	0.0		
2. Royalties, payroll tax and Council rates	7.0		
3. Company tax	0.0		
Total direct benefits	**7.0**	**Total direct costs**	**-**

Benefits	NPV[2]	Costs	NPV[2]
Indirect Benefits		***Indirect Costs***	
1. Net economic benefit to landholders	0.0	1. Air quality	-
2. Net economic benefit to NSW workers	95.5	2. Greenhouse gas emissions	-
3. Net economic benefit to NSW suppliers	29.5	3. Visual amenity	-
		4. Transport impact	-
		5. Net public infrastructure cost	-
		6. Surface water impact	-
		8. Residual value of land	-
		7. Biodiversity impact	19.7
		8. Noise impact	10.7
		9. Loss of surplus to other industries	-
		10. Water	-
		11. Aboriginal cultural and Historical heritage	-
		12 Subsidence[3]	11.8
Total indirect benefits	**125.0**	**Indirect Costs**	**42.2**
Total Project economic benefit	**132.0**	**Incremental Indirect Cost**	**0.0**
NPV of project - ($m)	**132.0**		**0.0**

Source: Cadence Economics estimated based on information from various sources.
[1] Real 2017 Australian dollars
[2] NPV in 2017 Australian dollars based on a 7 per cent real discount rate
[3] Incorporated operational costs

11.16.5 CGE Modelling Framework

The economy-wide impacts of the proposed development have been assessed using a CGE model of the regional and NSW economy. The assessment aims to estimate the net benefit of the proposed development on economic activity and the living standard of those residing within the Wollondilly SA3 and in NSW.

Modelling was based on the central case assumptions of capital expenditure of $310.8 million and coal revenue of $2,985.5 million. Flow on benefits of the proposed development outside of the Wollondilly region and the NSW economy were also factored into the modelling; for example royalty payments accrued by NSW and corporation tax to the Australian government.

The central consideration for the CGE relates to the responsiveness of the NSW labour market to the increase in expenditure (the labour supply response). Three labour market response scenarios were incorporated into the modelling:

- zero labour supply elasticity: Assumes that no new jobs would be created by the proposed development. This scenario would occur if the NSW economy was operating at full employment and no new workers were available to service the proposed development. Workers would therefore be drawn from their existing jobs to the new project via increased wages. Similarly, if a new project required very specific highly trained and skilled workers and there were none readily available, the proposed development would not create additional jobs;

- medium labour supply elasticity: Assumes the economy is operating at below capacity, as evidenced by higher unemployment and slower growth. Potential workers are therefore encouraged into the workforce, through increased wages. A labour elasticity assumption of 0.15 as per the Australian Treasury has been used, which assumes workers are slow to respond to changes in wages due to the economy being close to full employment or the proposed development under consideration requires highly skilled workers; and
- High labour supply elasticity: Assumes the economy is operating at below capacity and the labour supply elasticity is higher than the medium scenario. Therefore assumes that workers respond more readily to marginal changes in the wage rate.

The results of the projected economy-wide impacts of the proposed development generated by the CGE model are shown in **Figure 13** of **Appendix R** (Economic Impact Assessment) under the three labour market response assumptions. The results are summarised below.

Under the Zero, medium, and high labour market response assumptions the proposed development is projected to increase gross regional income (GRI) in both the Wollondilly region and NSW broadly. GRI is a measure of economic welfare. In NPV terms, the projected increase in GRI in the Wollondilly region ranges from $3,288 million under the zero labour supply response to $3,561 million under the high labour response assumption. The increase in projected economic welfare is related to the projected employment which averages 339 FTE (Full Time Equivalent) under the high labour response assumption and 183 FTE under the medium assumption.

The economic benefits of the proposed development also accrue to the broader NSW economy. In NPV terms, the projected increase in GRI in NSW ranges from $4,692 million under the zero labour supply response to $5,055 million under the high labour response assumption. The associated employment effects in NSW are 339 FTE under the high labour response assumption and 183 FTE under the medium assumption.

11.16.6 Conclusion

In accordance with the NSW Treasury guidelines, a CBA and LEA has been undertaken for the proposed development. The CBA compares the proposed development central case to a baseline case where the proposed development does not proceed, to assess the net benefits to the NSW community. The overall finding of the CBA is that the proposed development as a whole is likely to deliver net economic benefits. In the central case (which is based on a 7% discount rate) the proposed development delivers net benefits of around $699.5 million over its life, of which up to $132.0 million would flow through to the local Wollondilly region (in NPV terms).

Community benefits will be generated primarily through employment, which would average at 422 full time equivalent employees in the operational stage of the proposed development (post 2020). The proposed development is also expected to generate increased economic activity and employment within the wider NSW community, including both direct employment and employment from downstream suppliers. Systematic sensitivity analysis of the estimated net benefits has been undertaken for the CBA and LEA. The sensitivity analysis shows that the estimated net benefits are robust in the sense that they remain (strongly) positive after testing all key assumptions underpinning the analysis.

Royalties generated by this proposed development, relative to the baseline, are estimated to be worth around $149.1 million in NPV terms to the NSW Government. In addition, economy-wide modelling indicates that the proposal would accrue benefits to the Wollondilly region and the broader NSW economy under zero, medium and high labour market responses. Overall, the proposed development is expected to generate net benefits and is also expected to generate increased economic activity and employment within the NSW community.

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11.17 Visual and Landscape

This section provides an assessment of the potential visual impacts of the proposed development, and is supported by the Tahmoor South Project Visual Impact Assessment (VIA) (Green Bean Design, 2018). The VIA is provided in **Appendix S**. The objectives of the VIA were to:

- determine the likely visual significance of the proposed development on local residents and people living and working in or travelling through the landscape surrounding the Project Area;
- assess the existing visual character of the Project Area and the surrounding landscape;
- determine the extent and nature of the potential visual significance of the proposed development on surrounding areas; and
- identify measures to mitigate and minimise any potential visual impacts arising from the proposed development.

The visual and landscape assessment addresses the SEARs relevant to visual and landscape impacts. These are listed in **Table 11-90**.

Table 11-90 SEARs relating to visual amenity

Visual SEARs
Visual – including:
• an assessment of the likely visual impacts of the development on private landowners in the vicinity of the development and key vantage points in the public domain, and minimising the lighting impacts of the development.

11.17.1 Background

The proposed development has the potential to create a visual impact on the surrounding areas due to the expansion of the REA, construction of the two new ventilation shafts and upgrades to the Surface Facilities Area. The VIA determined the extent of these visual impacts and provided ways in which to mitigate the visual impacts of the proposed development.

11.17.2 Methodology

The VIA included the following key components:

- A desktop study to assess the visual character of the Project Area, and to identify potentially sensitive receiver locations. The desktop study involved a review of topographic maps (Land and Property Information, NSW Government), aerial photographs and satellite imagery to identify an indicative viewshed for key visible elements within the Project Area. Topographic maps and aerial photographs were also used to identify the locations and categories of potential viewpoints that could be verified during the fieldwork component of the assessment. The desktop study also helped establish the visual character of the landscape including features such as landform, elevation, land cover and the distribution of residential dwellings surrounding the proposed development;
- A field study, involving site inspections and photography to confirm the potential extent of visibility of the proposed development, including ancillary structures. The field study also included confirmation of the various view location categories and locations from which the key structures of the proposed development could potentially be visible. During the site inspections, digital photographs were taken to capture the existing views in the vicinity of a number of view locations inspected and assessed as part of the VIA. The locations where these photographs were taken are shown on Figure 6 of **Appendix S**. The digital photographs are also provided in **Appendix S**, labelled as Photo P1 to P17;
- An assessment of the visual sensitivity of the landscape and the magnitude of the proposed development using the information obtained from the desktop and field studies;
- An assessment of visual significance by determining a combination of the following factors:
  - the distance between the view location and the proposed development;

- the duration of view from view locations towards various constructed elements that form part of the proposed development;
- the predicted impact of the proposed development on the existing visual amenity;
- the nature of the predicted impacts; and
- the visual sensitivity of locations from which views towards the proposed development exist.

- Assessment of visual impact of the proposed development using the visual effect criteria and visual significance criteria outlined in **Table 11-91** and **Table 11-92** respectively; and
- Identification of mitigation measures to assist in the reduction and/or amelioration of adverse potential visual impacts of the proposed development that were identified in the VIA.

Table 11-91 Visual Effect Criteria

Criteria	Description
Nature of predicted impact	The visual impact would be either temporary (T) or permanent (P) in nature and would be considered reversible (R) or irreversible (IR).
Magnitude of impact	*High (H):* Total loss or major change to pre-development view or introduction of elements which are uncharacteristic to the existing landscape features. *Medium (M):* Partial loss or alteration to pre-development view or introduction of elements that may be prominent but not necessarily uncharacteristic with the existing landscape features. *Low (L):* Minor loss or alteration to pre-development view or introduction of elements that may not be necessarily uncharacteristic with the existing landscape features. *Negligible (N)*: Very minor loss or alteration to pre-development view or introduction of elements which are not uncharacteristic with the existing landscape (resulting in a no change situation).

Table 11-92 Visual Significance Criteria

Criteria	Description
View distance	*Long (L):* greater than 1 km *Medium (M):* 500m to 1 km *Short (S):* less than 500 m
View duration	*Long term (LT):* more than two hours *Moderate term (MT):* 30 minutes to two hours *Short term (ST):* 10 to 30 minutes
Receptor sensitivity	*High:* Residential locations *Medium:* Public recreation areas *Low:* Motorists or rail passengers

Criteria	Description
Visual significance	*High:* the proposed development would be a significant, dominant feature within the surrounding landscape and at complete variance with the landform, scale and pattern of the landscape. The proposed development would have the capacity to cause a significant deterioration in the existing view and the effects of the proposed development may not be minimised by mitigation measures. Cumulative impacts may result in an increased level of impact. *Moderate:* The proposed development would be a recognisable feature but would not dominate views within the surrounding landscape. It would be out of scale and discordant with the landform, scale and pattern of the surrounding landscape and would have the capacity to cause a noticeable deterioration in the existing view. The proposed development's visual effects may be partially alleviated by mitigation measures. *Low:* The proposed development would form a visible element within the surrounding landscape but is unlikely to constitute a marked effect on existing views. The proposed development would complement the scale, landform and pattern of the surrounding landscape and would not create a noticeable deterioration in the existing view. The proposed development's visual effects would be positively mitigated through appropriate mitigation measures. *Negligible:* The proposed development would result in no discernible deterioration in the existing view.

11.17.3 Existing Landscape

The Guidelines for Landscape and Visual Assessment (Landscape Institute, 2002) state that '*landscape effects describe the likely nature and scale of changes to individual landscape elements and characteristics, and the consequential effect on the landscape character resulting from the proposed development'.* The extent of resilience of a landscape depends on existing land use, the pattern and scale of the landscape and the visual enclosure/openness of views.

The Project Area is characterised by existing mining operations associated with Tahmoor Mine which have been present since operations commenced in 1979. Visual elements of the existing mine include pit top and surface infrastructure. The surface infrastructure of Tahmoor Mine is bounded by bushland to the north, east and south and Remembrance Driveway to the east. The existing REA is bounded on all sides by native bushland. The proposed development is located within a landscape that also includes rural residential and denser urban development associated with the townships of Tahmoor and Bargo The broader local area is characterised by national parks, bushland, WaterNSW catchment areas (MSA) and rural land.

Landscape Pattern and Scale

The landscape pattern and scale of landforms within the Project Area are defined by the existing land uses in the area. The Project Area is characterised by simple, regular and uniform landscape patterns and medium to small scale landforms, formed by the predominant land uses being mosaics of dense to moderate tree cover, rural occupation, industrial/ commercial development and urban development.

Visual Enclosure and Openness of Views

The visual environment of the Project Area is largely enclosed, being restricted by the gently undulating landform and the extensive areas of medium to dense tree cover. Along local roads and transmission line corridors, there are short distance and indirect views.

Visual Absorption Capacity

The relative ability of a landscape to absorb change without affecting landscape character is identified as the Visual Absorption Capacity. The Project Area is located within an undulating landscape with moderate to dense tree cover, providing the area with a high visual absorption capacity.

11.17.4 Impact Assessment

The key components of the proposed development were assessed in relation to visual effect and significance against the criteria outlined in **Table 11-91** and **Table 11-92** above. The results of the assessment are provided in **Table 11-93** below. The visual effect criteria outlined in **Table 11-91** is used as a guide to determine significance of visual impact. The significance of visual impact for each view location is also considered against other factors, which include the overall visibility of the proposed development from surrounding view locations.

Construction activities

Whilst construction activities would tend to be more visible than the operational stage of the proposed development, the construction activities would be temporary and transient in nature. Views toward construction activities associated with construction of the two (2) new ventilation shafts and expansion of the REA would be largely restricted by existing tree cover within the Project Area. Views of construction activities at the entry to the existing Tahmoor Mine (such as the Mine Access Road intersection upgrade) from vehicles travelling on Remembrance Driveway would be transitory in nature.

Operation

The proposed development involves the continuation of an existing underground mining operation, with minimal additional visual elements to be introduced to the landscape. New visual elements required for the proposed development would include expansion of the REA, construction of two new ventilation shafts and upgrades to the Surface Facilities Area. Operation of the proposed development would result in existing infrastructure remaining in the landscape for a longer period of time.

The landform within the Project Area and surrounds comprises a combination of sloping and ridgeline landforms and extensive areas of established, moderate to dense tree cover. As a consequence, the proposed development has been assessed to have a negligible visual effect and significance with regards to the proposed key constructed elements and associated infrastructure, including views from the majority of surrounding rural residential dwellings, roads that carry higher volumes of traffic such as Remembrance Driveway and from local road corridors (Refer **Table 11-93**).

Whilst the proposed development will require the removal of some existing tree cover (as detailed in **Section 11.6**), the VIA has considered and determined that the extent of proposed tree removal will not have an adverse impact on the overall visibility of the proposed development including views from sensitive receptors such as residential dwellings and motorists travelling along Remembrance Driveway. Overall, the magnitude of landscape effects associated with the proposed development has been determined as negligible to low, given the location, extent and purpose of the mining operations that exist in the Project Area and the existing landscape characteristics within and surrounding the proposed development. The proposed development would be of a similar nature to the operation of the existing Tahmoor Mine and is not expected to change existing land use within and surrounding the Project Area. The existing landscape character of the Project Area is considered to be robust with a High Visual Absorption Capacity that is able to absorb change without any significant alteration to the existing landscape character.

Night time lighting

The two new ventilation fan sites will include additional low-level intensity night lighting. Given the low-level intensity light to be used, and the location of these sites in areas away from residential dwellings, it is unlikely to be visible from residential dwellings. Low level night lighting at existing facilities will continue to include individual and direction spot lighting and avoid broad area or floodlighting which will minimise the potential for ‘sky glow’ above existing facilities. The majority of infrastructure areas associated with the proposed development will be unlikely to require additional lighting, or light fixtures that will create significant brightness.

Nattai National Park

The south east boundary of the Nattai National Park is located around eight km from the existing Tahmoor Mine and extends around 20 km to the north-west. The Burragorang and Wollondilly lookouts on the edges of the Nattai Reserves System are located 25 km north-west and 37 km south-west of the existing Tahmoor Mine, both offering viewpoints westward into the Nattai National Park

and the Yerranderie State Recreation Area. Views towards the existing Tahmoor Mine from these locations are obstructed by the landform and the extent of established tree cover. Given the distance, orientation, topography and intervening tree cover from these viewpoints, the proposed development would not result in any visual impact for visitors to the Park engaged in low impact bush walks or camping activities or affect the visual significance of the scenic escarpment of the Nattai National Park.

Table 11-93 Evaluation of Visual Impacts of the proposed development

Component of Project	Description of Potential Impact	Visual Effect	Visual Significance
Underground mining operations	Underground mining operations and pre mining activities would be largely confined to the existing Surface Facilities Area and below ground. As a result there would be no visual effect or significance for view locations beyond the existing Tahmoor Mine site or more broadly within the Project Area.	Negligible	Negligible
TSC1 upcast ventilation shaft	The proposed TSC1 up-cast ventilation shaft will be located on Tahmoor Coal's property at Charlies Point Road. Views from vehicles travelling along Charlies Point Road toward the upcast ventilation shaft will be partially screened and filtered by roadside tree planting. Views toward the upcast ventilation shaft from residential dwellings beyond the Tahmoor Coal mine site will be completely screened by extensive tree cover between the upcast ventilation shaft site and surrounding dwellings.	Negligible	Negligible
TSC2 downcast ventilation shaft	The proposed TSC2 down-cast ventilation shaft will be located on Crown Land opposite Tarmoor Coal's property at Charlies Point Road. Views from vehicles travelling along Charlies Point Road toward the upcast ventilation shaft will be partially screened and filtered by roadside tree planting. Views toward the upcast ventilation shaft from residential dwellings beyond the Tahmoor Coal mine site will be completely screened by extensive tree cover between the upcast ventilation shaft site and surrounding dwellings.	Negligible to low	Negligible to low
Mine access	Existing access points would be utilised for the proposed development and no additional visual effect or significance is likely to occur.	Negligible	Negligible
Coal logistics	Coal products would continue to be transported to Port Kembla via existing infrastructure and the existing rail movements would be sufficient for the proposed development. There would be no additional level of visual effect or significance.	No impact	No impact
Surface Facilities Area	Upgrades within the existing pit top area would be visually contained with the existing infrastructure and would not be visible from surrounding view locations, including Remembrance Driveway and residential dwellings	Negligible	Negligible
Electrical infrastructure works	These works would be mostly within the existing mine Surface Facilities Area and would not be visible from view locations within the Project Area beyond the existing Tahmoor Mine site. A new substation and associated 66kV power line would be constructed at the TSC2 ventilation shaft site. The substation would not be visible from surrounding dwellings and would be screened by established tree cover. The power line would be located away from existing dwellings and pass through or alongside areas of established tree cover which would provide partial or full screening from the majority of the surrounding landscape.	Negligible	Negligible to low

Component of Project	Description of Potential Impact	Visual Effect	Visual Significance
REA	The existing approved REA has a footprint of approximately 73ha with a final landform profile consists of a stable battered slope, approximately 12 m high (at approximately RL 300 m) with external batters ranging from 1:4 to 1:8. The maximum height of the REA would be increased from RL 300 m to RL 305 m in the southern section. The proposed two stage development footprint of the REA expansion is shown in **Figure 4.12**. The expansion area will cover up to an additional 43 hectares (resulting in a total REA area of 116 ha including the existing 73 ha), The two stages would be developed with a 1:5 (vertical: horizontal) batter and would each have a final design height of about RL 305.8m. The REA would be largely screened from surrounding rural dwellings by established, dense tree cover which extends up to and beyond 1 km from the REA site. The final REA landform would be visually consistent and contiguous with adjacent landforms that surround the existing REA and would not disrupt the existing distant skyline views from elevated and accessible view locations. The development of the REA would have some limited visual exposure to traffic movements along Charlies Point Road; however, the proposed REA stages would be partially screened by existing tree planting alongside the road corridor. Progressive and ongoing planting during rehabilitation and vegetation of the REA would provide further screening potential. During the design of the proposed development, Tahmoor Coal considered a third stage REA development which would expand the REA footprint further to the south. This option was not preferred due to the additional land clearing required, and proximity to additional residences. The proposed REA footprint has reduced the visual extent of the REA to the south and requires less land clearing when compared to this third stage option.	Low	Low

Cumulative impacts

A cumulative visual impact may result from elements of the proposed development being constructed concurrently with other existing or proposed developments.

Due to the abovementioned extent of visual screening surrounding the Project Area as well as the location of proposed constructed elements relative to the existing infrastructure, the proposed development is considered to have limited potential to increase the significance of cumulative visual impacts.

11.17.5 Management and Mitigation Measures

The following mitigation measures would further minimise the level of residual visual impacts associated with the proposed development:

- The colour and texture of new structures to be constructed for the proposed development would be dark in tone and would utilise non-reflective materials where possible. This would potentially minimise the visual contrast between these structures and the surrounding background to a number of view locations surrounding the Project Area;
- New lighting required for the proposed development would consist of low level night lighting designed to avoid direct line of sight from areas surrounding the site and avoid broad area or large floodlighting where practicable;
- Security lighting would be designed to minimise light spill where reasonable and feasible;
- Progressive rehabilitation and tree planting on the REA will continue to allow the REA to blend into the landscape;
- Existing tree cover would be retained and protected to the fullest extent where reasonable and feasible, particularly in the vicinity of the two ventilation shafts and along the boundary of the REA; and
- Landscaping works, including shrub and tree planting would be undertaken to increase the level of existing screening potential to proposed development infrastructure. Planting would be progressive through construction or as temporary works are rehabilitated, including along the Remembrance Driveway boundary to mitigate views from the road corridor as well as residential dwellings and the Wollondilly Anglican College to the west of the surface facility.

11.17.6 Conclusion

The proposed development is not expected to create a visual impact on existing land uses within and surrounding the Project Area. Additional visual elements associated with the proposed development would be minimal and would be limited to expansion of the REA, construction of two new ventilation shafts and upgrades to the Surface Facilities Area. Further, the high Visual Absorption Capacity of the Project Area and surrounds would likely reduce the potential magnitude of the visual impact.

The proposed development will be located in a landscape which is generally robust and has the ability to absorb any change without any significant alteration to the existing landscape character. The landscape character, coupled with the location and extent of existing mining operations has resulted in the proposed development having a low to negligible landscape effect.

The REA will be visually contained by established and dense tree cover. The final landform will not result in a disruption to existing distant skyline views where visible from elevated and accessible view locations. Views from private dwellings, community facilities (including the Wollondilly Anglican College) and publicly accessible areas beyond the proposed development would be screened by the gently undulating and low ridgeline landforms, together with the moderate to dense tree cover that is present across large portions of the landscape within and surrounding the Project Area. Existing and established tree cover beyond the road corridor will screen views towards proposed infrastructure within the existing Tahmoor Mine Surface Facilities Area from vehicles travelling along Remembrance Driveway. The proposed development will have an overall negligible visual impact on distant views from landscape areas beyond the existing Tahmoor Mine, including the scenic escarpment of the Nattai National Park.

The proposed development area is considered to have limited potential to increase the significance of cumulative visual impact due to the extent of existing visual screening within the Project Area and the location of proposed constructed elements relative to existing infrastructure within the Tahmoor Mine Surface Facilities Area.

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11.18 Soils and Land Capability

An Agricultural Impact Statement (AIS) was prepared by SLR and is provided in **Appendix T**. This involved the identification of the existing soil environment and the land capability of the Project Area, which is described in this section.

11.18.1 Background

Land capability is the physical capacity of the land to sustain a range of land uses and management practices in the long term without degradation to soil, land, air and water resources (OEH, 2012). An assessment of soils and land capability has been undertaken as part of the AIS for the proposed development. The purpose of the assessment was to outline the existing conditions with regards to soils and land capability within the Project Area as well as to inform the broader assessment of agricultural land uses and resources which is provided later in **Section 11.19**.

11.18.2 Methodology

Assessment of the soils and land capability of the Project Area was undertaken primarily as a desktop assessment, with some detailed soils surveys undertaken in the areas where new mining leases will be required. The desktop assessment included:

- A review of available soils mapping to identify:
  - soil landscapes within the Project Area and their characteristics; and
  - the presence or absence of acid sulfate soils, saline soils and contaminated soils.
- Application of the rural classification method to determine the land capability of the Project Area;
- A review of the NSW *Strategic Regional Land Use Policy* (DPE, 2012) to identify the status of biophysical strategic agricultural land (BSAL) within or near the Project Area, and assessing whether land within the Project Area is likely to satisfy the classification of BSAL. This is determined by reviewing land capability and classification, in addition to other criteria (discussed below);
- Defining a disturbance assessment area (DAA) to which the impact assessment would focus, and undertaking an assessment of the proposed development on soils, land capability and BSAL for this DAA. The DDA is limited to areas of known and potential disturbance and includes three areas:
  - The Subsidence Study Area (SSA): the area of potential surface subsidence associated with underground mining, covering an area of 2,624 hectares;
  - The Ventilation Shaft Sites: the proposed two new surface ventilation shafts and associated infrastructure covering an area of approximately 13 hectares; and
  - The expansion of the REA: the area required for the expansion of the REA which would involve the disturbance of 43 hectares.

Soils

The type and condition of soils within the Project Area were determined through a review of previous studies, available online searches and mapping.

- The soil landscapes units within the Project Area were identified through a review of the *Wollongong – Port Hacking 1:100,000 Sheet* (Hazelton & Tille, 1990);
- Acid sulfate soils (ASS) within the Project Area were identified through a review of the NSW Atlas of Acid Sulfate Soils available from the Australian Soil Resource Information System (ASRIS) (CSIRO, 2013);
- Saline soils within the Project Area were identified through a review of the *Salinity Potential in Western Sydney 2002 1:100,000 sheet* (DIPNR, 2003); and

- Contaminated soils within the Project Area were identified through a search of the NSW OEH record of notices issued under the *Contaminated Land Management Act 1997* (CLM Act) for the Wingecarribee and Wollondilly LGAs. Phase I and Phase II contamination assessments previously undertaken for the Tahmoor Mine were also reviewed (refer **Section 11.22**).

Land and Soil Capability

The Land and Soil Capability (LSC) classification applied to the Project Area was according to the OEH guideline *The Land and Soil Capability Assessment Scheme; Second Approximation* (OEH, 2013a). This scheme uses the biophysical features of the land and soil to derive detailed rating tables for a range of land and soil hazards. The scheme consists of eight classes (**Table 11-94**) which classify the land based on the severity of long-term limitations according to:

- The biophysical features of the land to derive the LSC classes associated with various hazards; and
- The management of the hazards including the level of inputs, expertise and investment required to manage the land sustainably.

Table 11-94 Land and Soil Capability Classification

Class	Land and Soil Capability
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, conservation)	
1	**Extremely high capability land**: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	**Very high capability land**: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
3	**High capability land**: Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
4	**Moderate capability land**: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	**Moderate–low capability land**: Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)	
6	**Low capability land**: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.

Class	Land and Soil Capability
Land generally incapable of agricultural land use (selective forestry and nature conservation)	
7	**Very low capability land**: Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	**Extremely low capability land**: Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

Biophysical Strategic Agricultural Land Assessment

An initial desktop assessment was undertaken to determine if any mapped BSAL (as identified in *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 - Strategic Agricultural Land Map - Sheet STA_41* (DPE, 2013)) occurred in the Project Area. There is no mapped BSAL in the Project Area. The nearest area of mapped BSAL is located between Douglas Park and Camden, approximately 20 km to the north-east of the Project Area.

Further assessment was required due to the need to apply for a Site Verification Certificate (refer to **Section 8.1.3**) to certify that that the land on which the proposed development is to be carried out is not BSAL. A Site Verification Certificate for the proposed development was issued during October 2018 to confirm there is no BSAL in areas where new mining leases are required for the proposed development.

Disturbance Assessment Area

For the purposes of the assessment, the AIS considered both the Project Area and a DAA, which comprises the area within the Project Area that would be subject to known and potential disturbance of LSC classified land, including the SSA, Ventilation Shaft Sites and the REA (refer **Figure 11.37**).

11.18.3 Existing Environment

The soil landscapes units within the Project Area include the Blacktown, Gymea, Hawkesbury, Lucas Heights, Luddenham, Volcanic and Disturbed Terrain soil types (refer **Figure 2.2**). The characteristics and limitations of the soil types are shown in **Table 11-95** and have been used to determine the land capability of the Project Area.

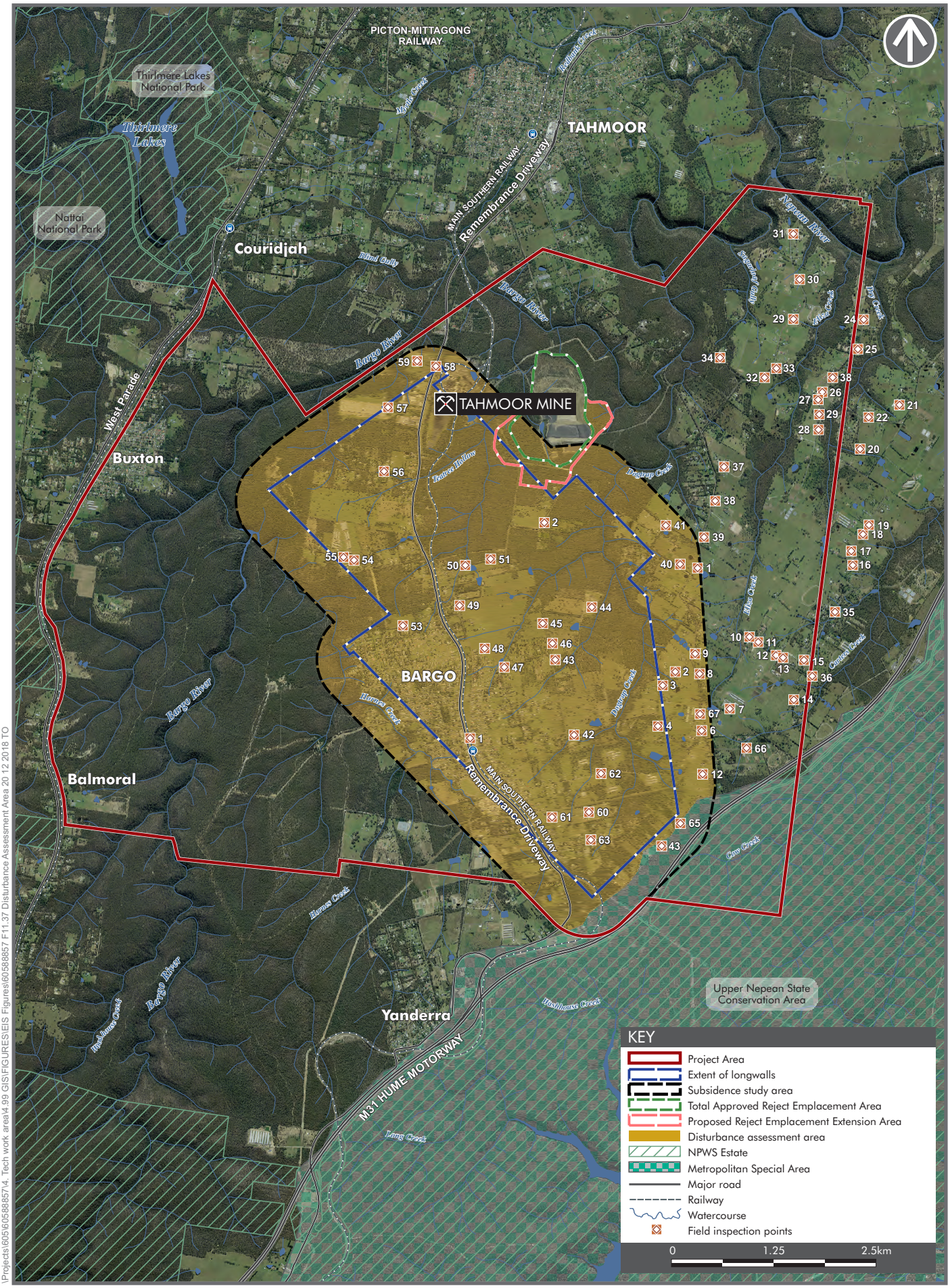
Table 11-95 Soil Landscapes within the Project Area

Soil Landscape Unit	Description / Characteristics
Blacktown (residual)	• The landscape is described as gentle undulating with the general fertility of the soils low; • Limitations are moderately reactive soil and seasonal waterlogging; • Vegetation is described as extensively cleared eucalypt low open-forest and eucalypt low woodland with sclerophyllous shrub understorey; • Erosion hazard for non-concentrated flows is generally moderate and may range from slight to extreme; and • This soil landscape unit is suitable for cropping (requiring intensive management practices) and grazing.
Gymea (erosional)	• The landscape is described as undulating to rolling rises and low hills with the general fertility of the soils very low; • Limitations are localised steep slopes, high soil erosion hazard and rock outcrops; and • This soil landscape is not suitable for any agricultural practices (designated as MSA).

Soil Landscape Unit	Description / Characteristics
Hawkesbury (colluvial)	• The landscape is described as rugged, rolling to very steep hills with the general fertility of the soils low; • Limitations of the soil landscape unit are extreme erosion hazard, mass movement, steep slopes, and rock outcrop; and • This soil landscape is not suitable for any agricultural enterprises.
Lucas Heights (residual)	• The landscape is described as gently undulating crests, ridges and plateau surfaces with the general fertility of the soils low; • Limitations to this soil landscape unit are stoniness, and localised surface movement potential; and • This soil landscape is predominately suited to grazing enterprises.
Luddenham	• Landscape is described as undulating to rolling low hills on Wianamatta Group shales, often associated with Minchinbury sandstone; • The general fertility of the soils is low to moderate; • Vegetation is described as extensively cleared dry sclerophyll open forest; • Limitations associated with this soil type include high soil erosion hazard, mass movement and moderate surface swelling potential; and • This soil landscape unit is suitable to grazing enterprises.
Volcanic	• Landscape generally covers gently inclined valley floors surrounded by steep side slopes; • Limitations associated with this soil type include localised erosion hazard, including mass movement on steep slopes; and • This soil landscape is predominately suited to grazing enterprises on localised areas on valley floors.
Disturbed Terrain	• Disturbed terrain has been highly modified by human activity. The original soil has often been removed, greatly disturbed or buried; and • This soil landscape unit is generally not suitable for agricultural production.

Five Australian Soil Classification soil types are present within the Project Area including Dermosols, Ferrosols, Kurosols, Rudosols and Tenosols. The soil types are described below:

- Kurosols are the major soil type within the Project Area and the DAA. Kurosols are soils with a strong texture contrast between the topsoil layer and lower acidic layers. Kurosols generally have moderately low inherent fertility;
- Tenosols are soils characterised by sandy to sandy loam textures. Tenosols generally have moderately low inherent fertility;
- Rudosols are generally young soils which have not had time to form structurally. Rudosols generally have moderately low inherent fertility;
- Ferrosols are soils which are derived from volcanics, are high in iron oxide. Ferrosols have moderately high inherent fertility; and
- Dermosols are soils with a structured secondary soil layer with a concentration of clay, minerals, or organics. Dermosols generally have moderately high inherent fertility.



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SIMEC MINING

DISTURBANCE ASSESSMENT AREA

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.37

Acid Sulfate Soils

Soils can contain iron pyrite in an unoxidised state and when air comes in contact with them they oxidise forming ASS. When water passes through the ASS, sulphuric acid leaches out and passes into waterways. ASS were formed in locations where marine sediment was deposited during the Holocene geological period (<11,000 years before present). These soils generally occur below and up to 5 m AHD in estuaries, rivers, floodplains, back swamps and sand dunes and are therefore typically associated with low-lying coastal areas, including estuarine flood plains, rivers and creeks.

The elevation of the Project Area is greater than 5 m AHD and it is not located in a coastal area. Therefore the likelihood of ASS occurring is considered to be low. A review of the NSW Atlas of ASS mapping identifies the Project Area as having a low to very low probability of occurrence for ASS.

Saline Soils

Areas that are underlain by shale with a shallow water table are generally classified as having a high probability of containing saline soils. In the Southern Coalfields, salinity is generally associated with the Wianamatta Group shales, in particular, with drainage systems within soil types that include the Blacktown Soil Landscape (DNR, 2006). Within the Blacktown Soil Landscape, localised recordings of saline soils have been recorded. Reference to the *Salinity Potential in Western Sydney 1:100,000 sheet* (DIPNR, 2003), indicates that the Project Area has a very low to moderate salinity potential.

Salinity can result in the deterioration of road and concrete surfaces and the disturbance of saline soils can result in an increased saline load in surface water runoff from land. Salinity may also result in the deterioration of rural and agricultural land use.

Contaminated Soils

Construction of the additional surface infrastructure associated with the proposed development would be largely located on land within the existing Tahmoor Mine Surface Facilities Area. Potential for contamination from the existing Tahmoor Mine surface facilities was investigated through a previous Phase I and Phase II Contamination Assessment (ENSR, 2009; AECOM, 2011) as discussed in **Section 11.22**. It identified contaminating activities which had historically occurred at Tahmoor Mine but concluded that soil contamination was limited, generally in the vicinity of waste oil and underground tanks, and did not represent a significant risk of harm to the environment.

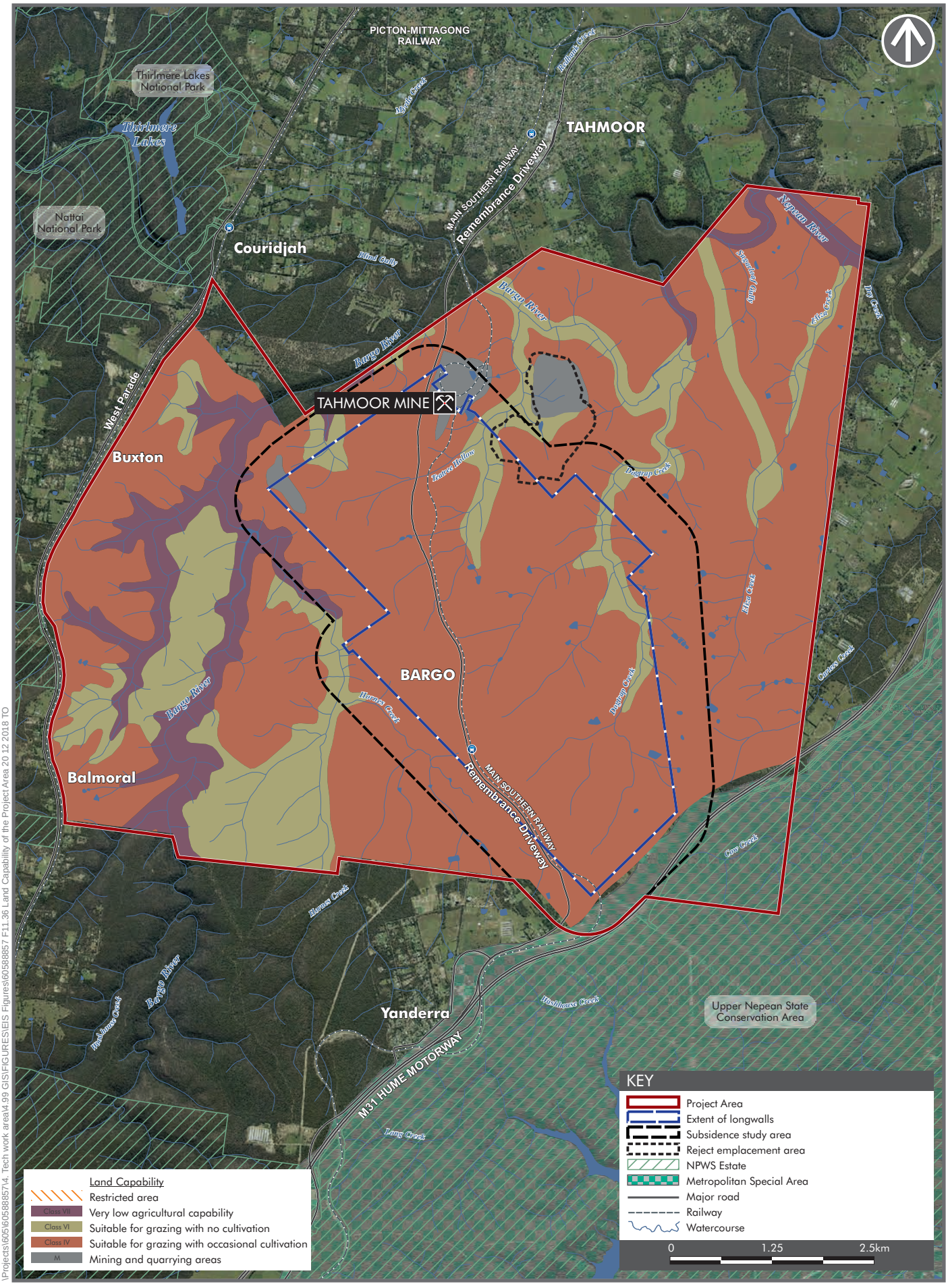
Further, surrounding land uses (primarily agricultural) are unlikely to have been impacted by these activities. Should ground excavation works during the construction of surface infrastructure associated with the proposed development encounter contaminated land or soil suspected to be contaminated, appropriate mitigation measures would be implemented consistent with existing Tahmoor Mine soil management procedures including the testing, containment, and removal of the material to an approved waste facility, to ensure protection of workers and the environment.

There is potential for historic land uses within the Project Area, such as livestock intensive industries to result in soil contamination. The extension of the REA is located on land not currently utilised for agricultural or other pastoral uses and is therefore unlikely to contain contaminated soils. The extension of longwall mining would undermine land used for agricultural land purposes, therefore there is potential for contaminated land to exist in these areas. However, infrastructure that would be established in these areas would be limited to additional ventilation and gas drainage works, and would be subject to the management procedures identified above, should contaminated land be encountered.

An investigation of the OEH record of notices issued under the CLM Act for the Wingecarribee and Wollondilly LGAs identified one record existing within the Wollondilly LGA. This site is the Maldon Works located on Wilton Park Road which is located outside of the Project Area and would not be impacted by the proposed development. Four sites were identified within the Wingecarribee LGA which were the Former Gasworks Site (Bowral), Former Shale Oil Refinery (Joadja), Former Shale Oil Plant (Mittagong) and Moss Vale North Deport (Moss Vale). None of these sites are within the Project Area and therefore would not be impacted.

Land Capability

Land capability of the Project Area was determined using the methods described in **Section 11.18.2**. The results of the assessment are shown on **Figure 11.38** and detailed in **Table 11-96**.



\Projects\605\605885714. Tech work area\4.99 GIS\FIGURES\EIS Figures\605885857 F11.36 Land Capability of the Project Area 20 12 2018 TO

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LAND CAPABILITY OF THE PROJECT AREA

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.38

Table 11-96 Land and Soil Capability Classes

Land & Soil Capability	Project Area		DAA		Agricultural Capability
Class	**Hectares**	**%**	**Hectares**	**%**	
4	4,615	71	2,254	86	Moderate capability land
6	11,000	15	200	8	Low capability land
7	509	8	37	1	Very low capability land
Metropolitan Special Area	271	4	78	3	No classification for agricultural use
Mine Disturbed	103	2	55	2	
Total	**6,498**	**100**	**2,624**	**100**	

Three LSC classes are present within the Project Area and DAA: class 4, 6 and 7. Some areas within the Project Area are not classed under the LSC system and include the Metropolitan Special Area and the existing disturbed areas of the Tahmoor Mine.

Biophysical Strategic Agricultural Land

As discussed in **Section 11.18.2**, there is no BSAL within the Project Area. The nearest mapped BSAL is located between Douglas Park and Camden, approximately 20 km to the north-east of the Project Area. Due to the absence of BSAL in the project area, no impacts to BSAL would occur as a result of the proposed development.

11.18.4 Impact Assessment

Potential impacts on soils and land capability are largely associated with soil erosion of hardstand areas and surface infrastructure, as well as surface impacts as a result of subsidence.

Soils

Activities likely to disturb soils within the Project Area include:

- Construction activities associated with the upgrade of the Surface Infrastructure Area;
- Extension, operation and progressive rehabilitation of the REA;
- Construction of ventilation shafts;
- Access road upgrade; and
- Surface subsidence effects from the mining of longwalls, and the rehabilitation of these surface impacts.

Disturbance of soils during these activities could temporarily increase potential erosion and sediment loads within the vicinity of the activity with the potential to impact on nearby waterways. Soil disturbance would also occur where stripping is required to rehabilitate surface cracking and impacts during rehabilitation of the proposed development as part of mine closure (which would be addressed as part of the Mine Closure Plan, refer **Section 11.23**).

ASS and saline soils are not likely to be present within the Project Area. As such, impacts from the proposed development on soils are expected to be negligible. However, the potential exists for soils to be contaminated through fuel, chemical and oil spillages from vehicles and machinery working on site.

Potential subsidence impacts associated with longwall mining have been detailed in **Section 11.1** and include ground deformations such as surface cracking, heaving, buckling, humping and stepping of land at the surface. These ground deformations may result in land degradation at the surface and the potential for increased erosion.

Impacts on soil are expected to be minimal given the limited ground surface disturbance associated with the proposed development and given the continued implementation of mitigation measures successfully and currently implemented at Tahmoor Mine.

Land Capability

The only surface impacts likely to impact on the classification of potential land productivity include land clearing associated with surface works (i.e. ventilation shafts and REA expansion). Based on the mapped areas of rural land capability within the DAA (**Figure 11.38**), the following potential impacts to land capability were identified:

- Temporary removal of 13 hectares of Class 4 land from potential agricultural production during the life of the proposed development as a result of ventilation shaft site development. These areas will be rehabilitated to conditions that are generally consistent with pre-mining conditions in accordance with the *Conceptual Mine Closure Plan* (Appendix V) and therefore would not result in a permanent loss of agricultural potential.
- Permanent removal of 43 hectares of land with potential agricultural production as a result of the expansion of the REA: 37 hectares of Class 4 (moderate capability) land; and 6 hectares of Class 6 (low capability) land.

  This area would ultimately be rehabilitated to native bushland as part of the establishment of the final landform during mine closure. Following rehabilitation, the land would have a lower land capability than pre-mining and as such has been assessed as a permanent loss of potential agricultural value.

The permanent removal of potential agricultural land represents approximately 1% of the DAA.

11.18.5 Management and Mitigation Measures

Mitigation measures are currently employed as part of the existing Tahmoor Mine in order to manage potential impacts on soil. The current overarching environmental management system at Tahmoor Mine includes a Soil and Water Management Plan which mitigates potential impacts on soils of the area through stipulating requirements for regular inspections of the surface features for soil erosion and surface cracking due to longwall mining (refer to **Section 11.1** for subsidence management).

An approved SMP for Tahmoor Mine also contains a series of TARPs, which provide for corrective action and ongoing mitigation and management of subsidence impacts affecting the Project Area. A similar TARP would be prepared for the proposed development.

In addition, the Conceptual Mine Closure Plan provided in **Appendix V** and summarised in **Section 11.23** provides details on the progressive rehabilitation of disturbed land and the management of soil impacts during rehabilitation and ultimately during mine closure.

The successful rehabilitation of disturbed land to the target LSC classification is a critical component of mining operations that has been previously demonstrated by Tahmoor Coal through successful rehabilitation of disturbed lands at the Tahmoor Mine.

11.18.6 Conclusion

The soils and land capability of the Project Area have been identified as moderate to low capability land with generally poor fertility soils. No ASS or saline soils are expected to be present within the Project Area.

A total of 43 hectares of current bushland that is classified as potential agricultural land will be permanently removed as part of the REA expansion. Importantly however; this land is not currently used for agricultural purposes. Further discussion on the potential for impacts to agricultural land use is provided in **Section 11.19**.

The potential for impacts resulting from the proposed development include the disturbance of soil during surface works and surface impacts from subsidence. However, these impacts are expected to be manageable through erosion and sediment controls and subsidence management measures contained within the existing SMP. The SMP would be updated for the proposed development.

Rehabilitation is proposed and would be undertaken in accordance with the existing SMP and as detailed in the Conceptual Mine Closure Plan (**Appendix V**). Provided the existing mitigation measures and proposed rehabilitation measures are implemented, the proposed development is unlikely to significantly alter the land capability of the Project Area.

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11.19 Land Use, Agriculture and Resources

An Agricultural Impact Statement was prepared by SLR (2018) and is provided in **Appendix T**. This section identifies land use within the Project Area, as well as identifying key agricultural land and water resources and enterprises in the local area.

11.19.1 Background

The NSW *Strategic Regional Land Use Policy* (DPE, 2012) applies to areas within NSW where there is high value agricultural land and mining activity. Part of this policy requires all State-significant mining development proposals with the potential to affect agricultural resources, whether or not they are located on land mapped as biophysical strategic agricultural land, to prepare an Agricultural Impact Statement.

The purpose of the Agricultural Impact Statement prepared for the proposed development was to conduct a detailed assessment of the potential impacts of the proposed development on:

- soil and land capability (which has been detailed previously in **Section 11.18**);
- land use, including forestry, conservation and recreational use, with particular reference to the Thirlmere Lakes and Nattai National Parks, and the Upper Nepean and Bargo River State Conservation Area; and
- agricultural resources and/or enterprises in the local area including any change in land use or resources as a result of the proposed development.

11.19.2 Methodology

Assessment of land use and agricultural resources of the Project Area involved:

- A desktop review of available information to characterise the Project Area and to identify mapped and described land uses, including a review of State and local strategic and planning documents;
- A land capability assessment which identified the potential for agricultural land within the Project Area (refer **Section 11.18**);
- A field visit and site inspection, which was undertaken in June 2013, December 2017 and October 2018 by SLR's Associate Agronomist to validate the desktop review and to identify specific agricultural enterprises within the Project Area; and
- Utilising the findings of the land capability assessment and desktop review to inform assessment for the potential of agricultural and other land uses that may be impacted by the proposed development. The assessment identified potential impacts on agricultural resources and industry, and recommended mitigation measures for identified impacts.

Potential impacts to land use and agricultural resources were anticipated to be limited to a defined DAA which includes the SSA, ventilation shaft sites and the REA expansion area (refer to **Section 11.18.2**). The DAA is located entirely within the Wollondilly LGA. As described in **Section 11.19.4**, impacts to land use and agricultural resources within the SSA would be limited to temporary, indirect impacts compared to impacts associated with the ventilation shaft sites and REA expansion area which would consist of direct temporary and permanent impacts.

11.19.3 Existing Environment

Regional Land Use

The Project Area is located primarily within the Wollondilly LGA, and partially within the Wingecarribee LGA. Land use in the region is characterised by a mix of village residential, rural residential, market gardens, agricultural and conservation areas. Most of the rural land is used for agricultural purposes, including market gardens, orchards, dairy farms, poultry farms and grazing (Wollondilly profile.id, 2013).

The Project Area traverses semi-rural and partly forested landscapes, along with a mix of rural and environmental land uses. Townships, villages and rural residences dot the landscape, the nearest of which include the township of Tahmoor and villages of Bargo, Yanderra, Pheasants Nest, Couridjah, Balmoral and Buxton.

The Project Area is located in a region with a long history of agricultural use. Rural uses within the Project Area include small-scale agricultural activities such as horticulture, poultry, cattle grazing, trotting horse training, greyhound training and several horse studs. While incised gullies and plateaux have largely remained undisturbed, large areas of flat and low gradient slopes have undergone moderate landscape disturbances as a result of large-scale native vegetation clearing to allow agricultural production.

Agricultural Land and Resources

Agriculture is a minor land use for the regional area, accounting for 11% of land use within the Wollondilly LGA (SLR, 2018). Of the agricultural land within the LGA, the vast majority is utilised for grazing activities, primarily for cattle and sheep. A small portion of land is utilised for cropping activities primarily for vegetable and fruit production. Poultry accounts for a large proportion of livestock numbers within the LGA.

The land capability assessment (**Section 11.18**) generally supports the LGA profile and identified that the majority of agricultural land within the Project Area and DAA (as defined in **Section 11.19**) is best suited to grazing enterprises and is highly to severely constrained for cultivation (cropping) enterprises. Smaller portions of agricultural land within the Project Area and DAA were considered suited to cultivation enterprises using intensive soil management practices.

The site inspection undertaken for the proposed development to ground-truth desktop information identified a number of differing agricultural land uses within the DAA. The various land uses at each site were recorded and are described in **Table 11-97**. Land uses within the Project Area are shown in **Figure 11.39**. Approximately 26% (or 677 hectares) of the DAA is considered to be available for agricultural production in its current form. Using a precautionary assessment and assuming this total area is LSC Class 4, this area has the potential to generate a gross margin of $200,392 per annum from beef cattle production.

The main income generating enterprises in the DAA relating to agriculture are poultry hatching and growing-out operations (Ingham's and Cordina), vegetables grown in market gardens and greenhouses, pacing horse (standard bred trotters) and greyhound breeding and training facilities (SLR, 2018).

Table 11-97 Observed Land Use (SLR, 2018)

Site	Land Use	Site	Land Use
1	Cattle grazing	35	Pleasure horses
2	Irrigated olives	36	Hydroponic lettuce
3	Alpacas 2013, rural residential 2017	37	Standard bred (pacing) horses
4	Cattle and horse grazing	38	Pleasure horses
5	Market garden	39	Pleasure horses
6	Boarding kennels	40	Tomato greenhouses & irrigated vegetables
7	Inghams poultry sheds & cattle grazing	41	Horse pre-training complex
8	Pleasure horses	42	Pleasure horses
9	Sheep grazing	43	Pleasure horses
10	Rural residential	44	Bargo waste facility
11	Standard bred (pacing) horses	45	Cattle grazing 2013, rural residential 2017
12	Cattle grazing	46	Pleasure horses
13	Markey garden	47	Pleasure horses
14	Market garden & Fresian horse stud	48	Cattle grazing 2013, rural residential 2017

Site	Land Use	Site	Land Use
15	Oat crop	49	Pleasure horses
16	Hard rock quarry	50	Cattle grazing
17	Cattle grazing	51	Disused cattle feedlot
18	Cordina poultry sheds	52	Pleasure horses
19	Draught horses	53	Rural residential
20	Cattle grazing	54	Hydroponic lettuce
21	Disused poultry sheds	55	Poultry sheds
22	Pleasure horses	56	Disused cut flower greenhouses
23	Sheep grazing	57	Inghams poultry sheds
24	Sheep grazing	58	Olives & sheep grazing
25	Pleasure horses	59	Irrigated olives & alpaca stud
26	Pleasure horses	60	Rural residential
27	Pleasure horses	61	Pleasure horses
28	Pleasure horses	62	Inghams poultry sheds
29	Standard bred (pacing) horses	63	Disused cut flower greenhouses
30	Pleasure horses	64	Boarding kennels
31	Rural residential	65	Critter Bits rural produce store
32	Rural residential	66	Greenhouses & market garden
33	Cattle grazing 2013, rural residential 2017	67	Poultry sheds
34	Horse pre-training complex		

Water Resources

The Project Area is covered by the Greater Metropolitan Groundwater Sources Water Sharing Plan. 791 privately-owned groundwater extraction bores have been identified within, and surrounding the Project Area. Most of the groundwater usage in the area is from the Hawkesbury Sandstone or from surficial alluvium and basalt aquifers (about 89% of the total), with about 10% from the Bulgo Sandstone (Hydrosimulations 2018).

Tahmoor Mine holds three groundwater licences with a total volume of 1,642 ML per annum, and a 5 ML per year surface water extraction licence.

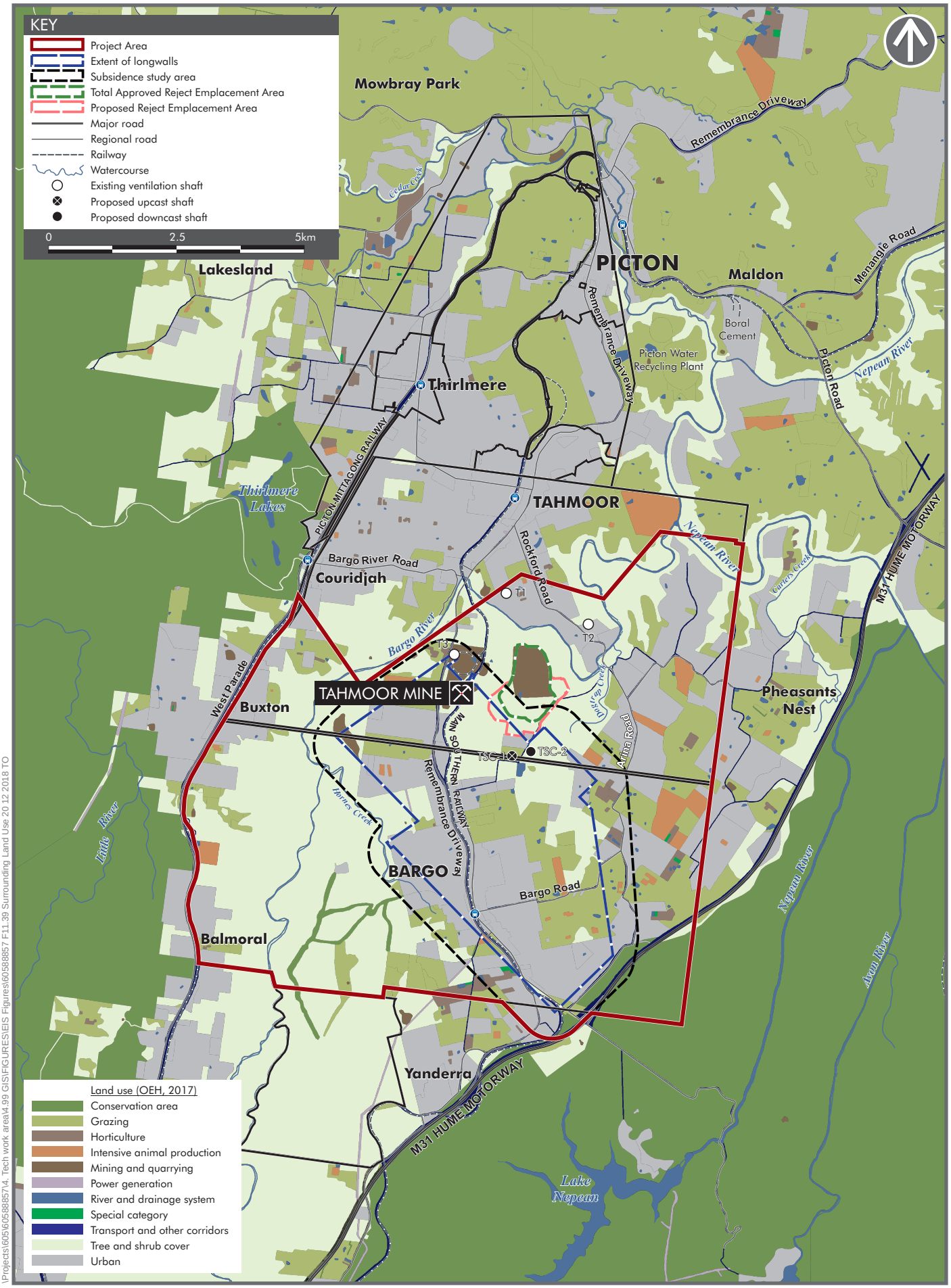
National Parks and State Conservation Areas

The region surrounding the Project Area encompasses large areas dedicated to conservation and the protection of drinking water catchments, referred to as the Metropolitan Special Area. These are the Upper Nepean State Conservation Area, Bargo River State Conservation Area, Thirlmere Lakes National Park and Nattai National Park as described in **Table 11-98** and shown in **Figure 2.3**. The principal difference between the management, objectives and principles of National Parks and State Conservation Areas is that mineral and petroleum exploration and mining may be permitted in State Conservation Areas (OEH, 2014).

Table 11-98 National Parks and State Conservation Areas in proximity to the Project Area

Name	Description / Land Use Values	Location
Upper Nepean State Conservation Area	Upper Nepean State Conservation Area protects the Nepean dam and the upper catchment area.	East of the M31 Hume Motorway, within the south eastern portion of the Project Area (but not within proposed development)
Bargo River State Conservation Area	Bargo River State Conservation Area is a smaller conservation area (1,970 ha), protecting a section of the upper Bargo River catchment.	South of the Project Area
Bargo State Conservation Area	Bargo State Conservation Area is known to contain several Aboriginal sites and contains several items of European history. It also provides undisturbed bushland areas popular with bushwalkers.	Adjacent to the western boundary of the Project Area, west of the Southern Railway (Picton to Colo Vale spur line)
Thirlmere Lakes National Park	Thirlmere Lakes National Park is known for natural wetlands, bushland and the five freshwater lakes which make up the Park. This National Park is also part of the Greater Blue Mountains World Heritage Area.	North-west of the Project Area, west of the Southern Railway (Picton to Colo Vale spur line)
Nattai National Park	The Nattai National Park encompasses the Warragamba dam catchment and provides bushland and wilderness qualities popular with bushwalkers. This National Park is also part of the Greater Blue Mountains World Heritage Area.	West of the Project Are, joining the Thirlmere Lakes National Park and Bargo State Conservation Area.

The Upper Nepean State Conservation Area is the largest of the State Conservation Areas surrounding the Project Area. It was established in 2007 and covers a total area of 25,869 ha. Approximately 171 hectares of this area (2%) lies within the Project Area although the proposed development itself does not extend within its land. The majority of the State Conservation Area encompassed within the Project Area is designated within the Fire Management Strategy (OEH, 2008) as Strategic Fire Advantage Zones or Land Management Zones.



\Projects\605\605888574. Tech work area\4.99 GIS\FIGURES\EIS Figures\605888857 F11.39 Surrounding Land Use 20 12 2018 TO

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SURROUNDING LAND USE

Tahmoor South Project
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FIGURE 11.39

11.19.4 Impact Assessment

Agricultural Land and Resources

As discussed in **Section 11.18** there is no BSAL within the Project Area. The nearest mapped BSAL is located between Douglas Park and Camden, approximately 20 km to the north-east of the Project Area. Due to the absence of BSAL in the project area, no impacts to BSAL would occur as a result of the proposed development.

LSC classified land within the DDA included: the SSA, the ventilation shaft sites and the REA expansion area, but did not include existing disturbed areas of the mine (i.e. Surface Facilities Area). The agricultural assessment has focused on LSC classified land.

It is considered that potential impacts would consist of:

- Temporary impacts related to:
  - direct surface disturbance of LSC classified land at ventilation shaft sites that can be rehabilitated back to the same land capability post mining; and
  - indirect surface disturbance at the SSA resulting from subsidence following the mining of longwalls.
- Permanent impacts related to direct disturbance at the REA where construction, use and subsequent rehabilitation following mine closure results in a permanent change of land use and loss of land that is classified as having potential for agricultural production.

Temporary Impacts

Approximately 13 hectares of potential agricultural land would be temporarily removed during the proposed development for the construction of the ventilation shaft sites and associated services (approximately 6 hectares at each site). These 13 hectares are LSC Class 4 land that are currently used for grazing pleasure horses in the case of TSC1 and comprises bushland on Crown Reserve that has not historically been used for agricultural production in the case of TSC2. The areas would be rehabilitated to a native bushland area generally consistent with pre-mining conditions upon the cessation of mining.

In relation to the potential impacts from subsidence, no change to the LSC Class across the SSA is predicted as a result of subsidence resulting from the proposed development (MSEC, 2018). Notwithstanding, a number of agricultural structures were identified during the field inspection that may be subject to impacts resulting from subsidence. These structures include:

- Rural structures – which are more susceptible to impacts when in poor existing condition. However, risk to public safety is considered low and minor expected impacts are readily remediated;
- Water tanks – which are unlikely to experience impacts as a result of ground strains. However, associated underground pipework to these tanks may experience minor impacts such as leaking joints which are readily remediated;
- Gas and fuel storages– which are unlikely to experience impacts as a result of ground strains. However, associated underground pipework to these tanks may experience minor impacts such as minor gas leaks which are readily remediated;
- Poultry sheds – which are expected to remain in safe and serviceable condition. Any potential impacts would be minor in nature and readily remediated;
- Greenhouses and hothouses – which are unlikely to experience impacts as a result of subsidence. Any potential impacts would be minor in nature and readily remediated;
- Irrigation systems – which are usually constructed of polyethylene pipe which are resilient to predicted subsidence impacts. Any potential impacts would be minor in nature (such as minor pipe leaks) and readily remediated;

- Farm fences – which can be affected by tilting of the fence posts and changes of tension in the fence wire as a result of subsidence strains. Impacts to fences are anticipated to be minor in nature and readily remediated; and
- Farm dams – which can experience changes in water levels, capacity and stability as a result of subsidence tilt. It is unlikely the majority of farm dams would experience adverse impacts. However, remedial measures are readily available where impacts to storage capacity or levels are experienced such as increasing the heights of impacted dam walls. There is extensive experience of mining underneath farm dams within the Southern Coalfields and there have been minimal claims of significant adverse impacts. As such, the likelihood of expected impacts for the proposed development is considered low and is considered manageable.

It is considered that potential subsidence impacts to agricultural enterprises within the Project Area during the life of the proposed development will be temporary, involving relatively minor subsidence related damage to farm infrastructure, which are readily manageable through appropriate repair measures. Direct impacts to agricultural land (LSC Class 4) would be temporary subject to post-mining rehabilitation back to existing land capability. Based on the above impacts are not anticipated to be significant.

Permanent Impacts

There is no land within the DAA that is currently used for agricultural purposes that will permanently be removed from production. However, there is approximately 43 hectares of land within the DAA that is classified as having potential for agricultural production that would be removed as a result of the REA expansion. This consists of 37 hectares of Class 4 (moderate capability) land and 6 hectares of Class 6 (low potential) land, and is estimated as having potential to provide a gross margin of $11,840 per annum were it utilised for agricultural production.

The REA will be rehabilitated to LSC Class 6 or 7 land. Conservatively assuming it will be returned to Class 7 land, the rehabilitated area would have a potential gross margin of $3,182 per annum. Therefore, the total calculated loss as a result of the reduction in LSC Class from Class 4 and 6 to Class 7, is $8,658 per annum calculated over 43 hectares. When compared to the gross annual value of agricultural production for the Wollondilly LGA ($61.3 million) this amount is considered a negligible impact on agricultural enterprises, agricultural employment and related industries. Also, none of the 43 hectares has been used for agricultural production currently or in the past. Further, a loss of $8,658 per annum is considered acceptable given the significant economic benefits of the proposed development (refer **Section 11.16**).

Water Resources

An assessment of impacts to water resources has been undertaken for both surface water and groundwater resources and has been presented previously in **Section 11.4** and **Section 11.3**, respectively. Based on the findings of these assessments, predicted changes in flood inundation, water flow velocity and stream profile are not considered likely to significantly impact agricultural resources or enterprises within the Project Area.

With respect to groundwater impacts, a total of 30 registered bores and three unregistered bores are predicted to experience drawdown of greater than 2 m as a result of the proposed development (Hydro Simulations, 2018). Due to changes in hydraulic properties and depressurisation of the strata there is potential for mixing of groundwater between different units, however it is considered unlikely to result in changes to beneficial uses of groundwater (refer **Section 11.3**). Tahmoor Coal would implement make good measures in relation to all bores identified to be impacted by water drawdown and/ or quality. Make good measures have been routinely and successfully implemented as part of existing Tahmoor Mine operations and would continue to be applied for the Tahmoor South Project. With the implementation of these measures, it is considered that impacts to groundwater bores can be managed. Make good measures and other groundwater mitigation and management measures are further discussed in **Section 11.3**.

Offsets

A Biodiversity Offset Strategy has been proposed by Tahmoor Coal to offset the loss of vegetation from clearing associated with the construction of the new surface facilities required to support the proposed development (refer to **Section 11.6**). The Biodiversity Assessment Report (Niche, 2018) identifies five biodiversity offset sites for the Biodiversity Offset Strategy:

- Rockford Road BioBank Site;
- Pit Top BioBank Site;
- Ventilation Shaft No. 2 Site;
- Bargo Colliery BioBank Site; and
- Anthony Road BioBank Site.

One of these is potentially considered to be an agricultural resource (Anthony Road BioBank Site) and is currently used to graze pleasure horses. The remainder are heavily timbered with native bushland. Therefore, the Biodiversity Offset Strategy will have a minor impact upon an agricultural resource or enterprise.

State Conservation Areas

The Subsidence Impact Assessment (**Appendix F**) for the proposed development identified that subsidence within the Upper Nepean State Conservation Area is expected to be negligible.

11.19.5 Management and Mitigation Measures

Management of land use for the proposed development include measures prior to, during and post mining activities. These measures include:

- Minimising disturbance to agricultural lands through minimising land clearing activities during mine planning and ensuring prompt rehabilitation following impacts.
- In accordance with existing practice at Tahmoor Mine, a Surface, Safety and Serviceability Management Plan would be developed for each asset expected to experience impacts from subsidence. This would include impacts on rural structures, tanks, sheds, fencing and farm dams.
- Development of a Land Management Plan or equivalent to manage land use and agricultural land within the Project Area. The plan would complement or include other management plans which cover impacts to land use such as surface and groundwater management, weed control, and rehabilitation. Regular inspection would be undertaken under this Plan to identify and remediate subsidence impacts such as cracking or other surface deformations.
- Re-establishing agricultural lands following mine closure in accordance with the Conceptual Mine Closure Plan (refer **Section 11.23**) to ensure acceptable post-disturbance land use and stability of the post-disturbance landform. This includes ensuring the successful restoration of agricultural land to target LSC Classifications.

11.19.6 Conclusion

Land use within the Project Area and DAA has been identified as predominately rural with some urban townships. There is no mapped BSAL in the Project Area. The nearest area of mapped BSAL is located between Douglas Park and Camden, approximately 20 km to the north-east of the Project Area. Conservation Areas surround the Project Area; however a small portion of only one, the Upper Nepean State Conservation Area, is located within the Project Area (though not within the proposed development). Subsidence impacts to the Upper Nepean State Conservation Area are considered to be negligible.

Rural land use in the Project Area includes existing agricultural land and land identified as having agricultural potential or availability. Temporary impacts to this land are anticipated as a result of ventilation shaft construction (which would be restored as part of post-mining rehabilitation), as well as subsidence related impacts to agriculture structures. However, these impacts are expected to be minor and readily managed through the SMP and/or the Extraction Plan.

Land disturbed for surface infrastructure (ventilation shafts) would be rehabilitated consistent with pre-mining conditions, following the cessation of mining. As such there would be no permanent loss of potential agricultural land use (post-mining) as a result of surface facility development associated with the Tahmoor South Project.

However, approximately 43 hectares of potential agricultural land, comprising 37 hectares of LSC Class 4 and 6 hectares Class 6 land, would be reduced to Class 7 land and therefore permanently removed from potential agricultural production as a result of the REA expansion. This land is not currently used for agricultural production and would be returned to bushland as part of the rehabilitation of the site following mine closure. It is considered that the economic benefits of the proposed development would exceed the economic loss of the 43 hectares of potential agricultural land.

The Anthony Road BioBank Site is considered potentially agriculturally productive land and is currently used to graze horses. Therefore the Biodiversity Offset Strategy would have a minor impact on agricultural resources or enterprises. All other BioBank sites are heavily timbered with native bushland.

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11.20 Rejects Disposal

This section addresses the SEARs relevant to rejects emplacement for the proposed developed. Relevant SEARs are listed in **Table 11-99**.

Table 11-99 SEARs for the assessment of rejects emplacement

Rejects SEARs	Section Addressed
Waste – including a waste management strategy;	**Section 11.21**
Rehabilitation and Final Landform – including an assessment of the likely impacts of the development on existing landforms and topography, including justification of the final landform design of the rejects emplacement area expansion and its long term geotechnical stability.	**Section 11.20**

Environmental assessment requirements for key agencies, including the EPA and OEH also requested investigation of alternative methods for reject disposal and use, including underground emplacement. Alternatives considered for rejects disposal are outlined in **Section 6.2.6.**

11.20.1 Existing Environment

Coal Rejects Material

Coal rejects generally comprise a mixture of carbonaceous shale and mudstone, with minor quantities of sandstone and small quantities of low quality coal. There are four types of coal rejects generated at the Tahmoor Mine, including:

- oversize rejects, comprised of small quantities of larger ROM oversize reject material and coal produced occasionally during screen or belt maintenance;
- coarse rejects, which are by-products from the coal washing process;
- fine rejects produced from the washery filter and belt equipment and generally have a higher moisture content; and
- coal sludge and yard clean-up spoil, comprising small quantities of sediment from site water treatment ponds and sumps.

Typical moisture content of coarse rejects is 4% to 8%, and 20% to 30% for fine rejects. When combined on the conveyor, the overall combined reject product has a moisture content of about 6% to 12%. **Table 11-100** below details the typical size faction and moisture content of coal rejects from the CHPP.

Table 11-100 Typical size faction and moisture content of all coal rejects from the CHPP

Size Fraction (mm)		Cumulative Mass (%)	
		Passing	Retained
	+ 100.0		Nil
- 100.0	+ 75.0	100.0	0.2
- 75.0	+ 50.0	99.8	1.4
- 50.0	+ 31.5	98.6	29.3
- 31.5	+ 16.0	70.7	55.7
- 16.0	+ 8.0	44.3	73.7
- 8.0	+ 4.0	26.3	83.6
- 4.0	+ 2.0	16.4	89.5

Size Fraction (mm)		Cumulative Mass (%)	
		Passing	Retained
- 2.0	+ 1.0	10.5	94.1
- 1.0	+ 0.5	5.9	96.1
- 0.5	+ 0.250	3.9	96.7
- 0.250	+ 0.150	3.3	97.1
- 0.150	+ 0.075	2.9	97.7
- 0.075		2.3	100

Tahmoor Mine REA

Historically, up to 50,000t of rejects material per annum from the Tahmoor Mine were used as select fill for a range of local community and construction projects within the Southern Coalfields, including residential developments and commercial applications. Currently, all coal rejects material is disposed of within the REA.

The existing Tahmoor Mine REA was approved as part of the 1979 Tahmoor development consent and subsequently modified by the 1994 development consent. The use of the existing Tahmoor Mine REA commenced in 1980 and currently occupies an area of about 89 ha, measuring about 1,300 m long from north to south, and 650 m wide in an east-west direction. The existing approved REA has a capacity of about 13Mt and average depth of fill to about 12 m. The REA was designed with a maximum height of about 300 m AHD. There is about 4 Mt of capacity remaining, which is expected to be used by 2022, aligning with the completion of the Tahmoor North operations.

A condition of the 1994 development consent was the development of a management, rehabilitation and monitoring plan for the REA. Operation of the REA is generally carried out in accordance with this plan which was developed in 1995. The management plan outlines design criteria, operational procedures, stormwater management, rehabilitation criteria and water monitoring requirements.

Oversize rejects, coal sludge and yard clean up spoil is transported to the REA by truck. The fine stream is dewatered using belt press and drum filter before being combined with the coarse stream, and transported by the 3R conveyor to the reject bin, for loading into rear-dump haul trucks. The rejects are transported by haul trucks, on private roads within the site, and emplaced at the REA. Rejects are dumped, compacted, shaped, topsoiled and progressively rehabilitated. The general deposition principles for the REA are outlined in Tahmoor Coal's *Reject Emplacement Area Plan* and are as follows:

- The active REA is not to exceed 4.5 ha under normal circumstances.
- All slopes are contour ploughed to reduce the potential for erosion to occur. The maximum batter slopes are:
  - external batters – 1 in 8;
  - maximum external batters – 1 in 4;
  - internal batters – 1 in 4; and
  - maximum internal batters – 1 in 3.

Rejects deposition is undertaken with the aim of minimising the area of disturbance as much as possible, with rehabilitation of disturbed surfaces commencing as soon as practical following the completion of rejects disposal within each area. Mobile equipment used to service the REA includes haul trucks, dozers, excavators, scrapers, graders and water trucks.

11.20.2 Impact Assessment

Reject Disposal

It is predicted that the proposed development would produce 15 Mt of coal reject material. Options considered for reject disposal and the configuration of the REA are described in **Section 6.2.6**. An

indicative annual breakdown of the generation of this material based on a 70% yield is provided in **Table 11-101**. The total coal reject quantities shown in the table below are based on maximum production. However, the actual quantity produced in any one year will be dependent on localised geological features, detailed mine design, the actual mine development sequence and operational factors. The preferred disposal strategy consists of two new areas adjoining the existing REA, using a staged fill plan approach. The REA will be progressively rehabilitated over the life of the mine.

The volume summary for the proposed expanded portion of the Tahmoor Mine REA is summarised in **Table 11-102** below.

Final shaping of the REA will occur in line with mine closure planning and will be managed within the footprint shown in **Figure 4.13**.

Table 11-101 Indicative schedule of annual coal reject material production

Year	Coal Reject Production (tonnes)	Cumulative Coal Reject Production (tonnes)
2019	30,000	30,000
2020	94,000	124,000
2021	322,000	446,000
2022	825,000	1,271,000
2023	1,066,000	2,337,000
2024	1,041,000	3,378,000
2025	1,061,000	4,439,000
2026	1,081,000	5,520,000
2027	1,171,000	6,691,000
2028	1,099,000	7,790,000
2029	1,014,000	8,804,000
2030	1,136,000	9,940,000
2031	1,053,000	10,993,000
2032	1,056,000	12,049,000
2033	1,186,000	13,235,000
2034	780,000	14,015,000
2035	335,000	14,350,000

Table 11-102 REA Volume Summary

Description	Area (m^2)	Fill (m^3)	Compaction Level (t/m^3)	Storage capacity (t)
Area 1	592,989 m^2	5,693,000 m^3	2.002 t/m^3	11,500,000
Area 2	210,677 m^2	1,750,000 m^3	2.002 t/m^3	3,500,000
Total	803,666 m^2	7,443,000 m^3		15,000,000

Construction

Construction works to accommodate the expansion of the REA would include construction of new internal haul roads around and within the REA and would potentially have a range of minor biophysical and social impacts. These include impacts on the amenity of local residents and visitors to the area, with regards to noise, air and visual impacts, as well as impacts to local ecological values and surface water quality.

The expansion of the REA will result in the clearance of a total of 39.7 ha of native vegetation, mainly comprising Shale Sandstone Transition Forest (SSTF) (34 ha). Construction activities for the expansion of the REA, have the potential to increase dust generation, erosion and sedimentation which may impact air quality, surface water quality, and surrounding habitat quality.

Construction impacts from the expansion of the REA with regards to surface water, ecology, noise and vibration, air quality and visual amenity are further discussed in **Section 11.4.4**, **11.6.4**, **11.10.4**, **11.11.5** and **11.17.4** respectively.

Operation

As described in **Section 4.3.2**, the expanded REA would cover up to an additional 43 hectares, providing an additional emplacement capacity of approximately 15 million tonnes for the rejects generated during the operation of the proposed development (refer to **Plate 1**). The maximum height of the REA would be increased from RL 300 m to RL 305 m in the southern section of the REA (refer to **Plate 2**). The REA will operate during the daytime and evening noise periods, that is from 7am to 10pm per day. Operational activities will typically include:

- removing existing vegetation, including all trees and shrubs;
- stripping and stockpiling of topsoil, typically the top 150 mm of soil;
- transporting of reject material, including minimisation of dust through the use of water carts;
- placing of the reject material, including spreading and compacting of the reject in layers to a density of 95 per cent standard;
- trimming and shaping to achieve the planned landform; and
- covering the reject material with the stockpiled topsoil when the landform has reached its planned shape.

These operational activities will require the use of haul trucks, dozers, front end loaders, excavators, water carts and scrapers. The proposed operation of the REA will adopt a staged reject emplacement approach progressing from the existing REA to the approved design surface and into REA Areas 1 and 2 (as shown in **Figure 4.13**).

The operational activities and the plant and equipment required to undertake these would generate a range of impacts. These would include impacts to:

- Terrestrial ecology, comprising the direct removal of 39.7 ha of native vegetation including 34 ha of SSTF. The REA expansion also has the potential to impact on connectivity of habitat in the Project Area due to fragmentation and edge effects as a result of the proposed vegetation clearance. Impacts to terrestrial ecology would be offset through the implementation of a biodiversity offset strategy as further described in **Section 11.6**;
- Operational noise. The noise assessment for the proposed development predicts noise reductions compared to existing mine levels at all receivers during the night time, evening and day time periods with the exception of two receivers at Charlies Point Road (south of the REA) where day time noise levels are predicted to increase by 3 dB compared to existing mine levels as a result of the southern extension to the REA. Tahmoor Coal has committed to implementing negotiated noise agreements or voluntary acquisition in accordance with the NSW VLAMP for receivers predicted to experience residual noise above PSNLs. Noise management measures and voluntary acquisition requirements are further discussed in **Section 11.10**;
- Operational dust. The air quality impact assessment indicates compliance with annual average $PM_{2.5}$, annual average PM_{10}, annual average TSP, annual average deposited dust and 24-hour $PM_{2.5}$ criterion, however predicts exceedances of the maximum 24 hour PM_{10} criterion at some receptors. Receptor R10 located in close proximity to the REA is predicted to experience the highest estimated number of days exceeding the 24-hour average PM_{10} criterion (up to 9 days per year). Comprehensive TARP and other dust management practices would be implemented to manage exceedances and this is further discussed in **Section 11.11**;
- Surface water impacts would primarily involve reductions to catchment flow from the expansion of the REA potentially affecting dry weather flows at Tea Tree Hollow and Bargo River. The

expansion of the REA would represent an up to 0.5% reduction of the Bargo River catchment area at its confluence with the Nepean River (HEC, 2018). However it is expected that any reductions in flow at Tea Tree Hollow would likely be offset by ongoing mine water discharge from LDP1. Surface water impacts are further discussed in **Section 11.4**; and

- Visual and landscape which are expected to be minor, as the REA Stages would be significantly visually contained by established and dense tree cover, which extends up to and beyond 1 km from the proposed REA boundary. It is therefore highly unlikely that views of the proposed REA would exist from the small number of rural receptors that are located within and immediately beyond the REA site. Visual impacts are further discussed in **Section 11.17**.

11.20.3 Management and Mitigation Measures

Potential impacts associated with the REA relating to noise, air quality, biodiversity, surface water and visual amenity would be minimised in accordance with the recommended management and mitigation measures outlined in **Section 11.10**, **11.11**, **11.6**, **11.4** and **11.17**.

Key mitigation measures relevant to management of the REA include:

- The REA will be progressively rehabilitated to minimise fragmentation of vegetation;
- A biodiversity offset strategy will be developed to compensate for the removal of native vegetation;
- Impacts to threatened species within the Project Area will be mitigated and managed through the implementation of a Biodiversity Management Plan and an on-going monitoring program;
- A Noise Management Plan (NMP) will be developed and implemented outlining a noise monitoring program which would include attended and continuous use of the existing real time noise monitoring system;
- Negotiated noise agreements and/ or voluntary acquisition would be implemented in accordance with the NSW Government VLAMP at affected receivers; and
- The existing Soil and Water Management Plan for Tahmoor mine would continue to be implemented during operation of the proposed development.

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11.21 Waste

11.21.1 Background

Waste management for both the existing operations and the proposed development is largely guided by the *Protection of the Environment (Waste) Regulation 2014*, NSW *Waste Avoidance and Resource Recovery Strategy* (WARR Strategy) and the NSW Waste Classification Guidelines (NSW EPA, 2014), as described below.

NSW Waste Classification Guidelines

The Waste Classification Guidelines (NSW EPA, 2014) describe a number of pre-classified wastes and provides specific direction on the classification of waste, based on chemical composition and associated environmental impacts. Waste streams require different management, transportation and disposal depending on their classification. The six waste categories outlined in the guidelines are:

- special waste (e.g. clinical, asbestos and tyres);
- liquid waste (e.g. human waste);
- hazardous waste (e.g. waste with a pH ≤2, coal tar, lead paint waste);
- restricted solid waste;
- general solid waste (putrescibles) (e.g. household waste, manure, food waste); and
- general solid waste (non-putrescibles) (e.g. glass, plastic, rubber, garden waste).

NSW Waste Avoidance and Resource Recovery Strategy

The WARR Strategy (NSW EPA, 2014) sets out principles incorporating the adoption of measures which avoid unnecessary resource consumption and promotes resource recovery, including reuse, reprocessing, recycling and energy recovery. The WARR Strategy identifies six key areas where outcomes must be achieved in order to avoid and manage waste, as follows:

- avoiding and reducing waste generation;
- increasing recycling;
- diverting more waste from landfill;
- managing problem wastes better;
- reduce litter; and
- reduce illegal dumping.

11.21.2 Methodology

A desktop assessment was carried out to consider the potential waste streams likely to be generated as part of the construction, operation and decommissioning stages of the proposed development. Management and mitigation measures were then considered with respect to the WARR Strategy.

Construction waste streams were identified through a review of the proposed construction methodology of the proposed development.

The waste streams of the operation of the proposed development are not anticipated to differ from the waste streams currently generated by the existing operations. Consequently, in order to assess the future waste streams of the proposed development, the waste streams and volumes of the existing operations were investigated and reported on below.

11.21.3 Existing Environment

Wastes generated

The existing operations of the Tahmoor Mine generate a number of types of waste, as summarised in **Table 11-103.** Wastes generated at the existing Tahmoor Mine are classified and separated in accordance with the Waste Classification Guidelines and managed in accordance with the existing Tahmoor Waste Management Plan.

The longwall mining at Tahmoor Mine results in groundwater seeping into the underground mine, which is collected and pumped to the onsite water treatment plant.

In the 12 month period between 1 January 2016 and 31 December 2016, the existing Tahmoor Mine produced 603,245 tonnes of rejects material from the coal washing process. The 2017 Annual Review Report for the Tahmoor Mine predicted that 476,228 tonnes of coarse rejects material would be produced in 2017.

Table 11-103 Waste register for operation of the existing Tahmoor Mine

Waste Type*	Source	Description	Management
Hazardous Waste	Batteries	Small batteries in non-commercial quantities (e.g. AAA and 9 volt batteries)	Waste contractor collects and disposes of batteries at an appropriate off site licensed facility.
		Used car and truck batteries Computer wet cell batteries	Tracked and transported to an approved metals recycling facility by waste contractor. The weight of all batteries is recorded and reported on a monthly basis.
		Underground cap lamps	Waste contractor collects and disposes of lamps at an appropriate off site licensed facility.
	Oil Drums	Not cleaned and containing hydrocarbon residues	Disposal at a licensed facility by waste contractor. Waste data is recorded and maintained on site for four years.
	Oil filters and oily rags	Containing free oil	
Special waste	Medical and hygiene waste	From the first aid room	Waste is placed within appropriately labelled storage bins at the Tahmoor Mine and collected on an as required basis by waste contractor. Weight of medical and hygiene waste is recorded on a monthly basis. All waste is incinerated at an appropriately licensed facility.
	Tyres	Used, rejected or unwanted tyres (includes shredded tyres or tyre pieces)	Disposed of on mine site in quantities less than 5,000 tonnes per annum. Any excess tyres are removed by waste contractor to a licensed waste facility that is licensed for the treatment or disposal of tyres.
Liquid waste	Grease in 205L grease drums	Grease	Full drums are relocated to secure bunded area and transported and tracked to an appropriately licensed waste facility for recycling.
	Oily water/ hydrocarbon spillages	From washdown bay, workshop floors and lube bay floor, hydraulic fluid spills etc.	Collected from site by waste contractor and disposed of at an appropriately licensed facility.
	Parts, washers, liquid waste	Parts, washers, liquid waste	Disposed to a licensed facility by waste contractor. Waste data is recorded and maintained on site for four years.
	Sewage	Generated from bathhouses and office toilets	Treated by onsite sewage treatment plant.
	Engine Coolant	Generated from equipment and site vehicles	Transported and tracked to an approved recycling facility where water and glycol are separated and recycled. Waste recorded in litres on a monthly basis.
	Waste oil	Black oil – a mixture of a range of oils	Pumped into storage tanks onsite and pumped into approved waste oil tankers when required. Transported and tracked to a waste oil refinery for processing.

Waste Type*	Source	Description	Management
General waste (non-putrescible)	Municipal waste	Domestic office waste	Disposed of within general waste bins on site.
	Paper and cardboard	Paper and cardboard from administration building	Placed in onsite recycling bins.
	Scrap metal	Scrap metal	Transported to an approved scrap metal recycling facility. Types and weights of metals are recorded and reported monthly.
	Toner cartridges	From printers and photocopiers	Disposed using cartridges.
Non-applicable	Dredged sediment	From surface sediment dams, sumps etc.	Disposal onsite at the REA.
	Coal washery rejects	Generated during the coal processing process at the CHPP	Disposal within the REA.

**As defined by the NSW Waste Classification Guidelines (NSW EPA, 2014)*

11.21.4 Impact Assessment

Construction

Waste generated throughout construction will primarily be from civil works associated with site preparation, construction of ventilation shafts and development of the REA. Waste generating activities will include:

- preparation and construction of ventilation shaft sites and the development of the REA:
  - vegetation clearance, generating green wastes;
  - excavation and construction of hardstand areas, generating soils and gravel stockpiles;
  - installation of environmental controls, fencing, silt fences, lockable gates, generating material off-cuts;
- drilling activities for the construction of the ventilation shafts;
- general construction activities;
- construction of new and modification of existing infrastructure; and
- construction of internal haul roads and a stormwater management system to facilitate the development and expansion of the REA.

Table 11-104 lists the waste streams that are anticipated to be generated throughout the construction phase of the proposed development.

Table 11-104 Wastes Generated during the Construction Phase of the Proposed Development

Waste Type*	Description
General Waste (putrescible)	Waste from litter bins and food waste
General waste (non-putrescible)	Glass, plastic, rubber, concrete, metal, paper, cardboard, dewatered sediment from sediment treatment devices, general building wastes, asphalt waste, garden waste and wood waste
Special waste	Tyres and medical and hygiene waste
Hazardous waste	Oil filters and oily rags, oil drums, and batteries
Liquid waste	Grease, oily water and hydrocarbon, sewage, engine coolant and waste oil
Restricted solid waste	Used erosion and sediment control materials
	Spoil from construction of ventilation shafts
	Groundwater from ventilation shaft construction. The management of groundwater generated through the ventilation of the ventilation shafts is described in **Section 11.3**

Inappropriate management of construction waste has the potential to impact on visual amenity, and/or result in water and soils contamination, as well as the infestation of feral and pest populations and weeds.

With the exception of the construction of the ventilation shafts, construction waste streams will be similar to those generated from the operation of the existing Tahmoor Mine. It is therefore considered that construction waste will be able to be managed appropriately by adopting the practices and procedure prescribed by the existing Waste Management Plan. Management and mitigation measures to avoid and minimise impacts of inappropriate construction waste management are detailed in **Section 11.21.5**.

Spoil from the construction of ventilation shafts TSC1 and TSC2 would be temporary stockpiled at the ventilation shaft sites or at the REA. Sediment from sedimentation ponds within this area would be removed from ponds and placed in drying areas adjacent to the water reticulation ponds. Once drained, this spoil would be added to the dry spoil stockpile from the construction of ventilation shaft TSC1 and TSC2.

Operation

Coal rejects

The largest waste generating activity that will be undertaken throughout the operational life of the proposed development would be coal washery rejects from the coal washing process, with the proposed development anticipated to generate an average of about 0.700 Mt of rejects material per annum.

The existing REA would be expanded onto 43 ha of adjacent land to accommodate the disposal of this reject material, providing an additional emplacement capacity of 12 Mt of rejects material. The maximum height of the REA would be increased from RL 300 m to RL 305 m in the southern section of the REA. The development of the REA to accommodate coal rejects would require vegetation clearance. The impact of this clearance on visual amenity and terrestrial ecology is considered a construction impact and has been assessed in **Sections 11.6** and **11.17**. Green waste generated from the development of the REA would be utilised where possible (e.g. harvestable timber or fence posts), otherwise, green waste would mulched on site and stored within the REA where practicable. The mulch would be reused onsite for landscaping works.

General Operational Waste

Over the 12 month period between 1 January 2016 and 31 December 2016 79% or 1,557 tonnes of the waste generated was disposed of offsite to landfill by licensed waste contractors and 21% or 414 tonnes of waste was reused or recycled.

It is anticipated that the proposed development would generate the same waste streams as those described in **Table 11-104.** However, as the operations would be larger than existing, with periods of increased numbers of employees, quantities of wastes generated would be slightly greater for waste disposed of offsite to landfill (i.e. ≥1,557 tonnes per 12 month period) and for waste reused or recycled onsite (i.e. ≥414 tonnes per 12 month period).

Inappropriate management of operational waste generated by the proposed development has the potential to impact on visual amenity and result in water and soils contamination. Potential impacts of the proposed development on visual amenity, surface water, terrestrial ecology, aquatic ecology and soils are outlined in **Section 11.17, 11.4**, **11.6**, **11.7** and **11.18** respectively.

The Waste Management Plan for the existing Tahmoor Mine would be amended to reflect the operation of the proposed development. The updated Waste Management Plan would be implemented throughout the operational life of the proposed development to ensure that operational waste is managed appropriately. It is therefore considered unlikely that waste generated throughout the development would impact on visual amenity, local waterbodies and soils.

11.21.5 Management and Mitigation Measures

To manage waste generated by the proposed development throughout construction and operation, the existing Waste Management Plan would be updated to reflect the proposed development. The existing Waste Management Plan has been prepared based on the principles of the WARR Strategy and in accordance with the NSW Waste Classification Guidelines. The updated Waste Management Strategy would include measures to be implemented throughout construction and operation of the proposed development to avoid or minimise waste generation where practicable, followed by reuse and recycling where reasonable and feasible. Waste avoidance and reuse strategies employed by Tahmoor Mine would include:

- purchase and use of products that generate minimal waste (including packaging) and pollution;
- purchase and use materials that may be less toxic or hazardous, or that can be reused, recycled or more readily disposed of; and

- consideration of opportunities for material reuse when purchasing resources from suppliers and during equipment procurement.

The following mitigation measures will be continued at Tahmoor Mine under the updated Waste Management Strategy:

- confirm that waste that cannot be reused or recycled would be disposed of at an appropriate licensed facility by waste contractors;
- avoid unnecessary resource consumption by making realistic and accurate predictions on the required quantities of resources such as construction materials;
- separate wastes generated by the proposed development prior to disposal by licensed contractors;
- where practicable, mulch green wastes onsite and reuse for landscaping in the absence of a more beneficial use being identified (such as harvestable timber or fence posts);
- store hazardous wastes in secure areas on site within areas that have adequate bunding and containment measure to minimise the potential for spillages and leakages which could affect surface water quality or cause soil contamination;
- store waste oil and other flammable waste streams at locations away from any likely ignition sources to minimise the risk of fire; and
- track wastes and confirm that these are being transported and disposed of in accordance with the *Protection of the Environment (Waste) Regulation 2014* and the POEO Act.

11.21.6 Conclusion

Construction waste from the proposed development would largely be from civil works associated with site preparation, construction of ventilation shafts and development of the REA. Construction waste would be managed in accordance with the Waste Management Strategy for the proposed development, and is not considered to have a significant impact.

With the exception of additional coal washery rejects, the proposed development once fully operational would not result in a significant change in the amount or type of wastes generated on site. As a result, the existing waste management practices are considered to be adequate for the proposed development.

The Waste Management Plan for the existing Tahmoor Mine would be amended to reflect the operation of the proposed development, ensuring that waste is recycled and reused where possible and that minimal general waste is disposed to landfill.

Waste management measures to be implemented for the proposed development would encourage efficient resource use alternatives, reuse and recycling. Wastes that cannot be reused or recycled would be disposed of in an appropriate manner.

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11.22 Hazard and Risk

11.22.1 Background

The proposed development is subject to risks associated with the storage of hazardous goods, underground fire/explosion, spontaneous combustion, contamination and bushfire. This section outlines the risks present as part of the operation of the existing Tahmoor Mine and risks associated with the proposed development, and is supported by an *Acid and Metalliferous Drainage and Spontaneous Combustion Assessment* (GeoTerra, 2014), which is provided in **Appendix W**.

11.22.2 Existing Environment

There are several potential hazards and risks associated with the operation of the existing Tahmoor Mine, including the storage of hazardous goods, the potential for underground fire and/or explosion and the generation of contamination. Additionally, the Tahmoor Mine is located in an area which comprises extensive stands of vegetation that pose a bushfire risk.

Storage of hazardous goods

The proposed development requires the storage of hazardous materials on-site. An initial screening was undertaken using *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (NSW Department of Planning, 2011) to identify whether the type and quantity of hazardous materials exceed the screening thresholds for potentially hazardous developments. The initial screening identified that the existing and the proposed development are likely to fall below the relevant thresholds, and therefore would not constitute a potentially hazardous development.

As part of the operation of the existing Tahmoor Mine, fuels, hydraulic fluid and oils are supplied to machinery and equipment around the mine. These materials are stored in appropriately contained and/or bunded depots around the mine to ensure compliance with the relevant codes, standards and regulations. The locations of the depots within the surface infrastructure facilities area are shown in **Figure 11.40**.

Hazardous materials are managed in accordance with Tahmoor Coal's Sustainable Development Procedure Health and Safety Management System Document *TAH SD PRO 0034 – Hazardous Materials Management*. In accordance with this procedure, bulk fuel storage areas are contained within bunded areas in accordance with *Australian Standard AS 1940 – The Storage and Handling of Flammable and Combustible Liquid*.

In line with the *Explosives Act 2003* and the *Explosives Regulation 2013,* the existing Tahmoor Mine has developed and submitted a site security plan and has also notified WorkCover NSW of the dangerous goods kept onsite, detailed in **Table 11-105** below. Operation of the proposed development is unlikely to result in greater volumes of these materials being stored at the existing Tahmoor Mine.

Table 11-105 Hazardous or Dangerous Goods Stored on the Premises of the Existing Tahmoor Mine

Dangerous Goods Class	Type of Storage	Product Name	Quantity	Distance from Boundary	Screening Method*	Assessment
3PGIII	Underground tank	Ethyl Hexanol	11,000L (approximately 8.9 tonnes)	>10 m	Figure 9	Below the threshold
3PGIII	Underground tank	Diesel Fuel	11,000L (approximately 9.7 tonnes)	>10 m	Figure 9	Below the threshold
3PGIII	Two above ground tanks	Diesel Fuel	27,500L (approximately 24.3 tonnes)	>10 m	Figure 9	Below the threshold
3PGIII	Underground tanks (above ground use)	Reagent (similar properties to Diesel Fuel)	9,000L (approximately 8 tonnes)	>10 m	Figure 9	Below the threshold

Dangerous Goods Class	Type of Storage	Product Name	Quantity	Distance from Boundary	Screening Method*	Assessment
3PGIII	Ground tank (underground use)	Reagent (similar properties to Diesel Fuel)	15,000L (approximately 13.3 tonnes)	>10 m	Figure 9	Below the threshold
1.1D	Above ground magazine	Explosive: Blasting Type E	900kg (0.9 tonnes)	200 m	Figure 5	Below the threshold
1.4B	Above ground magazine	Detonators: Electric for blasting	2,000 units	200 m	Figure 5	Below the threshold
8PGII	Above ground tank housed and separately bunded inside the water recycling plant	Sodium Hydroxide Solution	5,000L (approximately 10.65 t)	NA	Table 3	Below the threshold
8PGII	Above ground tank housed and separately bunded inside the water recycling plant	Sulphuric Acid	5,000L (approximately 9.2 t)	NA	Table 3	Below the threshold
8PGII	Above ground tank housed and separately bunded inside the water recycling plant	Hypochlorite Solution	5,000L (approximately 5.55 tonnes)	NA	Table 3	Below the threshold

* Figure and table numbers refer to the figures and tables within *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (NSW Department of Planning, 2011). Data source: Tahmoor Coal

Other hazardous goods stored on the site include:

- Aerosols: Class 2.1 used for minor spraying works, lubrication, marking paints and similar activities. Stored within a steel cage in the stores warehouse;
- Various types of oils: used for lubrication of equipment and machinery. About 6,000L stored in 20L drums on pallets within a dedicated oil storage shed. An additional oil store is located at the rear of the CHPP. The CHPP oil stores comprises a steel frame shed with sheet steel cladding and holds about 500L of oil in 20L drums fitted with hand pumps for decanting into containers;
- Flammable liquids – including aerosols, paint and other flammable liquid containers within a AS1940: 2004 compliant cabinet;
- A 14,000L quintolubric hydraulic oil tank is located within depot two;
- A 12,000L capacity Diesel Fuel tank is located within the REA adjacent to the rejects store bin;

- A mixture of lubricating oil and flammable liquids is located in a steel framed storage shed adjacent to the rejects area office; and
- A 5,000L capacity aboveground Diesel Fuel tank is located at the northern edge of the coal stockpile for the refuelling of bulldozers and front end loaders.

Underground Fire/Explosion

Outbursts are ejections of gas and coal from the working coal face. The potential for outbursts is managed primarily via gas drainage of the coal seam prior to mining to lower the gas content of the seam. Details regarding gas drainage are provided in **Section 4.2.4**.

REA Spontaneous Combustion

Coal naturally undergoes a continuous oxidising reaction when exposed to air which results in the release of heat. When the rate of heat produced by this exothermic reaction exceeds the rate at which the coal is cooled, there is a gradual build-up of heat and the temperature reaches the ignition point of coal thereby causing it to combust.

The process of spontaneous combustion is complex and is subject to a number of influencing factors, including but not limited to gas and water content, particle size, oxygen supply, and the rate of exposure of coal to oxygen. The Bulli seam has a low tendency to spontaneously combust. The Bulli seam has been mined for more than 120 years, during which there has been no reports of spontaneous combustion events.

Although the risk of spontaneous combustion at the Tahmoor Mine is considered to be remote, a Spontaneous Combustion Management Plan is currently in place which includes specific provisions for managing surface stockpile spontaneous combustion risks.

Fire and explosion (other)

Mining operations have the potential to provide sources of:

- flammable, combustible and explosive substances and materials, both natural and introduced, including gas, dust, ores, fuels, solvents and timber;
- ignition, fire or explosion, including plant, electricity, static electricity, spontaneous combustion, lightning, light metal alloys, hot work and other work practices; and
- flammable material with a flash point of less than 61° Celsius, including materials on the top of any shaft, outlet or well at the mine or petroleum site.

Tahmoor's *Fire and Explosion Principal Mining Hazard Management Plan* identifies potential sources of fire and explosions and details requirements for managing the risk of fire or explosion. The plan also details requirements for controlled materials and plant such as flame resistant and anti-static materials, lasers, overhead power lines and diesel particulate matter.

Contamination

The potential for contamination to exist at the Tahmoor Mine has been considered through the following assessments:

- Phase I Environmental Site Assessment and Targeted Underground Storage Tank Investigation;
- Phase II Environmental Site Assessment; and
- Underground Petroleum Storage Systems (UPSS) Assessment.

Phase I Environmental Site Assessment and Targeted Underground Storage Tank Investigation

A Phase I Environmental Site Assessment (ESA) was undertaken in 2009 for the existing surface infrastructure facilities area. The Phase I ESA assessed the contamination status of the pit top area for ongoing use. **Table 11-106** summarises the potential contaminating activities and land uses of the surface infrastructure facilities area and the resultant potential contaminants of concern.

Table 11-106 Historical Potential Contaminating Activities and Contaminants of Concern

Potential Past Contaminating Activities/Land Use	Potential Contaminants of Concern
Underground Storage Tanks (USTs) and Above Ground Storage Tanks (ASTs), bowsers and associated fill points, pipelines and vents.	TPH, Monocyclic Aromatic Hydrocarbons (MAH), Polycyclic Aromatic Hydrocarbons (PAH), phenols and lead
Oil/water separators and associated infrastructure	TPH, MAH, PAH, phenols and lead.
Coal Washery and Site Dams – Polymers, frothers, flocculants and conditioners used in the coal washing process and in the on-site dams for settlement purposes.	Ethyl Hexanol, Hexanedioic acid, Acrylic acid, Poly aluminium, chloride.
Workshop operations	TPH, MAH, PAH, VOC, phenols and lead.
Potential for imported fill material at the site.	Metals, MAH, PAH, VOC, phenols and lead.
Storage and use of explosives.	Nitrated compounds.
Former agricultural use of the site.	Organochlorides and Organophosphorous pesticides and asbestos .
Sewage Treatment Plant.	Heavy metals, Major cations, anions, phosphate, nitrate, ammonia, alkalinity, Total cyanide, Phosphorus.
Electrical transformers in the substation.	Polychlorinated biphenyls (PCBs), asbestos.
Hazardous Waste Storage.	Metals, PCBs, TPH, MAH, VOC, PAH and phenols.
General rubbish, scrap and dilapidated machine parts and machinery.	Metals, PCBs, TPH, MAH, PAH, asbestos.

A subsequent targeted UST investigation was undertaken to assess the potential for contamination associated with these facilities to have impacted on surrounding groundwater. Groundwater sampling identified concentrations of TPH and benzene, toluene, ethylbenzene and xylenes (BTEX) in five of six monitoring wells commissioned as part of the assessment.

Phase II Environmental Site Assessment

The findings of the Phase I and UST investigation assessments were submitted to the EPA, who issued Pollution Reduction Program 19 (PRP 19) for the site which required that the Tahmoor Mine undertake the following:

- assess the full nature and extent of contamination in soils and groundwater in the vicinity of the waste oil tank and USTs; and
- assess the potential for off-site migration of the contamination and the risk of harm to human health and the environment posed by such contamination.

The additional assessments undertaken with regards to PRP 19 included the advancement of 14 boreholes to assess the groundwater conditions in the vicinity of the waste oil tank, ASTs and USTs as well as the potential for migration of groundwater contamination from these areas.

Widespread soil contamination was not detected in the vicinity of the USTs or the waste oil tank area. Hydrocarbon impacted soil was considered likely to be a result of localised minor spills/leakages of fuels and the extent of soil impact was identified as being limited in extent.

Hydrocarbon contamination, likely to be diesel from historical storage, was identified in groundwater north, northwest and northeast of USTs in shallow and deep monitoring wells, indicating likely horizontal and vertical migration of groundwater. The extent of migration was considered to be minor given that there was limited hydraulic connectivity and the source of the contamination (diesel) is no longer stored in USTs in this area.

Other hydrocarbon contamination was detected in the vicinity of the USTs; however the nature, source and extent of contamination could not be inferred. In the vicinity of the waste oil tank and ASTs, other TPH was also identified as well as in deeper wells indicating potential vertical migration.

Offsite migration of diesel or other TPH is considered unlikely given the slow recharge of groundwater wells and low hydraulic connectivity. Existing soil and groundwater contamination is considered unlikely to present a risk of harm to human health or the environment. At the time of the Phase II ESA, a remediation action plan was not required to be prepared.

Underground Petroleum Storage Systems (UPSS) Assessment

In 2013, a UPSS Assessment was completed to comply with the requirements of the Protection of the Environment (Operations) (POEO) UPSS Regulation (2008). The UPSS Assessment comprised a groundwater monitoring event (GME) utilising existing groundwater monitoring wells at the site, in the vicinity of the USTs and in the waste oil tank area.

Light non-aqueous phase liquid (LNAPL) was detected in three monitoring wells near the USTs and in one monitoring well near the waste oil tank, and total recoverable hydrocarbons (TRH) were reported at concentrations greater than the adopted assessment criteria in groundwater samples collected at a number of locations in both areas. Volatile halogenated compounds (VHCs) were also reported in groundwater samples collected in both areas of assessment, at a concentration greater than the assessment criteria in one location.

The UPSS Assessment concluded that contamination sources in each area of the site were likely to be different. Near the USTs, reported leaks from underground fuel lines between the USTs and the CHPP were considered to be the primary source of contamination, while near the waste oil tank, a reported spill of diesel during refilling of a generator was considered to have caused the highest concentrations of TRH and the LNAPL detected.

Minor contamination was discovered and the EPA has been notified in accordance with section 60 of CLM Act (notification in 2009 and 2014). The underground tanks remain operational and will continue to be monitored.

UST Validation Report

In 2017 two 11,000 L USTs at the Tahmoor Colliery Facilities were decommissioned by excavation and offsite disposal. Soil validation sampling was undertaken to assess the suitability of the soil following removal of the USTs. Potential contaminants of concern identified included aliphatic hydrocarbons (total recoverable hydrocarbons (TRH)), benzene, toluene, ethylbenzene, xylenes (BTEX), heavy metals (lead) and polycyclic aromatic hydrocarbons (PAHs).

Analysis of the soil samples showed that concentrations of TRH, BTEX, PAHs and heavy metals were below the EPA endorsed site assessment criteria for commercial and industrial sites. One sample, collected from near a 15 KvA underground electrical cable, reported concentrations above the NEPM management limited; however the report noted that given the industrial setting the exceedance represents an isolated and inaccessible area of residual hydrocarbons. The report recommend that should future works enable access to this area, further soil removal and validation sampling should be undertaken.

Stage 1 Preliminary Contamination Investigation

A Stage 1 Preliminary Contamination Investigation of the operational area of Tahmoor Coal was undertaken by GHD Pty Ltd in 2017. The investigation includes a review of historical information, NSW WorkCover and EPA information and a site inspection.

The investigation reported that the site was used for agricultural activities until the 1970's when construction of the mine began. The overall likelihood of significant contamination to be present at the site was considered to be low, with the exception of hydrocarbon contamination around waste oil, fuel and diesel tanks and groundwater. The report recommended monitoring in these areas to determine the extent of these impacts. Other areas identified with the potential for soil contamination included:

- laydown/hardstand areas;
- USTs and aboveground storage tanks (ASTs), delivery lines and refuelling areas;

- waste oil tanks and waste oil water separator units/sumps;
- septic tanks and waste water treatment plant;
- truck wash areas;
- electrical transformers/substations;
- leaking conveyor gearbox/motor plant;
- stormwater retention ponds;
- historical areas of filling and waste disposal;
- buildings that may potentially contain hazardous building materials; and
- areas where aqueous film forming foam (AFFF) product have been stored or used.

The investigation concluded that the site is considered to be suitable for on-going use as underground mining operations provided the following measures are undertaken:

- assessment of soils around areas where spills/leaks of fuels, oils and/or other chemicals have been identified and remediated of any impacts including:
  - hardstand/laydown areas;
  - AST/refuelling points; and
  - electrical transformers;
- the assessment should provide information regarding possible health and ecological impacts from potential surface contamination;
- repair of leaking equipment and remediation of any impacts;
- review of the use of AFFF products on site and completion of sampling to assess potential impacts. The assessment should provide information regarding possible health and ecological impacts from potential contamination;
- engage competent person such as a licenced asbestos assessor to undertake a hazardous buildings materials/asbestos survey of structures present on site;
- continue to monitor groundwater impacts around the former USTs and waste oil/diesel AST areas; and
- document known areas of contamination within site management plans such as those associated with former UST and waste oil tank.

Bushfire

The proposed development is located in a basin dominated by undulating to very steep hills along the westerly aspect with an effective south to north orientated ridgeline within the local topography. In the central region of the Project Area, the topography broadens out to flatter and more gently undulating lands with generally south-west to north-east ridge-like features.

The bushfire season within and surrounding the Project Area coincides with seasonal strong south-west to north-west winds and is influenced by drought and rainfall conditions. The main sources of ignition in the Project Area are lightning strikes, arson and pile burns escaping from private residential properties. The most recent bushfire was the Hall Road Fire, which encroached into the southern portion of CCL 747. The Hall Road Fire was ignited by power lines after strong winds caused a branch to fall across the power line at Balmoral during a period where the Rural Fire Service had rated the fire danger as severe. The fire burnt 17,657 ha of land, comprising national park, Sydney catchment land and private land.

Tahmoor Coal works closely with the local Rural Fire Service, and the State Property Authority, providing and maintaining an open communication network that is emergency ready should the need arise. Firefighting equipment caches are situated at various strategic locations around the existing Tahmoor Mine, including a fire hydrant network that forms part of the mine safety system. Problematic bushfires associated with land surrounding the existing Tahmoor Mine have not previously been reported. However, Tahmoor Coal is alert to the dangers and risks associated with bushfires in this location (Tahmoor Coal, 2011).

Areas of land under the control of the Tahmoor Mine are routinely inspected and subject to controlled burning if recommended by the local bush fire brigade.

Bushfire management for the Tahmoor Mine is undertaken in accordance with Tahmoor Coal's Bushfire Management Plan, which applies to all assets owned by Tahmoor Coal within the following landholdings. The bushfire behaviour rating for these sites is detailed in **Table 11-107**.

The Bushfire Management Plan details measures to prevent the occurrence of unplanned bushfire, to suppress unplanned bushfire and to minimise the potential for the spread of bushfire in, from, or into lands under the care and control of Tahmoor Coal.

Table 11-107 Fire Behaviour Potential of Tahmoor Coal Assets in the Project Area

Fire Behaviour Potential	Tahmoor Coal Assets	Description
Low	Charlies Point Road, Tahmoor Innes Street Thirlmere Bridge Street, Thirlmere	Areas of managed grassland and vegetation and the managed curtilage to the Colliery assets.
High	Tahmoor Colliery site Ventilation Shaft TSC1 Ventilation Shaft TSC2 Rockford Road Areas of unmanaged woodland/forest vegetation	Unmanaged woodland and forest vegetation has a high fire potential due in part to the exposure to the predominant hot, dry fire winds from the northwest and west, as well as the extent of unmanaged vegetation and topography of the land on or adjoining the sites.
Very High	Forested vegetation within Bargo Colliery	Very high risk as a result of the aspect, exposure, topography, vegetation structure and unmanaged fuel loads present within and surrounding the sites.

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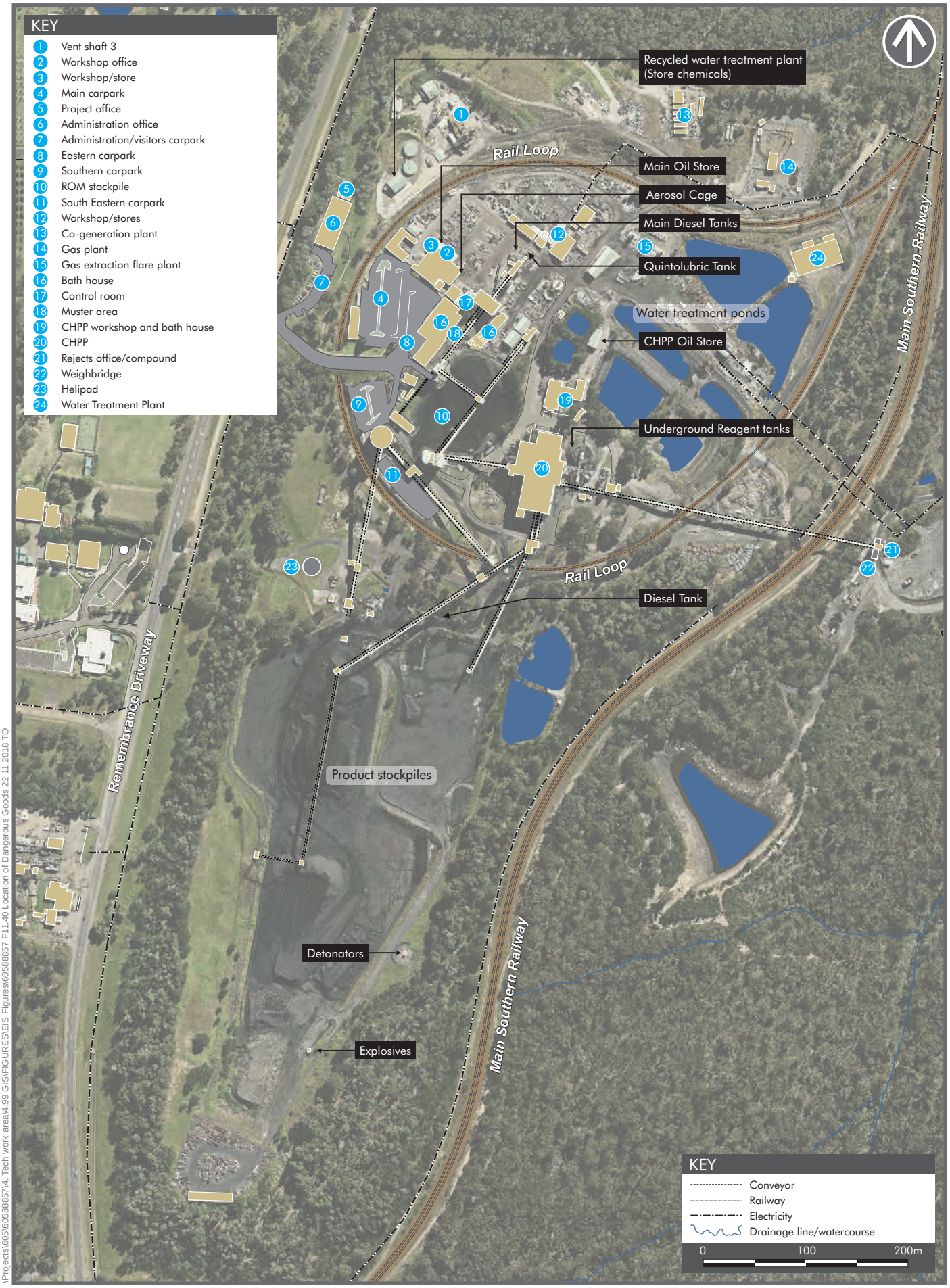

\Projects\605\605885714. Tech work area\4.99 GIS\FIGURES\EIS Figures\605885857 F11.40 Location of Dangerous Goods 22 11 2018 TO

SIMEC MINING

LOCATION OF DANGEROUS GOODS WITHIN THE SURFACE INFRASTRUCTURE FACILITIES AREA

Tahmoor South Project
Environmental Impact Statement

FIGURE 11.40

11.22.3 Methodology

Desktop Review

Hazards and risks associated with the existing Tahmoor Mine and the proposed development with regards to the storage and handling of dangerous goods, contamination and bushfire were identified by undertaking a desktop review of existing available information including:

- Tahmoor Coal Annual Environmental Monitoring Reports;
- Tahmoor Underground Annual Review Reports;
- The *Tahmoor Underground Bushfire Management Plan*;
- *Tahmoor Colliery Phase 1 Environmental Site Assessment* (AECOM, 2009);
- *Tahmoor Colliery Additional Site Investigations Report* (AECOM, 2011);
- UST Validation Report (ENRS, 2016); and
- Stage 1 Preliminary Contamination Investigation (GHD, 2017).

Acid Metalliferous Drainage and Spontaneous Combustion Assessment

An assessment was undertaken by GeoTerra (2013) to understand the potential acid and metalliferous drainage and spontaneous combustion characteristics of the proposed REA waste materials, the existing physical and chemical baseline status of the shallow regional groundwater up and down gradient of the existing REA and to identify the existing and potential acid and metalliferous drainage and spontaneous combustion nature of the REA.

The assessment comprised sampling, laboratory assessment and interpretation of the following:

- selected laboratory washery recovery tests at core intervals from the Bulli seam within the Project Area;
- an Adiabatic Self Heating Test on coal samples from the Bulli seam within the proposed development area;
- leachate and runoff samples from the existing Tahmoor Mine REA that contains in excess of 10 million tonnes of reject material from the existing Tahmoor Mine Bulli seam, roof and floor material; and
- installation of an upslope and a downslope piezometers which were used to measure the standing water level and water chemistry of groundwater within the Hawkesbury Sandstone that underlies the existing and proposed extension to the REA.

Additional detail regarding the *Acid and Metalliferous Drainage and Spontaneous Combustion Assessment* is provided in **Appendix W**.

11.22.4 Impact Assessment

Storage of hazardous goods

The Tahmoor Mine operates in accordance with a Hazardous Materials Management Procedure, which provides a framework for the management of hazards and risks associated with the operation of the mine. Operation of the proposed development would not be significantly different to the operations of the existing Tahmoor mine. Hazardous goods would continue to be contained within bunded facilities in accordance with *Australian Standard AS 1940 – The Storage and Handling of Flammable and Combustible Liquid*.

As the hazardous goods required for the proposed development would be the same as those required for the operation of the existing Tahmoor Mine, the storage of hazardous goods and combustible liquids would continue to be managed under the existing *Hazardous Materials Management Procedure* and *Fire and Explosion Principal Hazard Management Plan*.

Underground fire/explosion

The risk of outburst occurring during the operation of the proposed development is not expected to increase from the level of risk that is currently managed for the existing operations at Tahmoor North. The potential for outburst during operation of the proposed development would be managed via pre and post gas drainage of the coal seam prior to mining to lower the gas content of the seam as described in **Section 4.2.4**.

Spontaneous Combustion within the REA

It is generally observed that;

- reshaping batters allows the movement of air over the surface rather than penetrating through the unshaped steep batters into rock voids and lowers the likelihood of spontaneous combustion outbreaks; and
- compaction can assist in controlling and managing spontaneous combustion as areas that experience higher compaction, such as roads, exhibit less spontaneous combustion than batter areas.

Monitoring of the existing REA, as it has been sequentially constructed, shaped and revegetated since the early 1980's, indicates there has been no observed occurrence of spontaneous combustion. The Adiabatic Self-Heating Test conducted on the Bulli seam rejects materials from the Project Area indicated that the rate of self-heating from 40°C to 70°C was 0.003°C per hour. This data indicates that spontaneous combustion of carbonaceous material is unlikely.

Regular monitoring of the existing REA indicates that there has been no observed occurrence of spontaneous combustion, which supports laboratory test results that the occurrence of spontaneous combustion from CHPP rejects from the Bulli seam extraction associated with the proposed development is unlikely.

Fire and explosion (other)

Operation of the proposed development would not be significantly different to the operations of the existing Tahmoor mine which would be undertaken in line with the requirements set out in the Fire and Explosion Principal Hazard Management Plan.

Contamination

Existing contamination has been identified or has the potential to be present at the site, as stated in the previous contamination investigation undertaken for the site. Construction works have the potential to encounter contamination when occurring in known or potentially contaminated areas, as outlined in **Section 11.18**.

When metalliferous material is excavated from below the groundwater table and exposed to air and water, it may undergo natural oxidation of sulphide materials. The drainage produced from this oxidation process, termed acid and metalliferous drainage always contains sulphate, may be acidic or neutral, and could potentially contain dissolved heavy metals. The discharge of acid and metalliferous drainage impacted water has the potential to impact on surface water and groundwater quality, and can potentially affect ecological processes and water supply. The generation of acid and metalliferous drainage can continue after the cessation of mining operations and is difficult to ameliorate once local waterways have been impacted.

Analysis of the potential rejects from the CHPP after extraction of the Bulli seam within the Project Area indicates that the REA should be non-acid forming due to the low pyrite (chromium reducible sulfur) levels in all samples. Acid and metalliferous drainage is not anticipated as a result of these materials. The analysis of water chemistry from leachate samples from the CHPP rejects samples indicated no potential acid generation and a low potential salinity for the CHPP rejects from the proposed development. The analysis of leachate samples identified that the major ions and metals present were generally below the ANZECC/ARMCANZ (2000) trigger values for freshwater upland streams and protection of 95% of aquatic species, with the exception of pH, total dissolved solids, Copper and total Nitrogen.

Bushfire

Bushfire risk is currently managed in accordance with Tahmoor Mine's Bushfire Management Plan which forms part of the Tahmoor Coal Health and Safety Management System. The Bushfire Management plan addresses the risk of bushfire and has in place procedures and management measures to mitigate the impact of bushfire on land within and surrounding the Tahmoor Coal landholdings. The proposed development would not alter the potential risk of bushfire or the behaviour of bushfires with regards to Tahmoor Coal's assets. The existing Bushfire Management Plan is considered to be adequate to manage bushfire risks associated with the proposed development.

11.22.5 Management and Mitigation Measures

The management and mitigation of hazards and risks associated with the proposed development with regards to the storage of dangerous goods, contamination, spontaneous combustion and bushfire would be in accordance with Tahmoor Coal's, Health and Safety Management System. Management and mitigation measures for the proposed development include the following:

Storage of hazardous goods

The storage of dangerous goods during construction and operation of the proposed development would be managed using Tahmoor Coal's Health and Safety Management System Document *TAH SD PRO 0034 – Hazardous Materials Management*. Storage of combustible liquids would be managed using Tahmoor Underground *Fire and Explosion Principal Hazard Management Plan.*

Fire and explosion (other)

The management of fire and explosion would continue to be managed by the *Fire and Explosion Principal Hazard Management Plan.*

Contamination

- Tahmoor Coal would undertake ongoing acid and metalliferous drainage testing during the REA construction process;
- Tahmoor Coal would continue to routinely monitor water quality during active placement of rejects at the REA to identify any variation in acid and metalliferous drainage;
- Should contaminated land be uncovered during construction appropriate identification, containment and disposal measures would be carried out to minimise exposure risk to the environment and personnel; and
- Construction and maintenance workers who may be exposed to contaminated soil and groundwater in the vicinity of the USTs, ASTs and waste oil tank should adopt appropriate protective measures, including Personal Protective Equipment.

Spontaneous combustion

- Tahmoor Coal would undertake Adiabatic Self Heating testing throughout the REA construction process;
- the existing Spontaneous Combustion Management Plan would be updated to reflect the operation of the proposed development; and
- regular visual inspections of the REA would be undertaken for the presence of spontaneous combustion. Inspections would involve observing stockpiles for any visible signs of smoke or other obvious signs of heat production.

Bushfire

- Preventative measures for potential ignition sources would be enforced as per the preventative measures detailed in Table 11 of the existing Bushfire Management Plan. This would include discussion of bushfire and ignition prevention measures during toolbox talks and in relevant health and safety plans.
- Tahmoor Coal would continue to enforce a cigarette ban at all landholdings.
- A monitoring program would be conducted to reduce the risk of bushfire occurring.

- Fuel reduction activities would be undertaken to limit the speed and spread of potential unscheduled fires. This would include thinning or removal of undergrowth.
- Hazard reduction burning would not be undertaken during periods of declared total fire bans.
- Fire trail and access roads to, from and within Tahmoor Coals landholdings would continue to be maintained to provide access for Rural Fire Service Tankers.
- The responsibility for fire management would continue to be implemented in accordance with the Tahmoor Emergency and Management Plan, which forms part of the Health and Safety Management System.
- In the instance of a bushfire event, the existing Emergency Response Procedures for the Colliery and REA, and other landholdings would be followed.

11.22.6 Conclusion

The field and laboratory studies undertaken as part of the *Acid and Metalliferous Drainage and Spontaneous Combustion Assessment* for both potential and existing REA materials determined that there is not anticipated to be any significant observable acid and metalliferous drainage, metalliferous discharge, elevated salinity or spontaneous combustion associated with the proposed placement of rejects material on the proposed extension to the REA. The REA is not anticipated to generate acid and metalliferous drainage, and the tested samples of rejects material were classified as Non Acid Forming with a low spontaneous combustion potential. It is not anticipated that any monitoring or lime treatment would be required, nor would management measures for the capture of runoff and/or leachate be implemented.

The risks associated with the storage of dangerous goods, underground fire and explosion and bushfire on the proposed development would not differ to that which is present for the operation of the existing Tahmoor Mine. These risks would be managed through the continued implementation of the existing *Hazardous Materials Management Procedure*, *Bushfire Management Plan* and pre and post gas drainage.

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11.23 Mine Closure and Rehabilitation

This section summarises the Conceptual Mine Closure Plan SLR (2018) for the proposed development, identifies the strategies for the Surface Facilities Area with regard to the proposed final land use and considers key principles for mine closure. Proposed rehabilitation measures for the proposed development during construction, operation and closure are provided. The Conceptual Mine Closure Plan for the proposed development has been prepared by SLR (2018) and is provided in **Appendix V**.

This section addresses the SEARs for rehabilitation and final landform as shown in **Table 11-108** below.

Table 11-108 SEARs for the assessment of final landform

Rehabilitation and Landform SEARs
Rehabilitation and Final Landform – including:
• an assessment of the likely impacts of the development on existing landforms and topography, including justification of the final landform design of the rejects emplacement area expansion and its long term geotechnical stability;
• a detailed description of the progressive rehabilitation measures that would be implemented for the development;
• a detailed description of the proposed rehabilitation and mine closure strategies for the proposed development, having regard to DRG's requirements (see Attachment 2) and the key principles in Strategic Framework for Mine Closure, and the: - rehabilitation objectives, methodology, monitoring programs, performance standards and proposed completion criteria; - decommissioning and management of surface infrastructure; - nominated final land uses, having regard to any relevant strategic land use planning or resource management plans or policies; and - potential for integrating the rehabilitation strategy with offset strategies proposed for the development.
• the measures which would be put in place for the long-term protection and management of the site, any biodiversity offset areas following the cessation of mining, and
• measures to avoid the propagation of acid sulphate soils.

11.23.1 Background

The proposed development is anticipated to extend the life of the Tahmoor Mine until 2035. Following completion of mining at Tahmoor South, the land would be rehabilitated and returned to a nominated final land use. It is anticipated that closure and rehabilitation of the proposed development would be undertaken in four stages:

- closure planning (five years before closure);
- decommissioning and rehabilitation (within four years of closure);
- monitoring and maintenance (within eight years of closure); and
- relinquishment and post-relinquishment activities (within ten years of closure).

It is acknowledged that Tahmoor Mine is over a decade from closure and therefore there is potential for legislation and guidelines relating to mine closure obligations to change. For this reason, the closure plan prepared for the proposed development is considered to be conceptual and would be reviewed in more detail at the detailed closure planning stage (no later than five years prior to permanent mine closure). During the detailed phase of closure planning, Tahmoor Coal will consider applicable legislation, policy and strategic land use options for the area under the relevant planning instruments, as well as undertake further stakeholder consultation to finalise the most suitable post closure land-use.

The conceptual closure plan for this EIS has been prepared on the basis that at closure, all existing mine related infrastructure and associated aspects will be entirely removed and the affected land returned to as close to pre-mining land use as possible. The purpose of preparing this plan during the EIS is to identify a viable rehabilitation strategy for the site post-mining in order to demonstrate that the land would be rehabilitated to an appropriate land use, in accordance with the SEARs for the proposed development. In particular, the purpose of the plan is to:

- nominate final land use for the site;
- provide objectives, performance standards and completion criteria to be achieved through the rehabilitation strategy for the proposed development;
- identify rehabilitation methods to be implemented during closure; and
- nominate timeframes for rehabilitation and closure activities.

The Conceptual Mine Closure Plan considers the *Strategic Framework for Mine Closure* (Minerals Council of Australia, 2000).

11.23.2 Rehabilitation and Closure Domains

In order to effectively address the complexity of various land uses at Tahmoor Mine, the Project Area has been divided into six management domains. These domains are shown in **Figure 11.41** and are summarised below.

- Domain1: Surface Facilities Area, which includes existing surface infrastructure and T3 ventilation shaft in addition to proposed infrastructure such as upgrades to the CHPP.
- Domain 2: Stockpiles, which include the ROM coal stockpile and reclaim tunnel, product coal stockpile and reclaim tunnel, and associated water management infrastructure (including dams S2, S3 and S4).
- Domain 3: REA, which includes the REA and water management infrastructure.
- Domain 4: Mine Ventilation, which includes the discontinued Bargo ventilation shaft, existing ventilation shafts T1 and T2 and proposed ventilation shafts TSC1 and TSC2.
- Domain 5: Roads, which includes haul roads within the Surface Facilities Area.
- Domain 6: Other Lands, which includes subsidence areas, extension of overhead power line from the REA to the Charlies Point Road property ventilation shafts, gas drainage and management infrastructure, exploration boreholes, light vehicle access tracks and Biodiversity Offset Areas.

A preliminary assessment was undertaken to identify a number of potential post-mining land use options for each of the rehabilitation and closure domains. As discussed above, the conceptual closure plan has assumed that all infrastructure would (as far as practicable) be removed from the site in each of the domains, details of which are provided in **Appendix V** and summarised in **Table 11-109**.

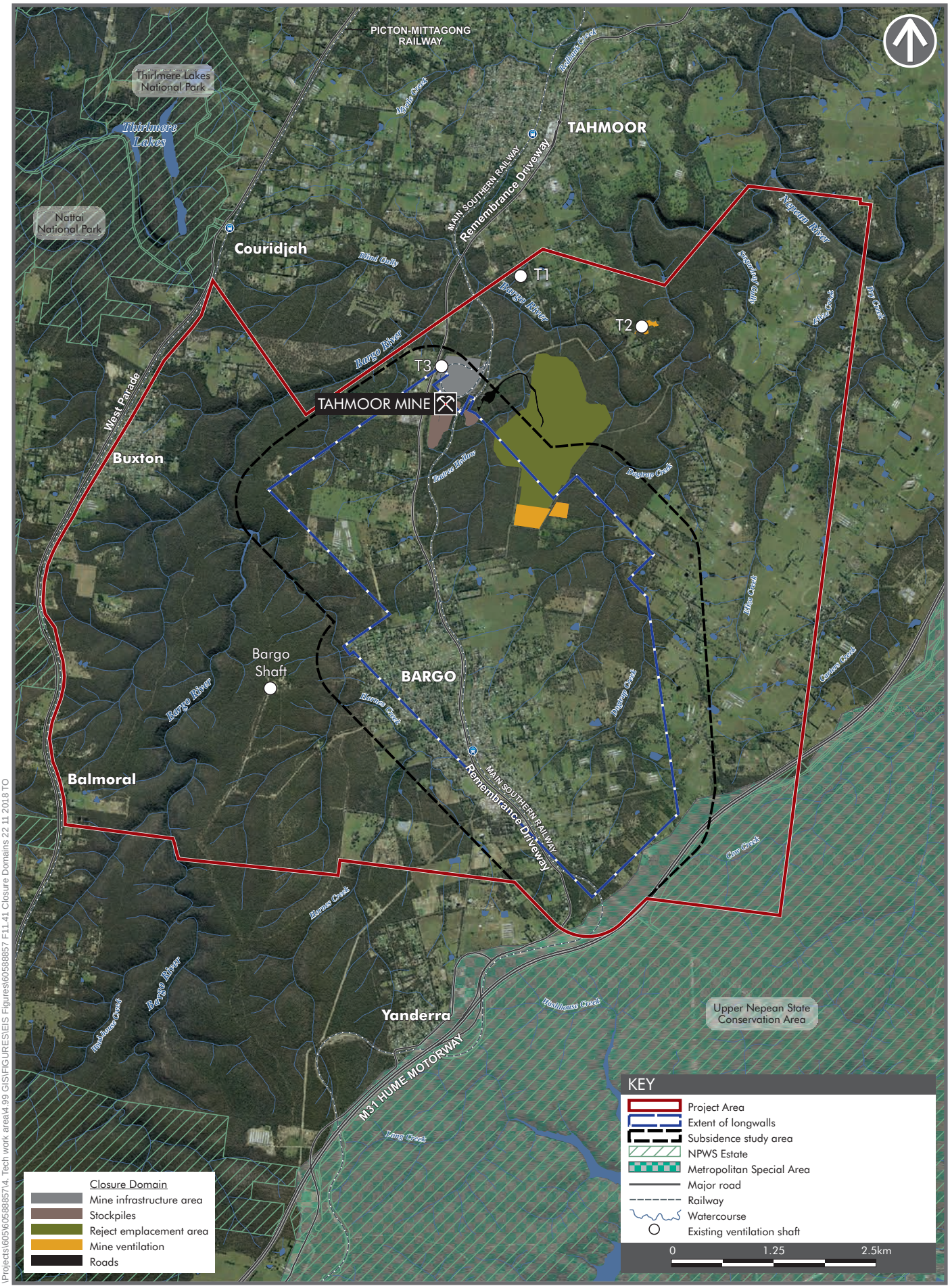
At the time of closure, there may be opportunities for infrastructure such as roads and buildings to remain to service future industries on-site and/or neighbouring industries subject to agreement with relevant stakeholders and landowners. In addition, where practicable, pipelines and cables with a diameter of approximately 200 mm or less would be capped and remain in-situ where they are located greater than 1.5 m below ground level, to reduce the risk of disturbing re-established vegetation by excavation and removal. A number of other opportunities for re-use and/or recycling (e.g. the reuse of crushed concrete footings and pads as road base for track stabilisation) may also be available and these opportunities will be considered during the detailed closure planning phase, which will include extensive stakeholder consultation.

The preliminary post-mining final land use options identified for the six domains as part of the Conceptual Mine Closure Plan are also shown in **Table 11-109**. The Conceptual Mine Closure Plan has been prepared on the basis that all existing and proposed mine related infrastructure and associated aspects will be entirely removed and the Project Area will be returned to as close to pre-mining land use as possible (predominantly native bushland) consistent with best practice mine rehabilitation. All key areas would be reshaped, deep ripped, topsoiled and seeded in accordance with the Rehabilitation and Revegetation Strategy for the proposed development (refer **Appendix V**). The post mining land use will be reviewed during preparation of the detailed closure plan five years from closure.

Table 11-109 Closure and Preliminary Post-Mining Land Use Options (SLR, 2017)

Key Area	Infrastructure and assets to be decommissioned and rehabilitated	Preliminary Final Land Use options
Domain 1: MIA	• Site services • Power lines • Equipment and buildings • Conveyors • Personnel and materials drift and ventilation shaft • Fuel farms and chemical storage areas • Roads and tracks • Sewerage and water treatment plant • Gas plant, WCMG Power Plant and on-site flare • Rail load out and rail loop • Water management infrastructure	a. Access to future mining areas (additional reserves, subject to potential future approvals) b. Re-development of the pit top area for industrial use (coal related)where compatible with end use c. Re-development of the site for some other industrial use d. Re-development of the site for a commercial use e. Re-development of the site for residential use f. Return to native bushland
Domain 2: Stockpiles	• Site services • Stockpile areas • Reclaim tunnels • Conveyors, transfer stations and gantries • Water management infrastructure • Roads and tracks	a. Access to future mining areas (additional reserves, subject to potential future approvals) b. Re-development of the stockpile area for industrial use (coal related) c. Re-development of the site for some other industrial use d. Re-development of the site for a commercial use e. Re-development of the site for residential use f. Environmental value (biodiversity) g. Grazing or other agricultural use h. Return to native bushland
Domain 3: REA	• REA • Water management infrastructure	a. Return to native bushland
Domain 4: Mine Ventilation	• Security (fencing and signage) • Site services • Ventilation shafts • Gas drainage infrastructure • Associated infrastructure	a. Return to native bushland
Domain 5: Roads	• Haul roads • Roads and tracks	a. Return to native bushland b. Retain for access to existing properties

Key Area	Infrastructure and assets to be decommissioned and rehabilitated	Preliminary Final Land Use options
Domain 6: Other lands	• Subsidence areas • Subsidence marker pegs • Gas drainage and management infrastructure • Power lines • Exploration boreholes • Roads and tracks • Associated infrastructure	a. Commensurate with the surrounding land use b. Protection for biodiversity offsets



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SIMEC MINING

REHABILITATION AND CLOSURE DOMAINS

Tahmoor South Project
Environmental Impact Statement

Source: SLR Consulting (2018)

FIGURE 11.41

11.23.3 Rehabilitation and Revegetation Measures

The rehabilitation of disturbed land for the proposed development will be conducted so that:

- Suitable vegetation species are used to achieve the nominated post-mine land uses;
- The potential for water and wind induced erosion is minimised, including the likelihood of environmental impacts being caused by the release of dust;
- The quality of surface water released from the site is such that releases of contaminants are not likely to cause environmental harm;
- The water quality of any residual water bodies is suitable for the nominated use and does not have the potential to cause environmental harm; and
- The final landform is stable and not subject to slumping or erosion which would result in the agreed post mining landform not being achieved.

The general rehabilitation measures to be implemented following the removal of infrastructure within closure domains are detailed in the Rehabilitation and Revegetation Strategy (refer **Appendix V**) and summarised below for relevant aspects.

Discussion regarding potential temporary and permanent impacts to LSC Class is provided in **Section 11.19**.

Landform Design and Planning

Rehabilitation planning at the Project Area will aid in minimising the total area of disturbance at any one time, to reduce the potential for wind-blown dust, visual impacts and sediment-laden run-off.

Rehabilitation will be designed to achieve a stable final landform compatible with the surrounding environment. This will involve the reshaping of the majority of REA to 10° or less. Should slopes exceed 10° an assessment will be made as to whether additional drainage and revegetation works are required. These control measures will help to prevent erosion and aid in groundcover establishment.

Progressive Rehabilitation

As the proposed development proposes to continue underground mining activities utilising existing surface infrastructure there would be limited opportunities for progressive rehabilitation of surface facility areas (with the exception of the REA). However, to the extent practicable where surface areas cease to be used for mining or mine-related activities, rehabilitation will be progressively undertaken as soon as reasonably practicable. The proposed progressive rehabilitation of the REA is discussed below.

Rehabilitation of REA

The REA is proposed to be progressed in approximately 15 stages over the life of the proposed development. Where practicable, each stage would be progressively rehabilitated once that section of the REA is no longer in use. Rehabilitation would commence once the portion of the REA to be rehabilitated is sufficiently dry to allow the placement of permanent capping material. Given that the remaining portions of the REA will still be in use while initial rehabilitation is completed, rehabilitation of the REA would be designed to consider:

- Capping of the rejects with a layer of compacted clay or similar impermeable substance over which a layer of free draining material would be placed;
- Use of topsoil to resurface the area to provide a suitable base for revegetation. Revegetation would be undertaken in order to inhibit ponding and infiltration of surface water and to minimise the potential for leachate;
- Rock armouring (if required) to prevent excessive slope erosion;
- Suitable clean fill and top soil will be imported on-site as required to enable progressive rehabilitation; and
- Ongoing monitoring and maintenance of the final landform to assess the rate of ongoing settlement and surface integrity.

The REA will be rehabilitated to be LSC Class 6 or 7 land (refer to **Section 11.19**). A more detailed closure strategy for the REA would also be developed in consultation with regulators as part of the detailed closure and rehabilitation planning to ensure a stable final landform.

Topsoil management

Topsoil management would be undertaken through the updating and implementation of the existing Soil and Water Management Plan, including measures such as topsoil stripping, stockpiling and the development of topsoil inventories, handling, re-spreading, amelioration and seedbed preparation. These measures are further detailed in **Appendix V**.

An assessment of the topsoil quality across the Project Area was undertaken to determine the suitability of the soil for revegetation. The assessment determined that while the topsoils are generally suitable to facilitate germination and revegetation, they will require appropriate amelioration with gypsum or lime due to the presence of strong acidity (SLR, 2018).

Erosion and sediment control

Erosion and sediment control during rehabilitation would be undertaken through the update and implementation of the existing Erosion and Sediment Control Plan.

Acid Sulfate Soils

The site is not considered at risk of acid sulfate soil or acid generation as a result of disturbance, due to the distance and elevation from the low lying coastal soils, as well as the soil types identified on site. In the event acid generation is observed measurements of soil acidity will be taken and remedial action in accordance with NSW OEH Acid Sulfate Soil Manual (1998).

Revegetation

Revegetation for the Project Area would seek to compliment the desirable post-mining land-use objectives (**Table 11-111**). Plant species would therefore be selected for each area to be rehabilitated based on their ability to successfully establish on the existing soil type and meet final land-use objectives. A list of species proposed for rehabilitation is contained in **Appendix V** and include trees, shrubs, grasses and ground covers.

Monitoring and Maintenance

Regular monitoring of rehabilitation activities would be undertaken to demonstrate whether the objectives of the Rehabilitation and Revegetation Strategy are being met and whether a sustainable landform has been achieved. Monitoring and maintenance activities would include:

- Monitoring of rehabilitation compared against reference sites (reference sites would be located in un-mined areas to indicate the pre-mining condition to be met).
- Weed monitoring and management (including regular inspection and remedial actions such as weed spraying).
- Maintenance of rehabilitated areas as required including re-seeding or planting of tube stock, application of fertiliser, and implementation of erosion protection measures.

11.23.4 Final Landform and Rehabilitation Completion Criteria

A conceptual final landform for the proposed development has been developed. Conceptual rehabilitation success criteria have been developed to provide long-term performance goals for rehabilitation activities and landform and are provided in **Table 11-110**. It is anticipated that these criteria would be further developed following consultation on the final land use with the relevant stakeholders.

Table 11-110 Preliminary Rehabilitation Success Criteria

Rehabilitation Element	Domain	Indicator	Criteria
Phase 1 – Decommissioning			
Infrastructure	Domains 1 and 2	Land use (proposed industrial)	All buildings, water storage, roads and other infrastructure (except those used by the public) have been removed unless agreed with stakeholders for their retention.
	Domains 3 and 4	Land use (Native Bushland)	All infrastructure within areas to be returned to native bushland has been removed, and disposed appropriately, for example to an appropriate waste management facility. Infrastructure may remain if the relevant stakeholders agree to their retention.
	Domain 5 and 6	Land use	Roads (except those used by the public) and other infrastructure have been removed unless stakeholders have entered into formal written agreements for their retention. Minor dozer reshaping work will be undertaken to ensure surface level consistency with the surrounding areas. Any creek crossings (i.e. culverts, etc.) will be removed and the pre-existing drainage line re-instated where applicable. If required the area will be deep ripped to loosen compacted material. A light vehicle access road is to be maintained to enable inspections of the site following closure of the mine. Fertiliser and pasture/tree seed will be applied to assist establishment of pasture post-mine land use.
	Domain 6	Boreholes	All boreholes (except those retained for monitoring purposes) have been shut down, bore casings near the surface are removed and holes plugged or capped to comply with relevant regulatory standards.
	All Domains	No contamination	All sites have been assessed by a suitably qualified expert as not containing contaminants above the relevant criteria for the proposed final land use.
Safety	All Domains	Physical	Excavations to be rendered safe. All holes/pits and other openings are to be securely capped, filled or otherwise made safe. Access to members of the public and livestock is restricted as appropriate to site conditions. No waste should remain at the surface, or at risk of being exposed through erosion. Risk assessment has been undertaken in accordance with relevant guidelines and Australian Standards and risks reduced to levels agreed with the stakeholders. Closure documentation includes the contaminated sites register which identifies contaminated sites and the treatment applied.
Phase 2 – Landform Establishment			
Landform Stability	Domains 1 and 2	Slope Gradient	Area has gradient less than 2 degrees.
	Domain 3	Capping	The REA is capped to a depth to be defined in field trials, which includes a minimum of 200 mm of topsoil. No water is observed leaching from the facility.
	Domains 1, 2, 3, 4 and 5	Surface water drainage	The landform is stable and contour banks and diversion drains are installed to direct water into stable areas or sediment control basins.

Rehabilitation Element	Domain	Indicator	Criteria
	Domains 1, 2, 3, 4 and 5	Erosion control	Erosion control structures are installed at intervals commensurate with the slope of the landform.
	Domain 6	Erosion control	Erosion mitigation measures have been applied.
	Domain 6	Subsidence impacts	Perform regular inspections over subsidence areas to identify any surface cracks and/or sinkholes. Undertake minimal clearing, if required, of areas around cracks and/or sinkholes to allow for ripping and seeding. Carry out ripping and seeding of areas where required. Following initial ripping and seeding, if trees are to be planted, they will not be planted until enough rain has fallen. Seed and/or plant appropriate species of vegetation to achieve a post-subsidence land use the same as that pre-subsidence (i.e. low intensity cattle grazing). Regrade subsidence areas and where necessary backfill with mine spoil to control surface water flow and minimise erosion and sedimentation. If ripping is not feasible due to the width of the cracks, topsoil will be stripped and stockpiled. Clay material will be imported to fill and seal cracks and the topsoil will be respread once the cracks have sealed. The area will then be reseeded with appropriate plant species.
	Domain 6	Surface water drainage	Design local drainage works to prevent the uncontrolled flow of runoff from the subsided floodplain area over the channel banks. Small diversion bunds directing floodplain runoff to properly engineered rock chute structures will be installed to minimise bank erosion.
Water Storage	Domains 3, 4 and 5	Stable landform	Water storages to be rehabilitated to a stable non-polluting condition.

Rehabilitation Element	Domain	Indicator	Criteria
Water Storage and Waterways	Domain 6	Surface water management	Provide a cover of topsoil in a weathered rock matrix to create a stable substrate for revegetation of channel banks. Weathered rock provides temporary erosion protection by covering erodible soils and minimising topsoil loss. Replace sand across the channel bed, including higher sand deposits suitable for re-creation of in-channel benches. Install timber groynes/pile field retards at the base of the channel banks (extending into the channel) to mitigate erosion undercutting the channel banks and to facilitate creation of in-channel benches. The structures will be built between each of the subsided panels affecting the river before subsidence occurs. In areas where less active bank erosion develops, large woody debris will be placed in-stream to encourage the deposition of sediment and revegetation over time. Local drainage works will be designed to prevent the uncontrolled flow of runoff from the subsided floodplain area over the channel banks. Small diversion bunds directing floodplain runoff to properly engineered rock chute structures will be installed to minimise bank erosion. Topsoil will be placed on banks and banks will be revegetated. Stock will be excluded to a width of at least 30 m from the top of bank and subsided floodplain areas in order to minimise further impacts on vegetation cover and land condition. A targeted revegetation will be undertaken in areas where surface water patterns have been affected.
Phase 3 – Growth Media Development			
Top soil	Domains 1 and 2	Physical and chemical parameters	Where practical, previously stockpiled topsoil will be used to sustain the proposed post-mining land use. Where it is assessed as not being suitable an alternative top-soil substitute will be considered (for example bio-solids, organics, etc.)
	Domains 3, 4, 5 and 6	Physical and chemical parameters	Soil salinity content is <0.6 dS/m. Soil pH is between 5.5 and 8.5. Soil Exchange Sodium Percentage is >15%. Nutrient accumulation and recycling processes are occurring as evidenced by the presence of a litter layer, mycorrhizae and/or other microsymbionts. Adequate macro and micro-nutrients are present. Where practical, previously stockpiled topsoil will be used to sustain the proposed post-mining land use. Where it is assessed as not being suitable an alternative top-soil substitute will be considered (for example bio-solids, organics, etc.)
Phase 4 – Ecosystem Establishment			
Vegetation	Domains 3, 4, 5 and 6	Species composition	Where relevant, for example areas where the post-mining land use is native bush, vegetation present is commensurate with the pre-mining environment and/or nearby undisturbed reference sites.

Rehabilitation Element	Domain	Indicator	Criteria
Phase 5 – Ecosystem Development			
Vegetation	Domains 3, 4, 5 and 6	Surface cover	Minimum of 70% vegetative cover is present (or 50% if rocks, logs or other features of cover are present). No bare surfaces >20 m^2 in area or >10 m in length down slope.
	Domains 3, 4, 5 and 6	Community structure	That the community structure is commensurate with pre-mining conditions and/or nearby undisturbed reference sites.
	Domains 3, 4, 5 and 6	Resilience to disturbance	Established species survive and/or regenerate after disturbance. Weeds do not dominate native species after disturbance or after rain. Pests do not occur in substantial numbers or visibly affect the development of native plant species.
	Domains 3, 4, 5 and 6	Sustainability	Species are capable of setting viable seed, flowering or otherwise reproducing. Evidence of second generation of tree/shrub species.
Fauna	Domains 3, 4, 5 and 6	Vertebrate Species	The number of vertebrate species does not decrease by more than 25% in the successive seasons prior to mine lease relinquishment or by more than 40% over the two successive seasons prior to mine lease relinquishment.
	Domains 3, 4, 5 and 6	Invertebrate species	Presence of representatives of a broad range of functional indicator groups involved in different ecological processes.
	Domains 3, 4, 5 and 6	Habitat structure	Typical food and water sources required by the majority of vertebrate and invertebrate inhabitants of that ecosystem type are present, including a variety of food plants and signs of natural generation of shelter sources including leaf litter.
Land Use	Domains 3, 4 and 5	Land use	The site can be managed for its designated land use without any greater management inputs than other land in the area being used for a similar purpose.

11.23.5 Conclusion

The proposed development is anticipated to extend the life of the Tahmoor Mine until 2035. Following completion of mining at Tahmoor South, the land would be rehabilitated and returned to a nominated final land use. A conceptual final landform for the proposed development has been developed and is contained within the Conceptual Mine Closure Plan (**Appendix V**). The Conceptual Mine Closure Plan has been prepared on the basis that all existing and proposed mine related infrastructure and associated aspects will be entirely removed and the Project Area will be returned to as close to pre-mining land use as possible (predominantly native bushland) consistent with best practice mine rehabilitation. The post mining land use will be reviewed during preparation of the detailed closure plan five years from closure. Conceptual rehabilitation success criteria have been developed to provide long-term performance goals for rehabilitation activities and landform.

Six management domains have been identified and the conceptual assessment has been undertaken on the basis that all infrastructure would be removed from the site in each of the domains. Preliminary final land use options for each domain were identified based on previous use, current use and the ability to rehabilitate that land following decommissioning.

The general rehabilitation measures to be implemented following the removal of infrastructure within closure domains include rehabilitation of the REA, rehabilitation of subsidence impacts, topsoil management, erosion and sediment control, revegetation and monitoring and maintenance requirements.

It is anticipated that detailed mine closure planning would be undertaken at least five years from closure, and would build upon the concept outlined in this EIS.

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11.24 Cumulative Impacts

11.24.1 Overview

Cumulative impacts result from the aggregation and interaction of impacts on a receptor and may be the product of past, present or future activities (Franks, et al. 2010). Cumulative impacts of the proposed development have been considered for the relevant environmental issues in **Section 11.0** of this EIS. There are two separate levels of cumulative impacts considered:

- Localised cumulative impacts of the proposed development on the Project Area. This includes the interaction of project impacts that in combination can cause increased effects on the environment or sensitive receptors.
- Regional interaction with other mining developments (including the existing Tahmoor Mine) in the Southern Coalfields. This includes the contribution of the proposed development to other impacts occurring at a regional scale.

Cumulative impacts have been identified and assessed across the lifecycle of the Tahmoor Mine, including activities from exploration, construction, operation and through to closure and post-closure.

11.24.2 Existing Environment and Baseline

The cumulative impact assessment has considered the key environmental issues discussed in **Section 11.0** and the existing and baseline conditions are described in the relevant sections.

The method for subsidence prediction for the proposed development used observed monitoring data from previous mining at Tahmoor Mine, as well as data from the Southern Coalfields of NSW. Subsidence predictions were used to inform assessments of natural and built features, and were also compared to observed subsidence and impacts at neighbouring collieries.

Cumulative local impacts on groundwater, surface water, terrestrial and aquatic ecology have been assessed by utilising two years' worth of baseline data. Regional impacts were assessed through analysis of observed data from the existing Tahmoor Mine, other collieries in the Southern Coalfields, and other available data sources relevant to the environmental issue.

Other mining developments identified in the region and considered in the assessment include:

- Appin and Appin West Colliery;
- West Cliff Colliery and North Cliff Colliery (non-operational);
- Metropolitan Colliery;
- Russell Vale Colliery (care and maintenance);
- Dendrobium Colliery; and
- Wongawilli Colliery.
- Berrima Colliery (closure, care and maintenance).

11.24.3 Approved and Committed Development

The following section considers approved and committed developments which are not yet fully operational, which could give rise to potential cumulative impacts in combination with the proposed development. A review of the current Major Projects, listed on the DPE website, identified several major developments relevant to the proposed development in order to assess cumulative impacts. **Table 11-111** lists these developments and identifies the anticipated timeframes.

Table 11-111 Review of Surrounding Developments

ID	Project	Status	Proponent	Anticipated Timeframe/ Project Life
09_0013	Russell Vale Colliery Underground Expansion Project	More information requested	Wollongong Coal Limited	Currently in care and maintenance mode Expansion proposes to extend mine life by 18 years
SSD 15_7172	Hume Coal Project	Project is currently being assessed by Department of Planning	Hume Coal Pty Ltd	23 years
SSD 16_8194	Dendrobium Mine Expansion Project	SEARs Issued	Illawarra Coal Holdings Pty limited	Existing operation extended for an additional 18 year timeframe.
SSD 13_6334	Sutton Forest Quarry Project	Proponent reviewing submissions	Sutton Forest Quarries Pty Ltd	30 years

The Russell Vale Colliery is located approximately 30 km south east of the proposed development. The mine was placed into care and maintenance mode in 2015 pending approval of the Russell Vale Colliery Underground Expansion Project. The proposed development seeks to extend mining operations at the site, establish new domains, and upgrade associated surface infrastructure. An EIS was submitted for review for the proposed development in 2014 and more information was requested. The proposed development was referred to the Planning Assessment Commission (PAC) and an addendum report was submitted to the PAC. In March 2016 the PAC requested additional information from the proponent.

Access to the existing Russell Vale Colliery pit top is provided via the Princess Highway and therefore traffic for the Russell Vale Colliery Underground Expansion Project and the proposed development is not expected to interact. Due to the location of the Russell Vale Colliery and site access arrangements no cumulative impacts are expected should the proposed Tahmoor South project proceed.

The Hume Coal Project is a proposed new underground coal mine and associated rail infrastructure located approximately 40 km south west of the proposed development. An EIS has been prepared for the proposed development and is currently being assessed by the Department of Planning and Environment. Due to the distance of the Hume Coal Project no cumulative impacts are expected should the proposed Tahmoor South project proceed.

The Dendrobium Mine Expansion Project proposes to expand the Dendrobium Coal Mine, located approximately 30 km south east of the proposed development. SEARs for the proposed development were issued in February 2017. Access to the existing Dendrobium Coal Mine pit top is provided via the Princess Highway and therefore traffic for the Dendrobium Coal Mine Expansion Project and the proposed development is not expected to interact. Due to the location of the Dendrobium Colliery and site access arrangements no cumulative impacts are expected should the proposed Tahmoor South project proceed.

In addition to the above projects the cumulative impact assessment also considered specific elements of the Tahmoor North operations that were not already integrated into the demolition works assessment.

11.24.4 Cumulative Impact Assessment

Tahmoor North

Coal mining operations are currently being undertaken within the Tahmoor North mining area and are scheduled for completion in 2022. While longwall mining for the proposed development would not occur until completion of Tahmoor North, the proposed development would commence pre-mining activities prior to this completion. This means there will be a period of ramping down of the existing Tahmoor North operations and the ramping up of the proposed development in order to replace current production. It is important to note that this would not increase cumulative impacts, but would rather transfer some impacts from one mining area to the other. These impacts include issues such as noise, air quality, greenhouse gas, waste and mine rejects, traffic, rail and port capacity, housing and infrastructure, social and hazard and risk.

While there will be a period of overlap between the completion of mining at Tahmoor North and the commencement of operation of the proposed development, it is considered there will be no regional net change in cumulative impacts for these issues. Further, the gradual transfer of output from Tahmoor North to the proposed development presents net beneficial outcome when compared to a scenario where both mining areas are operating concurrently at full capacity.

Subsidence

As previously discussed, subsidence predictions were modelled and compared to observed data from the existing Tahmoor Mine and other mining developments in the Southern Coalfields, therefore relying on a cumulative data set. Regional impacts are likely to result from far-field subsidence movements. Far-field subsidence movements are known to occur regularly within the Southern Coalfields but are difficult to predict by a model or prediction method. However, as no adverse impacts have been recorded as a result of such movements, cumulative impacts at a regional scale are considered unlikely.

The Subsidence Impact Assessment identified houses, amenities and infrastructure that would be impacted by subsidence movements over the life of the proposed development. As subsidence movements that have the potential to damage infrastructure are primarily limited to the SSA (i.e. excludes far-field movements), impacts to houses and structures located outside of this area are not anticipated. Further, future residential development within affected townships will be subject to the same predicted subsidence.

Cumulative impacts on infrastructure have the potential to occur where large scale linear infrastructure such as the Main Southern Railway, M31 Hume Motorway or the high pressure gas pipelines experience greater than predicted subsidence resulting in cracking or other damage. As these infrastructure link regional areas, impacts can have flow on effects. However, predictions for these infrastructure items are unlikely to result in significant impacts or deformation and therefore cumulative impacts are considered unlikely.

Groundwater

The cumulative impacts of groundwater relate to localised drawdown and impacts on water quality, volume and baseflow. The cumulative impacts were assessed through numerical modelling and included review of data from several mines in the regional area. The assessment considered impacts to sensitive water features in the region such as Thirlmere Lakes, baseflow changes to significant watercourses and drawdown impacts on private bores.

Given the simulated potential cumulative impact on the water table at Thirlmere Lakes as well as on existing groundwater users' bores within the Permian and Triassic strata, the proposed development falls within the *NSW Aquifer Interference Policy,* Level 2 classification of the minimal impact considerations.

An ongoing commitment to manage groundwater through monitoring and trigger action response and make-good measures is anticipated to minimise cumulative impacts to groundwater.

Geomorphology

The proposed development is not anticipated to cause cumulative impacts to geomorphology. The qualitative assessment of geomorphology found that the overall risk of geomorphic change as a result of mining-induced subsidence was minor. Further, as geomorphology is limited to surface water catchments, impacts are unlikely to be experienced outside these catchments. The waterways within the Project Area are described as resilient and would recover with appropriate monitoring and management should there be changes that result from the proposed development.

Surface Water

The surface water assessment considered long-term averages for rainfall data, stream flow and water quality data for the local surrounding area and included observed data for Tahmoor North. The modelling was limited to the relevant catchments within the Project Area. Due to the nature of the surface water environment, impacts are limited to these catchments and therefore other regional catchments were not assessed. No other mining developments lie within these catchments (other than Tahmoor North which was assessed) and as such the regional cumulative impact on surface water is considered minimal. Surface water has been considered cumulatively in relation to other environmental issues assessed in this EIS, such as aquatic ecology.

The impacts on both water quality and quantity are likely to be small. With consideration to the combined effects of the proposed development, consumptive groundwater extraction and the effects of other existing mining projects in Tahmoor, the cumulative impacts to baseflow reductions are assessed to be relatively small as a percentage of average flow. The largest change in baseflow is predicted to be at Dog Trap Creek where baseflow reductions would likely be distinguishable from natural variability in creek flow.

Terrestrial Ecology

Land use within and surrounding the Project Area comprises a mix of agriculture, residential development, and conservation areas. Similar land use characteristics exist for the Southern Coalfields. In a regional ecological context, the Project Area is located within the Sydney Basin Bioregion.

With the exception of existing conservation areas, land use pressures on natural systems in the Project Area have increased over time for housing, agriculture and other land uses. The proposed development has the potential to increase pressures on the natural system when combined with the existing modification and degradation of the area.

Direct impacts to terrestrial ecology will be primarily limited to surface disturbance as a result of the expansion of the REA, upgrade of the Surface Facilities Area and to a lesser extent, subsidence. The proposed development would result in the clearance of a total of 49.2 ha of native vegetation, including about 43.4 ha of Shale Sandstone Transition Forest (SSTF) EEC as well as 5.7 ha of Upper Georges River Sandstone Woodland, and impacts to individuals of threatened flora *Persoonia bargoensis* and *Grevillea parviflora* subsp. *parviflora*. While predominately localised impacts, the removal of this endangered community and species would further reduce the already limited distribution.

It is proposed that impacts will be offset through the protection of other sites within the Sydney Basin Bioregion as identified in the Biodiversity Offset Strategy for the proposed development (**Appendix K**). It is considered that the adoption of offset lands will contribute to conservation within the greater Sydney Basin Bioregion.

Aquatic Ecology

The Aquatic Ecology Assessment for the proposed development identified that cumulative impacts on aquatic ecology include the combined influence of water quality, stream connectivity and habitat loss. In addition to potential impacts from the proposed development, these can increase as a result of other land use activities such as agriculture which may contribute to sources of pollution.

Potential cumulative impacts include localised (e.g. to a pool), transient (e.g. occur in prolonged low flow condition only), or gradational impacts (e.g. downstream from a point source). Impacts to stream and biological processes may alter aquatic communities through localised reduced abundances of sensitive flora and fauna, increased abundance on tolerant flora and fauna, reduction of abundances of all aquatic flora and fauna, and a reduction of fauna richness. It is considered that the majority of stream fauna are able to recover or partially recover naturally, or through the implementation of mitigation measures (such as PRPs to control water quality).

Aboriginal Heritage

The Aboriginal Cultural Heritage Assessment involved a desktop review, field survey and consultation with Aboriginal representatives to determine local and regional cultural heritage values that may be impacted by the proposed development. One archaeological site was predicted to be impacted by direct surface disturbance and 26 archaeological sites were predicted to be impacted by indirect subsidence impacts. As a result, it was identified that the proposed development would cause a minor increase to the cumulative development impact on the Aboriginal cultural heritage of the region and local area. However, the mine plan has been designed to avoid direct undermining of rock shelter sites with art along Dog Trap Creek and archaeological heritage sites in the south east section of the Project Area south of the Hume Highway to minimise impacts to cultural heritage values in the area.

Non-Aboriginal Heritage

The Historic Heritage Assessment involved a desktop review and field survey to determine local and State items of heritage significance that may be impacted by the proposed development. The assessment considered subsidence impacts which may negatively impact heritage values. As the heritage sites identified are discrete locations, and significant impacts are not anticipated, it is considered the proposed development would not have a cumulative effect on Non-Aboriginal heritage.

Noise and Vibration

The NVIA undertaken for the proposed development considered background data for the affected area and considered meteorological effects to provide more accurate predictions. The assessment considered surrounding receptors as categorised into nine noise catchment areas. Noise modelling was undertaken for construction noise, operational noise, and road traffic noise impacts. Acoustic mitigation measures were identified that can be implemented to reduce noise levels generated at source from the proposed development. There are no other major noise sources (such as other mine developments) close enough to the proposed development that would further contribute to overall noise impacts.

While there will be some overlap in the cessation of the Tahmoor North mining area and commencement of the proposed development cumulative noise impacts are not likely to increase as a result. While there will be a period of overlap of activities to maintain coal production, activities at Tahmoor North will be ramped down as the proposed development ramps up, therefore providing no net change to regional noise emissions predicted in the NVIA.

Air Quality

Cumulative air quality impacts, including dust generation have been assessed against background concentrations of pollutants within the local region. A Monte Carlo Simulation was completed to assess PM_{10} 24-hour impacts at the most affected receptor locations. The analysis concluded that there was a probability that the selected receptors may exceed the EPA criterion of 50 $\mu g/m^3$ when impacts are considered cumulatively.

The probability of exceedances occurring are dependent on actual mine activities, other nearby dust generating activities, weather conditions as well as the implementation of real-time controls.. There are no receptors that are predicted to experience annual average PM_{10}, annual average TSP or annual average dust deposition levels above the EPA assessment criteria, either from the proposed development alone or cumulatively.

While there will be some overlap in the cessation of the Tahmoor North mining area and commencement of the proposed development cumulative air quality impacts are not likely to increase as a result. While there will be a period of overlap of activities to maintain coal production, activities at Tahmoor North will be ramped down as the proposed development ramps up, therefore providing no net change to regional air emissions predicted in the AQIA.

Greenhouse Gas

The proposed development will result in a cumulative impact in GHG emissions, with increases in Scope 1 GHG emissions representing approximately 0.19% of Australia's Paris Agreement target. The assessment of GHG emissions considered ROM and coal product values projected for years 2019 to 2035.

While there will be some overlap in the cessation of the Tahmoor North mining area and commencement of the proposed development cumulative greenhouse gas emissions are not likely to increase as a result. While there will be a period of overlap of activities to maintain coal production, activities at Tahmoor North will be ramped down as the proposed development ramps up, therefore providing no net change to regional greenhouse gas emissions predicted in the GHG assessment.

Traffic

The proposed development will result in a marginal incremental increase in traffic movements associated with employee vehicle movements travelling to and from Tahmoor Mine over its extended life, with traffic impacts peaking in 2020. The TIA considered the existing and future road network capacity and concluded that impacts would be minor. The cumulative increase in traffic is not anticipated to result in significant traffic delays or safety issues.

While there will be some overlap in the cessation of the Tahmoor North mining area and commencement of the proposed development cumulative traffic impacts are not likely to increase as a result. While there will be a period of overlap of activities to maintain coal production, activities at Tahmoor North will be ramped down as the proposed development ramps up, therefore providing no net change to regional traffic impacts predicted in the TIA.

Rail and Port Capacity

The Rail and Port Capacity study provided a cumulative assessment of the proposed development's main export route. The study identified that there is existing capacity, and included potential future growth from other sources received at Port Kembla. The transition between Tahmoor North and the proposed development is unlikely to result in a change to net cumulative impacts on rail and port capacity assessed in the study.

Social

The SIA for the proposed development considered cumulative social impacts with other environmental issues, as well as impacts from the presence and further development of mines within the Southern Coalfields. It also identified the benefits of the proposed development as a result of ongoing and increased employment within the local community, and regional benefits to the economy. Tahmoor Coal provides community contributions in accordance with a Corporate Social Involvement Plan which was developed to accommodate local and regional planning strategies. The transition between Tahmoor North and the proposed development is unlikely to result in a change to net cumulative impacts on social impacts as the social investments by Tahmoor Coal would continue to be undertaken.

Economic

A net benefit of around $699.5 million in NPV terms is expected to be generated by the proposed development over its life, of which up to $423.6 million would flow through to the NSW economy through both the labour market and suppliers. The employment benefits of the project would peak at approximately 565 employees during the transition period between ongoing mine operations at Tahmoor North and pre-mining development at Tahmoor South. Operational employment at Tahmoor South would peak at 510 employees in 2020 and involve a long term operational workforce of approximately 422 employees (post 2020).

Visual

The proposed development is not expected to create a visual impact on existing land use within and surrounding the Project Area. The existing landscape character of the Project Area is considered to be robust with a High Visual Absorption Capacity that is able to absorb change without any significant alteration to the existing landscape character. No cumulative impacts are expected.

Soils and Land Capability

Soil disturbance will occur for the expansion of the REA and upgrade of the Surface Facilities Area. The land disturbed for ventilation shaft sites (approximately 13 ha) would be rehabilitated consistent with pre-mining conditions following the cessation of mining and therefore would not result in the permanent loss of potential agricultural land. The land required for the REA expansion (approximately 43 ha) is classified as Class 4 moderate capability land (37 ha) and Class 6 low capability land (6 ha). This land would be reduced to Class 7 land (upon post-mining rehabilitation) and therefore permanently removed from potential agricultural production as a result of the REA expansion. As the land has not been historically or currently used for agricultural purposes, the impact on cumulative land capability would be low. Minor cumulative impacts could occur during construction where potential erosion and sedimentation may affect water quality in local watercourses. However, surface areas are managed by existing and proposed environmental management plans.

Land Use, Agriculture and Resources

Land use within the Project Area is primarily rural but also includes residential development, agricultural developments and conservation areas. As discussed above, around 43 ha of potential agricultural land will be reduced to Class 7 agricultural land and thereby permanently removed from potential agricultural production as a result of the REA expansion. This land is not currently used for agricultural production and would be returned to bushland as part of the rehabilitation of the site following mine closure. The rehabilitation of this land is anticipated to re-link native vegetation previously impacted by the REA.

The Conceptual Mine Closure Plan for the proposed development has identified that where possible, post-rehabilitation land use options include returning suitable land to agricultural use. A review of future rehabilitation plans of other developments (e.g. Appin Mine) identified that post-rehabilitation land-use goals would similarly aim to ensure land is returned to a quality suitable for rural agriculture.

Waste

The proposed development will generate construction and operational waste. While waste will be minimised or recycled where possible, some waste materials will require off-site disposal by a licensed contractor. The majority of off-site disposal will be required during construction, as operational waste is primarily limited to the disposal of rejects to the REA.

The transition between Tahmoor North and the proposed development is unlikely to result in a change to net cumulative impacts on waste as existing disposal methods would continue. There are no other major waste generating developments in the area and it has been assumed that other mining developments in the Southern Coalfields generate comparable waste types and volumes. Neighbouring mines also adopt an on-site reject disposal approach therefore cumulative impacts would be relatively minor.

Hazard and Risk

The proposed development will need to manage hazard and risks associated with storage of dangerous goods, underground fire and explosion and bushfire. However, the risks and management of those risks would not differ from the existing Tahmoor Mine. Cumulative impacts on hazard and risk are unlikely.

Mine Closure and Rehabilitation

The Conceptual Mine Closure Plan for the proposed development identifies suitable final land-use options following decommissioning of infrastructure. Rehabilitation of Tahmoor Mine would provide positive cumulative impacts as impact sources such as noise and dust generating activities would be removed from the area.

11.24.5 Management Measures

Cumulative impacts would be mitigated and managed by the measures presented in **Section 11.0** for each environmental issue. The commitment to ongoing groundwater and surface water monitoring programs would provide an accurate and contemporary baseline for further assessments and management as needed.

12.0 Environmental Management Commitments

12.1 Environmental Management

12.1.1 Environmental Management System

Tahmoor Coal currently operates Tahmoor Mine under an existing EMS, although the EMS is not accredited or externally audited under ISO14001. Tahmoor Coal also operates under several key EMPs as described in **Table 12-1**. Management plans that form the base of the EMS have been developed to identify, analyse, evaluate and manage all significant potential and actual risks and impacts of activities and operations in the environment and the community. The existing EMS would continue to be adopted for the proposed development but would be updated and augmented where required to incorporate additional environmental management requirements.

Table 12-1 Tahmoor Coal Environmental Management System Document Directory

Tahmoor Coal Existing Environmental Management Plans	
Title	**Purpose**
Cultural Heritage Management Plan	Protect, maintain and mitigate any impacts to items of indigenous and non-indigenous heritage as a result of Tahmoor Mine's operations.
Biodiversity and Land Management Plan	Documents land management practices and control measures to be implemented by Tahmoor Coal to minimise the impact of operations on the surrounding area.
Air Quality and Greenhouse Gas Management Plan	Documents the management practices and control measures which have been implemented at Tahmoor Mine to maintain compliance with all relevant approval conditions related to air quality. Identifies control measures aimed at minimising the release of fugitive greenhouse gas emissions from the operation.
Waste Management Plan	Documents the management measures to be implemented at Tahmoor Mine in accordance with the conditions of development consent, EPL No.1389 and legislative requirements pertaining to waste management.
Noise Management Plan	Provides a framework for site personnel to ensure that compliance is achieved with relevant internal and external regulatory requirements related to noise management at the site.
Conceptual Mine Closure Plan	Provides an overall framework for the mine closure process. The document will form the basis for the development of a detailed mine closure plan within 5 years of the planned completion of mining.
Environmental Monitoring Program	Details the environmental monitoring requirements of Tahmoor Mine and ensure that the environmental monitoring methods are appropriate to assess the environmental performance of the operation, and comply with the relevant regulatory conditions.
Social Involvement Plan	To continually improve and maintain Tahmoor Mine's role as a responsible corporate citizen and to assist with the implementation of appropriate communication strategies to promote positive and long-term relationships with our community
Pollution Incident Response Management Plan	Addresses the legislative Pollution Incident Response Management Plan requirements. This document also details the procedures for notification of pollution incidents resulting in or having the potential to cause material harm to the environment.
Soil and Water Management Plan	Provides a framework for the management of soil and water on-site at Tahmoor Mine.

Tahmoor Coal Existing Environmental Management Plans	
Title	**Purpose**
Groundwater Management Plan	Provides a framework for the operation of Tahmoor Mine so that surface and subsurface mining operations will be conducted in a manner which minimises the potential impacts on groundwater flow and quality, aquifer integrity, groundwater dependent ecosystems and other off-site groundwater related impacts.

12.1.2 Environmental Monitoring and Reporting

Tahmoor Coal is committed to continuous improvement of its environmental management of the existing Tahmoor Mine and would continue this process for the proposed development. Tahmoor Coal would continue to record all complaints received in a database and would respond to complaints received as quickly as possible. Throughout construction and operation of the proposed development, environmental reporting would include the following:

- annual reporting including a summary of the following over the reporting period:
  - compliance with all relevant approvals and licenses;
  - mining operations;
  - environmental performance;
  - water management;
  - rehabilitation works; and
  - community engagement and complaints.
- compliance reports;
- incident reports;
- remedial actions undertaken should an incident occur;
- checklists to address operational compliance;
- details of stakeholder consultation and meetings;
- outcomes of any auditing that is carried out; and
- the findings of any monitoring that is conducted.

Tahmoor Coal would ensure that all reporting that is undertaken in relation to environment and OHS issues would be in compliance with the relevant licence conditions and regulatory requirements.

12.2 Summary of Management and Mitigation Measures

Management and mitigation measures outlined in this section would be implemented throughout the detailed planning, construction and operational phases of the proposed development, should it proceed. These safeguards would minimise any potential adverse impacts arising from the proposed development on the surrounding environment. The management and mitigation measures recommended for the proposed development are summarised in **Table 12-2**.

Table 12-2 Summary of Management and Mitigation Measures for the Proposed Development

Ref#	Potential Impact	Management and Mitigation Measures	Proposed/ existing commitment	Timing
Subsidence				
S-1	Subsidence impacts to natural and built features	Prepare an Extraction Plan for the proposed development that includes: • Requirements for pre-mining subsidence assessment and ongoing monitoring. • Preparation of subsidence management sub-plans for natural and built feature categories that will be impacted by subsidence. Each subsidence sub-plan would detail subsidence performance measures, criteria, predictions and descriptions for each feature as well as monitoring requirements, risk controls and a TARP. • Consideration of the potential for increased subsidence impacts to occur.	Proposed	Pre-construction
Geomorphology				
GE-1	Impacts to geomorphological features in the Project Area from mining-induced subsidence	Undertake pre-, during- and post-mining photographic surveys and visual inspections of geomorphological features for each longwall. Results would be documented in the EP and end of panel report.	Proposed	Operation
GE-2		Undertake an annual catchment survey at 10 headwater photographic sampling locations to monitor mining-induced subsidence impacts of the proposed development over time. Monitoring results reported annually within the Annual Environmental Monitoring Report.	Proposed	Operation
GE-3		For each longwall monitor risk of knickpoint formation and implement appropriate controls to prevent knickpoint formation. Monitoring and controls to be reported within the longwall's end of panel report.	Existing	Operation
Groundwater				
GW-1	Impacts to groundwater as a result of mining-induced subsidence	Develop and implement a Groundwater Management Plan.	Existing	Pre-construction
GW-2		Develop and maintain regional groundwater monitoring network, with monitoring results reported annually within the Annual Environmental Monitoring Reports and/ or longwall end of panel reports.	Existing	Ongoing

Ref#	Potential Impact	Management and Mitigation Measures	Proposed/ existing commitment	Timing
GW-3	Impacts to groundwater as a result of longwall mining and mining-induced subsidence	Monitoring of inflows to the mine using the total mine inflow metering method, with volumes reported within the Annual Environmental Monitoring Report.	Existing	Operation
GW-4	Impacts of mining-induced subsidence on groundwater bore users	Remediation of impacts to groundwater bores to a 'make good' standard, which would involve deepening and/or replacing bores and wells and/or providing an alternative water source to affected users.	Proposed	Operation
Surface Water				
SW-1	Impacts to surface water from mining-induced subsidence	Undertake monitoring of potentially impacted streams for flow and water quality. Monitoring results reported within the Annual Environmental Monitoring Reports	Existing	Ongoing
SW-2		Install an additional gauging station at Tea Tree Hollow, downstream of the edge of the longwall and upstream of LDP1. Establish continuous pool water level monitoring network within representative sites along Dog Trap Creek, and Tea Tree Hollow. Monitoring results reported within the Annual Environmental Monitoring Reports	Proposed	Pre-construction
SW-3		Develop an adaptive monitoring program and TARP which includes triggers for water quality exceedances, unexpected flow loss based on analysis of baseline (pre-subsidence) streamflow data and unexpected loss of pool water holding capacity based on analysis of baseline (pre-subsidence) pool water level data. TARP to be documented in the longwall's EP and outcomes reported within the end of panel report.	Proposed	Pre-construction
SW-4		Monitoring of waterways within 200m of active longwall mining, including weekly photographic recording and monthly water quality sampling upstream and downstream of potentially affected areas. Results would be analysed in relation to action response triggers. Monitoring to be reported within the longwall's end of panel report.	Existing	Pre-construction

Ref#	Potential Impact	Management and Mitigation Measures	Proposed/ existing commitment	Timing
SW-5		In accordance with the Extraction Plan following the cessation of longwall mining, monitor streamflow, pool water levels and water quality of waterways in the Project Area. Monitoring to be reported within the Annual Environmental Monitoring Report.	Existing	Post-operation
Terrestrial Ecology				
TE-1	Impacts to terrestrial ecology from surface impacts of the proposed development	Monitor site disturbance works to, where possible, avoid or minimise impacts to terrestrial ecology.	Existing	Ongoing
TE-2		Revise and update the existing Biodiversity Management Plan.	Proposed	Construction and operation
TE-3		Undertake on-going monitoring of potential flora and fauna impacts, including ongoing amphibian monitoring. Monitoring to be reported annually within the Annual Environmental Monitoring Report.	Existing	Ongoing
TE-4		Implement the Tahmoor South Project Biodiversity Offset Strategy.	Proposed	Ongoing
Aquatic Ecology				
AE-1	Impacts to aquatic ecology as a result of longwall mining and mining-induced subsidence	Monitor site disturbance works to, where possible, avoid or minimise impacts to aquatic ecology. Monitoring to be reported within the Annual Environmental Monitoring Report.	Existing	Ongoing
AE-2		Undertake monitoring of macroinvertebrates for a baseline period prior to longwall extraction. The monitoring program may require adding or relocating sites according to the final mine plan, and using the same sampling methods as used in the aquatic monitoring conducted to date.	Existing	Pre-construction
AE-3		Implement a BACI (Before After Control Impact) designed monitoring program to compliment the baseline information collected and to assess monitoring impacts in an adaptive management framework.	Existing	Ongoing
Aboriginal Heritage				
AH-1	Impacts to items and/or places of Aboriginal Cultural Heritage Significance as a	Prepare a Heritage Management Plan in consultation with Aboriginal stakeholders	Proposed	Construction and operation
AH-3		Develop site-specific management strategies in consultation with Aboriginal stakeholders should any monitored rock shelters be impacted by mining-induced subsidence associated with the proposed development.	Proposed	Operation

Ref#	Potential Impact	Management and Mitigation Measures	Proposed/ existing commitment	Timing
AH-4	result of longwall mining and mining-induced subsidence.	Expand the Tahmoor Aboriginal Heritage Monitoring Program to include AHIMS sites. Undertake monitoring prior, during and after longwall mining, with monitoring results reported annually within the Annual Environmental Monitoring Report	Proposed	Ongoing
AH-5		Complete subsurface test excavation at TSC 2 Ventilation shaft and fan site location, after the confirmation of its final location.	Proposed	Construction
Non-Aboriginal Heritage				
HH-1	Impacts to items of non-Aboriginal Cultural Heritage Significance as a result of longwall mining and mining-induced subsidence.	Update the existing Cultural Heritage Management Plan to include relevant information from the Historic Heritage Assessment for the proposed development.	Proposed	Construction
HH-2		Develop a site specific Heritage Management Plan for each heritage site of local and/or State significance identified within the SSA including Wirrimbirra Sanctuary, Bargo Railway Station and Toilet Block, Bargo Cemetery, Bargo Railway Bridges (South and North) and Tahmoor Mine. Each Heritage Management Plan would form part of the Extraction Plan for the longwalls relevant to each item, and would be developed in consultation with property owners/managers and the Wollondilly Shire Council prior to commencement of mining within one year of mining.	Proposed	Construction
HH-3		Develop a site specific Heritage Management Plan for Wirrimbirra Sanctuary prior to commencement of mining, including a detailed site inspection. The outcomes of the assessment would be provided in an addition Statement of Heritage Impact in consultation with the National Trust and NSW Heritage Council, or its delegate.	Proposed	Operation
Noise and Vibration				
NV-1	Impacts of construction noise on sensitive receivers	Update the Noise Management Plan to include regular site operator education about best practice work methods to minimise construction noise as part of site inductions. Delivery of site operator education to be reported within the Annual Environmental Monitoring Report.	Proposed	Construction
NV-2		Develop and implement a Construction Noise and Vibration Management Plan. Monitoring to be reported within the Annual Environmental Monitoring Report.	Proposed	Construction
NV-3	Impacts of operational noise on sensitive	Implement all mitigation measures determined to be reasonable and feasible which were modelled in the proposed development operational mine scenario.	Proposed	Operation

Ref#	Potential Impact	Management and Mitigation Measures	Proposed/ existing commitment	Timing
NV-4	receivers	Update the Noise Management Plan, including a noise monitoring program for the proposed development, including attended and continuous real time noise monitoring. Monitoring to be reported annually within the Annual Environmental Monitoring Report.	Proposed	Operation
NV-5		Continue the existing noise monitoring program.	Proposed	Operation
Air Quality				
AQ-1	Impacts of construction of the proposed development on air quality sensitive receptors	Develop and implement an Air Quality Management Plan for inclusion in the CEMP. The Air Quality Management Plan would include management and mitigation measures to minimise dust generation.	Proposed	Construction
AQ-2	Impacts of the operation of the proposed development on air quality sensitive receptors	Update the Air Quality and GHG Management Plan to align with the operation of the proposed development. Monitoring to be reported annually within the AEMR.	Proposed	Operation
AQ-3		Continue to implement the reactive and predictive Air Quality Control System to manage dust impacts. Monitoring to be reported annually within the AEMR.	Existing	Operation
AQ-3		Implement a Target Action Response Plan relating to meteorological triggers for dust generation.	Existing	Operation
Greenhouse Gas				
GHG-1	Generation of GHG from operation of the proposed development	Implement fugitive emissions abatement measures.	Proposed	Operation
GHG-2		Continue use of an electric winder as the primary method of materials transport for the mine rather than diesel transport	Existing	Pre-construction
GHG-3		Monitor the upcast ventilation shaft sites to enable accurate measurements of ventilation emissions. Monitoring to be reported within the AEMR.	Proposed	Operation
GHG-4		Prepare an Energy Savings Action Plan in accordance with the NSW Energy Administration Amendment (Water and Energy Savings) Act, 2005 and the Guidelines for Energy Savings Action Plans (DEUS, 2005). The plan will include standards to minimise energy use and GHG emissions from the proposed development's operations.	Proposed	Operation

Ref#	Potential Impact	Management and Mitigation Measures	Proposed/ existing commitment	Timing
GHG-5		Ensuring maintenance, calibration and record keeping is undertaken on the main ventilation shafts and fans to enable GHG emission calculations. Maintaining records for monthly electricity use and monthly ROM coal production to allow calculation of greenhouse gas emissions. Monitoring to be reported annually within the AEMR.	Proposed	Operation
Traffic				
T-1	Impacts of construction traffic on the local road network	Prepare and implement a Construction Traffic Management Plan in consultation with RMS and the Wollondilly Shire Council.	Proposed	Pre-construction
T-2		Staging of construction of the proposed ventilation shafts, with one ventilation shaft constructed at a time. A benefit of this approach is that it will reduce the cumulative impact of heavy and light vehicle movements on the local road network and reduce the overall traffic volume generated by the proposed development.	Proposed	Construction
T-3	Impacts of the proposed development on road safety and traffic efficiency along the local road network	Upgrade the Remembrance Driveway/Mine Access Road intersection to improve the performance and safety of the intersection.	Proposed	Construction
T-4		Construct a new carpark at the Surface Facilities Area to accommodate the increased number employees and contractors.	Proposed	Construction
T-5	Impacts of operational traffic on the local road network	Update the existing Tahmoor Mine Traffic Management Plan	Proposed	Operation
Social Impacts				
SI-1	Impacts of the proposed development on the social environment of the Project Area	Manage amenity impacts in accordance with the measures outlined in the relevant sections outlined in this table and in **Section 11.11**, **11.13**, **11.15** and **11.17.**	Proposed	Construction and Operation
SI-2		Review community engagement activities regularly to ensure the information and mechanisms for providing key community and government stakeholders are appropriate.	Proposed	Ongoing
SI-3		Update the existing Social Investment Plan to would provide a framework for ongoing contributions to community partnerships and initiatives through Tahmoor Coal's Corporate Social Involvement (CSI) program.	Proposed	Operation

Ref#	Potential Impact	Management and Mitigation Measures	Proposed/ existing commitment	Timing
SI-4		Continuing discussions with the Wollondilly Shire Council regarding a Voluntary Planning Agreement	Proposed	Prior to determination
Visual Impacts				
V-1	Impacts of the surface development of the proposed development on visual amenity.	New structures would be dark in tone and utilise non-reflective materials where possible.	Proposed	Pre-construction
V-2		Design new lighting to consist of low level night lighting and avoid direct line of sight from surrounding areas where possible.	Proposed	Pre-construction
V-3		Design security lighting to minimise light spill where reasonable and feasible.	Proposed	Pre-construction
V-4		Retain and protect tree cover to the fullest extent possible where reasonable and feasible.	Proposed	Construction
V-5		Implement landscaping which is progressive and increases the level of existing screening potential	Proposed	Construction
V-6		Implement progressive rehabilitation and tree planting on the REA to allow the REA to blend into the landscape.	Proposed	Operation
Soils and Land Capability				
SLC-1	Impacts of mining induced subsidence from the proposed development on soil and land capability.	Update existing Soil and Water Management Plan. Monitoring to be reported within the AEMR.	Existing	Ongoing
SLC-2		Prepare and implement a TARP as part of the revised Soil and Water Management Plan.	Proposed	Operation
Land Use and Resources				
LUR-1	impacts of the surface aspects of the proposed development on land use	Limit land clearing to minimise disturbance to agricultural land.	Proposed	Construction
LUR-2		Develop a Surface, Safety and Serviceability Management Plan for each asset expected to experience impacts from subsidence.	Proposed	Pre-construction
LUR-3		Develop a Land Management Plan to manage land use and agricultural land within the Project Area.	Proposed	Pre-construction
LUR-4		Re-establishing agricultural lands following mine closure in accordance with the Conceptual Mine Closure Plan to ensure successful restoration of agricultural land to target Rural Land Capability Classification.	Proposed	Post-operation

Ref#	Potential Impact	Management and Mitigation Measures	Proposed/ existing commitment	Timing
Rejects disposal				
RD1	Impacts associated with improper management of the REA	Update the existing management, rehabilitation and monitoring plan for the REA.	Proposed	Operation
Waste				
W-1	Inappropriate waste management throughout construction and operation of the proposed development	Update the existing Waste Management Plan. Monitoring to be reported annually within the AEMR.	Proposed	Construction and Operation.
Mine Closure and Rehabilitation				
MCR-1	Inappropriate rehabilitation and revegetation of the Project Area	Undertake rehabilitation in accordance with the Rehabilitation and Revegetation Strategy. Monitoring to be reported within the AEMR.	Existing	Operation and post-mining
MCR-2	Surface cracking and impacts to waterways and drainage lines from mining-induced subsidence	Undertake rehabilitation as soon as practical following subsidence.	Proposed	Operation.

Ref#	Potential Impact	Management and Mitigation Measures	Proposed/ existing commitment	Timing
Hazard and Risk				
HR-1	The generation of contamination from the proposed development.	Undertake ongoing acid and metalliferous drainage monitoring. Monitoring to be reported within the AEMR.	Existing	Construction
HR-2	Spontaneous combustion as a result of rejects emplacement	Update the existing Spontaneous Combustion Management Plan.	Proposed	Operation
HR-3		Undertake regular visual inspections of the REA for the presence of spontaneous combustion	Existing	Ongoing
HR-4	Impacts of bushfire	Enforce a cigarette ban at all landholdings	Existing	Ongoing
HR-5		Undertake fuel reduction activities to limit the speed and spread of potential unscheduled fires	Existing	Ongoing
HR-6		Maintain Fire trail and access roads to, from and within Tahmoor Coals landholdings	Existing	Ongoing
HR-7		Continued implementation of the Tahmoor Emergency and Management Plan	Existing	Ongoing
HR-8		Follow the existing Emergency Response Procedures.	Existing	Ongoing
Environmental Risk				
EHR-1	Potential impact of diesel emissions on the health of individuals	Undertake reactive monitoring programs and regular maintenance and servicing of diesel vehicles on site to reduce risks to the exposed community.	Existing	Ongoing
Cumulative Impacts				
N/A	Cumulative impacts of the proposed development	Cumulative impacts would be mitigated and managed by the measures presented in **Section 11.0** for each environmental issue.	Proposed	Ongoing

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13.0 Project Justification

13.1 Net Project Benefits

The proposed development will provide a range of benefits to local, Regional and State economies, including continued provision of employment for Tahmoor Mine's existing workforce of approximately 390 employees, as well as providing employment for additional employees (up to around 175 additional staff at peak employment), until 2035. Additional wages, royalties and flow-on effects with a net benefit of a total of $699.5 million will be injected into regional and State economies as a result of the additional 13 year life of mining activities at Tahmoor resulting from the proposed development.

From an environmental perspective, the proposed development utilises the existing Surface Facilities Area of Tahmoor North therefore alleviating the need to develop undisturbed areas. Similarly, as the Tahmoor Mine has been operating in the region since the 1970s, the geology and environmental conditions are well known and therefore allow informed impact predictions and identification of suitable and proven mitigation and management measures.

Based on the identified environmental effects of the proposed development, the ability to confidently manage those effects to minimise harm to the environment, and the gradual transition of mining activities from Tahmoor North to Tahmoor South, the proposed development will present an overall minimal residual consequence, provided that the recommended mitigation, management and monitoring measures outlined in **Section 11.0** and the Statement of Commitments in **Section 12.0** are implemented. On balance, the benefits of the proposed development with identified management, mitigation and offset measures in place, are considered to outweigh the predicted residual consequences.

13.2 Economic Benefits

The proposed development will create the following economic benefits:

- net benefits of around $699.5 million over its life;
- royalties estimated to be worth around $149.1 million to the NSW Government;
- lower bound estimate of net benefits to the Wollondilly region of $103.4 million and upper bound estimate of $139.5 million in NPV terms;
- increase in gross regional income ranging from $3,288 million under the zero labour supply response to $3,561 million under the high labour response assumption (in NPV terms).

13.3 Ecologically Sustainable Development

13.3.1 Precautionary Principle

The Precautionary Principle, in summary, holds that where there are threats of serious or irreversible environmental damage, the lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

A precautionary and conservative approach to mine plan development has been employed to avoid or minimise potential subsidence impacts to natural and built features, including the following:

- Identification of sensitive features within the Project Area and amending the mine plan to avoid or minimise impacts to those features. These features include the Nepean Fault, Nepean River and Bargo River and the WaterNSW Metropolitan Special Area.
- A risk-based approach to subsidence impact assessment and management including specialist environmental studies for key environmental aspects as outlined in **Section 11.0**. This approach involved the establishment of RMZs as described in **Section 5.3.6**.

A detailed understanding of the issues and potential impacts associated with the proposed development has been obtained through consultation and assessment to a level commensurate with the scale of the proposed development, industry standards, the level of environmental risk and the legislative framework under which the proposed development is permitted. Specialist assessments, including the use of engineering and scientific modelling, have been undertaken to aid the design of the mine and for impacts relating to subsidence, groundwater, surface water, terrestrial ecology, aquatic ecology, Aboriginal heritage, European heritage, noise, air quality (including GHG) and traffic, to be understood and for appropriate mitigation and management measures to be developed. Assessment has also been undertaken for other issues, including social, economic, waste, hazards and land capability and land use considerations. To this end, there has been careful and thorough evaluation undertaken in order to recognise the potential for and then avoid where possible, serious or irreversible damage to the environment.

13.3.2 Intergenerational Equity

Intergenerational Equity is centred on the concept that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations. There is a moral obligation to ensure that today's economic progress, which will benefit both current and future generations, is not offset by environmental deterioration.

The primary objective of the proposed development is to allow continued operation of mining at Tahmoor and maintain the continuity of coal production from existing and proposed mining areas, optimising resource recovery for the life of mining in an environmentally and socially responsible manner. The engagement of suitably qualified and experienced consultants has ensured that the planning, design and environmental assessment phases of the proposed development have been transparent. The contents of this EIS (including appendices) has enabled the potential implications of the proposed development to be understood, and the management strategies, mitigation measures and monitoring activities required to ensure potential impacts are appropriately minimised, to be identified.

The management strategies, mitigation measures and monitoring programs have been identified to minimise short and long term potential impacts on the local environment and nearby communities. The development of the Conceptual Mine Closure Plan well in advance of mine closure demonstrates Tahmoor Coal's commitment to the future rehabilitation and goals of identifying final land-uses commensurate with the surrounding and future environment.

13.3.3 Conservation of Biological Diversity and Ecological Integrity

The principle of Conservation of Biological Diversity and Ecological Integrity holds that the conservation of biological diversity and ecological integrity should be a fundamental consideration for development proposals. The potential environmental impacts of the proposed development, including impacts upon ecological communities and habitat values, and measures to ameliorate these potential impacts are described within this EIS.

The proposed development has initially aimed to avoid and minimise potential impacts on ecological values during mine planning, and through the identification of RMZs within the Project Area. Specialist ecological assessments were undertaken for the proposed development for both terrestrial and aquatic ecology. The assessments identified that a significant impact will occur to SSTF EEC, and threatened flora species *Persoonia bargoensis*. A Biodiversity Offset Strategy has been prepared for the proposed development.

In accordance with obligations under the EPBC Act, the proposed development has been referred to the DOEE to determine if the Project was a controlled action under the EPBC Act. The proposed development was determined to be a Controlled Action under the EPBC Act on 12 January 2018. It is noted that the DoEE Controlled Action determination was based on an earlier mine plan layout. As discussed in **Section 6.2.4,** subsequent mine planning has led to a revised mine plan involving mining in the Central Domain only (proposed development) which would result in significantly less native vegetation clearing and associated habitat loss and reduced impacts to water resources.

13.3.4 Improved Valuation and Pricing of Environmental Resources

The principle of Improved Valuation and Pricing of Environmental Resources is based on environmental factors being included in the valuation of assets and services. The cost associated with using or impacting upon an environmental resource is seen as a cost incurred to utilise that resource.

Whilst clear, consistent and widely accepted standards have not yet been established for the application of this principle (to date there are few widely accepted methods by which monetary values are attributed to environmental factors), Tahmoor Coal acknowledges and accepts the financial costs associated with all the measures required to avoid, minimise, mitigate and manage potential environmental and social impacts for the proposed development.

13.3.5 Decision Making Process

The proposed development requires approval under Division 4.1, Part 4 of the EP&A Act. An assessment of the short, medium and long term impacts of the proposed development, taking into account the principles of ESD is provided in this EIS. The mitigation measures described in **Section 11.0**, the existing Tahmoor Coal EMS, and the Statement of Commitments, provided in **Section 12.0**, form the environmental mitigation, management and monitoring requirements for the proposed development.

The development consent process prescribed under Division 4.1, Part 4 of the EP&A Act and subsequent environmental management frameworks ensure that decision making and monitoring of the proposed development will be undertaken in an integrated and transparent manner, having regard to relevant issues associated with the proposed development.

Additionally, transparency throughout the decision making process for the design, impact assessment and development of management measures has been carried out through consultation with regulatory authorities, Indigenous stakeholders, and other stakeholders during the preparation of the EIS (see **Section 9.0**). This has allowed coordinated understanding and discussion regarding potential environmental impacts and proposed mitigation and management procedures.

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14.0 Conclusion

Development consent is sought for the extension of an existing underground coal mine and use of an existing Surface Facilities Area within an existing mining lease area. Tahmoor Mine is an established underground coal mine which has operated since 1979. As a result of historical and current operations, Tahmoor Coal has a strong understanding of mine design principles and requirements for the protection of surface features, and the appropriate management of potential environmental impacts.

From an environmental perspective, the proposed development utilises the existing Surface Facilities Area of Tahmoor North therefore alleviating the need to develop undisturbed areas. Similarly, as the Tahmoor Mine has been operating in the region since the 1970s, the geology and environmental conditions are well known and therefore allow informed impact predictions and identification of suitable and proven mitigation and management measures.

The proposed Mine Plan was developed by Tahmoor Coal following consultation and included consideration of predicted subsidence impacts on the MSA and associated built and natural features. Tahmoor Coal made a number of revisions to the original Mine Plan, including shortening Longwall 105 to 108 from the commencing ends of the longwalls such that they do not encroach into the MSA and impact on a number of built and natural features.

Underground mining for the existing operations at Tahmoor Mine is anticipated to be completed by 2022, depending upon geological and mining conditions. Cessation of mining at Tahmoor Mine would result in the early mine closure in 2022, the loss of employment for the existing mine employees and loss of revenue from the extraction of up to 4 Mtpa run of mine coal until 2035.

Tahmoor Coal is seeking approval for the proposed development, being the extension of underground coal mining at Tahmoor Mine, to the south and east of Tahmoor Coal's existing Tahmoor Mine Surface Facilities Area. The proposed development would extend mining at Tahmoor Mine within the Project Area, using longwall mining methods, mining the Bulli seam with the continued use of ancillary infrastructure at the existing Tahmoor Mine Surface Facilities Area.

Approval of the proposed development is required to allow Tahmoor Mine to operate beyond 2022 and to ensure that coal extraction is maximised from within CCL 747 and CCL 716. The objectives of the proposed development are to allow continued operations of the existing Tahmoor Mine and maintain continuity of coal production from existing and proposed mining areas, optimising resource recovery for the life of mine in an environmentally and socially responsible manner.

The proposed development will provide a range of benefits to local, Regional and State economies, including continued provision of employment for Tahmoor Mine's existing workforce of approximately 390 employees, as well as providing employment for additional employees (up to around 175 additional staff at peak employment), until 2035. Additional wages, royalties and flow-on effects with a net benefit of a total of $699.5 million will be injected into regional and State economies as a result of the additional 13 year life of mining activities at Tahmoor resulting from the proposed development.

The proposed development has been assessed utilising a risk-based approach to appropriately identify the potential environmental impacts of the proposed development. The identified potential environmental impacts were then the subject of an environmental assessment using:

- an assessment of existing site characteristics (the existing environment);
- consultation with relevant government agencies;
- engagement with Aboriginal and community stakeholders;
- environmental risk analysis;
- application or the principles of ecologically sustainable development;
- redesign of the proposed development where possible to avoid potential environmental impacts; and

- identification of management strategies, mitigation measures and monitoring programs to minimise adverse impact upon the local environment and nearby communities.

The proposed development meets environmental performance requirements, will result in direct and indirect economic benefits to the local community, and has been considered in accordance with the principles of ESD in order for the proposed development to be considered for approval.

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