

APPENDIX

R

Air Quality Technical Report

Part 1 of 2

BORDER TO GOWRIE REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT

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Abbreviations

Abbreviation	Explanation
°C	degrees celsius
µg	microgram
µg/m ³	microgram per cubic metre
µm	micron or micrometre
AADT	annual average daily traffic
AAQ NEPM	<i>National Environment Protection (Ambient Air Quality) Measure 2021 (Cth)</i>
AERMOD	Gaussian style air quality dispersion model
AHD	Australian height datum
Air Toxics NEPM	<i>National Environment Protection (Air Toxics) Measure 2011 (Cth)</i>
AQPSP	Air Quality Planning Scheme Policy
AQIA	air quality impact assessment
AQIA area	the air environment and footprint of identified sensitive receptor locations adjacent to the Project alignment running from the NSW/QLD border to Gowrie
AQMS	air quality monitoring station
ARTC	Australian Rail Track Corporation
AS	Australian Standard
AUSPLUME	Gaussian style air quality dispersion model
B2G	Border to Gowrie Project
BCC	Brisbane City Council
bhp	brake horsepower
BoM	Bureau of Meteorology
CALPUFF suite	CALPUFF suite, including meteorological (CALMET), dispersion (CALPUFF) and post processing modules (CALPOST), is an advanced non-steady-state modelling system designed for meteorological and air quality modelling.
CDMP	Coal Dust Management Plan
CEMP	Construction Environment Management Plan
CO	carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cth	Commonwealth
DES	Department of Environment and Science (Qld) (former)
DESI	Department of Environment, Science and Innovation (Qld)
DTMR	Department of Transport and Main Roads
EIS	Environmental Impact Statement
EMEP/EEA	European Monitoring and Evaluation Agency/European Environment Agency
ENSO	El Niño-Southern Oscillation
EP	equivalent population
EP Act	<i>Environmental Protection Act 1994 (Qld)</i>
EPA Victoria	Environment Protection Authority Victoria
EPP (Air)	<i>Environment Protection (Air) Policy 2019</i>
FIDOL	Methodology for assessing odour- Frequency, Intensity, Duration, Offensiveness, Location
g	grams
g/kWh	grams per kilowatt hour

Abbreviation	Explanation
g/m/s	grams per metre per second
g/tonne	grams per tonne
g/VKT	grams per vehicle kilometre travelled
G2H	Gowrie to Helidon Project
GRC	Goondiwindi Regional Council
hp	horsepower
hr	hour
UK IAQM	United Kingdom Institute of Air Quality Management
Inland Rail	Melbourne to Brisbane Inland Rail
kg	kilogram
kg/kL	kilograms per kilolitre
kg/tonne	kilogram per tonne
kL	kilolitre
km	kilometre
km/hr	kilometres per hour
kW	kilowatt
kWh	kilowatt hour
L	litres
m	metres
m/s	metres per second
m ²	square metres
m ³	cubic metres
MDC	Material Distribution Centre
MEI	Multivariate ENSO Index
mg	milligrams
mg/kg	milligrams per kilogram
mg/m ² /day	milligrams per square metres per day
mL	millilitres
ML	megalitres
mm	millimetres
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NO	nitrogen oxide
NO ₂	nitrogen dioxide
NO _x	oxides of nitrogen
NPI	National Pollutant Inventory
NRMMC	National Resource Management Ministerial Council
NS2B	North Star to Border Project
NSW	New South Wales
NSW EPA	NSW Environment Protection Authority
NZS	New Zealand Standard
O ₃	ozone

Abbreviation	Explanation
OLM	ozone limiting method
ONI	Oceanic Niño Index
PAHs	polycyclic aromatic hydrocarbons
PM ₁₀	particulate matter less than 10 micrometres
PM _{2.5}	particulate matter less than 2.5 micrometres
ppm	parts per million
Qld	Queensland
QR	Queensland Rail
RTAQMM	Road Traffic Air Quality Management Manual
s	second
SCRAM	Support Centre for Regulatory Atmospheric Modelling
SO ₂	sulfur dioxide
SOI	Southern Oscillation Index
t	tonne
TAPM	The Air Pollution Model
THC	total hydrocarbons
the Project	The Border to Gowrie section of the Inland Rail alignment
the proponent	Australian Rail Track Corporation Ltd
TRC	Toowoomba Regional Council
TSP	total suspended particulate
US EPA	United States Environmental Protection Agency
VOCs	volatile organic compounds

Executive summary

The proponent proposes to construct and operate the Border to Gowrie (B2G) section of Inland Rail (the Project), which consists of approximately 217.48 kilometres of single-track railway with five crossing loops to accommodate double stack freight trains.

Key elements of the air quality impact assessment (AQIA) included:

- Desktop review, including review of relevant legislation, historical meteorological data and ambient air quality monitoring data
- Adoption of air quality goals based on relevant legislation and guidance
- Desktop survey of sensitive receptors within the air quality study area, with a total of 1,948 receptors considered in the assessment
- Generation of AQIA area specific meteorology
- Risk-based assessment for the construction works stage to estimate the potential risk of air quality impacts, including cumulative air quality impacts
- Primarily quantitative impact assessment for the operations stage to estimate potential air quality impacts, including cumulative air quality impacts
- Identification of mitigation strategies
- Assessment of the residual impact with the inclusion of the identified mitigation measures
- Assessment of the construction works stage of the Project was undertaken following the method prescribed in *Guidance on the assessment of dust from demolition and construction* (United Kingdom Institute of Air Quality Management (UK IAQM), 2014). This document provides a qualitative risk assessment process for the assessment of the potential impact of dust generated from demolition, earthmoving, and construction activities.

For the assessment of the operations stage, an emissions inventory was developed to quantify emissions from diesel locomotives. The key pollutants of interest included in the emissions inventory for diesel locomotives were oxides of nitrogen (NO_x), particulates less than 10 micrometres (PM₁₀), particulates less than 2.5 micrometres (PM_{2.5}), and total suspended particulates.

The air quality dispersion modelling assessment for the operations stage was completed based upon methodologies and guidance presented in the following:

- *Application requirements for activities with impacts to air*, a guideline document under the *Environmental Protection Act 1994* (Qld) (EP Act) to support applications for activities with impacts to air (Department of Environment and Science (DES), 2023)
- *Air – EIS information guideline*, a guideline providing advice to proponents in relation air emissions when preparing an Environmental Impact Statement (EIS) (DES, 2022)
- *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, which provides statutory methods for modelling and assessing emissions of air pollutants in NSW (NSW Environment Protection Authority (EPA), 2022) but is considered robust and applicable for Queensland
- *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'* (Barclay & Scire, 2011) which provides detailed guidance on selection of CALPUFF modelling variables.

Meteorological data utilised in the assessment was derived in accordance with the aforementioned guidance using *The Air Pollution Model* developed by Commonwealth Scientific and Industrial Research Organisation (CSIRO) (2008). Dispersion modelling of pollutants was then completed utilising CALPUFF, with meteorology refined using CALMET.

The methodology adopted for the assessment is conservative and is considered likely to over-estimate impacts, as is typically required for AQIAs. A number of assumptions have been made in the assessment, including the following key assumptions:

- Emission factors for the locomotives have been adopted from the United States Environmental Protection Agency (US EPA) (2009) and the European Monitoring and Evaluation Programme/European Environment Agency (EMEP/EEA) (2016)
- The diesel locomotive particulate fraction for PM_{2.5} was assumed to be 96 per cent of the PM₁₀ emission rates as indicated in the *Emission estimation technique manual for Railway yard operations* (Department of the Environment, Water, Heritage and the Arts (DEWHA), 2008), which is considered the most accurate reference for particulate emissions from locomotives
- Nitrogen dioxide (NO₂) concentrations were derived from modelled results utilising the ozone (O₃) limiting method (OLM) as per NSW EPA (2022). Background NO₂ and O₃ concentrations for the AQIA study area have been assumed based on measured concentrations from the DESI Mutdapilly air quality monitoring station
- The study assumes low sulfur content fuel as per the requirements of the *Fuel Quality Standards Act 2000* (Commonwealth (Cth)) and the Fuel Standard (Automotive Diesel) Determination 2001 (Cth). The regulation of low sulfur content fuel in Australia has significantly decreased the generation and concentrations of sulfur dioxide (SO₂) near transport sources and concentrations are typically well below the relevant air quality objectives. Due to the low likelihood of significant impact, SO₂ has not been considered in this assessment.

A survey of sensitive receptors in the AQIA area has been undertaken via desktop review of aerial imagery from Queensland Globe. Approved developments (e.g. residential sub-divisions) that may in future become sensitive receptor locations have also been considered and included within the AQIA. Identification of these potential future receptors was completed through a desktop review of current cadastral boundaries, and where clear undeveloped sub-divisions are present, these lots have been included as sensitive receptor locations. The identified sensitive receptors within the AQIA area were included in the dispersion model developed for the Project. Potential worst case pollutant concentrations were also predicted across the AQIA area through the inclusion of a grid of receptors.

The predicted pollutant concentrations and deposition rates were compared to Project specific air quality goals that were adopted considering the EP Act, the *Environmental Protection (Air) Policy 2019* (EPP (Air)) and guideline values commonly recommended by DESI. The adopted air quality goals for the Project are set for the protection of human health and wellbeing, aesthetic amenity and the health and biodiversity of ecosystems.

Dispersion modelling carried out for the Project predicted that cumulative pollutant concentrations and deposition levels would be below the adopted air quality goals at all sensitive receptors identified in the AQIA for all pollutants of concern.

The operations stage assessment also investigated the potential for impact to the quality of water stored in rainwater tanks. Compliance with the drinking water guideline values prescribed by the *Australian Drinking Water Guidelines* (National Health and Medical Research Council (NHMRC) and National Resource Management Ministerial Council (NRMCC), 2011) is predicted by a significant margin for all pollutant species of concern.

Mitigation measures and recommendations for air quality monitoring have been identified for the Project. For the construction works stage of the Project, dust sources will be variable in nature and the proximity to sensitive receptors within the AQIA will also vary. Implemented construction mitigation measures need to address this variability and a range of mitigation measures have been recommended. Prior to the start of construction, an Air Quality and Dust Management Plan will be developed as a component of the Construction Environmental Management Plan as detailed in the Draft Outline EMP (EIS Chapter 24: Draft Outline Environmental Management Plan) to ensure Project construction works avoid significant impacts to the environmental values of air quality in the Project area for pollutant species including nuisance, dust and odour.. The Air Quality and Dust Management Plan will specify performance criteria, controls, procedures, monitoring, corrective action, reporting and complaint response procedures.

1 Introduction

This air quality impact assessment (AQIA) provides an assessment of the impacts of the Border to Gowrie (B2G) Project (the Project) on the environmental values of air, and subsequent impacts on sensitive receptors.

This report has been prepared as part of the Environmental Impact Statement (EIS). This report addresses Sections 11.127 to 11.138 of the Terms of Reference that were issued for the Project in November 2018 and additional information requirements from the Office of the Coordinator-General.

The Project is one of the interlinking projects making up the Inland Rail Program as presented in Figure 1.1. The Project comprises approximately 149.48 kilometres (km) of new (greenfield) rail corridor and utilisation of approximately 68.00 km of existing (brownfield) rail corridor. The 217.48 km of new rail track will consist of 7 km of single-gauge track and 210.48 km of dual-gauge track.

The Project ties into adjoining Inland Rail projects at either end; specifically, the North Star to NSW/QLD Border (NS2B) project at the southern end and the Gowrie to Helidon (G2H) project at the northern end.

The location of the Project is shown in Figure 1.2.

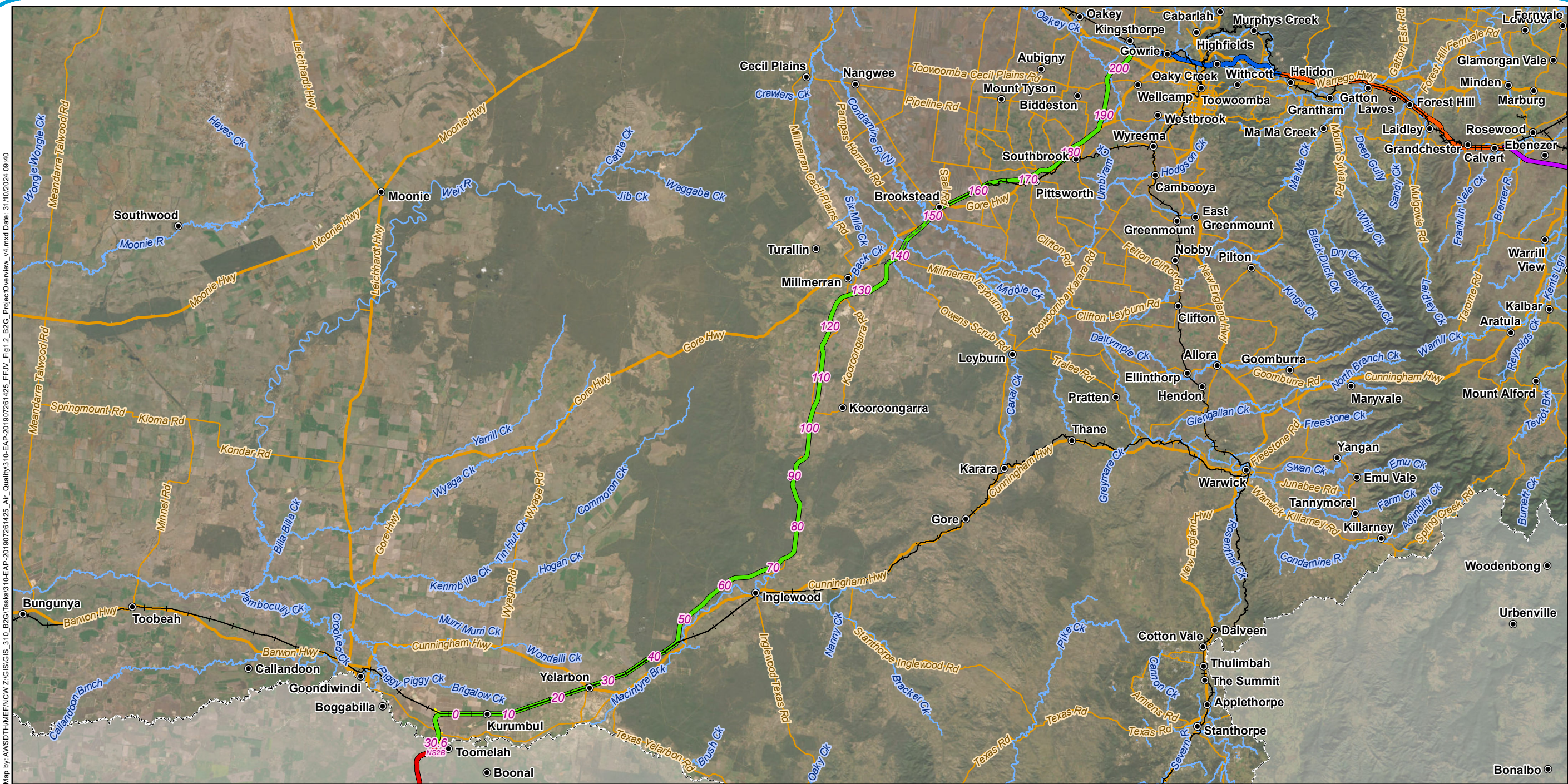
1.1 Assessment scope

The AQIA has been developed through the following steps:

- Identification of typical and peak operation train movements for the year 2040
- An analysis of the expected construction and operation activities from an air quality perspective
- Identification of the relevant ambient air quality objectives that protect or enhance the environmental values of the air environment, and adoption of air quality goals for the AQIA
- Review of existing air quality and local meteorology
- Identification of potential sources of air emissions associated with the Project
- Identification of nearby sensitive receptors within the AQIA area
- Identification of potential air quality impacts through:
 - A qualitative risk assessment of particulate emissions from construction activities
 - A quantitative dispersion modelling assessment of operational emissions associated with freight rail movements for peak train operations, including prediction of pollutant concentrations in water in rainwater water tanks
- Identification of mitigation and management measures to minimise potential air quality impacts, and assessment of the residual impact with the implementation of these measures
- Assessment of the residual impact with the inclusion of the identified mitigation measures.



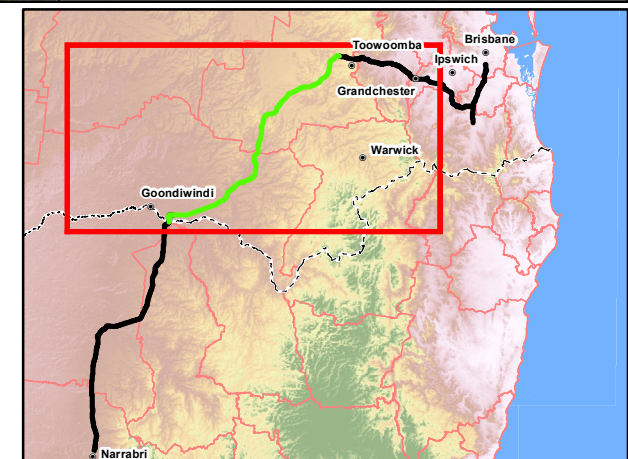
Figure 1.1 Melbourne to Brisbane Inland Rail location map



Map by: AWS/DTM/EF/NCW 2:GIS/GIS 310_B201Tasks/10-EAP-201907261425_Air_Quality/10-EAP-201907261425_FFJV_Fig12_B2G_ProjectOverview_v4.mxd Date: 31/10/2024 09:40

Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Calvert to Kagaru alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border



A3 scale: 1:800,000
0 6 12 18 24 30 km



Issue date: 03/10/2024 Version: 4
Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie
Figure 1.2:
Project overview

The air quality impact assessment has been prepared with consideration given to the following guidelines:

- *Application requirements for activities with impacts to air*, guideline document under the *Environmental Protection Act 1994* (Qld) (EP Act) to support applications for activities with impacts to air, (Department of Environment and Science (DES), 2023)
- *Air – EIS information guideline*, guideline providing advice to proponents in relation air emissions when preparing an EIS (DES, 2022)
- *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, which provides statutory methods for modelling and assessing emissions of air pollutants in New South Wales, NSW Environment Protection Agency (NSW EPA, 2022)
- *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'* (Barclay & Scire, 2011)
- *Guidance on the assessment of dust from demolition and construction* (United Kingdom Institute of Air Quality Management (UK IAQM), 2014).

1.2 Impact assessment area

For the purposes of the AQIA, the impact assessment area (AQIA area) refers to the air environment and identified sensitive receptor locations within 1 km of the Project alignment, extending from the NSW/QLD border to the township of Gowrie.

2 Proposal description

2.1 Overview

A detailed description of the Project is provided in EIS Chapter 5: Project Description. The Project consists of the key permanent and temporary features listed in Table 2.1.

Table 2.1 Key features of the Project

Aspect	Description
Permanent features	
New track	- Approximately 217.48 km of new single track railway, consisting of: 7.0 km of standard gauge rail (1,435 millimetres (mm)) 210.48 km of dual gauge rail (standard (1,435 mm) and narrow (1,067 mm) gauge)
Rail corridor	- Establishment of approximately 149.48 km of new rail corridor and use of approximately 68.00 km of existing rail corridor 30 metres (m) (minimum) however, it is wider, as required, to accommodate the earthworks associated with large cuts and fills, drainage works, rail infrastructure, access roads and fencing.
Crossing loops and turnouts	- Crossing loops are places on a single-line track where trains in opposing directions can pass each other. Five crossing loops will be constructed as part of the Project, at a minimum of 2,200 m in length for each loop - Turnouts allow the train to be guided from one section of track to another. Turnouts that connect in to crossing loops and Queensland Rail's (QR's) existing South Western Line, Millmerran Branch Line and sidings have been incorporated into the design
Construction features (temporary)	
Land	- Temporary access tracks will be used to access construction sites. Where possible, access tracks will be retained to serve as rail maintenance access road during the operation of the Project - Land requirements for construction will include temporary workspaces, site offices and laydown facilities. These requirements are encompassed within the nominated temporary construction footprint for the Project - Laydown areas will be at designated locations within the Project footprint.
Embankments and cuttings	Embankments and cuttings will be required along the length of the rail alignment
Borrow pits	Identification, establishment and lawful use of six borrow pit location for the sourcing of construction materials for the Project.
Whetstone Material Distribution Centre (MDC)	Operation of Whetstone MDC that includes the receipt and stockpiling of bulk track construction materials, including concrete sleepers, ballast and steel rail.
Non-resident workforce accommodation	Construction, use and decommissioning of two temporary non-resident workforce accommodation facilities.

2.2 Construction

For the purposes of the AQIA, it has been assumed that the following activities will occur during the pre-construction and construction of the Project as further detailed in EIS Chapter 5: Project Description:

- Pre-construction and early works including:
 - Site preparation for construction
 - Establishment of access roads/tracks

- Vegetation clearing and other ground disturbance activities which will be required to comply with relevant legislative requirements, approval conditions, guidelines and plans
- Additional surveys and geotechnical investigations to inform construction works
- Relocation or protection of QR assets that were not required to be undertaken well in advance as part of enabling works
- Utility/service interfaces that were not required to be undertaken well in advance as part of enabling works
- Modification of biosecurity fencing
- Installation of boundary fencing
- Establishment of site offices and initial laydown areas including Whetstone MDC
- Establishment of non-resident workforce accommodation
- Construction works:
 - Site set out and pegging within the Project footprint, where not completed in pre-construction activities and early works
 - Establishment of laydown areas and compounds, including vehicle inspection/workshops, washdown facilities and temporary fencing, where not completed in pre-construction activities and early works
 - Clearing – using dozers, chainsaws, excavators, trucks and similar equipment, where not completed in pre-construction activities and early works
 - Establishment of erosion and sediment controls as per approved Erosion and Sediment Control Plan, where not completed in pre-construction activities and early works
 - Rail corridor works, including track works turnouts and crossing loops
 - Road and road-rail interface works
 - Road realignments, grade separations and upgrades works
 - Rail maintenance access roads
 - Bridge construction
 - Fencing
 - Signalling and communications
 - Laydown, stockpile, and storage areas, that are not for enabling works and where not completed in pre-construction activities and early works
 - Ballast – supply, delivery and installation
 - Concrete sleepers – supply, delivery and installation
 - Utilities and services to support/service the Project (that are not for enabling works)
 - Bulk earthworks – major cut-to-fill operations include the winning of suitable construction material from sections of cut along the Project alignment or from borrow pits external to the site
 - Permanent and temporary drainage controls, including culverts and longitudinal drainage
 - Clean-up, landscaping, site restoration and rehabilitation, and any other activities necessary to complete such works
 - Demobilisation of construction sites and activities.

2.3 Operations

The locomotive types that have been assessed in this AQIA are provided in Table 2.2, with the specifications of each presented in Table 2.3. The train and wagon specifications and operational data presented in this section has been used as the basis for the impact assessment.

Table 2.2 Locomotive data

Train description	Locomotives ¹	Maximum wagons length (m)	Maximum rail speed (km/hr)	Modelled average rail speed (km/hr) ²	Locomotive height (m)	Wagon height (m)
Express freight	NR Class (3) ⁵	1,750	115	86	4.24	6.8
Super freighter	SCT/LDP Class (2) ⁶	1,750	115	86	4.24	5.925
Grain, cotton, and livestock	Class 82 & 2300 Class (2, 3) ^{3,7}	1,750 ⁸	80	60	~ ⁴	~ ⁴

Table notes:

1. Number in brackets indicates the number of locomotives per train.
2. Calculated assuming 75 per cent of journey time at maximum speed, 25 per cent of journey time is idling.
3. Locomotive configuration dependant on wagon payload.
4. No information was available for this item for this locomotive.
5. UGL National Rail Class locomotive.
6. Downer EDI SCT/LDP Class locomotive.
7. Downer EDI 82 Class locomotive.
8. Livestock trains are expected to be a maximum of 900m in length.

Table 2.3 Locomotive specifications

	NR Class	SCT/LDP	Class 82
Manufacturer	UGL/GE	Downer EDI	Downer EDI/EMD
Prime Mover	7FDL16	GTA46C-ACe	12-710G3AJWC
US EPA Emissions Standard	Tier 0	Tier 1	Tier 0
Rated Max Power (kW)	2,917	3,350	2,425

Table note:

US EPA = United States Environmental Protection Agency

For the purpose of developing the infrastructure for Inland Rail, Australian Rail Track Corporation (ARTC) developed a train plan to translate the predicted tonnage profile expected on Inland Rail from the 2015 Business Case, into an outline train number and frequency for impact assessment.

The forecast typical and peak volume of trains anticipated to be using the Project by year 2040 are presented in Table 2.4, which shows that the forecast for typical train movements (136 trains per week) is significantly fewer than the forecast for peak train movements (174 trains per week). The peak train numbers represent the design capacity of the individual rail section, while the typical train numbers represent the modelled train numbers for each year. Air emissions as a result of the operation of the Project are directly related to the volume of trains, therefore a lower number of trains will result in a lower rate of pollutant emissions to air.

Emission rates for both typical and peak train movement scenarios have been calculated. However, dispersion modelling has only been undertaken for peak train movements as this operational scenario has the greater potential to result in air quality impacts.

Table 2.4 Weekly typical and peak train movements by service in 2040

Train type/description	Number of trains per week – typical movements			Number of trains per week – peak movements		
	NR Class ¹	SCT/LDP Class ²	Class 82 ³	NR Class ¹	SCT/LDP Class ²	Class 82 ³
MB Express (Bromelton)	12	-	-	14	-	-
MB Express (Acacia Ridge)	12	-	-	14	-	-
MB Superfreighter (Bromelton)	-	32	-	-	40	-
MB Superfreighter (Acacia Ridge)	-	6	-	-	8	-
GB Superfreighter (Bromelton)	-	16	-	-	22	-
GB Superfreighter (Acacia Ridge)	-	8	-	-	10	-
Narrabri – PoB Grain	-	-	18	-	-	24
Yelarbon – PoB Grain	-	-	18	-	-	24
Narrabri – PoB Export Continuation	-	-	10	-	-	12
Yelarbon – PoB Cotton	-	-	4	-	-	6
Total	136			174		

Table notes:

- 1 UGL National Rail Class locomotive
 - 2 Downer EDI SCT/LDP Class locomotive
 - 3 Downer EDI 82 Class locomotive
- PoB = Port of Brisbane

Five new crossing loops are proposed for the Project. The loops are to be constructed as new sections of track parallel to the existing track to enable the passing of trains moving in opposite directions. Each crossing loop is 2,200 m in length, initially constructed for 1,800 m long trains as assessed by this AQIA. Table 2.5 presents the crossing loop start and end chainage locations.

Table 2.5 Crossing loop chainage locations

Closest location	Start chainage (km)	End chainage (km)
Yelarbon	16.3	18.5
Inglewood	50.2	52.4
Kooroongarra	89.2	91.4
Yandilla	132.2	134.4
Broxburn	176.1	178.4

2.4 Project air emissions

Pollutants of potential concern to the Project have been identified through a review of expected activities, applicable National Pollutant Inventory (NPI) emission estimation manuals and international emissions estimation guidelines.

During the construction works stage, particulate matter deposited as total suspended particulates (TSP) and airborne concentrations of particulate matter less than 10 micrometres in diameter (PM₁₀) will be of primary concern. These pollutants can be emitted in significant quantities by construction activity and have the potential for nuisance and human health impacts if not correctly managed (UK IAQM, 2014). For construction activities, particulate matter less than 2.5 micrometres in diameter (PM_{2.5}) is typically emitted in minor quantities from mechanical sources and is more predominant from combustion point sources (i.e. combustion engines). Point source emissions of combustion gases (e.g. oxides of nitrogen (NO_x) and carbon monoxide (CO)) and PM_{2.5} from diesel construction vehicles and mobile plant will be significantly lower than particulate emissions from construction activities. Point source emissions of combustion gases and PM_{2.5} are considered unlikely to result in exceedance of air quality goals or cause nuisance to sensitive receptors and therefore have not been assessed for the construction works stage (UK IAQM, 2014).

In addition to construction dust, odour and volatile organic compounds (VOCs) will be emitted as fugitive emissions from fuel tanks located at laydown areas.

The primary source of air pollution during the operation of the Project will be locomotive engine exhaust. The gaseous pollutants contained in the exhaust are produced as a product of diesel combustion and include NO_x, PM₁₀, PM_{2.5}, VOCs, and polycyclic aromatic hydrocarbons (PAHs).

A brief discussion regarding these pollutants and their potential effects on health and the environmental values follows. Note that in addition to the pollutants considered in this AQIA, discussion of other pollutants not considered in detail (due to their low expected emissions) has also been provided in this section. The information presented in this section has been acquired from the NPI website (Department of Agriculture, Water and the Environment (2019) and the NSW Department of Planning, Industry and Environment website (2019).

2.4.1 Particulate matter

Particulate matter, sometimes referred to as dust, is commonly differentiated according to size based on its equivalent aerodynamic diameter. TSP refers to airborne particles generally up to 100 micrometres (µm) in diameter. TSP is primarily associated with aesthetic impacts associated with coarse particles settling on surfaces, which also causes soiling and discolouration. These large particles can, however, cause some irritation of mucosal membranes, which pose a greater risk to health when ingested if they are contaminated. Particles with diameters less than or equal to 10 µm (known as PM₁₀) can be created through crushing and grinding of rocks and soil, and typically comprise soot, dirt, mould and pollen. These particles tend to remain suspended in the air for longer periods than larger particles (minutes or hours) and can penetrate into human lungs.

Fine particulates (those with diameters less than or equal to 2.5 µm, known as PM_{2.5}) are typically generated from vehicle exhaust, bushfires, and some industrial activities and can remain suspended in the air for days or weeks. As these fine particulates can travel further into human lungs than the larger particulates and are often made up of heavy metals and carcinogens, fine particulates are considered to pose a greater risk to health.

Exposure to particulate matter has been linked to a variety of adverse health effects, with epidemiological research suggesting that there is no threshold at which health effects do not occur. Factors that influence the health effects related to exposure include the mass concentration, the size of the particles and the duration of exposure (e.g. short or long-term). Short-term or acute health effects include respiratory problems such as coughing, aggravated asthma and acute bronchitis, with long-term or chronic effects including lung damage and non-fatal heart attacks. Furthermore, if the particles contain toxic materials (such as lead, cadmium, zinc) or live organisms (such as bacteria or fungi), toxic effects or infection can occur from inhalation of the dust.

In addition to the respiratory health impacts from fine particulate matter suspended in air, dust can cause nuisance impacts by settling on surfaces and possessions. Dust deposition is the result of suspended particles settling out of suspension. Dust deposition is a common cause of complaints, particularly due to staining of clothes (hanging on washing lines) and deposition on vehicles and window sills. Deposition on surfaces that feed into water storage can also result in contamination of potable water supplies.

2.4.2 Nitrogen oxides

Nitrogen dioxide (NO₂) is a brownish gas with a pungent odour. It exists in the atmosphere in equilibrium with nitric oxide (NO). The mixture of these two gases (and some other minor nitrogen and oxygen gas mixtures) is commonly referred to as nitrogen oxides, or NO_x. Nitrogen oxides are a product of combustion processes. In urban areas, motor vehicles and industrial combustion processes are the major sources of ambient nitrogen oxides.

Short-term exposure to low levels of NO₂ can irritate the eyes, nose, throat and lungs, possibly leading to coughing, shortness of breath, tiredness and nausea. Short-term exposure to high levels of NO₂ can cause rapid burning, spasms and swelling of tissues in the throat and upper respiratory tract, reduced oxygenation of tissues, and build-up of fluid in the lungs. Long-term exposure to high levels of NO₂ can cause chronic health effects including lung disease.

Sensitive populations, such as the elderly, children, and people with pre-existing health conditions are most susceptible to the adverse effects of NO₂ exposure. Long-term exposure to NO₂ can also cause damage to plants, especially in the presence of other pollutants such as ozone (O₃) and SO₂. Nitrogen oxides are also primary ingredients in the reactions that lead to photochemical smog formation. Also, excessive levels of NO_x, and specifically NO₂, can cause death in plants, and damage the leaves of agricultural crops.

2.4.3 Carbon monoxide

Carbon monoxide is a colourless, odourless gas produced by the incomplete combustion of fuels containing carbon (e.g. oil, gas, coal and wood). CO is absorbed through the lungs of humans, where it reacts to reduce the blood's oxygen-carrying capacity. In urban areas, motor vehicles account for up to 90 per cent of all CO emissions.

Short-term inhalation of relatively low levels of CO (200 parts per million (ppm) for 2 to 3 hours) can cause headaches, dizziness, light-headedness and fatigue. Short-term exposure to higher concentrations (400 ppm) of carbon monoxide can cause sleepiness, hallucinations, convulsions, collapse, loss of consciousness and death. Long-term exposure to low levels of CO can result in heart disease and damage to the nervous system, whilst long-term exposure of pregnant women to CO may result in low birth weights and other birth defects.

Concentrations of CO near transport sources (e.g. road traffic, freight rail) are typically well below air quality goals and are unlikely to cause ill effects. Due to the low likelihood of significant impact, CO has not been considered in this assessment.

2.4.4 Sulphur dioxide

Sulphur dioxide is a colourless gas with a sharp, irritating odour. It is formed in combustion processes through burning fossil fuels containing sulphur. SO₂ may be oxidised in the atmosphere to form sulfuric acid, which contributes to acid rain.

Sulphur dioxide is also an irritant gas that can cause respiratory tract infections. People with pre-existing respiratory conditions such as asthma are most sensitive to SO₂ exposure and the simultaneous presence of airborne particulate matter can compound these effects. SO₂ and its aerosols can also damage vegetation and some materials.

Sulphur dioxide in low concentrations is a common pollutant in cities and some industrial environments. Higher exposure to SO₂ is typically limited to workplace environments where it is produced as a by-product. Short-term exposure (5 to 15 minutes) to concentrations of 10 to 50 ppm causes irritation of the eyes, nose and throat, choking and coughing.

The study assumes low sulphur content fuel as per the requirements of the *Fuel Quality Standards Act 2000* (Cth) and *Fuel Standard (Automotive Diesel) Determination 2001* (Cth). The regulation of low sulphur content fuel in Australia has significantly decreased the generation and concentrations of SO₂ near transport sources and concentrations are typically well below the relevant air quality goals. Due to the low likelihood of significant impact, SO₂ has not been considered in this assessment.

2.4.5 Volatile organic compounds

Organic compounds with a vapour pressure at 20°C exceeding 0.13 kilopascals are referred to as VOCs. VOCs can be a major precursor in the production of photochemical smog, which causes atmospheric haze, eye irritation, and respiratory problems. VOCs are commonly emitted from vehicle exhausts. Three primary VOCs (benzene, toluene and xylenes) are components of petroleum and diesel fuel and are typically the focus for assessments of engine combustion emissions.

2.4.5.1 Benzene

Benzene is an airborne substance that is a precursor to photochemical smog. Benzene exposure commonly occurs through inhalation of air containing the substance. It can also enter the body through the skin, although it is poorly absorbed this way. Low levels of benzene exposure result from car exhausts. Benzene is a toxic health hazard and a known carcinogen. It has high acute toxic effects on aquatic life and long-term effects on marine life. It can cause death in plants and damage to the leaves of many agricultural crops, however normal environmental concentrations of benzene are unlikely to damage plants (Scottish Environment Protection Agency, 2016). Human exposure to very high levels for even brief periods of time can potentially result in death, while lower level exposure can cause skin and eye irritation, drowsiness, dizziness, headaches and vomiting, damage to the immune system, leukaemia and birth defects.

2.4.5.2 Toluene

Toluene (methylbenzene) is a highly volatile chemical that quickly evaporates to a gas if released as a liquid. Due to relatively fast degradation, toluene emissions are usually confined to the local area in which it is emitted. Human exposure typically occurs through breathing contaminated air, but toluene can also be ingested or absorbed through the skin (in liquid form). Toluene usually leaves the body within twelve hours.

Short-term exposure to high levels of toluene can cause dizziness, sleepiness, unconsciousness and sometimes death. Long-term exposure can cause kidney damage and permanent brain damage that can lead to speech, vision and hearing problems, as well as loss of muscle and memory functions. The substance can cause membrane damage in plant leaves and is moderately toxic to aquatic life with long-term exposure.

2.4.5.3 Xylenes

Xylenes are flammable liquids that are moderately soluble in water. They are quickly degraded by sunlight when released to air, and rapidly evaporate when released to soil or water. They are used as solvents and in petrol and chemical manufacturing.

Xylenes can enter the body through inhalation or skin absorption (liquid form), and can cause irritation of the eyes and nose, stomach problems, memory and concentration problems, nausea and dizziness. High-level exposure can cause death. The substances have high acute and chronic toxicity to aquatic life and can adversely affect crops.

2.4.6 Polycyclic aromatic hydrocarbons

Polycyclic aromatic hydrocarbons are a group of over 100 chemicals, which are formed through the incomplete combustion of organic materials, such as petrol. Exposure to these chemicals can cause a range of adverse reactions, including irritation of the eyes, nose and throat and skin. Exposure to very high levels can result in symptoms such as headaches, nausea, damage to the liver and kidneys, and damage to red blood cells. Some PAHs are declared to be probable or possible carcinogens to humans by the International Agency for Research on Cancer.

Polycyclic aromatic hydrocarbons can vaporise or attach to dust particles and be transported through the air. The compounds commonly break down over days or weeks through chemical reactions in the atmosphere, others can persist for longer periods.

Polycyclic aromatic hydrocarbons are moderately or highly acutely toxic to birds and aquatic organisms and moderately/highly chronic toxicity to aquatic life. Some of these compounds are known to cause damage and death to crops. PAHs can bioaccumulate and are moderately persistent in the environment.

2.4.7 Dioxins

Dioxins form part of a group of chemicals known as persistent organic compounds, which are of concern due to their highly toxic potential. Exposure in the long-term can cause cancer, and impairment of the endocrine, immune, and reproductive systems. Dioxins can bioaccumulate within animals in the environment and tends to accumulate in fat.

Emissions of dioxins will occur as a result of fuel combustion in trains, motor vehicles and mobile plant. An inventory of dioxin emission sources in Australia in 2002 was prepared by the Department of the Environment and Heritage (2004). The inventory determined that transport was a minor source of dioxins, contributing less than 2 per cent of total emissions.

Based on the rural location of the Project, it is expected that existing background concentrations of dioxins will be low, and therefore a background concentration of zero has been assumed for the assessment.

2.4.8 Trace metals

Heavy metals such as cadmium, lead, and mercury are common air pollutants that are typically emitted from industrial activities and fuel combustion. Exposure to heavy metals can result in a range of health impacts, including kidney and bone damage, developmental and neurobehavioral disorders, elevated blood pressure and potentially even lung cancer.

Long-term exposures to cadmium can cause anaemia, fatigue and loss of the sense of smell. Short-term high exposures to cadmium can cause rapid lung damage, shortness of breath, chest pain, and a build-up of fluid in the lungs. Cadmium is a 'probable carcinogen'.

Lead can affect a wide variety of organs in the body, but mostly affects the nervous system. Exposure to lead may also cause paralysis in fingers, wrists or ankles and can cause small increases in blood pressure and may cause anaemia, malnutrition, abdominal pain and colic. High levels of lead can severely damage the brain and kidneys in adults and may cause death.

Exposure to high levels of any types of mercury can permanently damage the brain, kidneys, and developing foetus. Effects on brain functions may result in irritability, shyness, tremors, changes in vision or hearing and memory problems. High exposures of mercury vapour may cause chest pain, shortness of breath, and a build-up of fluids in the lungs that can be fatal.

Very minor emissions of trace metals will occur as a result of fuel combustion in trains, motor vehicles and mobile plant. Trace heavy metals have been considered in this assessment.

2.4.9 Ozone

Ozone is not emitted directly from fuel combustion, but rather is a secondary pollutant formed via chemical reaction of other pollutant species (primarily NO_x and VOCs) in the local atmosphere.

Ozone is a short-term lung irritant, affects lung function and can worsen asthma. Short-term exposure to O₃ can cause difficulty in breathing, coughing, and throat irritation if exercising outdoors when O₃ levels are high.

Assessment of the formation of O₃ and other secondary pollutants has not been considered in this assessment.

2.4.10 Odour

Odour emissions can be either a single compound or a mixture of compounds that have the potential to affect environmental amenity and cause nuisance. Potential sources of odour from the Project include agricultural freight trains, fuel storage and wastewater odour from small scale sewage treatment.

2.4.10.1 Agriculture freight trains

Operations stage odour emissions may arise from agriculture freight trains. Specifically, for livestock trains where many animals are transported in confined spaces an accumulation of odour can occur, with this odour generally associated with animal waste and/or feedstuffs.

Historically, a small number of livestock train movements (two services operating in the past 5 years) have been accommodated by the QR network between Goondiwindi and Warwick.

Presently there is no plan for livestock trains to use the alignment. For the purpose of the assessment, to evaluate the risk of odour impacts it has been conservatively assumed that one livestock train per week, of a maximum length of 900 m, may use the alignment.

2.4.10.2 Fuel storage

Fugitive emissions of odour will occur as a result of fuel storage, dispensing of fuel and the refilling of fuel tanks during the construction works stage. Fuel storage areas have the potential to impact nearby sensitive receptors and have been considered in this assessment.

2.4.10.3 Sewage treatment

Portable toilet facilities will be located along the alignment during construction for workers. A suitably qualified contractor will be engaged for the removal and transport of the sewage to an approved off-site treatment facility.

Wastewater treatment and collection facilities will be included as component of non-resident workforce accommodation for the construction workforce. Sewage treatment plants with a capacity of 300 equivalent population (EP) will be required to service each non-resident workforce accommodation facility. A qualitative assessment of odour from sewage treatment plants of this size has been undertaken in this assessment.

3 Regulatory environment

The relevant legislation and policy instruments considered in the assessment of air quality are:

- *Environmental Protection Act 1994 (Qld)* (EP Act)
- Environmental Protection Regulation 2019 (Qld)
- *Environmental Protection (Air) Policy 2019* (Qld) (EPP (Air))
- National Environment Protection (Ambient Air Quality) Measure 2021 (Cth) (AAQ NEPM)
- National Environment Protection (Air Toxics) Measure 2011 (Cth) (Air Toxics NEPM)
- *Australian Drinking Water Guidelines* (Cth) (National Health and Medical Research Council (NHMRC) and National Resource Management Ministerial Council (NRMMC (2011)).

3.1 Environmental Protection Act 1994 and Environment Protection Regulation 2019

The EP Act is intended to protect Queensland's environment while allowing for development that improves total quality of life, now and in the future, by encouraging ecologically sustainable development. The EP Act regulates environmentally relevant activities under the Environmental Protection Regulation 2019, with some of these activities requiring an environmental authority to operate. The EP Act also outlines primary duties which are applicable to everyone in Queensland, including the general environmental duty, which states that *'a person must not carry out any activity that causes or is likely to cause environmental harm, unless measures to prevent or minimise the harm have been taken'*.

There are several policies under the EP Act that govern the requirement for management of environmental issues such as noise, air and water. These policies determine objectives to be achieved in various environments with reference to sensitive receptors within the AQIA area. One of these, the EPP (Air) must be considered for the AQIA.

3.2 Environmental Protection (Air) Policy 2019

The EPP (Air) was prepared by the Queensland Government to enhance or protect the atmospheric environment in Queensland by providing air quality objectives. The EPP (Air) objectives are intended to be progressively achieved over the long-term. The air quality objectives in the EPP (Air) do not apply to workplaces with respect to workplace health and safety as this is covered by the workplace exposure standards set by Safework Australia.

The EPP (Air) recommends different strategies to control emissions for different types of activities, including:

- Identifying environmental values to be enhanced or protected
- Stating indicators and air quality objectives for enhancing or protecting the environmental values
- Providing a framework for making consistent, equitable and informed decisions about the air environment.
- The environmental values to be enhanced or protected under the EPP (Air) are the qualities of the air environment that are conducive to protecting the:
 - Health and biodiversity of ecosystems
 - Human health and wellbeing
 - Aesthetics of the environment, including the appearance of buildings, structures and other property
 - Agricultural use of the environment.

The air quality objectives from the EPP (Air) relevant to the Project have been adopted as air quality goals for the AQIA and are provided in Table 3.1.

3.3 National Environment Protection (Ambient Air Quality) Measure and National Environment Protection (Air Toxics) Measure

The NEPM are broad framework-setting measures that outline agreed national objectives for protecting or managing particular aspects of the environment. The air quality of an environment is protected by the AAQ NEPM (2021). The AAQ NEPM provides guidance relating to air in the external environment and does not include air inside buildings or structures.

The AAQ NEPM outlines monitoring, assessment and reporting procedures for the following pollutants:

- PM₁₀
- PM_{2.5}
- NO₂
- CO
- O₃
- SO₂.

In addition to the AAQ NEPM, the Air Toxics NEPM provides a framework for monitoring, assessing and reporting on ambient levels of air toxics. The purpose of this NEPM is to collect information to facilitate the development of standards for ambient air toxics.

The Air Toxics NEPM includes monitoring investigation levels for use in assessing the significance of monitored levels of air toxics with respect to human health. The monitoring investigation levels are levels of air pollution below which lifetime exposure, or exposure for a given averaging time, does not constitute a significant health risk. If these limits are exceeded in the short-term, it does not mean that adverse health effects automatically occur; rather some form of further investigation by the relevant jurisdiction of the cause of the exceedance is required.

The AAQ NEPM and Air Toxics NEPM standards are intended to be applied to air quality experienced by the general population in a region and not to air quality in areas in the region affected by localised air emissions, such as individual industrial sources or projects. The standards prescribed by the AAQ NEPM and Air Toxics NEPM are not intended to be applied as impact assessment criteria for individual projects.

The goal of the AAQ NEPM and Air Toxics NEPM is to achieve the recommended standards with the allowable exceedances, as assessed in accordance with the associated monitoring protocol. The standards were set at a level intended to adequately protect human health and wellbeing. The pollutant species included in the AAQ NEPM and Air Toxics NEPM are also included in the EPP (Air). The air quality objectives from the EPP (Air) relevant to the Project have been adopted as air quality goals (Table 3.1) and therefore the pollutants included in the NEPM standards are addressed.

3.4 Other guidelines

Not all compounds of interest are detailed in the aforementioned legislation or guidelines. Other sources have been utilised to provide air quality goals, which include the following:

- *Air Quality Planning Scheme Policy (AQSPS)* (Brisbane City Council (BCC), 2014)
- *Application requirements for activities with impacts to air*, a guideline document under the EP Act to support applications for activities with impacts to air (DES, 2023).

The BCC and DESI guideline documents are considered to be robust guidance policies and are considered appropriate for application in the assessment.

In addition, the AQIA has been prepared with consideration given to the following:

- *Air – EIS information guideline* (DES, 2022)
- *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2022), which provides statutory methods for modelling and assessing emissions of air pollutants in NSW but is considered robust and applicable for Queensland
- *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'* (Barclay & Scire, 2011)
- Environment Protection Authority Victoria (EPA Victoria) *Guideline Recommended separation distances for industrial residual air emissions* (EPA Victoria, 2013)
- *Guidance on the assessment of dust from demolition and construction* (UK IAQM, 2014). This document provides a qualitative risk assessment process for the potential impact of dust generated from demolition, earthmoving, and construction activities
- Department of Transport and Main Roads (DTMR) *Road Traffic Air Quality Management Manual* (RTAQMM) (2014), provides DTMR's guidance on road traffic air quality impact assessment and planning methodologies for road projects. This guidance has been considered in the assessment, noting that the manual does not include recommendations for rail projects.

3.5 Air quality goals

The air quality objectives and guideline values shown in Table 3.1 have been applied as the air quality goals for the Project. Where air quality goals for identified pollutants are not listed within the EPP (Air), air quality goals have been sourced from the NSW EPA (2022) and the BCC AQPSP (2014). The air quality goals adopted for the Project do not apply to workplaces, however these are covered under the relevant workplace exposure standards set by Safework Australia.

The air quality goals in Table 3.1 have designated averaging periods. Some pollutants have goals expressed as annual average concentrations due to the chronic way in which they affect health or the natural environment (i.e. effects occur (long-term) after a prolonged period of exposure to elevated concentrations) and others have goals expressed as 24-hour, 1 hour or 30 minute average concentrations (short-term) due to the acute way in which they affect health or the natural environment (i.e. after a relatively short period of exposure). Some pollutants have standards expressed in terms of both long-term and short-term concentrations.

The dust deposition goal shown in Table 3.1 is a daily deposition average (120 mg/m²/day), calculated using the deposition level predicted at a modelled receptor over an averaging period of one month. Although this deposition limit is not a legislative requirement, it is frequently used in Queensland (DES, 2021) and is considered to be an appropriate criterion. For the purposes of the AQIA, this recommended dust deposition goal has been adopted.

The air quality goals presented in Table 3.1 are ambient air quality goals and require consideration of existing background air quality in addition to contributions from the Project. Further discussion of background air quality for the Project is provided in Section 4.2.

The environmental values listed in Section 3.2 that are being protected by each air quality goal are listed from the EPP (Air). The environmental values protected through meeting these air quality goals include the following:

- Health and wellbeing
- Protecting the aesthetics of the environment
- Health and biodiversity of ecosystems.

With respect to the environmental value of health and biodiversity of ecosystems, the only air pollutant of concern for the Project for which the EPP (Air) prescribes an air quality goal is NO₂ (Table 3.1). As discussed in Section 2.4.2, NO₂ has the potential to damage plants. Other pollutants which have goals to protect the health and biodiversity of ecosystems include fluoride, O₃ and SO₂. Fluoride, O₃ and SO₂ also have goals to protect agriculture. However, fluoride, O₃ and SO₂ are not pollutants of concern for the Project (Section 2.4) and therefore the impact of these pollutants on the health and biodiversity of ecosystems and on agriculture does not require consideration.

In addition to NO₂, deposited dust is also considered to have the potential to impact on agricultural crops and livestock, through the inhibition of plant growth or impairment of livestock development.

Research on vegetation response to dust deposition impact (Doley, 2003) has shown that, for sunny conditions, a dust deposition rate of up to 15 g/m²/month (or 500 mg/m²/day) is unlikely to have a detectable effect on crop growth, and it is not until a deposition rate of up to 30 g/m²/month (or 1,000 mg/m²/day) that there is a measurable reduction in crop growth under overcast conditions.

Livestock research on dairy cows (Andrews & Skriskandarajah, 1992) has shown that a dust deposition rate of up to 120 g/m²/month (or 4,000 mg/m²/day) does not influence the amount of feed cattle eat or the amount of milk produced. These dust deposition levels have been considered in the assessment of the operations stage of the Project to assess the potential for impact to agriculture.

Table 3.1 Proposed air quality goals

Pollutant	Air quality goal (µg/m ³ , unless stated)	Averaging period	Environmental value	Source
NO ₂	250	1 hour ¹	Health and wellbeing	EPP (Air)
	62	Annual	Health and wellbeing	EPP (Air)
	33	Annual	Health and biodiversity of ecosystems	EPP (Air)
TSP	90	Annual	Health and wellbeing	EPP (Air)
PM ₁₀	50	24-hours	Health and wellbeing	EPP (Air)
	25	Annual	Health and wellbeing	EPP (Air)
PM _{2.5}	25	24-hours	Health and wellbeing	EPP (Air)
	8	Annual	Health and wellbeing	EPP (Air)
Arsenic and compounds (measured as the total metal content in PM ₁₀)	6 ng/m ³	Annual	Health and wellbeing	EPP (Air)
Cadmium and compounds (measured as the total metal content in PM ₁₀)	5 ng/m ³	Annual	Health and wellbeing	EPP (Air)
Lead and compounds (measured as the total metal content in TSP)	0.5	Annual	Health and wellbeing	EPP (Air)
Nickel and compounds (measured as the total metal content in PM ₁₀)	22 ng/m ³	Annual	Health and wellbeing	EPP (Air)
Chromium (III) compounds (as PM ₁₀)	9	1 hour	-	NSW EPA
Chromium (VI) compounds (as PM ₁₀)	0.1	1 hour	Screening health risk assessment	BCC AQPSP
	0.01	Annual	Screening health risk assessment	BCC AQPSP
1,3-butadiene	2.4	Annual	Health and wellbeing	EPP (Air)
Benzene	5.4	Annual	Health and wellbeing	EPP (Air)
Toluene	1,100	30 minutes	Protecting aesthetic environment	EPP (Air)
	4,100	24-hours	Health and wellbeing	EPP (Air)
	400	Annual	Health and wellbeing	EPP (Air)

Pollutant	Air quality goal ($\mu\text{g}/\text{m}^3$, unless stated)	Averaging period	Environmental value	Source
Xylenes	1,200	24-hours	Health and wellbeing	EPP (Air)
	950	Annual	Health and wellbeing	EPP (Air)
Benzo(a)pyrene (as a marker for polycyclic aromatic hydrocarbons)	$0.3 \text{ ng}/\text{m}^3$	Annual	Health and wellbeing	EPP (Air)
Polychlorinated dioxins and furans	3.0×10^{-08}	Annual	Screening health risk assessment	BCC AQPSP
Dust deposition	$120 \text{ mg}/\text{m}^2/\text{day}$	Monthly	Nuisance	DES 2021

Table notes:

$\mu\text{g}/\text{m}^3$ micrograms per cubic metre

ng/m^3 nanogram per cubic metre

$\text{mg}/\text{m}^2/\text{day}$ milligram per square metre per day

1 Not to be exceeded more than one day per year

2 Not legislated but adopted for the Project (Section 3.4)

4 Existing environment

The existing values of the air environment that may be affected by the Project are described in this section. Aspects of the ambient environment relevant to this assessment include:

- Meteorological conditions and climate
- Existing air quality due to regional and local sources of air pollution (natural and anthropogenic) that emit similar air pollutants as those being assessed
- Terrain and land use.

In addition to discussion of existing air quality and meteorological conditions, this section also introduces and presents the locations of sensitive receptors which have been used in assessing the impact of the Project on the air environment.

The following sections describe the existing environment of the AQIA area.

4.1 Climate and meteorology

The Project is located in the Darling Downs and spans across the Toowoomba Regional Council (TRC) and Goondiwindi Regional Council (GRC) local government areas. The Darling Downs generally experiences a sub-tropical climate with distinct wet and dry seasons.

The Bureau of Meteorology (BoM) operates a network of monitoring stations around Australia that have long-term climatic data available for analysis. Two BoM monitoring stations have been considered in this AQIA, specifically the Oakey Aero and Inglewood Forest stations.

Several air quality stations operated in South East Queensland by DESI also record meteorological data. However, there are no operational DESI monitoring stations that allow for the collection of data that would be representative of the AQIA area. The nearest DESI monitoring station which measures meteorological data is more than 150 km to the west of the Project. All monitoring stations to the east of the Project are near the coast of Queensland or below the Great Dividing Range and are therefore not representative of the climate in the AQIA area.

Locations of BoM and DESI meteorological monitoring stations nearest the Project are shown in Figure 4.1.

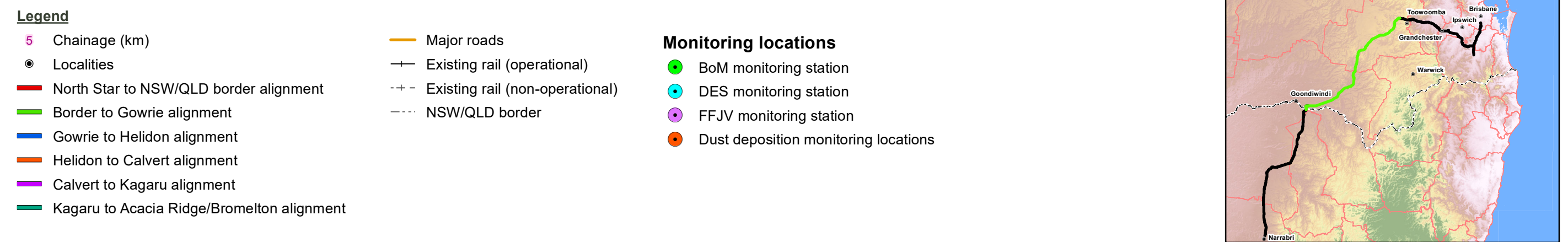
The Project spans 216.2 km and local meteorological conditions are expected to vary across this distance, especially at areas further inland and/or away from notable terrain features. The two BoM-operated Oakey Aero and Inglewood Forest stations are considered to provide an appropriate regional coverage of climatic conditions. Another BoM-operated station located at the Toowoomba Wellcamp Airport is located nearer to the Project than the Oakey Aero and Inglewood Forest stations, however, the data from this station is not publicly available at the time of this AQIA. Climate data from the Oakey Aero station is expected to be similar to that obtained at the Toowoomba Wellcamp Airport station.

Details of the meteorological monitoring stations selected for use in the AQIA are provided in Table 4.1.

Table 4.1 Location of meteorological monitoring stations

Operator	Name	Coordinates	Distance from Project (closest point, km)	Direction from Project	Years of data analysed	Elevation (m)
BoM	Oakey AERO	-27.40, 151.74	13.1	NW	1973 to Present	406
BoM	Inglewood Forest	-28.37, 150.95	7.0	NW	2000 to 2014	379

In addition to meteorological data from the BoM stations, output data from CALMET (Section 5.3.2) has also been analysed and presented in this section to describe atmospheric stability (Section 4.1.4) and mixing height (Section 4.1.5).



4.1.1 Temperature

Mean minimum and maximum temperatures have been collected from the two selected BoM stations, and are displayed in Table 4.2. Temperatures recorded at the two stations are similar: the annual mean minimum and mean maximum temperatures are higher at Inglewood Forest by 1.6°C and 1.1°C respectively.

In winter (June, July and August), mean minimum temperatures are slightly lower at Oakey Aero (4.2°C, 2.9°C and 3.6°C respectively) than at Inglewood Forest (6.7°C, 5.6°C and 6.9°C). Mean maximum temperatures for winter very similar between the two sites.

In summer (December, January and February) mean minimum temperatures are higher at Inglewood (17.7°C to 18.7°C) than at Oakey Aero (16.7°C to 17.9°C). The mean maximum temperatures are also higher at Inglewood Forest (31.5°C to 33.2°C) than at Oakey Aero (30.3°C to 31.0°C).

Overall, temperatures measured at the two stations and those expected across the AQIA area are consistent with a warm sub-tropical climate.

Table 4.2 Mean minimum (blue) and maximum (red) monthly temperatures for selected Bureau of Meteorology monitoring stations

Station	Mean minimum and maximum temperature (°C)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Oakey Aero ¹	31.0	30.1	28.7	25.9	22.3	19.1	18.7	20.5	24.0	26.7	28.8	30.3	25.5
	17.9	17.7	15.8	11.8	7.8	4.2	2.9	3.6	7.3	11.4	14.5	16.7	11.0
Inglewood Forest ²	33.2	32.2	30.4	27.3	22.4	19.0	18.6	21.0	25.3	28.0	30.1	31.5	26.6
	18.7	18.0	16.2	13.1	8.8	6.7	5.6	6.9	10.6	13.1	15.9	17.7	12.6

Source: BoM (2019)

Table notes:

- 1 Mean maximum and minimum temperature values have been calculated based on data from 1973 to 2019.
- 2 Mean maximum and minimum temperature values have been calculated based on data from 2000 to 2013.

4.1.2 Rainfall

Mean rainfall values have been collected from the two selected BoM stations and are presented in Table 4.3. A wet season (summer) and a dry season (winter) are shown to be experienced by the region annually.

Table 4.3 shows that for both monitoring stations, approximately 40 per cent of average annual rainfall occurs during the three months of summer, with significantly less rainfall recorded during winter months.

Table 4.3 Mean monthly and annual rainfall for selected Bureau of Meteorology monitoring stations

Station	Mean rainfall (mm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Oakey Aero ¹	77.7	78.2	51.1	29.9	39.5	30.0	28.8	25.7	31.0	57.7	75.2	91.8	618.2
Inglewood Forest ²	72.3	54.5	63.5	27.4	28.6	33.3	28.7	24.3	34.0	49.7	79.9	97.3	620.0

Source: BoM (2019)

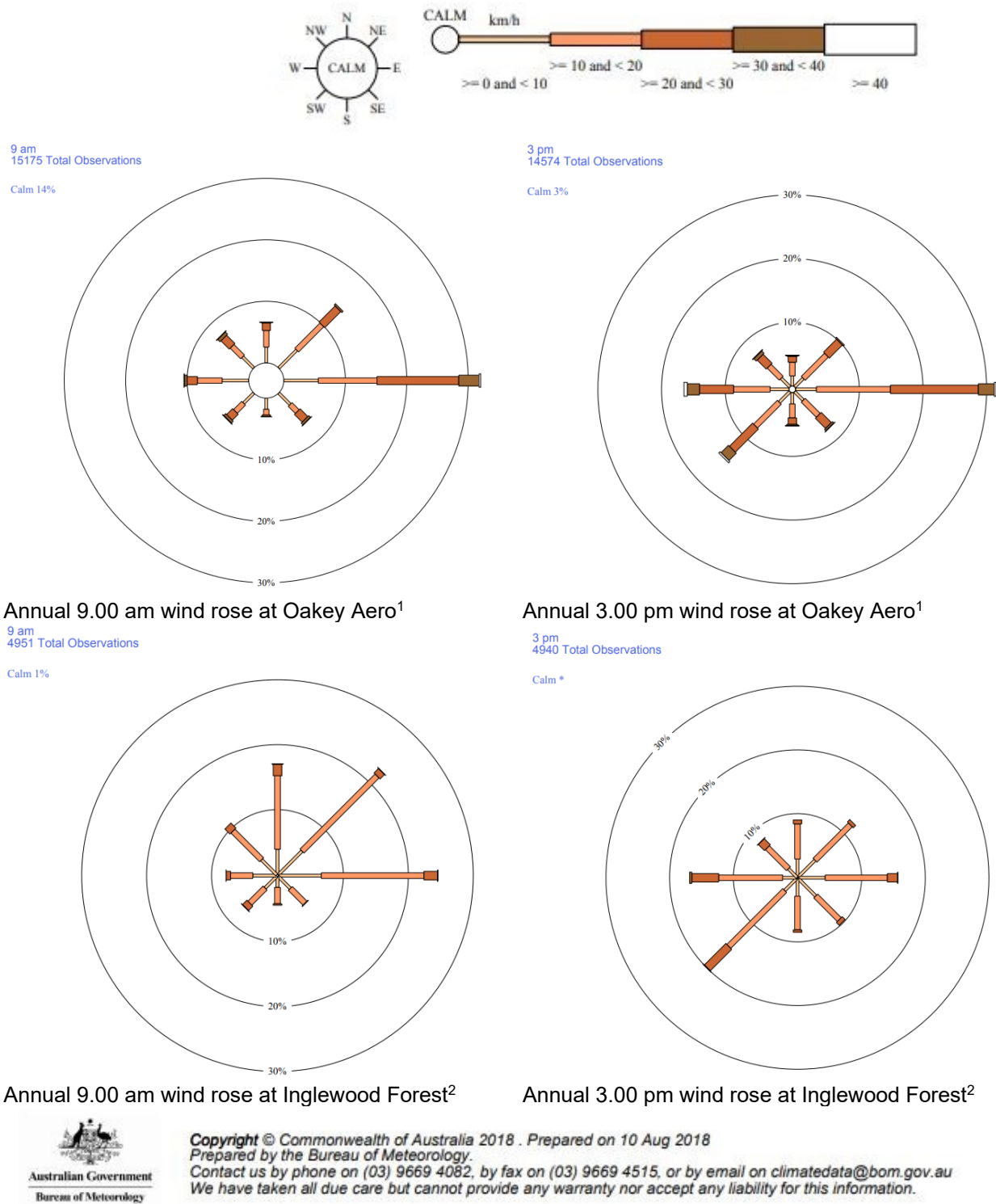
Table notes:

- 1 Mean rainfall values have been calculated based on data from 1970 to 2019.
- 2 Mean rainfall values have been calculated based on data from 2000 to 2013.

4.1.3 Wind speed and direction

Long-term annual wind roses for morning and afternoon conditions at the Oakey Aero and Inglewood Forest stations are published by BoM. The 9.00 am and 3.00 pm annual wind roses for the Oakey Aero and Inglewood Forest stations are presented in Figure 4.2.

Morning winds at the Oakey Aero location blow predominantly from the east and north-east and are low to moderate strength when not calm. Calm conditions represent 14 per cent of 9.00 am wind observations.



Wind speeds at the Inglewood Forest station location are overall lower than those observed at the Oakey Aero station. Morning winds are most frequently from the north, north-east and east, and generally of low speed, with minimal calm conditions at 9.00 am (1 per cent). Afternoon winds have a comparatively higher speed and blow predominantly from the south-west and west.

Overall, analysis of the annual wind roses for the two stations indicates that wind speed and direction is influenced on the local scale by terrain and land use. Terrain and land use are discussed further in Section 4.4.

4.1.4 Atmospheric stability

Stability is a measure of the convective properties of a parcel of air. Stable conditions occur when convective processes are low, while unstable conditions are associated with stronger convective processes, which are associated with potentially rapid changes in temperature. Stable atmospheres occur when a parcel of air is cooler than the surrounding environment, so the parcel of air (and any pollution within it) sinks. Conversely, unstable atmospheres occur when a parcel of air is warmer than the surrounding environment, making the parcel of air buoyant and, subsequently, leading to the parcel of air rising.

Stability is commonly explained using Pasquill-Gifford A – F stability class designations. Classes A, B and C represent unstable conditions, with Class A representing very unstable conditions and Class C representing slightly unstable conditions. Class D stability corresponds to neutral conditions, which are typical during overcast days and nights. Classes E and F correspond to slightly stable and stable conditions respectively, which occur at night.

Meteorological modelling for the assessment has been undertaken using CALMET, with the alignment represented by three CALMET modelling domains. The three CALMET files represent the northern, central, and southern modelling domains, which cover the entire Project alignment (Section 5.3.2.3). Stability class data extracted from the three CALMET domains has been analysed for stability.

Figure 4.3 to Figure 4.5 show stability classes for the three domains by time of day. As expected, the stability classes indicate stable conditions during the night hours and neutral and unstable conditions during the day.

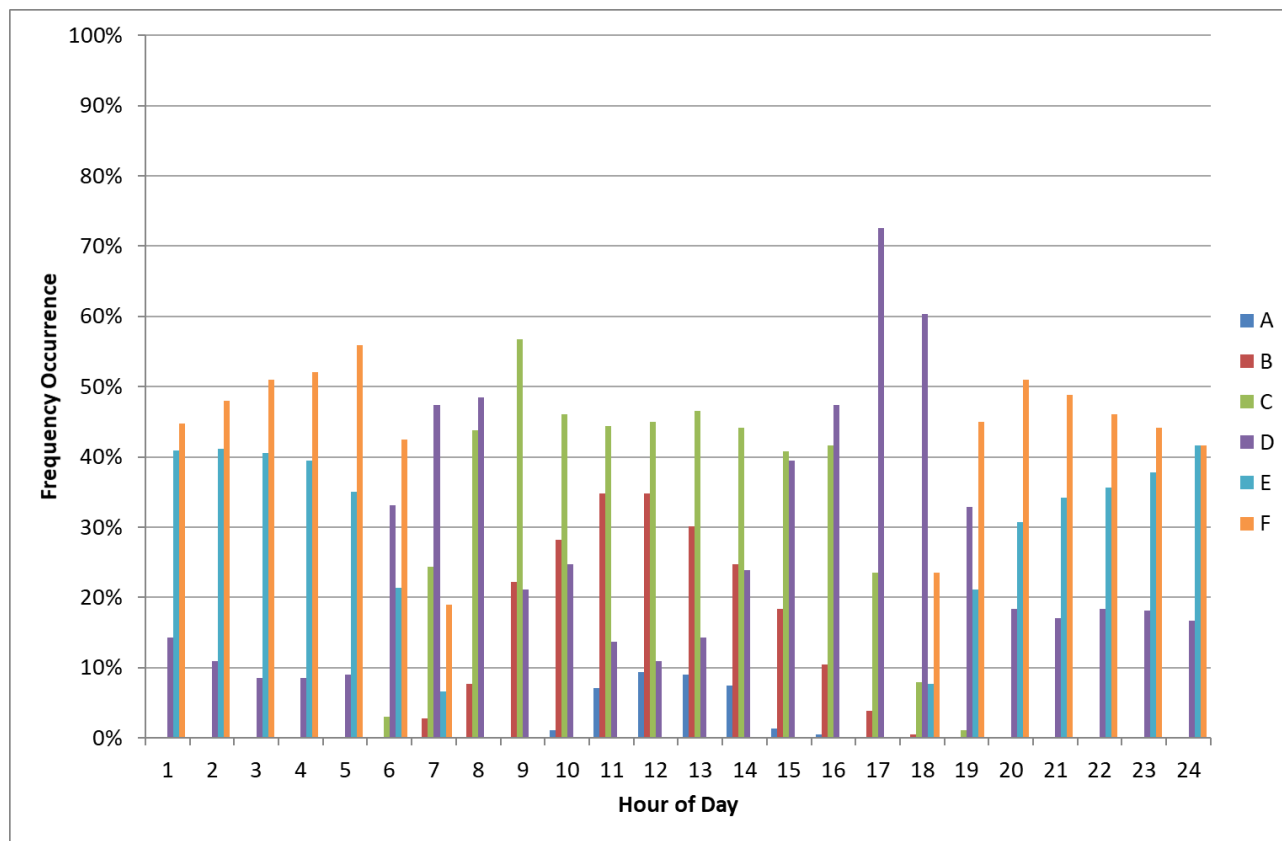


Figure 4.3 CALMET hourly stability class frequency for northern modelling domain

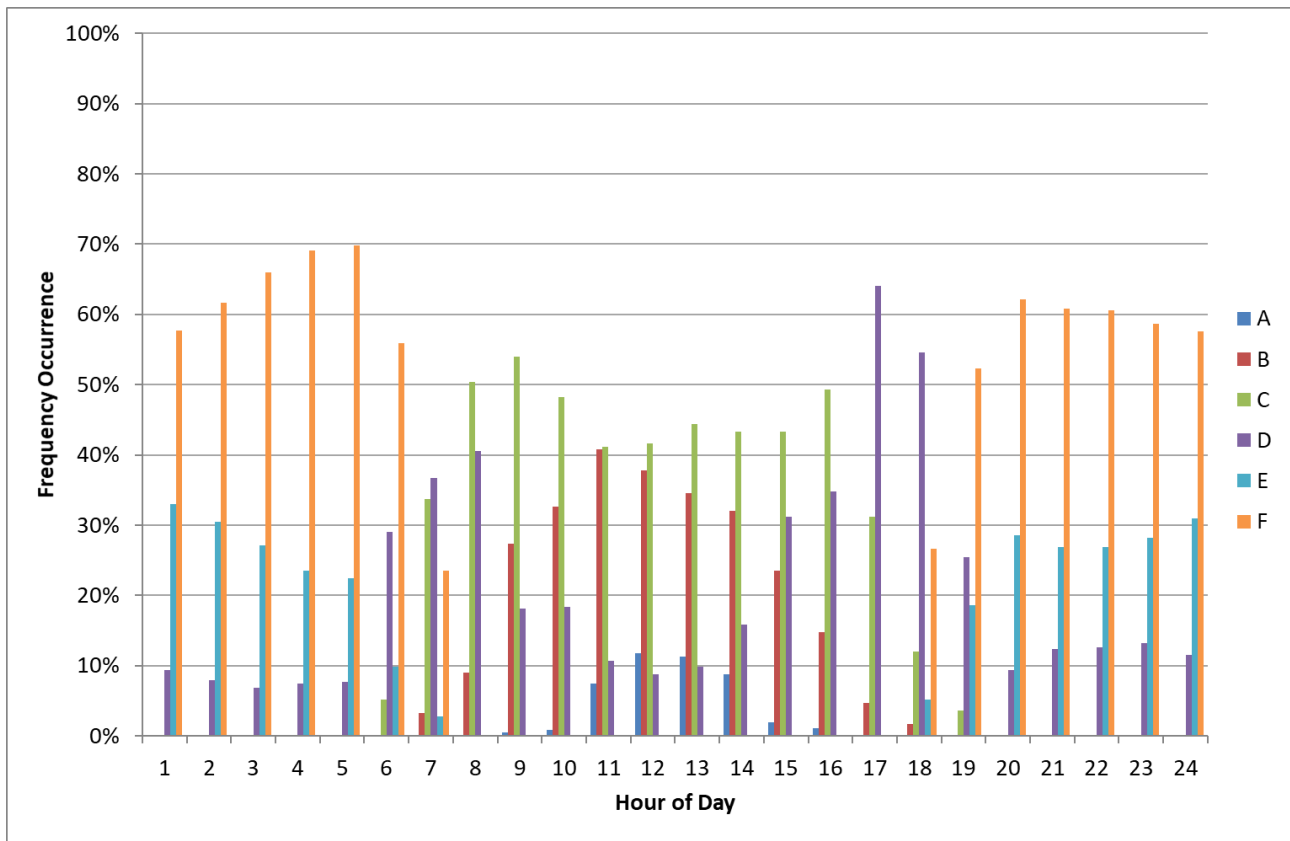


Figure 4.4 CALMET hourly stability class frequency for central modelling domain

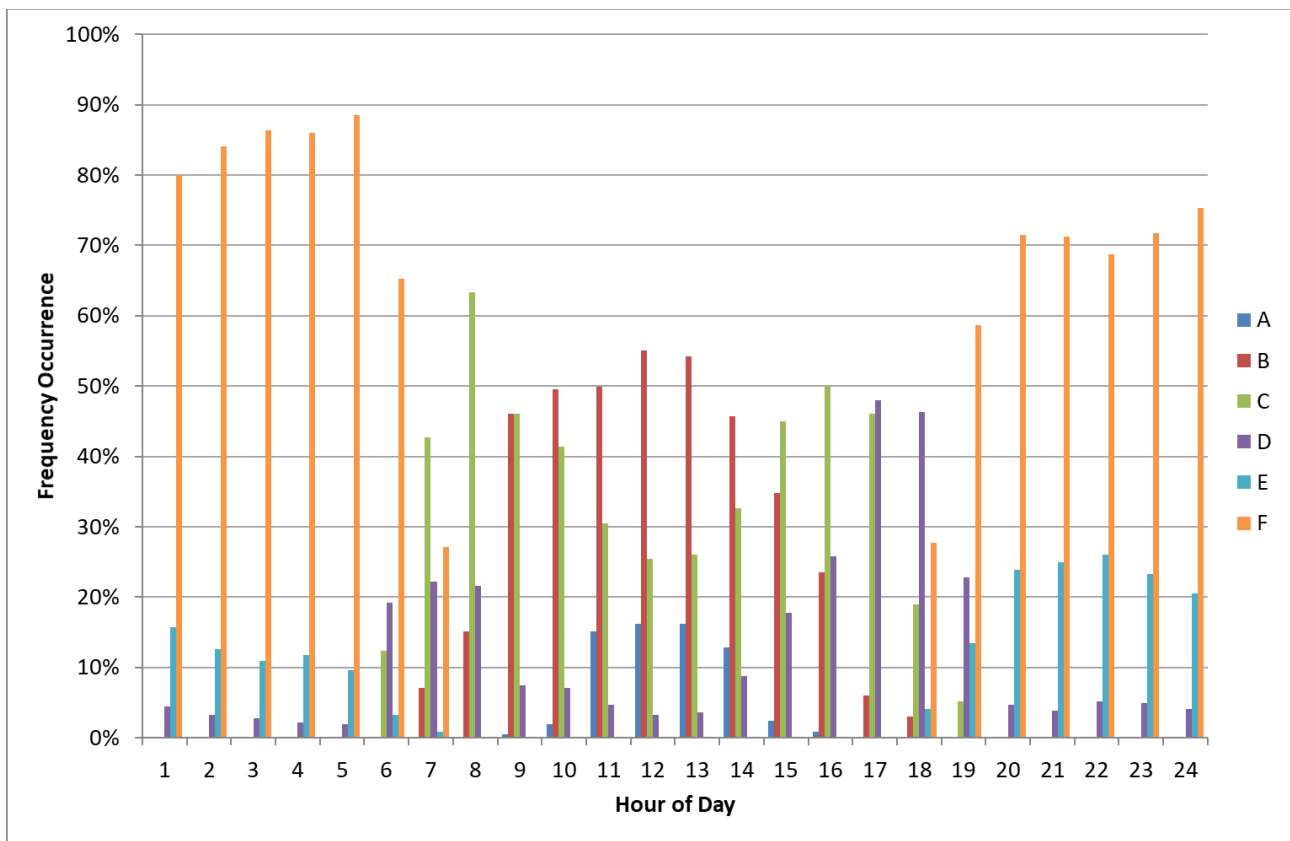


Figure 4.5 CALMET hourly stability class frequency for southern modelling domain

Figure 4.6 to Figure 4.8 show stability classes in relation to wind speed. As expected, stable conditions are more prevalent with lower wind speeds.

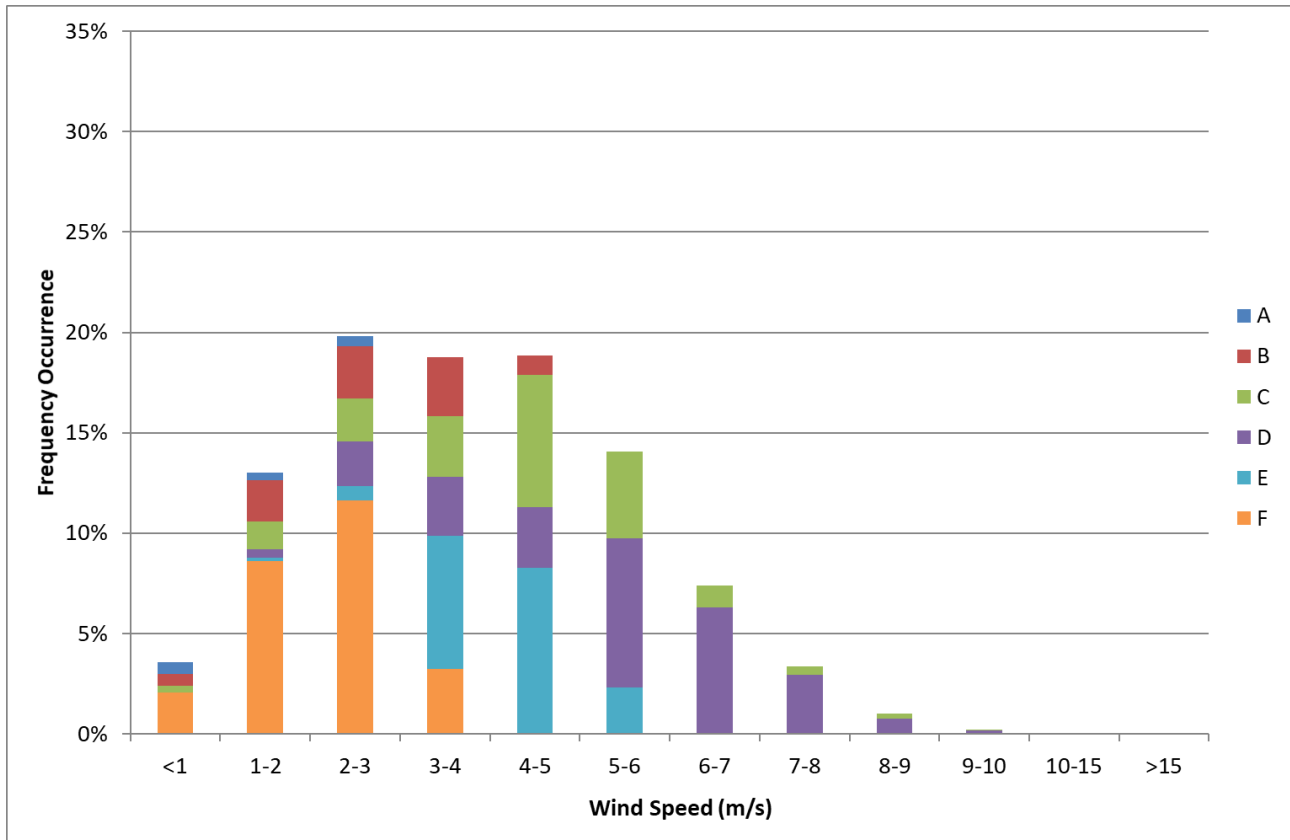


Figure 4.6 CALMET stability class frequency by wind speed for northern modelling domain

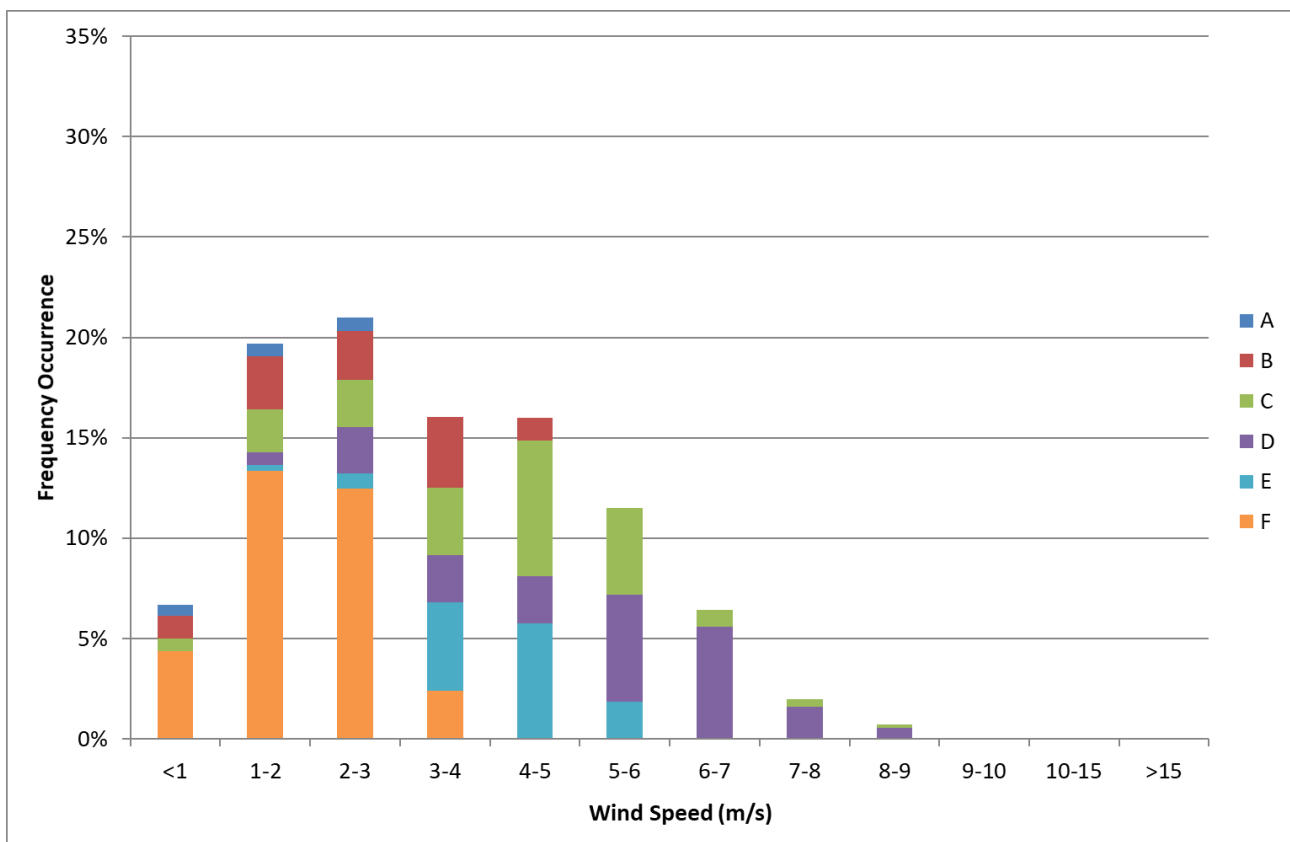


Figure 4.7 CALMET stability class frequency by wind speed for central modelling domain

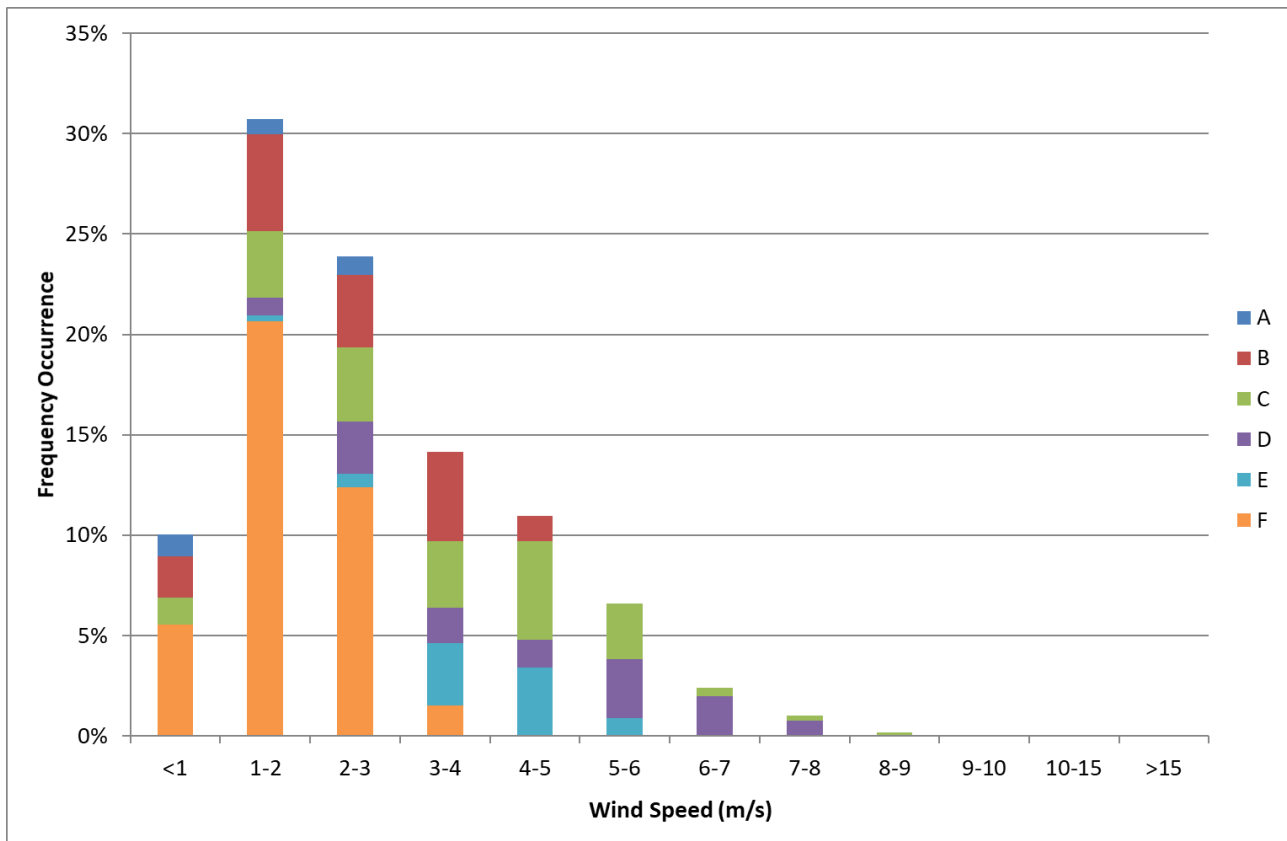


Figure 4.8 CALMET stability class frequency by wind speed for southern modelling domain

4.1.5 Mixing height

The planetary boundary layer is the lowest part of the atmosphere and is directly influenced by the Earth's surface. This layer can extend up to 2,000 m above ground level. The height of this layer above ground level is referred to as the mixing height.

Mixing height is estimated within CALMET for stable and convective conditions (respectively), with a minimum mixing height of 50 m. Figure 4.9 to Figure 4.11 present average mixing height by hour of day across the meteorological dataset, as generated by CALMET. These results are consistent with general atmospheric processes that show increased vertical mixing with the progression of the day, as well as lower mixing heights during night-time. Peak mixing heights are consistent with typical ranges.

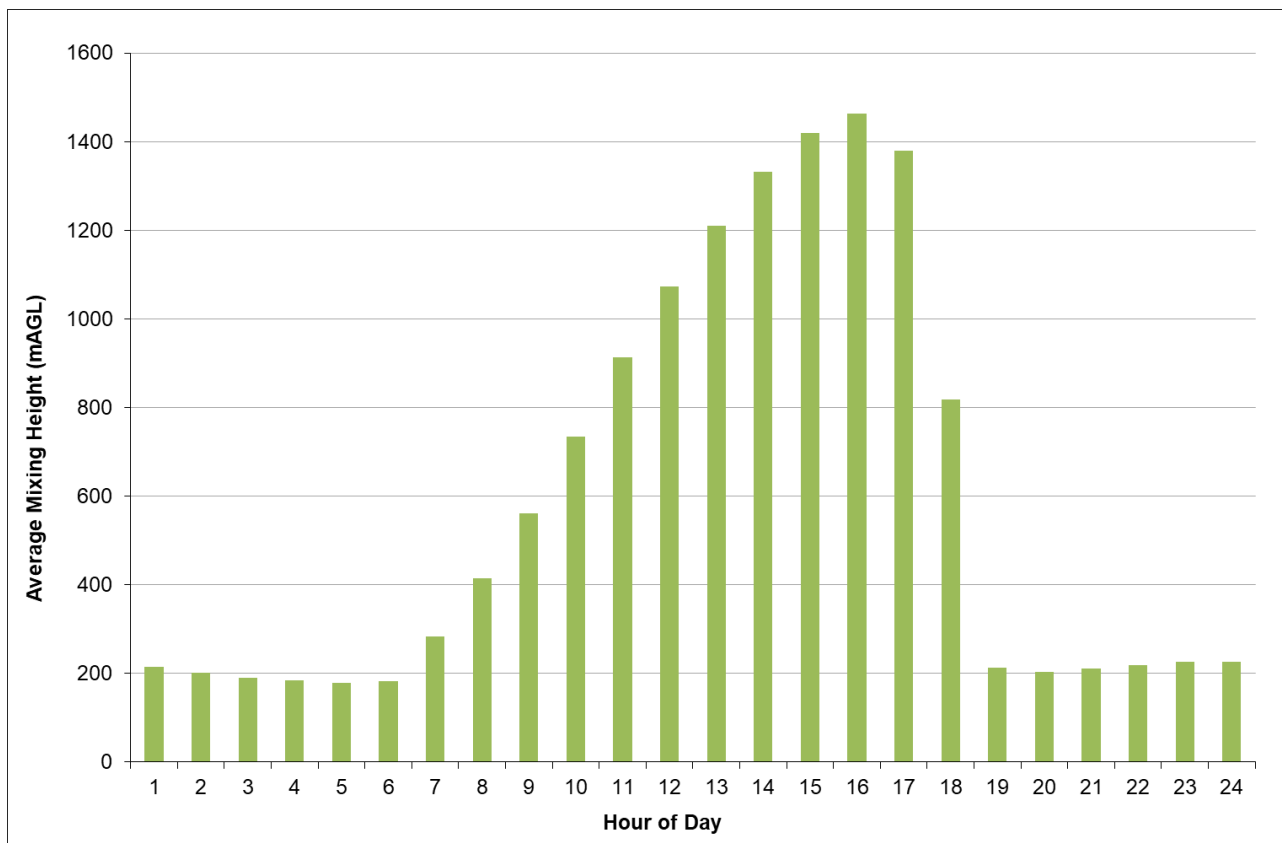


Figure 4.9 CALMET average mixing height by hour of day for northern modelling domain

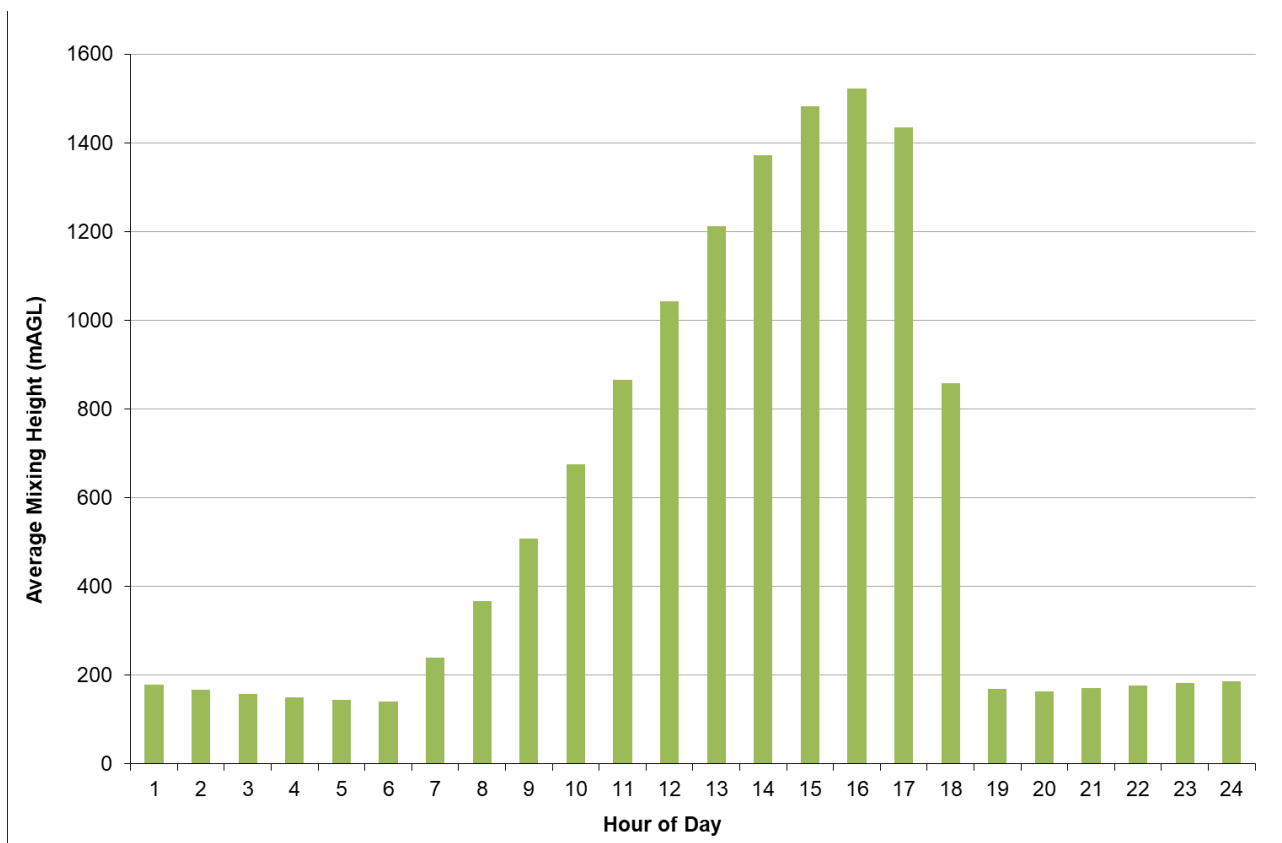


Figure 4.10 CALMET average mixing height by hour of day for central modelling domain

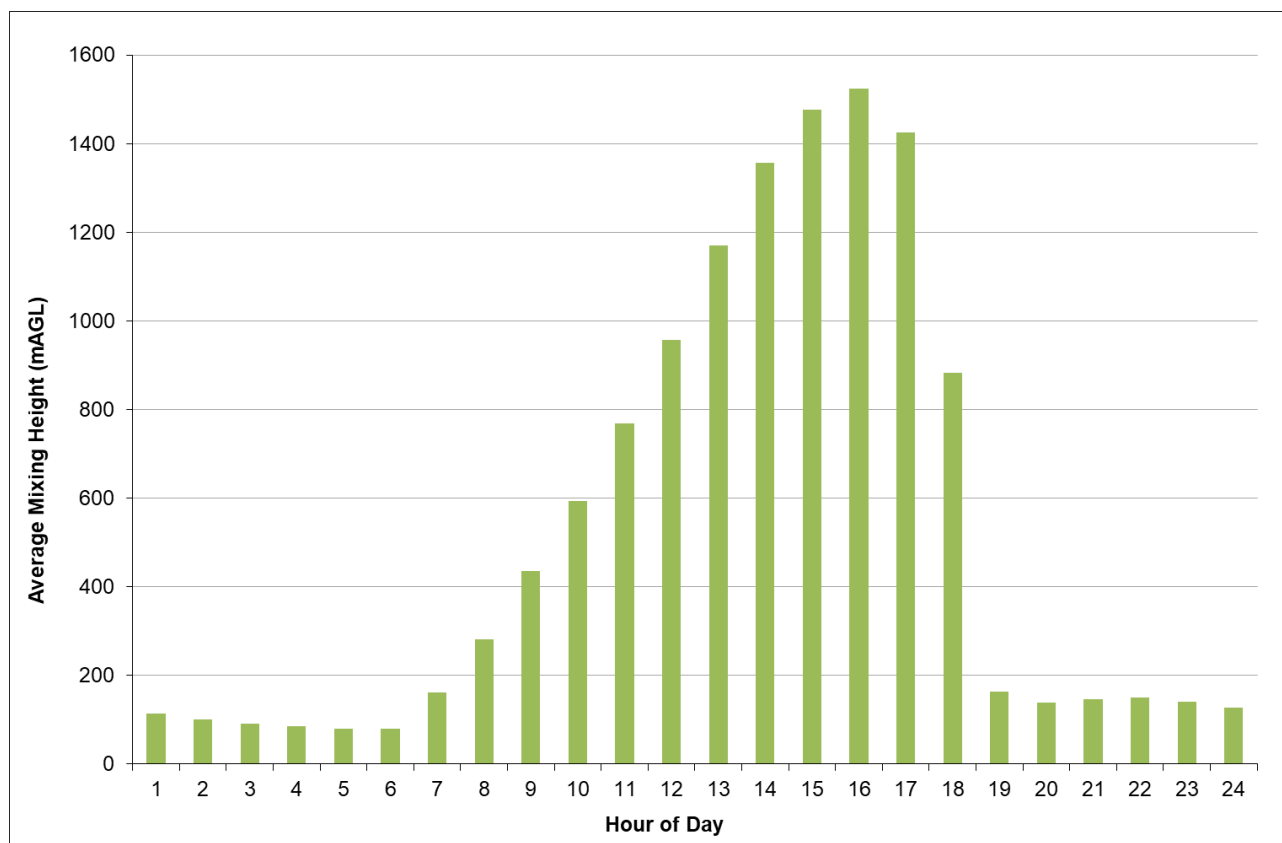


Figure 4.11 CALMET average mixing height by hour of day for southern modelling domain

4.1.6 El Niño–Southern Oscillation

For Australia, the El Niño–Southern Oscillation (ENSO) has the strongest effect on year to year climate variability in Australia, mostly affecting rainfall and temperature. El Niño incidences represent periods of unusually warm Pacific Ocean conditions along the western coast of South America, which frequently presents as high rainfall events in South America and drought conditions for Australia. Conversely, La Niña periods represent cooler ocean surface temperatures along the western coast of South America and increase the likelihood of drought conditions locally and high rainfall periods in Australia.

The Southern Oscillation Index (SOI), Oceanic Niño Index (ONI), and Multivariate ENSO Index (MEI) are measures that can indicate episodes of El Niño and La Niña. Due to differences in methodology, each of these aforementioned indices can have slightly differing results. However, utilising the SOI, ONI, and MEI measures for ENSO, concurrence can be seen on which years represent periods of El Niño or La Niña. The three indices show that the year 2013 was relatively neutral in terms of ENSO and has been selected as the year of assessment. Appendix A includes further detail on the analysis of the ENSO measurement indices and justification of selecting 2013 as the year of assessment.

4.2 Background air quality

An air quality monitoring program was conducted for the AQIA for the Project which included monitoring of PM₁₀ and PM_{2.5}. Two air quality monitoring stations (AQMSs) were established near the alignment. The Inland Rail AQMS was established in 2018 at a private property located off Draper Road, Charlton (Lot 29, SP294200), immediately adjacent to the northern end of the Project (Figure 4.1). The Millmerran AQMS was established in March 2021 on a privately owned property associated with Millmerran Power Station and in close proximity to Commodore Mine (Figure 4.1).

The Inland Rail AQMS is located approximately 200 m to the south of the existing QR Western Line. Measured concentrations at the station are influenced by emissions from existing freight rail traffic operating on the QR network. Due to the influence of freight rail emissions on measured concentrations, the Inland Rail AQMS represents a conservative estimate of background air quality. PM₁₀ and PM_{2.5} monitoring data from the Inland Rail AQMS has been used to define existing background concentrations for these pollutants for use in the AQIA.

PM₁₀ and PM_{2.5} monitoring data from the Millmerran AQMS has been used to investigate ambient air quality in the area near the Commodore Mine and the Millmerran Power Station, which are existing air emission sources. Further discussion of the monitoring data and these sources is provided in Section 5.3.1.2.

Background concentrations for other pollutants of interest not monitored at either AQMS have been estimated using monitoring data available from AQMSs operated by DESI. DESI has an ambient monitoring network across Queensland that monitors for controlled pollutants in areas with large population bases or heavy industry adjacent to residential areas. To determine appropriate baseline levels of each pollutant, recent data from the operational stations closest to the alignment was reviewed.

The nearest historic DESI monitoring station to the Project was located at Jondaryan, 40 km north-west of Toowoomba. This station operated between March 2014 to April 2015. When operational, its purpose was to serve as a peak monitoring station and it was positioned in a location near a significant local pollution source. This station is not considered suitable to provide representative background concentrations for the AQIA area and therefore has not been considered further.

A further four monitoring stations are present in South West Queensland at Hopeland, Miles Airport, Burncluth, and Condamine. Although no exceedances of ambient air quality goals were found at these monitoring sites, it was concluded in the Commonwealth Scientific and Industrial Research Organisation's (CSIRO's) Gas Industry Social and Environmental Research Alliance investigation by Lawson et al. (2018) that coal seam gas activities are a likely contributor to the local air shed in this region. As the area surrounding the Project has no coal seam gas activity, monitoring data from these stations is not considered an accurate representation of the background air environment for the Project and data from these stations has not been used in this assessment.

A DESI monitoring station was previously located in North Toowoomba, however, this station ceased operation in 2010 and its data is not considered representative of current conditions in the AQIA area.

The nearest operational and representative DESI monitoring station to the Project is located at Mutdapilly, approximately 90 km to the east. Not all pollutants of interest are measured at the Mutdapilly station, therefore, data from the Springwood DESI station was also reviewed. Springwood is the only DESI station in South East Queensland that provides measurements of air toxics (VOCs) such as benzene and toluene, therefore this station represents the best available monitoring station for these pollutants for use in the AQIA.

The details of the stations considered in the AQIA including the pollutants monitored are presented in Table 4.4, with the location of these stations shown in Figure 4.1.

Table 4.4 Monitoring stations considered in the air quality impact assessment

Station name	Location	Location relative to the Project alignment	Pollutants monitored
Mutdapilly	27.7528° S, 152.6509° E	90 km to east	NO _x , O ₃
Springwood	27.6125° S, 153.1356° E	135 km to east-north-east, in the grounds of a high school	NO _x , O ₃ , SO ₂ , PM ₁₀ , PM _{2.5} and air toxics (organic pollutants, (e.g. benzene, toluene))
Inland Rail AQMS	27.4932° S, 151.8481° E	<0.1 km to the south, at a residential dwelling located off Draper Road, Charlton (Lot 29, SP294200)	PM ₁₀ , PM _{2.5}
Millmerran AQMS	27.9041° S, 151.2649° E	0.4 km to the north, at a residential dwelling located off Millmerran Inglewood Road, Millmerran (Lot 1, RP193091) (approximately 1 km north of the Commodore Mine)	PM ₁₀ , PM _{2.5}

In addition to monitoring data from the Project AQMS and DESI monitoring stations, dust deposition monitoring data from a 3 month deposited dust monitoring program conducted for the Inland Rail Project in 2016 has also been reviewed. This monitoring data is discussed in Section 4.2.2.3.

4.2.1 Data analysis and availability

Data from the Inland Rail AQMS and Millmerran AQMS monitoring stations has been validated using the methodology outlined in the NEPM technical paper *Data Collection and Handling* (2001), which details basic data validation methodologies, methods for the calculation of averages, and reporting requirements for data. Periods of data were invalidated for several reasons such as data recorded immediately after power failures, persistent negative data, and data measured during routine maintenance.

Monitoring data from the Inland Rail AQMS is available from July 2018 to 31 October 2021 (approximately 3 years and 3 months). Monitoring data from the Millmerran AQMS is available from 1 April 2021 to 31 March 2022, representing a full 12 months of monitoring.

The DESI monitoring station datasets were sourced as validated datasets; however, the data does contain gaps that are either missing monitoring data or invalidated by DESI.

Data is considered to be representative of actual pollutant concentrations in the air at the time of monitoring. The datasets consist of hourly averages that have been summarised and analysed for the required averaging periods. Where there was less than 75 per cent available valid data for an averaging period, then that averaging period was not calculated. Annual averages were considered valid when at least three of the year's quarterly periods had a data availability threshold of at least 75 per cent, as per guidance from NEPM (2001).

4.2.2 Particulate matter

Particulate matter (PM₁₀ and PM_{2.5}) was measured at the Inland Rail AQMS and the Millmerran AQMS using Beta Attenuation Monitors in accordance with Australian Standard (AS)/New Zealand Standards (NZS) 3580.9.11:2016 *Method 9.11: Determination of suspended particulate matter — PM 10 beta attenuation monitors* (Standards Australia and Standards New Zealand, 2016a) and AS/NZS 3580.9.12:2013 *Method 9.12: Determination of suspended particulate matter — PM2.5 beta attenuation monitors* (Standards Australia and Standards New Zealand, 2013). Both monitoring sites were located in accordance with requirements listed in AS/NZS 3580.1.1:2016 *Part 1.1: Guide to siting air monitoring equipment* (Standards Australia and Standards New Zealand, 2016b).

4.2.2.1 PM₁₀

PM₁₀ monitoring data is available from the Inland Rail AQMS from 21 July 2018 to 31 October 2021. PM₁₀ monitoring data is available from the Millmerran AQMS for the period from 1 April 2021 to 31 March 2022. Measured 24-hour average PM₁₀ concentrations for the Inland Rail AQMS and Millmerran AQMS are presented in Figure 4.12 and Figure 4.13. Average annual and 24-hour average PM₁₀ concentrations and statistics are presented in Table 4.5.

Figure 4.12 shows that several exceedances of the PM₁₀ 24-hour air quality goal of 50 µg/m³ were measured at the Inland Rail AQMS during 2018 and 2019. Table 4.5 also shows that the highest measured PM₁₀ 24-hour concentrations and average annual concentration were measured in 2019.

The *Queensland air monitoring* reports for 2018 and 2019 (DES, 2019; DES, 2020) noted that exceedances of the 24-hour PM₁₀ air quality goal of 50 µg/m³ were recorded at DESI operated air quality monitoring sites in South East Queensland, and that all exceedances 'were directly attributed to an exceptional event (emissions from a bushfire or jurisdiction authorised hazard reduction burning, or continental scale windblown dust)'. The *Queensland air monitoring* reports for 2018 and 2019 excluded measured concentrations resulting from these events for the purpose of determining compliance with the PM₁₀ 24-hour goal.

Figure 4.12 and Table 4.5 show that measured concentrations at the Inland Rail AQMS during 2020 and 2021 are significantly lower than as measured in 2018 and 2019, and do not include significant exceptional air quality events.

Due to the significant influence of exceptional events on measured PM₁₀ concentrations, 2019 is considered to be an atypical year with respect to air quality. As a result, air quality monitoring data from 2019 in isolation is not considered to be representative of typical air quality for the AQIA and the measured PM₁₀ annual average for 2019 from the Inland Rail AQMS has not been used in the assessment. Discussion of the adopted background concentrations for the assessment is provided in Section 4.2.5.

There were no exceedances of the 24-hour PM₁₀ air quality goal of 50 µg/m³ recorded at the Millmerran AQMS during the monitoring period. Table 4.5 shows that the maximum measured 24-hour average at the Millmerran AQMS was 49.3 µg/m³. Analysis of this measurement (which occurred on 15 October 2021) determined that the cause of the elevated concentration was a regional dust storm experienced throughout South East Queensland. Further discussion of this event is provided in Section 5.3.1.2. Figure 4.13 shows that measured 24-hour PM₁₀ concentrations at the Millmerran AQMS during the monitoring period were generally well below the air quality goal of 50 µg/m³.

Table 4.5 24-hour and annual average PM₁₀ concentration statistics (µg/m³) for Project air quality monitoring stations

Monitoring station	Monitoring period (µg/m ³)	Annual average (µg/m ³)	24-hour maximum (µg/m ³)	24-hour 70 th percentile (µg/m ³)	Number of exceedances of 24-hour goal	Data capture rate (per cent)
Inland Rail AQMS	21 July 2018 to 31 December 2018	17.4 ^a	171.4	18.3	4	97
	1 January 2019 to 31 December 2019	21.7	283.1	19.9	13	81
	1 January 2020 to 31 December 2020	12.4	35.6	13.9	0	80
	1 January 2021 to 31 October 2021	9.8 ^a	19.5	11.6	0	61
	Entire monitoring period (21 July 2018 to 31 October 2021)	N/R	N/R	16.2	N/R	77
Millmerran AQMS	1 April 2021 to 31 March 2022	10.3	49.3	11.7	0	87
Air quality goals		50 µg/m ³ (24-hour) 25 µg/m ³ (Annual)				

Table note:

N/R Not required or relevant for the assessment.

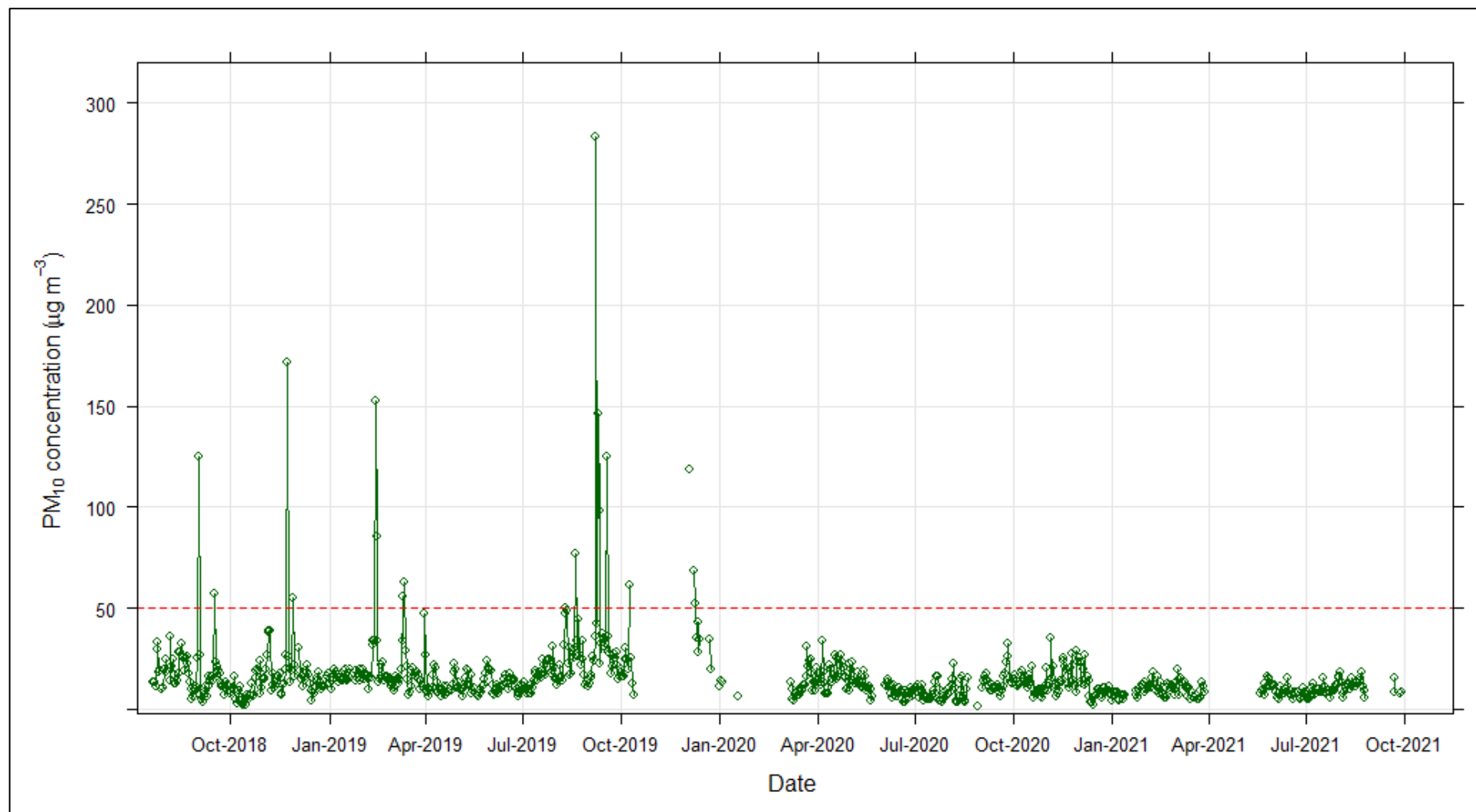


Figure 4.12 24-hour average PM₁₀ concentrations measured at the Inland Rail air quality monitoring stations

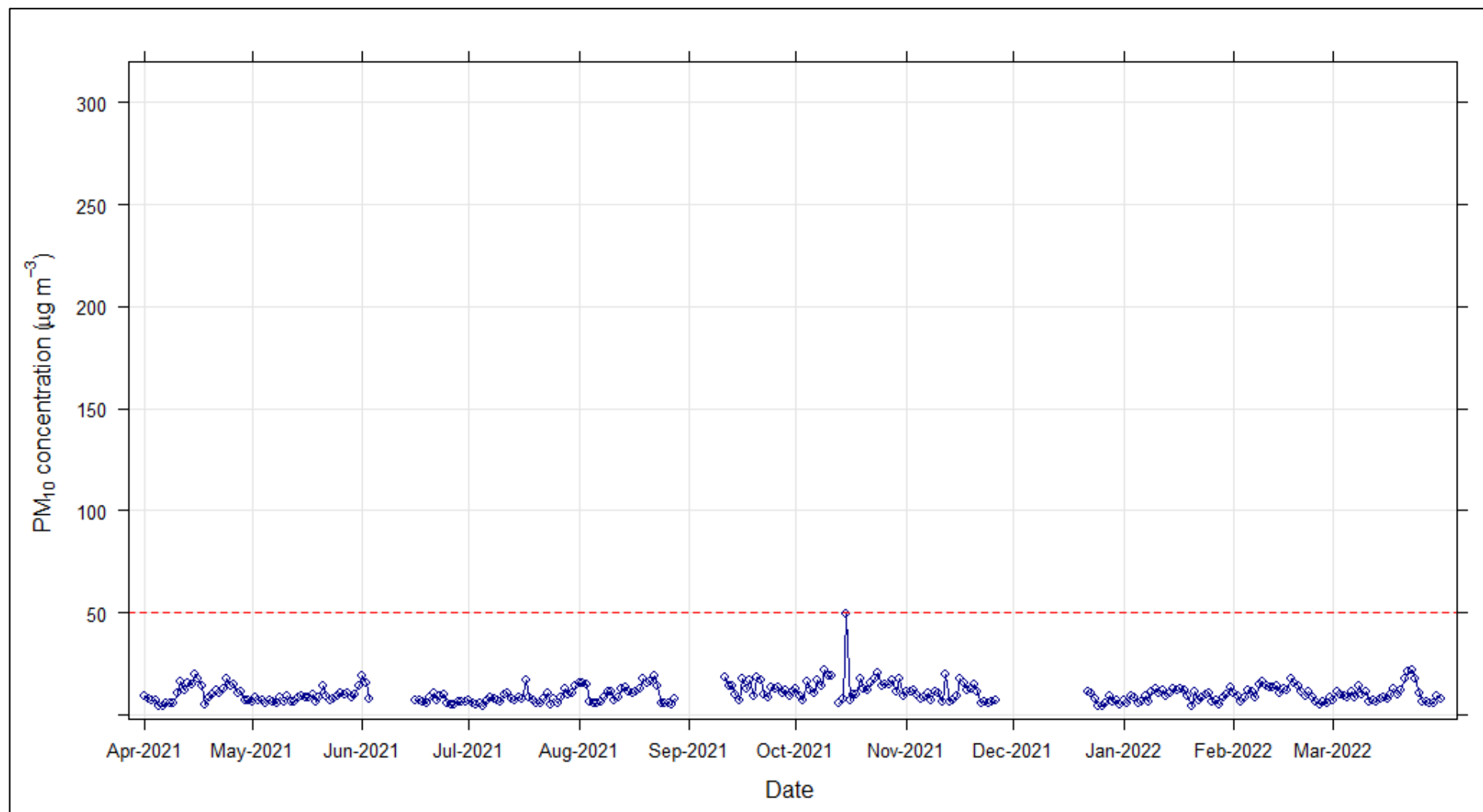


Figure 4.13 24-hour average PM₁₀ concentrations measured at the Millmerran air quality monitoring stations

4.2.2.2 PM_{2.5}

PM_{2.5} monitoring data is available from the Inland Rail AQMS from 21 July 2018 to 31 October 2021. PM_{2.5} monitoring data is available from the Millmerran AQMS for the period from 1 April 2021 to 31 March 2022. Measured 24-hour average PM_{2.5} concentrations for the Inland Rail AQMS and Millmerran AQMS are presented in Figure 4.14 and Figure 4.15. Average annual and 24-hour average PM₁₀ concentrations and statistics are presented in Table 4.6.

Figure 4.14 shows that exceedances of the PM_{2.5} 24-hour air quality goal of 25 µg/m³ were measured at the Inland Rail AQMS during 2018 and 2019. Table 4.6 also shows that the highest measured PM_{2.5} 24-hour concentration and average annual concentration were measured in 2019.

Similar to the findings for PM₁₀ (Section 4.2.2.1), the *Queensland air monitoring* reports for 2018 and 2019 (DES, 2019, DES, 2020) noted that exceedances of the 24-hour PM_{2.5} air quality goal of 25 µg/m³ were recorded at DESI operated air quality monitoring sites in South East Queensland, and that all exceedances 'were directly attributed to an exceptional event (emissions from a bushfire or jurisdiction authorised hazard reduction burning, or continental scale windblown dust)'. The *Queensland air monitoring* reports for 2018 and 2019 excluded measured concentrations resulting from these events for the purpose of determining compliance with the PM_{2.5} 24-hour goal.

Figure 4.14 and Table 4.6 show that measured concentrations at the Inland Rail AQMS during 2020 and 2021 are significantly lower than as measured in 2018 and 2019, and do not include significant exceptional air quality events.

Due to the significant influence of exceptional events on measured PM_{2.5} concentrations, 2019 is considered to be an atypical year with respect to air quality. As a result, air quality monitoring data from 2019 in isolation is not considered to be representative of typical air quality for the AQIA and the measured PM_{2.5} annual average for 2019 from the Inland Rail AQMS has not been used in the assessment. Discussion of the adopted background concentrations for the assessment is provided in Section 4.2.5.

There were no exceedances of the 24-hour PM_{2.5} air quality goal of 25 µg/m³ recorded at the Millmerran AQMS during the monitoring period. Table 4.6 shows that the maximum measured PM_{2.5} 24-hour average at the Millmerran AQMS was 11.7 µg/m³. Figure 4.15 shows that the measured 24-hour PM_{2.5} concentrations at the Millmerran AQMS during the monitoring period were generally well below the air quality goal of 25 µg/m³.

Table 4.6 24-hour and annual average PM_{2.5} concentration statistics (µg/m³) for Project air quality monitoring stations

Monitoring station	Monitoring period	Annual average (µg/m ³)	24-hour maximum (µg/m ³)	24-hour 70 th percentile (µg/m ³)	Number of exceedances of 24-hour goal	Data capture rate (per cent)
Inland Rail AQMS	21 July 2018 to 31 December 2018	7.0 ^a	32.2	8.3	1	91
	1 January 2019 to 31 December 2019	7.1	45.4	7.7	4	82
	1 January 2020 to 31 December 2020	5.6	22.5	6.2	0	76
	1 January 2021 to 31 October 2021	5.3 ^a	14.5	6.1	0	71
	Entire monitoring period (21 July 2018 to 31 October 2021)	N/R	N/R	6.8	N/R	77
Millmerran AQMS	1 April 2021 to 31 March 2022	5.1 ^a	11.7	5.8	0	86
Air quality goals	25 µg/m ³ (24-hour) 8 µg/m ³ (Annual)					

Table note:

N/R Not required or relevant for the assessment.

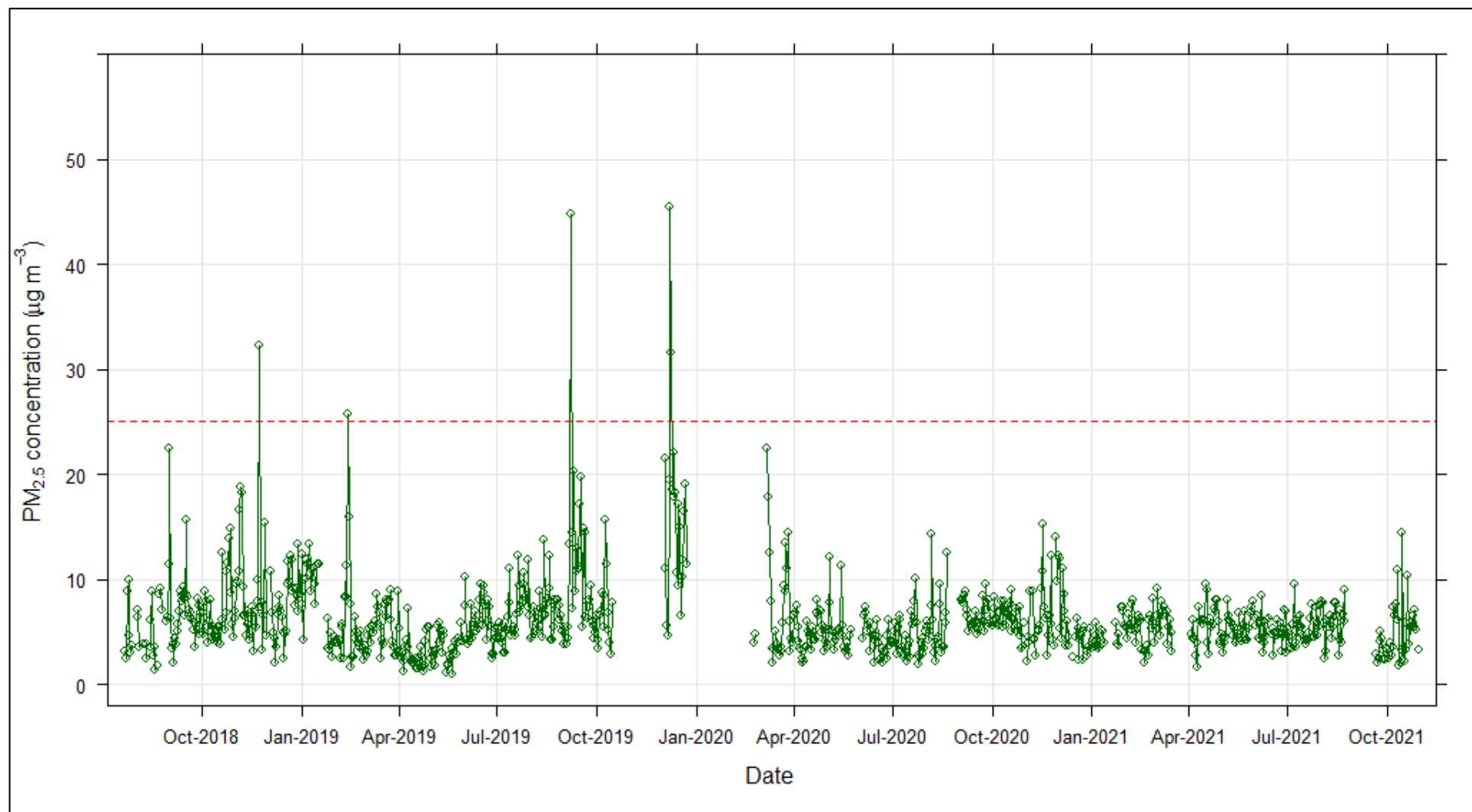


Figure 4.14 24-hour average PM_{2.5} concentrations measured at the Inland Rail air quality monitoring stations

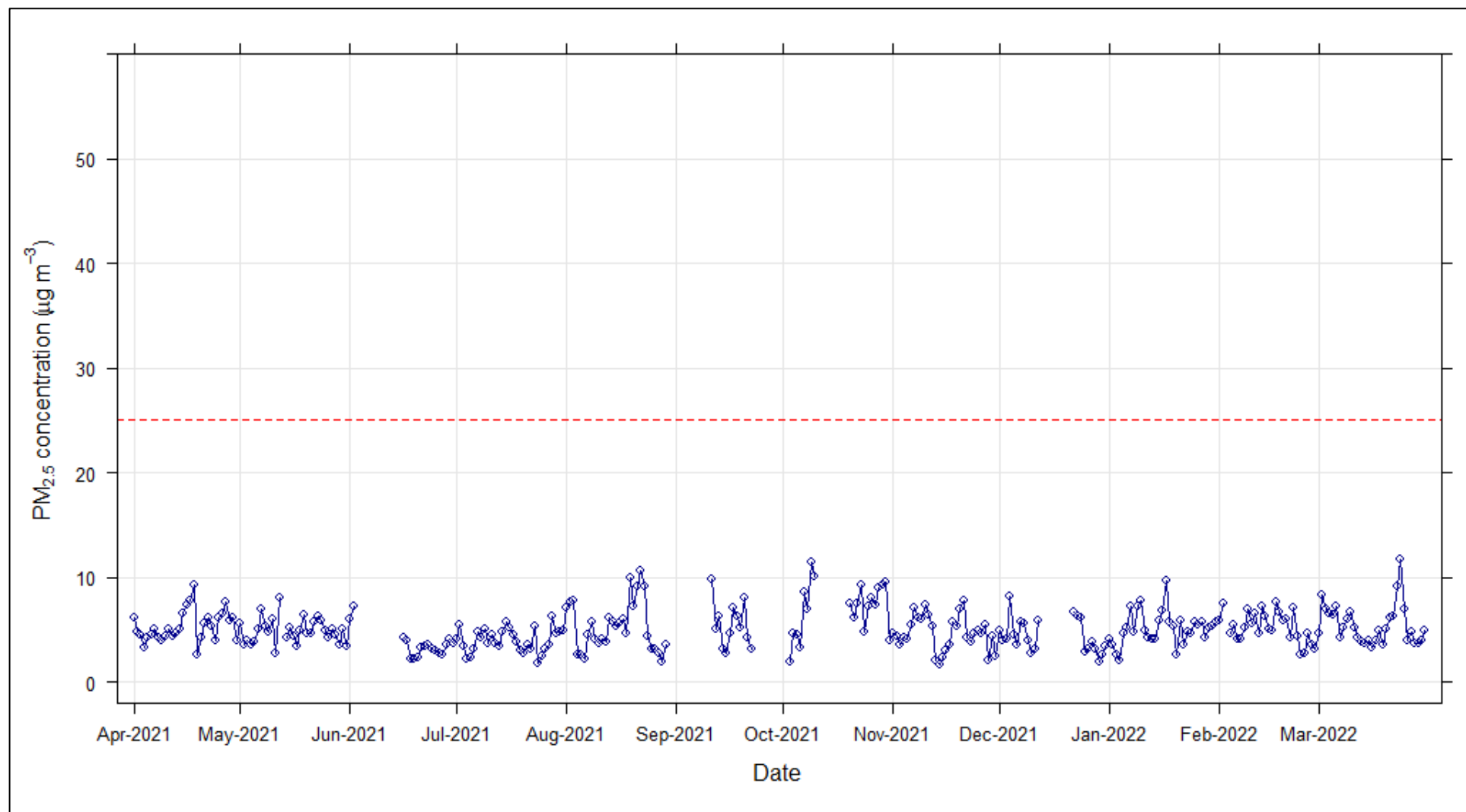


Figure 4.15 24-hour average PM_{2.5} concentrations measured at the Millmerran air quality monitoring stations

4.2.2.3 Total suspended particulates

Total suspended particulates is not measured at the DESI stations and is not measured at the Inland Rail AQMS or the Millmerran AQMS. For the purpose of the assessment, annual average TSP concentrations were estimated from the measured annual average PM₁₀ concentrations at the Inland Rail AQMS. TSP concentration was estimated using a ratio of 2.5, which is based on a PM₁₀:TSP ratio of 0.4 as reported by the Australian Coal Association Research Program (1999), which is a ratio commonly applied for air quality assessments in Queensland. This is considered a conservative estimate and is likely an over estimation of the actual TSP present.

4.2.2.4 Deposited dust

The DESI does not monitor dust deposition rates, however, a 3 month deposited dust monitoring program was conducted for the Inland Rail Project in 2016. The Yelarbon to Gowrie section was a previous alignment option which has been replaced by the Project alignment. The monitoring was conducted at four sites in accordance with AS/NZS 3580.10.1:2003 *Method 10.1: Determination of particulate matter – Deposited matter – Gravimetric method* (Standards Australia and Standards New Zealand, 2003). The locations of each site are shown in Figure 4.1. The measured dust deposition rates (reported as total insoluble solids) are presented in Table 4.7.

Table 4.7 shows that there were no measured exceedances of the adopted goal of 120 mg/m²/day. The highest measured rate of 50 mg/m²/day (measured at Site 3 during May/June 2016) has been adopted as the background deposition level for the AQIA area. The monitoring locations represent rural areas with agricultural sources in the surrounding area, similar to the Project alignment. For the urban areas of the Project alignment this may result in conservative estimates of dust deposition rates. However, for the purposes of this AQIA the data collected at these monitoring locations is deemed appropriate.

Table 4.7 Measured deposited dust levels (mg/m²/day)

Site	Coordinates	Dust deposition Rate (mg/m ² /day)		
Monitoring period		03/05/2016 to 02/06/2016	02/06/2016 to 30/06/2016	30/06/2016 to 28/07/2016
Site 2 (Brookstead)	27.7583, 151.4499	27	<u>33</u>	27
Site 3 (Pampas)	27.7936, 151.4102	<u>50</u>	33	23
Site 4 (Mt Tyson)	27.5721, 151.5709	20	<u>23</u>	17
Site 5 (Aubigny)	27.5046, 151.6825	<u>40</u>	33	17
Air quality goal		120		

Table note:

Highest monitored concentrations at each site are underlined.

4.2.3 Nitrogen dioxide

The DESI Mutdapilly monitoring station is located approximately 90 km east of the Project but is the nearest AQMS that measures NO₂. The Mutdapilly site has no local emission sources and therefore provides an ideal source of background data for NO₂.

Maximum 1 hour and annual average NO₂ concentrations for Mutdapilly from the period of 2010 to 2020 are presented in Table 4.8 and Table 4.9 respectively.

It is noted that the USEPA's Ozone Limiting Method (OLM) has been used to predict ground level concentrations of NO₂ as discussed in Section 4.4. The OLM considers the ambient concentrations of O₃ and NO₂ to determine the resulting cumulative NO₂ concentration with contribution (emissions) from the source under assessment (the Project). To facilitate the use of the OLM, hourly O₃ and NO₂ monitoring data for the year 2013 from the Mutdapilly monitoring station has been used as this is the same year as has been used for the meteorological modelling.

Table 4.8 1 hour NO₂ maximum concentrations (µg/m³) for Mutdapilly

Monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mutdapilly	<u>69.8</u>	55.4	51.3	57.5	59.6	53.4	<u>69.8</u>	<u>69.8</u>	57.5	51.4	43.1
Air quality goal	250										

Table note:

Highest monitored concentrations are underlined.

Table 4.9 Annual NO₂ average concentrations (µg/m³) for Mutdapilly

Monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mutdapilly	6.5	<u>8.3</u>	7.2	7.8	6.9	6.5	7.6	7.6	7.1	7.4	6.6
Air quality goal	62										

Table note:

Highest monitored concentrations are underlined.

4.2.4 Volatile organic compounds

The Springwood station is located 135 km to the east of the Project in a built-up residential area close to a major traffic corridor. Measured concentrations from the Springwood station have been adopted as background concentrations for the assessment of toluene, xylenes, and benzene. However, due to the differing nature of the station's location (in contrast to the AQIA area), the adopted concentrations are considered conservative. Table 4.10, Table 4.11, and Table 4.12 present the measured concentrations for toluene, xylenes, and benzene at the Springwood station for the period of 2010 to 2020 (most recent available data).

No exceedances of the air quality goals for toluene, xylenes or benzene have been recorded in the period between 2010 to 2020. The species closest to its objective is annual average benzene, with a measured concentration of 5.2 µg/m³ in 2017.

Table 4.10 1 hour toluene concentrations (µg/m³) for Springwood

Pollutant	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Maximum 1 hour concentration											
Toluene	71.5	207	182	299	535	497	164	<u>678</u>	170	145	40.7
70th Percentile 1 hour average concentration											
Toluene	6.6	7.8	16.4	19.3	20.1	21.8	<u>23.0</u>	8.6	9.0	7.8	9.0
Air quality goal	1,100 ^a										

Table notes:

a 30-minute average as per the EPP (Air)

b Highest monitored concentrations are underlined.

Table 4.11 24-hour average toluene and xylenes concentrations (µg/m³) for Springwood

Pollutant	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Maximum 24-hour concentration											
Toluene	15.6	18.4	37.3	37.3	88.6	52.9	46.6	<u>107</u>	31.6	26.0	21.9
Xylenes	25.3	31.1	30.3	18.2	19.1	18.9	28.5	43.8	72.0	61.8	<u>101</u>
70th Percentile 24-hour average concentration											
Toluene	6.6	7.6	15.6	18.9	19.0	19.4	<u>21.7</u>	8.9	9.0	7.8	9.0
Xylenes	13.3	19.5	15.5	13.3	12.6	15.4	16.2	31.5	41.0	37.3	<u>50.3</u>

Pollutant	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Air quality goals	4,100 – Toluene 1,200 – Xylenes										

Table note:

Highest monitored concentrations are underlined.

Table 4.12 Annual average concentrations ($\mu\text{g}/\text{m}^3$) for Springwood

Pollutant	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Benzene	2.5	3.9	3.1	2.5	2.4	3.0	3.3	<u>5.2</u>	3.1	3.5	-a.
Toluene	5.9	6.9	14.0	16.2	17.5	<u>18.5</u>	17.8	8.1	8.6	7.0	-a.
Xylenes	11.9	18.3	14.6	12.0	11.4	14.2	15.8	26.0	36.8	<u>34.1</u>	-a.
Air quality goals	5.4 – Benzene 400 – Toluene 950 – Xylenes										

Table notes:

Highest monitored concentrations are underlined.

a. Springwood monitoring of VOCs ended in May 2020, insufficient data to calculate annual average concentration.

4.2.5 Summary of adopted pollutant concentrations

Table 4.13 summarises the background concentrations and deposition levels which have been adopted for the AQIA and the monitoring locations which are the source of the background level.

For NO_2 , cumulative concentrations have been assessed using hourly sequential O_3 and NO_2 monitoring data for the year 2013 from the Mutdapilly monitoring station.

DES (2023) does not prescribe a methodology for adopting background concentrations. However, the BCC AQPSP (2014) does provide a method which has been adopted for the AQIA. The BCC AQPSP is a robust technical document which is widely used throughout Queensland regardless of the type of project or the rural or urban setting of the assessment area.

For AQIAs, the BCC AQPSP prescribes that the 70th percentile of measured concentrations should be used for the assessment of pollutant species with short-term air quality goals. The BCC AQPSP does not prescribe the use of other percentiles. In accordance with the BCC AQPSP, the 70th percentile concentration has been used as the adopted background concentration for assessment of the 24-hour average goals for PM_{10} , $\text{PM}_{2.5}$, toluene and xylene, and for the assessment of the one hour average goal for toluene.

It is highlighted that although the BCC AQPSP is the guidance set for a predominantly urban area (Brisbane), the 70th percentile approach is appropriate for rural areas as the 70th percentile concentration is calculated based on monitoring data from a representative location or a location that is conservative for the study area (e.g. Springwood).

The BCC AQPSP typically requires that five years monitoring data is considered when assessing background air quality. Five years of monitoring data is not available for the Inland Rail AQMS. However, the monitoring data is considered to provide suitable information to describe background air quality in the AQIA. As less than five years data is available for the Inland Rail AQMS, the 70th percentile concentration over the monitoring dataset (21 July 2018 to 31 October 2021) has been used as the background concentration for 24-hour concentrations for PM_{10} ($16.2 \mu\text{g}/\text{m}^3$) and $\text{PM}_{2.5}$ ($6.8 \mu\text{g}/\text{m}^3$). The calculation of the 70th percentile concentration includes consideration of measured elevated 24-hour concentrations resulting from exceptional events such as bushfires as discussed in Section 4.2.2.1 and Section 4.2.2.2.

It is noted that the 70th percentile concentrations for PM_{10} and $\text{PM}_{2.5}$ over the monitoring dataset for the Inland Rail AQMS are higher than the 70th percentile concentrations measured at the Millmerran AQMS ($11.8 \mu\text{g}/\text{m}^3$ for PM_{10} and $5.6 \mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$). On this basis, the adopted 70th percentile 24-hour concentrations for PM_{10} and $\text{PM}_{2.5}$ could be considered a conservative estimate of background air quality.

Measured annual average concentrations were used as the background concentration for the assessment of pollutants with annual average goals. Measured annual average concentrations for 2020 for PM₁₀ and PM_{2.5} from the Inland Rail AQMS have been used in the assessment. Measured annual average concentrations from 2020 have been used as monitoring was undertaken at the Inland Rail AQMS over the entire year, and as 2020 is considered a typical year with respect to regional air quality conditions for PM₁₀ and PM_{2.5}.

Table 4.13 Summary of adopted existing pollutant concentration and dust deposition levels

Pollutant	Averaging time and statistic	Air quality goal (µg/m ³)	Adopted background (µg/m ³)	Monitoring location
Deposited Dust	30 days, maximum	120 mg/m ² /day	50 mg/m ² /day	4 x locations near the along Project alignment
NO ₂	1 hour, maximum	250	57.5	Mutdapilly
	Annual average	62	7.8	
TSP	Annual average	90	31.0	Inland Rail AQMS
PM ₁₀	24-hours, 70 th percentile	50	16.2	
	Annual average	25	12.4	
PM _{2.5}	24-hours, 70 th percentile	25	6.8	
	Annual average	8	5.6	
Benzene	Annual average	5.4	5.2	
Toluene	1 hour, 70 th percentile	1100	23	Springwood ^c
	24-hours, 70 th percentile	4100	21.7	
	Annual average	400	18.5	
Xylenes	24-hours, 70 th percentile	1200	50.3	
	Annual average	950	34.1	

4.2.6 Assimilative capacity of the receiving environment

The assimilative capacity of the receiving air environment can be quantified through the difference between the adopted background concentrations and the air quality goals defined in Table 3.1. For most pollutants and averaging times, the background concentrations represent less than half of the air quality goal, indicating a moderate assimilative capacity of the receiving environment. Pollutants that show lower levels of assimilative capacity include the following:

- PM_{2.5} 5.6 µg/m³ annual average, representing 70 per cent of the 8 µg/m³ air quality goal
- Benzene 5.2 µg/m³ annual average, representing 96 per cent of the 5.4 µg/m³ air quality goal.

4.2.7 Consideration of climate change influence on background air quality

Changing climatic conditions due to climate change also has the ability to influence ambient air quality via increased frequency of atypical events such as bushfires and dust storms. However, it is considered difficult to confidently predict the influence of climate change on the duration, frequency and magnitude of extreme air quality events. It is also highlighted that in comparative terms, emissions from the operation of the Project could be considered insignificant in comparison to major regional air quality events such as bushfires and dust storms. Due to the uncertainty which would be inherent in assessing the influence of changing climatic conditions due to climate change on the background air quality, climate change has not been considered beyond the bushfires and dust storms that are already present in the datasets used to establish the existing environment background concentrations adopted for the air quality assessment.

4.3 Existing emission sources

The NPI (Department of Agriculture, Water and the Environment, 2021) is regulated by the Commonwealth Government. The purpose of the NPI is to track pollution sources across Australia and ensure that the community has access to information about the emission and transfer of toxic substances which may affect them locally.

Facilities which exceed NPI reporting thresholds are required by the Commonwealth Government to submit annual reports of their emissions to air. The NPI has emission estimates for 93 toxic substances and the source and location of these emissions. These substances have been identified as important due to their possible effect on human health and the environment. The data comes from facilities like mines, power stations and factories, as well as other sources. NPI data tends to be a conservative estimate of industry emissions for sites like quarries and mines due to the broad and generalised assumptions made during the emission estimations.

An NPI search conducted for the AQIA area shows eight facilities are required to report emissions annually. The locations of these facilities are shown in Figure 4.16. A description of each existing emission source and its approximate distance from the Project alignment is presented in Table 4.14.

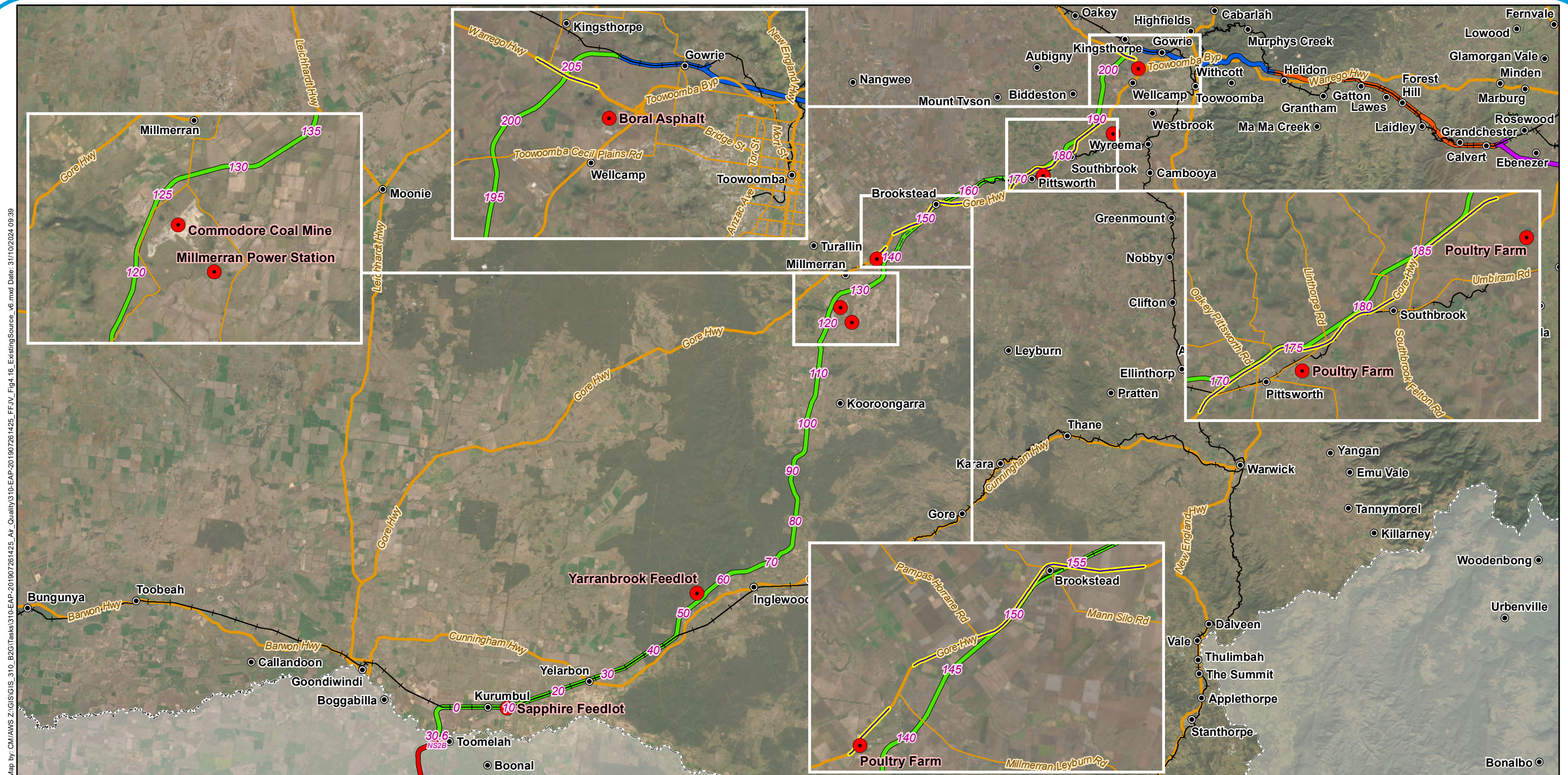
Table 4.14 National Pollutant Inventory listed facilities in the AQIA area

Facility name	Industry	Coordinates	Distance from the Project alignment (km)	Direction from the Project alignment
Commodore Mine	Coal mining	-27.938, 151.260	<1	East
Millmerran Power Station	Power generation	-27.963, 151.278	4.5	South-east
Sapphire Feedlot	Sheep, beef cattle and grain farming	-28.619, 150.594	<1	South
Yarranbrook Feedlot	Sheep, beef cattle and grain farming	-28.426, 150.967	<1	North-west
Doug Hall Enterprises	Poultry farming	-27.852, 151.330	<1	West
Pittsworth	Poultry farming	-27.714, 151.652	1.6	South
Inghams TF3 Breeder Farm Toowoomba	Poultry farming	-27.637, 151.793	4.0	East
Boral Asphalt Charlton	Hot mix asphalt manufacturing	-27.527, 151.842	3.6	South-east

Pollutant emissions of concern for the Commodore Mine and Millmerran Power Station include particulate matter and NO_x. Due to the distance from the AQMSs considered in the assessment, emissions from the Commodore Mine and Millmerran Power Station will not be represented in the background concentrations adopted. Based on this, emissions from the mine and power station have been included in the dispersion model developed for the assessment to assess the cumulative impact of the Project. Further discussion on the inclusion of the mine and power station in the assessment is provided in Section 5.3.1.2.

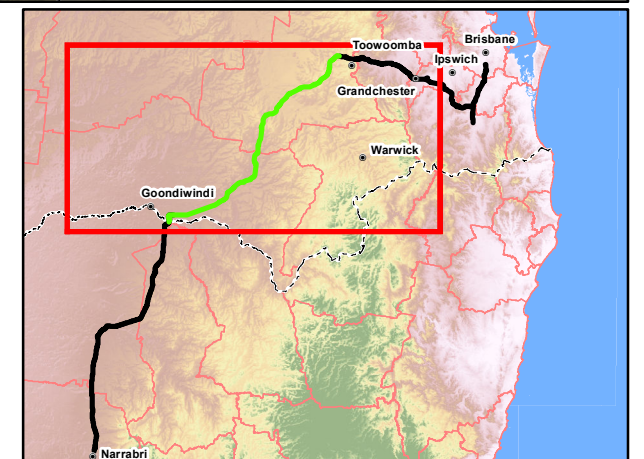
The primary pollutant of concern for the feedlots and poultry farms listed in Table 4.14 is ammonia, which is the only pollutant reported to the NPI by these facilities. Ammonia is not a pollutant of concern for the Project and emissions from these four facilities were not included in the model.

Boral Asphalt Charlton is 3.6 km to the south-east of the Project alignment and reports emissions of particulate matter, total VOCs, CO, NO_x, and SO₂ to the NPI. Emissions of all pollutants other than total VOCs are relatively minor and are not considered likely to contribute to a cumulative impact at sensitive receptors near the Project. There is the possibility of minor concentrations of VOCs from the asphalt plant reaching sensitive receptors near the Project; however, these concentrations are likely to be well below those measured at the DESI Springwood monitoring station, which is influenced by large volumes of traffic emissions. Inclusion of the Springwood background values is considered conservative and the Boral emissions were not included in the model on this basis.



Legend

- 5 Chainage (km)
- Localities
- Existing emission source
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Calvert to Kagaru alignment
- State Roads
- Major roads
- Minor roads
- Existing rail (operational)
- Existing rail (non-operational)
- NSW/QLD border



A3 scale: 1:800,000
0 6 12 18 24 30 km

In addition to these operational cumulative NPI regulated sources, the following emission sources have been included in the dispersion model for the assessment due to their potential to contribute to cumulative air quality impacts at receptors in the AQIA area:

- NS2B Project (Inland Rail)
- G2H Project (Inland Rail)
- West Moreton System (existing rail line west of the junction between the Project and the G2H section of Inland Rail)
- Gore Highway and Warrego Highway for lengths which intersect or run parallel to the alignment (Section 5.3.1.2).

Emissions from other local anthropogenic and non-anthropogenic sources such as local traffic on minor roads, wind-blown dust, have not been modelled individually as they are assumed to be adequately represented by the assumed background concentrations presented in Section 4.2.5.

4.4 Terrain and land use

Terrain features and land use can influence meteorological conditions on both a local and regional scale. There are five distinctive regions within the impact assessment area:

- Low-lying alluvial floodplains of the Macintyre River (typically 200.0 m Australian height datum (AHD) to 250.0 m AHD)
- Forested sandstone hills of the Macintyre Brook catchment (typically 250.0 m AHD to 350.0 m AHD)
- Undulating grazing lands and peaks near Millmerran (typically 300.0 m AHD to 650.0 m AHD)
- Broad cultivated alluvial plains of the Condamine River (typically 300.0 m AHD to 350.0 m AHD)
- Basaltic uplands and isolated peaks of the Toowoomba plateau (typically 325.0 m AHD to 700.0 m AHD).

The landscape surrounding the Project is typically a sparsely settled rural landscape characterised by generally flat irrigated and non-irrigated croplands and undulating pastures, interspersed by a network of vegetated watercourses associated with the Dumaresq, Macintyre and Condamine Rivers and set against a backdrop of forested low hills and isolated volcanic peaks. It is, for the most part, a highly modified landscape as a result of historical clearing practices for agriculture and grazing, the establishment of linear infrastructure (railways, highways and powerlines) and other development activity (e.g. Commodore Mine, Toowoomba Wellcamp Airport and surrounds). Several small townships exist within 5 km of the Project alignment, these include Yelarbon, Inglewood, Millmerran, Brookstead, Pittsworth, Southbrook, Kingsthorpe and Gowrie.

The influence of terrain on wind flows and dispersion has been considered in the meteorological modelling undertaken for the assessment as discussed in Section 5.3. The effect of land use on surface roughness and dispersion has also been included in the meteorological model developed for the assessment. The height of the train emission source included in the model was based on the proposed design elevations for the alignment.

4.5 Sensitive receptors

4.5.1 Selection of receptors

Sensitive air quality receptors in the AQIA area were identified as per DES (2023). As per the DES guideline, a sensitive receptor can include the following:

- A dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises
- A motel, hotel or hostel
- A kindergarten, school, university or other educational institution
- A medical centre or hospital
- A protected area under the *Nature Conservation Act 1992* (Qld), the *Marine Parks Act 2004* (Qld) or a World Heritage Area
- A public park or garden, or
- A place used as a workplace including an office for business or commercial purposes.

Indigenous Heritage sites have not been included in the assessment as sensitive receptors as they do not fall within the air quality definition of a sensitive receptor. However, assessment of Indigenous Heritage sites will be managed via the Cultural Heritage Management Plans to determine appropriate mitigation measures during the construction works and operations stages of the Project on these sites.

The *Nature Conservation Act 1992* (Qld) defines protected areas as national parks, conservation parks, resource reserves, special wildlife reserves, nature refuges or coordinated conservation areas. There are no World Heritage Areas or areas protected under the *Nature Conservation Act 1992* (Qld) or the *Marine Parks Act 2004* (Qld) located within the AQIA study area.

In addition to the DES (2023) definition for a sensitive receptor, DES (2022) states that 'remnant and regrowth ecosystems of all types' may be affected by the dispersal of air contaminants and should be considered. The impact of NO₂ on ecosystems, including remnant and regrowth ecosystems, has been investigated through the assessment of predicted annual average NO₂ concentrations against the EPP (Air) annual average goal for NO₂ set for the protection of the health and biodiversity of ecosystems (33 µg/m³) (Table 3.1).

Due to the large area which could be considered sensitive under the definition of 'remnant and regrowth ecosystems of all types', individual discrete sensitive receptor points have not been included for ecological receptors (remnant and regrowth ecosystems). Rather, the assessment of potential impacts to ecological receptors has been undertaken via review of annual average NO₂ concentration contour plots, generated by processing of model predictions at a grid of receptors included in the model covering the AQIA study area.

The primary sensitive receptor types of interest for the AQIA are primarily rural and semi-rural dwellings, although other sensitive receptor types are present (e.g. schools). Surfaces that lead to potable water tanks in the vicinity of the Project are also considered sensitive receptors.

Figure 4.17 shows the location of sensitive receptors considered for the AQIA. The sensitive receptors were identified via a desktop review of aerial imagery and no site verification was undertaken. Only sensitive receptors within the AQIA area (within 1 km of the Project alignment centreline) were included in the modelling for the operations stage impact assessment. Appendix B provides further detailed figures presenting receptor locations.

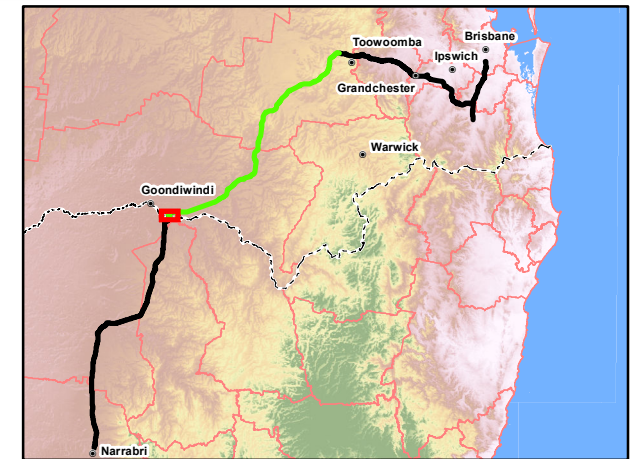
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Legend

- 5 Chainage (km)
- Localities
- Sensitive receptors
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Existing rail (operational)
- NSW/QLD border
- Laydown area access track

- Impact assessment area**
- Temporary footprint



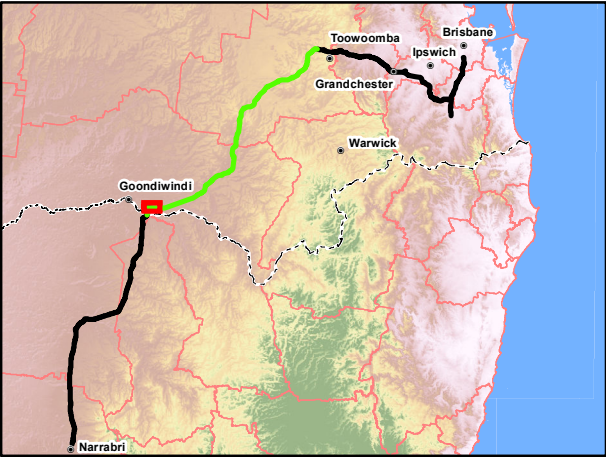
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0 0.3 0.6 0.9 1.2 1.5 km

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Legend

- 5 Chainage (km)
 - Localities
 - Sensitive receptors
 - Border to Gowrie alignment
 - Existing rail (operational)
 - Laydown area access track
- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



Future Freight
Integrating Community, Environment and Engineering

Issue date: 03/10/2024 Version: 8
Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 4.17b:

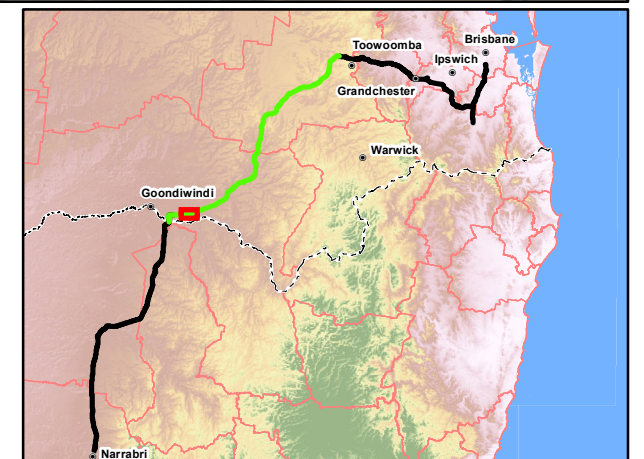
Identified sensitive receptor locations

Map by: T:\CMAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201807261425_Air_Quality\310-EAP-201807261425_FF\JV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
 - Localities
 - Sensitive receptors
 - Border to Gowrie alignment
 - Existing rail (operational)
 - Laydown area access track
- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



Future Freight
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Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 4.17c:

Identified sensitive receptor locations

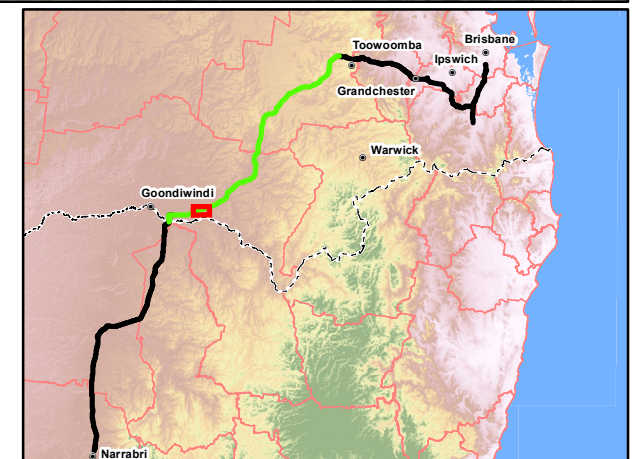
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Legend

- 5 Chainage (km)
- Localities
- Sensitive receptors
- Construction only receptors
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Laydown area access track

- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 4.17d:

Identified sensitive receptor locations

Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\JV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)

Localities

Sensitive receptors

Construction only receptors

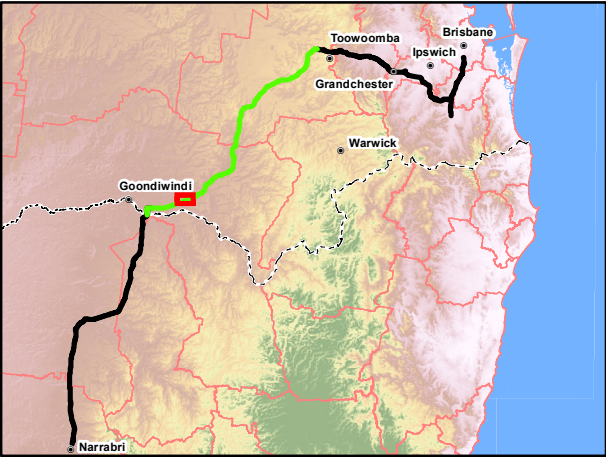
Border to Gowrie alignment

Existing rail (operational)

Major roads

Laydown area access track
- Impact assessment area**

Temporary footprint



A3 scale: 1:40,000

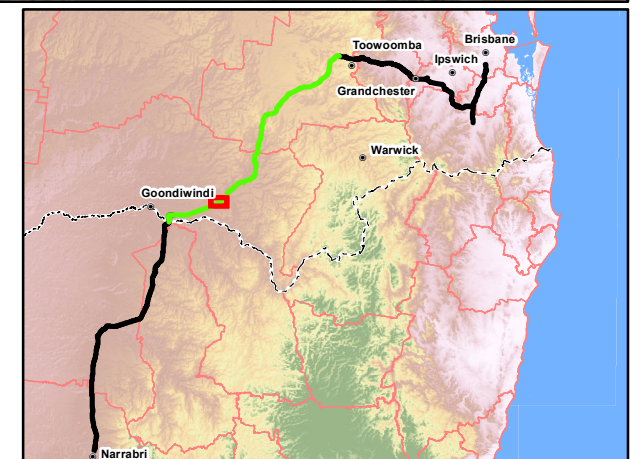
0 0.3 0.6 0.9 1.2 1.5 km

Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\JV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Laydown area access track
- Impact assessment area**
 - Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17f:

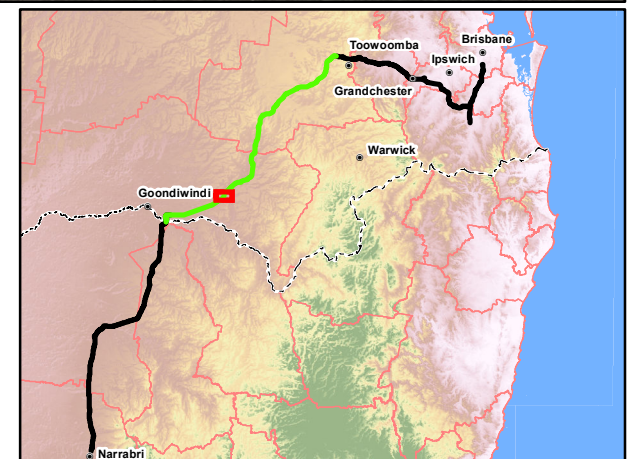
Identified sensitive receptor locations

Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201807261425_Air_Quality\310-EAP-201807261425_FF\JV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
 - Sensitive receptors
 - Border to Gowrie alignment
 - Existing rail (operational)
 - Major roads
 - Laydown area access track
- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17g:

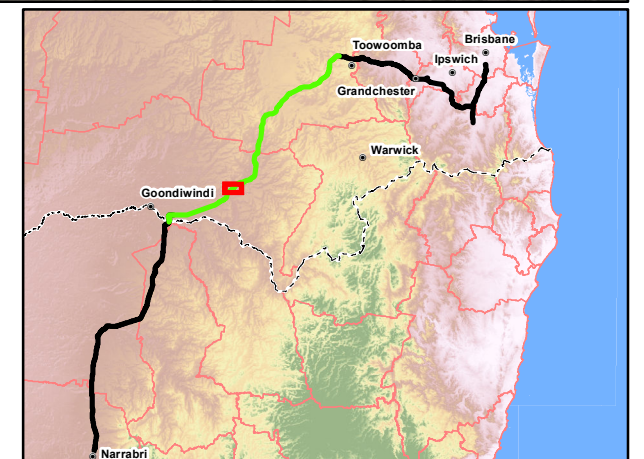
Identified sensitive receptor locations

Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\JV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
 - Sensitive receptors
 - Border to Gowrie alignment
 - +— Existing rail (operational)
 - Major roads
 - Laydown area access track
- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17h:

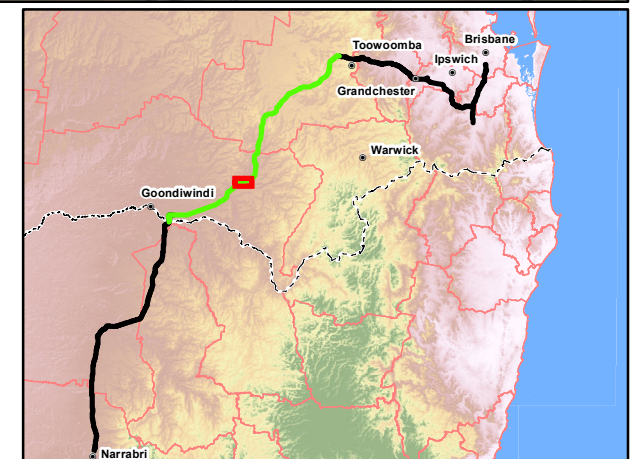
Identified sensitive receptor locations

Map by: T:\MCM\AWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\JV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
 - Localities
 - Sensitive receptors
 - Border to Gowrie alignment
 - Existing rail (operational)
 - Major roads
 - Laydown area access track
- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17i:

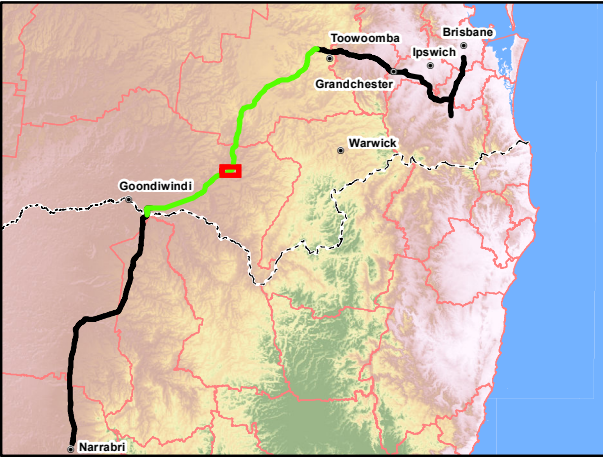
Identified sensitive receptor locations

Map by: T:\MCM\AWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201807261425_Air_Quality\310-EAP-201807261425_FF\JV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- | | |
|------------------------------|-------------------------------|
| 5 Chainage (km) | Impact assessment area |
| ○ Sensitive receptors | □ Temporary footprint |
| — Border to Gowrie alignment | |
| — Laydown area access track | |



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5km



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Border to Gowrie

Figure 4.17j:

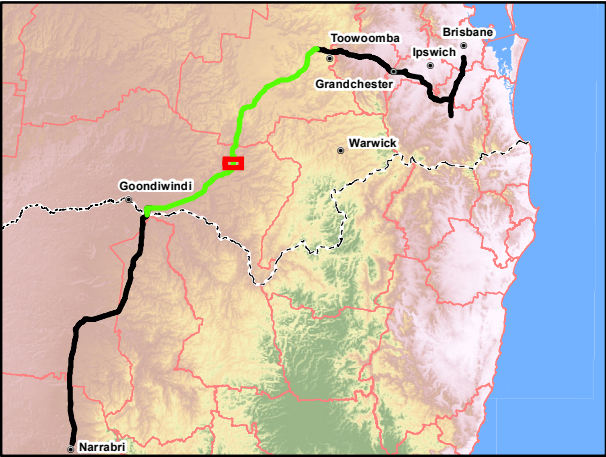
Identified sensitive receptor locations

Map by: T:\CMAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201807261425_Air_Quality\310-EAP-201807261425_FF\JV_Fig_17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53

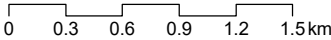


Legend

- | | | |
|---|----------------------------|-------------------------------|
| 5 | Chainage (km) | Impact assessment area |
| ● | Sensitive receptors | Temporary footprint |
| — | Border to Gowrie alignment | |
| — | Laydown area access track | |



A3 scale: 1:40,000



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Border to Gowrie

Figure 4.17k:

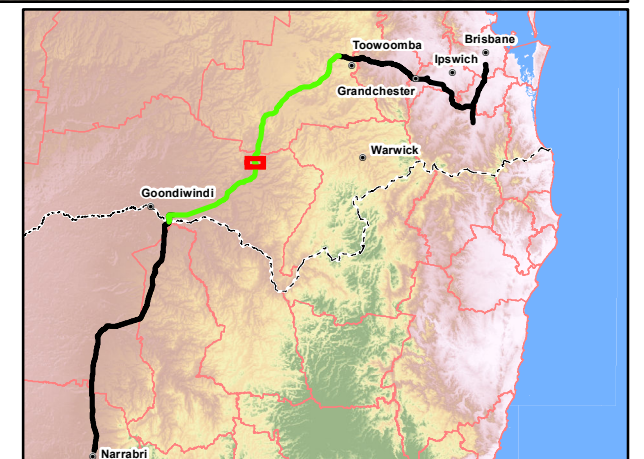
Identified sensitive receptor locations

Map by: T:\MCM\AWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201807261425_Air_Quality\310-EAP-201807261425_FF\JV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53

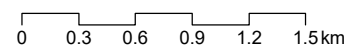


Legend

- 5 Chainage (km)
- Border to Gowrie alignment
- Laydown area access track
- Impact assessment area
 - Temporary footprint



A3 scale: 1:40,000



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Border to Gowrie

Figure 4.17I:

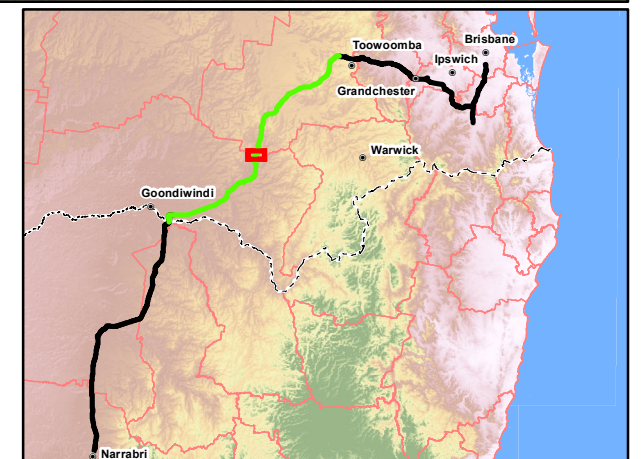
Identified sensitive receptor locations

Map by: T:\MCM\AWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201807261425_Air_Quality\310-EAP-201807261425_FF\JV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
- Border to Gowrie alignment
- Laydown area access track
- Impact assessment area
- Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17m:

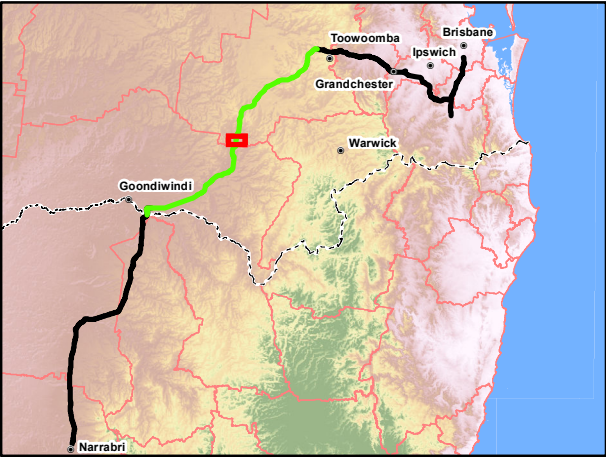
Identified sensitive receptor locations

Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201807261425_Air_Quality\310-EAP-201807261425_FF\JV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- | | | |
|---|----------------------------|-------------------------------|
| 5 | Chainage (km) | Impact assessment area |
| ● | Sensitive receptors | Temporary footprint |
| — | Border to Gowrie alignment | |
| — | Laydown area access track | |



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5km



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Border to Gowrie

Figure 4.17n:

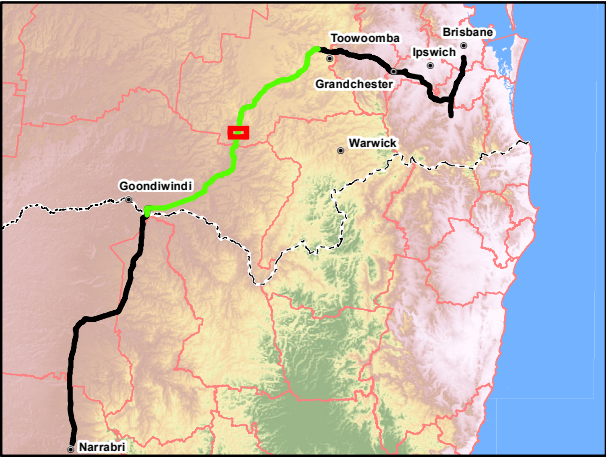
Identified sensitive receptor locations

Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\JV_Fig_17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53

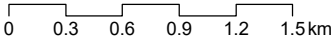


Legend

- | | |
|----------------------------|-------------------------------|
| 5 Chainage (km) | Impact assessment area |
| ● Localities | Temporary footprint |
| ● Sensitive receptors | |
| Border to Gowrie alignment | |
| Laydown area access track | |



A3 scale: 1:40,000



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Border to Gowrie

Figure 4.17o:

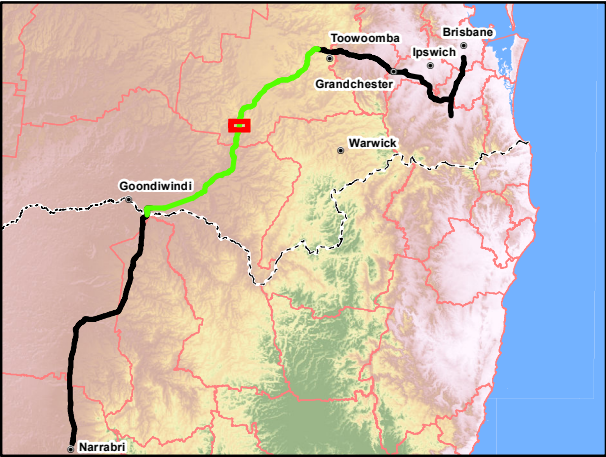
Identified sensitive receptor locations

Map by: T:\CMAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201807261425_Air_Quality\310-EAP-201807261425_FF\JV_Fig_17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
- Sensitive receptors
- Border to Gowrie alignment
- Laydown area access track
- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17p:

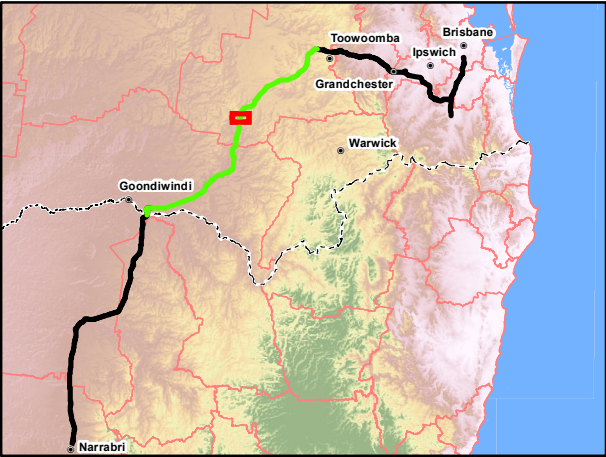
Identified sensitive receptor locations

Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201807261425_Air_Quality\310-EAP-201807261425_Air_Quality_Fig_17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- | | | |
|---|----------------------------|------------------------|
| 5 | Chainage (km) | Impact assessment area |
| ● | Sensitive receptors | Temporary footprint |
| — | Border to Gowrie alignment | |
| — | Laydown area access track | |



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17q:

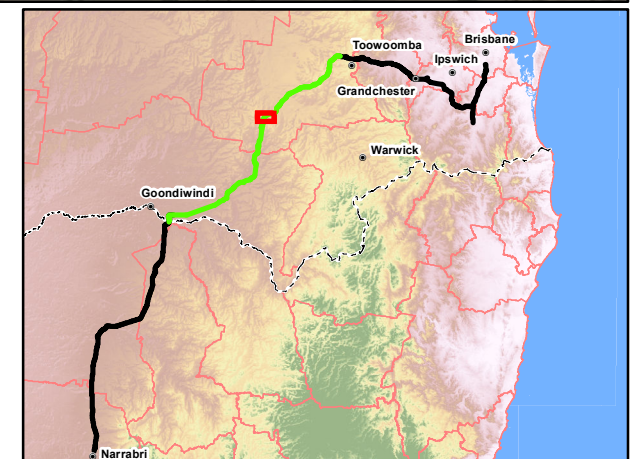
Identified sensitive receptor locations

Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\JV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
 - Sensitive receptors
 - Border to Gowrie alignment
 - Major roads
 - Laydown area access track
- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000

0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17r:

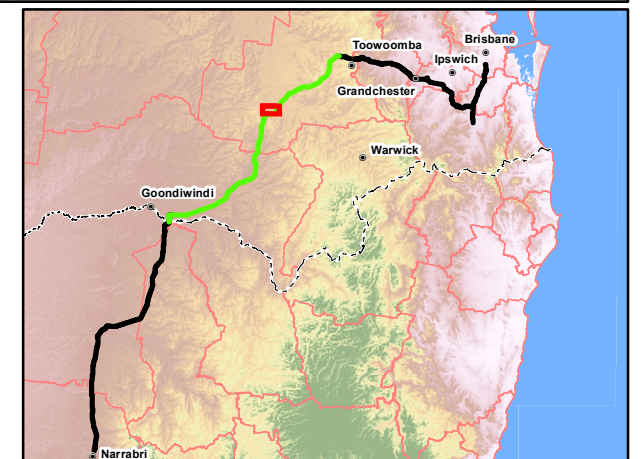
Identified sensitive receptor locations

Map by: TM/CMAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201807261425_Air_Quality\310-EAP-201807261425_FF\JV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
- Localities
- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (non-operational)
- Major roads
- Laydown area access track
- Impact assessment area**
 - Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17s:

Identified sensitive receptor locations

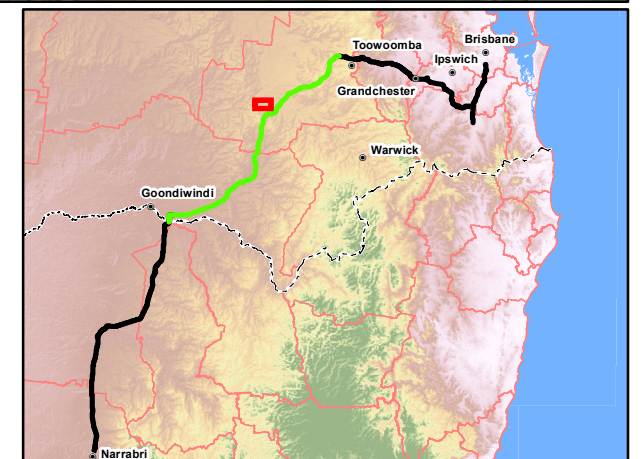
Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201807261425_Air_Quality\310-EAP-201807261425_FFJV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
- Localities
- Construction only receptors
- Existing rail (non-operational)
- Major roads
- Laydown area access track

- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17t:

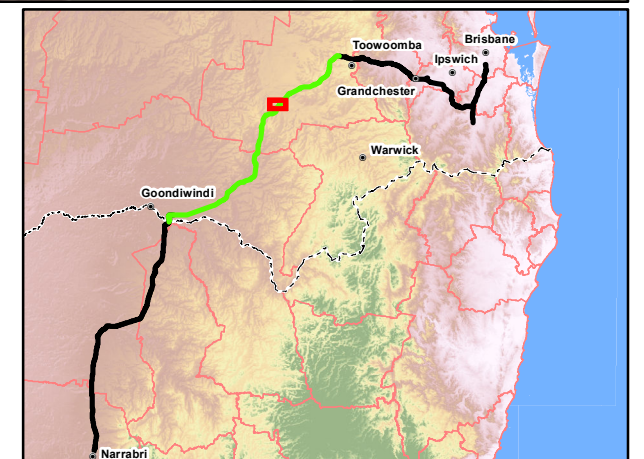
Identified sensitive receptor locations

Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201807261425_Air_Quality\310-EAP-201807261425_FF\JV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (non-operational)
- Major roads
- Laydown area access track
- Impact assessment area**
 - Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5km



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Border to Gowrie

Figure 4.17u:

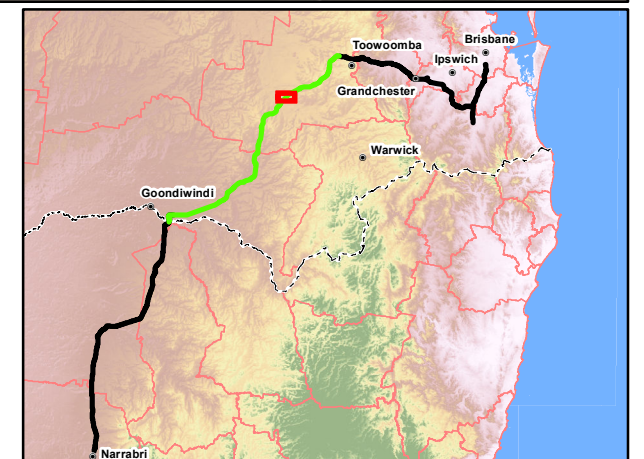
Identified sensitive receptor locations

Map by: TMCMAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\JV_Fig_17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
 - Localities
 - Sensitive receptors
 - Border to Gowrie alignment
 - Existing rail (operational)
 - Existing rail (non-operational)
 - Major roads
 - Laydown area access track
- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000

0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17v:

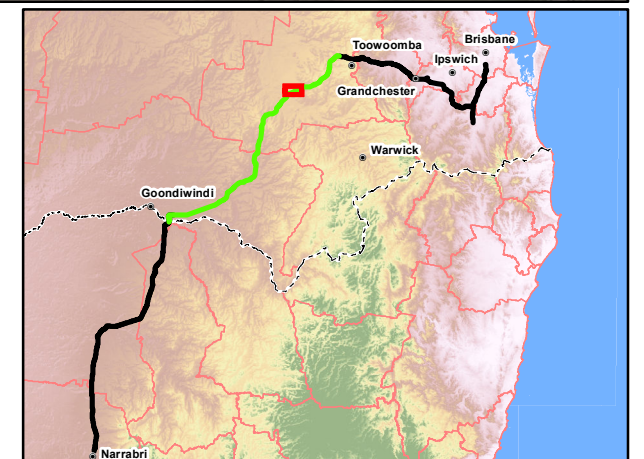
Identified sensitive receptor locations

Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_Air_Quality_Fig_17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
 - Localities
 - Sensitive receptors
 - Border to Gowrie alignment
 - Existing rail (operational)
 - Major roads
 - Laydown area access track
- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17w:

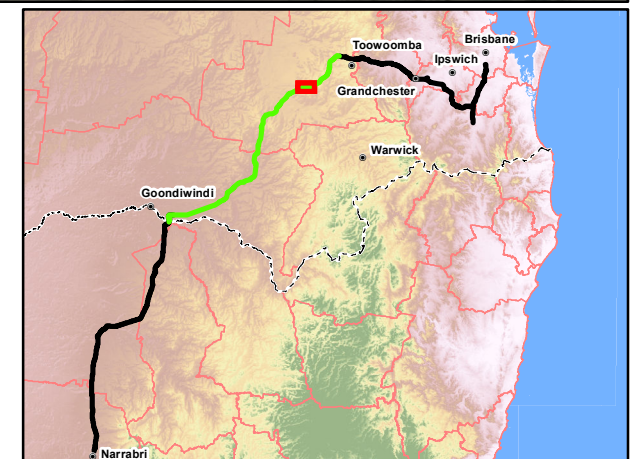
Identified sensitive receptor locations

Map by: T:\MCM\AWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\JV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
 - Localities
 - Sensitive receptors
 - Border to Gowrie alignment
 - Existing rail (operational)
 - Major roads
 - Laydown area access track
- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



Future Freight
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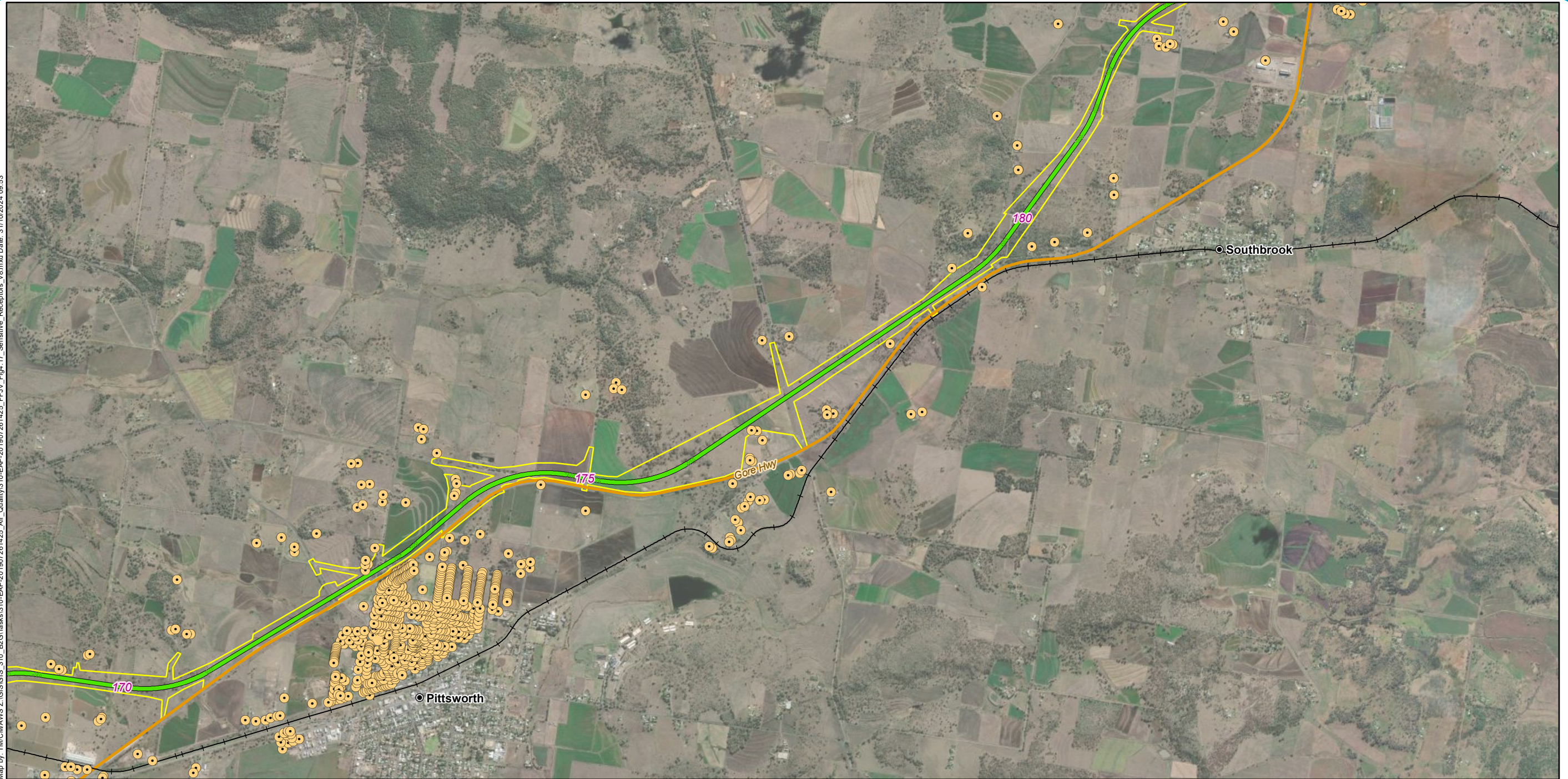
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Border to Gowrie

Figure 4.17x:

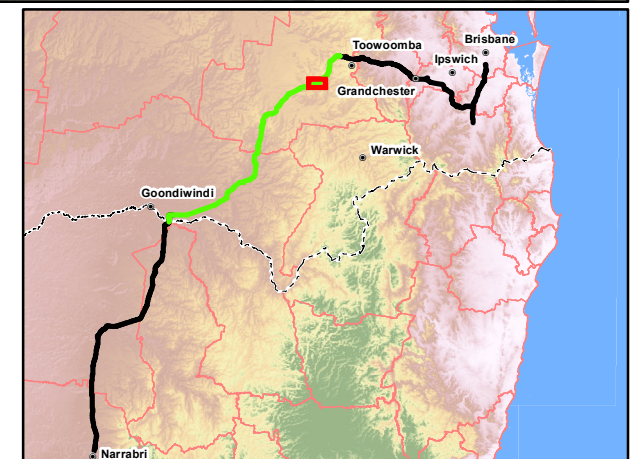
Identified sensitive receptor locations

Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\JV_Fig_17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
 - Localities
 - Sensitive receptors
 - Border to Gowrie alignment
 - Existing rail (operational)
 - Major roads
 - Laydown area access track
- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000

0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17y:

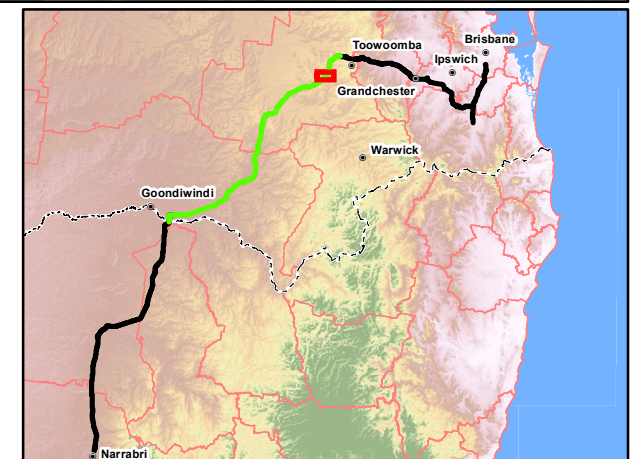
Identified sensitive receptor locations

Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\JV_Fig_17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
 - Sensitive receptors
 - Border to Gowrie alignment
 - Existing rail (operational)
 - Major roads
 - Laydown area access track
- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



Future Freight
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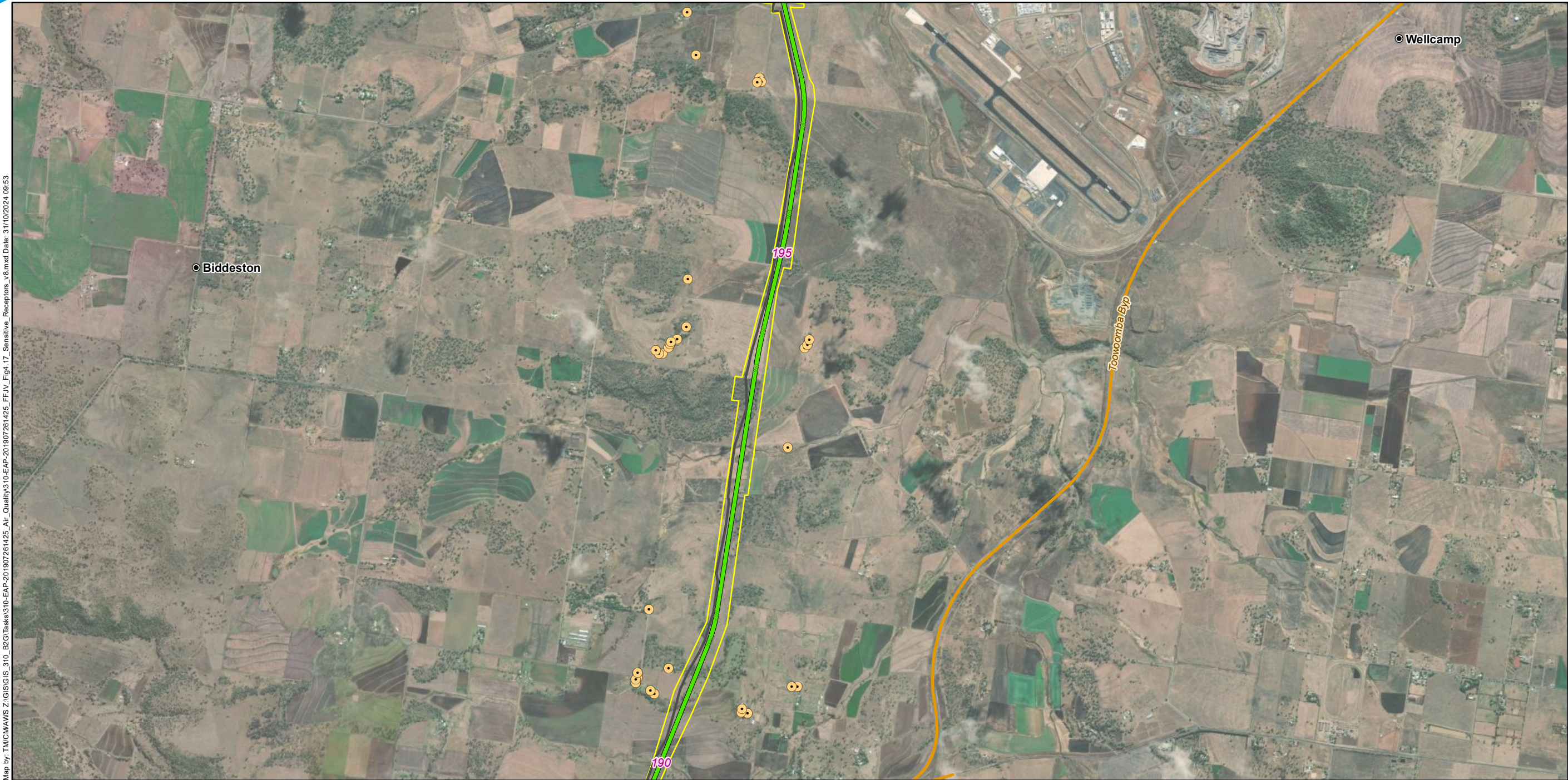
Issue date: 03/10/2024 Version: 8
Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 4.17z:

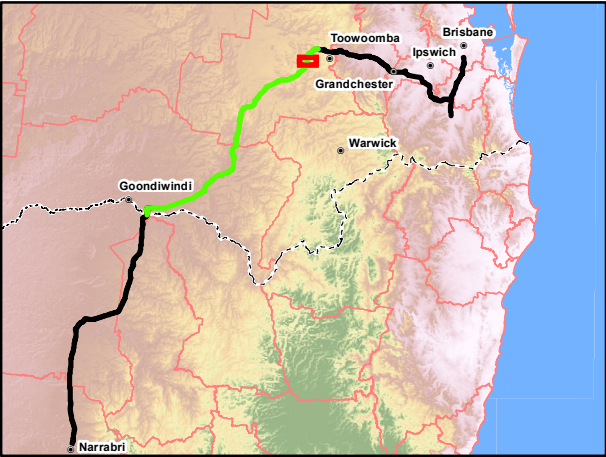
Identified sensitive receptor locations

Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\JV_Fig_17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
 - Localities
 - Sensitive receptors
 - Border to Gowrie alignment
 - Major roads
 - Laydown area access track
- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17aa:

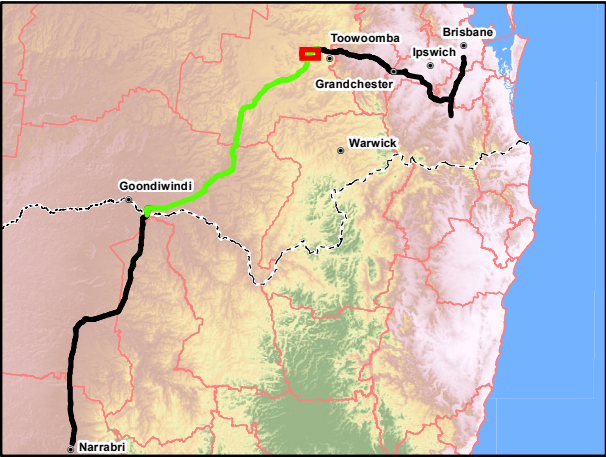
Identified sensitive receptor locations

Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\JV_Fig4.17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
 - Localities
 - Sensitive receptors
 - Border to Gowrie alignment
 - Gowrie to Helidon alignment
 - Existing rail (operational)
 - Major roads
 - Laydown area access track
- Impact assessment area**
- Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17ab:

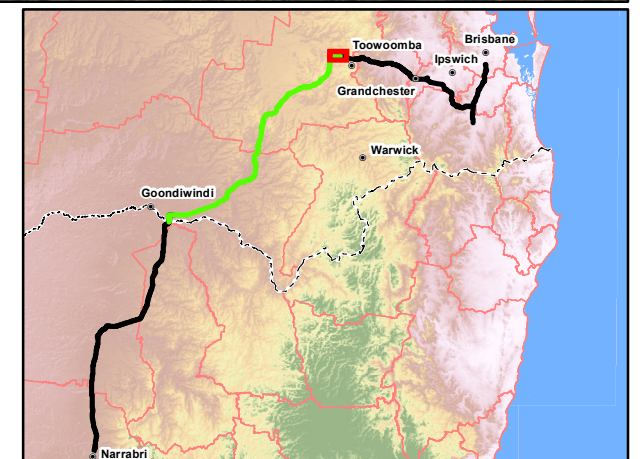
Identified sensitive receptor locations

Map by: TMCMAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201807261425_Air_Quality\310-EAP-201807261425_FF\JV_Fig_17_Sensitive_Receptors_v8.mxd Date: 31/10/2024 09:53



Legend

- 5 Chainage (km)
- Localities
- Sensitive receptors
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Existing rail (operational)
- Major roads
- Laydown area access track
- Impact assessment area
- Temporary footprint



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 4.17ac:

Identified sensitive receptor locations

Approved developments (e.g. residential sub-divisions) that may in future become sensitive receptor locations have also been considered and included within the AQIA. Identification of these potential future receptors was completed through a desktop review of current cadastral boundaries, and where clear undeveloped sub-divisions are present, these lots have been included as sensitive receptor locations. Additionally, the spatial data from the Queensland Government *Broadhectare (residential land supply) study* was referenced to identify further areas that in future may be residentially developed (Queensland Treasury, 2012a, 2012b).

In addition to existing sensitive receptors, two non-resident workforce accommodation sites have been included in the temporary footprint to accommodate the Project construction workforce requirements, one at Inglewood and another at Yelarbon. A third non-resident workforce accommodation site will be required in the Millmerran area and feasibility assessments will be undertaken to identify the optimal location for the site. The location for a Millmerran workforce accommodation has not been included in the revised draft EIS. The site selection and due diligence associated with locating a Millmerran workforce accommodation will be undertaken during the detailed design stage. These non-resident workforce accommodation facilities will be occupied during the construction of the Project and therefore have been included as sensitive receptors for the construction works stage impact assessment. Non-resident workforce accommodation will not be occupied during the operation of the Project and therefore are not considered in the operations stage impact assessment.

The number of sensitive receptors included in this assessment is based on the Project footprint established to accommodate the revised reference design and the land required to safely and efficiently construct and maintain the Project. As a consequence, the number and location of sensitive receptors of relevance for air quality impacts may change during the detailed design stage of the Project and as the construction approach is finalised.

4.5.2 Modelled receptor height

Discrete receptor points have been included for sensitive receptors within the AQIA area and have been modelled at ground level (0 m above ground) as per the requirements of DES (2023). In addition to the discrete receptors, grids of receptors have been included in the modelling (at a height of 0 m above ground) to facilitate the generation of concentration contours.

It is standard (air quality) industry practice to represent predicted impacts at sensitive receptors at ground level and to determine ground level concentrations. This is stated in several State government air quality modelling guidelines in addition to the DESI guideline, including in NSW EPA (2022), the South Australia Environment Protection Authority (SA EPA) *Ambient air quality assessment* (2016a), and the EPA Victoria *Guideline for Assessing and Minimising Air Pollution in Victoria* (2022).

It is noted that guidance documents such as the RTAQMM (DTMR, 2014) include reference to assessing air quality at a receptor height of 1.8 m above ground. Although road and rail projects are similar (linear infrastructure) with respect to air emissions, the RTAQMM is only strictly applicable for the assessment of air quality impacts from State-controlled road related projects. It is also noted that the RTAQMM is not definitive in the use of 1.8 m as a receptor height, rather, it advises that a receptor height of 1.8 m is an acceptable assumption.

Experience with air quality dispersion modelling has shown that the difference in predicted concentration levels between receptors at 0 m and small heights above ground level (e.g. 1.8 m as advised by the RTAQMM) is minor in magnitude and generally insignificant with respect to the outcomes of an AQIA. This is due to the atmospheric layer near the ground level typically being well mixed. The absence of sensitivity to small changes in height is different to other similar environmental disciplines which use predictive modelling (e.g. environmental noise) where height above ground has a more significant impact due to the strong influence of line of sight and travel path distance.

Additionally, dust deposition can only be predicted at receptor points located at ground level (0 m above ground). A key assumption of air pollutant dispersion models (both Gaussian and Lagrangian puff models, such as AERMOD and CALPUFF) is the mass depletion of pollutants (such as dust) in the model surface layer next to the ground surface. Should the conditions for deposition of air pollutants while present in this surface layer be met (e.g. sufficient residence time within the surface layer for particles to settle out of suspension), air pollutants are deposited and consequently depleted from within the model and are no longer available for dispersion. In laymen's terms, air pollutant dispersion models cannot predict deposition onto a surface (e.g. the ground) if the surface does not exist in the model at the assessed height.

As deposition cannot be predicted at heights above ground level and as the difference in predicted concentration levels between receptors at 0 m and small heights above ground level is not expected to be significant, all sensitive receptor heights in the model have been set at 0 m above ground. This receptor height has been used for the prediction of pollutant concentrations, dust deposition rates (amenity impacts) and for the assessment of impacts to water tank quality (deposition on residential rooves which lead to water tanks) as discussed in Section 5.3.7.

Similar to concentration, the difference in deposition between 0 m and roof level (e.g. 3.5 m) is not expected to be significant. Therefore, predicting deposition at 0 m for the assessment of impacts to tank water quality is considered appropriate and is expected to provide a robust assessment of potential impacts.

5 Assessment methodology

The AQIA methodology for the Project has included the following key elements:

- Qualitative impact assessment of the construction works stage
- Primarily quantitative impact assessment of the operations stage, with minor emissions sources assessed qualitatively
- Identification of potential mitigation measures
- Assessment of the residual impact with the inclusion of the identified mitigation measures

Stakeholder and community engagement identified that impacts to tank water quality were of concern and therefore the AQIA has included assessment of potential pollutants in water tanks against drinking water guidelines. Dust generation during construction and operation have also been key matters raised by stakeholders and the community, which has helped to inform the development of mitigation measures for both construction and operation. This includes consideration of both onsite construction activities and the movement of construction vehicles and equipment to and within the works areas.

Details of the methodology used to assess air quality impacts during each stage of the Project are described in this section.

5.1 Construction works stage air quality assessment

Construction emissions for large linear infrastructure projects are complex due to the number of construction activities, the distribution of sites across a large geographical area, and the transitory nature of many individual construction activities at particular locations. The potential construction air quality impacts associated with the Project were therefore assessed by describing the nature of proposed works, plant and equipment, potential emissions sources and the expected magnitude of construction dust emissions.

Potential dust impacts on surrounding sensitive receptors were determined through a qualitative risk assessment, based on information provided at the time of writing. Sensitive receptors located within 1 km of the alignment were considered in the assessment; this includes the two temporary non-resident workforce accommodation facilities for the Project. Further quantitative assessment of potential dust deposition at sensitive receptors from construction activity will be completed in future stages (prior to construction) when more detailed construction information is available.

The highest proportion of construction emissions results from mechanical activity (e.g. material movement or mobile equipment travel) which typically generate coarser particulate emissions (PM₁₀ and TSP). Airborne PM₁₀ and deposited dust (TSP) are the main pollutants of concern for construction activities and these pollutant species are the focus of the assessment for construction dust.

Particulate matter less than 2.5 micrometres in diameter (PM_{2.5}) is typically emitted in minor quantities from material movement sources, and is more predominant from combustion point sources (i.e. combustion engines). Point source emissions of combustion gases (e.g. NO_x and CO) and PM_{2.5} from diesel construction vehicles, mobile plant and generators will be significantly lower than particulate emissions from construction activities. Emissions of combustion gases and PM_{2.5} are considered unlikely to result in exceedance of air quality goals or cause nuisance to sensitive receptors and therefore have not been assessed in detail. However, mitigation measures for these sources have been identified to minimise the potential for impacts on sensitive receptors within the AQIA area.

The assessment methodology for construction dust is the UK IAQM *Guidance on the assessment of dust from demolition and construction* (2014). The IAQM process is a four-step risk-based assessment of dust emissions associated with demolition, including land clearing and earth moving, and construction activities. The construction assessment steps are as follows:

- Step 1 – screening assessment: assess distance from receptors to active construction areas

- Step 2 – dust risk assessment: assess the dust emission magnitude (scale of activity) of the identified sources, determine the sensitivity of the surrounding area, and determine the risk of impacts if no mitigation is implemented
- Step 3 – management strategies: identify the mitigation measures required to minimise the risk of impacts to sensitive receptors
- Step 4 – reassessment: review the potential for residual impacts post mitigation.

The methodology of the IAQM risk assessment procedure is tailored specifically to the assessment of emissions to air from construction activities. The IAQM risk assessment method considers the sensitivity of the AQIA area to air quality impacts based on separation distance and existing air quality, and the potential risk of adverse impacts based on the emissions magnitude of the construction activities. The IAQM method is considered the most appropriate risk assessment method for the assessment of construction impacts for the Project.

Construction impacts from blasting have also been assessed qualitatively considering the EPA Victoria guideline *Recommended separation distances for industrial residual air emissions* (2013), which provides guidance on suitable separation distances between mining and extractive activities (which undertake blasting) and neighbouring sensitive receptors. The EPA Victoria guideline has been used in the absence of Queensland specific guidance. The EPA Victoria guideline is commonly applied for air quality assessments in Queensland and interstate and is considered appropriate for the assessment. A breakdown of each step and the associated findings of the dust impact assessment are detailed in Section 6.

In addition to construction dust, odour will be emitted from the sewage treatment plants required for non-resident workforce accommodation. The assessment of odour from these facilities has been undertaken following the EPA Victoria guideline *Recommended separation distances for industrial residual air emissions* (2013) which is referenced in the DES guideline *Application requirements for activities with impacts to air* (2023) as being applicable for assessments in Queensland. Assessment of sewage treatment plants for non-resident workforce accommodation is presented in Section 6.3.

The construction works stage impact assessment covers construction along the Project alignment including the Turallin facility and the Whetstone MDC, which are discussed in Section 6.2 and Section 6.3. Odour and VOCs will also be emitted as fugitive emissions from fuel tanks located at laydown areas. Impacts from fuel storage are assessed in Section 6.5.

The impact of construction dust, odour and VOC emissions on ecological receptors has not been considered as there are no air quality goals (Table 3.1 in Section 3.5) for particulate matter (e.g. PM₁₀ and TSP), odour or VOCs for the protection of the health and biodiversity of ecosystems.

No other significant pollutant emissions (excluding dust, odour and VOCs) are anticipated from the construction works stage of the Project.

Detailed dispersion modelling of construction is not typically undertaken as construction activities are difficult to forecast accurately and emissions are typically well controlled by standard construction practices. The qualitative assessment method applied for the assessment of construction works stage impacts is considered appropriate for the Project and is consistent with industry standard methodology.

5.2 Commissioning stage air quality assessment

The commissioning stage of the Project will involve testing and checking the rail line and communication and signalling systems to ensure that all systems and infrastructure are designed, installed and operating according to ARTC's operational requirements. All rail system commissioning activities will be undertaken in accordance with an approved Test and Commissioning Plan developed as part of the Project and approved by ARTC.

Air emissions during the commissioning stage of the Project are anticipated to be minor and are expected to be limited to combustion engine emissions from transport vehicles and train locomotives, and limited dust emissions from vehicle travel on unsealed roads.

In regard to locomotive movements along the railway, emissions from the commissioning stage of the Project will be significantly lower than emissions during the operations stage.

Air emissions from the commissioning stage of the Project are expected to be insignificant and are considered unlikely to generate nuisance or risk exceedance of the Project's air quality goals and therefore have not been assessed.

5.3 Operations stage air quality assessment

This section outlines the approach taken for the modelling and assessment of the operations stage of the Project, including:

- Emissions inventory and assessment assumptions, including potential cumulative emission sources
- The dispersion modelling methodology, including:
 - Software packages
 - Meteorological data used
 - Scenarios assessed and model inputs
 - The method applied for the conversion of NO_x to NO₂
 - Limitations of the modelling approach
- The method for the assessment of impacts to tank water quality
- The method for the assessment of agricultural freight odour.

5.3.1 Emissions inventory

An emissions inventory has been developed to quantify emissions from the diesel locomotives that may operate on the Project, based on the engine types, rail traffic quantities and locomotive speeds for the forecast train services. The key pollutants of interest included in the emissions inventory for diesel locomotives are TSP, PM₁₀, PM_{2.5} and NO_x.

5.3.1.1 Diesel locomotive emissions

Emissions factors have been sourced from emissions testing completed on locomotives by the NSW EPA (ABMARC, 2016), as well as rated emission standards published by the US EPA (2009). The US EPA emission factors are the most accurate source of available emissions data for the locomotives and are considered appropriate for use in the assessment. Table 5.1 presents the referenced emissions factors on a gram's per kilowatt hour basis (g/kWh).

Table 5.1 Locomotive emissions factors for NO_x, total particulates and VOCs (as total hydrocarbons)

Locomotive	NR Class ²		SCT/LDP ³	82 Class ⁴
	Cycle weighted	Idling		
Locomotive Max Power in kilowatts (kW)	2,917		3,350	2,425
Rated Emission Standard	US EPA – Tier 0	-	US EPA – Tier 1	US EPA – Tier 0
Total Particulates (g/kWh)	0.101	1.09	0.60	0.8
NO _x (g/kWh)	16.6	43.7	9.92	12.74
Total Hydrocarbons (THC) ¹ (g/kWh)	0.519	4.66	0.74	1.34

Locomotive	NR Class ²		SCT/LDP ³	82 Class ⁴
	Cycle weighted	Idling		
Source	<i>Emission Factors for Locomotives</i> (US EPA, 2009)	<i>NSW EPA's Diesel Locomotive Fuel Efficiency & Emissions Testing</i> (ABMARC, 2016) (applicable for NR121 and 93 Class)	<i>Emissions Factors for Locomotives</i> (US EPA, 2009)	

Table notes:

- 1 VOCs are a subset of THC. For this assessment 100% of THC emissions are assumed to be VOCs
- 2 UGL National Rail Class locomotive
- 3 Downer EDI SCT/LDP Class locomotive
- 4 Downer EDI 82 Class locomotive

In diesel locomotive operation, engine power is determined by the notch setting, which ranges from notches one through eight (Spiryagin M. et al., 2016). During normal operation a diesel locomotive will progress through the notch settings to accelerate to the required rail line speeds. The locomotive would then operate at a certain notch setting that is dependent on the power output required to maintain the required rail speed.

The engine power at each notch setting differs greatly, for example, the power rating at notch eight is equivalent to 100 per cent of the maximum locomotive engine power. Whereas, at notch four, the engine power would be closer to 35 per cent of maximum locomotive engine power (Spiryagin M. , Wolfs, Szanto, & Cole, 2015). Therefore, it is important to know the power ratings and time speed at each notch setting to provide an accurate estimate of diesel locomotive emissions.

Power ratings for each notch setting for the proposed diesel locomotive engines were not available at the time of the assessment; therefore, a review of literature was completed. The notch setting and percentage of engine power for each setting as obtained via literature review is summarised in Table 5.2.

Table 5.2 Power ratings for locomotive notch settings or operating mode from various sources

Notch setting or operating mode	Maximum engine power					
Source	Spiryagin et al. (2016) ¹	Spiryagin et al. (2015)	StarCrest Consulting Group (2008)	Therma-Dynamics Rail LLC (2014)	Kim et al. (2017)	Casadei & Maggioni (2016)
Idle	0.0 per cent	0.0 per cent (0 kW)	0.8 per cent (14 hp)	2.2 per cent (69 hp)	9.1 per cent (216 kW)	2.3 per cent (74.6 bhp)
Dynamic Braking	-	-	3.6 per cent (67 hp)	0.5 per cent (17 hp)	-	-
Notch 1	1.6 per cent	4.8 per cent (133 kW)	4.5 per cent (83 hp)	3.3 per cent (105 hp)	15.7 per cent (370 kW)	-
Notch 2	6.3 per cent	10.7 per cent (294 kW)	13.5 per cent (249 hp)	12.5 per cent (395 hp)	24.4 per cent (576 kW)	11.2 per cent (359 bhp)
Notch 3	14.1 per cent	24.1 per cent (665 kW)	26.4 per cent (487 hp)	21.7 per cent (686 hp)	34.3 per cent (810 kW)	-
Notch 4	25.0 per cent	34.3 per cent (945 kW)	39.9 per cent (735 hp)	32.7 per cent (1034 hp)	46.0 per cent (1086 kW)	33.0 per cent (1057 bhp)
Notch 5	39.1 per cent	45.4 per cent (1253 kW)	54.4 per cent (1002 hp)	46.2 per cent (1461 hp)	55.7 per cent (1316 kW)	-
Notch 6	56.3 per cent	66.0 per cent (1820 kW)	68.8 per cent (1268 hp)	62.4 per cent (1971 hp)	67.2 per cent (1589 kW)	59.1 per cent (1895 bhp)
Notch 7	76.6 per cent	87.1 per cent (2400 kW)	85.2 per cent (1570 hp)	84.2 per cent (2661 hp)	83.9 per cent (1983 kW)	-

Notch setting or operating mode	Maximum engine power					
Source	Spiryagin et al. (2016) ¹	Spiryagin et al. (2015)	StarCrest Consulting Group (2008)	Therma-Dynamics Rail LLC (2014)	Kim et al. (2017)	Casadei & Maggioni (2016)
Notch 8	100 per cent	100 per cent (2757 kW)	100 per cent (1843 hp)	100 per cent (3159 hp)	100 per cent (2363 kW)	100 per cent (3206 bhp)

Table notes:

1 Based upon the calculation method in Spiryagin et al. (2016) for notch power for diesel engine heavy haul operations - $P_n = (n^2/64) * P_{rated}$; Where P_n is the notch power; P_{rated} is the rated power in notch 8; and n is the discrete notch numbers, which takes a range from zero to eight.

Bold values represent adopted notch setting and operating mode percentages

bhp = brake horsepower

Spiryagin et al. (2016) provides a calculation method which follows a square-law relationship to estimate engine power at the eight engine notch settings. As an example, the Spiryagin et al. (2016) study uses engine power capabilities referenced from earlier work (Spiryagin et al., 2015) to estimate engine power. The Spiryagin et al. (2016) calculation method provides a procedure to estimate notch engine power in lieu of actual measured data. However, the calculated notch engine power is lower than all other referenced sources as shown Table 5.2

Notch power ratings cited by Kim et al. (2017) are greater than all other sources, especially for idling which is 9.1 per cent of maximum rated power, 3.9 times higher than the next highest idling power usage. However, the Kim et al. (2017) study investigated locomotives specific to Korea, and in combination with the relative high-power rating locomotives assessed, the results of this study were not considered suitable for the calculation of duty cycle power ratings for the Project.

Power ratings presented by Therma-Dynamics Rail LLC (2014) were lower than most sources at almost all notch settings.

The notch engine power values from Spiryagin et al. (2015) are higher than all other sources at notch seven and comparable at all other notches. The notch power ratings presented were for a line haul diesel locomotive with a total maximum power of 2,757 kW, which is similar to the engine power of the locomotives proposed for the Project. Due to the similarity in locomotive engine power, notch settings from Spiryagin et al. (2015) were used in calculating duty cycle power ratings for the Project for train travel.

For the literature reviewed, engine idling power ranged from zero per cent (Spiryagin et al., 2015) to 9.1 per cent (Kim et al., 2017). Cassadei and Maggioni (2016) presented the second highest idling power usage at 2.3 per cent of maximum engine power which was considered appropriate for adoption for the assessment as it was based on engine testing of diesel locomotives.

Limited information was available from literature with respect to engine power during dynamic braking. From the information available, the higher engine power percentage of 3.6 per cent (StarCrest Consulting Group, 2008) was adopted for duty cycle calculations.

Table 5.3 summarises the adopted notch setting, and operating mode percentages of maximum engine power utilised to calculate average duty cycle power ratings.

Table 5.3 Adopted notch setting and operating mode power rating percentages

Notch setting or operating mode	Adopted percentage of maximum engine power (per cent)	Source
Idle	2.3	Casadei & Maggioni (2016)
Dynamic Braking	3.6	StarCrest Consulting Group (2008)
Notch 1	4.8	Spiryagin et al. (2015)
Notch 2	10.7	
Notch 3	24.1	
Notch 4	34.3	

Notch setting or operating mode	Adopted percentage of maximum engine power (per cent)	Source
Notch 5	45.4	
Notch 6	66.0	
Notch 7	87.1	
Notch 8	100	

In terms of time spent at each engine notch setting or operating mode, data from United States rail operation was used to provide a basis for average duty cycle power ratings. Table 5.4 presents US EPA data from Ireson, Germer and Schmid (2005), which represents duty cycle data for line haul diesel locomotives in the United States. The line haul data is representative of analysis from 63 line-haul trains and 2,475 operational hours.

Table 5.4 Duty-cycles for line haul locomotives in the US (percentage time in notch)

Notch setting/operating mode	Percentage of time for line haul (per cent)
Idle	38.0
Dynamic Braking	12.5
Notch 1	6.5
Notch 2	6.5
Notch 3	5.2
Notch 4	4.4
Notch 5	3.8
Notch 6	3.9
Notch 7	3.0
Notch 8	16.2

Average hourly (duty cycle) power consumption rates have been calculated for each locomotive type using the adopted notch power ratings and duty cycle information presented in Table 5.3 and Table 5.4. The calculated average hourly power consumption rates in addition to the maximum and continuous idling power consumption rates at crossing loops for each locomotive are presented in Table 5.5.

Table 5.5 Locomotive power usage

Power	NR Class ¹	SCT/LDP ²	Class 82 ³
Maximum power (kWh)	2,917	3,350	2,425
Calculated average duty cycle (kWh)	823	945	684
Continuous idle (kWh)	68	78	56

Table notes:

- 1 UGL National Rail Class locomotive
- 2 Downer EDI SCT/LDP Class locomotive
- 3 Downer EDI 82 Class locomotive

Pollutant diesel combustion emission rates were then calculated based on a peak weekly total of 174 trains and the locomotive type and configuration (as per Table 2.4).

Table 5.6 presents the maximum anticipated travel speeds along the Project. Average line speeds were estimated to be 75 per cent of the maximum line speeds for the Project.

Table 5.6 Locomotive travel speeds

Power	Direction of travel	NR Class	SCT/LDP	Class 82
Maximum line speed (km/hr)	North	115	115	80
	South	115	115	80
Average line speed (km/hr)	North	86	86	60
	South	86	86	60

The following equation represents the calculation method to determine the total locomotive power per hour for the entire Project alignment.

$$P_{total} = \sum_{loco} (P_{loco} \times d \times v_{loco} \times n_{loco})$$

Where:

- P_{total} is the total locomotive calculated power per hour for entire alignment (kWh)
- P_{loco} is the calculated average duty cycle power for each locomotive type (kWh)
- d is the rail track length of the Project alignment (km)
- v_{loco} is the average line speed of each locomotive type (km/hr)
- n_{loco} is the total number of locomotives of each train type.

The following equation calculates the pollutant emissions from locomotive traffic along the entire Project alignment.

$$ER_{pollutant} = \frac{EF_{pollutant} \times P_{total}}{d}$$

Where:

- $ER_{pollutant}$ is the calculated pollutant emission rate for NO_x, TSP, PM₁₀, PM_{2.5} and Total VOCs (as THC) (g/m/s)
- $EF_{pollutant}$ is the pollutant emission factor as per Table 5.1 (g/kWh)
- P_{total} is the total locomotive calculated power per hour for entire alignment (kWh), and
- d is the rail track length of the Project alignment (m).

The following equation represents the calculation method to determine emissions from idling locomotives during normal assumed operation.

$$ER_{idle} = \left[\sum_{loco} \left(\frac{t_{loco}}{3} \times n_{loco} \times P_{loco} \right) \right] \times EF_{pollutant}$$

Where:

- ER_{idle} is the calculated pollutant emission rate for NO_x, TSP, PM₁₀, PM_{2.5} and total VOC's (as THC) (g/s)
- t_{loco} is the locomotive travel time along the Project alignment without stopping. Idling time is assumed to be 25 per cent of the total travel time along the Project alignment, (i.e. 1/3 of the non-stopping travel time of a locomotive to travel the Project alignment)
- n_{loco} is the total number of locomotives of each train type
- P_{loco} is the total locomotive calculated power per hour for the entire Project alignment from idling (kWh), and
- $EF_{pollutant}$ is the pollutant emission factor as per Table 5.1 (g/kWh).

To determine continuous idling emissions, it was assumed that NR class locomotives would idle for periods up to or greater than one hour depending on the scenario modelled. The idling emission rates were therefore derived from the hourly idling locomotive power usage presented in Table 5.5, and the locomotive emission factors presented in Table 5.1. The methodology for the assessment of crossing loops is described further in Section 5.3.2.4.

The derived pollutant locomotive diesel emission rates for typical and peak train movements are presented in Table 5.7. Air emissions as a result of the operation of the Project are directly related to the number of trains, therefore a lower number of trains will result in a lower rate of pollutant emissions to air. Table 5.7 shows that total Project emissions for typical train movements are lower than the total Project emissions for peak train movements. This AQIA has assessed emissions for peak train movements only, as emission rates for peak train movements are higher and therefore the risk of impacts is also higher for this scenario.

Table 5.7 also presents the emission rates for locomotives idling at crossing loops. The methodology for the assessment of emissions from the crossing loops is explained in Section 5.3.2.4. Differences in train movements (e.g. typical or peak) do not influence the methodology used to assess emissions from the crossing loops.

Table 5.7 Derived pollutant diesel combustion emission rates

Pollutant	Total Project emissions for typical movements (g/m/s)	Total Project emissions for peak movements (g/m/s)	Short-term average idling emissions (g/s) (per locomotive) ¹	Long-term average idling emissions (g/s) (per locomotive) ²
NO _x	6.91 x 10 ⁻⁵	8.88 x 10 ⁻⁵	0.824	0.2060
TSP	4.30 x 10 ⁻⁶	5.52 x 10 ⁻⁶	0.021	0.0051
PM ₁₀	4.19 x 10 ⁻⁶	5.38 x 10 ⁻⁶	0.020	0.0050
PM _{2.5}	4.03 x 10 ⁻⁶	5.17 x 10 ⁻⁶	0.019	0.0048
Total VOCs	6.68 x 10 ⁻⁶	1.01 x 10 ⁻⁵	0.088	0.0220

Table notes:

- 1 Short-term (1 hour average): continuous idling of NR Class locomotives assumed throughout the year (Section 5.3.2.4)
- 2 Long-term (24-hour and annual averages): idling assumed to occur 25 per cent of the travel time, (e.g. 15 minutes per hour or 6 hours per day (Section 5.3.2.4)

Table 5.8 Locomotive emission factors and speciation

Pollutant	Emission factor	Units	Speciation percentage (per cent)	Source
Total suspended particulates				
PM ₁₀	3.53	kg/kL	97.6	(DEWHA, 2008)
PM _{2.5}	3.39	kg/kL	93.7	(DEWHA, 2008)
Cadmium	0.01	g/tonne of fuel	0.0007	(EMEP/EEA, 2016)
Chromium	0.05	g/tonne of fuel	0.0033	(EMEP/EEA, 2016)
Copper	1.7	g/tonne of fuel	0.1118	(EMEP/EEA, 2016)
Nickel	0.07	g/tonne of fuel	0.0046	(EMEP/EEA, 2016)
Selenium	0.01	g/tonne of fuel	0.0007	(EMEP/EEA, 2016)
Zinc	0.03	g/tonne of fuel	0.0658	(EMEP/EEA, 2016)
Lead	0.0005	mg/kg of fuel	0.00003	(EMEP/EEA, 2016)
Arsenic	0.0001	mg/kg of fuel	0.00001	(EMEP/EEA, 2016)
SO ₂	0.0167	kg/kL	0.046	(DEWHA, 2008)

Pollutant	Emission factor	Units	Speciation percentage (per cent)	Source
Total hydrocarbons				
Non-methane VOCs	4.65	kg/tonne of fuel	100	(EMEP/EEA, 2016)
Benzo(a)pyrene	0.03	g/tonne of fuel	0.0006	(EMEP/EEA, 2016)
Toluene	-	-	0.01	(EMEP/EEA, 2016)
m,p-xylenes	-	-	0.98	(EMEP/EEA, 2016)
o-xylenes	-	-	0.40	(EMEP/EEA, 2016)
Benzene	-	-	0.07	(EMEP/EEA, 2016)
Polychlorinated dioxins and furans (TEQ)	8.35×10^{-11}	kg/kL	-	(DEWHA, 2008)

Table notes:

EMEP/EEA = European Monitoring and Evaluation Programme/European Environment Agency

DEWHA = Department of the Environment, Water, Heritage and the Arts

5.3.1.2 Cumulative impacts and modelled cumulative sources

The AQIA for the Project requires assessment of the background air quality and the cumulative impact of emissions from the Project in combination with emissions from existing and future sources (which will be operational at the same time as the Project). The following existing emission sources have been included in the dispersion modelling for the AQIA:

- Commodore Mine and Millmerran Power Station
- Gore Highway and Warrego Highway
- Existing non-project rail sources.

Commodore Mine and Millmerran Power Station

The Commodore Mine and Millmerran Power Station are existing emission sources in the AQIA area (Section 4.3). Due to distance from the AQMSs considered in the assessment, emissions from the Commodore Mine and Millmerran Power Station will not be represented in the background concentrations adopted and therefore these emissions sources have been included in the dispersion model developed for the assessment. To include emissions from these sources in the dispersion modelling, NPI emissions data for each of the sources has been reviewed.

Table 5.9 provides a summary of the reported emissions for the Commodore Mine and Millmerran Power Station for the reporting years of 2012/2013 to 2020/2021 which are the most recent available years at the time of the assessment.

It is widely understood that the emissions estimation techniques for mining activities presented in the NPI guidance documents have significant uncertainty when compared with actual dust emissions. Several studies have sought to reduce the uncertainty in emissions estimates of PM₁₀ and PM_{2.5} by developing new emissions factors for mining activities in Australia (Roddiss *et al.*, 2015; Laing *et al.*, 2015; Roddiss *et al.*, 2013; Richardson, Putland & Verran, 2015; Richardson, 2013). However, these developed emissions factors have not been adopted by the NPI, and instead the NPI emission manuals reference estimation techniques developed by the US EPA for United States coal mines (1998), which generally yield over estimations of emissions from Australian coal mines.

Table 5.9 shows that there is significant variation in reported emissions for both the Commodore Mine and Millmerran Power Station. There is limited information available from the NPI website to explain the variations in reported yearly emissions for each source. Furthermore, it is noted that the Commodore Mine is the sole source of thermal coal for the Millmerran Power Station, and therefore it could be expected that emission values between the sources would correlate.

Table 5.9 **Reported National Pollutant Inventory emissions for Commodore Mine and Millmerran Power Station**

Facility	Reporting year	PM ₁₀ (kg)	PM _{2.5} (kg)	NO _x (kg)
Commodore Mine	2020/2021	950,000	67,000	1,000,000
	2019/2020	950,000	67,000	1,000,000
	2018/2019	880,000	71,000	1,100,000
	2017/2018	720,000	59,000	910,000
	2016/2017	605,023	53,656	820,240
	2015/2016	668,215	21,709	309,773
	2014/2015	668,389	21,812	313,853
	2013/2014	337,005	1,228	242,784
	2012/2013	277,999	1,101	241,433
Millmerran Power Station	2020/2021	770,000	440,000	9,700,000
	2019/2020	760,000	430,000	14,000,000
	2018/2019	170,000	42,000	9,400,000
	2017/2018	100,000	25,000	9,000,000
	2016/2017	91,520	11,441	8,891,295
	2015/2016	183,830	91,570	9,491,277
	2014/2015	54,159	50	12,614,517
	2013/2014	80,200	37,900	14,500,000
	2012/2013	90,566	33,000	18,130,000

Table note:

NPI 2019/2020 reporting year data shown in **bold** was used in the assessment as described in the text below.

During the preparation and execution of modelling for the assessment the most recent NPI data available was for the 2019/2020 reporting year (shown in bold in Table 5.9), and this data was used for the modelling for the mine and power station.

However, since the completion of the modelling but prior to the preparation of this report, reporting data for the year 2020/2021 was published. Table 5.9 allows for comparison between the 2019/2020 and 2020/2021 reporting years, summarised as follows:

- Reported emissions for Commodore Mine are identical between both reporting years
- Reported emissions for 2020/2021 for the Millmerran Power Station are:
 - Approximately 30 per cent lower than 2019/2020 NO_x emissions
 - Approximately 1.3 per cent higher than 2019/2020 PM₁₀ emissions
 - Approximately 2.3 per cent higher than 2019/2020 PM_{2.5} emissions.

Overall, the difference between the 2019/2020 and 2020/2021 emissions data is considered minor, with the exception of NO_x emissions from the power station which are significantly (30 per cent) higher in 2019/2020. As a result, emissions data for 2019/2020 is considered appropriate for use in the assessment.

Emission rates used in the modelling were calculated by averaging total emissions for the selected year (2019/2020) evenly over the year (365 days). Table 5.10 presents the modelled emission rates for Commodore Mine and Millmerran Power Station for each pollutant.

Table 5.10 National Pollutant Inventory emissions for Commodore Mine and Millmerran Power Station

Cumulative source	Emissions	PM ₁₀	PM _{2.5}	NO _x
Commodore Mine	NPI reported emissions (kg/annum)	950,000	67,000	1,000,000
	Total modelled emission rate (g/s)	30.1	2.1	31.7
Millmerran Power Station	NPI reported emissions (kg/annum)	760,000	430,000	14,000,000
	Total modelled emission rate (g/s)	24.1	13.6	443.9

Initially, emissions from the Commodore Mine and Millmerran Power Station were modelled using the emission values presented in Table 5.10. The predicted cumulative PM₁₀ 24-hour concentrations (Commodore Mine emissions, Millmerran Power Station emissions and adopted background concentrations) are presented in Figure 5.1 for receptor 438, which represents the closest modelled receptor (within 50 m) to the Millmerran AQMS.

Analysis of the modelling results identified that the mine, which is a ground level source, is the greatest contributor to predicted ground level concentrations at sensitive receptors. Emissions from the power station contribute significantly less and were identified to have limited influence on ground level concentrations due to the elevated release height of the emission source at the power station (200 m tall stacks).

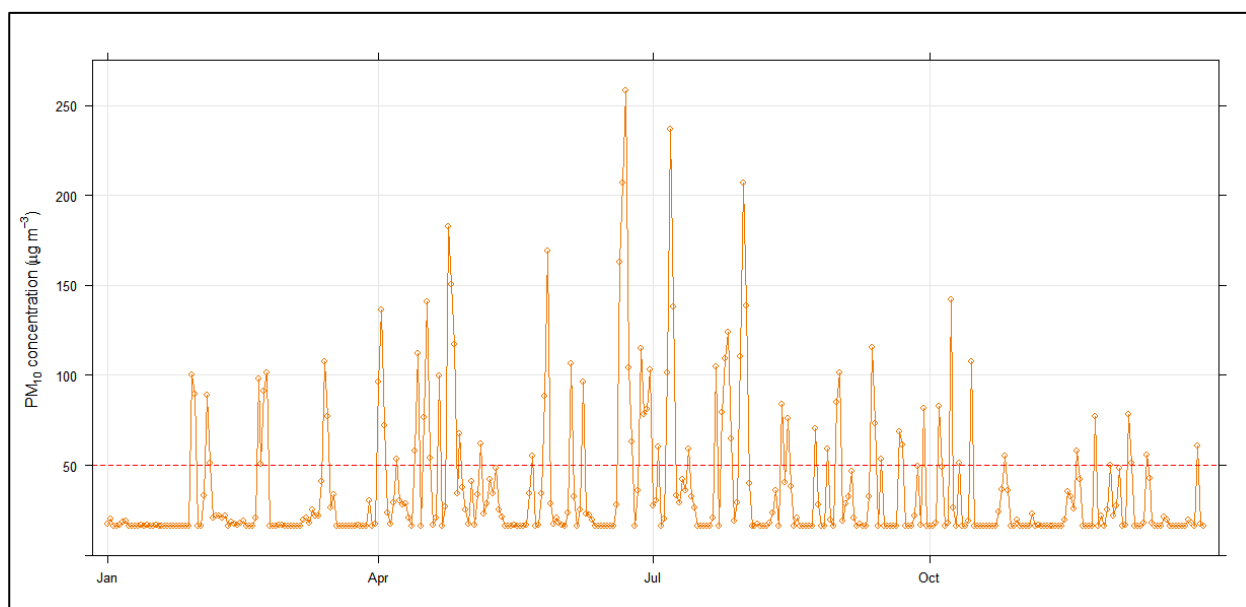


Figure 5.1 Predicted PM₁₀ 24-hour average concentrations (µg/m³) for sensitive receptor 438 modelled with 2019/2020 NPI reported emissions from Commodore Mine and Millmerran Power Station

The corresponding measured PM₁₀ 24-hour concentrations from the Millmerran AQMS for the 12 month monitoring period from 1 April 2021 to 31 March 2022 inclusive is presented in Figure 5.2. Figure 5.2 shows that measured 24-hour PM₁₀ concentrations are generally well below the air quality goal of 50 µg/m³ and that background concentrations near the mine and power station are not elevated.

The data capture rate for the Millmerran AQMS for PM₁₀ was 87 per cent over the monitoring period, above the target capture rate of 75 per cent for air quality monitoring (NEPM, 2001). As a result, monitoring data is available throughout the year with the exception of data gaps in 2021 in early June, August, September, November and December, as shown in Figure 5.2. These data gaps are due to minor equipment faults, inability to access the AQMS due to COVID-19 restrictions (August and September 2021) and sustained periods of rainfall which access to the AQMS unsafe (November and December 2021). Data gaps in monitoring campaigns is common for air quality monitoring and the Millmerran AQMS data gaps are not considered significant.

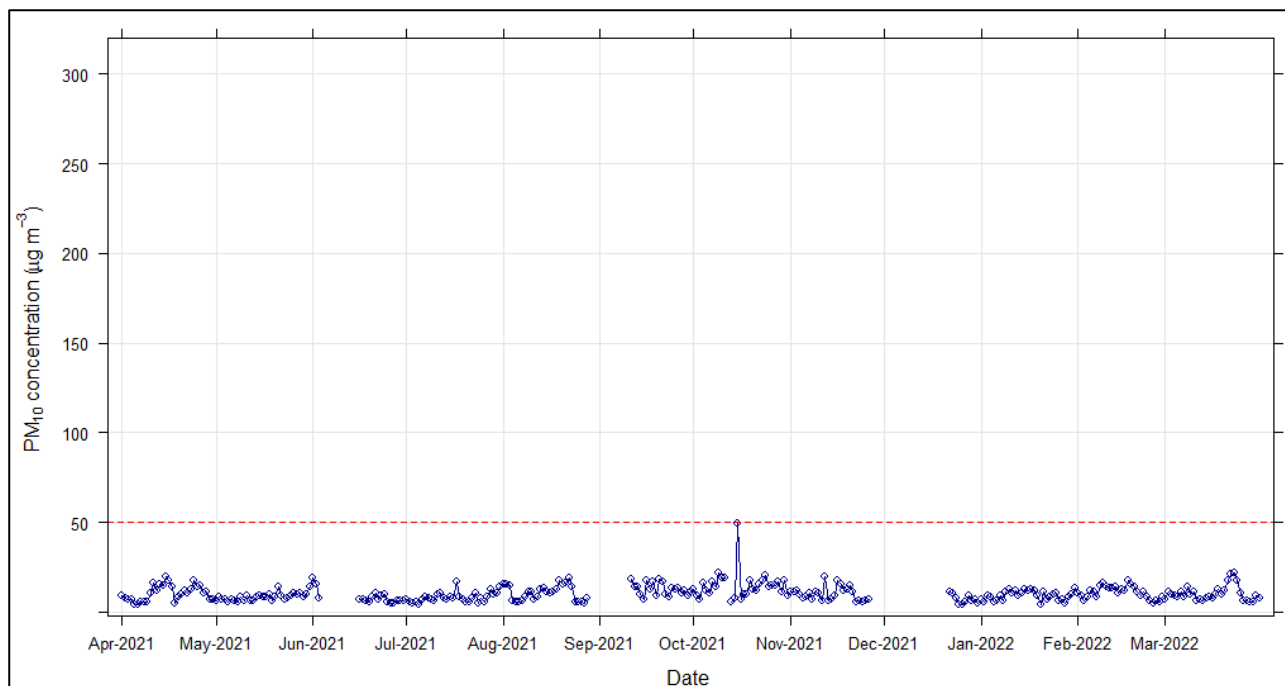


Figure 5.2 Millmerran air quality monitoring station measured PM₁₀ 24-hour average concentrations (µg/m³) (April 2021 to March 2022)

Comparison of the modelled results (Figure 5.1) against the Millmerran AQMS monitoring data (Figure 5.2) indicates significant differences, with predicted concentrations at receptor 438 being orders of magnitude greater than the concentrations measured at Millmerran AQMS. Figure 5.1 shows that the predicted maximum 24-hour PM₁₀ concentration is in excess of 250 µg/m³, with over 50 exceedances of the PM₁₀ 24-hour goal of 50 µg/m³ (shown as a red dotted line in Figure 5.1 and Figure 5.2) predicted for the modelled year. Conversely, the monitoring results show a maximum 24-hour PM₁₀ concentration of 49 µg/m³, with concentrations mostly between 10 and 20 µg/m³.

It is also highlighted that the peak 24-hour concentration measured at the Millmerran AQMS on 15 October 2021 (49 µg/m³) was the result of a regional dust storm experienced throughout southern Queensland. Figure 5.3 presents 24-hour PM₁₀ monitoring results for October 2021 for select AQMSs in southern Queensland that clearly show this regional event at each of the stations.

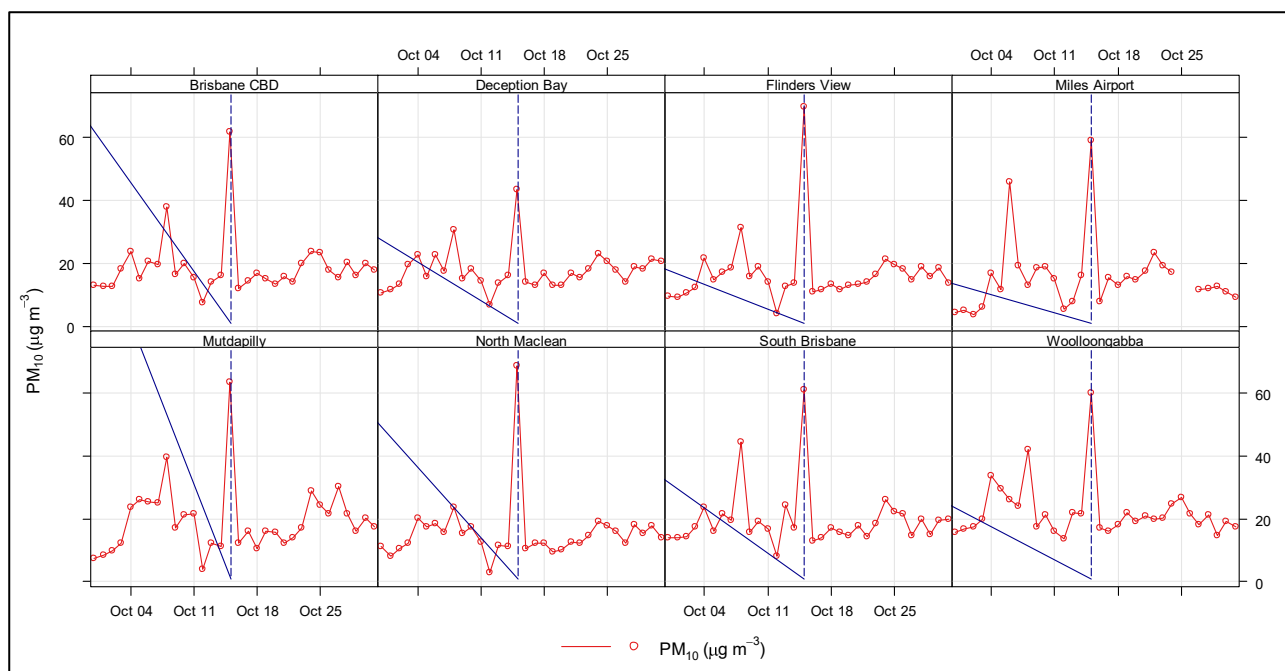


Figure 5.3 24-hour average PM₁₀ air quality monitoring data for stations in southern Queensland for October 2021

Figure notes:

Vertical dotted blue line indicates 15 October 2021

The second highest measured 24-hour PM₁₀ concentration (i.e. the highest concentration which cannot be attributed to a regional event) at the Millmerran AQMS was 22 µg/m³, measured in both October 2021 and March 2022. In comparison to the modelling results (Figure 5.1), a 24-hour concentration of 22 µg/m³ represents less than 10 per cent of the highest modelled result (in excess of 250 µg/m³).

Based on the comparison of modelling and monitoring data and the acknowledged uncertainty in the accuracy of emissions estimation techniques for mining activities, the NPI reported emissions quantities are expected to be a significant overestimate of actual emissions from Commodore Mine and Millmerran Power Station.

Commodore Mine and Millmerran Power Station operate under Environmental Authority (EA) permits (EA EPML00841513 for Commodore Mine, and EA ENRE00296005 for Millmerran Power Station), which both contain conditions regarding air quality and emissions to air. In addition, the EA for Commodore Mine states that they must take all reasonable and feasible avoidance measures so that particulate matter emissions generated do not exceed the following levels at sensitive receptors:

- Deposited dust: 120 mg/m²/day averaged over one month (no allowable exceedances per year)
- PM₁₀: 50 µg/m³ over a 24-hour averaging time (no allowable exceedances per year).

As it is part of their continual operating commitments (via the EA), it is reasonable to assume that the mine (which is a ground level source and the greatest contributor to ground level concentrations) is not exceeding these limits and that the modelled exceedance for PM₁₀ is a result of the uncertainties and conservativeness in the NPI emissions estimation techniques. This assumption is further strengthened by the recent air quality monitoring results from the Millmerran AQMS which do not show measured exceedances of the PM₁₀ 24-hour goal (50 µg/m³) over a 12 month monitoring period.

Therefore, to provide a more accurate estimation of local air quality in the area near the Commodore Mine, modelled particulate emissions from the mine (TSP, PM₁₀ and PM_{2.5} only) have been scaled so that peak modelled results (considering emissions from the mine, power station and adopted background) match the peak monitored 24-hour concentration (excluding the regional event on 15 October 2021) of 22 µg/m³ at the modelled receptor most affected by emissions from the mine (receptor 435). The scaled particulate emission rates for the mine have been used when assessing the cumulative impact of the Project.

Emissions of NO_x from the mine have not been scaled as no monitoring data is available for NO_x/NO₂. NPI reported emissions of NO_x (Table 5.9) for Commodore Mine for 2019/2020 are higher than average for the most recent nine years of reporting, and therefore the use of this emissions data provides a conservative assessment.

Due to the release height of the emission source modelled (200 m tall stacks), emissions from the power station have limited impact at ground level and power station emissions have not been scaled from those presented in Table 5.10.

Gore Highway and Warrego Highway

Several roads and highways intersect or run parallel to the alignment of the Project. A review of all roads and highways in the AQIA area found the most significant in terms of traffic volumes are the Gore Highway and Warrego Highway. As road vehicles emit the same pollutant species as those which are of concern for the Project, these highways have been included within the model developed for the assessment to allow for an assessment of cumulative air quality impacts.

The locations of the modelled Gore Highway and Warrego Highway sections are presented in Figure 5.6.

Pollutant species emitted from road traffic on these two highways include NO_x, PM₁₀, PM_{2.5} and TVOCs. Emissions of these pollutants on the Gore Highway and Warrego Highway have been represented within the modelling assessment using the following methodology:

- Existing traffic volumes for the Gore Highway and Warrego Highway were obtained for the year 2022
- The annual average daily traffic (AADT) volume for the year of assessment (2040) was calculated using traffic growth rates for each road section as adopted for the Traffic Impact Assessment
- Emissions for each modelled highway segment were calculated using DTMR road vehicle emission factors. Diurnal variation in emissions was determined based on hourly traffic count data
- Sections of the highways which are located within 2 km of the Project alignment have been included in the model
- PM_{2.5} emissions factors are assumed to be equivalent to the calculated PM₁₀ emission factors as the majority of particulate matter emissions are anticipated to be within the PM_{2.5} size fraction.

Table 5.11 presents the 2022 AADT and the calculated AADT for 2040 based on the growth rate. Table 5.12 details the input parameters and the resultant emission factors from the DTMR emission rate calculation spreadsheet.

Table 5.11 Base and modelled traffic volumes for the Gore Highway and Warrego Highway

Section (Figure 5.6)	Growth rate	AADT	
		2022	2040
Gore Highway Section 1 (northern-most section, south of Pittsworth to north of Southbrook) (both directions)	3.52%	6,057	11,292
Gore Highway Section 2 (middle section, through Brookstead) (both directions)	3.17%	3,236	5,670
Gore Highway Section 3 (southern-most section, south of Millmerran Leyburn Road) (both directions)	3.17%	3,236	5,670
Warrego Highway (southbound)	1.19%	6,755	8,356
Warrego Highway (northbound)	1.19%	6,998	8,656

Table 5.12 Calculated emission factors

Pollutants	Gore Highway (#1)	Gore Highway (#2)	Gore Highway (#3)	Warrego Highway (southbound)	Warrego Highway (northbound)	Units
Speed	100	100	100	100	100	km/hr
Seasonal correction	Hi-Temp	Hi-Temp	Hi-Temp	Hi-Temp	Hi-Temp	-
Heavy vehicles	29%	22%	22%	20%	20%	%
Gradient	-0.1%	0.2%	0.2%	-1.3%	-1.3%	%
PM ₁₀	0.20	0.14	0.14	0.13	0.13	g/VKT
NO _x	7.50	5.12	5.13	4.55	4.55	
TVOC	0.78	0.62	0.62	0.58	0.58	

The methodology for estimating and modelling emissions from the Warrego Highway and Gore Highway represents a conservative approach and is likely to over-predict pollutant concentrations from traffic on these roads.

In addition to the Gore Highway and Warrego Highway, the Cunningham Highway is also located within the AQIA area and intersects with the Project alignment at Yelarbon. However, the forecast AADT volume for the Cunningham Highway for 2040 is 1,592 vehicles (total for both directions of travel), which is significantly lower than the forecast volumes for the Gore Highway and Warrego Highway and is considered to be a low traffic volume overall. On the basis that traffic volumes on the Cunningham Highway will be low, the risk of cumulative impacts including emissions from this road is low and therefore the Cunningham Highway has not been included in the modelling for the assessment. As noted in Section 4.3, the contribution from local traffic on minor roads is represented by the adopted background concentrations.

Other rail sources

In addition to the Commodore Mine, Millmerran Power Station, Gore Highway and Warrego Highway the following emissions sources have also been included in the dispersion modelling:

- NS2B Project (Inland Rail)
- G2H Project (Inland Rail)
- West Moreton System (existing rail line west of the junction between the Project and the G2H section of Inland Rail).

One kilometre of the NS2B Project and G2H Project rail sources, and 3.5 km of the West Moreton System (near alignment chainage 207 km) have been included in the dispersion modelling at their respective ends of the Project to ensure that cumulative air quality impacts are assessed. The emission rates utilised for modelling were calculated based on predicted train numbers, locomotive type and freight type for each section. Modelled emission rates are presented in Table 5.13. Emission calculation details for these background rail sources are provided in Appendix C.

Table 5.13 Modelled emission rates for background rail sources

Pollutant	Modelled emission rate (g/m/s)		
	G2H Project	West Moreton System	NS2B Project
NO _x	1.84 x 10 ⁻⁴	7.78 x 10 ⁻⁵	8.88 x 10 ⁻⁵
TSP	5.83 x 10 ⁻⁵	5.17 x 10 ⁻⁵	5.52 x 10 ⁻⁶
PM ₁₀	3.37 x 10 ⁻⁵	2.72 x 10 ⁻⁵	5.38 x 10 ⁻⁶
PM _{2.5}	1.26 x 10 ⁻⁵	6.38 x 10 ⁻⁶	5.17 x 10 ⁻⁶
TVOC	2.81 x 10 ⁻⁵	1.62 x 10 ⁻⁵	1.01 x 10 ⁻⁵

Other existing rail lines near the Project alignment have not been modelled. Rail traffic volume data for other existing rail lines (i.e. the South Western Line and Millmerran Branch Line near alignment chainages 30 km, 45 km and 162 km) were analysed for the years 2016 to 2018. Existing monthly traffic volumes for these rail lines ranged from less than one train per week to up to six trains per week. Compared with the 174 trains per week (peak) that have been assessed for the AQIA, these volumes represent a very small percentage (i.e. 0.6 to 3.6 per cent) of the overall modelled rail traffic. As such, it is considered that inclusion of these rail sources would not result in an observable change to predicted cumulative results. Therefore, these existing rail lines have not been included in the AQIA.

In addition to the NPI sources (Commodore Mine and Millmerran Power Station) and the adjoining rail lines, other local emission sources will include environmentally relevant activities, local commercial and industrial uses and vehicle traffic. Local commercial uses near the Project will include the InterLinkSQ and Asterion Medicinal Cannabis Facility projects, which are approved but not currently operational. The operations of the InterLinkSQ and Asterion Medicinal Cannabis Facility projects are not anticipated to generate significant emissions and do not require detailed assessment.

It is expected that emissions from environmentally relevant activities, local commercial and industrial uses and vehicle traffic will be adequately represented by the assumed background concentrations as these activities emit significantly lower quantities of pollutants than the major polluters that report to the NPI.

5.3.2 Modelling methodology

The air dispersion modelling conducted for this assessment was undertaken based on a modelling approach using *The Air Pollution Model* (TAPM) (CSIRO, 2008) as a meteorological pre-processor to the air dispersion model CALPUFF.

The data that was available for this Project and a discussion of the data processing methodologies that were required in order to implement CALPUFF are discussed in the following sections. The CALPUFF model is briefly described in the following sections with further details provided in Appendix D. The modelling was undertaken in accordance with:

- *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2022)
- *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for Modeling and Assessments in NSW, Australia'* (Barclay & Scire, 2011)
- *CALPUFF View User Manual* (Lakes Environmental, 2017).

Figure 5.4 represents the modelling methodology undertaken for AQIA.

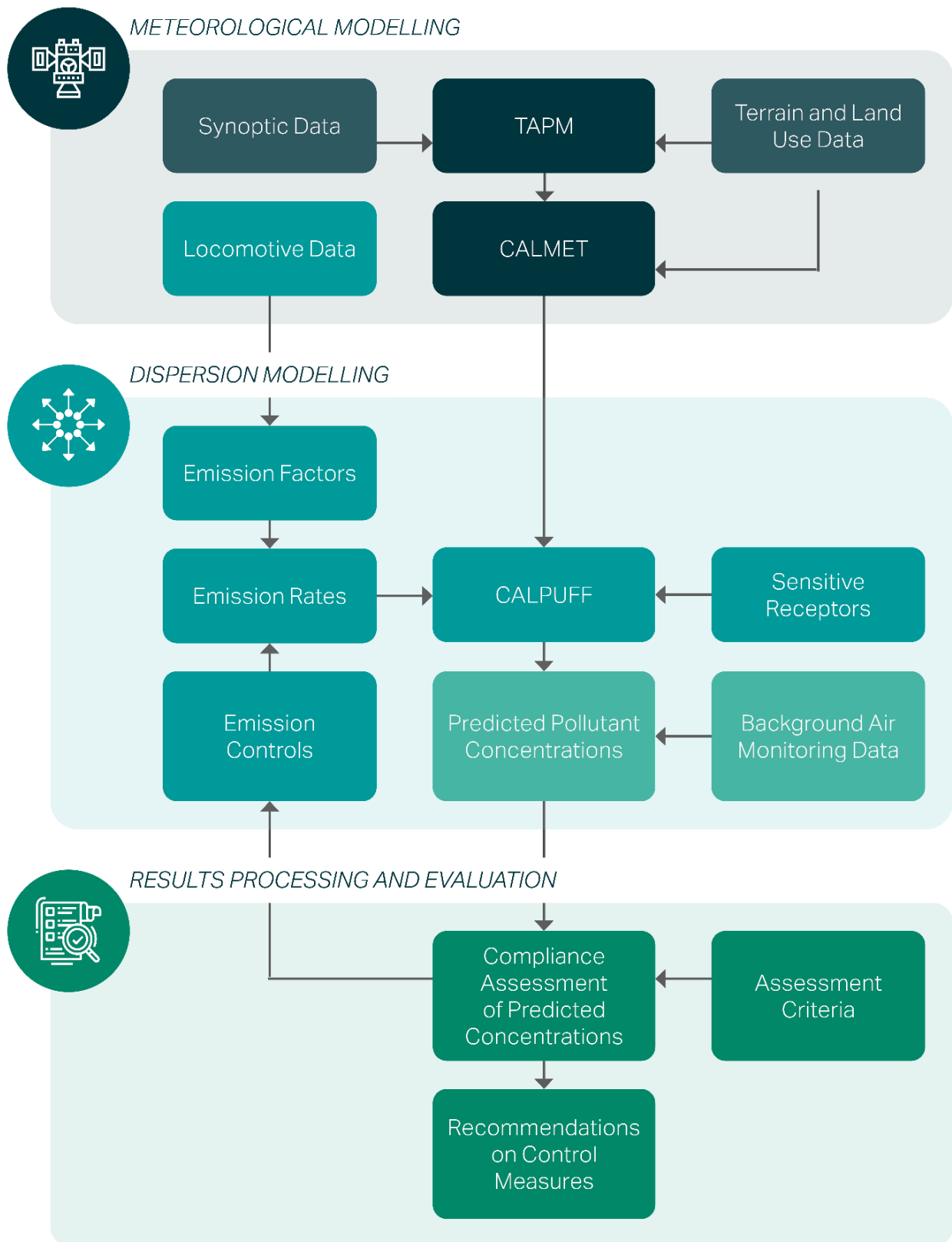


Figure 5.4 Diagrammatic representation of the CALPUFF modelling methodology

5.3.2.1 CALPUFF

The CALPUFF suite of programs, including meteorological (CALMET), dispersion (CALPUFF) and post processing modules (CALPOST), is an advanced non-steady-state modelling system designed for meteorological and air quality modelling. DESI does not require the use of any particular dispersion model (e.g. CALPUFF or AERMOD models). However, within DES (2023) reference is made to the NSW EPA guidance document (2022) which recommends CALPUFF. CALPUFF is appropriate in applications involving complex terrain, non-steady-state conditions, in areas where coastal effects may occur, and/or when there are high frequencies of stable or calm meteorological conditions (Barclay & Scire, 2011). As many of these features are present in the AQIA area, the CALPUFF model is preferred over Gaussian models such as AERMOD or AUSPLUME, which perform poorly in the aforementioned conditions.

5.3.2.2 Meteorological data

The meteorological data used in the dispersion model are of fundamental importance, as this data drives the predictions of the transport and dispersion of the air pollutants in the atmosphere. The most critical parameters are:

- Wind direction, which determines the initial direction of transport of pollutants from their sources
- Wind speed, which dilutes the plume in the direction of transport and determines the travel time from source to receiver
- Atmospheric turbulence, which indicates the dispersive ability of the atmosphere.

Prognostic meteorological data generated by TAPM for the year 2013 were used in this assessment. Further information regarding meteorological data and the selection of 2013 as the modelling year is presented in Appendix A.

5.3.2.3 Modelling domains

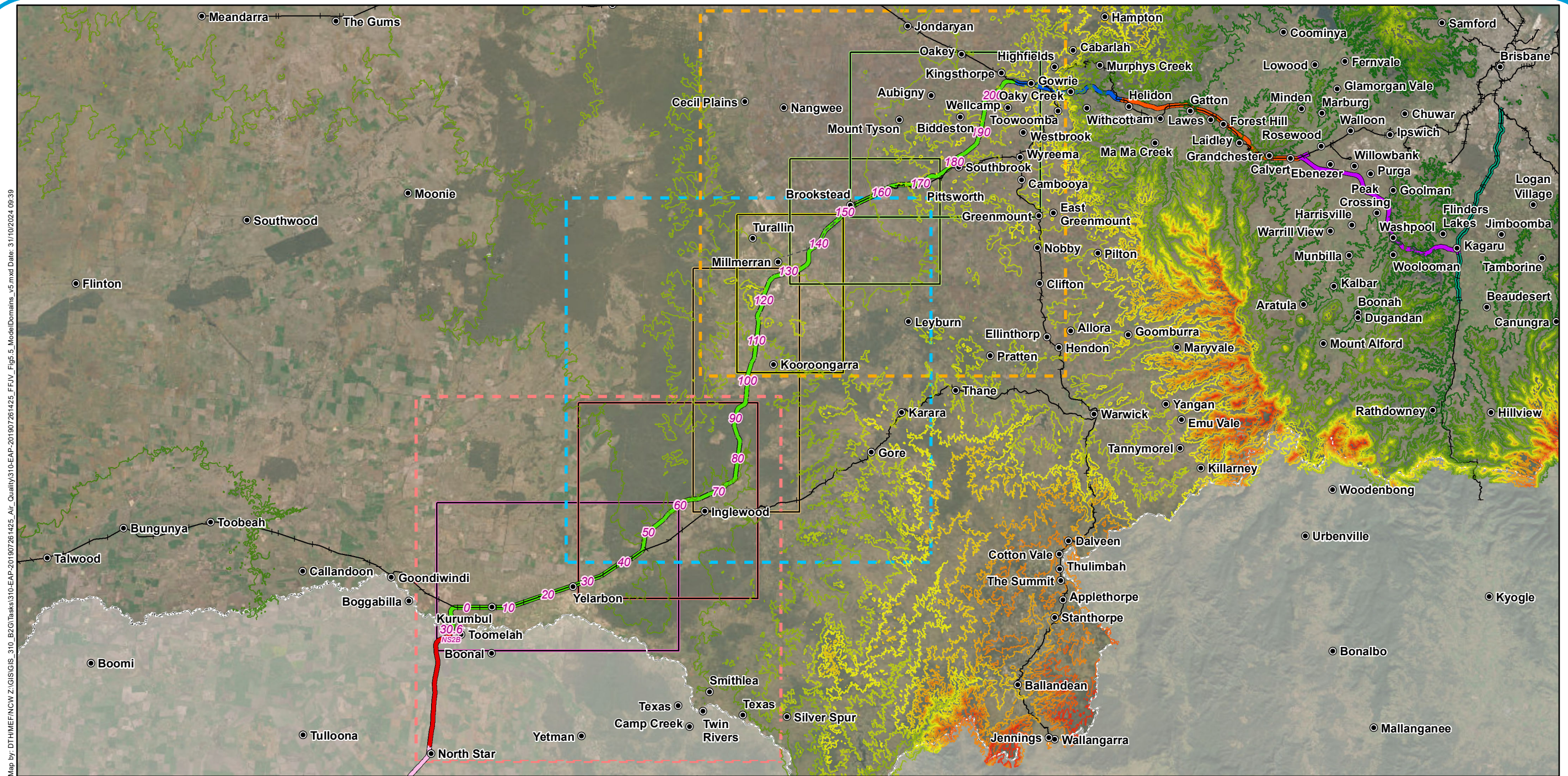
Due to the length of the Project, several modelling domains were utilised as part of the assessment. Figure 5.5 presents the meteorological domains for CALMET, as well as the eight CALPUFF dispersion domains for the Project.

5.3.2.4 Crossing loops

Crossing loops are places on a single line track where trains in opposing directions can pass each other. These are double ended and connected to the main track at both ends. Crossing loops are typically a little longer than any of the trains that might need to cross at that point. In operation, one train enters a crossing loop through one of the turnouts and idles at the other end, while the opposing train continues along the mainline track to pass the now stationary train.

The Project includes five crossing loops. The proposed locations for the crossing loops are:

- Yelarbon – Ch 16.3 km to Ch 18.5 km
- Inglewood – Ch 50.2 km to Ch 52.4 km
- Kooroongarra – Ch 89.2 km to Ch 91.4 km
- Yandilla – Ch 132.2 km to Ch 134.4 km
- Broxburn – Ch 174.9 km to Ch 177.1 km.



Map by: DTH/MEF/NCW Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FFIV_Figs_5_ModelDomains_v5.mxd Date: 31/10/2024 09:39

Legend

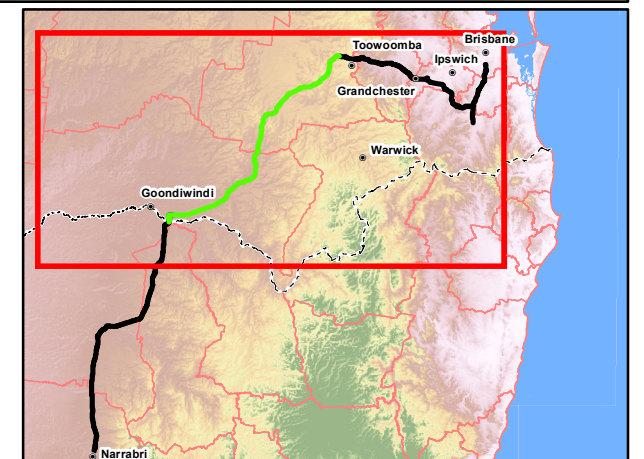
- 5 Chainage (km)
- Localities
- Narrabri to North Star alignment
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Calvert to Kagaru alignment
- Kagaru to Acacia Ridge/Bromelton alignment

- Existing rail (operational)
- Existing rail (non-operational)
- NSW/QLD border
- CALMET domain 1
- CALMET domain 2
- CALMET domain 3

- Computational Grid 1
- Computational Grid 2
- Computational Grid 3
- Computational Grid 4
- Computational Grid 5
- Computational Grid 6

Elevation (m)

- 100
- 200
- 300
- 400
- 500
- 600
- 700
- 800
- 900
- 1000
- 1100



A3 scale: 1:1,000,000
0 7.5 15 22.5 30 37.5 km



Future Freight
Integrating Community, Environment and Engineering

Issue date: 03/10/2024 Version: 5
Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 5.5:
Meteorological and dispersion model domains

Locomotive diesel emissions from crossing loops have been modelled based on the following:

- Emissions have been modelled from locomotives idling on the crossing loops. Travel around the crossing loops has not been modelled.
- When operational, freight trains could enter a crossing loop from either direction and therefore idling locomotives could be located at either end of the crossing loop. To replicate this, emissions sources (point sources) representing idling locomotives have been modelled at either end of the crossing loops.
- Three point sources were positioned at each end of the crossing loop (representing three locomotives) based on maximum number of locomotives of any train type. Overall, a total of six point sources were modelled per crossing loop.
- Two different approaches (hereafter referred to as versions) have been assessed for crossing loops to accurately consider emissions and allow for assessment against both short and long-term averaging periods:
 - Short-term (one hour average): continuous idling of six NR Class locomotives assumed to occur every hour of the year
 - Long-term (24-hour and annual averages): idling of six NR Class locomotives assumed to occur six hours per day (25 per cent of a 24-hour period)
- The locomotive point sources have been located on the top and in the centre of 'buildings' included in the model to account for the influence of downwash caused by the structure of the locomotives.

Fugitive odour from agricultural freight trains stopped at the crossing loops has been assessed qualitatively. The methodology for the qualitative assessment of fugitive odour is described in Section 5.3.8.

5.3.2.5 Modelling scenarios

Peak train volumes have been considered in the assessment. Modelling of emissions from train travel along the Project alignment has been undertaken assuming an even volume of train travel per day (e.g. daily train volumes) and train emissions from travel along the alignment have been modelled based on the weekly train volumes divided by seven.

Two different versions (short-term and long-term) have been run to enable accurate assessment of emissions from the crossing loops against both short-term and long-term air quality goals (Section 3.5). The modelled scenarios and crossing loop versions assessed are summarised in Table 5.14.

The model predictions from the short-term version have been used to assess compliance against the short-term goals (1 hour, 24-hour), with the model predictions from the long-term version used to assess compliance against annual average goals.

Table 5.14 Dispersion modelling scenarios

Scenario	Crossing loop version	Crossing loop idling description	Air quality goal averaging periods assessed
Peak train volumes 2040	Short-term	Continuous idling emissions from crossing loops	30 minute, 1 hour, 24-hour and monthly dust deposition
	Long-term	Idling at loops assumed to occur 25 per cent of the travel time	Annual

5.3.2.6 Consideration of climate change influence on meteorological modelling data

Climate change has the potential to influence wind conditions, atmospheric stability, mixing height and other meteorological factors important to the dispersion of ground-released pollution. However, as described in NSW EPA (2022), site-representative meteorological data is to be based on long-term historical meteorological data (presented in Section 4.1) therefore the potential influence of future altered conditions due to climate change has not been considered in this assessment.

5.3.2.7 Model input parameters

A summary of the data and parameters used as input parameters for dispersion modelling completed is shown in Table 5.15.

Table 5.15 Model input parameters

Parameter	Input
TAPM (v4.0.4)	
Horizontal resolution	41 x 41 grid points; outer grid spacing 30,000 m x 30,000 m with an inner grid spacing's of 10,000 and 3,000 m.
Grid centre coordinates	286,418m E, 6,838,999m S (Domain 1) 322,403m E, 6,886,706m S (Domain 2) 354,609m E, 6,931,466m S (Domain 3)
Vertical levels	25
Land use data	Default TAPM database
Simulation length	1 January to 31 December 2013
CALMET (v6.42)	
Meteorological grid domain	87.5 km x 87.5 km
Meteorological grid resolution	500 m resolution (175 x 175 grid cells)
Reference grid coordinate (SW corner)	242,668m E, 6,795,249m S 278,653m E, 6,842,956m S 310,859m E, 6,887,716m S
Cell face heights in vertical grid	0, 20, 40, 80, 160, 320, 640, 1200, 2000, 3000 and 4000 m
Simulation length	1 January to 31 December 2013
Surface and upper meteorological data	3D.dat from TAPM
Terrain data	Shuttle Radar Topography Mission Version 3.0 Global meshed with proposal design DEM (1 arc second)
Land use data	Australian Bureau of Agricultural and Resource Economics and Sciences (2016)
TERRAD (Terrain radius of influence)	10.0 km
CALPUFF (v7.2.1)	
Computational grid	A unique computational grid was used for each modelled source (Table 5.16 for list of sources). The grids were sized to fit each source with an appropriately sized (2 to 4 km) buffer.
Number of sensitive receptors	1944
Dispersion option	Dispersion coefficient using turbulence computed from micrometeorology
Dispersion modelling period	1 January 2013 to 31 December 2013

5.3.3 Source parameters

Table 5.16 presents the CALPUFF source parameters utilised in the dispersion modelling of the Project. Utilising guidance from US EPA (1992), the rail emission sources for diesel emissions were modelled as line sources approximated by separated volumes sources. Using this method, it is possible to emulate the effects of initial dispersion due to plume downwash (California Air Resources Board, 2004).

The idling point sources represent express freight trains that consist of three stationary NR Class locomotives. The locomotive exit temperatures were sourced from locomotive emissions testing for the NSW EPA completed by (ABMARC, 2016). Other cited emission parameters for idling locomotives were sourced from California Air Resources Board (2004) for a locomotive of similar type and size.

Table 5.16 presents the initial horizontal and vertical spreads used in the modelling of train travel. The spreads have been calculated using Lakes Environmental guidance (2017) on the calculation of dispersion from haul roads, which is based on the US EPA *Haul Road Workgroup Report* (2012). The dispersion of emissions from haul roads is very similar to dispersion from rail lines and is considered the most appropriate guidance. Initial vertical spread (sigma Z) is calculated by dividing the top of plume height (m) by 2.15. Top of plume height is equal to the vehicle (train) height (3.9 m) multiplied by 1.7 (6.63 m). Initial horizontal spread (sigma Y) is calculated by dividing the distance between the centre points of the segmented volume sources by 2.15. Plume width is calculated as the vehicle (train) width (3m) plus 6m to account for the mixing zone of a single line track.

The location of modelled sources are shown in Figure 5.6.

5.3.4 Terrain and land use data

The underlying terrain and dominant land use are important functions of plume transport modelling. Gridded terrain elevations for the modelling domain were derived from the Shuttle Radar Topography Mission one arc-second or around 30 m resolution data. To reflect the final terrain formation post-construction, this data was supplemented with detailed 1 m data that reflects bulk earthworks for the Project.

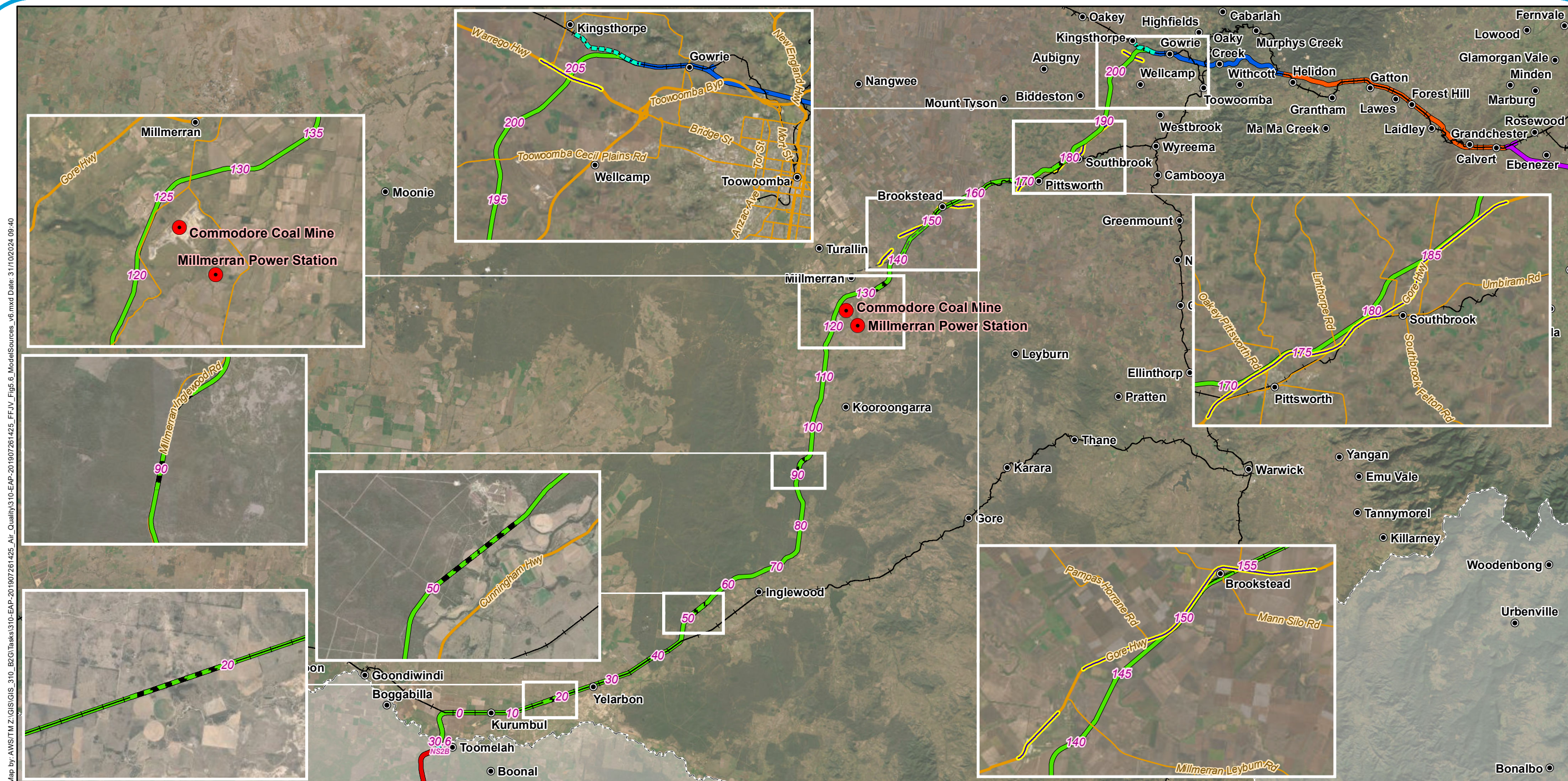
Land use within the AQIA area primarily consists of rural and agricultural areas, which are interspersed with occasional townships, bushland, and State forest. Land use data within the AQIA area has been derived from the Queensland Land Use Mapping Program utilising the Australian Land Use and Management Classification (Australian Bureau of Agricultural and Resource Economics and Sciences, 2016). The data are representative of the actual area associated with the Project, are recent and of a very fine resolution to increase the accuracy of the modelling. The land use data used in this application are different to the default land use data used in TAPM and for most CALMET model applications outside of the United States, which are the USGS 1 km land use data. Until recently, the USGS 1 km global land use data set was the most readily available data set for air quality applications. Limitations of this data set; however, include its age (more than 20 years old), coarse resolution (between 900 m and 1.2 km), and the fact that it is categorised according to the North American land use category system, which does not correspond to all relevant Australian land use types.

As stated above, plume transport is an important function of the underlying dominant land use. The inclusion of the Australian land use data set is, therefore, an important relevant addition to this modelling application as the data are recent, relevant and of a fine resolution.

Table 5.16 CALPUFF source parameters

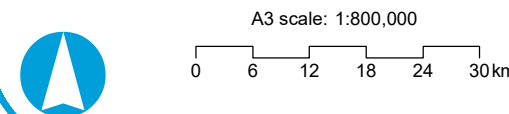
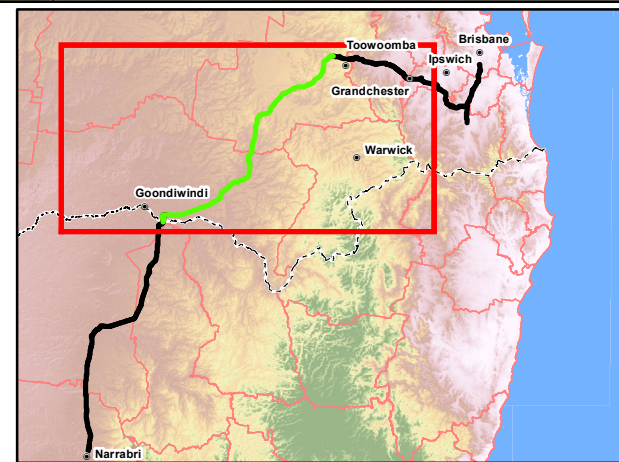
Source	Source type	Location (GDA 96, zone 56 J)	Release height above ground level (m)	Parameters
B2G-1	Line volume source (55.2 km, 1384 sources)	254,816; 6,832,169 to 279,025; 6,836,972	3.3	18.6 m (initial horizontal spread) 3.1 m (initial vertical spread)
B2G-2	Line volume source (44.0 km, 1103 sources)	279,025; 6,836,972 to 299,966; 6,851,547	3.3	18.6 m (initial horizontal spread) 3.1 m (initial vertical spread)
B2G-3	Line volume source (49.1 km, 1231 sources)	299,966; 6,851,547 to 319,661; 6,866,617	3.3	18.6 m (initial horizontal spread) 3.1 m (initial vertical spread)
B2G-4	Line volume source (36.8 km, 921 sources)	319,661; 6,866,617 to 323,056; 6,890,674	3.3	18.6 m (initial horizontal spread) 3.1 m (initial vertical spread)
B2G-5	Line volume source (36.8 km, 923 sources)	323,056; 6,890,674 to 330,525; 6,912,065	3.3	18.6 m (initial horizontal spread) 3.1 m (initial vertical spread)
B2G-6	Line volume source (49.2 km, 1232 sources)	330,525; 6,912,065 to 349,493; 6,929,627	3.3	18.6 m (initial horizontal spread) 3.1 m (initial vertical spread)
G2H	Line volume source (1.0 km, 26 sources)	386,428; 6,958,301 to 387,354; 6,957,936	3.3	18.6 m (initial horizontal spread) 3.1 m (initial vertical spread)
West Moreton System (Background)	Line volume source (3.5 km, 88 sources)	386,422; 6,958,310 to 383,406; 6,959,750	3.3	18.6 m (initial horizontal spread) 3.1 m (initial vertical spread)
NS2B	Line volume source (1.0 km, 26 sources)	250,695; 6,825,468 to 251,061; 6,826,394	3.3	18.6 m (initial horizontal spread) 3.1 m (initial vertical spread)
Crossing Loop 1	Point source (6 sources)	270,838; 6,834,172 270,860; 6,834,178 270,882; 6,834,184 272,867; 6,834,866 272,847; 6,834,857 272,826; 6,834,849	4.3 (0.1 m above locomotive engine)	134 °C (exit temperature) 0.6 m (stack diameter) 2.4 m/s (exit velocity)
Crossing Loop 2	Point source (6 sources)	298,619; 6,850,492 298,637; 6,850,507 298,656; 6,850,521 300,198; 6,851,724 300,180; 6,851,710 300,163; 6,851,696	4.3 (0.1 m above locomotive engine)	134 °C (exit temperature) 0.6 m (stack diameter) 2.4 m/s (exit velocity)

Source	Source type	Location (GDA 96, zone 56 J)	Release height above ground level (m)	Parameters
Crossing Loop 3	Point source (6 sources)	319,171; 6,876,924 319,177; 6,876,946 319,181; 6,876,969 319,575; 6,878,982 319,572; 6,878,959 319,569; 6,878,938	4.3 (0.1 m above locomotive engine)	134 °C (exit temperature) 0.6 m (stack diameter) 2.4 m/s (exit velocity)
Crossing Loop 4	Point source (6 sources)	334,228; 6,912,871 334,248; 6,912,882 334,268; 6,912,894 335,997; 6,914,001 335,979; 6,913,988 335,960; 6,913,975	4.3 (0.1 m above locomotive engine)	134 °C (exit temperature) 0.6 m (stack diameter) 2.4 m/s (exit velocity)
Crossing Loop 5	Point source (6 sources)	331,855; 6,912,841 331,873; 6,912,854 331,892; 6,912,868 333,512; 6,914,109 333,495; 6,914,095 333,478; 6,914,081	4.3 (0.1 m above locomotive engine)	134 °C (exit temperature) 0.6 m (stack diameter) 2.4 m/s (exit velocity)
Commodore Mine	Combination of volume sources, volume-line sources, and areas sources	Various	Various	Various
Millmerran Power Station	Combination of 2 x point sources (stacks) and 1 x area source (stockpile)	330,732; 6,905,970 330,736; 6,905,969	200 m (stacks)	140 °C (exit temperature) 5.0 m (stack diameter) 30 m/s (exit velocity)
Gore Highway	Line volume source (62.7 km, 1536 sources)	337,250; 6,920,350 361,254; 6,931,695	2.4	13.0 m (initial horizontal spread) 2.2 m (initial vertical spread)
Warrego Highway	Line volume source (8.0 km, 290 sources)	381,415; 6,958,169 385,024; 6,956,441	2.4	13.0 m (initial horizontal spread) 2.2 m (initial vertical spread)



Legend

- 5 Chainage (km)
- Localities
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Helidon to Calvert alignment
- Calvert to Kagaru alignment
- North Star to NSW/QLD border alignment
- Major roads
- Minor roads
- Existing rail (operational)
- Existing rail (non-operational)
- NSW/QLD border
- Modelled emission sources
 - Existing emission source
- Modelled State road extents
 - State roads
- Cumulative rail sources
 - Cumulative rail sources
 - Crossing loops



Border to Gowrie
Figure 5.6:
Modelled sources

5.3.5 Conversion of NO_x to NO₂

Nitrogen oxides are produced in most combustion processes and are formed during the oxidation of nitrogen in fuel and nitrogen in the air. During high-temperature processes, a variety of oxides are formed including NO and NO₂. NO will generally comprise 95 per cent of the volume of NO_x at the point of emission. The remaining NO_x will primarily consist of NO₂. The conversion of NO to NO₂ requires O₃ to be present in the air, as O₃ is the catalyst for the conversion. Ultimately, however, all NO emitted into the atmosphere is oxidised to NO₂ and then further to other higher oxides of nitrogen.

The US EPA's OLM was used to predict ground-level concentrations of NO₂. The OLM assumes that approximately 10 per cent of the initial NO_x emissions is emitted as NO₂. If the O₃ concentration is greater than 90 per cent of the predicted NO_x concentrations, all the NO_x is assumed to be converted to NO₂, otherwise NO₂ concentrations are predicted using the equation:

$$NO_2 = \frac{46}{48} \times O_3 + 0.1 \times NO_x$$

This method assumes instant conversion of NO to NO₂ in the plume, which can lead to overestimation of concentrations close to the source since conversion would usually occur over a period of hours. This method is described in detail in NSW EPA (2022), which also references work by Cole and Summerhays (1979) and Tikvart (1996). The OLM is a conservative approach as explained in Appendix E. Background O₃ data from the nearest AQMS to the Project that monitors O₃, the DESI station at Mutdapilly, was used to convert the modelled NO₂ concentrations in accordance with the OLM methodology presented in NSW EPA (2022). Figure 5.7 presents the variation plots of background concentrations for NO₂ and O₃ for Mutdapilly for the year 2013.

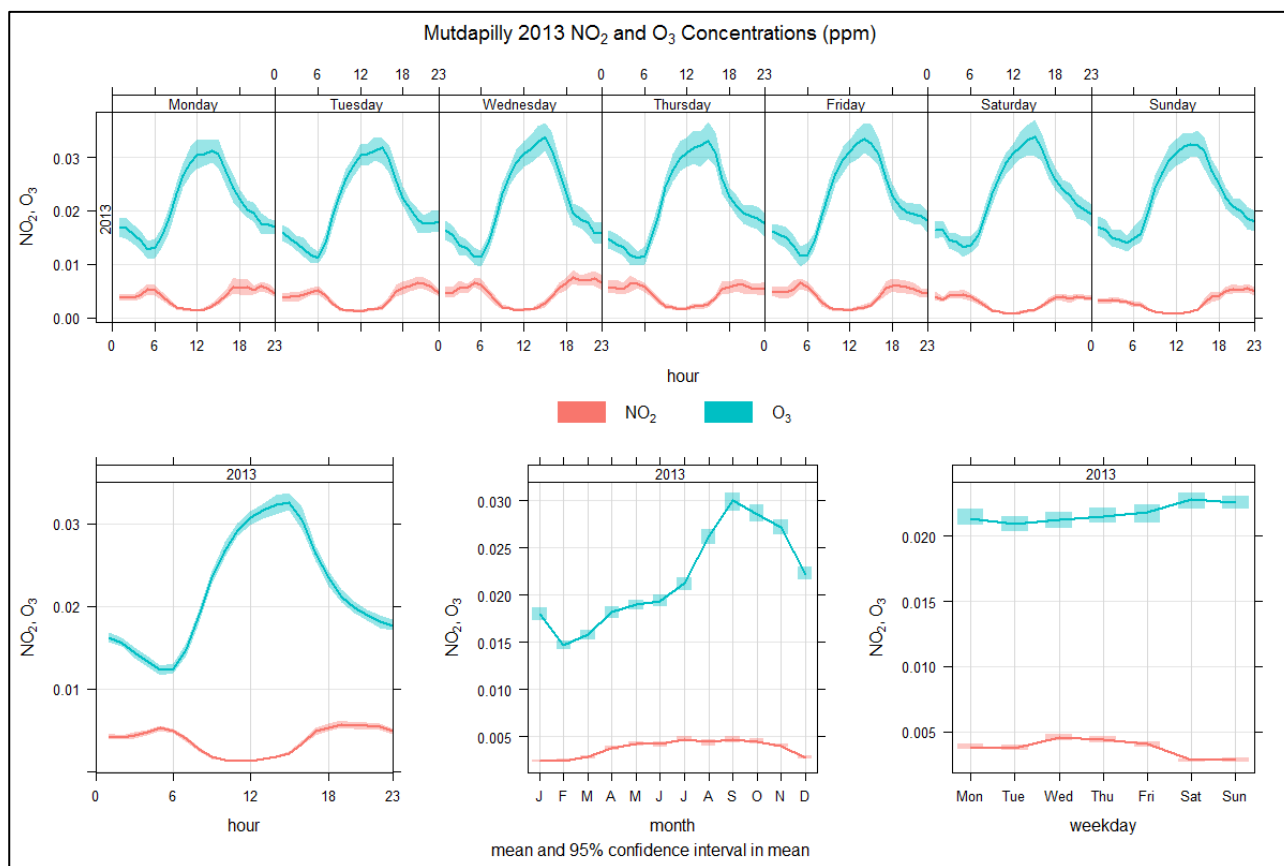


Figure 5.7 Variation plots of concentrations for NO₂ and O₃ from the Mutdapilly Department of Environment and Science monitoring station for 2013

5.3.6 Limitations

The atmosphere is a complex, physical system, and the movement of air in a given location is dependent on multiple variables, including temperature, topography and land use, as well as larger-scale synoptic processes. Dispersion modelling is a method of simulating the movement of air pollutants in the atmosphere using mathematical equations. The model equations necessarily involve some level of simplification of these complex processes based on our understanding of the processes involved and their interactions, available input data, and processing time and data storage limitations.

These simplifications come at the expense of accuracy, which particularly affects model predictions during certain meteorological conditions and source emission types. For example, the prediction of pollutant dispersion under low wind speed conditions (typically defined as those wind speeds less than one m/s) or for low-level, non-buoyant sources, is problematic for most dispersion models. To accommodate these known deficiencies, the model outputs tend to provide conservative estimates of pollutant concentrations at locations.

While the models contain a large number of variables that can be modified to increase the accuracy of the predictions under any given circumstances, the constraints of model use in a commercial setting, as well as the lack of data against which to compare the results in most instances, typically precludes extensive testing of the impacts of modification of these variables. Model developers typically specify a range of default values for model variables that are applicable under most modelling circumstances. These default values are recommended for use unless there is enough evidence to support their modification.

As a result, the results of dispersion modelling provide an indication of the likely level of pollutants within the modelling domain. While the models, when used appropriately and with high quality input data, can provide very good indications of the scale of pollutant concentrations and the likely locations of the maximum concentrations occurring, their outputs should not be representative of exact pollutant concentrations at any given location or point in time. As stated above, however, the model predictions are typically conservative, and tend to over predict maximum pollutant concentrations at receiver locations.

This assessment was undertaken with the data available at the time of the assessment. Should changes to the Project be made, further assessment may be required to determine if the findings of this assessment are still applicable.

5.3.7 Tank water quality

5.3.7.1 Potential impacts

In rural and remote Australia where reticulated water supply is not always available, the use of domestic rainwater tanks is common practice. Rainfall is collected from roof run-off, and where installed is most commonly used as the primary source of household drinking water (enHealth, 2010). Rainwater stored in tanks has the potential to be contaminated by chemical, physical and microbial sources, and become a hazard to human health. Industrial and traffic emissions have the potential to be a source of chemical contamination through their atmospheric deposition onto rooves where water is collected (Gunawardena, 2012).

5.3.7.2 Assessing impacts to tank water quality

The potential for the operation of the Project to impact tank water quality collected via roof catchments has been investigated, using the emissions inventory developed for assessment of operational impacts to air quality, dust deposition modelling was also completed using CALPUFF to determine the impact of diesel locomotive emissions on tank water quality. Dust deposition was predicted for all modelled sensitive receptors, consistent with the assessment of impacts to air quality. The methodology for predicting the potential impact to tank water quality is summarised as follows:

- Rain water collection systems can have first flush devices which take the first water captured by rooves and divert it for disposal rather than collection in a water tank. First flush systems were not assumed to be installed for any of the sensitive receptors considered
- Annual average dust deposition rates were predicted for every modelled sensitive receptor within the AQIA area. Every sensitive receptor was assumed to have a water tank, and the roof area (collection area) for each receptor was assumed to be 200 m²
- It was assumed that a full year of deposited dust at each receptor (200 m² roof area) was collected by a 10,000 litre (L) rainwater tank with a stored water volume of 1,000 L (10 per cent full). For the purpose of the assessment the stored water volume (1,000 L) was assumed to be constant, and did not fluctuate due to rainfall events. This conservative assumption allows for periods where there may be prolonged periods of drought where dust is deposited on rooves, and subsequent short rainfall events that wash pollutants into rainwater tanks resulting in higher than normal concentrations of pollutants in tank water
- The goals used for the assessment of impacts to water quality were taken from the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2011), which provides guideline water concentrations for arsenic, cadmium, lead, nickel and chromium VI, which are all metals
- The concentration of metals in water tanks was determined by taking the predicted Project only annual average dust deposition level and multiplying it by the assumed roof area (200 m²) to determine total mass, and then speciating the predicted dust deposition level into metal concentrations using the diesel locomotive emission factors (Table 5.8)
- The predicted water concentrations for each pollutant species were then assessed against the goals prescribed in the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2011).

The *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2011) present guideline values on allowable contaminants within drinking water, such as from rainwater tanks. Table 5.17 presents the guideline values from the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2011) for the pollutants of interest for the Project. Calculated water pollutant concentrations from diesel emission deposition modelling are compared to these guideline values.

Table 5.17 Australian Drinking Water Guidelines for the pollutants of interest for the Project

Pollutant	Guideline value (mg/m ³)	Environmental Value	Source
Arsenic	0.01	Health	(NHMRC & NRMMC, 2011)
Cadmium	0.002	Health	
Lead	0.01	Health	
Nickel	0.02	Health	
Chromium as Cr (VI)	0.05	Health	

5.3.8 Agricultural freight odour

To assess the nuisance impacts that may arise from agricultural freight trains, a qualitative assessment utilising FIDOL factors has been undertaken to determine the likelihood of odour. The following factors, described using the acronym FIDOL, are widely accepted (Department of Environment and Heritage Protection, 2018) as being important dimensions of odour nuisance:

- Frequency (F) – How often an individual is exposed to the odour
- Intensity (I) – The strength of the odour
- Duration (D) – The length of exposure
- Offensiveness (O) – The offensiveness or intrinsic character, known as the hedonic tone of the odour, may be pleasant, neutral, or unpleasant
- Location (L) – The type of land use, nature of human activities and sensitivity of the receiving community in the vicinity of an odour source.

5.4 Cumulative impact risk assessment

The air quality assessment for the Project addresses the cumulative impact of the release with other known releases of contaminants, materials or wastes associated with existing major projects and/or developments and those which are progressing through planning and approval processes and where public information is available. In response to this requirement, the assessment of operations stage air quality impacts has incorporated the emission contributions of existing or planned developments that are or will be a source of pollutants of interest that are also relevant to the Project.

The approach used to identify and assess potential construction works stage cumulative impacts of the Project is as follows:

- A review of the potential impacts identified within the assessment. The environment at the time of writing is the baseline, prior impacts from past land use has not be considered
- A preliminary list of projects for consideration in the cumulative impact assessment was collated with timelines to demonstrate the temporal relationship between projects. This preliminary list of projects was compiled through consideration of the following:
 - Projects subject to assessment under the EP Act or *State Development and Public Works Organisation Act 1971* (Qld), with an Initial Advice Statement published by DESI or Department of State Development, Infrastructure, Local Government and Planning
 - Projects listed in GRC and TRC development application databases
 - Development within Priority Development Areas and State Development Areas
 - Economic Development Queensland development projects
 - Community Infrastructure Designation projects
 - Projects within the public register of environmental authorities
 - DTMR infrastructure projects
 - Private infrastructure facilities
 - Development in accordance with Regional Planning Interests
 - The Inland Rail projects immediately adjacent to the Project, being the NS2B and G2H projects.
- The preliminary list of projects was assessed to identify those that meet one of the following criteria:
 - Projects that have been approved but where construction has not commenced
 - Projects that have commenced construction subsequent to the Project, but have potential for overlap in construction activities with the Project

- Projects that have been completed subsequent to the Project
- Are operational developments that have future plans for expansion.
- Projects that were excluded from further assessment were:
 - Existing projects, with no known plans for expansion. Such projects are typically considered part of the 'existing environment' and have been accounted for in the impact assessment of each specific matter.
 - Proposed projects that have not been developed to the point that details of their scale, size, location and core activities would be publicly available.
- Where there is a potential overlap in impacts (either spatially or temporally), a cumulative impact assessment was undertaken to determine the nature of the cumulative impact. Where possible, the assessment method was quantitative in nature however qualitative assessment has also been undertaken.
- An assessment matrix method (further detailed within Table 10.1 and Table 10.2) has been used to determine the significance of cumulative impacts with respect to beneficial or detrimental effects
- Where cumulative impacts are deemed to be of medium or high significance, additional mitigation measures are proposed, beyond those already proposed by the relevant technical impact assessments.

Following the identification of each potential cumulative impact, a relevance factor score of low, medium or high has been determined in consideration of the impacts, in accordance with the assessment matrix given in Table 10.1.

6 Construction works stage air quality impact assessment

The following sections provide an assessment of air quality impacts during the construction works stage of the Project.

As detailed in Section 5.1, the highest proportion of construction emissions results from mechanical activity, (e.g. material movement or mobile equipment activity) which typically generate coarser particulate emissions (PM₁₀ and TSP). Airborne PM₁₀ and deposited dust (TSP) are the main pollutants of concern for construction activities and these pollutant species are the focus of the assessment for construction dust.

In addition to construction dust, odour will be emitted from the sewage treatment plants required for non-resident workforce accommodation. The assessment of odour from these facilities is presented in Section 6.3.

No other significant pollutant emissions (excluding dust, odour and VOCs) are anticipated from the construction works stage of the Project.

6.1 Dust

The dust impact assessment was undertaken based on the methodology described in the UK IAQM document, *Guidance on the assessment of dust from demolition and construction* (2014). The risk of dust deposition (red to as dust soiling by IAQM) and human health impacts due to particulate matter (PM₁₀) on surrounding areas were determined based on the scale of activities and proximity to sensitive receptors within the AQIA area. The IAQM method uses a four-step process to assess dust impacts:

- Step 1: Screening based on distance to nearest sensitive receptors
- Step 2: Assess risk of dust impacts from activities based on:
 - Scale and nature of the works, which determines the potential dust emission magnitude
 - Sensitivity of the area.
- Step 3: Determination of site-specific mitigation for dust-emitting activities
- Step 4: Reassess risk of dust impacts after mitigation has been considered.

Figure 4.17 presents the locations of the permanent and temporary disturbance areas within the temporary construction footprint including laydown areas and haul routes.

The IAQM assessment process is described in the following sections.

6.1.1 Step 1 – Screening assessment

The IAQM method recommends further assessment of dust impacts for construction activities where sensitive receptors are located closer than:

- 350 m from the boundary of the site
- 50 m from the route used by construction vehicles on public roads that are located up to 500 m from the site entrance

There are 1,948 sensitive receptors identified within the AQIA area. Of these, 1,944 are sensitive receptors which have the potential to be impacted during the operations stage. Four receptors are located greater than 1 km from the Project alignment and therefore are not at risk of being impacted by the operations stage, but have been included in assessment of the construction works stage due to their location within 350 m of the temporary footprint.

The separation distances from the Project for the identified receptors are summarised in Table 6.1. The two temporary non-resident workforce accommodation facilities for the Project are considered in Table 6.1.

The construction disturbance area for the Project, including the location of laydown areas and non-resident workforce accommodation is shown in Figure 4.17.

Table 6.1 Summary of sensitive receptors

Distance from construction element (m)	Number of receptors			
	Access tracks	Laydown areas	Temporary area	Permanent area
< 1	0	3	24	14
1 to 20	0	10	102	94
21 to 50	1	9	127	121
51 to 100	6	69	262	254
101 to 350	99	462	578	551
>350	1842	1395	855	914
Total	1948			

As there are receptors located within 350 m of the Project footprint, further assessment of construction impacts is required.

The number of sensitive receptors identified in this assessment is current at the time of assessment and minor variations to the number of sensitive receptors may occur as the Project progresses and the surrounding land use is subject to change. The extent of property impacts should be confirmed prior the commencement of the construction works stage in consultation with property owners.

6.1.2 Step 2 – Dust risk assessment

The key components of the risk assessment are defining the dust emission magnitudes (Step 2A), the surrounding area sensitivity (Step 2B), and then combining these in a risk matrix (Step 2C) to determine an overall risk of dust impacts.

6.1.3 Step 2A – Dust emission magnitude

Dust emission magnitudes are estimated according to the scale of works being undertaken and other considerations such as meteorology, types of material being used, or general demolition methodology. The IAQM guidance provides examples to aid classification, as presented in the following excerpt from IAQM:

The dust emission magnitude is based on the scale of the anticipated works and should be classified as Small, Medium, or Large. The following are examples of how the potential dust emission magnitude for different activities can be defined. Note that, in each case, not all the criteria need to be met, and that other criteria may be used if justified in the assessment:

Demolition: Any activity involved with the removal of an existing structure (or structures). This may also be referred to as de-construction, specifically when a building is to be removed a small part at a time. Example definitions for demolition are:

- *Large: Total building volume >50,000 m³, potentially dusty construction material (e.g. concrete), on-site crushing and screening, demolition activities >20 m above ground level*
- *Medium: Total building volume 20,000 m³ to 50,000 m³, potentially dusty construction material, demolition activities 10 to 20 m above ground level; and*
- *Small: Total building volume <20,000 m³, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10 m above ground, demolition during wetter months.*

Earthworks: Earthworks will primarily involve excavating material, haulage, tipping and stockpiling. This may also involve levelling the site and landscaping. Example definitions for earthworks are:

- **Large:** Total site area >10,000 m², potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8 m in height, total material moved >100,000 tonnes
- **Medium:** Total site area 2,500 m² – 10,000 m², moderately dusty soil type (e.g. silt), 5 to 10 heavy earth moving vehicles active at any one time, formation of bunds 4 m to 8 m in height, total material moved 20,000 tonnes to 100,000 tonnes; and
- **Small:** Total site area <2,000 m² – soil type with large grain size, (e.g. sand), <5 heavy earth moving vehicles at one time, formation of bunds <4 m in height, total material moved <20,000 tonnes, earthworks during wetter months.

Construction: The key issues when determining the potential dust emission magnitude during the construction phase include the size of the building(s)/infrastructure, method of construction, construction materials, and duration of build. Example definitions for construction are:

- **Large:** Total building volume >100,000 m³, on site concrete batching, sandblasting
- **Medium:** Total building volume 25,000 m³ – 100,000 m³, potentially dusty construction material (e.g. concrete), on site concrete batching; and
- **Small:** Total building volume <25,000 m³, construction material with low potential for dust release (e.g. metal cladding or timber).

Track-out: Factors which determine the dust emission magnitude are vehicle size, vehicle speed, vehicle numbers, geology and duration. As with all other potential sources, professional judgement must be applied when classifying track-out into one of the dust emission magnitude categories. Example definitions for track-out are:

- **Large:** >50 truck (>3.5 t) outward movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length 50 m to 100 m
- **Medium:** 10 to 50 truck (>3.5 t) outward movements in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50 m to 100 m; and
- **Small:** <10 truck (>3.5 t) outward movements in any one day, surface material with low potential for dust release, unpaved road length <50 m.

Dust emission magnitudes for Project construction activities were estimated based on the IAQM examples listed above. Justification and the factors used in determining the magnitudes are presented in Table 6.2.

Table 6.2 Construction activities and dust emission magnitude justification

Activity	Potential dust emission magnitude	Justification
Demolition	Small	■ Existing buildings likely to be demolished, all assumed to be small homesteads ■ Buildings assumed to be primarily of low dust potential material (wood/cladding). Materials to be confirmed prior to demolition ■ Total building volume presently unknown although assumed to be <10,000 m³ ■ Possible demolition and realignment of existing roads - to be confirmed in detailed design stage of the Project.

Activity	Potential dust emission magnitude	Justification
Earthworks	Large	- Multiple work fronts at any one time along the alignment - Vegetation clearing along the proposed alignment corridor for new access tracks and laydown areas will occur where necessary. Clearing is staged to limit size of disturbance area at any one time - Topsoil along entire alignment (217.48 km) will be stripped (approximate depth of 0.21 m) and stockpiled. Wherever possible and appropriate material will be reused within Project area 78 laydown areas along the alignment, with the ability to provide locations for excavation stockpiling. Stockpiles to be located as close as possible to the excavation source - Total cut of 11,458,700 m³ and total fill of 12,678,300 m³ - Utility relocations Earthworks material likely to be dusty especially during dry season. Soil types along corridor location are detailed in EIS Appendix J: Soil Assessment Report. - Blasting, ripping and digging of material required between select chainages along the alignment - Mobile plant used for earthworks is expected to include dozers, excavators, scrapers, mulchers, rollers, graders, drilling rigs front end loaders, water carts and haul vehicles.
Construction	Large	- Construction period of approximately four years, with multiple work fronts at any one time along the alignment - Installation of approximately 217.48 km of railway utilising steel rail, sleepers, ballast and concrete. Concrete and ballast present high dust risk - Construction of 37 new bridge structures – steel material low dust risk but concrete high dust risk - Temporary site offices and parking facilities likely to be constructed at each laydown area - Construction of 16 fuel storage facilities: four approximately 20,000 L, and 12 approximately 10,000 L - Laydown areas to also include temporary parking facilities for construction workers - Construction of welding facilities - Construction of temporary and permanent fencing – total lengths to be determined during detailed design stage - Mobile plant used for the construction of structures is expected to include excavators, piling rigs, concrete trucks and concrete pumps, cranes, backhoes, compactors, dozers, graders, rollers, front end loaders, ballast train, rail tamper and regulator, water carts and haul vehicles.
Track-out	Large	- Multiple work fronts at any one time along alignment - High amount of daily vehicle movements expected per work site (both light and heavy vehicles) - Movement of ballast from sources, and between laydown areas and ballast handling facility via 18 t dump trucks - Movement of spoil by registered road trucks - Total length of unpaved road/access tracks unknown until design is finalised but will be >100 m due to the size of the Project.

Construction activities are proposed to be undertaken during the following Project construction hours:

- Monday to Sunday 6.00 am to 6.00 pm
 - No work on public holidays

Blasting is proposed to be undertaken during the following hours:

- Monday to Friday 9.00 am to 5.00 pm
- Saturday 9.00 am to 1.00 pm

- No blasting outside of the above hours
- No blasting on Sundays and public holidays.

The construction activities are proposed to be undertaken within the hours detailed above and adhere to the DTMR Noise Code of Practice Vol 2 with respect to standard and non-standard hours and mitigation requirements. Where feasible construction would be avoided during the night-time period. Where construction works occur near schools during school hours, ARTC will consult with the Department of Education to develop a works plan that minimises disruption and maintains safe access. EIS Chapter 5: Project Description provides further detail regarding works that may require to be actions outside the primary working hours.

Multiple construction work fronts will be active at any one time along the alignment.

Requirements for construction water for dust suppression have been evaluated as part of the constructability assessment undertaken for the Project. Water demand for the construction of the Project has been estimated based on a total allowance of 190 litres per cubic metre (L/m³) of earthworks, consisting of:

- Material conditioning (pre-wetting): 100 L/m³ of fill
- General dust suppression across the construction footprint: 50 L/m³ of fill
- Haul road and laydown area maintenance: 40 L/m³ of fill.

In addition, water demand for dust suppression has also been estimated for trackworks and concrete batching. Water demand for concrete batched at the temporary concrete batching plant proposed for the Project has been estimated at an allowance of 200 L/m³. Water demand for trackworks has been estimated at an allowance of 6 litres per track metre for ballast dropping, and 4 litres per track metre for tamping and regulating activities.

Based on the forecast construction schedule and the adopted water allowances, expected water demand along the alignment and over time has been estimated to assist in understanding and planning for the demand for construction water.

Several construction water sources have been identified as part of constructability assessments. Sources of construction water will be finalised as the construction approach and schedule is refined during the detailed design stage of the Project, and will be dependent on:

- Climatic conditions in the lead up to construction
- Confirmation of private water sources made available to the Project by landholders under private agreement
- Access agreements with local governments.

6.1.4 Step 2B – Sensitivity of surrounding area

The IAQM methodology allows the sensitivity of an area to dust deposition and human health impacts due to particulate matter to be classified as high, medium, or low. The classifications are determined according to matrix tables provided in the IAQM guidance document. Individual matrix tables for dust deposition and human health impacts are provided. Factors used in the matrix tables to determine the sensitivity of the surrounding area are described as follows:

- Receptor sensitivity (for individual receptors in the area):
 - High sensitivity: locations where members of the public are likely to be exposed for eight hours or more in a day. For example, private residences, hospitals, schools, or aged care homes
 - Medium sensitivity: places of work where exposure is likely to be eight hours or more in a day
 - Low sensitivity: locations where exposure is transient – i.e. one or two hours maximum. For example, parks, footpaths, shopping streets, playing fields.
- Ambient annual mean PM₁₀ concentrations (only applicable to the human health impact matrix)

- Number of receptors in the area
- Proximity of receptors to dust sources.

Table 6.3 details the IAQM guidance sensitivity levels for dust deposition effects on people and property. As detailed in Section 6.1.1 the total number of receptors identified in the impact assessment area is 1,944. All 1,944 receptors are classified as high sensitivity as they are residential uses. Of the 1,944 receptors:

- 1,093 are located within 350 m of a construction dust source (temporary disturbance area)
- 515 of the 1,093 are located within 100 m
- 253 of the 1,093 receptors are within 50 m
- 126 of the 1,093 receptors are within 20 m
- 24 of the 1,093 receptors are located within the bounds of the construction area (0 m separation distance).

Assessing the sensitivity level to dust deposition effects from the Project using the IAQM guidance the sensitivity is determined to be 'High' as there are more than 100 receptors located within 20 m of active construction areas. However, the length of the Project is 216.2 km and the density of receptors near active construction areas is much less than a standard construction site in an urban area. Based on the land use of the impact assessment area a rating of 'High' for sensitivity to dust deposition is considered overly conservative, and a rating of 'Medium' is considered more appropriate. A rating of 'Medium' has been used for the sensitivity of receptors to dust deposition impacts. This approach is consistent with the IAQM guidance, which recommends the use of professional judgement in the assessment of sensitivity.

Table 6.3 IAQM surrounding area sensitivity to dust deposition impacts

Receptor sensitivity	Number of receptors	Distance from the source			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

A modified version of the IAQM guidance for assessing the sensitivity of an area to human health impacts is shown in Table 6.4. For high and medium sensitivity receptors, the IAQM methods takes the existing background concentrations of PM₁₀ (as an annual average) experienced in the area of interest (e.g. air quality study area). As the UK goals for PM₁₀ differ from the ambient air quality goals adopted for use in this assessment (Queensland air quality goals) the annual mean concentration categories used in the assessment (Table 6.4) have been modified to be more stringent from those presented in the IAQM method. The IAQM thresholds are 32, 28 and 24 µg/m³ and these have been shifted down to 25, 21 and 17 µg/m³ for this assessment. This approach is consistent with the IAQM guidance, which notes that professional judgement may be used to determine alternative sensitivity categories.

Table 6.4 Surrounding area sensitivity to human health impacts

Receptor sensitivity ^a	Annual mean PM ₁₀ concentration ^b	Number of receptors	Distance from the source				
			<20	<50	<100	<250	<350
High	> 25 µg/m ³	> 100	High	High	High	Medium	Low
		10 to 100	High	High	Medium	Low	Low
		1 to 10	High	Medium	Low	Low	Low
	21 to 25 µg/m ³	> 100	High	High	Medium	Low	Low
		10 to 100	High	Medium	Low	Low	Low
		1 to 10	High	Medium	Low	Low	Low

Receptor sensitivity ^a	Annual mean PM ₁₀ concentration ^b	Number of receptors	Distance from the source				
			<20	<50	<100	<250	<350
	17 to 21 µg/m ³	> 100	High	Medium	Low	Low	Low
		10 to 100	High	Medium	Low	Low	Low
		1 to 10	Medium	Low	Low	Low	Low
	< 17 µg/m ³	> 100	Medium	Low	Low	Low	Low
		10 to 100	Low	Low	Low	Low	Low
		1 to 10	Low	Low	Low	Low	Low
Medium	> 25 µg/m ³	> 10	High	Medium	Low	Low	Low
		1 to 10	Medium	Low	Low	Low	Low
	21 to 25 µg/m ³	> 10	Medium	Low	Low	Low	Low
		1 to 10	Low	Low	Low	Low	Low
	17 to 21 µg/m ³	> 10	Low	Low	Low	Low	Low
		1 to 10	Low	Low	Low	Low	Low
	< 17 µg/m ³	> 10	Low	Low	Low	Low	Low
		1 to 10	Low	Low	Low	Low	Low
Low	Any	>1	Low	Low	Low	Low	Low

Table notes:

- a A relevant subset of the source table (UK IAQM, 2014) has been reproduced, for receptor sensitivity of 'High' only
b The annual mean PM₁₀ concentration categories have been modified from the IAQM guidance to adjust for assessment of a site in Queensland.

As detailed in Section 4.2.5, the background annual average PM₁₀ concentration from the Inland Rail AQMS adopted for the AQIA area for the assessment is 12.4 µg/m³.

Table 6.4 provides the modified IAQM guidance sensitivity levels for human health impacts for four annual mean PM₁₀ background categories. The background annual average PM₁₀ concentration of 12.4 µg/m³ falls within the below 17 µg/m³ category.

There are greater than 100 high sensitivity receptors within 20 m of the Project's temporary disturbance footprint, and therefore based on the IAQM risk matrix the sensitivity of the AQIA area to human health impacts is considered to be 'Medium'.

6.1.5 Step 2C – Unmitigated risks of impacts

The dust emission magnitudes for each activity as determined in Step 2A were combined with the sensitivity of the AQIA area (in Table 6.3 and Table 6.4) to determine the risk of construction dust air quality impacts, with no mitigation applied. The risk of impacts for each activity is assessed according to the IAQM risk matrix for each activity which is presented in Table 6.5. The 'without mitigation' dust risk impacts for each activity are summarised in Table 6.6.

Table 6.5 IAQM risk matrix

Activity	Surrounding area sensitivity	Dust emission magnitude		
		Large	Medium	Small
Demolition	High	High risk	Medium risk	Medium risk
	Medium	High risk	Medium risk	Low risk
	Low	Medium risk	Low risk	Negligible
Earthworks	High	High risk	Medium risk	Low risk
	Medium	Medium risk	Medium risk	Low risk
	Low	Low risk	Low risk	Negligible

Activity	Surrounding area sensitivity	Dust emission magnitude		
		Large	Medium	Small
Construction	High	High risk	Medium risk	Low risk
	Medium	Medium risk	Medium risk	Low risk
	Low	Low risk	Low risk	Negligible
Track-out	High	High risk	Medium risk	Low risk
	Medium	Medium risk	Low risk	Negligible
	Low	Low risk	Low risk	Negligible

Table 6.6 Without mitigation dust risk impacts for Project construction activities

Activity	Demolition	Earthworks	Construction	Track-out
Scale of Activity	Small	Large	Large	Large
Dust deposition	Low	Medium	Medium	Medium
Human health	Low	Medium	Medium	Medium

The result of the qualitative air quality risk assessment shows that the unmitigated air emissions from the construction of the Project poses a 'Low' to 'Medium' risk of impacts to human health and from dust deposition.

6.1.6 Step 3 – Management strategies

The outcome of Step 2C is used to determine the level of management that is required to ensure that dust impacts on surrounding sensitive receptors are maintained at an acceptable level. The IAQM guidance states that a high or medium-level risk rating means that suitable management measures will need to be implemented during construction to reduce the risk of significant impacts.

A Construction Environmental Management Plan (CEMP) will be developed to mitigate and manage potential impacts during the construction works stage. Approved site-specific and in-principle management measures are listed in Section 8.3 and have been selected with the goal of ensuring minimal risk of dust impacts on surrounding receptors.

6.1.7 Step 4 – Reassessment

The final step of the IAQM methodology is to determine whether there are likely to be significant residual impacts, post mitigation, arising from a proposed development.

A CEMP will be developed to mitigate and manage potential impacts during the construction works stage. Mitigation measures proposed to mitigate construction impacts are presented in Table 8.2. An assessment of the residual risk of impact from construction with the implementation of the proposed mitigation measures is presented in Table 9.1.

6.2 Whetstone Material Distribution Centre

Whetstone MDC will be temporarily established along the alignment, between Inglewood and Yelarbon, to support the construction of the Project and reduce the need for road transportation. Once the Project is fully constructed the Whetstone MDC will be progressively decommissioned.

The operation of the Whetstone MDC will involve the following works and activities:

- Material handling and distribution for both site-won and imported material
- Internal rail track construction
- Site offices and facilities

- Rolling stock provisioning and maintenance facilities
- Hardstand area for material stockpiling
- Ballast unloading facilities
- Rail welding facility and generators.

To facilitate the operation of the Whetstone MDC, upgrade of the Whetstone access road and Cunningham Highway intersection (e.g. turning lanes) will be undertaken.

Sensitive receptors within a 350 m buffer of the Whetstone MDC are included in the construction dust assessment in Section 6.1. The location of the Whetstone MDC is shown in Figure 4.17.

6.3 Turallin facility

A construction facility will be established near the township of Turallin to support the construction works of the Project. The Turallin facility is located over 10 km from the Project alignment and is shown in Figure 4.17.

The facility may have a number of potential uses, such as:

- Native plants nursery and traditional land management training facility
- Training and material testing facility
- General construction laydown and storage.

For the purposes of the construction dust assessment, it has been assumed that the Turallin facility will be used as a laydown area, which is the use with the highest potential for dust generation. Sensitive receptors within a 350 m buffer of the Turallin facility and are included in the construction dust assessment in Section 6.1.

This approach is considered to provide a conservative assessment of potential impacts as the separation distance between the Turallin facility and the Project alignment means that the risk of cumulative construction dust impacts is negligible.

6.4 Non-resident workforce accommodation

Construction personnel who do not live within a safely commutable distance to the Project will be housed in temporary non-resident workforce accommodation. Each accommodation facility will be required to hold approximately 300 staff during the peak construction period. The average occupancy of the non-resident workforce accommodation outside of the peak period will be approximately 150 people per facility. There are currently two non-resident workforce accommodation facilities proposed for the Project. Locations for the non-resident workforce accommodation have been identified in the vicinity of the townships of Yelarbon and Inglewood.

It is anticipated that each non-resident workforce accommodation facility will be self-contained, including the provision of on-site temporary package sewage treatment plants. Sewage treatment plants with a capacity of 300 EP will be required to service each non-resident workforce accommodation facility. Odour impacts are possible even from small scale sewage treatment plants, such as those proposed

The EPA Victoria guideline *Recommended separation distances for industrial residual air emissions* (2013) provides guidance on suitable separation distances between wastewater treatment facilities and neighbouring sensitive receptors. Table 6.7 presents the calculation methods and derived separation distances for a 300 EP sewage treatment plant.

Table 6.7 Separation distances for sewage

Type of installation	EPA Victoria separation distance equation	Separation distance required for 300 EP sewage treatment plant (m)
Mechanical/biological wastewater plants	$10 n^{1/3}$	67
Aerobic pondage systems	$5 n^{1/2}$	87
Facultative ponds	$10 n^{1/2}$	173

Mechanical or biological wastewater treatment systems are likely to be used and therefore a minimum separation distance of 67 m should be maintained from neighbouring sensitive receptors to minimise odour impacts for neighbouring sensitive receptors.

If the capacity of the accommodation facilities is required to change, the method described in this section can be used to determine the required separation distance to minimise the risk of odour impacts.

6.5 Fuel storage

Fuel tank storage locations are proposed at 12 laydown areas along the Project site during the construction of the Project. Table 6.8 presents the proposed construction laydown areas that will include diesel fuel storage areas, the storage volumes proposed, and distance from the laydown area to the closest identified sensitive receptor.

For the largest fuel storage tanks of 20,000 L, the distance to the closest sensitive receptor is approximately 120 m, whilst for the smaller tanks of 10,000 L the distance to the closest receptor is 15 m.

There is no Queensland specific guidance on recommended separation distances for fuel storage to prevent air quality impacts. EPA Victoria (2013) provides guidance on separation distances for the storage of petroleum products (100 m for floating roof tanks, and 250 m for fixed roof tanks), however this guidance is for tanks exceeding 2000 tonnes, which is far greater than the size of the tanks proposed for the Project.

Table 6.8 Fuel tank storage locations

Construction area ID	Chainage (km)	Location	Fuel storage proposed (L)	Distance from boundary of construction footprint to closest sensitive receptor
NS2B-LDN035.6	35.6	Eukabilla Road	20,000	800 m
B2G-LDN006.3	6.2	Yelarbon-Kurumbul Road	10,000	15 m
B2G-LDN025.9	25.9	Yelarbon Road (South)	10,000	95 m
B2G-LDN025.9	25.9	Yelarbon-Kurumbul Road (north)	10,000	90 m
Whetstone MDC	44.8	Whetstone Access and Cunningham Highway	20,000	150 m
B2G-LDN054.2	54.3	Cremascos Road	10,000	160 m
B2G-LDN074.0	74.2	Millmerran-Inglewood Road	10,000	680 m
B2G-LDN081.0	81.1	Wongavale Yugibar Road	10,000	3.45 km
B2G-LDN104.5	104.6	Partons Road	10,000	385 m
B2G-LDN116.5	116.2	Heckendorf Road	20,000	120 m
Turallin Facility	127.0	Turallin Road	10,000	50 m
B2G-LDN161.0	162.3	Yarralea Road	20,000	250 m
B2G-LDN175.5	176.9	Linthorpe Road Bridge	10,000	95 m
B2G-LDN188.2	189.5	Athol School Road	10,000	80 m
B2G-LDN192.3	193.6	via Athol Road	10,000	575 m
B2G-LDN206.3	207.6	Leesons Road	10,000	70 m

Due to the lack of applicable policy by TRC and GRC, guidelines from other councils within Queensland have been applied for the AQIA. The BCC Service Station Code within the Brisbane City Plan 2014 provides performance outcomes and acceptable outcomes for service stations to ensure that service station developments are located at sufficient distances from sensitive uses to maintain amenity, health and wellbeing. The current version of the Service Station Code is Version 28 (v28), released 1 September 2023. It provides minimum separation distances for service stations with the inclusion of Stage 1 vapour recovery (recovery of vapour from service station storage tanks while being refilled), which is not considered appropriate for small fuel storage tanks as proposed for the Project.

Version 19 of the Service Station Code (released 1 May 2020) included separation distances for service stations (based on annual throughput) without vapour recovery technology. Acceptable Outcome AO7.2 of Version 19 stated that for service stations with an annual fuel throughput of less than 1.2 megalitres (ML) the acceptable separation distance is 10 m, whilst for service stations with annual fuel throughput of between 1.2 to 9 ML, the accepted distance is 50 m.

Although this version of the Service Station Code is superseded, it is still considered appropriate to use in the assessment of separation distances for fuel storage. The Service Station Code specifically excludes diesel from the definition of fuel. However, diesel is less volatile than petrol and other motor spirits and therefore the application of the separation distances from the Service Station Code to fuel storage areas for the project represents a conservative assessment.

To exceed an annual throughput of 9 ML, the 20,000 L tanks would need to be refilled more than once per day (450 times per year), whilst the 10,000 L tanks would need to be refilled more than twice per day (900 times per year). It is considered improbable that this volume of diesel will be consumed, and it is expected that annual fuel throughput will be considerably less than 9 ML per tank.

It is recommended that at minimum fuel tanks should be located at least 50 m from the nearest sensitive receptor, but separation distances should be maximised as far as practical within site restrictions. A minimum separation distance of 50 m and compliance with *AS 1940:2017 The storage and handling of flammable and combustible liquids* (Standards Australia, 2017) is expected to result in negligible impacts to sensitive receptors.

All construction areas except for B2G-LDN006.3 have a separation distance from the nearest boundary to the closest receptor of greater than 50 m. However, the dimensions of B2G-LDN006.3 are approximately 300 m x 27 m, and therefore the tank can be located at a position that is further than 50 m from the nearest receptor within this construction area and therefore, be located an acceptable distance away from the closest neighbouring sensitive receptor.

In the event that the location of the fuel storage tanks needs to be altered, a minimum separation distance of 50 m should be adhered to in order to minimise the risk of significant impacts to air quality from fugitive emissions.

6.6 Concrete batching plant

Two temporary concrete batching facilities will be required for the for the dual activities of precast concrete structure storage (laydown) and on-site concrete batching as detailed in EIS Chapter 5: Project Description: B2G-LDN150.5 (Brookstead – Gore Highway and Dieckmann Road) and BNG-LDN138.5 (Millmerran – Gore Highway and Hall Road).

Concrete batching plants have the potential to impact local air quality primarily through emissions of dust associated with the handling of cement, aggregate, sand, and other input materials.

Recommended separation distances for concrete batching plants are provided in the SA EPA *Air & Water Quality Guideline - Concrete batching* (2016b). For batching plants, the SA EPA guideline recommends a minimum separation distance from housing or other activities of 100 m. In addition, SA EPA (2016b) also states the following:

'if a mobile batch plant is used for the preparation of concrete, the plant must not be positioned closer than 50 m to an environmentally sensitive location. In addition, where possible a buffer zone of 100 m from any township, municipality or residential dwelling should be provided when batching concrete'.

At B2G-LDN0150.5, the temporary batching plant would be located to the south-west of the Vary Agricultural Services (VAS) business, located at 92 Ware Street, Brookstead. VAS is an agricultural business which undertakes storage and transport of food (e.g. grain) and fertiliser products.

VAS has been included in the construction dust risk assessment (sensitive receptor 214). However, additional assessment has been undertaken for VAS to investigate potential impacts from the batching plant.

The dimensions of B2G-LDN0150.5 are approximately 700 m long (north to south), by 360 m wide (east to west) at its widest point (triangle shaped laydown area). The separation distance from the boundary of B2G-LDN0150.5 to the boundary of the VAS site is approximately 50 m, with the separation distance from the boundary of B2G-LDN0150.5 to the nearest façade of the VAS storage building being approximately 100 m.

To minimise the potential for impacts, the temporary batching plant at B2G-LDN0150.5 will be located as far as practical from the VAS site boundary and achieve a minimum boundary to boundary separation distance of 100 m. Based on the size of B2G-LDN0150.5, it is expected that this separation distance will be readily achievable.

The separation distance from the boundary of B2G-LDN138.5 to the nearest sensitive receptor is 230 m. Therefore, at B2G-LDN138.5, the recommended minimum separation distance of 100 m will be met.

In addition to this minimum separation distance, additional mitigation measures to minimise the potential for impacts from the batching plant are provided in Table 8.2.

In the event that the location of the batching plants needs to be altered, a minimum separation distance of 100 m should be adhered to in order to minimise the risk of significant impacts to air quality from batching plant emissions.

6.7 Blasting

Blasting is proposed for the construction of certain sections of the alignment as identified by chainage range in Table 6.9. Blasting will generate dust which has the potential to impact sensitive receptors within the AQIA area. Blasting will also result in fugitive gas emissions, however, gaseous emissions from blasting are generated in lower magnitudes than dust and pose a lower risk of impact.

During construction, ARTC will assess risks from blasting in two stages as required:

- Stage 1: ARTC will undertake an initial appraisal and provide 'in principle' approval to blast in proximity to ARTC infrastructure
- Stage 2: Detailed assessment and approval.

Assessment of the potential for dust impacts from blasting has been undertaken considering the EPA Victoria guideline *Recommended separation distances for industrial residual air emissions* (2013). The EPA Victoria guideline does not specifically include blasting for construction, but does include a recommended separation distance of 500 m for quarries which undertake blasting, which is considered an appropriate surrogate.

Chainages along the alignment where blasting is required are presented in Table 6.9. Table 6.9 also identifies sensitive receptors which are located within 500 m of these blast areas.

Table 6.9 shows that of the 1,948 receptors considered in the construction dust assessment, 30 receptors are located within 500 m of proposed blasting areas.

Table 6.9 Alignment chainages where blasting is required

Chainage	Receptors within 500m	Direction from the blast area
Ch 165.3 km to Ch 168.6 km	R1004	South
	R1012, R1016, R1017, R1025	North to West
Ch 176.1 km to Ch 176.6 km	R1502, R1659, R1660	East
	R1496, R1500, R1661, R1662	South-east
Ch 178.8 km to Ch 180.5 km	R1513, R1516, R1520, R1521	North to West
	R1512, R1514, R1515	South to East
Ch 186.5 km to Ch 186.9 km	R1548, R1551, R1553, R1842, R1843	South-east
Ch 190.2 km to Ch 191.6 km	R1575, R1578, R1866	West
Ch 193.5 km to Ch 194.6 km	R1581, R1874, R1875	East

Based on the EPA Victoria guideline, dust emissions from blasting have the potential to impact sensitive receptors. It is recommended that the risk assessments undertaken for blasting include consideration of the potential impact to air quality at sensitive receptors.

To minimise the risk of impact to sensitive receptors within the AQIA area it is recommended that blasting is limited where possible when the prevailing wind direction is likely to transport dust emissions towards sensitive receptors within 500 m. For example, for the blasting area between Ch 165.3 km to Ch 168.6 km, blasting should be avoided if the prevailing wind direction is blowing to the south (e.g. northerly wind), as this wind would transport dust towards receptor R1004. This approach to blasting will also minimise the risk of impacts to sensitive receptors as a result of fugitive gas emissions.

Blasting during periods of high wind speeds (>36 km/hr) should be avoided where practical, as per the CEMP (EIS Chapter 24: Draft Outline Environmental Management Plan).

Where there are sensitive receptors within 500 m in most directions, such as the blasting area between Ch 178.8 km to Ch 180.5 km, it may not be possible to identify a wind direction that blows away from all receptors. In this case, care should be taken to avoid blasting while winds are blowing in the direction of the closest receptors to the blast location. In addition, blasting during light winds (< 5 km/hr) that would limit the dispersion of pollutants should be avoided where possible.

7 Operations air quality impact assessment

7.1 Air quality

The results of the dispersion modelling for the operations stage assessment are presented in this section according to the increments presented in Table 7.1.

Table 7.1 Modelling increment descriptions

Increments	Description
Project only contribution	Represents the predicted concentrations from modelled Project locomotive emissions for peak train movements. Different versions of the model have been run to accurately assess emissions from the crossing loops as discussed in Section 5.3.2.4
Background concentration	Adopted background concentrations as per Section 4.2.5
Project only contribution + background concentration	The summation the Project only contribution and background concentration
Non-Project contribution	The modelled non-Project cumulative emission sources adjacent to the alignment, which include the Commodore Mine and Millmerran Power Station, sections of the Gore Highway and Warrego Highway, and existing non-Project rail sources such as the NS2B, G2H Inland Rail lines, and the West Moreton System.
Non-Project contribution + background concentration	The summation of the non-Project contribution and background concentration
Total cumulative concentration	The combined cumulative concentration from Project only contribution, non-Project contribution, and background concentration

Table 7.2 presents the highest total cumulative concentrations at the worst impacted sensitive receptor for each pollutant for peak operation train volumes (2040). The predicted concentrations have been compared against the relevant air quality goals (Section 3.5). The air quality goals adopted for the assessment are prescribed to protect the environmental values of health and wellbeing, the aesthetic environment (which includes avoiding nuisance) and the health and biodiversity of ecosystems.

The results in Table 7.2 show that the total cumulative ground level concentrations at the worst impacted sensitive receptor are below the air quality goals for all pollutants and all averaging periods. Therefore, compliance has been predicted at all modelled sensitive receptors for all pollutants and all averaging periods for peak operational train volumes.

The assessment has considered background air quality and existing emission sources in the prediction of cumulative concentration and deposition levels at sensitive receptors and has therefore considered the assimilative capacity of the air environment in determining the impact of the Project. Based on the results of the modelling, the operation of the Project is not expected to significantly adversely impact environmental values of the air environment.

Table 7.2 also presents the predicted Project only contribution at the worst affected receptor. Table 7.2 shows that the Project only contribution at the worst affected receptor is lower than the adopted background concentration (where a background concentration is available) for all pollutant species with the exception of 24-hour average PM_{2.5}. Further discussion of the Project contribution for receptors near the Commodore Mine and Millmerran Power Station is provided in Section 7.1.1.

The assessment of operations stage impacts has considered peak train numbers, in the year 2040 (Table 2.4). As typical train numbers will be lower than peak volumes, predicted concentrations and dust deposition levels and the impact to sensitive receptors within the AQIA area would be reduced for the typical number of train movements.

Predicted pollutant concentration contours are presented in Figure 7.1 to Figure 7.6. Figure 7.1 to Figure 7.3 present the cumulative concentration contours for PM₁₀ (24-hour), PM_{2.5} (annual) and NO₂ (1 hour) including all non-Project sources.

Figure 7.4 presents the NO₂ annual average pollutant concentration contours for comparison against the air quality goal (33 µg/m³) set for the protection of the health and biodiversity of ecosystems. Further discussion is provided in Section 7.3.

To demonstrate the influence of non-Project sources on particulate matter concentrations, Figure 7.5 and Figure 7.6 present the concentration contours for PM₁₀ (24-hour) and PM_{2.5} (annual) excluding emissions from Commodore Mine, Millmerran Power Station, Gore Highway and the Warrego Highway (e.g. the predicted concentration considering Project sources, the West Moreton System and the adjoining Inland Rail projects). The concentration contours presented include the adopted background concentrations (Section 3.5). Figure 7.5 and Figure 7.6 show that non-Project sources have a large influence on cumulative concentrations in the area local to these existing emission sources, and a larger influence than Project emissions.

7.1.1 Risk of impacts near Commodore Mine and Millmerran Power Station

As discussed in Section 5.3.1.2, emissions from the Commodore Mine and Millmerran Power Station have been modelled considering monitoring data obtained from the Millmerran AQMS, located to the north of these existing emission sources. This approach allows for assessment of cumulative air quality impacts.

In addition to modelling emissions from the mine and power station, further evaluation of the risk of impacts to sensitive receptors near the mine and power station has been undertaken by reviewing Project only contributions.

The pollutant species and averaging periods of most concern for receptors near the mine and power station are 24-hour averages of PM₁₀ and PM_{2.5}. The sensitive receptor which is worst impacted for these short-term averaging periods by emissions from the mine and power station is receptor 435, located approximately 500m to the north of the northern boundary of the mine. Project only contributions for receptor 435 have been evaluated for predicted 24-hour concentrations of PM₁₀ and PM_{2.5}. The predicted maximum 24-hour Project contributions at receptor 435 are:

- 24-hour PM₁₀: 0.021 µg/m³
- 24-hour PM_{2.5}: 0.020 µg/m³.

These maximum predicted Project contributions for 24-hour PM₁₀ and PM_{2.5} concentrations represent less than 1 per cent of the respective air quality goals (50 µg/m³ for PM₁₀, 25 µg/m³ for PM_{2.5}).

Due to the minor contribution to particulate matter concentrations, the risk of exceedances of particulate matter goals at sensitive receptors near Commodore Mine and Millmerran Power Station as a result of Project emissions is considered to be low.

Table 7.2 Highest predicted ground level concentrations for identified sensitive receptors for peak operational train numbers in 2040

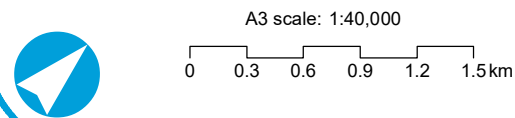
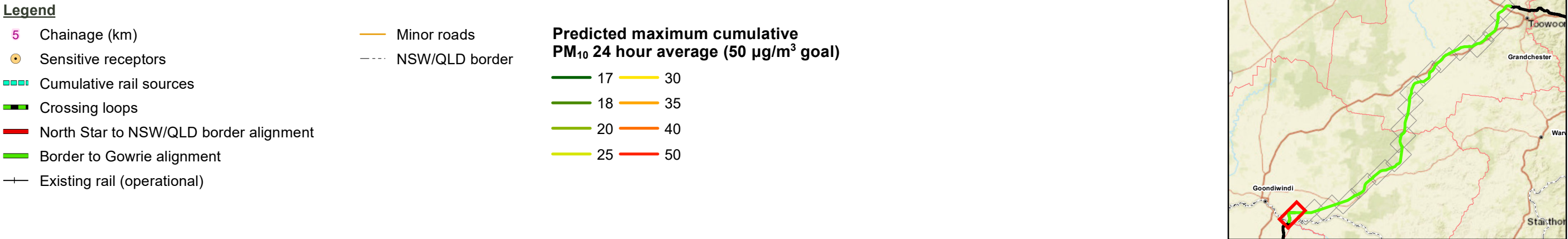
Pollutant	Average period	Highest predicted ground level pollutant concentration at identified sensitive receptor locations for peak operational train numbers in 2040					Highest Project contribution (A) sensitive receptor ID	Highest total cumulative concentration (A + B + C) sensitive receptor ID	Air quality goal (Section 3.5)	Units
		Project only contribution at worst affected receptor (A)	Background concentration (B)	Project only contribution + Background concentration (A + B)	Non-Project contribution (C)	Total cumulative concentration at worst affected (cumulative) receptor (A + B + C) ^d				
TSP	Annual average	1.1	31.0	32.1	9.0	40.0	r1910	r539	90	µg/m ³
Deposited dust	30 day, maximum	0.01	50.0	50.0	0.1	50.1	r1936	r539	120	mg/m ² /day
PM ₁₀	24-hour, maximum	7.5	16.2	23.7	26.3	42.5	r1509	r435	50	µg/m ³
	Annual average	0.6	12.4	13.0	3.1	15.5	r1911	r539	25	µg/m ³
PM _{2.5}	24-hour, maximum	7.1	6.8	13.9	3.4	13.9	r1509	r1509	25	µg/m ³
	Annual average	0.4	5.6	6.0	0.6	6.3	r143	r650	8	µg/m ³
NO ₂	1 hour, maximum	_ ^a	57.5 ^a .	_ ^a	_ ^a	167.0 ^a .	r1509	r1509	250	µg/m ³
	Annual average	_ ^a	7.8 ^a .	_ ^a	_ ^a	25.3 ^a .	r143	r650	62	µg/m ³
Arsenic and compounds	Annual average	4.3 x 10 ⁻⁵	_ ^b .	_ ^b .	_ ^c .	_ ^b .	r1911	r539	6	ng/m ³
Cadmium and compounds	Annual average	0.004	_ ^b .	_ ^b .	_ ^c .	_ ^b .	r1911	r539	5	ng/m ³
Chromium III and compounds	1 hour, maximum	0.0006	_ ^b .	_ ^b .	_ ^c .	_ ^b .	r1509	r539	9	µg/m ³
Chromium VI and compounds	1 hour, maximum	0.0006	_ ^b .	_ ^b .	_ ^c .	_ ^b .	r1509	r539	0.1	µg/m ³
	Annual average	2.1 x 10 ⁻⁵	_ ^b .	_ ^b .	_ ^c .	_ ^b .	r1911	r539	0.01	µg/m ³
Lead and compounds	Annual average	3.6 x 10 ⁻⁷	_ ^b .	_ ^b .	_ ^c .	_ ^b .	r1910	r539	0.5	µg/m ³

Pollutant	Average period	Highest predicted ground level pollutant concentration at identified sensitive receptor locations for peak operational train numbers in 2040					Highest Project contribution (A) sensitive receptor ID	Highest total cumulative concentration (A + B + C) sensitive receptor ID	Air quality goal (Section 3.5)	Units
		Project only contribution at worst affected receptor (A)	Background concentration (B)	Project only contribution + Background concentration (A + B)	Non-Project contribution (C)	Total cumulative concentration at worst affected (cumulative) receptor (A + B + C) ^d				
Nickel and compounds	Annual average	0.05	_b.	_b.	_c.	_b.	r1910	r539	22	ng/m ³
Dioxins and furans	Annual average	1.8 x 10 ⁻¹¹	_b.	_b.	_c.	_b.	r1509	r1614	3 x 10 ⁻⁰⁸	µg/m ³
Polycyclic aromatic hydrocarbon (as benzo[a]pyrene)	Annual average	0.006	_b.	_b.	_c.	_b.	r1509	r1614	0.3	ng/m ³
1,3-butadiene	1 hour, maximum	0.05	_b.	_b.	_c.	_b.	r143	r650	2.4	µg/m ³
Benzene	Annual average	0.0006	5.2	5.2	0.002	5.2	r1509	r1614	5.4	µg/m ³
Toluene	30 minute, maximum ^e	0.006	23.0	23.0	0.006	23.0	r1509	r1923	1,100	µg/m ³
	24-hour, maximum	0.003	21.7	21.7	0.002	21.7	r1509	r1923	4,100	µg/m ³
	Annual average	9.1 x 10 ⁻⁵	18.5	18.7	0.0003	18.7	r1509	r1614	400	µg/m ³
Xylenes	24-hour, maximum	0.5	50.3	50.8	0.2	50.8	r1509	r1923	1,100	µg/m ³
	Annual average	0.01	34.1	34.1	0.04	34.1	r1509	r1614	950	µg/m ³

Table notes:

Cells shaded red denote exceedance of adopted air quality goal (Section 3.5)

- a The OLM was used to determine NO₂ concentrations. The OLM method is complex as it uses modelled hourly NO_x concentrations and hourly varying background NO₂ and O₃ monitoring data from the Mutdapilly DESI monitoring station for 2013. Due to the complexity of this process the emission sources included in the model, including cumulative sources, were modelled in the same model run and were not modelled individually. As a result, the individual contribution from Project and non-Project sources cannot be determined, however, based on the location of the worst affected receptors the predominant sources at the worst affected receptors presented in Table 7.2 are the Project and the Warrego Highway.
- b No background monitoring data is available for this modelled pollutant.
- c Compound not emitted by modelled non-Project emission sources, and therefore nil value is presented.
- d The highest Project only contribution (A) and the highest non-Project contribution (C) may be predicted at different receptors and therefore the total cumulative concentrations does not necessarily equal the sum of the values A, B and C presented in this table.
- e 30 minute averages calculated from 1 hour modelling results as per (Turner, 1970).



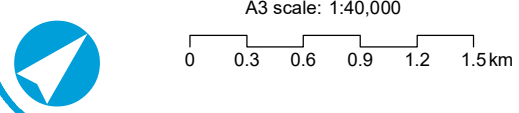
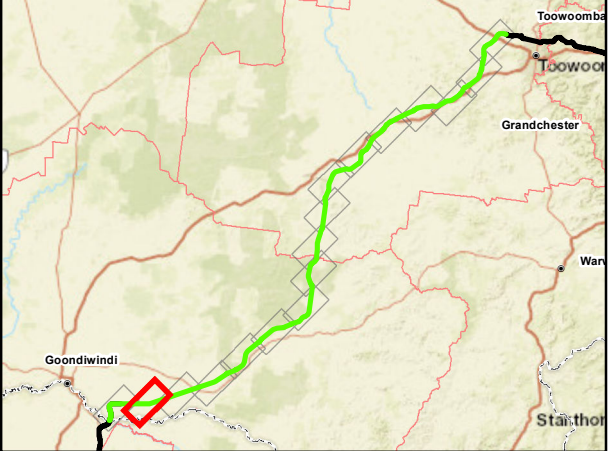


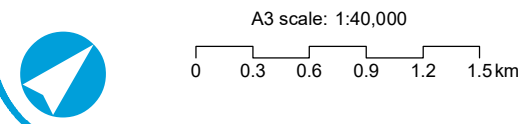
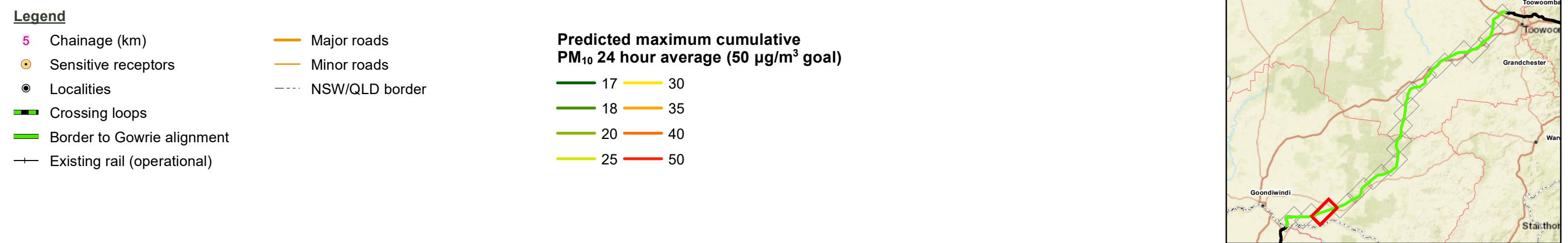
Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Minor roads
- NSW/QLD border

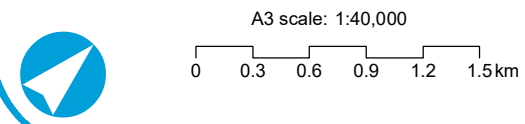
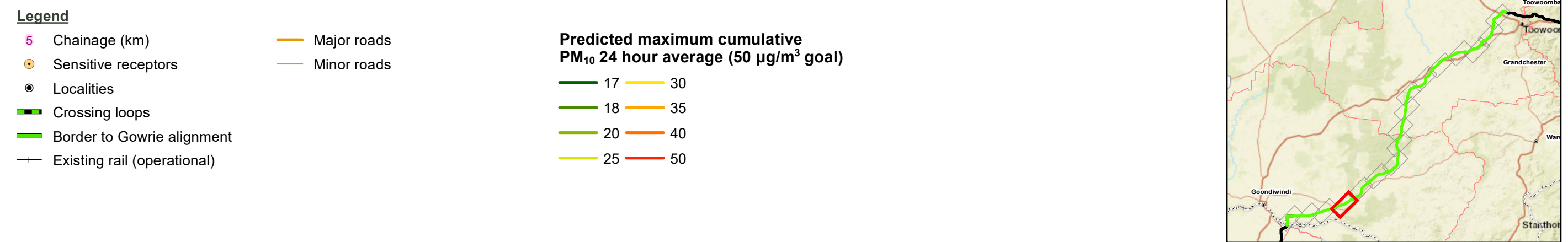
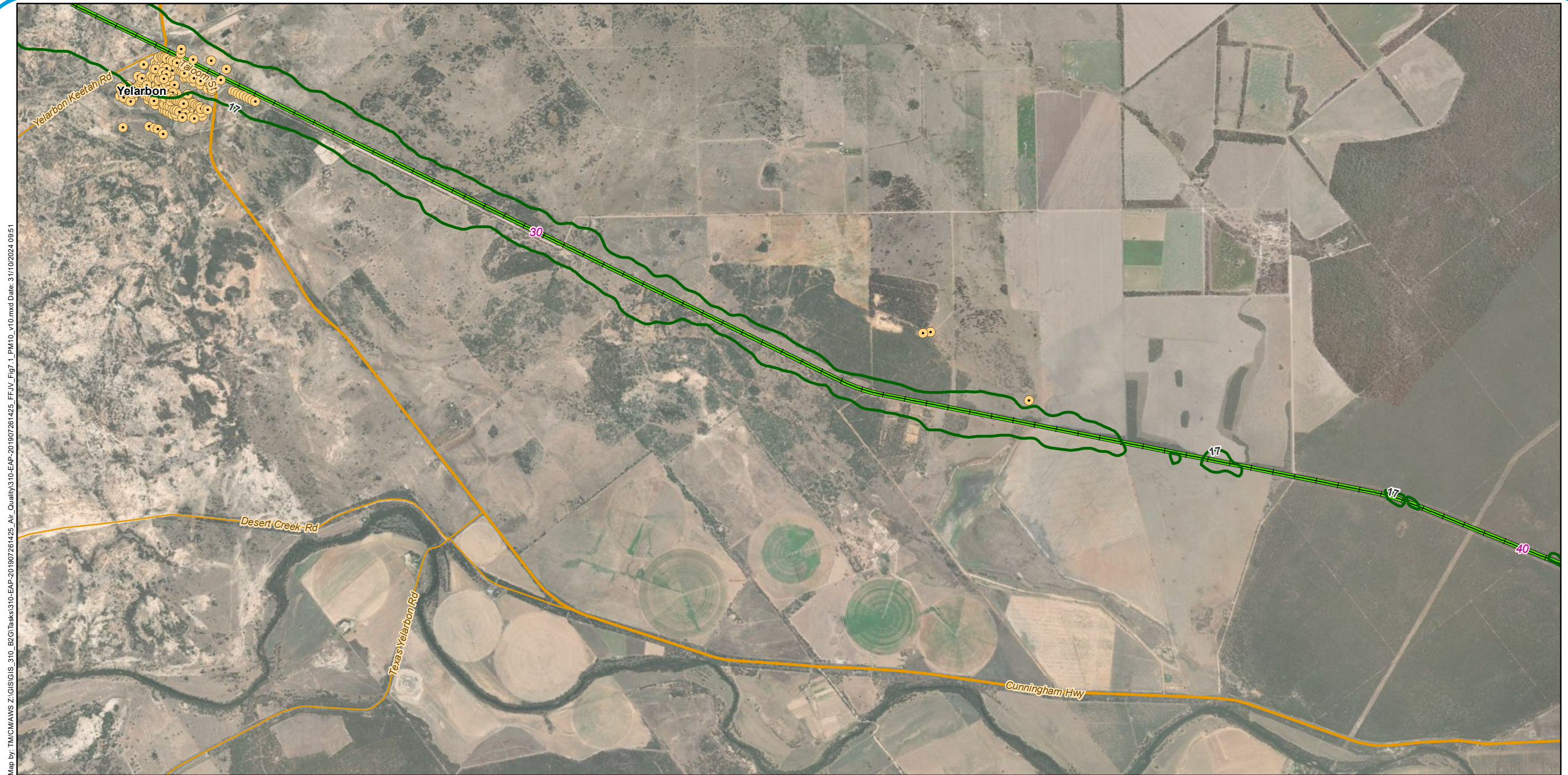
Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

17	30
18	35
20	40
25	50

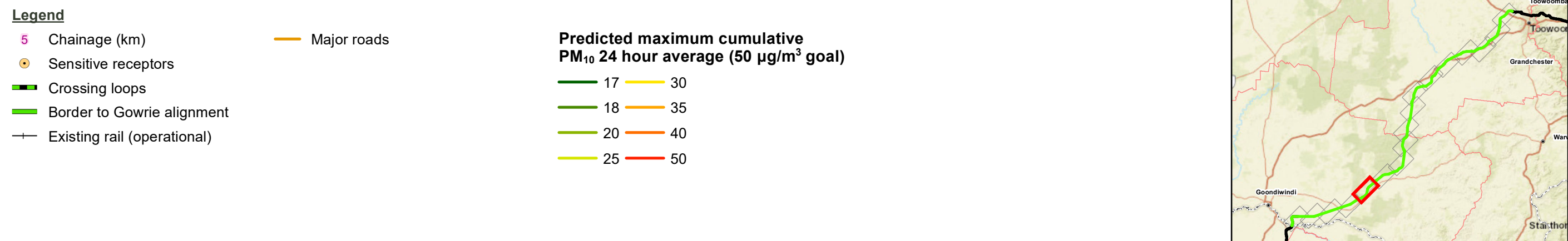
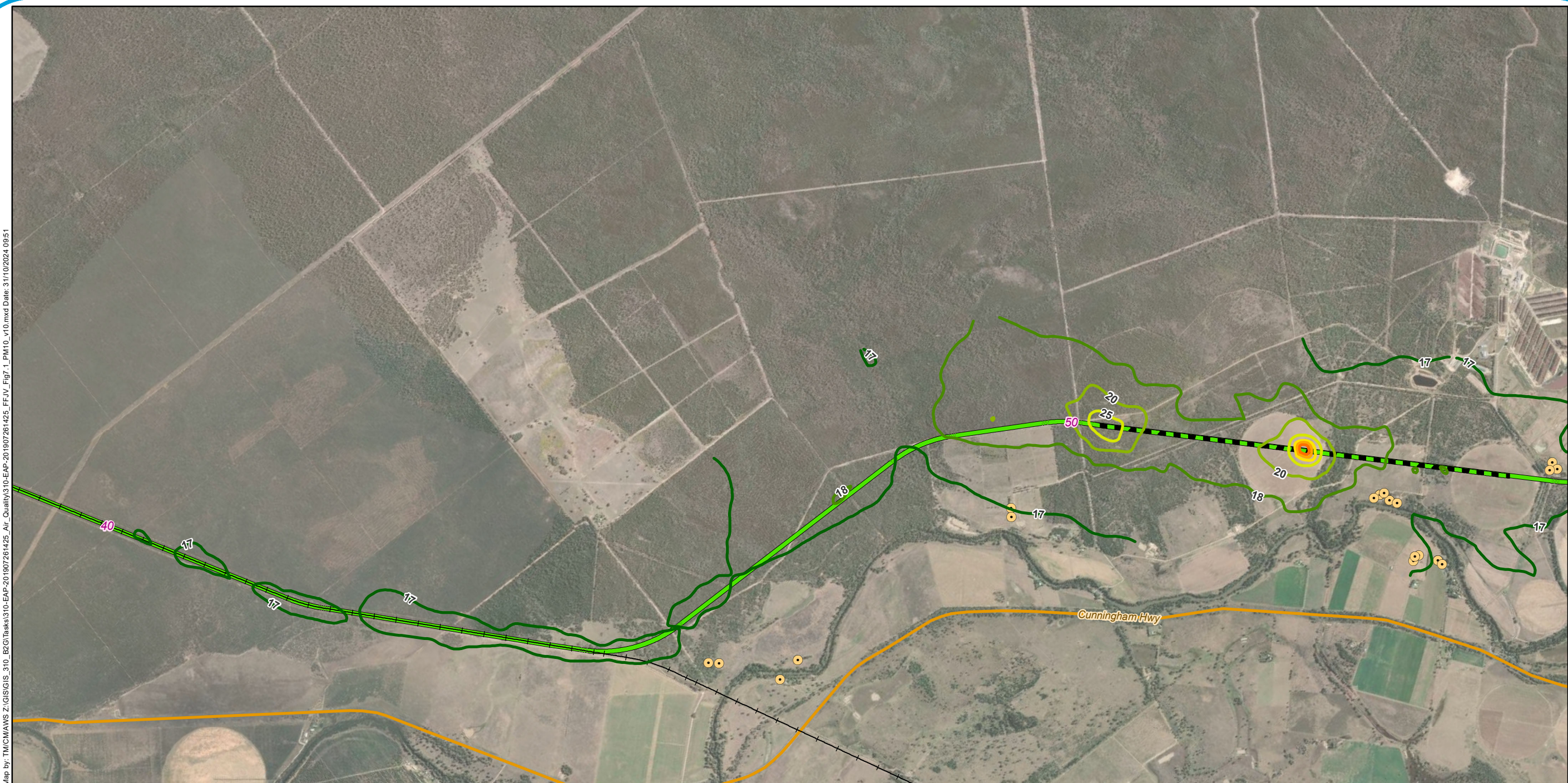




Border to Gowrie
Figure 7.1c:
Predicted maximum cumulative PM₁₀ 24 hour average ground level concentration plot



Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201807261425_Air_Quality\310-EAP-201807261425_FF\JV_Fig7.1_PM10_v10.mxd Date: 31/10/2024 09:51



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



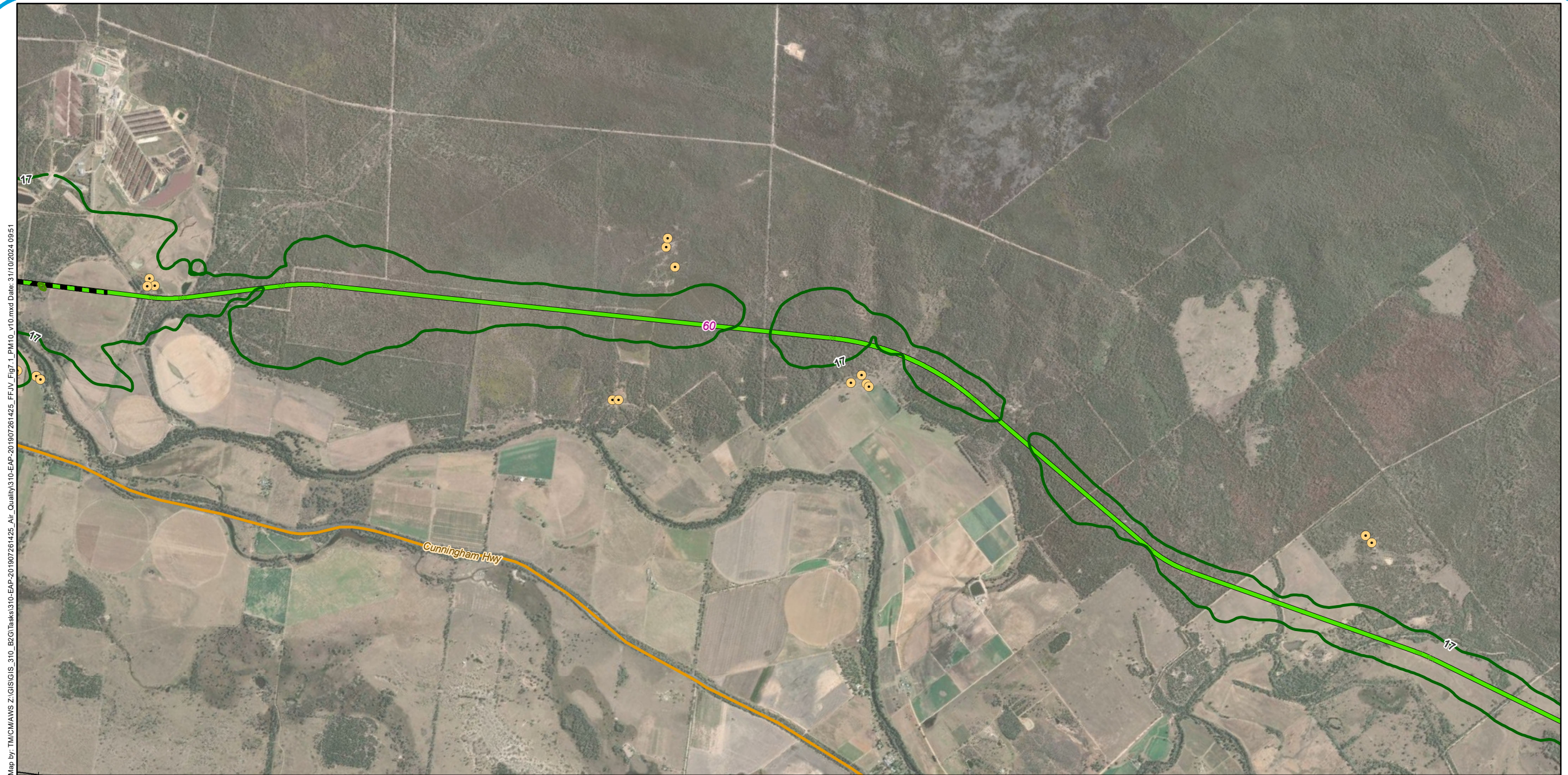
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Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 7.1e:

Predicted maximum cumulative PM₁₀ 24 hour average ground level concentration plot



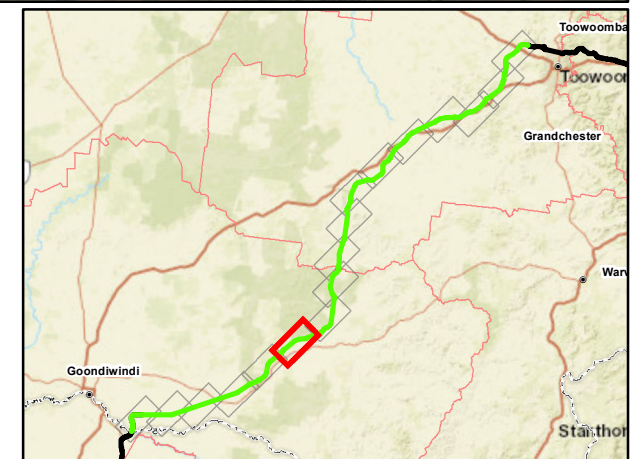
Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)

Major roads

**Predicted maximum cumulative
PM₁₀ 24 hour average (50 µg/m³ goal)**

- | | |
|----|----|
| 17 | 30 |
| 18 | 35 |
| 20 | 40 |
| 25 | 50 |



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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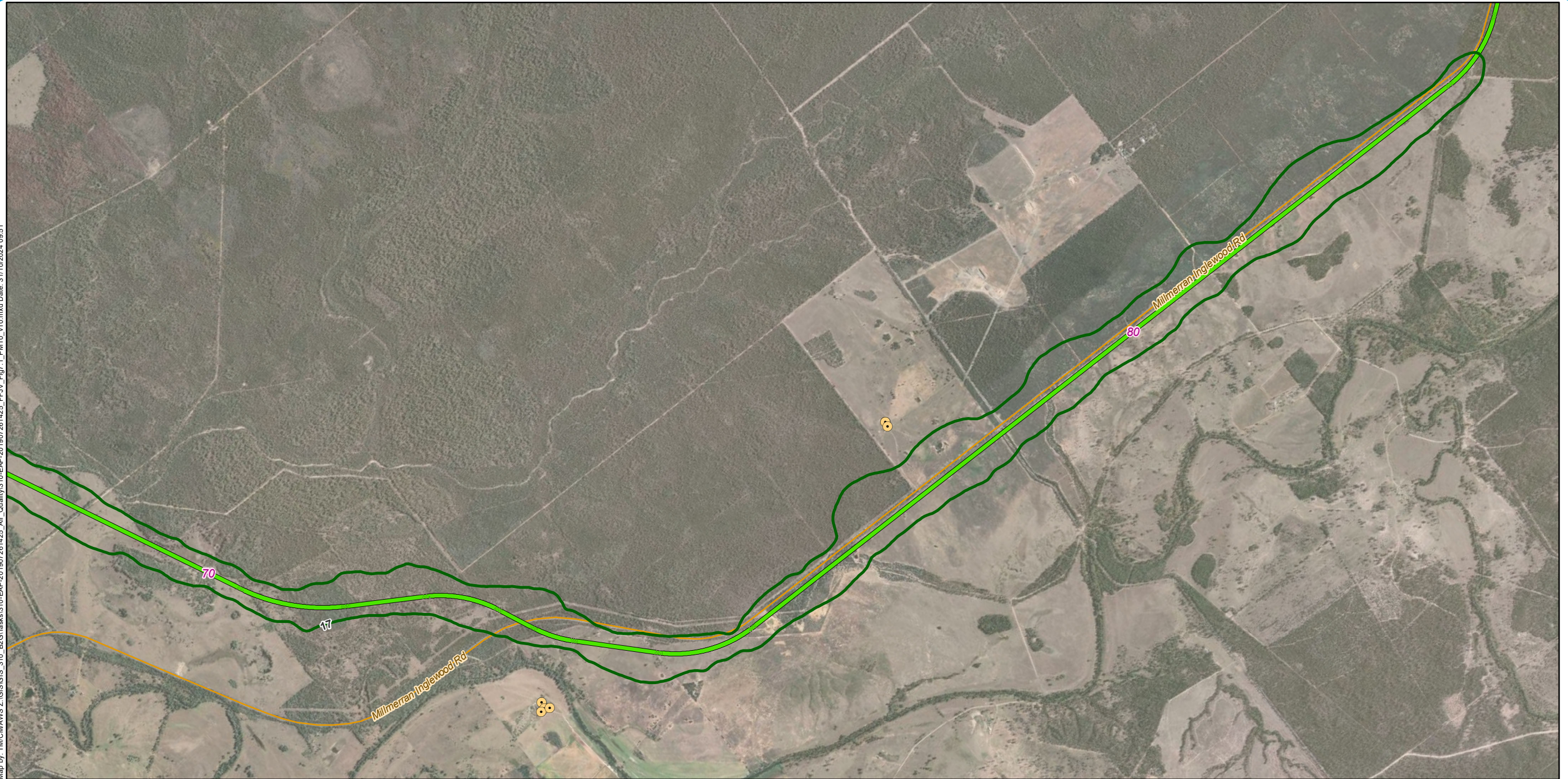
Issue date: 03/10/2024 Version: 10
Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 7.1f:

Predicted maximum cumulative PM₁₀ 24 hour average ground level concentration plot

Map by: TMCM/MAWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201807261425_Air_Quality\310-EAP-201807261425_FF\JV_Fig7.1g_PM10_v10.mxd Date: 31/10/2024 09:51

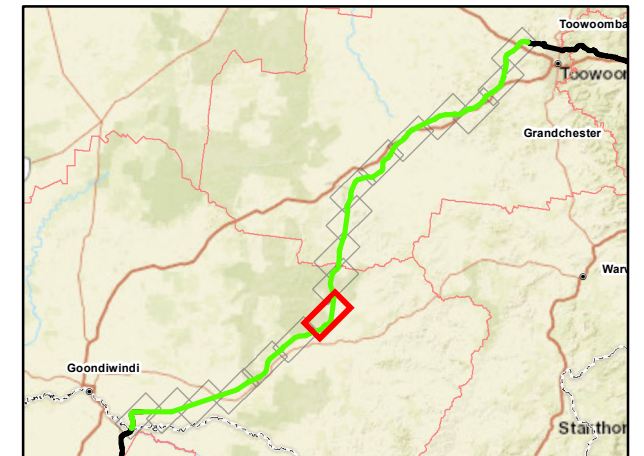


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

- | | |
|----|----|
| 17 | 30 |
| 18 | 35 |
| 20 | 40 |
| 25 | 50 |



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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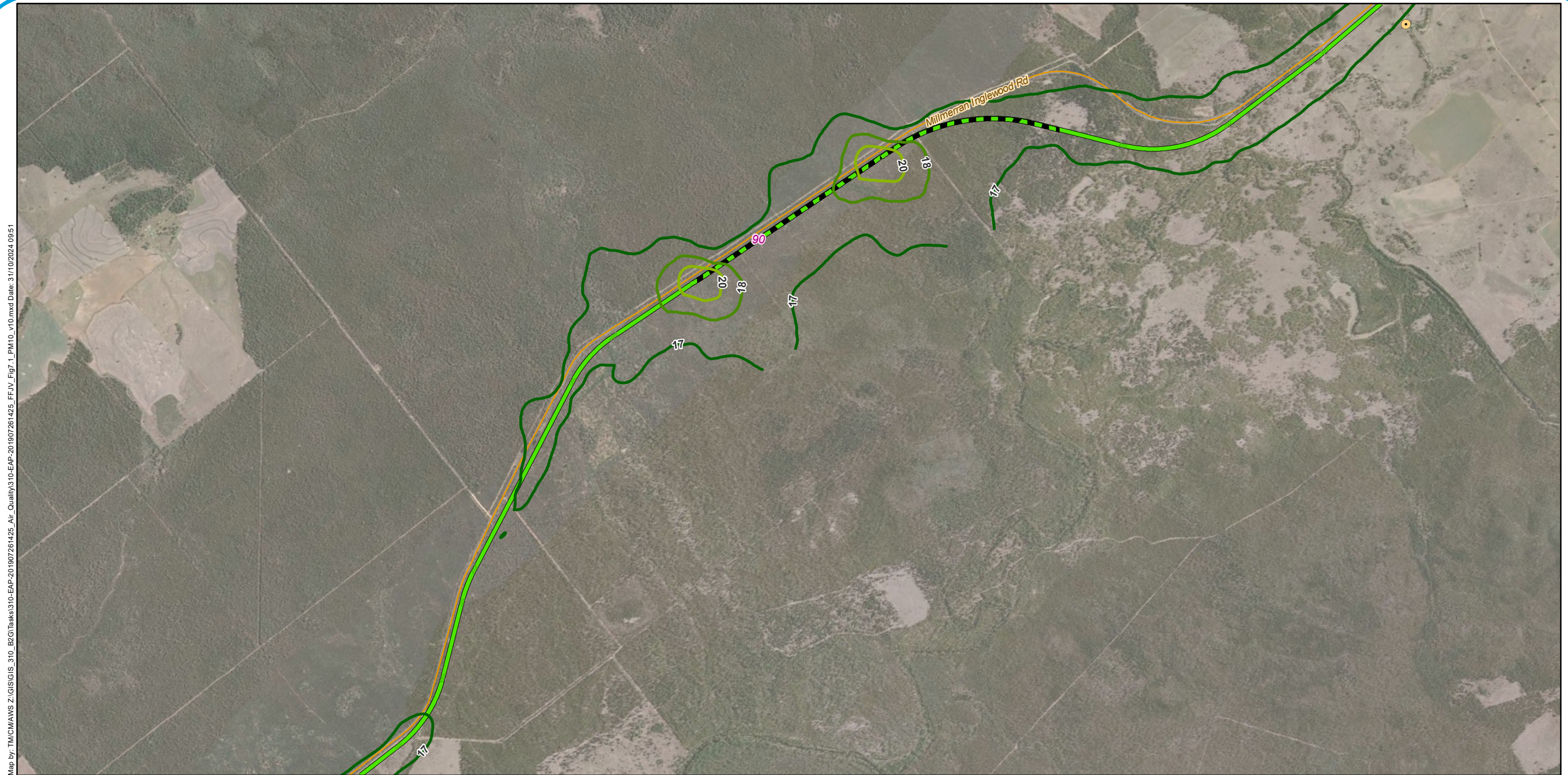
Issue date: 03/10/2024 Version: 10
Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 7.1g:

Predicted maximum cumulative PM₁₀ 24 hour average ground level concentration plot

Map by: T:\MCM\AWS Z:\GIS\GIS_310_B2\GIS\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\JV_Fig7.1_PM10_v10.mxd Date: 31/10/2024 09:51

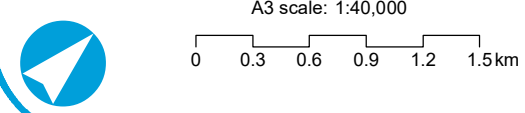
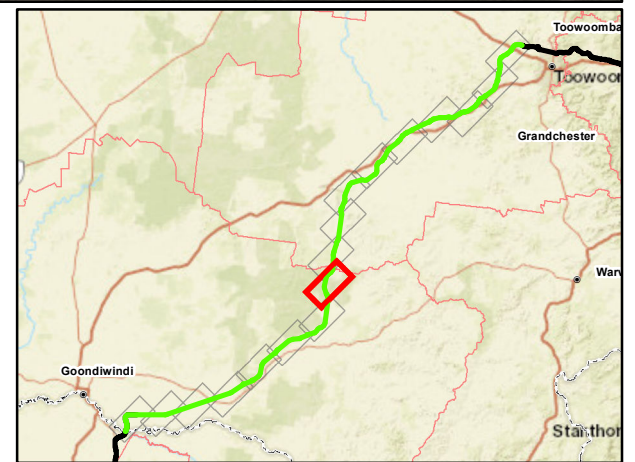


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

17	30
18	35
20	40
25	50



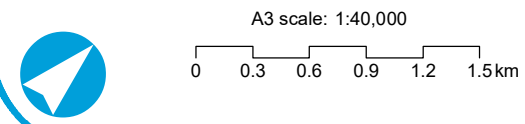
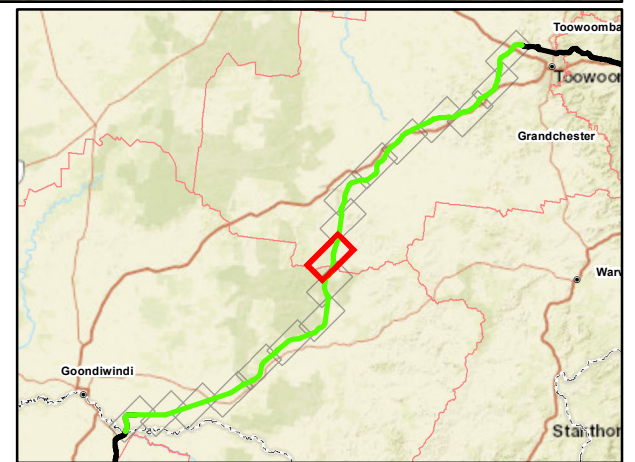


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

- | | |
|----|----|
| 17 | 30 |
| 18 | 35 |
| 20 | 40 |
| 25 | 50 |



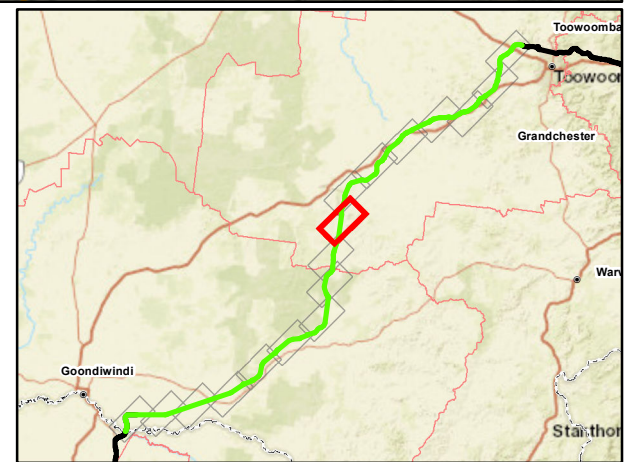


Legend

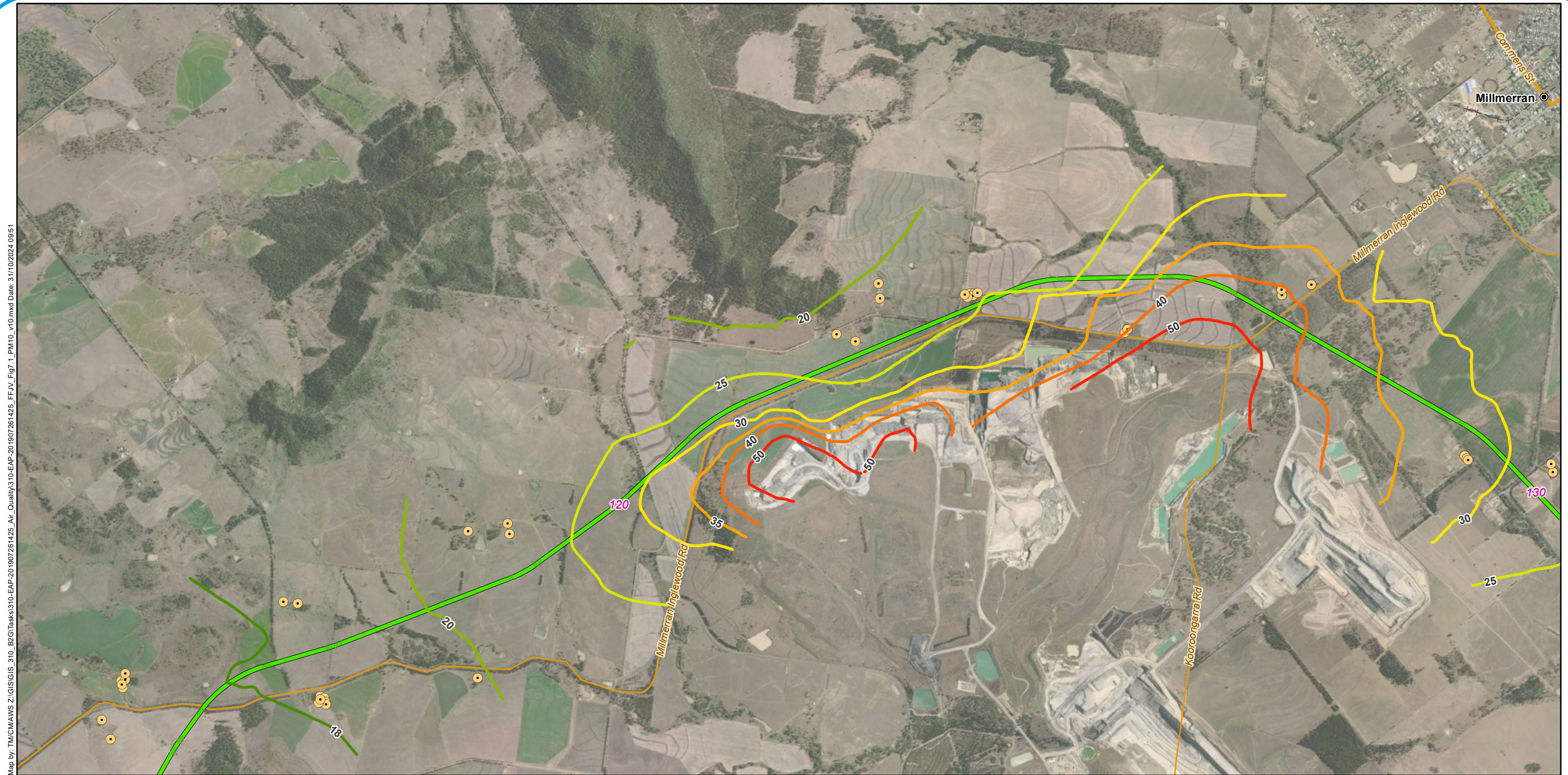
- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

17	30
18	35
20	40
25	50



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km

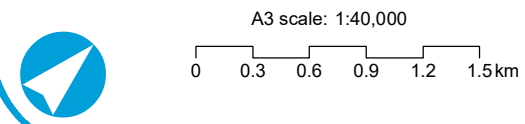


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- + - Existing rail (non-operational)
- Major roads
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

17	30
18	35
20	40
25	50



Border to Gowrie
Figure 7.1k:
Predicted maximum cumulative PM₁₀ 24 hour average ground level concentration plot

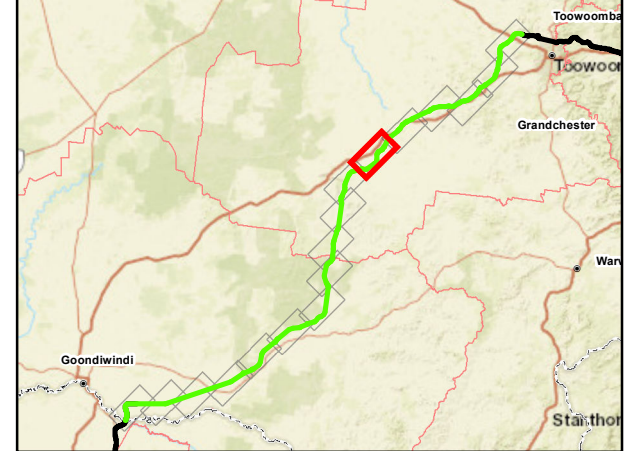


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- - - Existing rail (non-operational)
- Major roads
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

- 17
- 18
- 20
- 25
- 30
- 35
- 40
- 50



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km

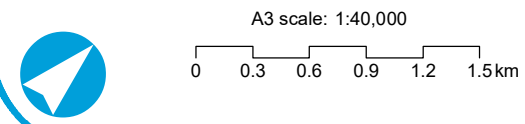
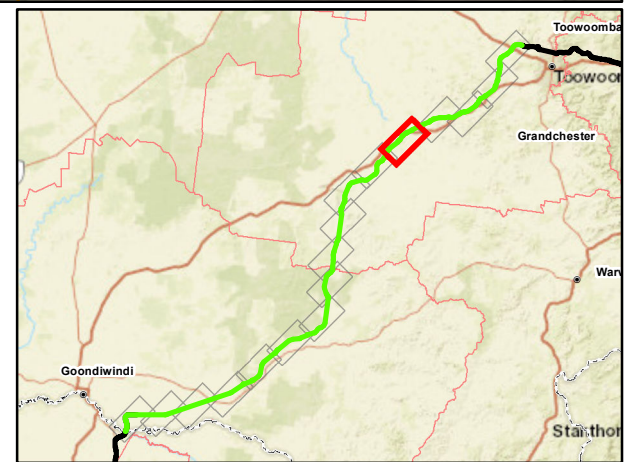


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- - - Existing rail (non-operational)
- Major roads
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

- 17 30
- 18 35
- 20 40
- 25 50



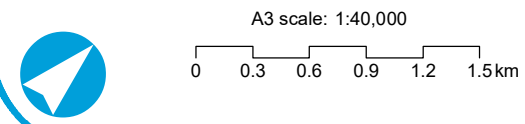
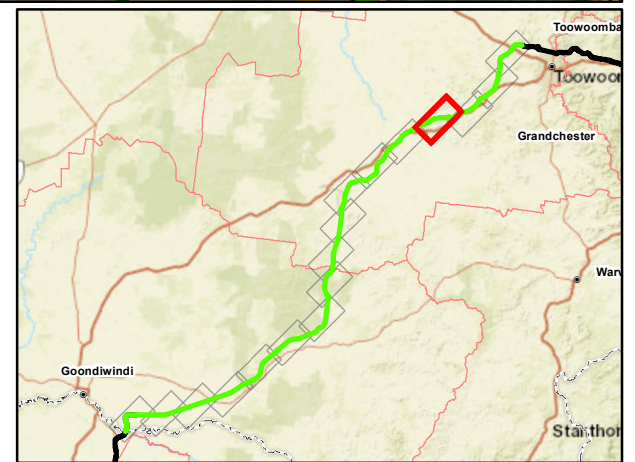


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

- 17
- 18
- 20
- 25
- 30
- 35
- 40
- 50



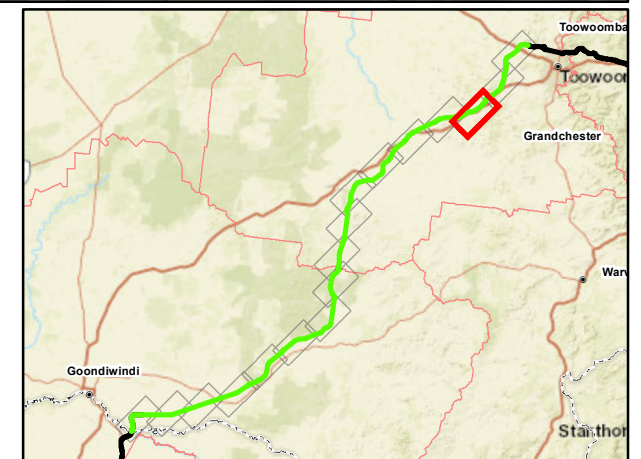


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

**Predicted maximum cumulative
PM₁₀ 24 hour average (50 µg/m³ goal)**

- 17
- 18
- 20
- 25
- 30
- 35
- 40
- 50



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 7.1o:

Predicted maximum cumulative PM₁₀ 24 hour average ground level concentration plot

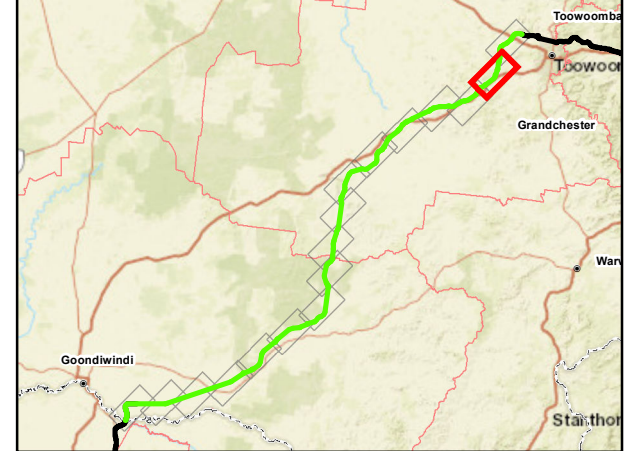


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

17	30
18	35
20	40
25	50



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km

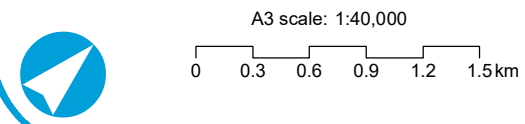


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Cumulative rail sources
- Crossing loops
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Existing rail (operational)

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

17	30
18	35
20	40
25	50





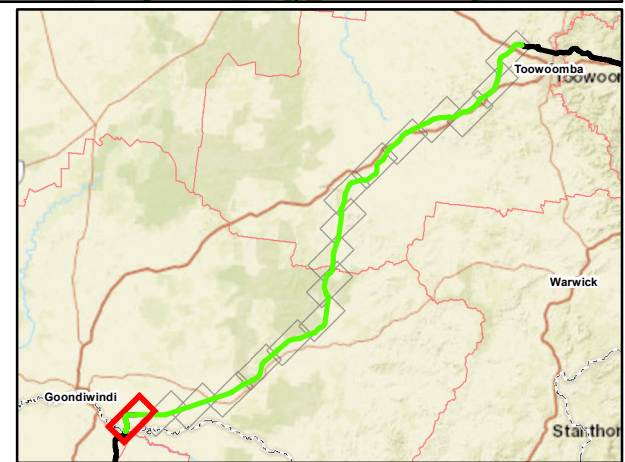
Legend

- 5 Chainage (km)
- Sensitive receptors
- Cumulative rail sources
- Crossing loops
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Existing rail (operational)

- Minor roads
- NSW/QLD border

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- | | |
|-----|-----|
| 5.7 | 6.5 |
| 5.9 | 6.7 |
| 6.1 | 6.9 |
| 6.3 | 7.1 |



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 7.2a:

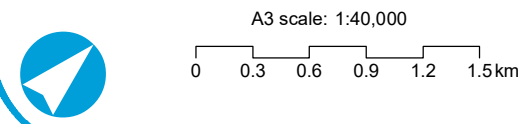
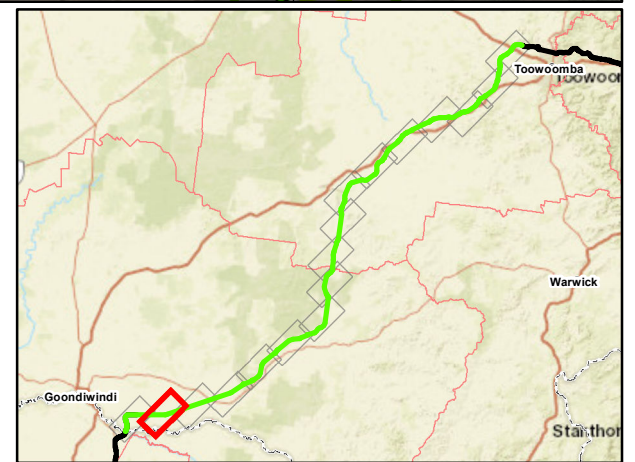
Predicted cumulative PM_{2.5} annual average ground level concentration plot

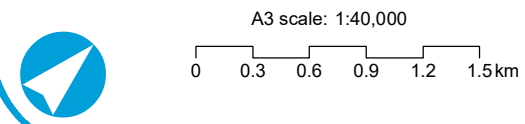
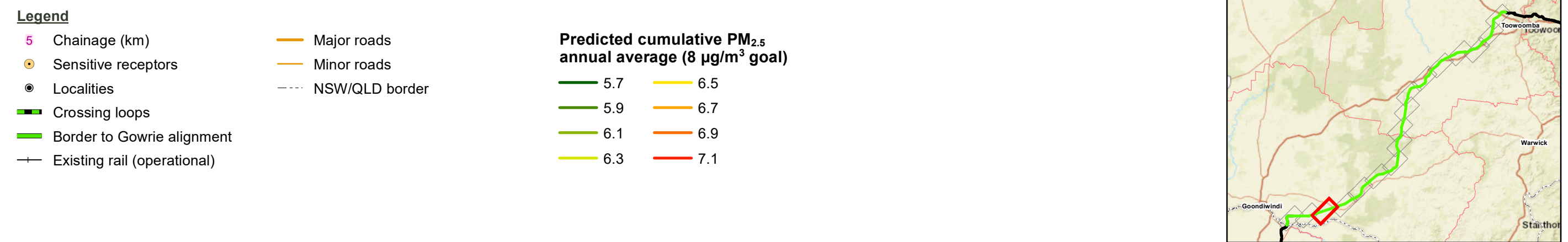


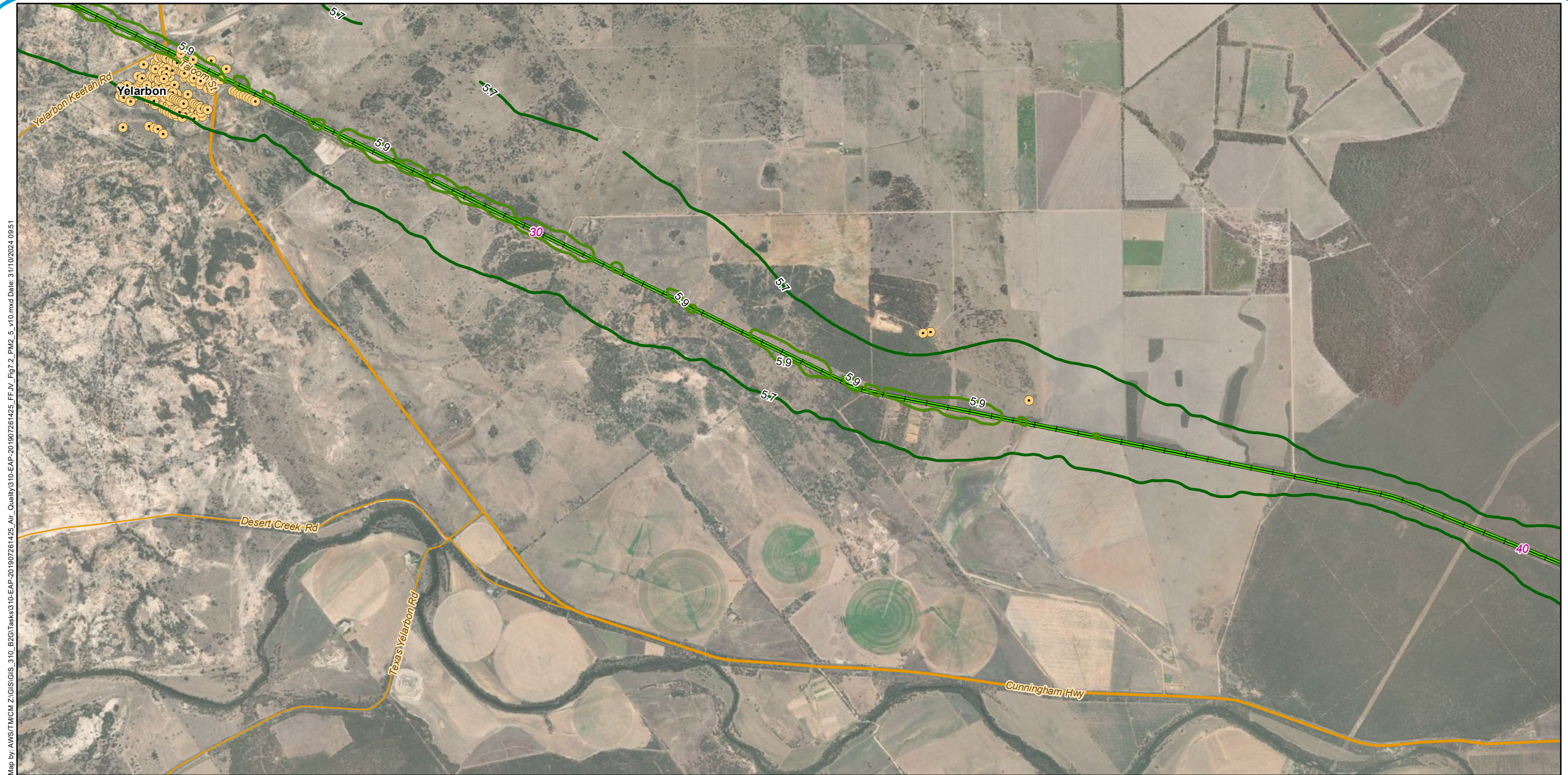
- Legend**
- 5 Chainage (km)
 - Sensitive receptors
 - Localities
 - Crossing loops
 - Border to Gowrie alignment
 - Existing rail (operational)
 - Minor roads
 - NSW/QLD border

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

5.7	6.5
5.9	6.7
6.1	6.9
6.3	7.1





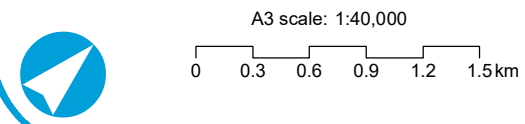


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

5.7	6.5
5.9	6.7
6.1	6.9
6.3	7.1



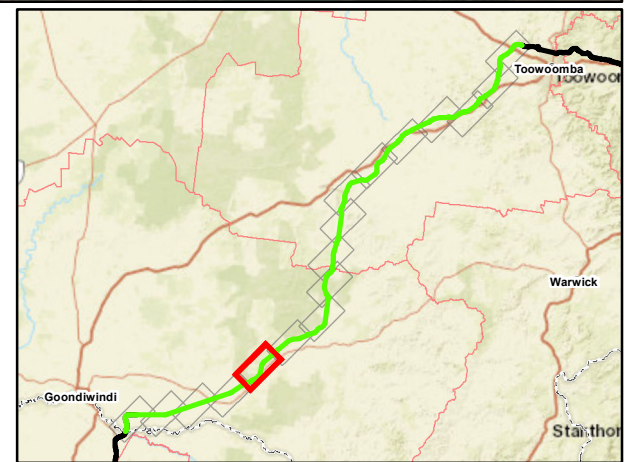


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

5.7	6.5
5.9	6.7
6.1	6.9
6.3	7.1



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km

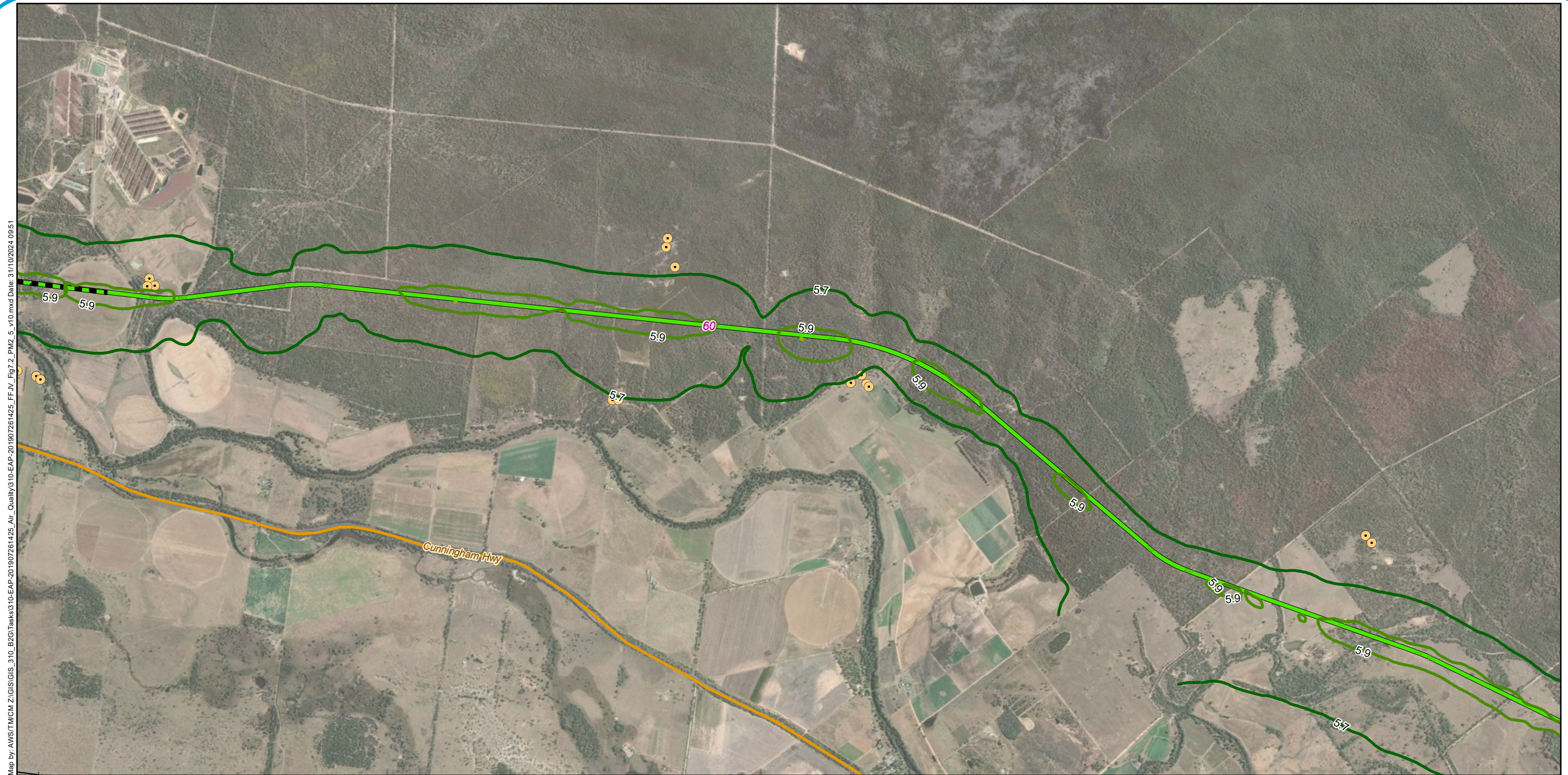


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Border to Gowrie

Figure 7.2e:

Predicted cumulative PM_{2.5} annual average ground level concentration plot

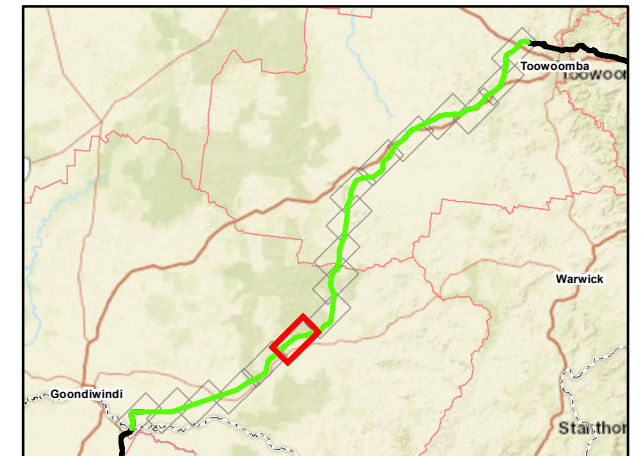


Legend

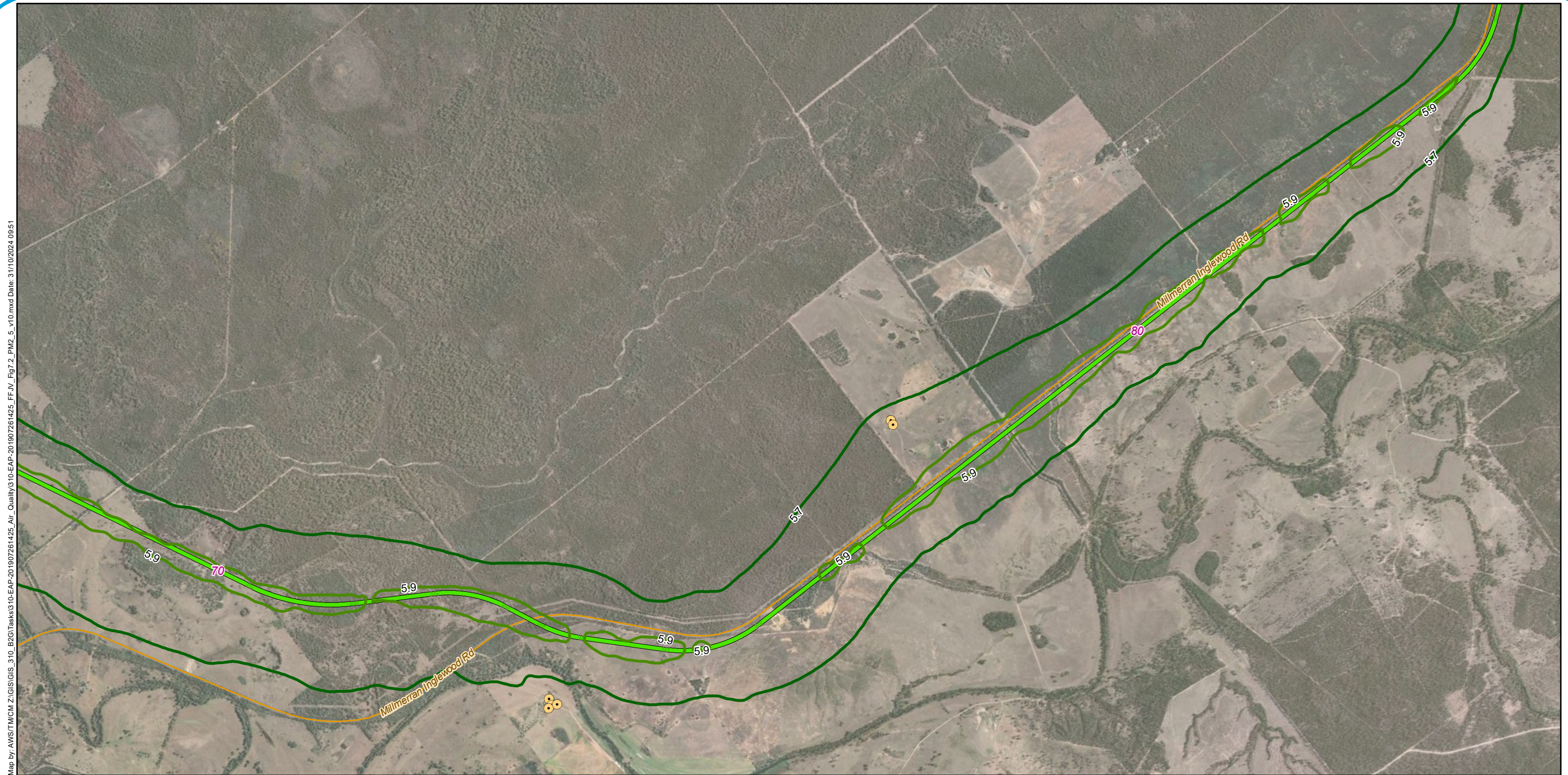
- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- | | |
|-----|-----|
| 5.7 | 6.5 |
| 5.9 | 6.7 |
| 6.1 | 6.9 |
| 6.3 | 7.1 |



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



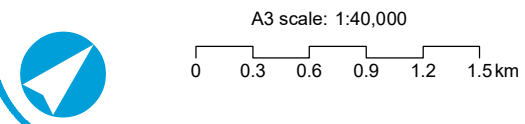
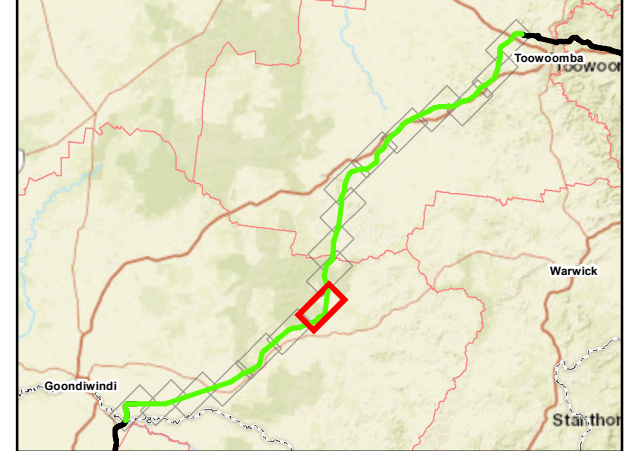
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Legend

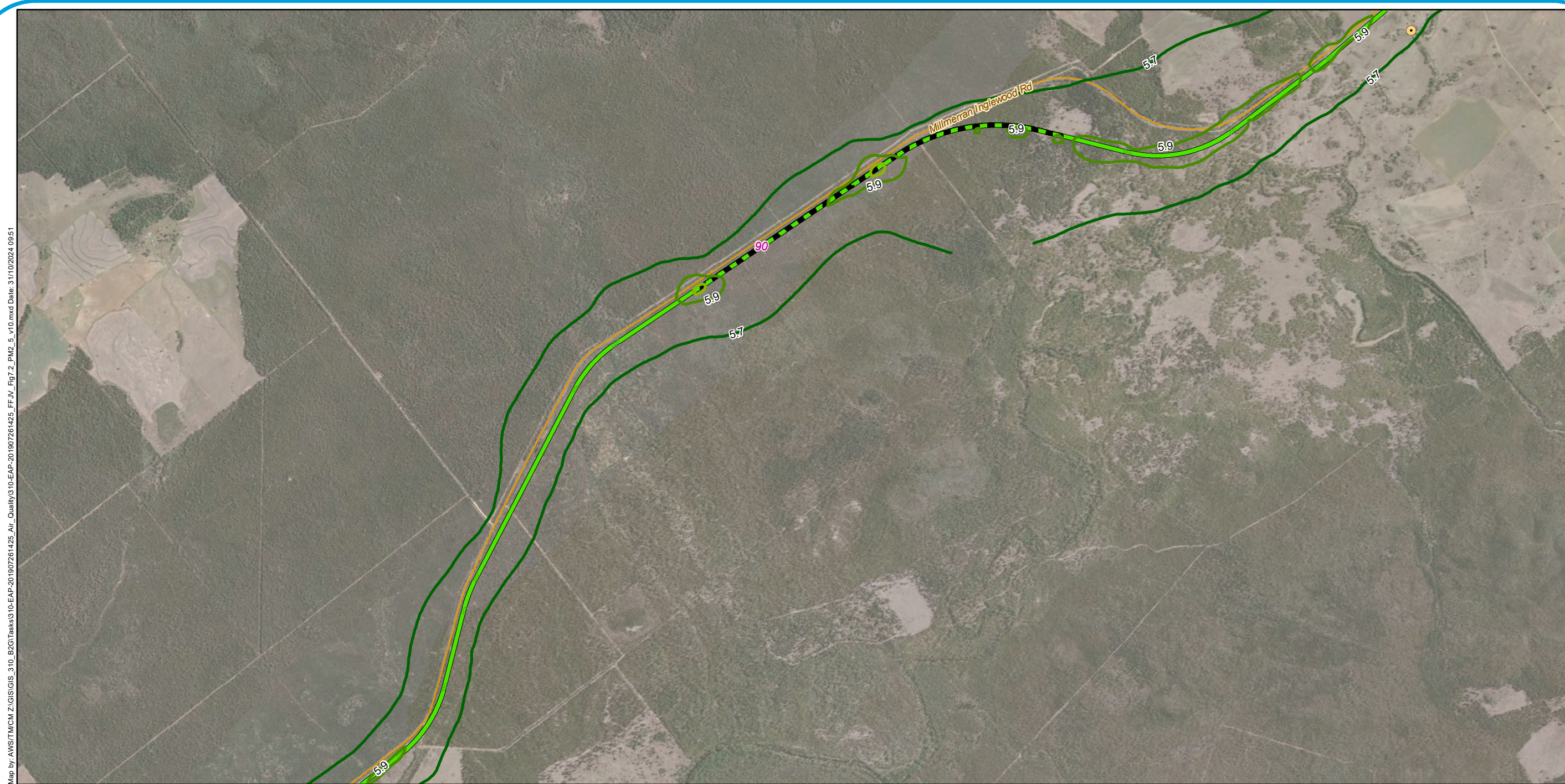
- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- | | |
|-----|-----|
| 5.7 | 6.5 |
| 5.9 | 6.7 |
| 6.1 | 6.9 |
| 6.3 | 7.1 |



Map by: AWS/TMCM Z:\GIS\GIS_310_B2G\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF JV_Fig7.2_PM2.5_v10.mxd Date: 31/10/2024 09:51

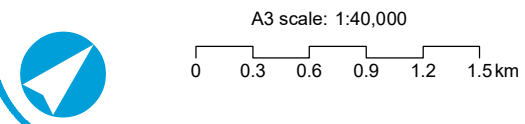
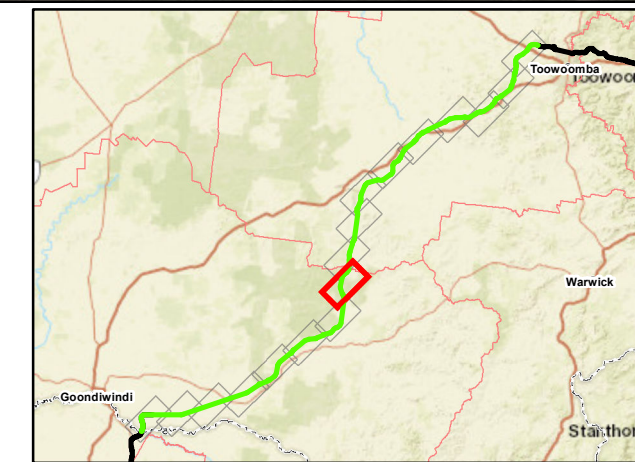


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- | | |
|-----|-----|
| 5.7 | 6.5 |
| 5.9 | 6.7 |
| 6.1 | 6.9 |
| 6.3 | 7.1 |





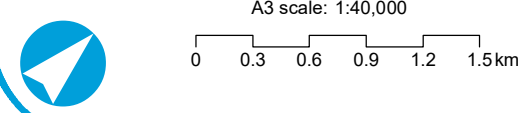
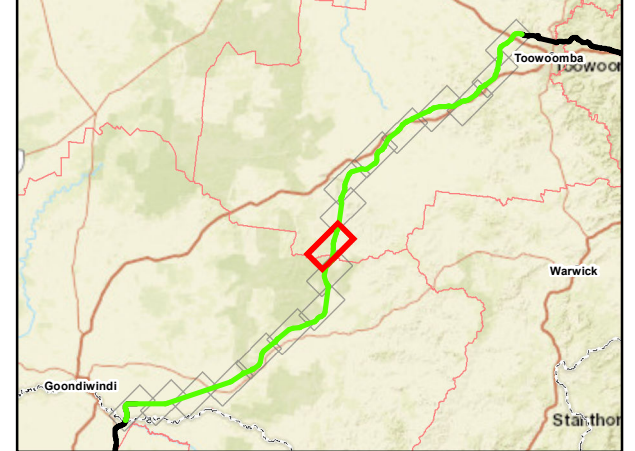
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Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- | | |
|-----|-----|
| 5.7 | 6.5 |
| 5.9 | 6.7 |
| 6.1 | 6.9 |
| 6.3 | 7.1 |



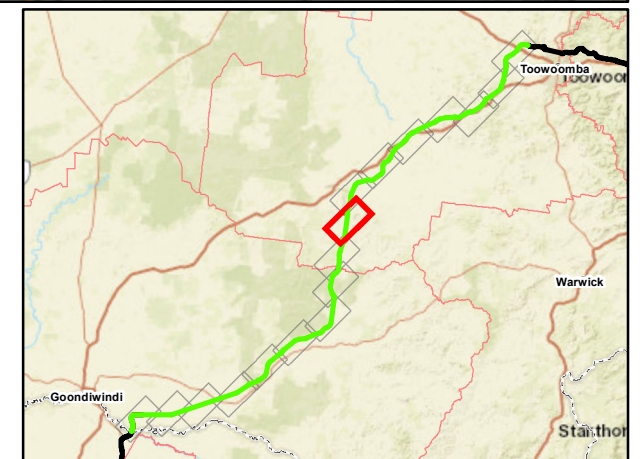


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- | | |
|-----|-----|
| 5.7 | 6.5 |
| 5.9 | 6.7 |
| 6.1 | 6.9 |
| 6.3 | 7.1 |



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



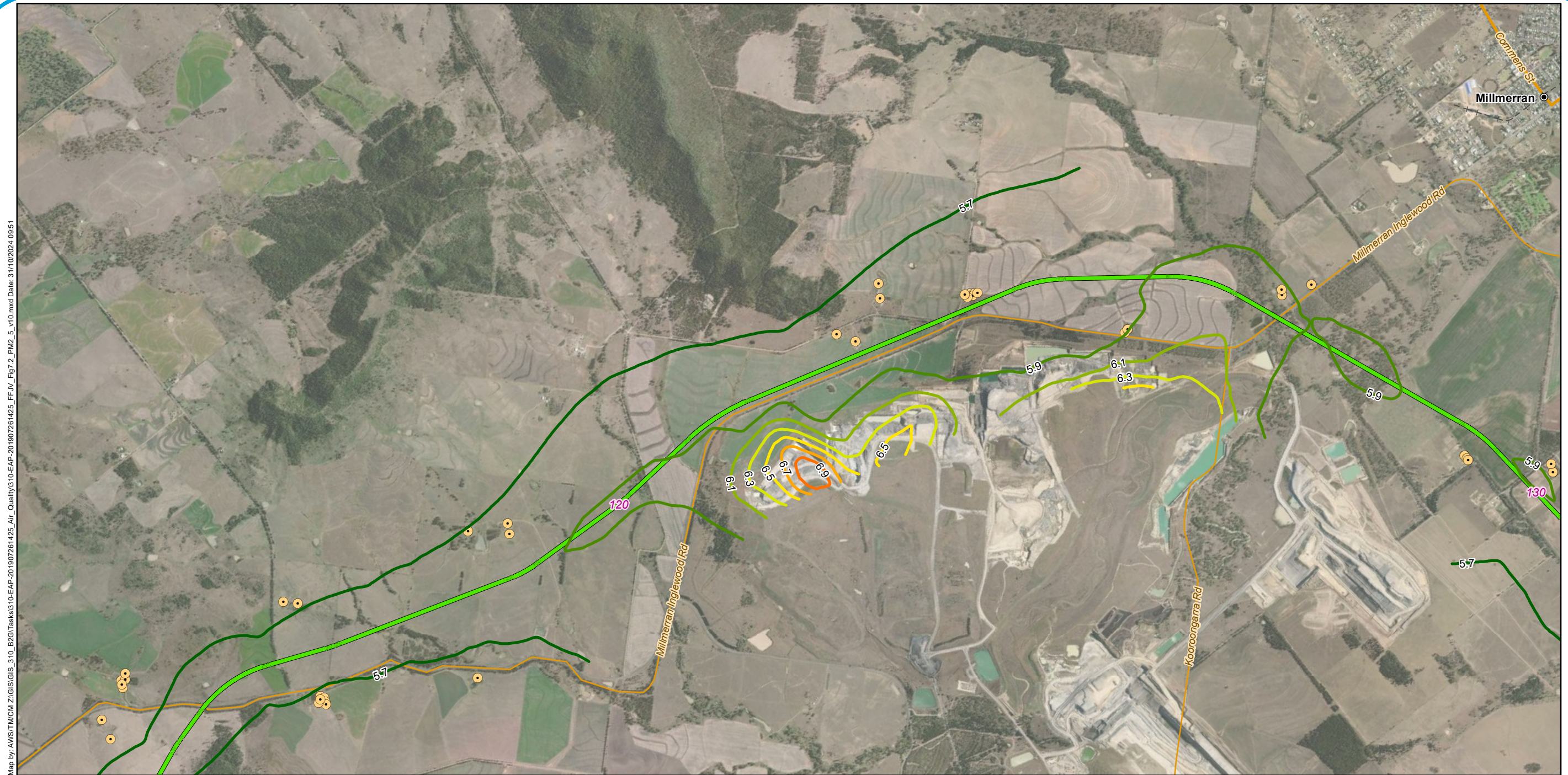
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Border to Gowrie

Figure 7.2j:

Predicted cumulative PM_{2.5} annual average ground level concentration plot



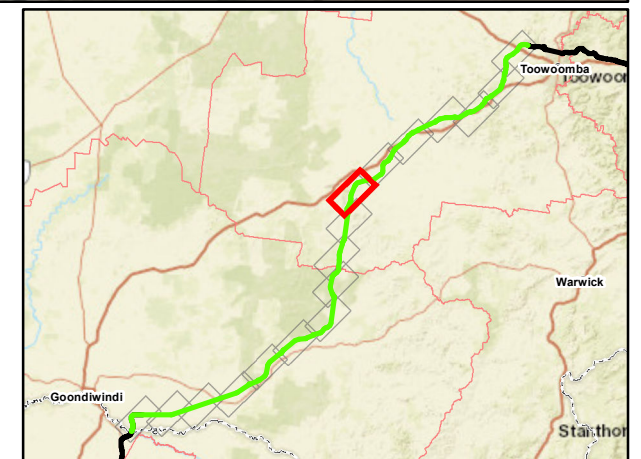
Map by: AWS/TMCM Z:\GIS\GIS_310_B2G\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF JV_Fig7.2_PM2.5_v10.mxd Date: 31/10/2024 09:51

Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- - - Existing rail (non-operational)
- Major roads
- Minor roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- | | |
|-----|-----|
| 5.7 | 6.5 |
| 5.9 | 6.7 |
| 6.1 | 6.9 |
| 6.3 | 7.1 |



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km

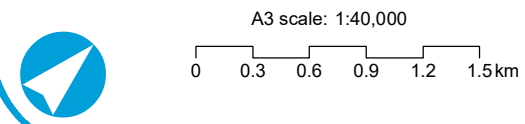


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- - - Existing rail (non-operational)
- Major roads
- Minor roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

5.7	6.5
5.9	6.7
6.1	6.9
6.3	7.1





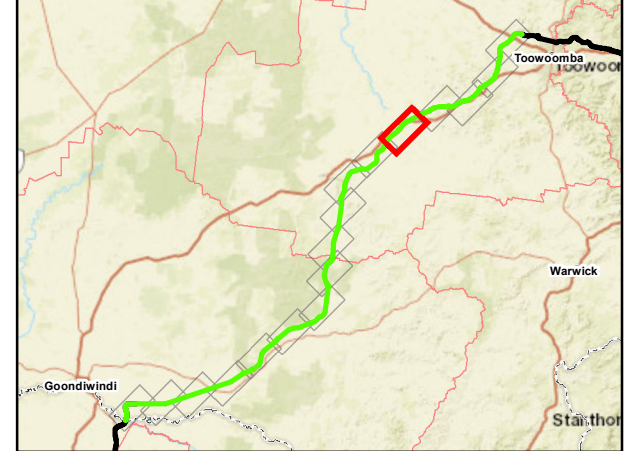
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Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- - - Existing rail (non-operational)
- Major roads
- Minor roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- 5.7
- 5.9
- 6.1
- 6.3
- 6.5
- 6.7
- 6.9
- 7.1



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 7.2m:

Predicted cumulative PM_{2.5} annual average ground level concentration plot



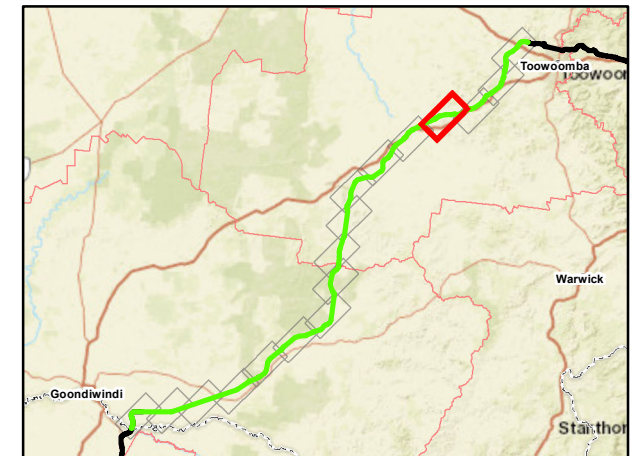
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Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- | | |
|-----|-----|
| 5.7 | 6.5 |
| 5.9 | 6.7 |
| 6.1 | 6.9 |
| 6.3 | 7.1 |



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 7.2n:

Predicted cumulative PM_{2.5} annual average ground level concentration plot



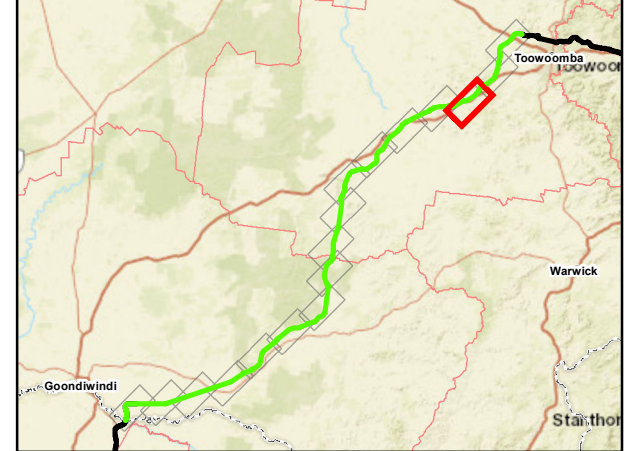
Map by: AWS/TMCM Z:\GIS\GIS_310_B2G\Tasks\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_Air_Quality\Fig7.2_PM2.5_v10.mxd Date: 31/10/2024 09:51

Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- 5.7
- 5.9
- 6.1
- 6.3
- 6.5
- 6.7
- 6.9
- 7.1



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km

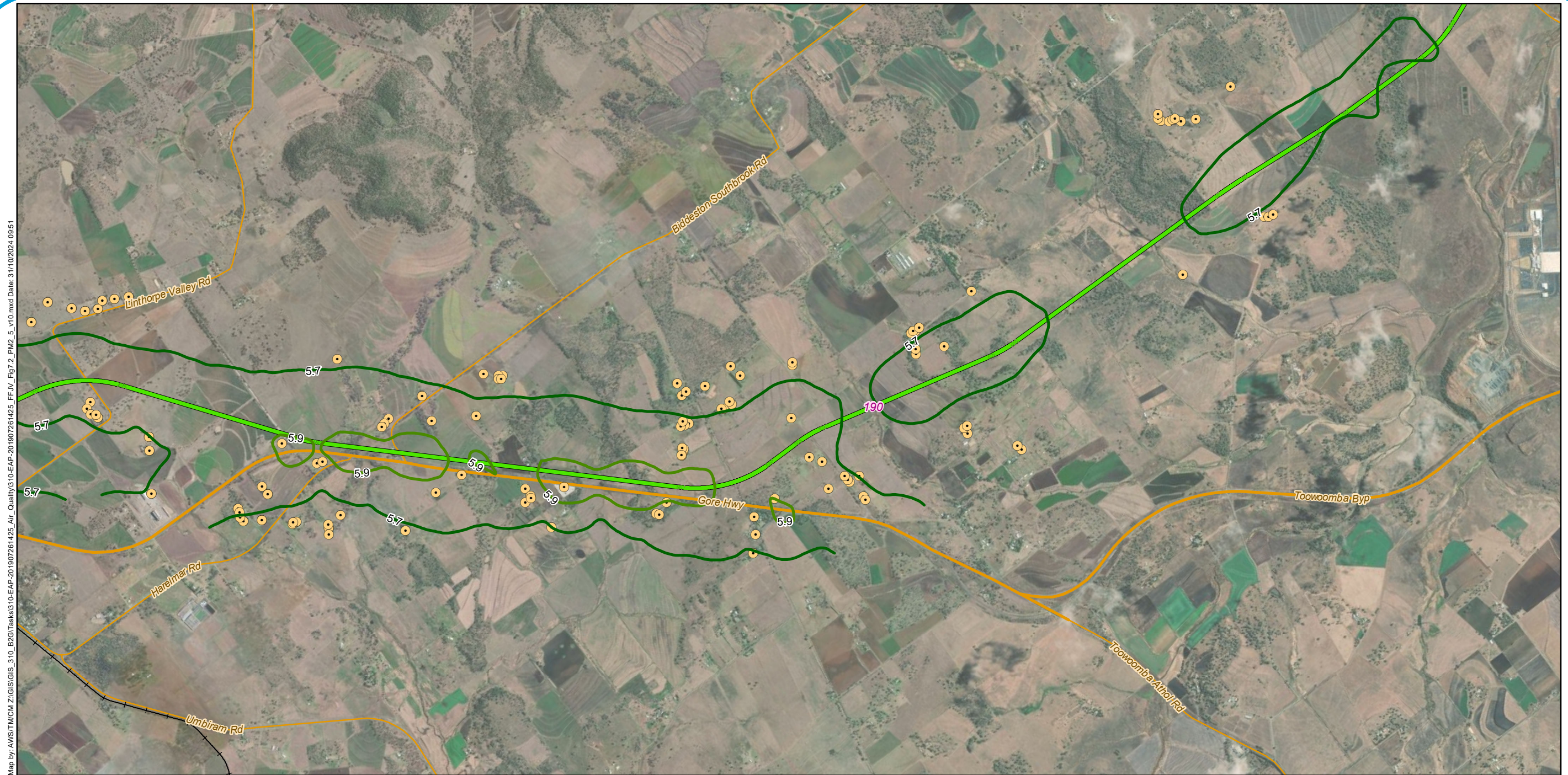


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Border to Gowrie

Figure 7.2o:

Predicted cumulative PM_{2.5} annual average ground level concentration plot



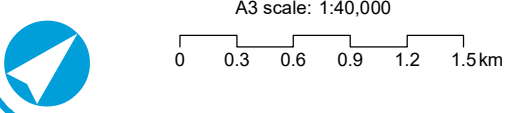
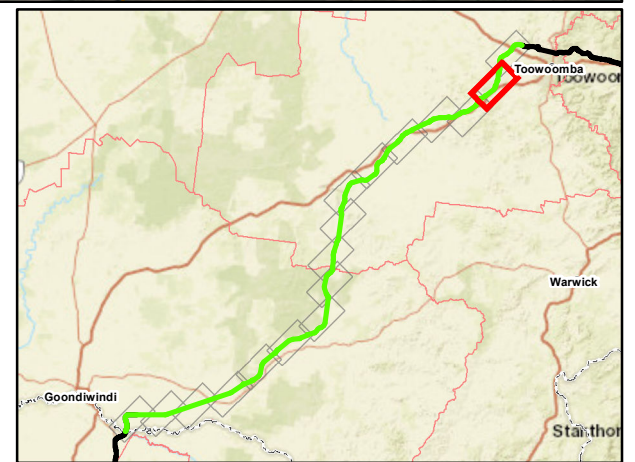
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Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- 5.7
- 5.9
- 6.1
- 6.3
- 6.5
- 6.7
- 6.9
- 7.1



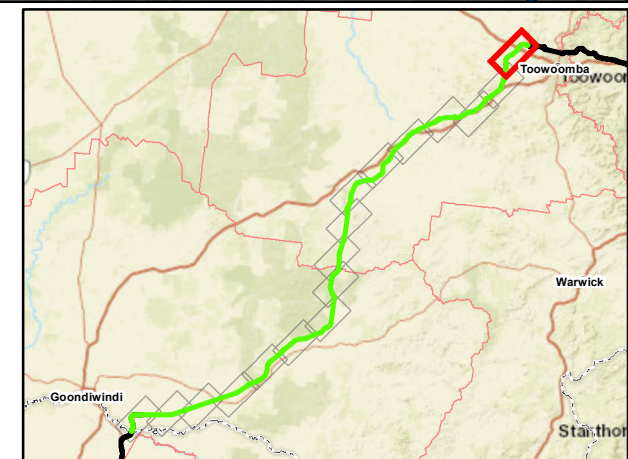


Legend

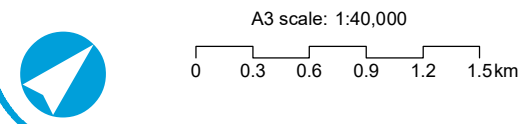
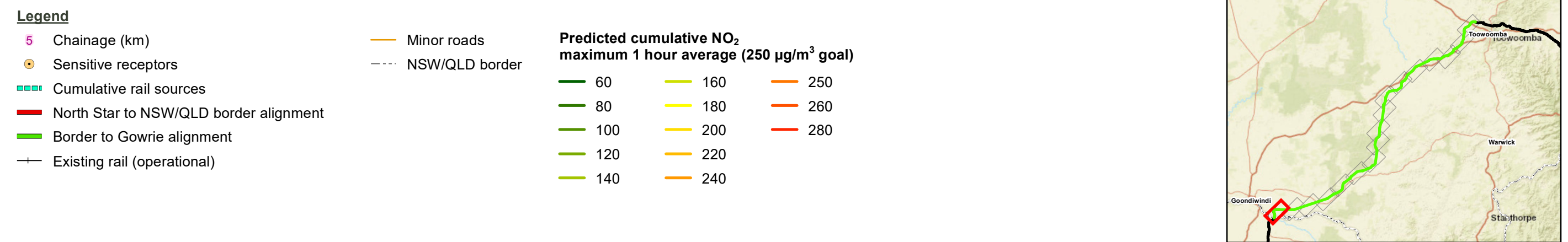
- 5 Chainage (km)
- Sensitive receptors
- Localities
- ▬ Cumulative rail sources
- ▬ Crossing loops
- ▬ Border to Gowrie alignment
- ▬ Gowrie to Helidon alignment
- Existing rail (operational)
- ▬ Major roads
- ▬ Minor roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- | | |
|-----|-----|
| 5.7 | 6.5 |
| 5.9 | 6.7 |
| 6.1 | 6.9 |
| 6.3 | 7.1 |



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km





Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- Minor roads
- NSW/QLD border

Predicted cumulative NO₂ maximum 1 hour average (250 µg/m³ goal)

60	160	250
80	180	260
100	200	280
120	220	
140	240	



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5km



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Border to Gowrie

Figure 7.3b:

Predicted cumulative NO₂ maximum 1 hour average ground level concentration plot



Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads
- NSW/QLD border

Predicted cumulative NO₂ maximum 1 hour average (250 µg/m³ goal)

60	160	250
80	180	260
100	200	280
120	220	
140	240	



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5km



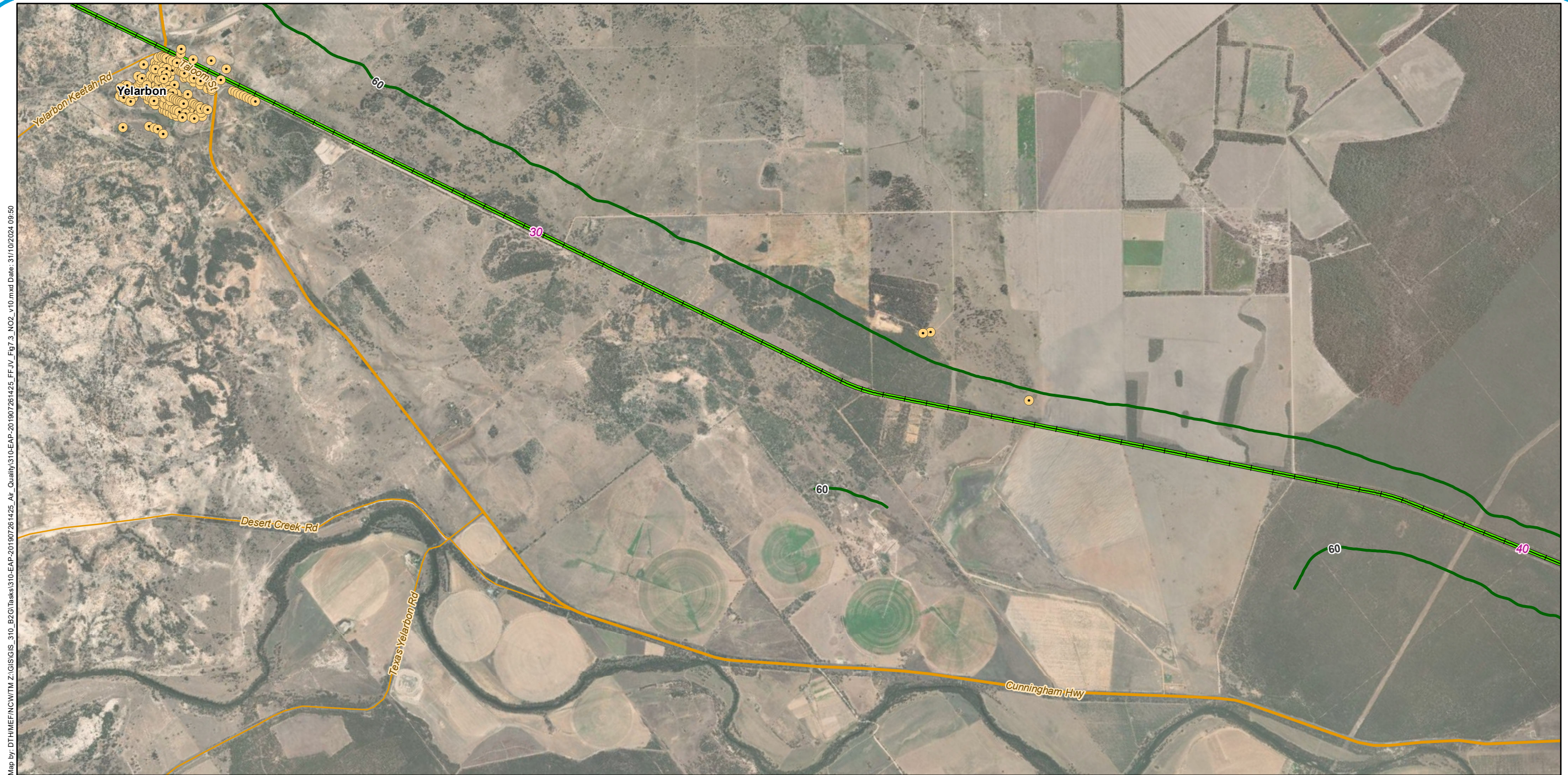
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Border to Gowrie

Figure 7.3c:

Predicted cumulative NO₂ maximum 1 hour average ground level concentration plot

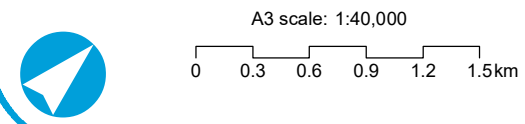
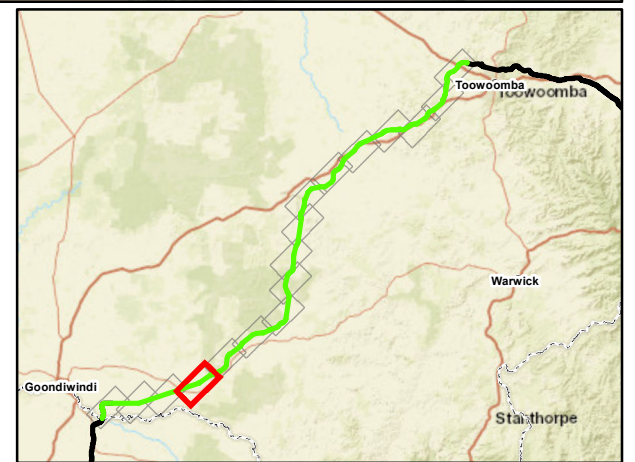


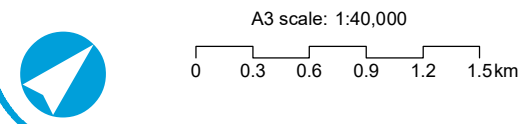
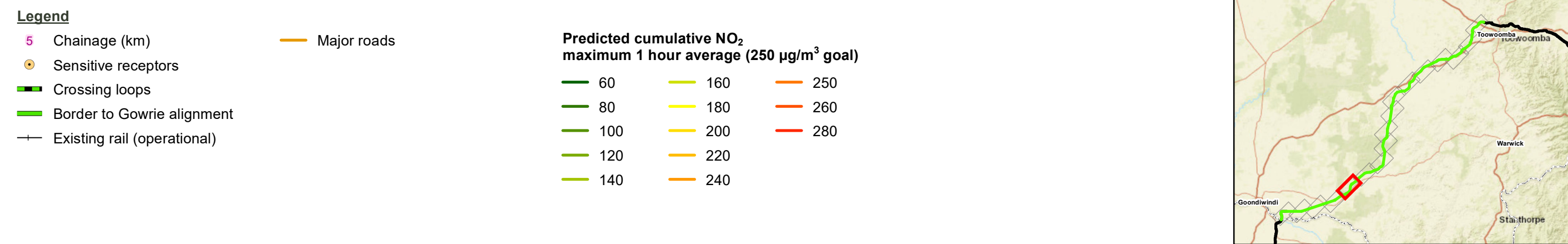
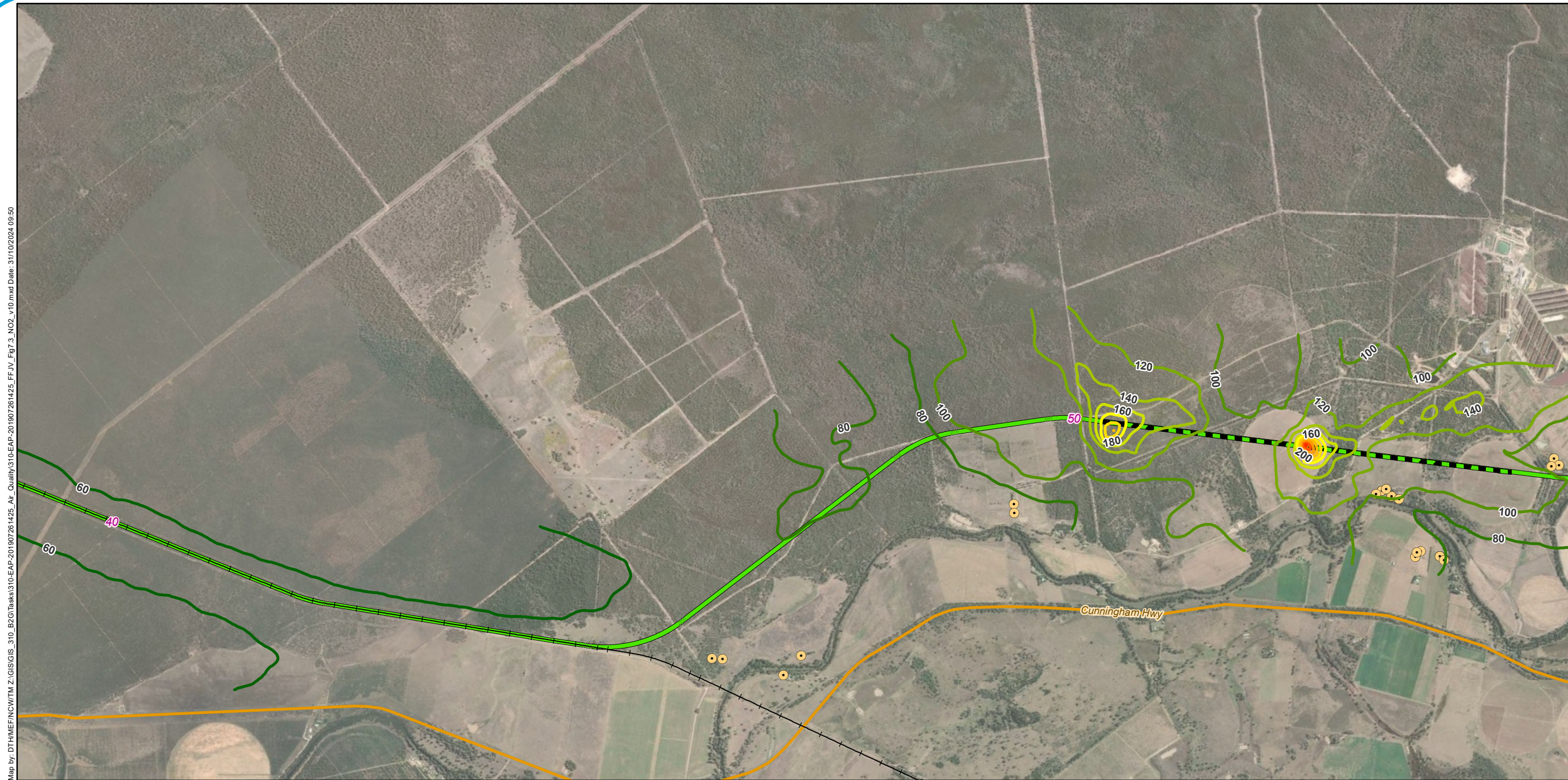
Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative NO₂ maximum 1 hour average (250 µg/m³ goal)

60	160	250
80	180	260
100	200	280
120	220	
140	240	





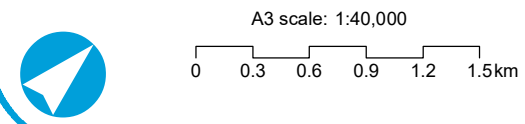
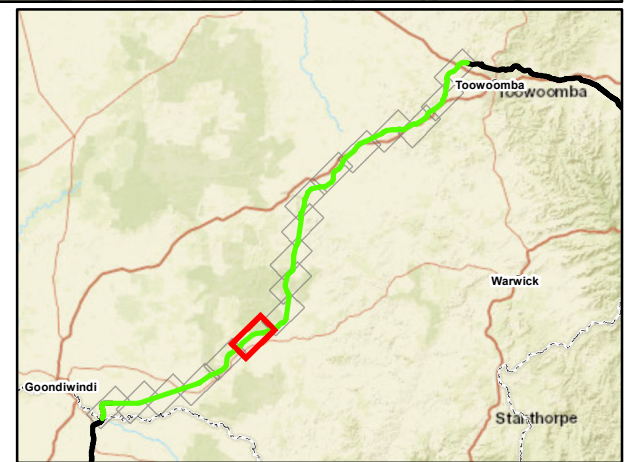


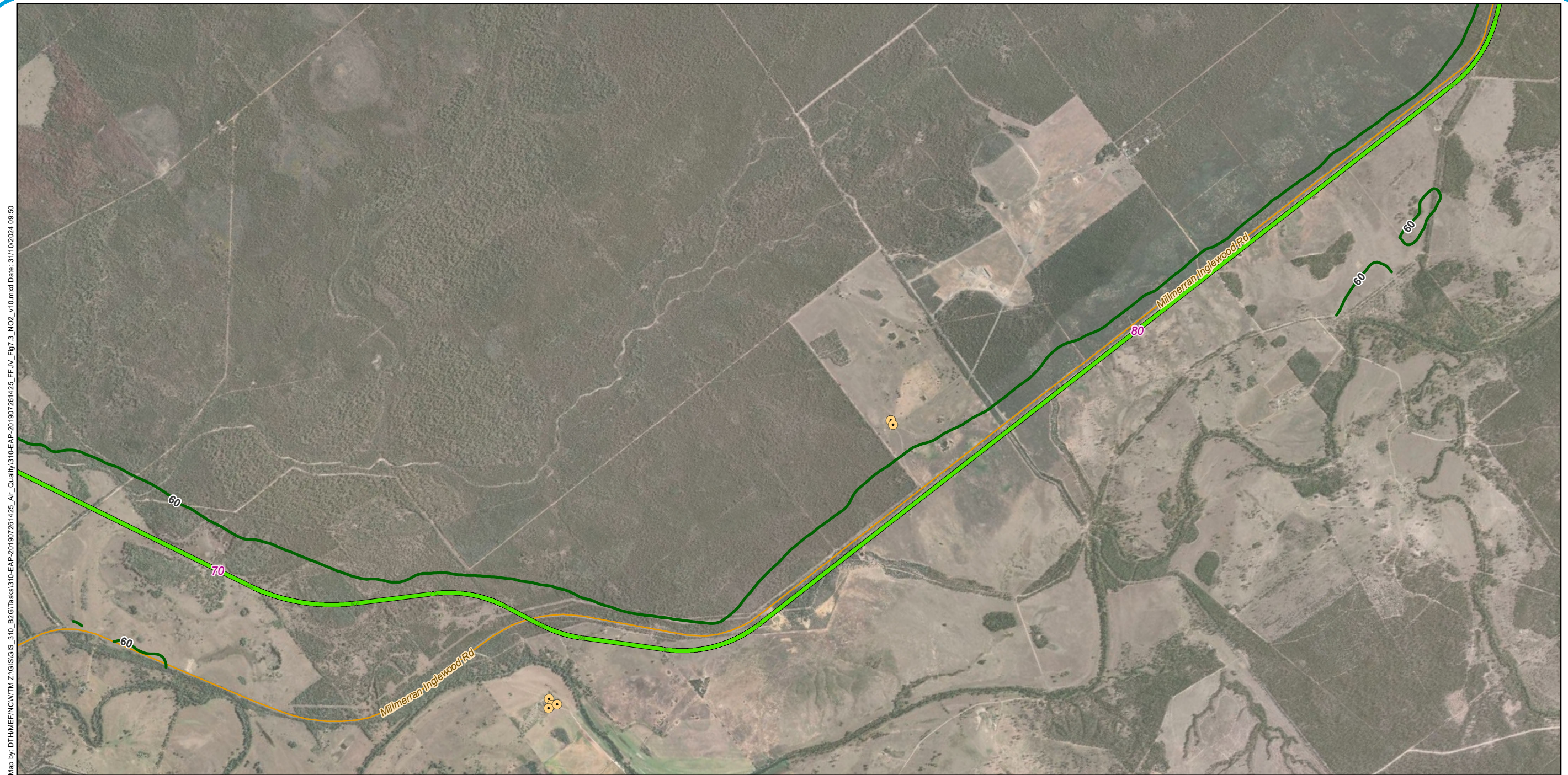
Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads

Predicted cumulative NO₂ maximum 1 hour average (250 µg/m³ goal)

60	160	250
80	180	260
100	200	280
120	220	
140	240	





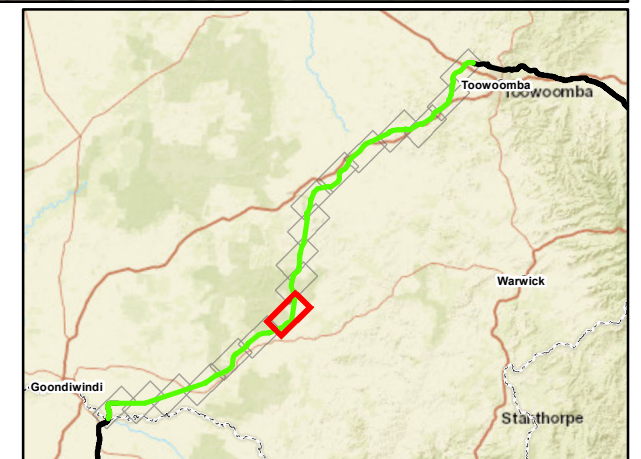
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Legend

- 5 Chainage (km)
- Sensitive receptors
- Border to Gowrie alignment
- Minor roads

Predicted cumulative NO₂ maximum 1 hour average (250 µg/m³ goal)

60	160	250
80	180	260
100	200	280
120	220	
140	240	



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5km



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Border to Gowrie

Figure 7.3g:

Predicted cumulative NO₂ maximum 1 hour average ground level concentration plot

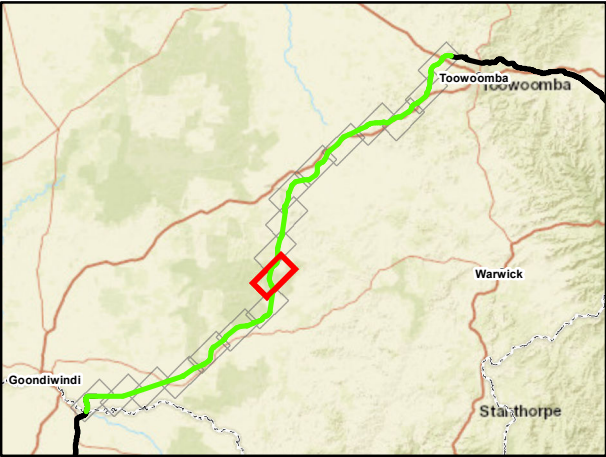


Legend

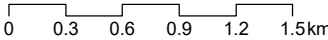
- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

Predicted cumulative NO₂ maximum 1 hour average (250 µg/m³ goal)

60	160	250
80	180	260
100	200	280
120	220	
140	240	



A3 scale: 1:40,000



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Border to Gowrie

Figure 7.3h:

Predicted cumulative NO₂ maximum 1 hour average ground level concentration plot

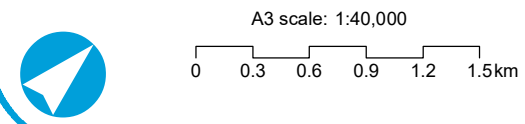
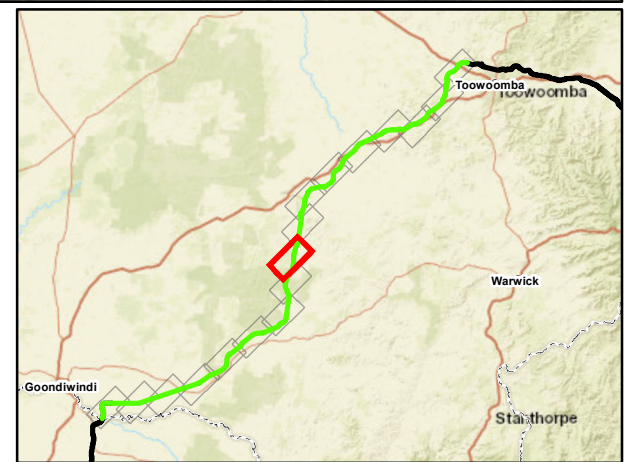


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

Predicted cumulative NO₂ maximum 1 hour average (250 µg/m³ goal)

60	160	250
80	180	260
100	200	280
120	220	
140	240	



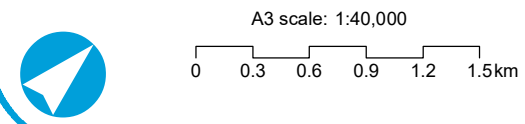
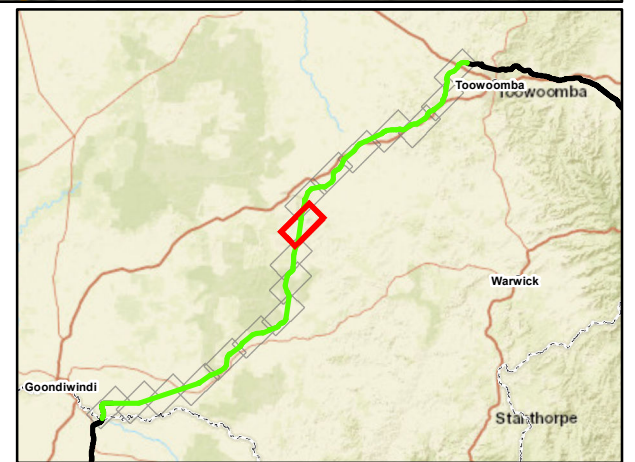


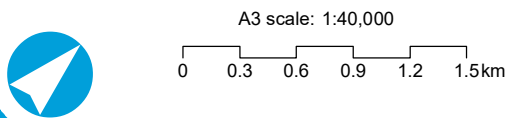
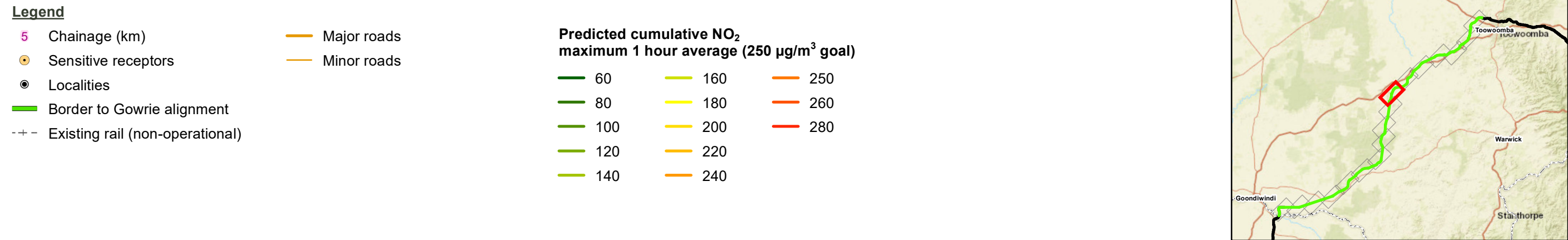
Legend

- 5 Chainage (km)
- Sensitive receptors
- Border to Gowrie alignment
- Minor roads

Predicted cumulative NO₂ maximum 1 hour average (250 µg/m³ goal)

60	160	250
80	180	260
100	200	280
120	220	
140	240	





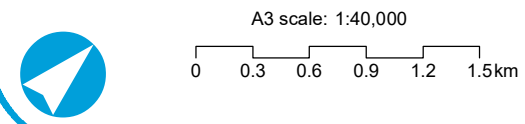
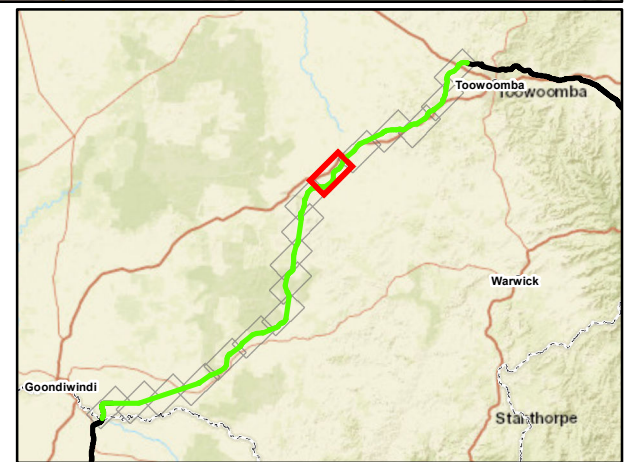


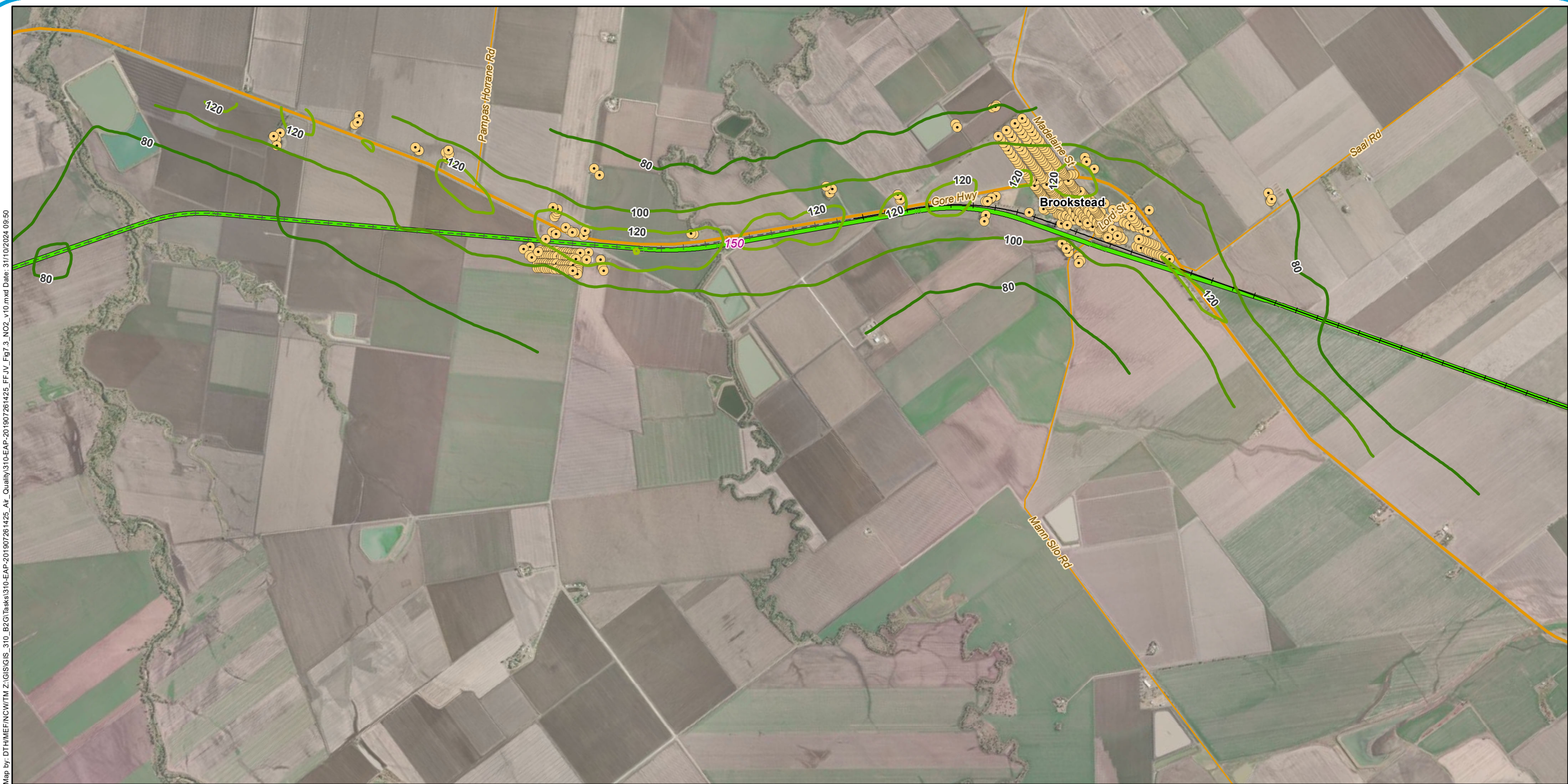
Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (non-operational)
- Major roads
- Minor roads

Predicted cumulative NO₂ maximum 1 hour average (250 µg/m³ goal)

60	160	250
80	180	260
100	200	280
120	220	
140	240	



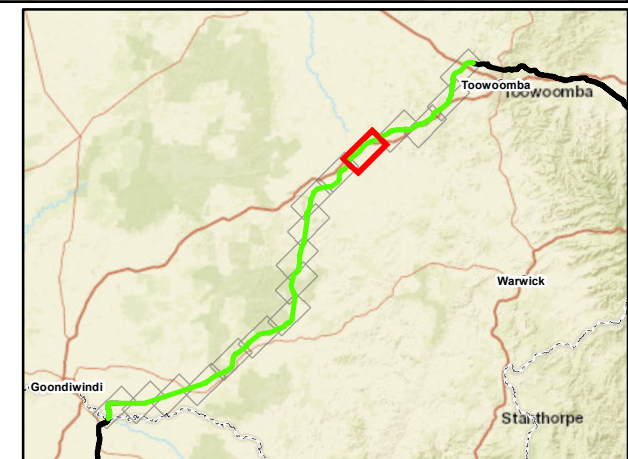


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Minor roads

Predicted cumulative NO₂ maximum 1 hour average (250 µg/m³ goal)

60	160	250
80	180	260
100	200	280
120	220	
140	240	



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 7.3m:

Predicted cumulative NO₂ maximum 1 hour average ground level concentration plot

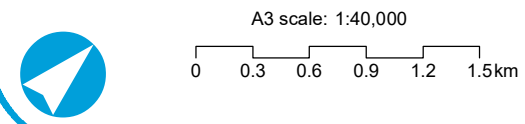
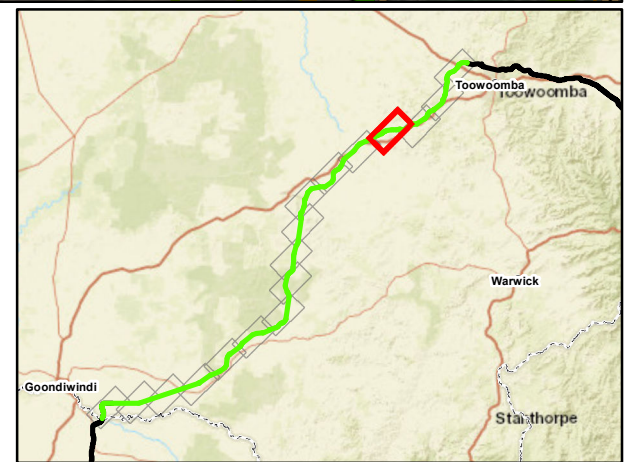


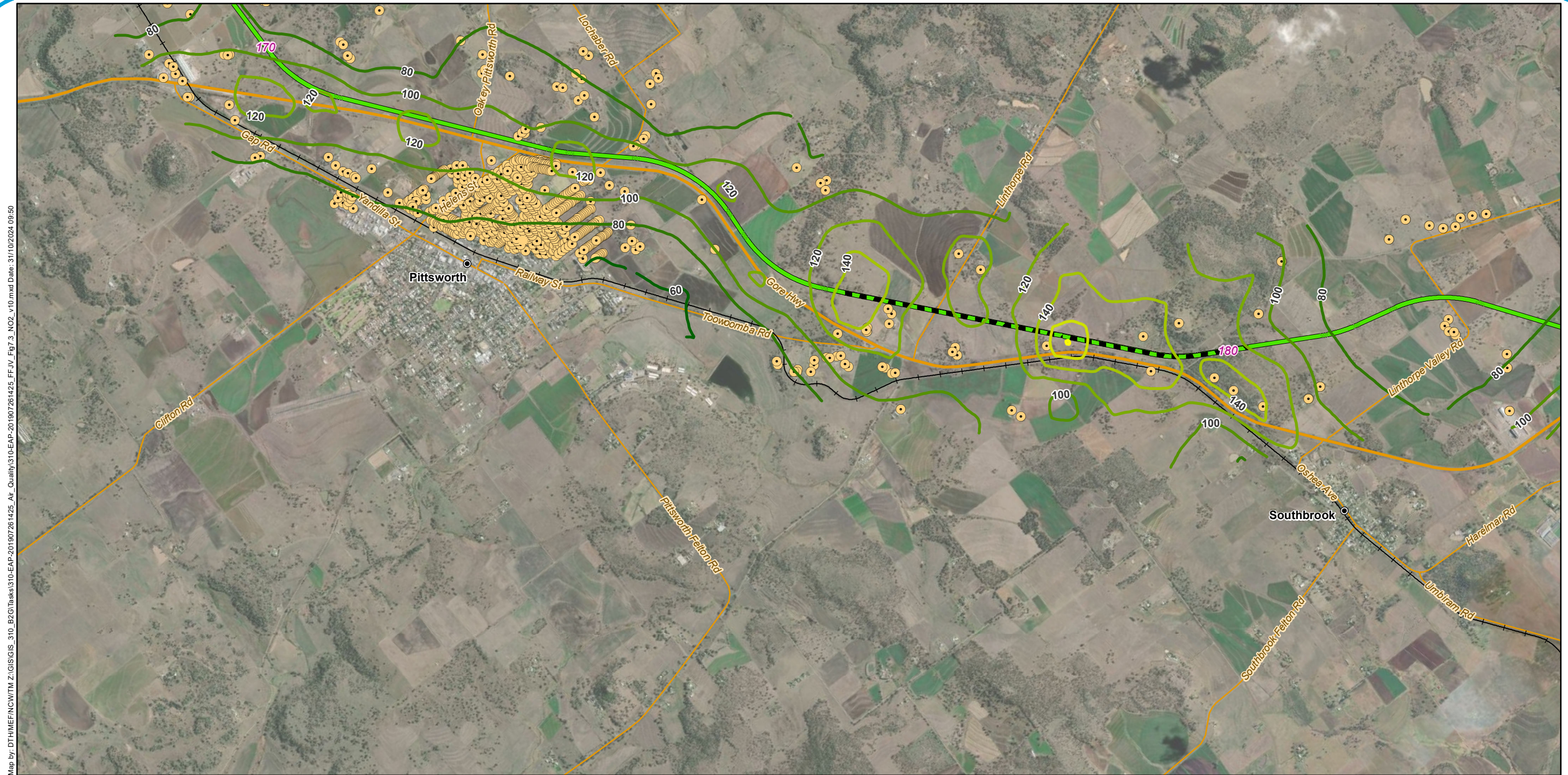
Legend

- 5 Chainage (km)
- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative NO₂ maximum 1 hour average (250 µg/m³ goal)

60	160	250
80	180	260
100	200	280
120	220	
140	240	



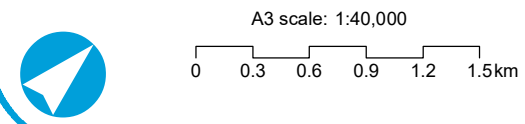
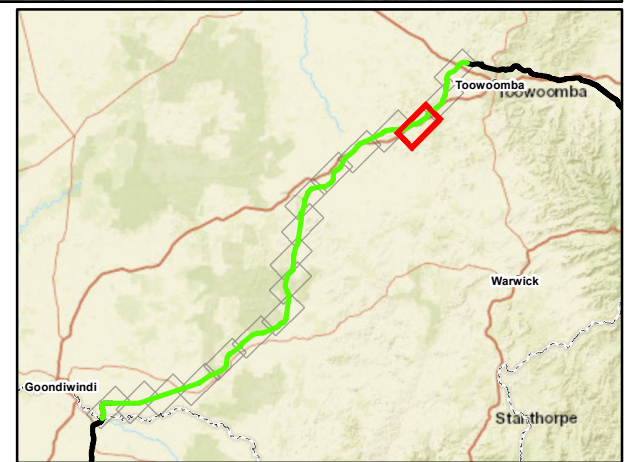


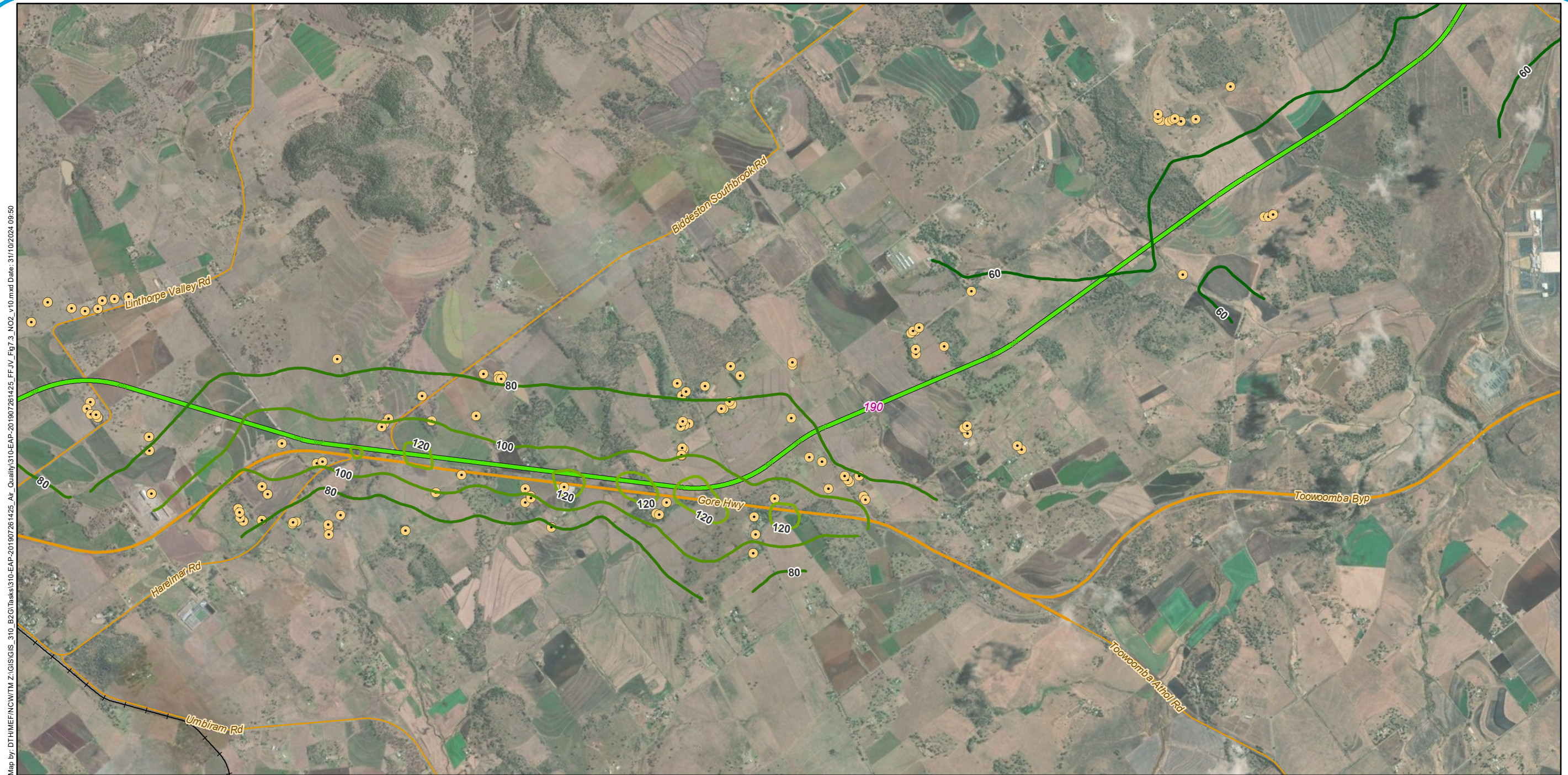
Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative NO₂ maximum 1 hour average (250 µg/m³ goal)

60	160	250
80	180	260
100	200	280
120	220	
140	240	



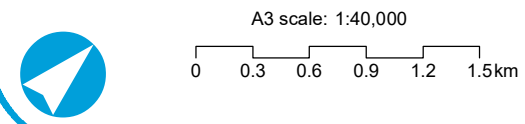
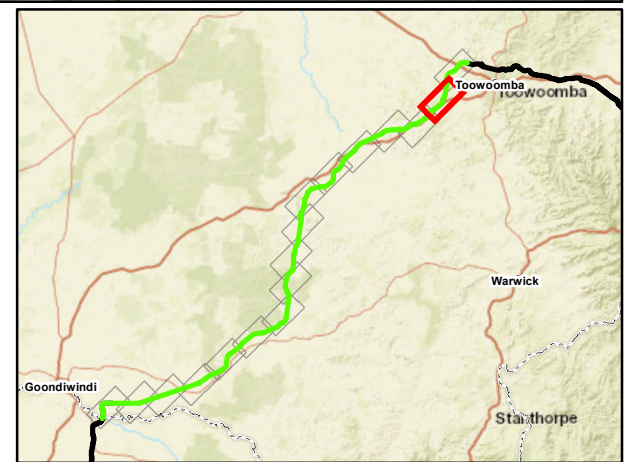


Legend

- 5 Chainage (km)
- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative NO₂ maximum 1 hour average (250 µg/m³ goal)

60	160	250
80	180	260
100	200	280
120	220	
140	240	





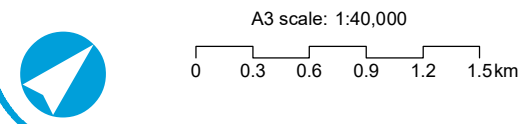
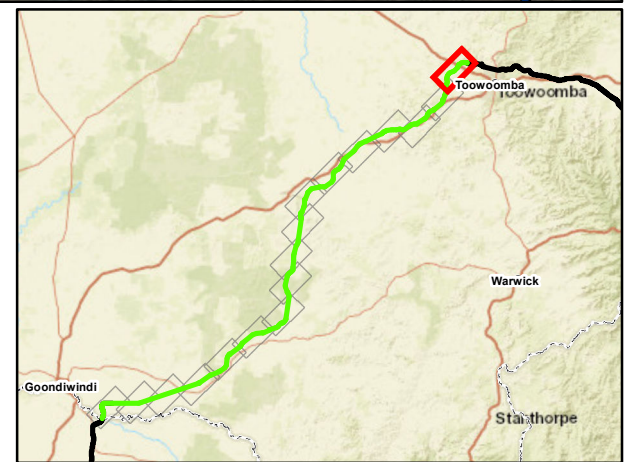
Map by: DTH/MEF/NCW/ITM 2:GIS/ISIS_310_B2G/Task/310-EAP-201907261425_Air_Quality/310-EAP-201907261425_FF JV_Fig 7.3_NO2_v10.mxd Date: 31/10/2024 09:50

Legend

- 5 Chainage (km)
- Sensitive receptors
- Cumulative rail sources
- Localities
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative NO₂ maximum 1 hour average (250 µg/m³ goal)

60	160	250
80	180	260
100	200	280
120	220	
140	240	



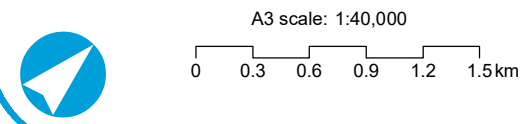
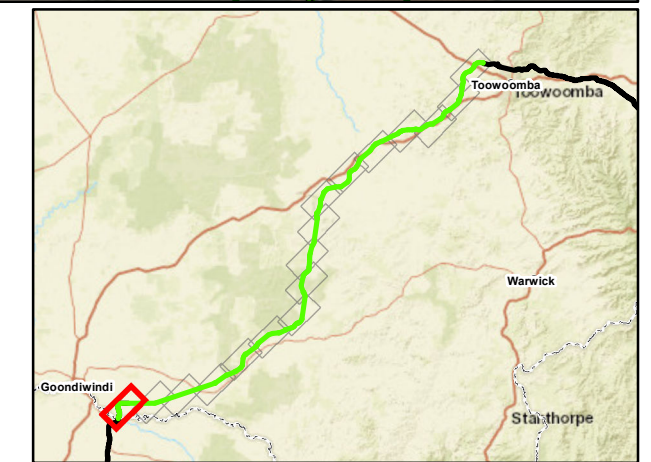


Legend

- 5 Chainage (km)
- Sensitive receptors
- Cumulative rail sources
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Existing rail (operational)
- Minor roads
- NSW/QLD border

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	





Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- Minor roads
- NSW/QLD border

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km

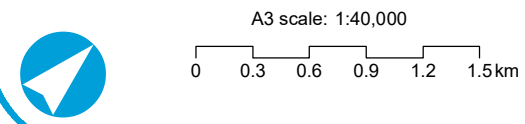
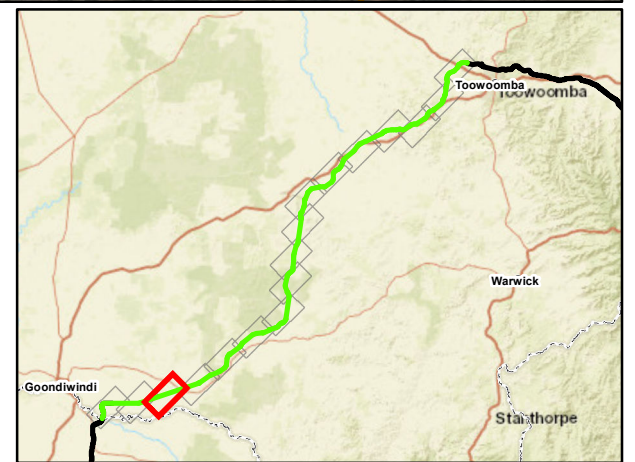


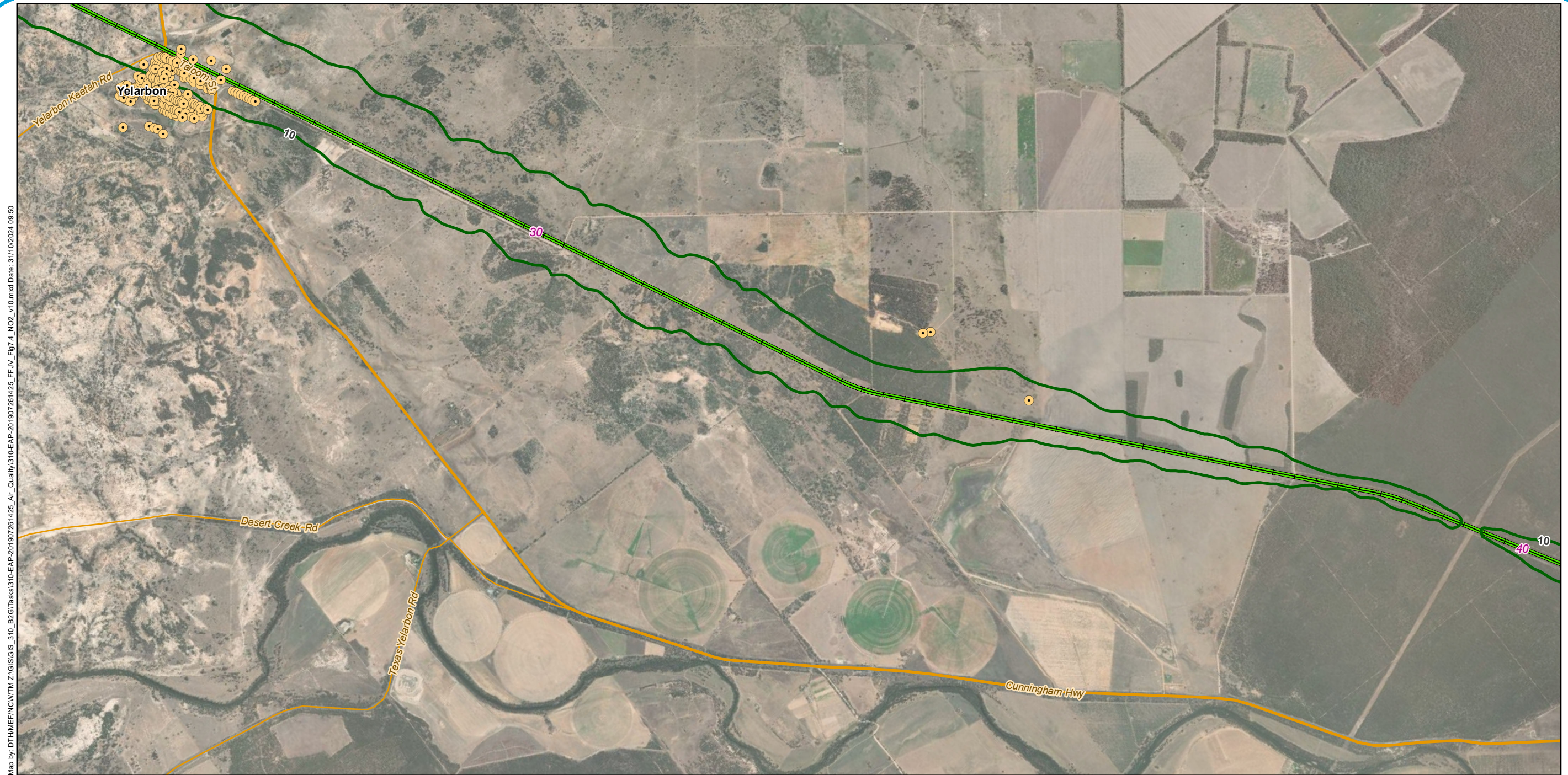
Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads
- NSW/QLD border

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	



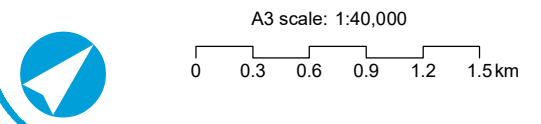
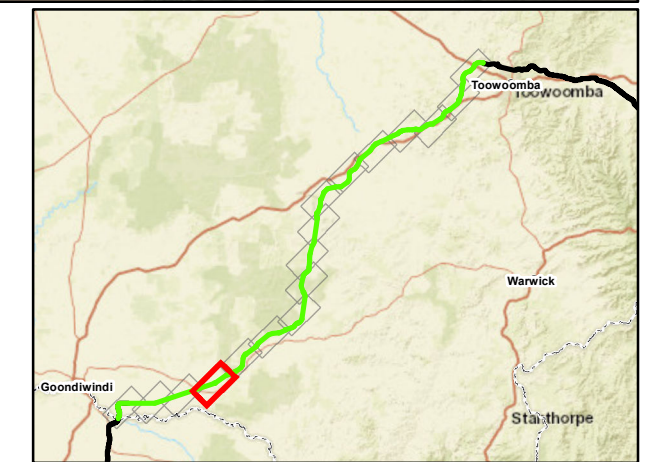


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	



Map by: D:\HME\IN\W\TM 2\GIS\GIS_310_B2\GIS\Task\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF_VJ_Fig7.4_NO2_v10.mxd Date: 31/10/2024 09:50

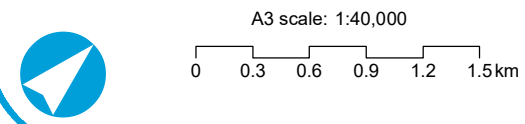
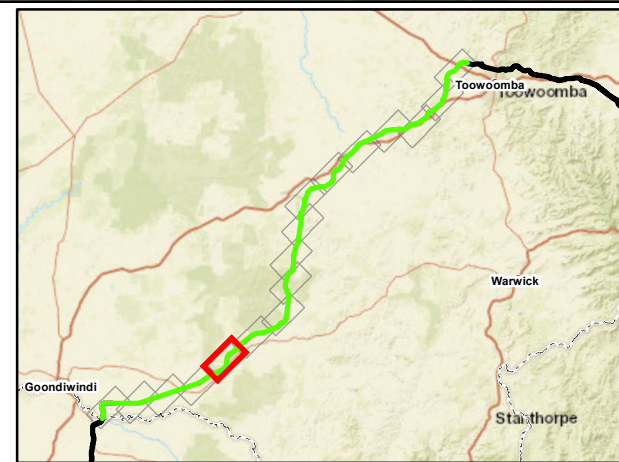


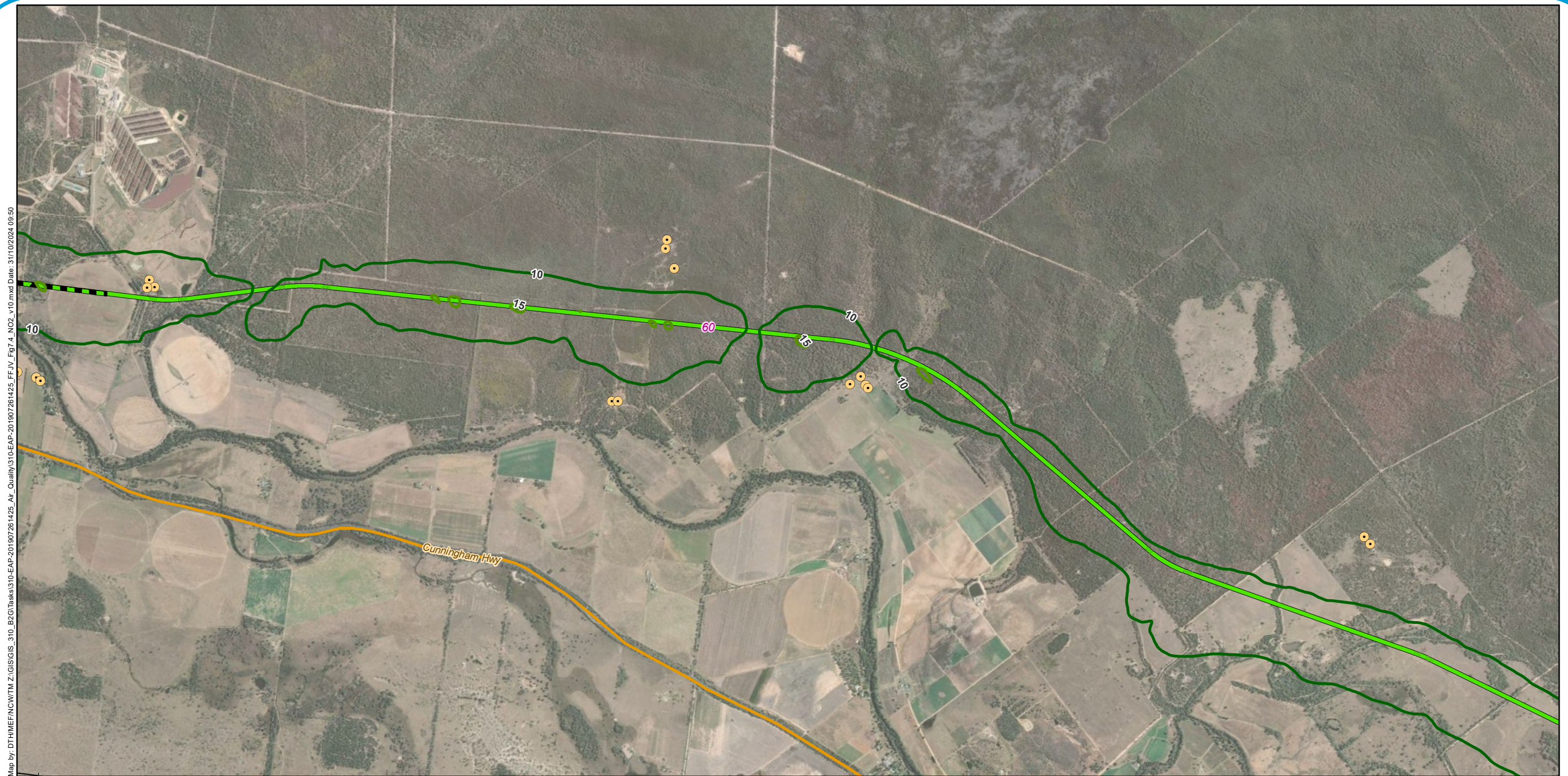
Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	



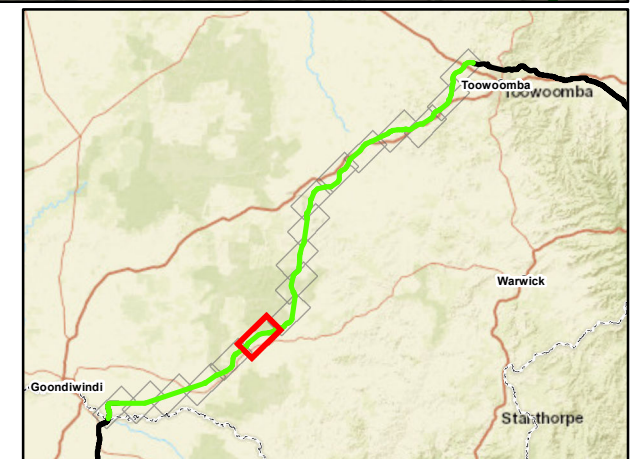


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



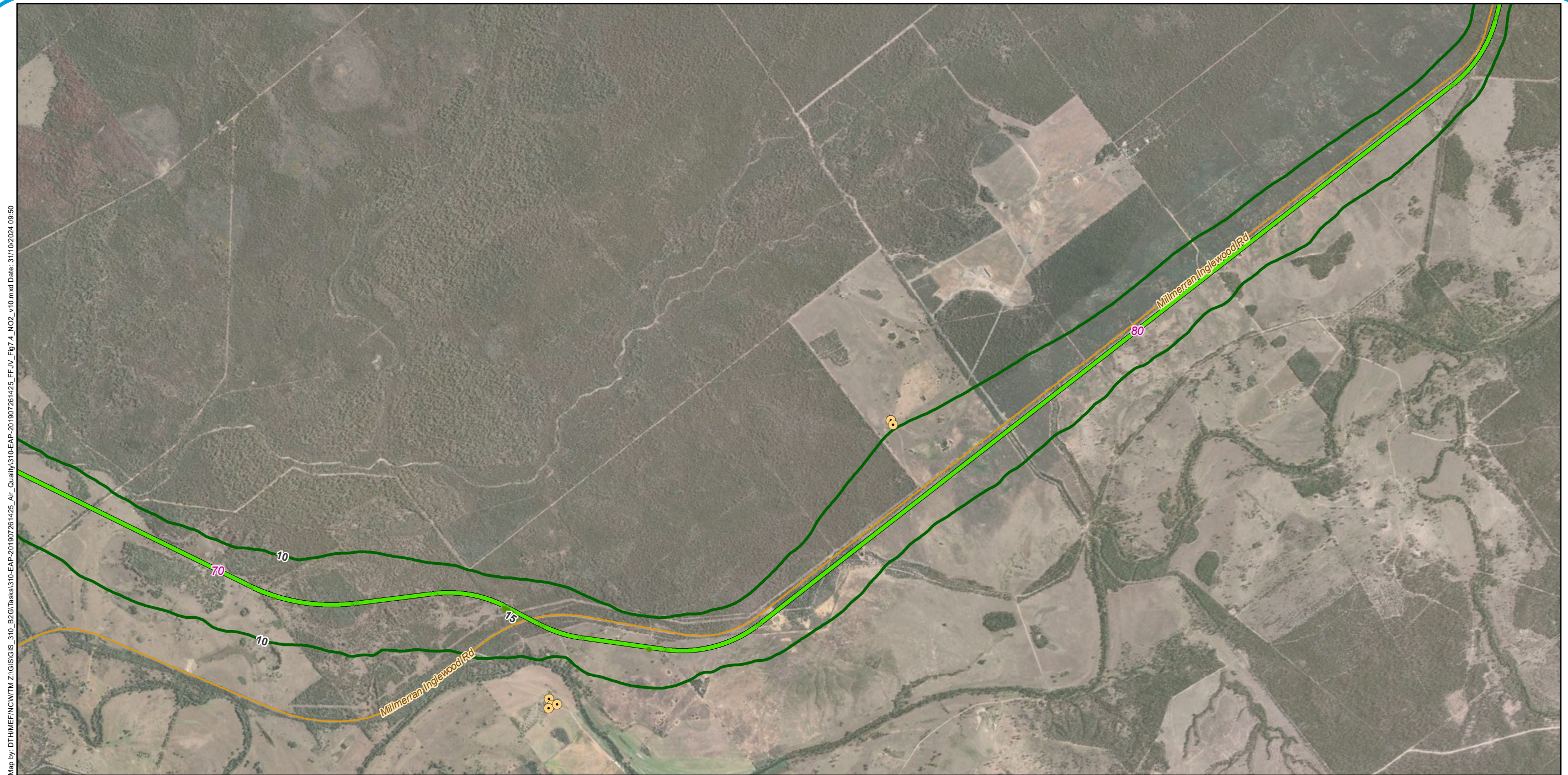
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Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 7.4f:

Predicted cumulative NO₂ annual average ground level concentration plot

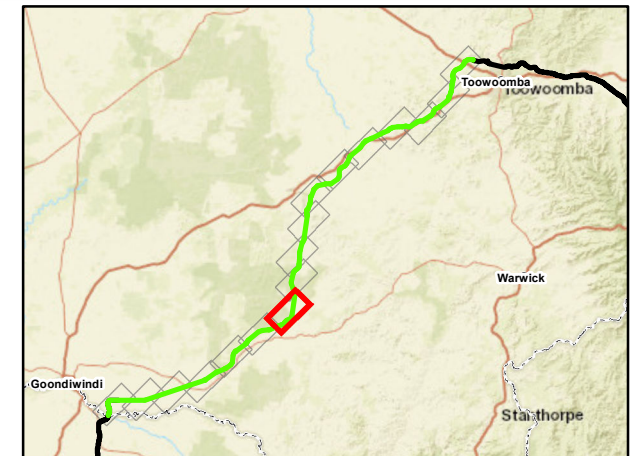


Legend

- 5 Chainage (km)
- Sensitive receptors
- Border to Gowrie alignment
- Minor roads

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 7.4g:

Predicted cumulative NO₂ annual average ground level concentration plot

Map by: D:\HMEF\NC\W\TM 2\GIS\GIS_310_B2G\Task\310-EAP-201907261425_A\ Qualif\310-EAP-201907261425_FF\JV_Fig7.4_NO2_v10.mxd Date: 31/10/2024 09:50

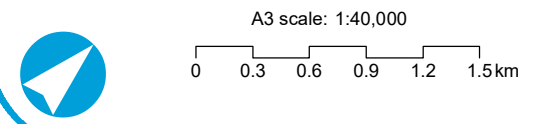
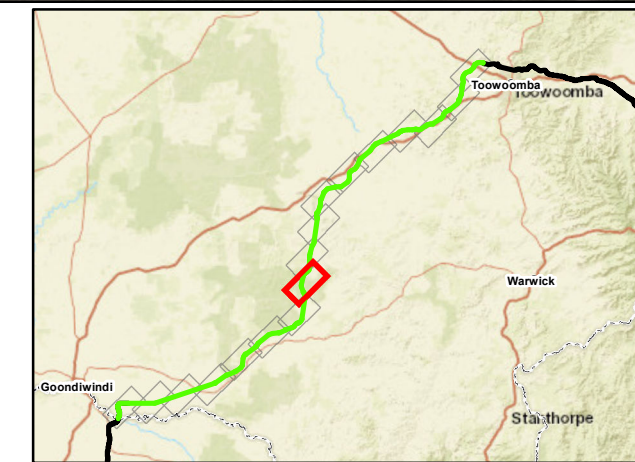


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	



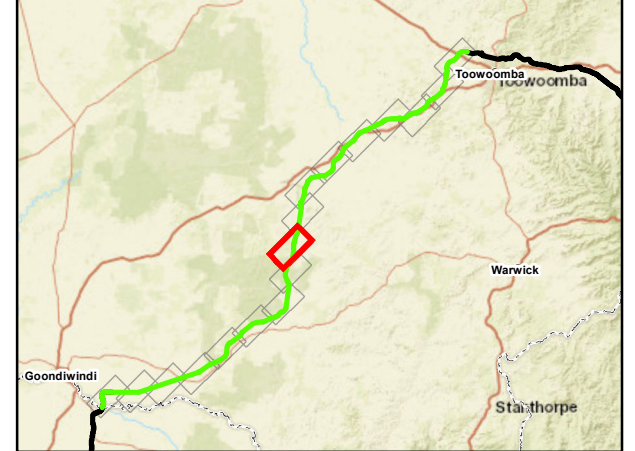


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km

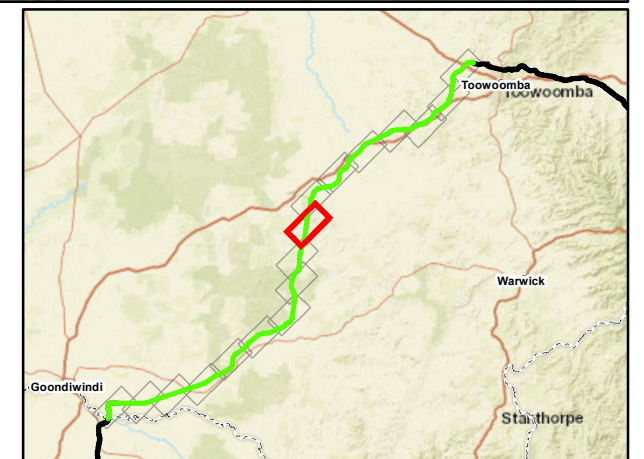


Legend

- 5 Chainage (km)
- Sensitive receptors
- Border to Gowrie alignment
- Minor roads

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5km

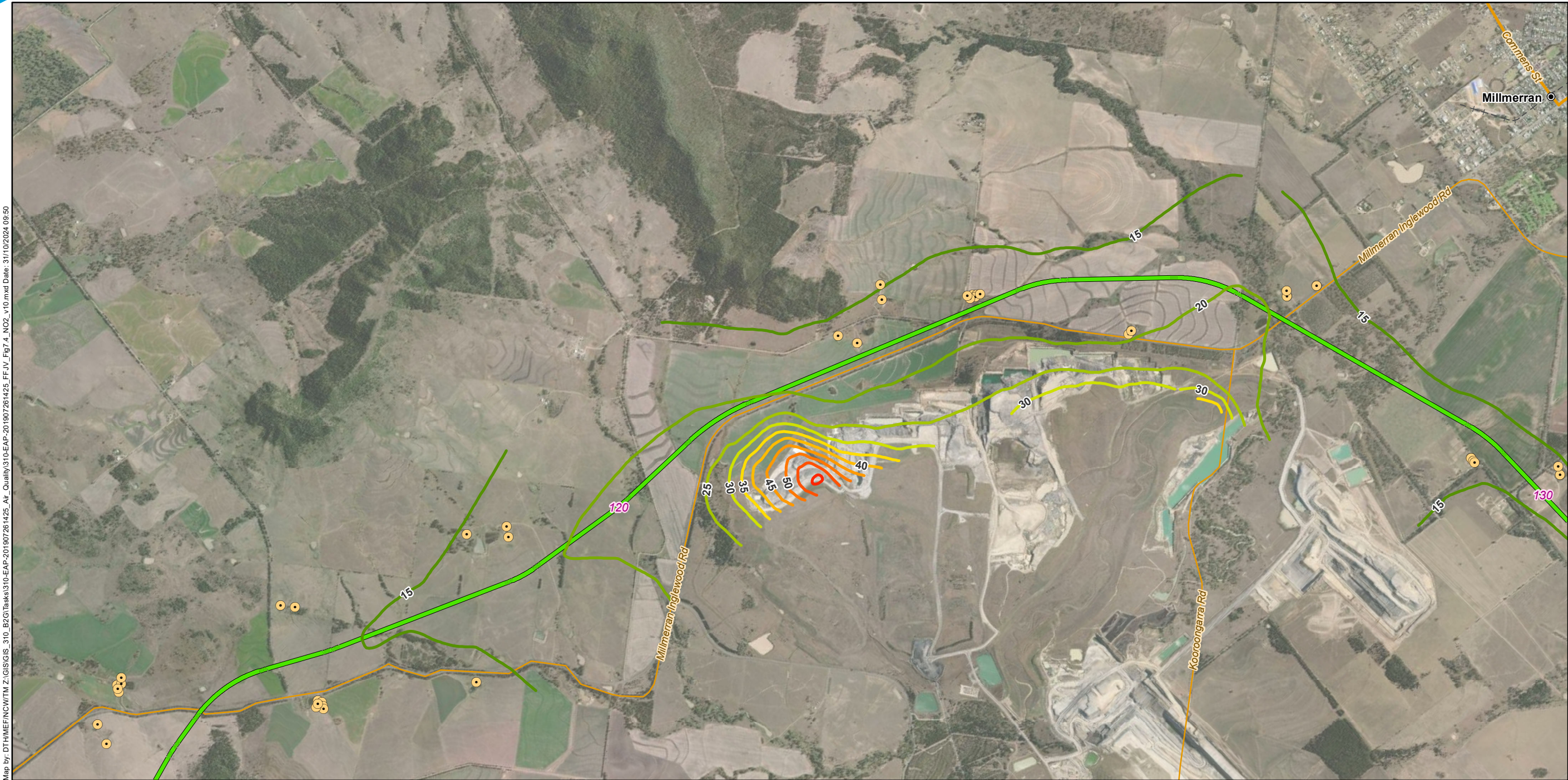


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Border to Gowrie

Figure 7.4j:

Predicted cumulative NO₂ annual average ground level concentration plot

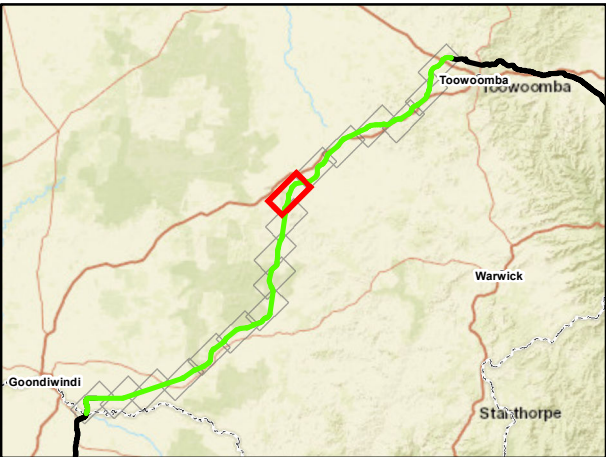


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Border to Gowrie alignment
- + - Existing rail (non-operational)
- Major roads
- Minor roads

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 7.4k:

Predicted cumulative NO₂ annual average ground level concentration plot

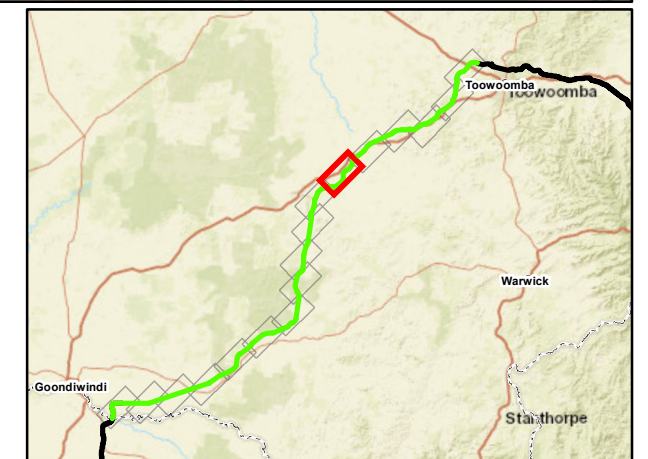


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (non-operational)
- Major roads
- Minor roads

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 7.41:

Predicted cumulative NO₂ annual average ground level concentration plot

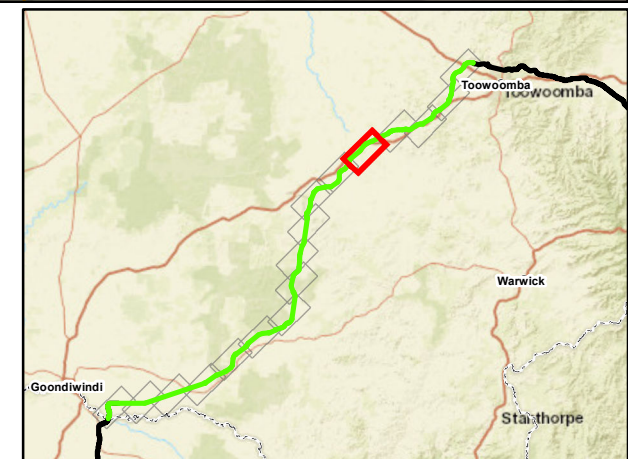


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Border to Gowrie alignment
- Existing rail (operational)
- - - Existing rail (non-operational)
- Major roads
- Minor roads

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 7.4m:

Predicted cumulative NO₂ annual average ground level concentration plot

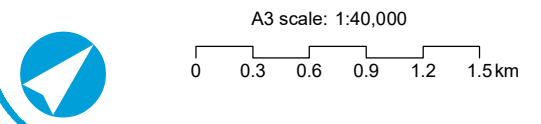
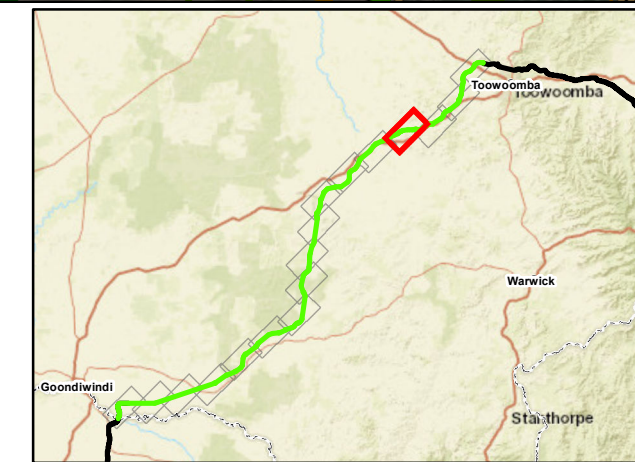


Legend

- 5 Chainage (km)
- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	



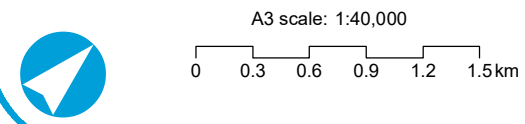
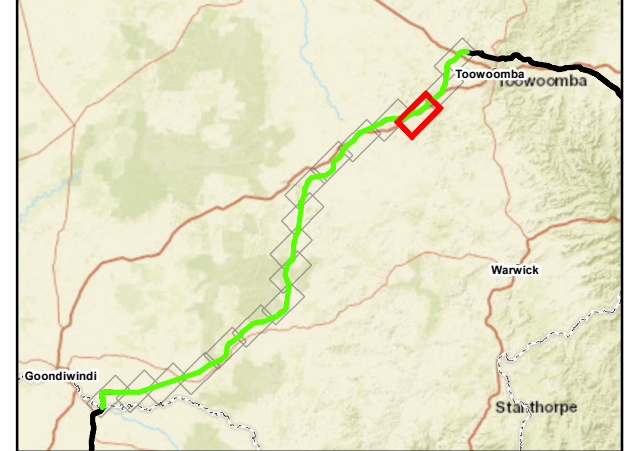


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	



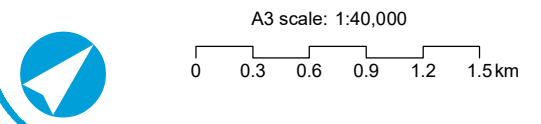
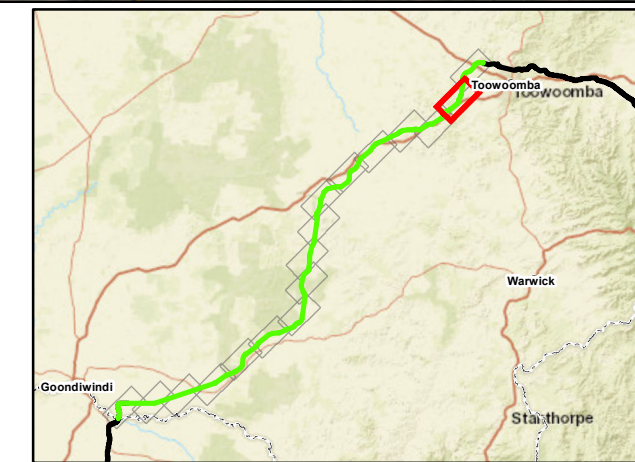


Legend

- 5 Chainage (km)
- Sensitive receptors
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	





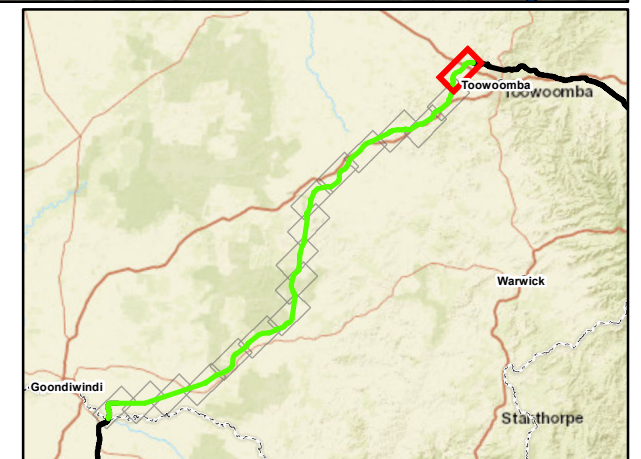
Map by: DTH/MEF/NCW/ITM 2:IGIS/IGIS_310_B2GTtask310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF JV_Fig7.4_NO2_v10.mxd Date: 31/10/2024 09:50

Legend

- 5 Chainage (km)
- Sensitive receptors
- Cumulative rail sources
- Localities
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative NO₂ annual average ground level concentration (33 µg/m³ goal for ecosystems, 62 µg/m³ goal for human health and wellbeing)

10	30	50
12	33	55
15	35	60
20	40	
25	45	



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 7.4q:

Predicted cumulative NO₂ annual average ground level concentration plot



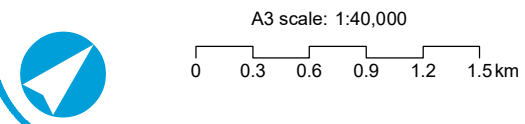
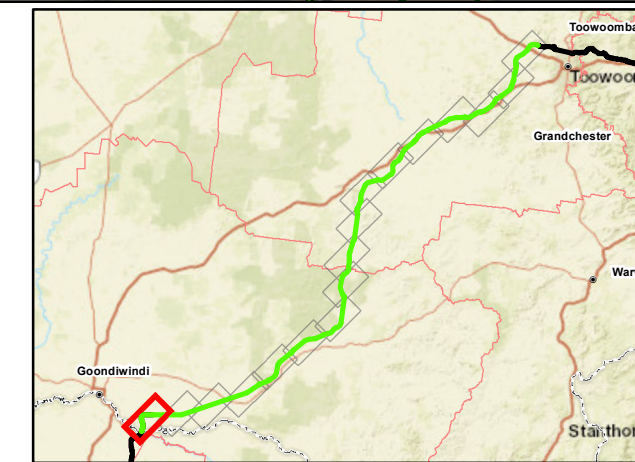
Legend

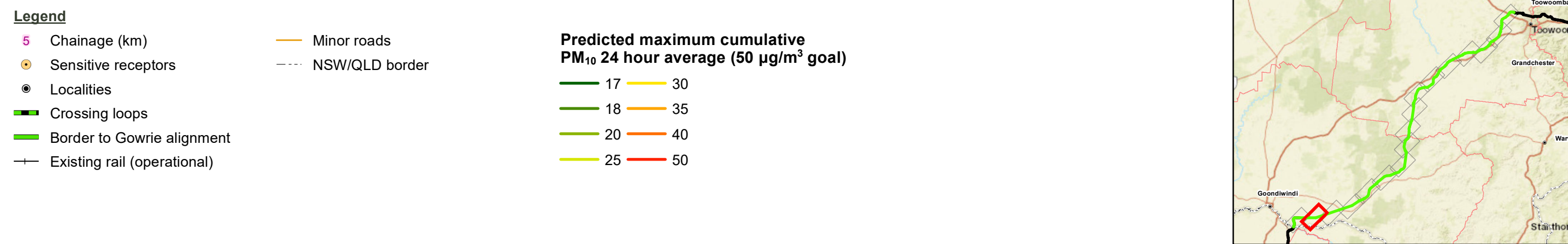
- 5 Chainage (km)
- Sensitive receptors
- Cumulative rail sources
- Crossing loops
- North Star to NSW/QLD border alignment
- Border to Gowrie alignment
- Existing rail (operational)

- Minor roads
- NSW/QLD border

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

- | | |
|----|----|
| 17 | 30 |
| 18 | 35 |
| 20 | 40 |
| 25 | 50 |





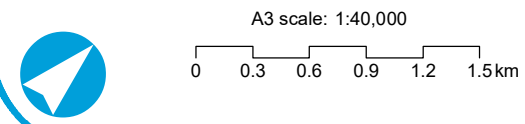
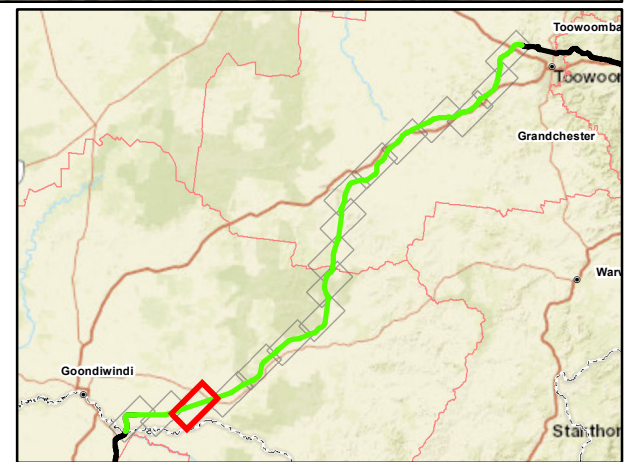


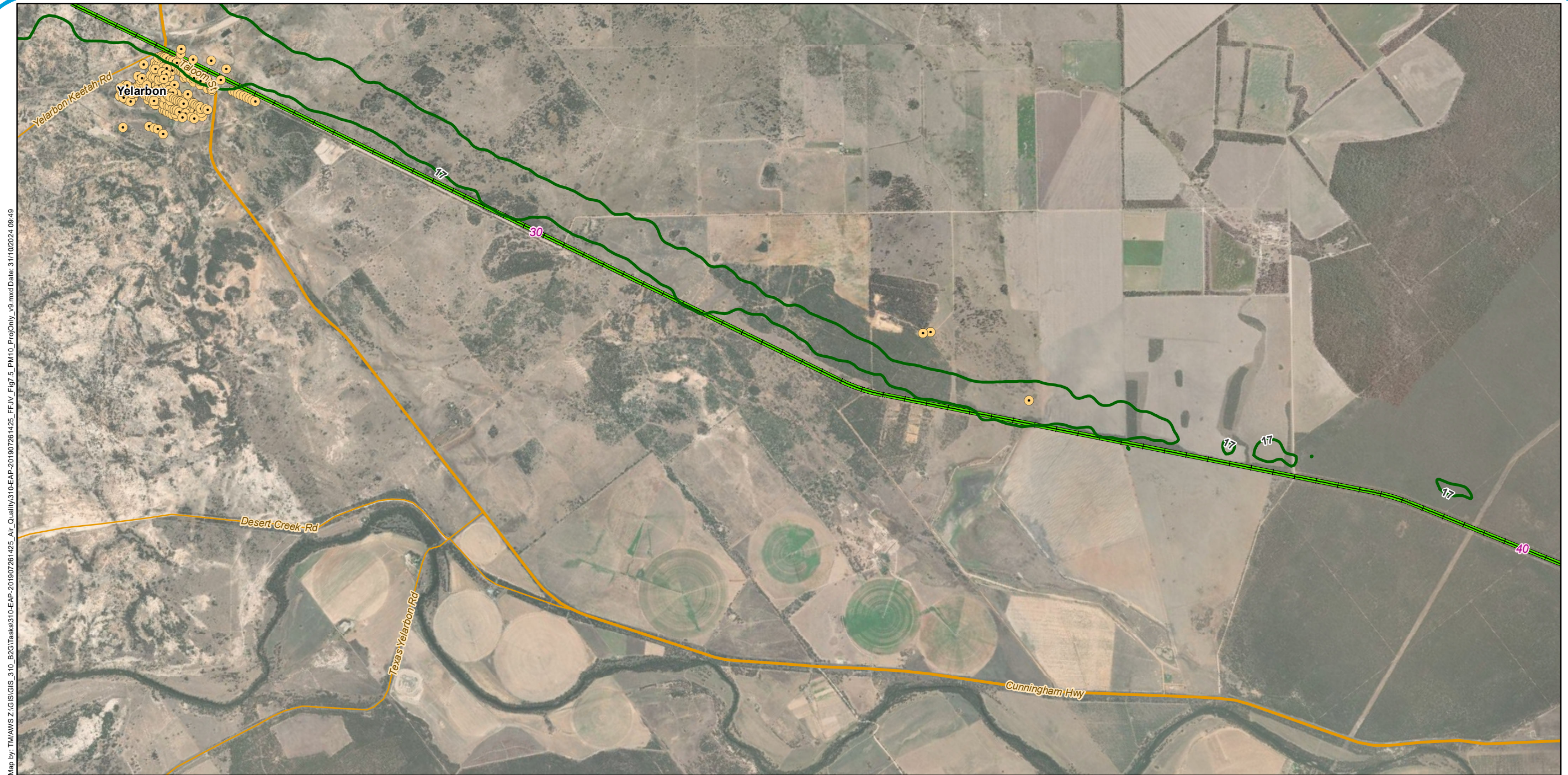
Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads
- NSW/QLD border

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

- 17 30
- 18 35
- 20 40
- 25 50



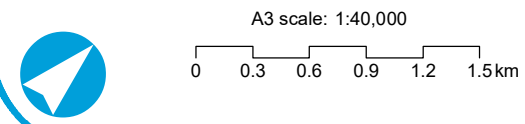
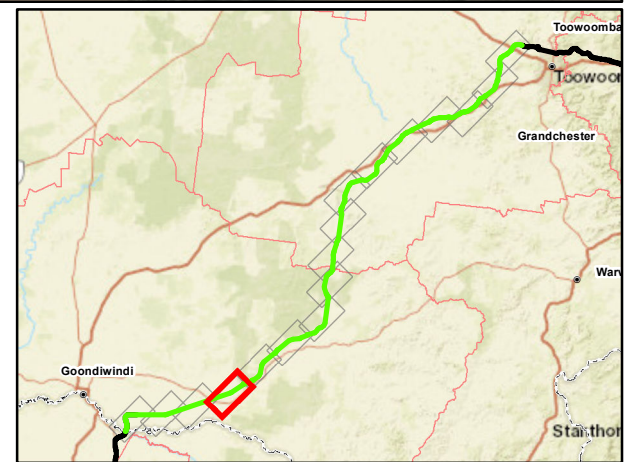


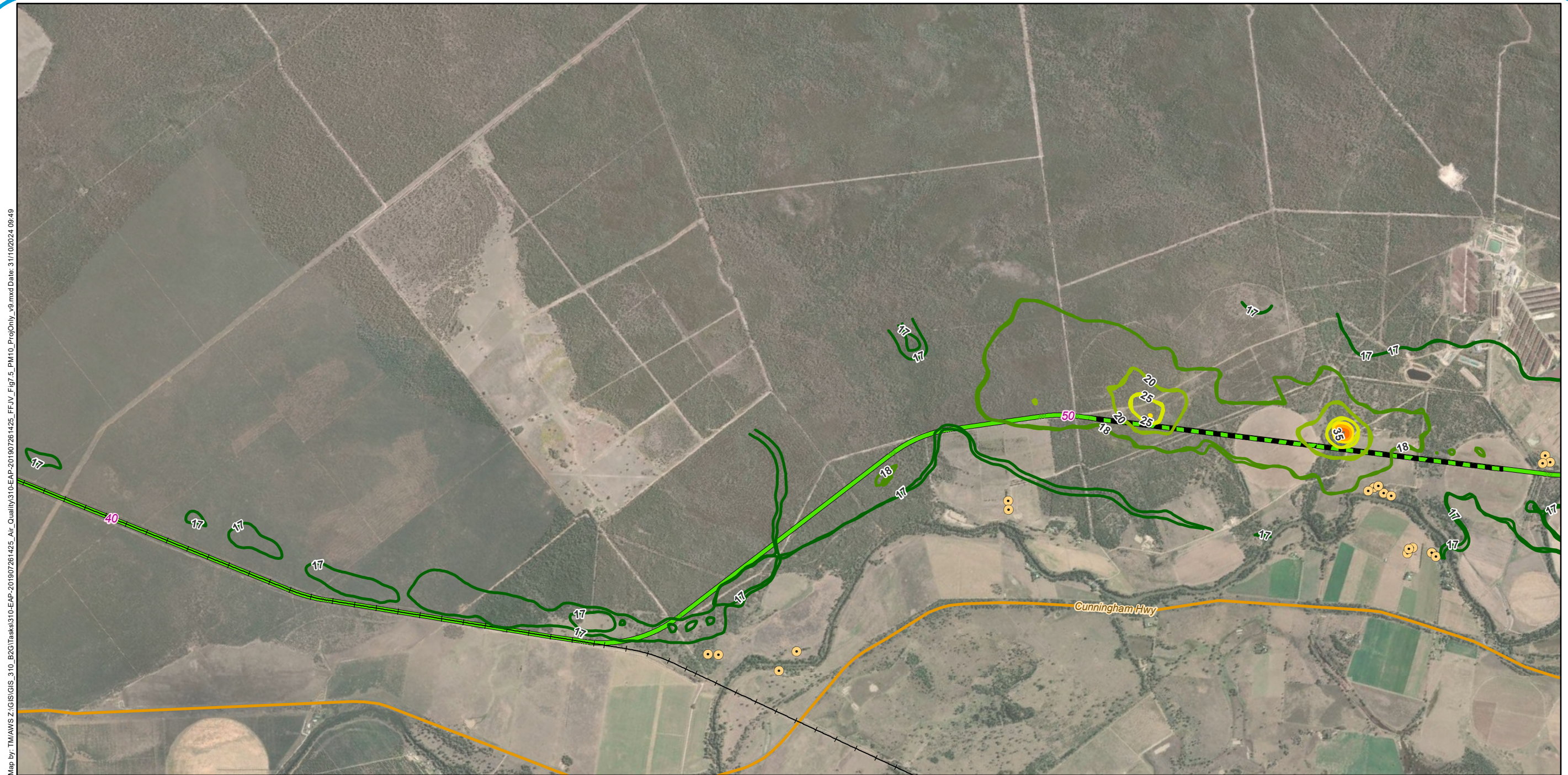
Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

- 17
- 18
- 20
- 25
- 30
- 35
- 40
- 50



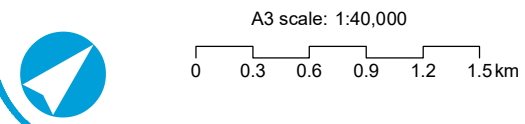
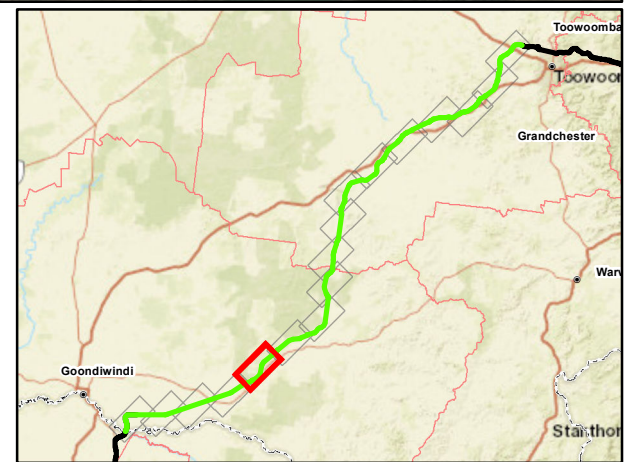


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

17	30
18	35
20	40
25	50



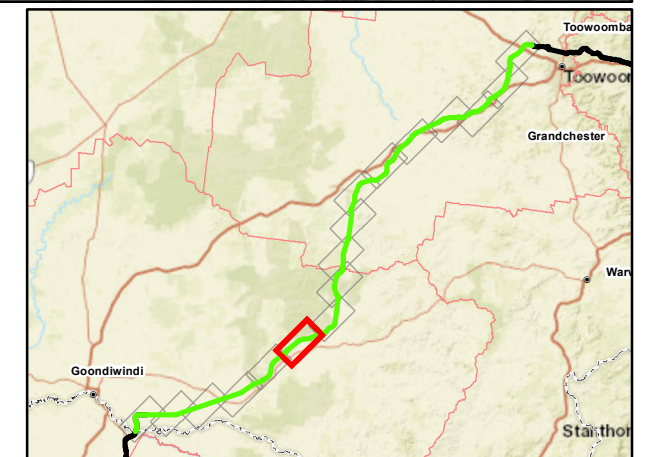


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads

**Predicted maximum cumulative
PM₁₀ 24 hour average (50 µg/m³ goal)**

- | | |
|----|----|
| 17 | 30 |
| 18 | 35 |
| 20 | 40 |
| 25 | 50 |



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



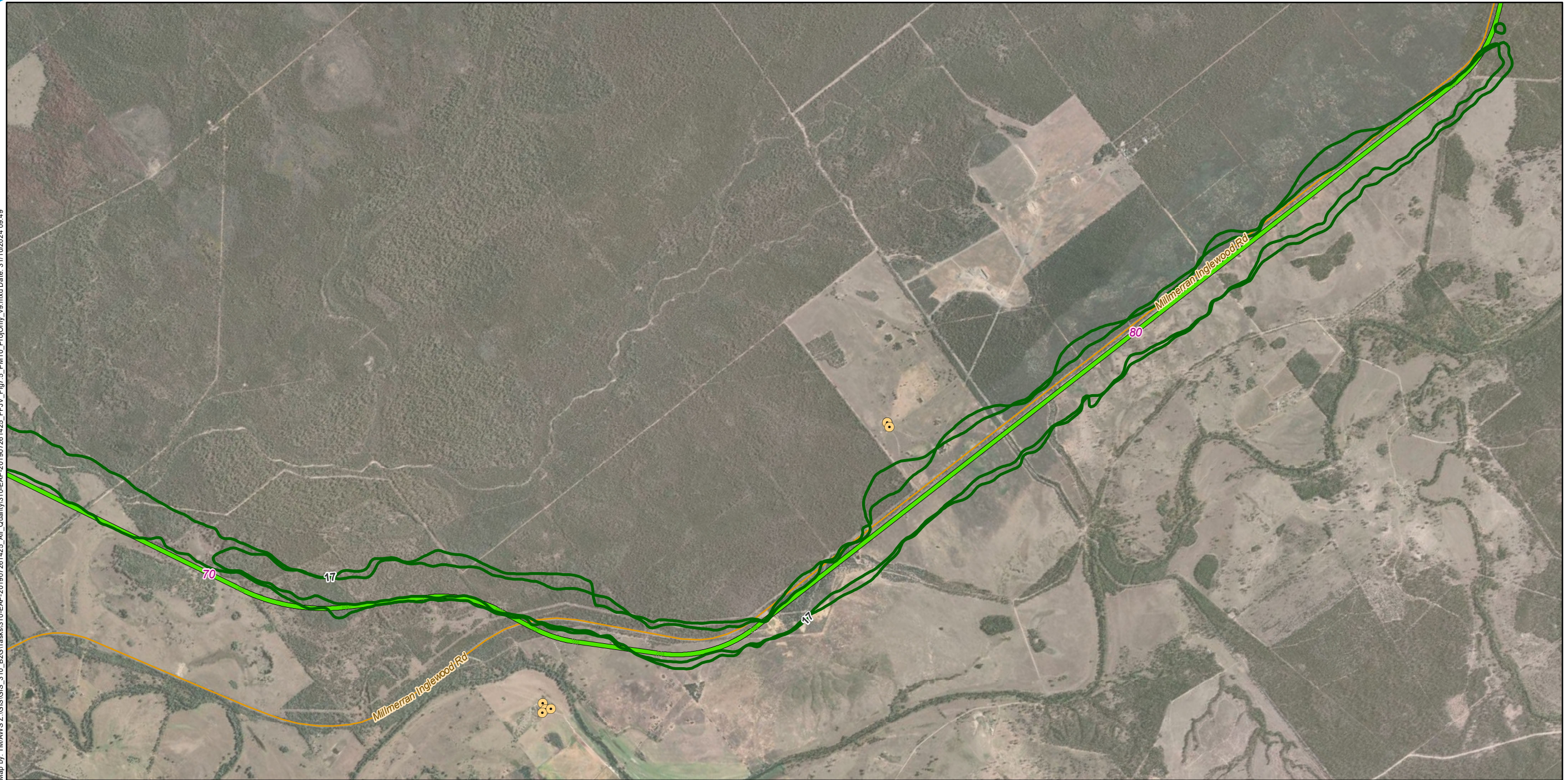
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Border to Gowrie

Figure 7.5f:
Predicted maximum cumulative PM₁₀ 24 hour average ground level concentration plot (Project only)

Map by: TM/AVS Z:\GIS\GIS_310_B20\Taska\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\IV_Fig7.5_PMI0_ProgOnly_v9.mxd Date: 31/10/2024 09:49

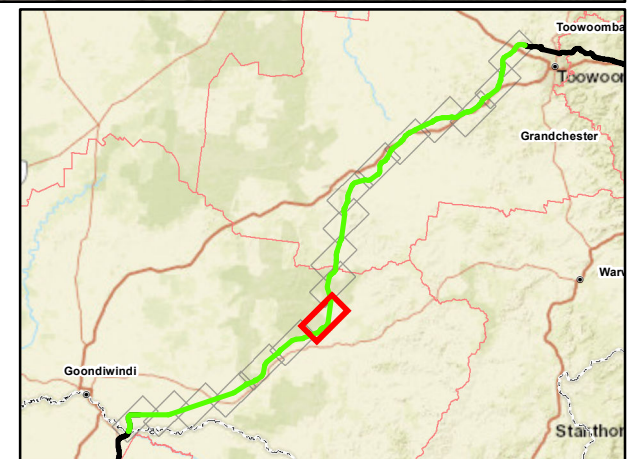


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

- | | |
|----|----|
| 17 | 30 |
| 18 | 35 |
| 20 | 40 |
| 25 | 50 |



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km

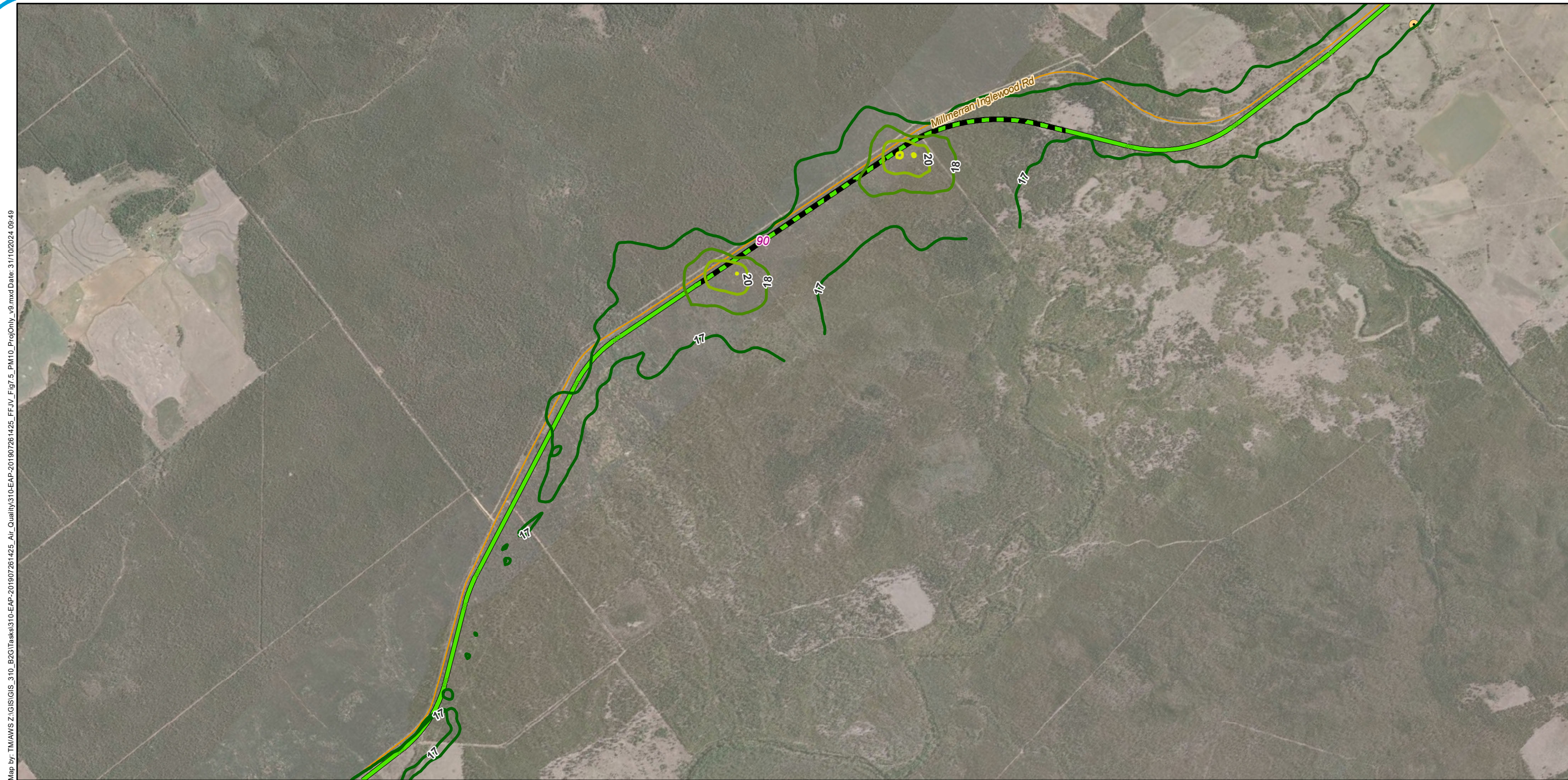


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Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 7.5g:

Predicted maximum cumulative PM₁₀ 24 hour average ground level concentration plot (Project only)



Map by: TMIAWS Z:\GIS\GIS_310_B20\Taska\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\IV_Fig7.5_PMI0_ProgOnly_v9.mxd Date: 31/10/2024 09:49

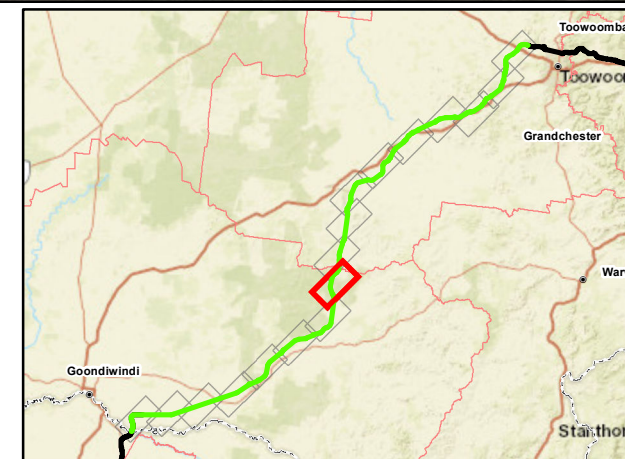
Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment

Minor roads

**Predicted maximum cumulative
PM₁₀ 24 hour average (50 µg/m³ goal)**

- | | |
|----|----|
| 17 | 30 |
| 18 | 35 |
| 20 | 40 |
| 25 | 50 |



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 7.5h:

Predicted maximum cumulative PM₁₀ 24 hour average ground level concentration plot (Project only)

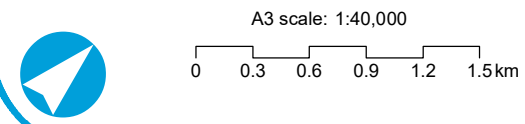
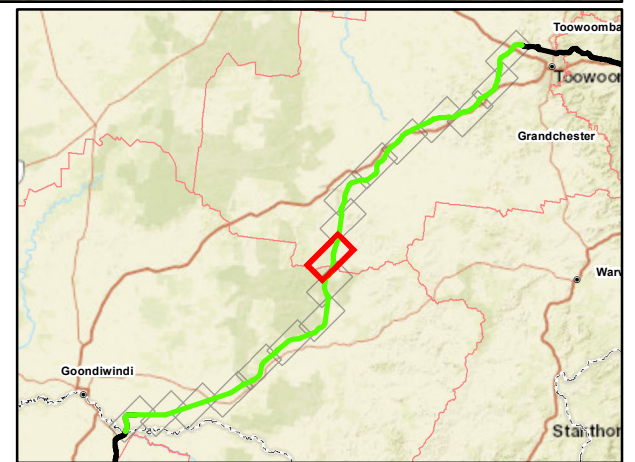


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

- | | |
|----|----|
| 17 | 30 |
| 18 | 35 |
| 20 | 40 |
| 25 | 50 |



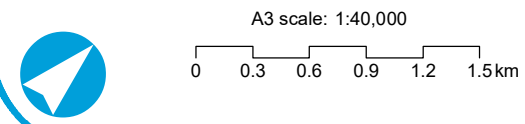
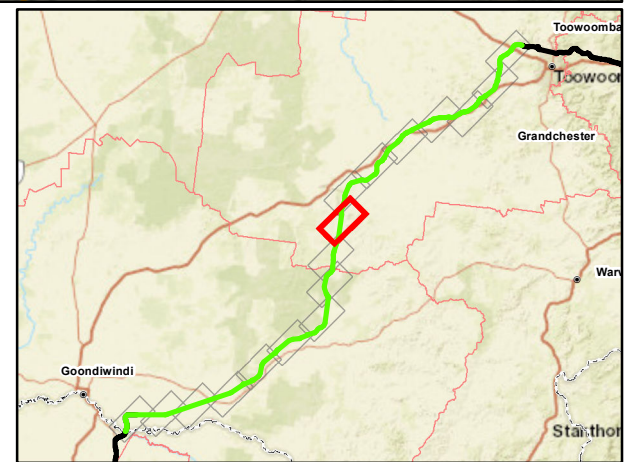


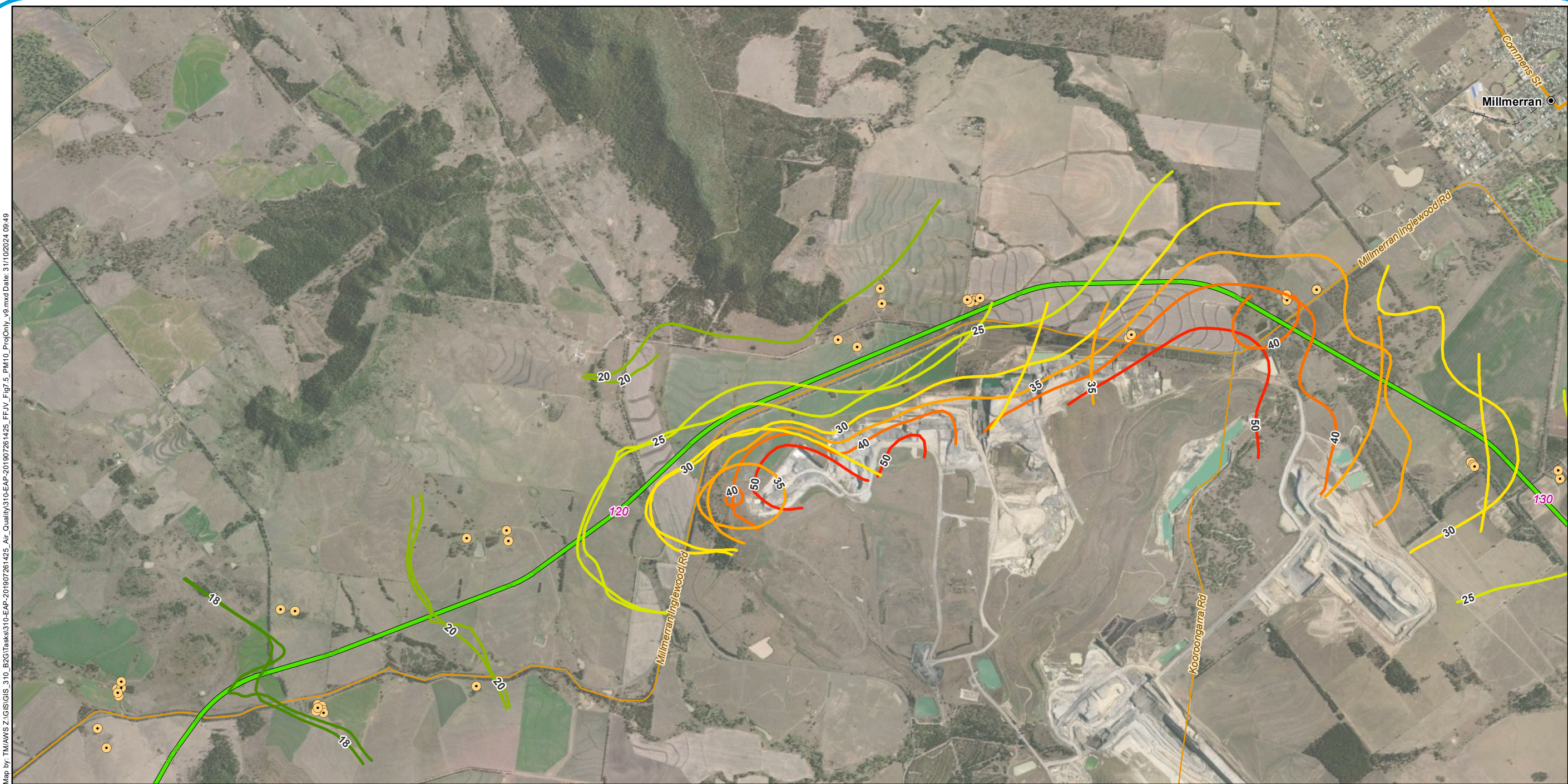
Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

- | | |
|----|----|
| 17 | 30 |
| 18 | 35 |
| 20 | 40 |
| 25 | 50 |





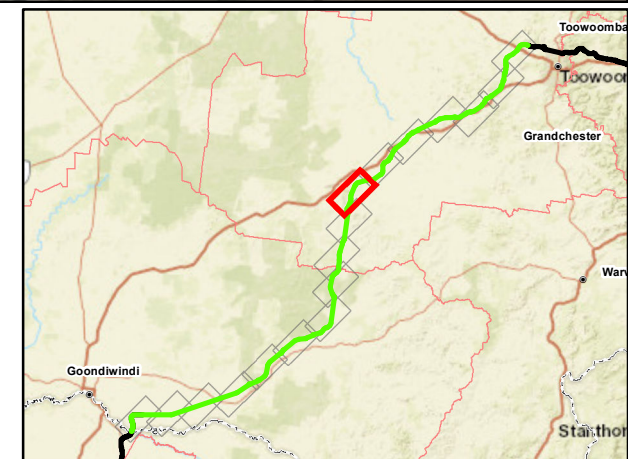
Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- - - Existing rail (non-operational)

- Major roads
- Minor roads

**Predicted maximum cumulative
PM₁₀ 24 hour average (50 µg/m³ goal)**

- 17
- 18
- 20
- 25
- 30
- 35
- 40
- 50



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 7.5k:

Predicted maximum cumulative PM₁₀ 24 hour average ground level concentration plot (Project only)

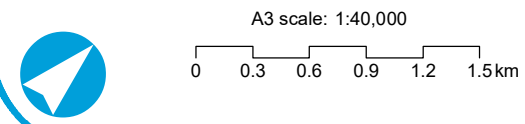
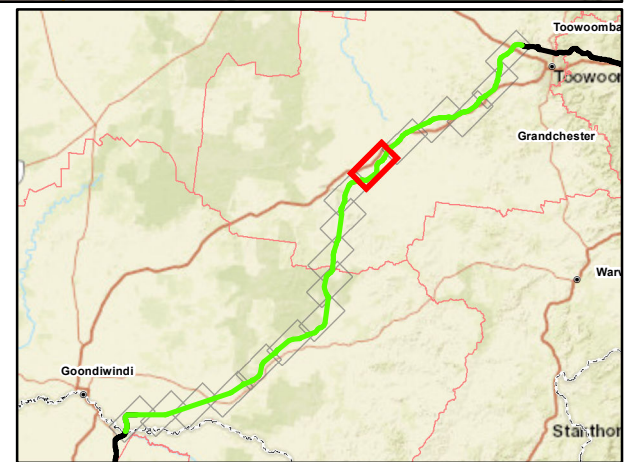


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- - - Existing rail (non-operational)
- Major roads
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

- 17
- 18
- 20
- 25
- 30
- 35
- 40
- 50



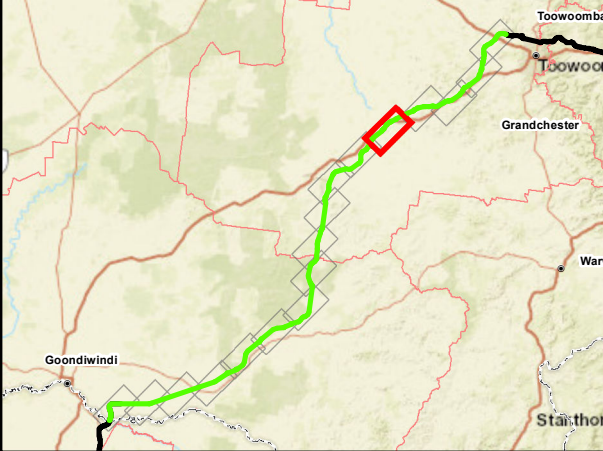


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- - - Existing rail (non-operational)

- Major roads
- Minor roads

- Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)**
- 17
 - 18
 - 20
 - 25
 - 30
 - 35
 - 40
 - 50



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km

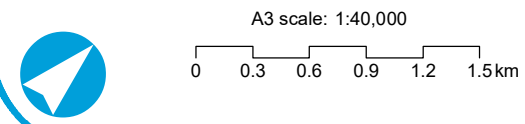
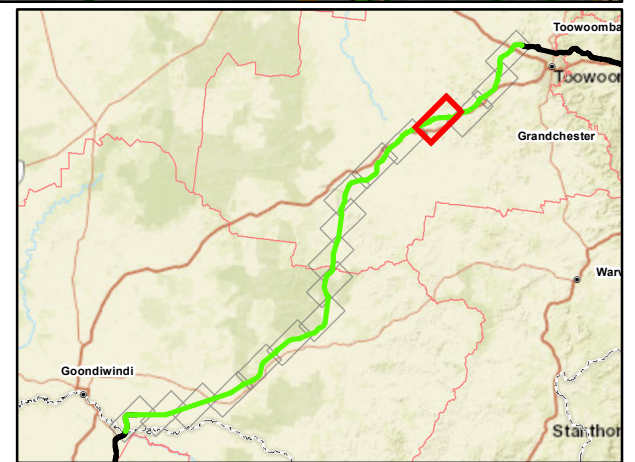


Legend

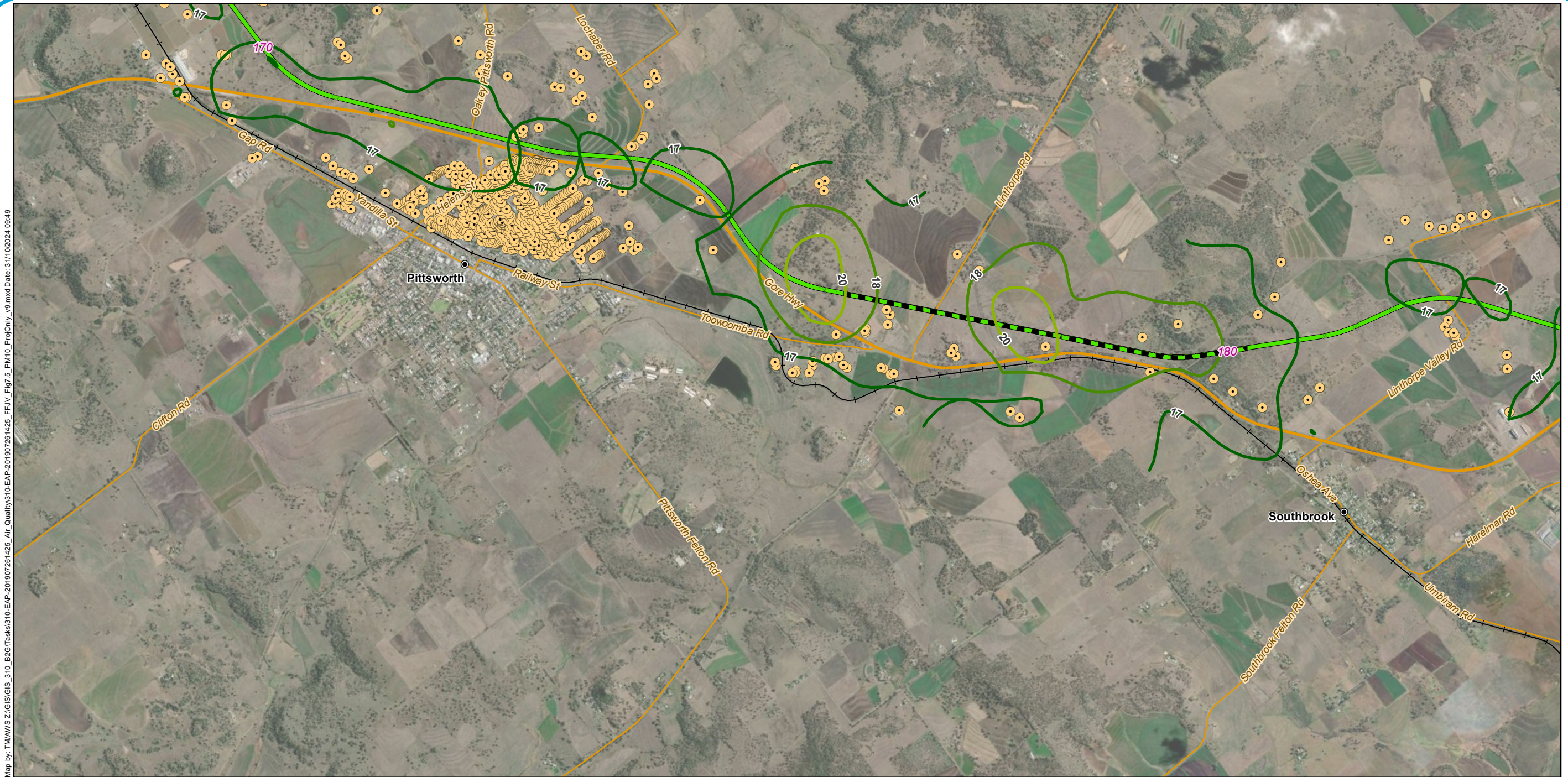
- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

- 17
- 18
- 20
- 25
- 30
- 35
- 40
- 50



Border to Gowrie
Figure 7.5n:
Predicted maximum cumulative PM₁₀ 24 hour average ground level concentration plot (Project only)

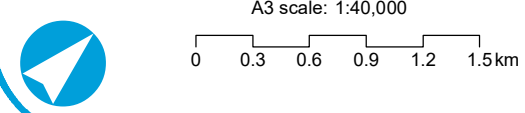
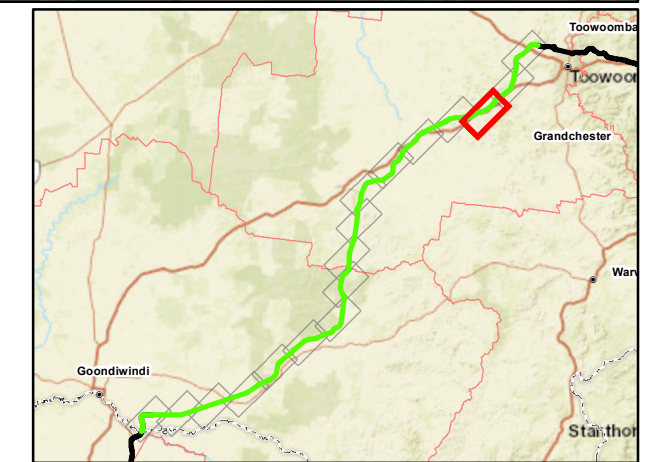


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

**Predicted maximum cumulative
PM₁₀ 24 hour average (50 µg/m³ goal)**

- 17
- 18
- 20
- 25
- 30
- 35
- 40
- 50



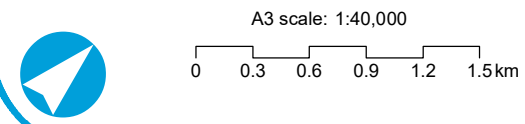
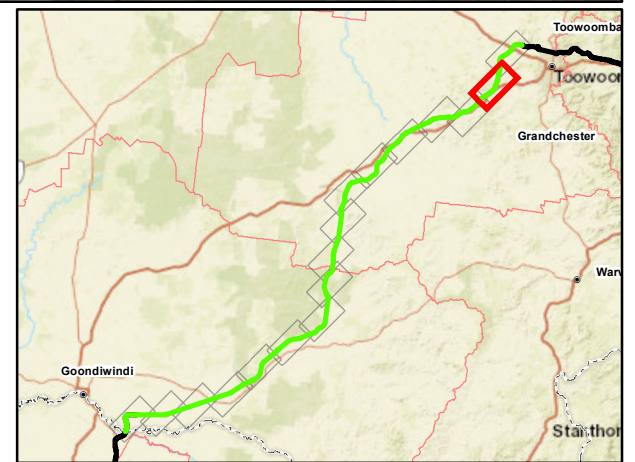


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

- 17
- 18
- 20
- 25
- 30
- 35
- 40
- 50





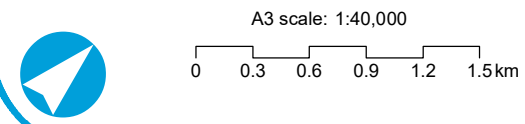
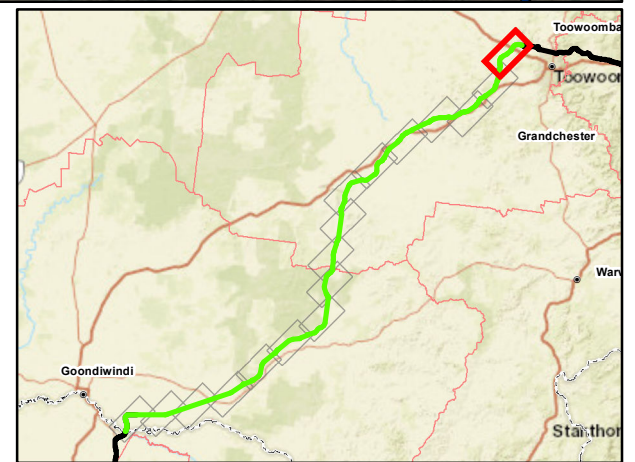
Map by: TM/WS Z:\GIS\GIS_310_B20\Task\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\IV_Fig7.5_PMI0_ProjOnly_v9.mxd Date: 31/10/2024 09:49

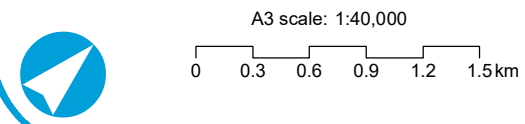
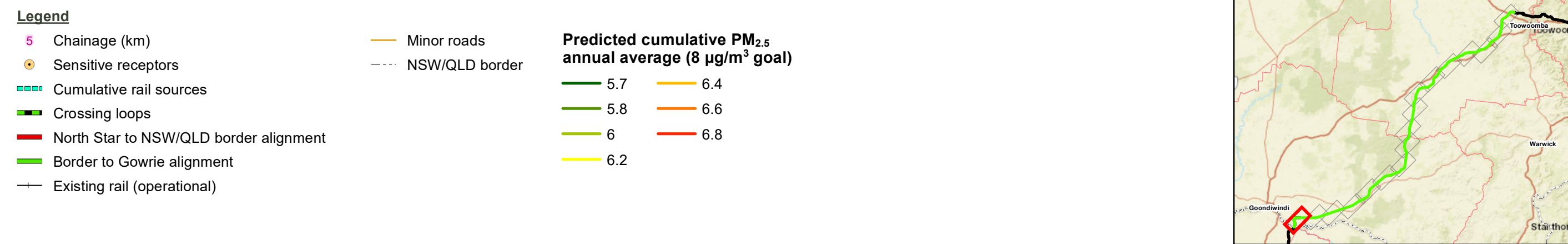
Legend

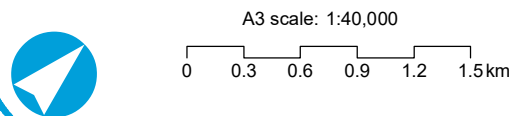
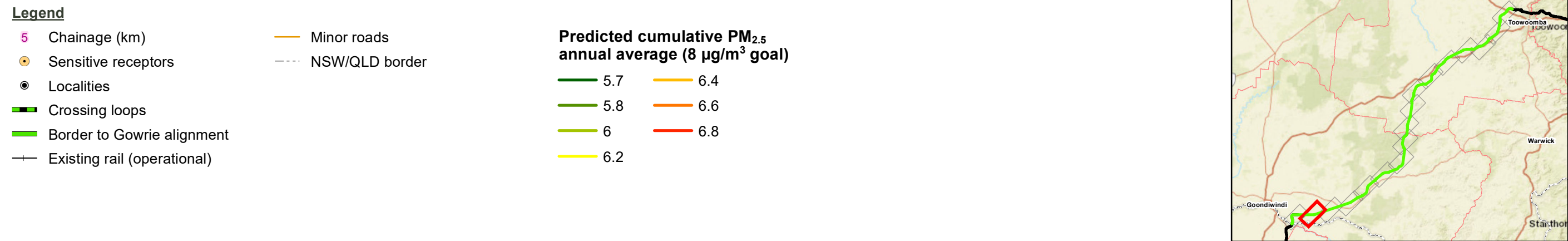
- 5 Chainage (km)
- Sensitive receptors
- Localities
- Cumulative rail sources
- Crossing loops
- Border to Gowrie alignment
- Gowrie to Helidon alignment
- Existing rail (operational)
- Major roads
- Minor roads

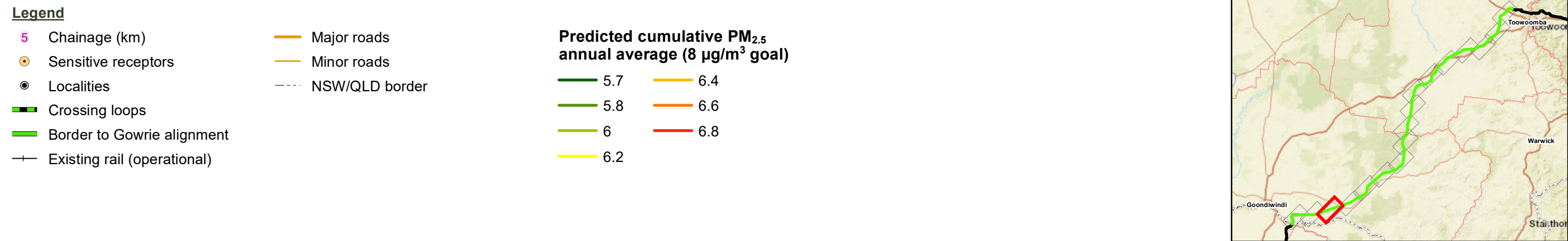
Predicted maximum cumulative PM₁₀ 24 hour average (50 µg/m³ goal)

17	30
18	35
20	40
25	50









A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



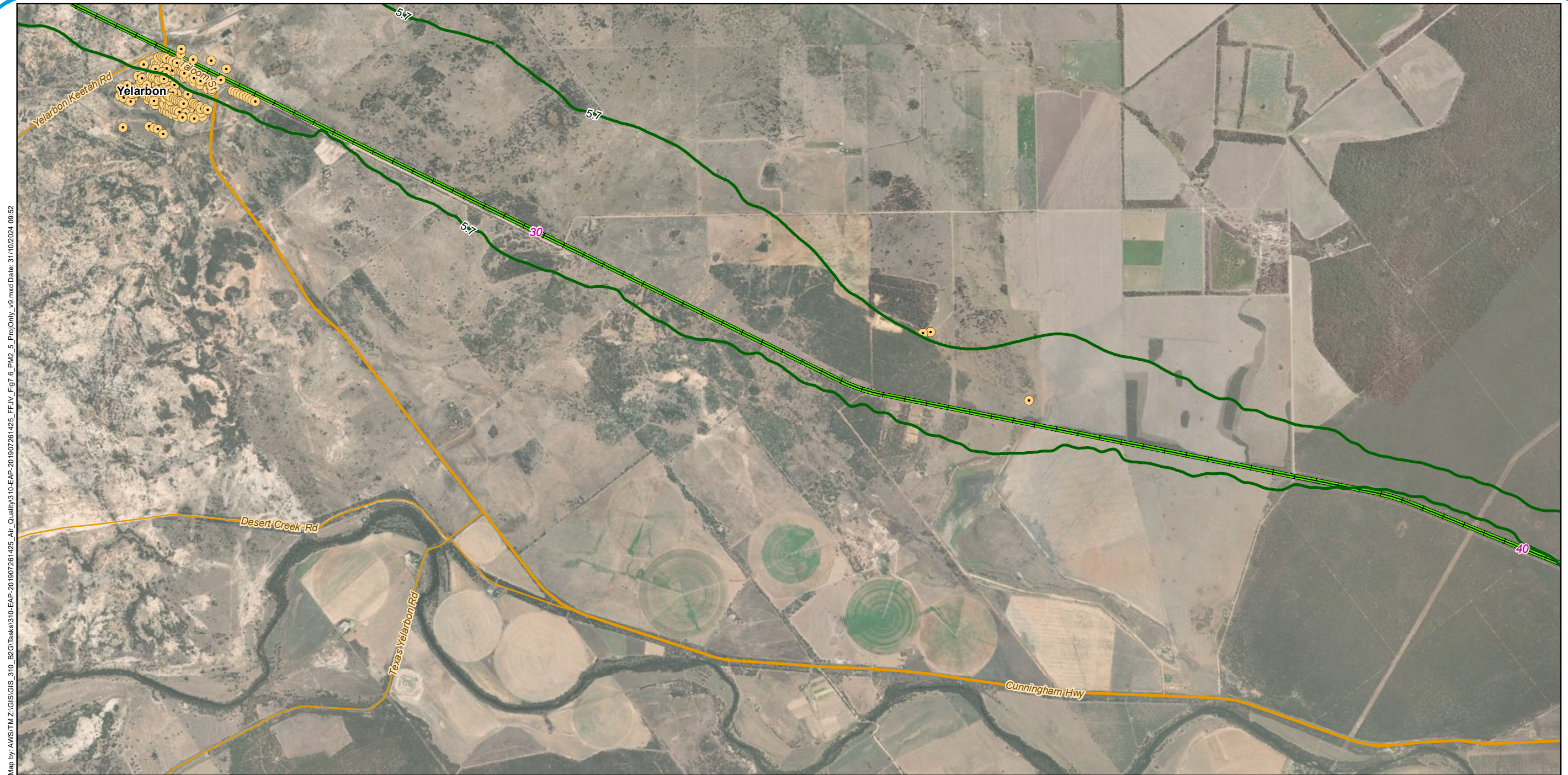
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Border to Gowrie

Figure 7.6c:

Predicted cumulative PM_{2.5} annual average ground level concentration plot (Project only)

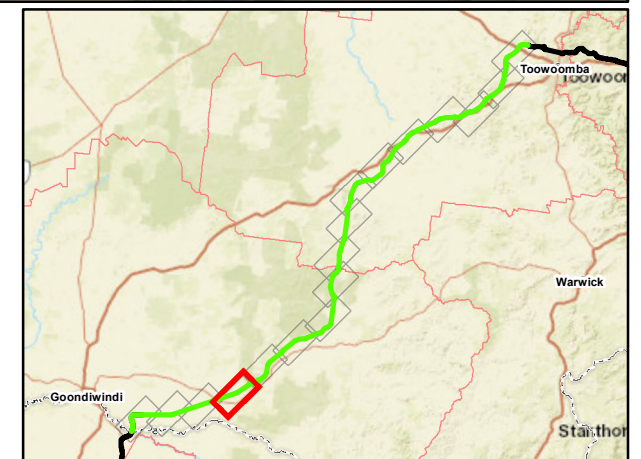


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- 5.7
- 5.8
- 6
- 6.2
- 6.4
- 6.6
- 6.8



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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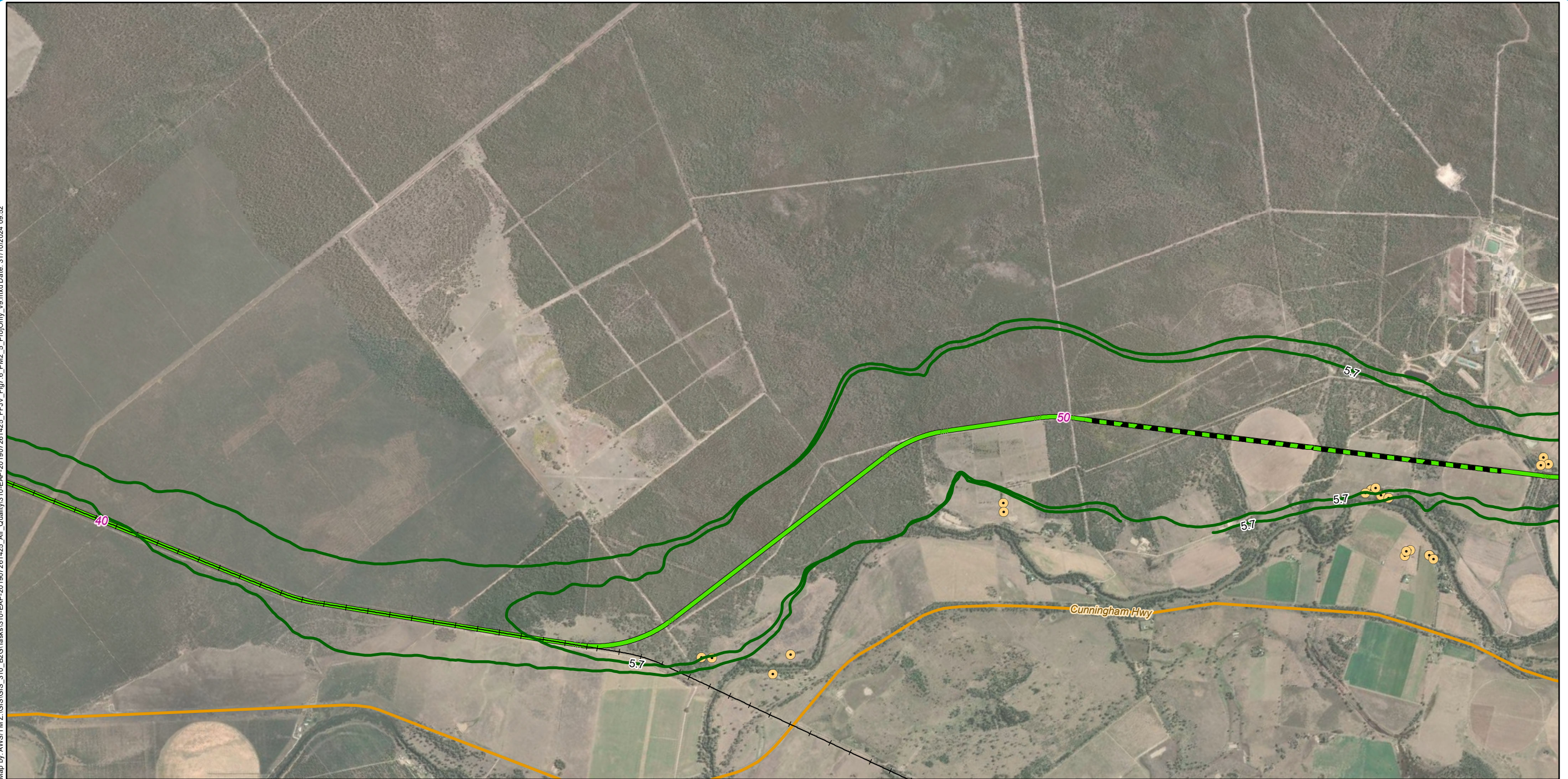
Issue date: 03/10/2024 Version: 9
Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 7.6d:

Predicted cumulative PM_{2.5} annual average ground level concentration plot (Project only)

Map by: AWS\TM2\GIS\GIS_310_B2G\Task\310-EAP-201907261425_FF\IV_Fig7.6_PM2.5_ProjOnly_v9.mxd Date: 31/10/2024 09:52



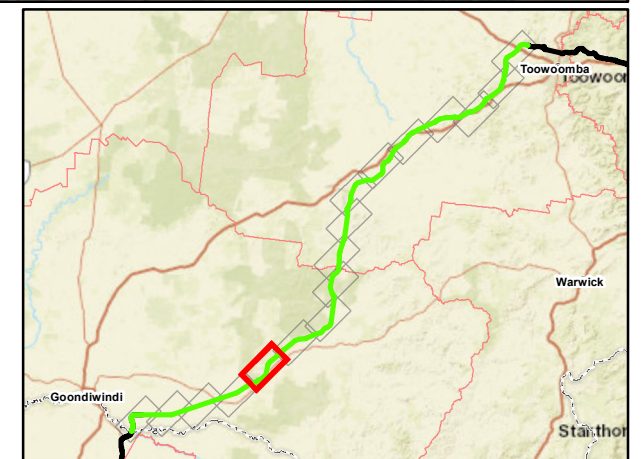
Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)

— Major roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- | | |
|-------|-------|
| — 5.7 | — 6.4 |
| — 5.8 | — 6.6 |
| — 6 | — 6.8 |
| — 6.2 | |



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



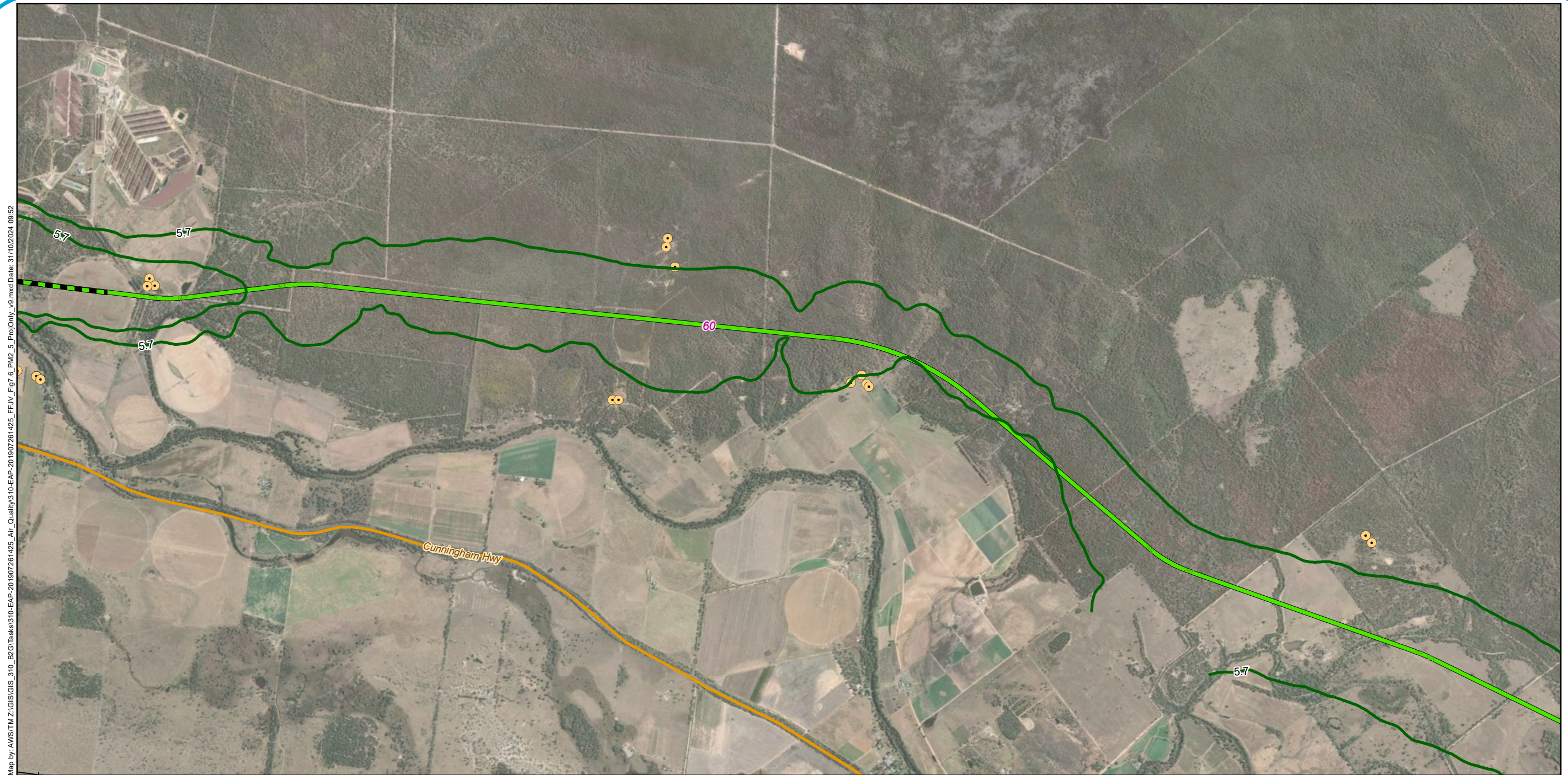
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Coordinate System: GDA 1994 MGA Zone 56

Border to Gowrie

Figure 7.6e:

Predicted cumulative PM_{2.5} annual average ground level concentration plot (Project only)

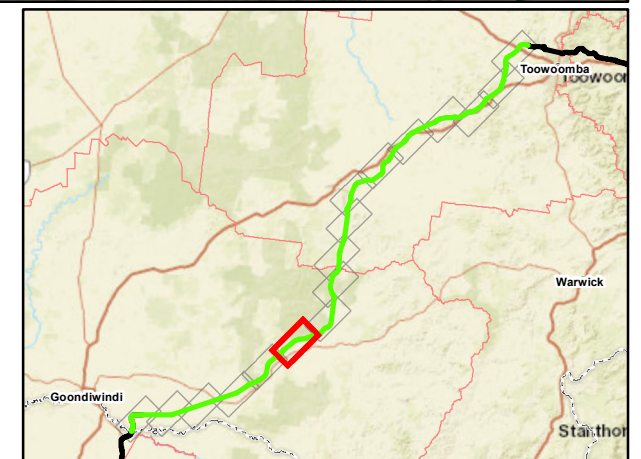


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- 5.7
- 5.8
- 6
- 6.2
- 6.4
- 6.6
- 6.8



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



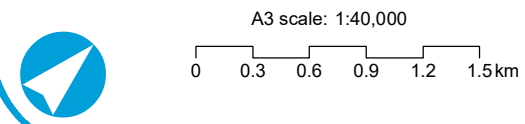
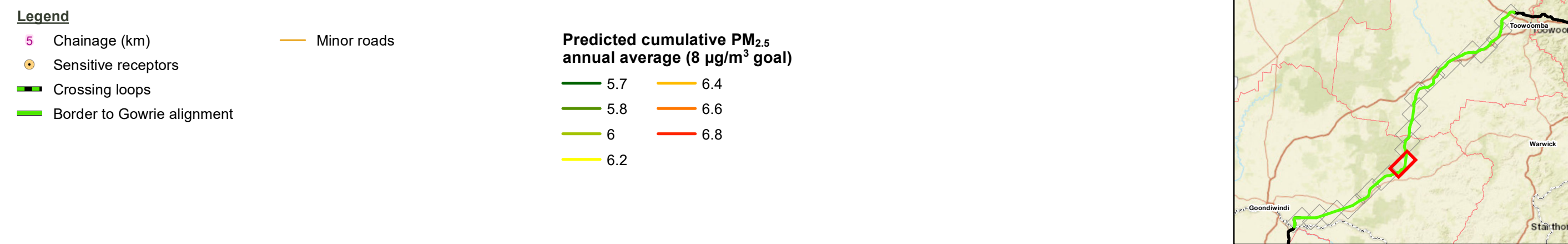
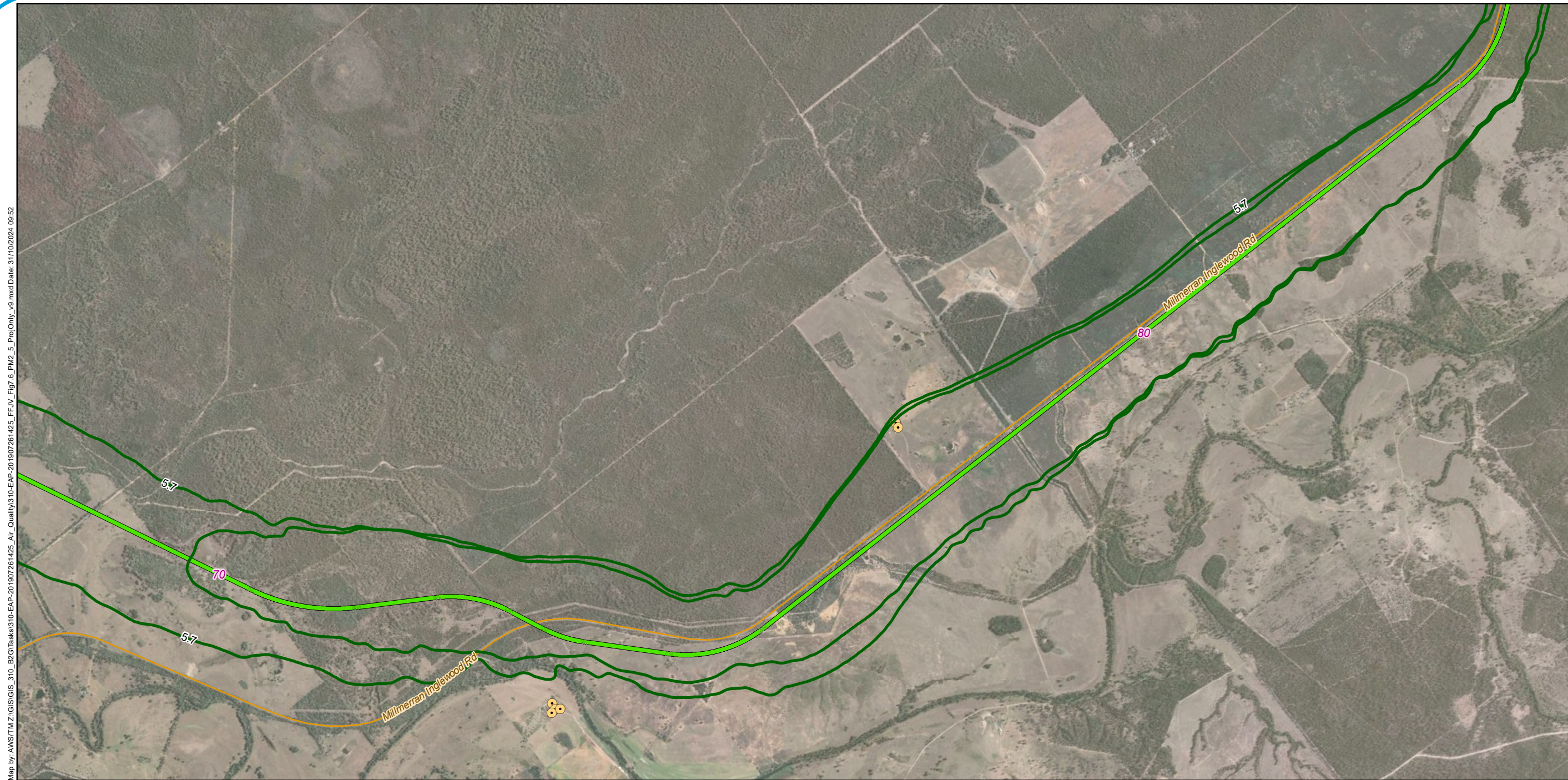
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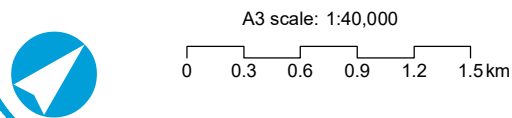
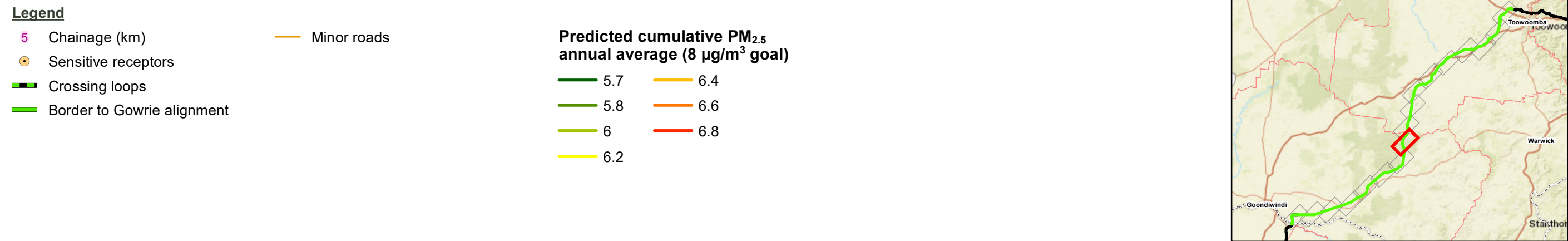
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Border to Gowrie

Figure 7.6f:

Predicted cumulative PM_{2.5} annual average ground level concentration plot (Project only)





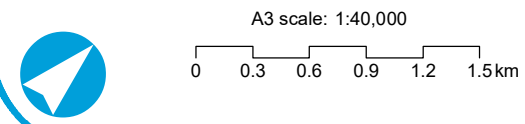
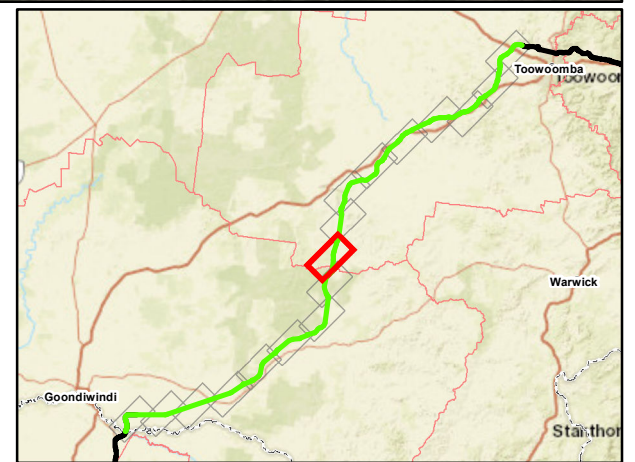


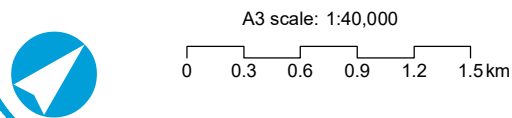
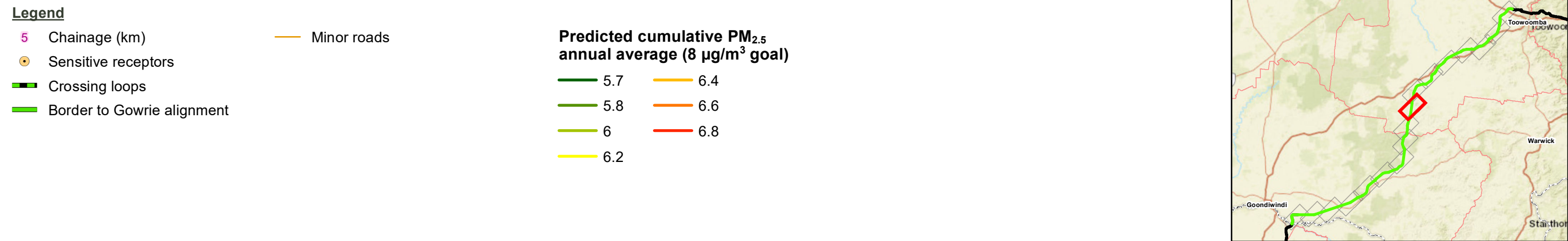
Legend

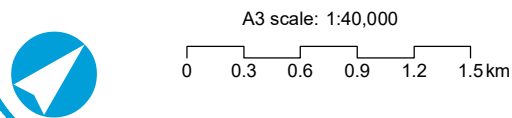
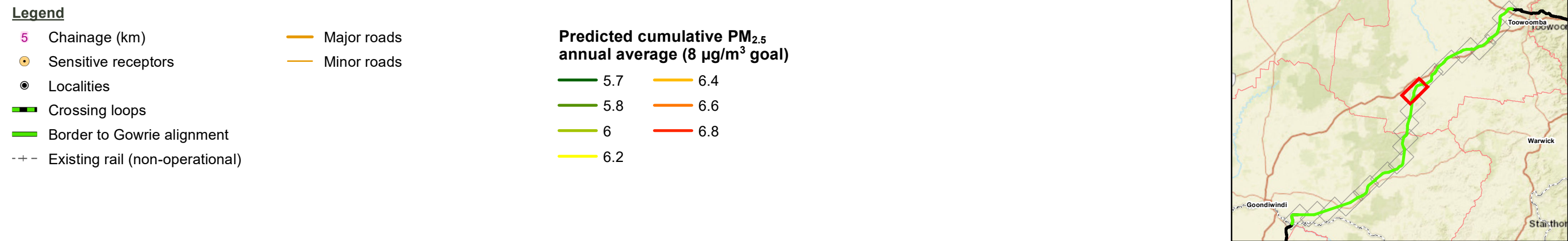
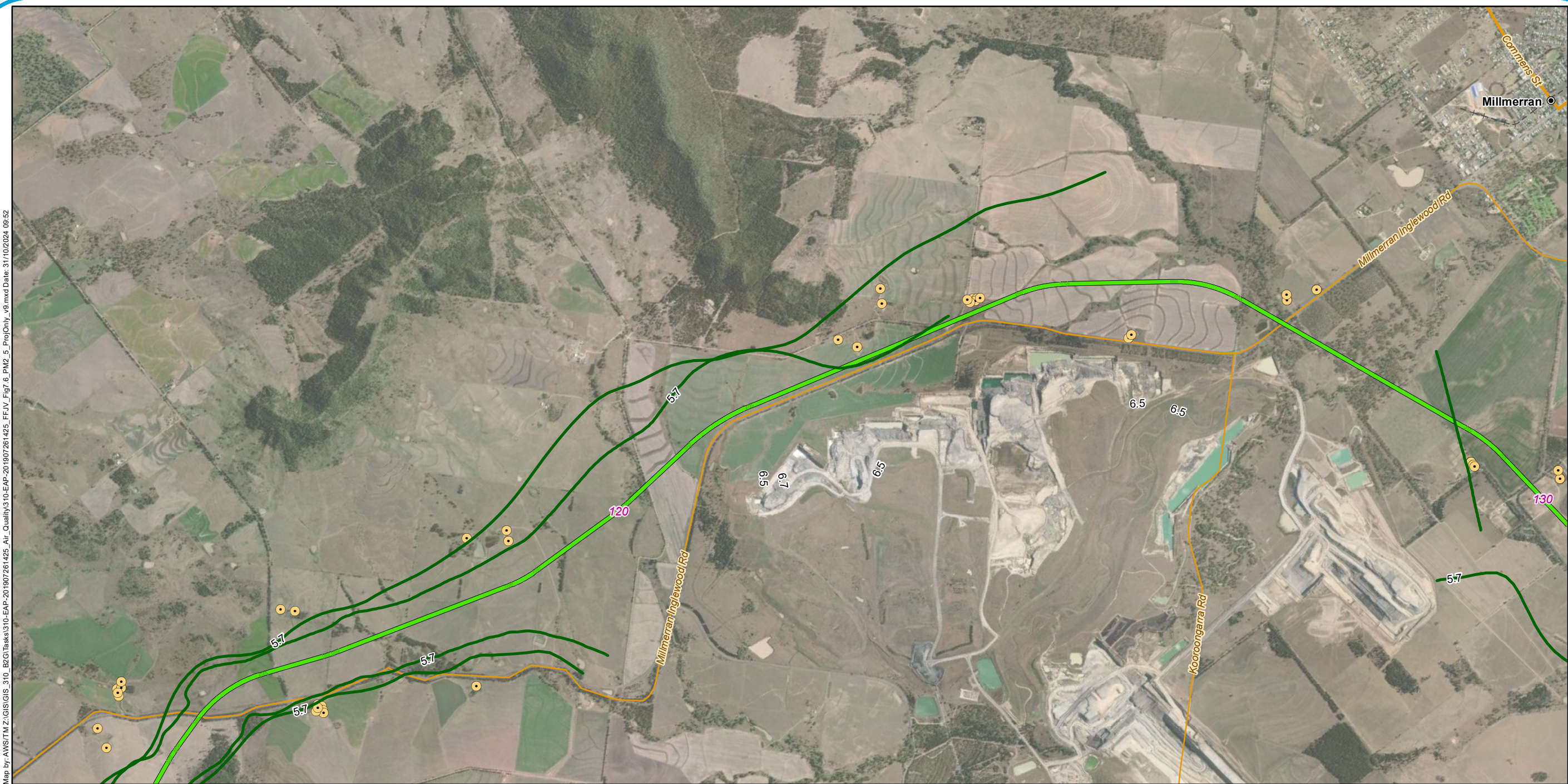
- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Minor roads

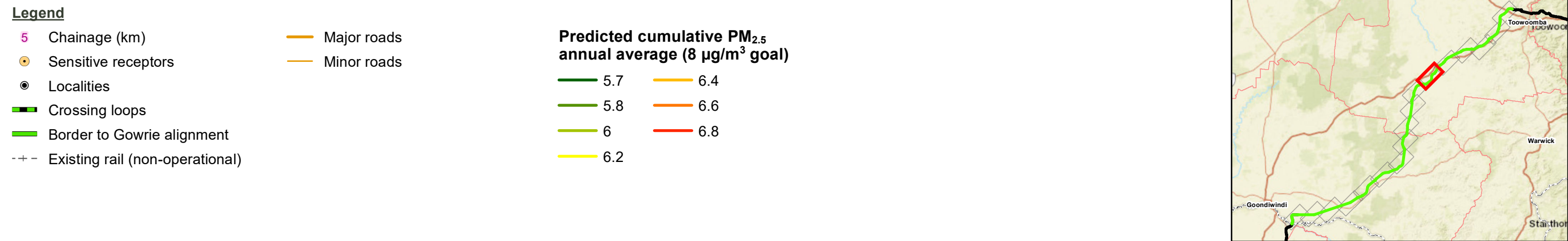
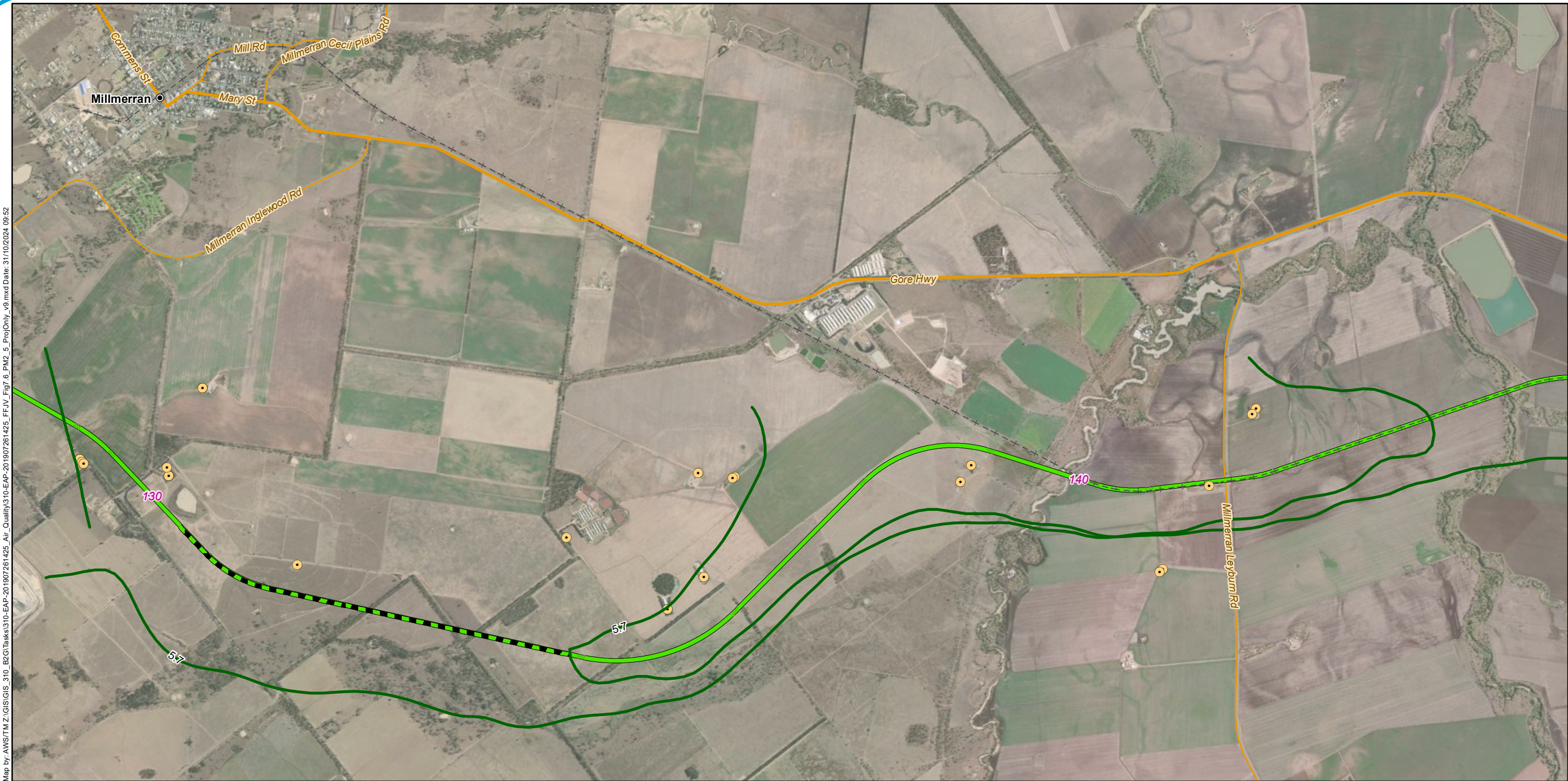
Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- | | |
|-----|-----|
| 5.7 | 6.4 |
| 5.8 | 6.6 |
| 6 | 6.8 |
| 6.2 | |









A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



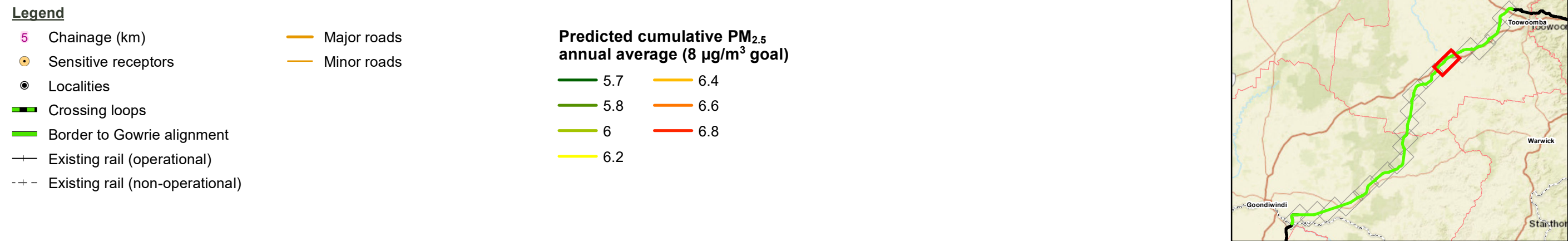
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Border to Gowrie

Figure 7.61:

Predicted cumulative PM_{2.5} annual average ground level concentration plot (Project only)



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 7.6m:

Predicted cumulative PM_{2.5} annual average ground level concentration plot (Project only)

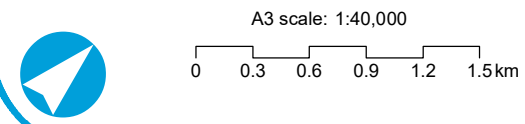
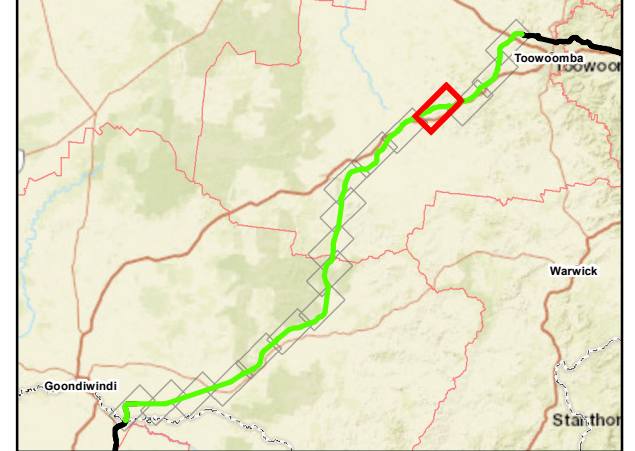


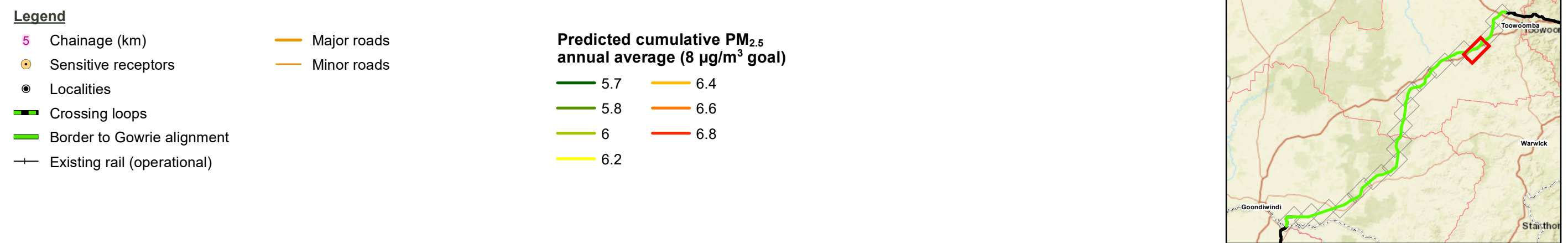
Map by: AWS\TM2\GIS\GIS_310_B2G\Task\310-EAP-201907261425_Air_Quality\310-EAP-201907261425_FF\IV_Fig7.6_PM2.5_ProjOnly_v9.mxd Date: 31/10/2024 09:52

Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

- Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)**
- 5.7
 - 5.8
 - 6
 - 6.2
 - 6.4
 - 6.6
 - 6.8





A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



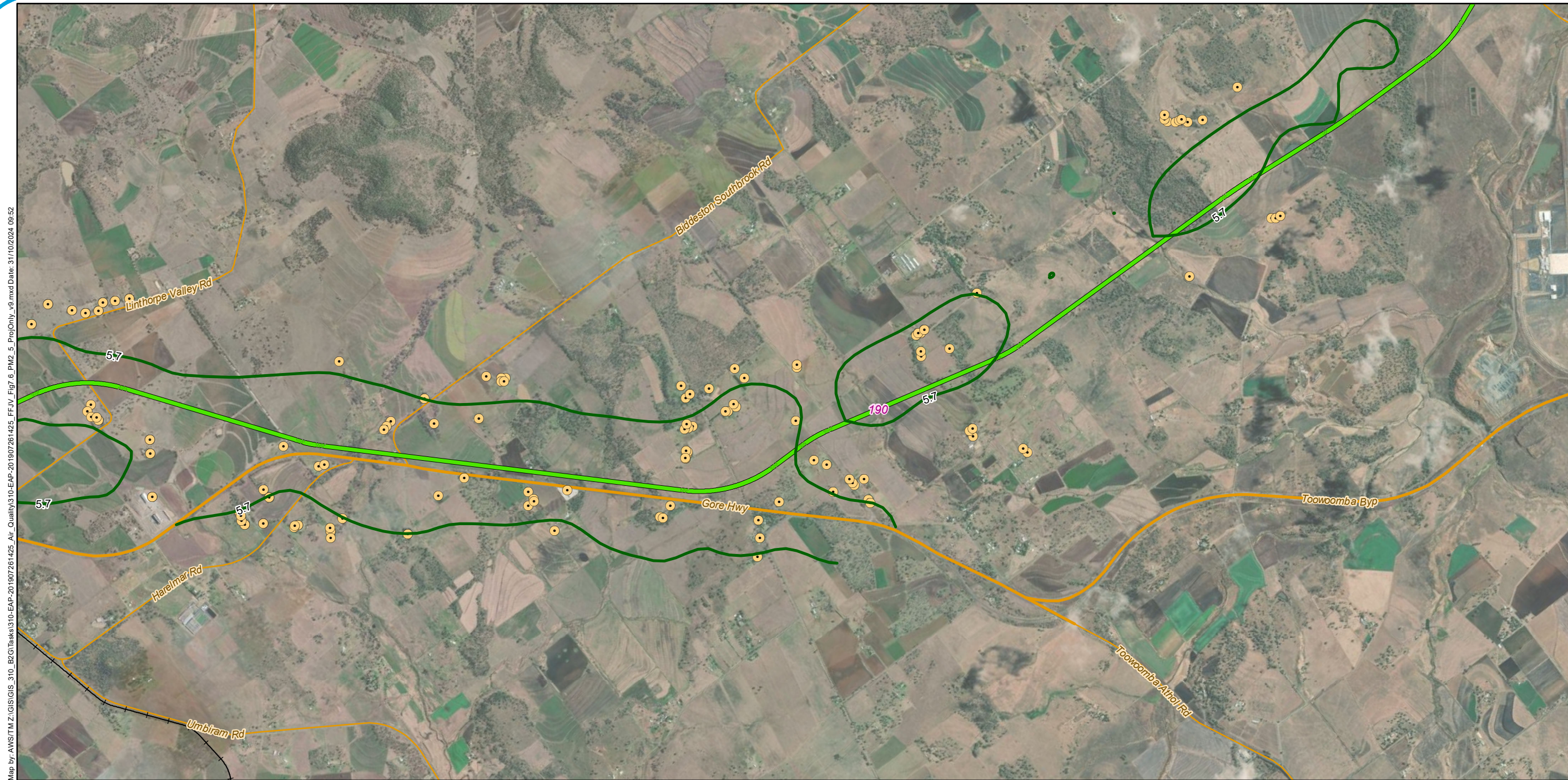
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Border to Gowrie

Figure 7.6o:

Predicted cumulative PM_{2.5} annual average ground level concentration plot (Project only)

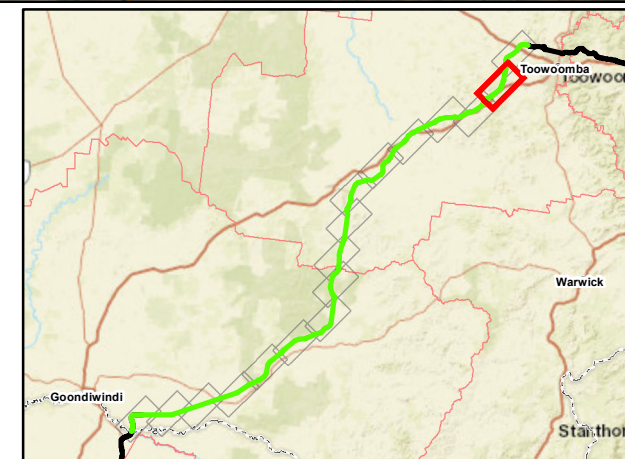


Legend

- 5 Chainage (km)
- Sensitive receptors
- Crossing loops
- Border to Gowrie alignment
- Existing rail (operational)
- Major roads
- Minor roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- 5.7
- 5.8
- 6
- 6.2
- 6.4
- 6.6
- 6.8



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 7.6p:

Predicted cumulative PM_{2.5} annual average ground level concentration plot (Project only)

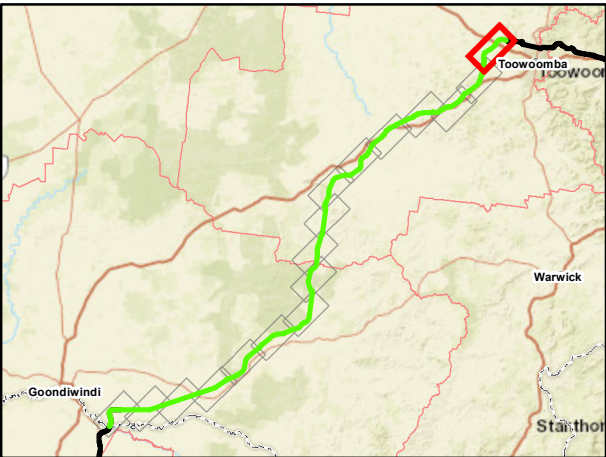


Legend

- 5 Chainage (km)
- Sensitive receptors
- Localities
- ▬ Cumulative rail sources
- ▬ Crossing loops
- ▬ Border to Gowrie alignment
- ▬ Gowrie to Helidon alignment
- Existing rail (operational)
- ▬ Major roads
- ▬ Minor roads

Predicted cumulative PM_{2.5} annual average (8 µg/m³ goal)

- 5.7
- 5.8
- 6
- 6.2
- 6.4
- 6.6
- 6.8



A3 scale: 1:40,000
0 0.3 0.6 0.9 1.2 1.5 km



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Border to Gowrie

Figure 7.6q:

Predicted cumulative PM_{2.5} annual average ground level concentration plot (Project only)

7.2 Tank water impacts

Impacts to tank water have been assessed using the methodology described in Section 5.3.7.

Table 7.3 presents the highest predicted Project only pollutant concentrations for the water tank of the sensitive receptor predicted to be worst affected by the operations stage of the Project. Table 7.3 also presents the drinking water guideline values prescribed by the *Australian Drinking Water Guidelines* (NHMRC and NRMCC, 2011).

Table 7.3 shows that at the worst affected receptor for peak train volumes in 2040, compliance is predicted for all pollutants by a significant margin. As typical train numbers will be lower than the peak numbers applied, impacts to tank water would generally be less than that predicted.

Compliance with the drinking water guideline values is predicted by a significant margin, as such the residual impact to drinking water because of the Project likely to be negligible.

Table 7.3 Highest predicted water tank concentrations at sensitive receptors

Pollutant	Receptor	Maximum predicted annual deposition rate ($\mu\text{g}/\text{m}^2/\text{s}$)	Estimated roof area (m^2)	Maximum predicted total deposited mass (microgram (μg))	Tank water volume (L)	Highest predicted concentration (mg/L)	Guideline value (mg/L)
Arsenic	r1911	3.6×10^{-12}	200 ^a	0.023	1,000 ^b	2.1×10^{-8}	0.01
Cadmium		3.6×10^{-10}		2.3		2.1×10^{-6}	0.002
Lead		1.8×10^{-11}		0.11		1.1×10^{-7}	0.01
Nickel		2.5×10^{-9}		15.8		1.5×10^{-5}	0.02
Chromium VI		1.8×10^{-9}		11.3		1.1×10^{-5}	0.05

Table notes:

a. Based upon the average surface area of a large house.

b. Assumption of a 10,000 L water tank at 10 per cent capacity, with a resultant water volume of 1000 L.

7.3 Ecological impacts

The potential for impacts to ecological receptors has been investigated via review of predicted annual average NO_2 concentration contours. Modelling predictions have been reviewed to determine if the annual average NO_2 air quality goal of $33 \mu\text{g}/\text{m}^3$, set for the protection of the environmental value of the health and biodiversity of ecosystems (Table 3.1), is exceeded within the AQIA study area.

Predicted cumulative NO_2 annual average concentration contours are shown in Figure 7.4.

Consistent with the concentration contour plots for PM_{10} (24-hour), $\text{PM}_{2.5}$ (annual) and NO_2 (1 hour) shown in Figure 7.1 to Figure 7.3, Figure 7.4 show that the highest predicted annual average NO_2 concentrations are predicted at locations near Project crossing loops, adjacent to the Commodore Mine and Millmerran Power Station, and adjacent to the Warrego Highway and Gore Highway.

The concentration contours in Figure 7.4 show that the annual average NO_2 air quality goal ($33 \mu\text{g}/\text{m}^3$) is only exceeded within the area of Commodore Mine (Figure 7.4k). It is evident from the contour plots that the influence of Project emissions is minor, and that the exceedance is limited to the area of mine disturbance.

The concentration contours shown in Figure 7.4 are cumulative predictions, and include emissions from the Gore Highway, Warrego Highway, Commodore Mine and Millmerran Power Station.

Based on the limited areas outside the Project permanent disturbance footprint at which the annual average NO_2 air quality goal of $33 \mu\text{g}/\text{m}^3$ is predicted to be exceeded, and the influence of Project emissions on these areas, it is considered unlikely that significant impacts to ecological receptors will occur as a result of the operation of the Project.

7.4 Impacts to agriculture

The predicted maximum dust deposition levels for the worst affected receptors in the AQIA area are shown in Table 7.2. The worst affected receptor is receptor 539, with the predicted maximum cumulative deposition level being 50.1 mg/m²/day.

As discussed in Section 3.5, research on vegetation response to dust deposition impact has shown that a measurable reduction in crop growth is not observed below a dust deposition rate of 1,000 mg/m²/day (Doley, 2003), and that a deposition rate of up to 4,000 mg/m²/day does not influence the amount of feed that cattle eat or the amount of milk produced (Andrews & Shriskandarajah, 1992).

Based on the predicted dust deposition levels, with the maximum cumulative deposition level being 50.1 mg/m²/day, the impact of dust deposition on agricultural uses within the AQIA area is not anticipated to be significant.

In addition to deposited dust, NO₂ has the potential to impact agricultural uses (Section 2.4.2). However, as discussed in Section 7.3, there is limited area outside the Project permanent disturbance footprint at which the annual average NO₂ air quality goal of 33 µg/m³ (set for the protection of the health and biodiversity of ecosystems) is predicted to be exceeded. Based on the predicted annual average concentrations of NO₂ within the AQIA area, it is considered unlikely that significant impacts to agricultural receptors will occur as a result of emissions of NO₂ from the operation of the Project.

7.5 Odour from livestock trains

Odour emissions from agriculture freight train pass-bys are expected to be highly diluted due to the volume of air which will pass through and around the train over the duration of travel, and therefore odour emissions from moving agriculture freight trains are considered unlikely to cause significant nuisance impact.

Table 7.4 presents an assessment of odour impacts from livestock freight trains using the FIDOL factors described in Section 5.3.8. Livestock trains have the highest potential for odour to impact sensitive receptors (much greater potential than grain, as an example) and therefore have been adopted for the assessment of odour.

Table 7.4 Summary of FIDOL factors for odour generated by agricultural trains

FIDOL factor	Livestock trains
Frequency (F)	During peak operations, it is expected that a maximum of one livestock train per week will travel the Inland Rail Program alignment. As such, the frequency of the event is low, with an average of less than one livestock train per day during peak periods
Intensity (I)	Odour intensity is expected to range from strong to very strong for livestock trains
Duration (D)	Duration of exposure is expected to be short, with the time of exposure limited to the length of time taken for train pass-by (approximately 1 minute for a 900 m livestock train travelling at 60 km/h). At crossing loops, the exposure is expected to be longer (estimated average of approximately one hour) but will still be relatively short
Offensiveness (O)	The offensiveness of the odour is expected to be unpleasant
Location (L)	The land use of the receiving environment can be classified as mainly rural agricultural and residential for the larger town centres of Yelarbon, Inglewood, Millmerran, Pittsworth, Southbrook, Kingsthorpe and Gowrie. Due to the land use of the receiving environment intermittent odour from agricultural activities and livestock is unlikely to be uncommon to the existing ambient air environment. People living and visiting rural areas are expected to have a higher tolerance for rural activities and their associated effects, such as odour.

It is expected that odour produced from passing trains or trains stopped at crossing loops could be of high intensity and offensiveness, depending on the separation distance of the nearest sensitive receptors and the sensitivity of the receptor to odour. However, impacts are expected to be infrequent and of a short duration (one hour or less). The Project is located in a predominantly rural area where intermittent odour from agricultural uses are likely to be common to the existing ambient air environment, therefore the sensitivity of the AQIA area to intermittent agricultural odour events is expected to be lower than for more urban environments.

Odour impacts can be cumulative if odour emitted by multiple sources is of the same character (the same type of odour). Although intermittent agricultural odour is expected to be common to the existing ambient air environment, the potential for significant cumulative odour impacts is considered to be low due to the short duration of a train pass-by event (Table 7.4).

Based on the reasoning provided, odour emissions from agriculture freight are unlikely to result in significant impacts to sensitive receptors within the AQIA area.

7.6 Q-Fever

Livestock have the potential to carry *Coxiella burnetii* (*C. burnetii*) bacteria, which can cause Q-Fever in humans (Queensland Health, 2019). Presently there is no plan for livestock trains to use the alignment. However, livestock train services have operated historically between Goondiwindi and Warwick and therefore for the purpose of the assessment of the Project it has been conservatively assumed that one livestock train per week may use the alignment.

C. burnetii bacteria are most prevalent in animal products including birthing tissues such as placenta, blood, urine, faeces, bedding and soils contaminated by these wastes (EPA Victoria, 2020). *C. burnetii* can survive harsh conditions and can attach to dust particles (Reedijk, Leuken, & Hoek, 2013) which can be inhaled by humans, resulting in the on-set of Q-Fever. The EPA Victoria guideline *Q-Fever: Guidance for Preparing Planning Approvals* (2020) states that at least 50 per cent of infected humans are asymptomatic. However, symptoms include fever, sweating, nausea, headaches, vomiting and diarrhea, with extreme fatigue seen in 5 to 20 per cent of cases, pneumonia seen in 1 to 2 per cent of cases and approximately 5 to 15 per cent of acute cases becoming chronic (Queensland Health, 2019).

Clark and Magalhaes (2018) indicated that *C. burnetii* bacteria can travel up 18 km on gale force winds, with the highest risk areas being in rural areas within 5 km of sources such as stockyards and abattoirs. The study also concluded that the species of livestock which most strongly correlated with Q-Fever outbreaks were sheep and goats, rather than cattle.

EPA Victoria (2020), provides guidance on assessing the risk of Q-Fever infection from new developments. The guideline indicates that high risk areas for Q-Fever are workplaces, such as such as abattoirs, knackeries, tanneries, dairy/animal farms, saleyards, or farmland located near residential communities, with workers having the highest risk of being exposed. The guidelines reference three thresholds where referrals for works approval is required to consider Q-Fever risk, these include the following:

- Animal industries, if greater than 5,000 animals
- Livestock saleyards or holding pens
- Abattoirs.

In contrast to the Project, each of these threshold activities represent a static and high-risk source of *C. burnetii* bacteria. The EPA Victoria guideline also states that risk groups are workers at high-risk workplaces (abattoirs, farmland), and that risks to the public are higher when the following factors increase:

- Size of facility and number of animals involved
- Birthing activity at a site such as intensive dairy farming
- Type of livestock; goats and sheep may be a higher risk than cattle (Clark and Magalhaes, 2018)
- Proximity to sensitive land uses and unvaccinated individuals
- Wind speed and direction
- Local topography, rainfall, vegetation cover which may contribute to the overall 'dustiness' of an area.

The Project represent a transient, intermittent and infrequent potential source of *C. burnetii* bacteria, and does not include high risk factors such as birthing activity or the transport of goats or sheep.

It is noted that as part of the assessment of Q-Fever risk, Queensland Health was consulted. Queensland Health advised that the risk of Q-Fever infection from livestock trains would be 'broadly similar to a road train transporting cattle' (Flynn, 2021).

Overall, based on the guidance provided in the EPA Victoria guideline, the transport of livestock along the Inland Rail Program alignment is considered to present a low level risk for Q-Fever.

8 Mitigation measures and monitoring

This section outlines the air quality mitigation measures that have been identified and incorporated into the design for the Project (Section 8.1), in addition to those that will need to be implemented through future stages of the Project (Section 8.2). It also discusses the air quality monitoring which will be undertaken to support the Project.

No comprehensive guideline information is currently available for best practice environmental management measures for the emissions of air pollutants from construction related emissions in Queensland or Australia. Guidance on management measures is provided within the UK IAQM (2014). The proposed mitigation measures for the Project align with the suggested mitigation measures from the UK IAQM guideline document.

In addition to the UK IAQM guideline document, the mitigation measures proposed for the construction works stage of the Project are also generally consistent with construction mitigation measures prescribed by the New Zealand Ministry for the Environment *Good Practice Guide for Assessing and Managing Dust* (2016) and the NSW EPA *Air quality guidance note for construction sites* (2017), which are both recognised technical guideline documents.

Mitigation measures prescribed in the *NPI Emission Estimation Technique Manual for Mining* (Department of Sustainability, Environment, Water, Population and Communities, 2012) are also considered applicable for the construction works stage, and selected mitigation measures from this document are proposed.

The mitigation measures that are identified are considered to represent best practice environmental management of air emissions.

8.1 Mitigation through the revised reference design stage

Development of the design for the Project has progressed in parallel with the impact assessment process. As a consequence, design solutions for avoiding, minimising or mitigating impacts have been incorporated into the revised reference design as appropriate and where possible.

Mitigation measures and controls that have been factored into the design development, or otherwise implemented during the revised reference design stage of the Project are summarised in Table 8.1.

Table 8.1 Initial mitigation measures of relevance to air quality

Aspect	Initial mitigation measures
Emissions from refuelling activities during construction	■ The planning, siting and assessment of potential temporary fuel storage locations has taken into consideration the location of sensitive receptors to avoid potentially impacting sensitive receptors as far as practical
Emissions from construction vehicles	■ The horizontal and vertical alignment has been established to optimise the earthworks required and achieve as close to a net-balance as is possible. By minimising the material deficit for construction of the Project, the volume of material required to be imported has been reduced. Less imported material equates to fewer construction works stage truck movements and less vehicular emissions ■ Construction works stage haulage routes that provide the shortest journey time between origin and destination have been identified. These routes restrict fuel consumption and vehicular emissions. These routes have been assessed as part of the traffic impact assessment (EIS Chapter 20: Traffic, Transport and Access)
Fugitive dust emissions (windborne erosion) during construction and operation	■ The Project footprint has been established to provide the minimum clearing extents required to safely and efficiently construct and operate the Project, thus minimising the total extent of exposed area where possible ■ Laydown areas and other construction works stage facilities have been located to avoid impacts to environmental and social receptors ■ Embankment batters and other exposed surfaces have been designed to enable stabilisation to reduce fugitive dust emissions

Aspect	Initial mitigation measures
Emissions from operational locomotives	■ The Project has been co-located within existing road and rail corridors as much as possible, including being positioned within the existing South Western Line and Millmerran Branch Line rail corridors, to avoid introducing a new linear infrastructure corridor in proximity to receptors potentially sensitive to air emissions ■ The Project has been aligned to avoid, where possible, steep terrain and topographical constraints to provide for more efficient operational track geometry and grade. This results in faster train transit time and less locomotive emissions
Emissions from idling locomotives	■ Crossing loops at Yelarbon, Inglewood, Kooroongarra, Yandilla and Broxburn have been positioned to avoid, where possible, the exposure of sensitive receptors to diesel emissions from idling trains

8.2 Operations considerations

During operations, ARTC will be responsible for the management of access to the Inland Rail network by third party freight train operators and maintenance of the railway and other infrastructure components within the rail corridor.

Dust and air quality management measures will be incorporated into the environmental risk management frameworks that will apply to third party freight train operators as part of network access agreements. The network access agreements established with ARTC will require train operators to prepare suitably detailed environmental management plans for their operations to detail how the operator will manage all foreseeable risks. These plans will include clear performance requirements and traceable corrective measures and be subject to verification and auditing by the rail network manager.

ARTC presently have no foreseeable market-driven demand for coal to be transported on the Inland Rail network between NSW/QLD border to Gowrie. However, should this change during operations in the future, the potential for coal dust generation would require management by a Coal Dust Management Plan (CDMP).

Should coal be planned to be transported as part of future operations, prior to transportation of coal, engagement would be undertaken with stakeholders and members of the South West Supply Chain regarding coal dust management and monitoring requirements necessary to maintain the integrity of the existing South West Supply Chain CDMP (2019).

Mitigation measures for fugitive emissions from residual coal dust will be included in the form of a CDMP. Such commitments that already exist in the South West Supply Chain CDMP (2019) among varying stakeholders in the coal supply chain include but are not limited to:

- Providing support and/or funding to air quality monitoring programs
- Speed restrictions in high risk areas
- Coal washing prior to entry on to the network
- Covered in-load dump stations and enclosed conveyors
- Video and LIDAR technology to monitor levels of residual coal remaining in wagons
- Use of water fogging sprays at the rail receipt hoppers
- Monitoring of sills of wagons prior to return journey along the supply route
- Dust monitoring at the port and along the supply route.

ARTC believes that the combination of all of these activities as well as others listed in the South West Supply Chain CDMP (2019) are adequate to reduce the exposure to airborne particulates. Should monitoring, further risk assessment or otherwise suggest the risk to exposure has increased along the alignment, ARTC will investigate other practical mitigation measures with the responsible rail user.

8.3 Proposed mitigation measures

To manage and mitigate the Project's risks, several mitigation measures have been proposed for implementation in future stages of Project delivery. Potential impacts and corresponding mitigation and management measures for the detailed design, pre-construction activities and early works, construction works and operations stages of the Project are included in Table 8.2.

Dust and air quality management measures will be incorporated into the environmental risk management frameworks that will apply to third party freight train operators as part of network access agreements. The Project network access agreements established with ARTC as the rail network manager will require train operators to prepare suitably detailed environmental management plans for their operations to detail how the operator will manage all foreseeable risks. These plans will include clear performance requirements and traceable corrective measures and be subject to verification and auditing by the rail network manager.

Table 8.2 identifies the relevant Project stage, the aspect to be managed and the proposed mitigation measure. For this purpose, proposed mitigation measures of relevance to pre-construction activities and early works and construction works stage activities have been combined. For several of the mitigation measures proposed, the expected control efficiency (emission reduction percentage) has been nominated. The control efficiencies reported have been obtained from the *NPI Emission Estimation Technique Manual for Mining* (Department of Sustainability, Environment, Water, Population and Communities, 2012)

Requirements for construction water for dust suppression have been evaluated as part of the constructability assessment undertaken for the Project. Water demand for the construction of the Project has been estimated allowing for water application for dust suppression for:

- Material conditioning (pre-wetting)
- General dust suppression across the construction footprint
- Haul road and laydown area maintenance
- Concrete batching
- Trackwork (ballast laying, tamping and regulating).

Based on the forecast construction schedule and the adopted water allowances, expected water demand along the alignment and over time has been estimated to assist in understanding and planning for the demand for construction water.

Several construction water sources have been identified as part of constructability assessments. Sources of construction water will be finalised as the construction approach and schedule is refined during the detailed design stage of the Project, and will be dependent on:

- Climatic conditions in the lead up to construction
- Confirmation of private water sources made available to the Project by landholders under private agreement
- Access agreements with local governments.

There are a number of mitigation measures presented in Table 8.2 which can be deployed in adverse conditions, for example, during dry periods or unfavourable wind conditions. As an example, the mitigation measures which could be employed under adverse conditions include:

- Dry conditions:
 - Increase the application of water to stockpiles, unsealed haul roads and exposed areas where there is significant risk of wind erosion and fugitive dust emissions. If required, apply temporary ground-stabilising treatments
 - If water application is not practical, cover exposed areas with an impermeable covering (i.e. tarpaulin)
 - Avoid or reduce the intensity of high magnitude dust generating activities such as blasting and ground-disturbing activities including excavation and vegetation clearing

- Move the active works location to an area which has significant separation distance to sensitive receptors and where the risk of dust impact is lower.
- Strong or adverse wind conditions (wind direction blowing from source to nearby sensitive receptor):
 - Avoid or reduce the intensity of works in areas which are upwind of the nearest sensitive
 - Move the active works location to an area which is not upwind of the nearest sensitive receptor, or is benefitted by wind breaks (either natural or Project related)
 - Increase the application of water to stockpiles and unsealed road sections located upwind of the nearest sensitive receptor. If required, apply temporary ground-stabilising treatments, and
 - Avoid ground-disturbing activities including excavation and vegetation clearing.

The mitigation measures presented in Table 8.2 have been factored into the assessment of residual significance, as documented in Table 9.1.

Table 8.2 Air quality mitigation and management measures for future stages of Project delivery

Delivery stage	Aspect	Mitigation and management measures
Detailed design	Potential impacts to sensitive receptors and special areas	- Assessment of the potential for air quality and odour impacts to the intrinsic value of Indigenous Heritage sites will be undertaken prior to construction. If the assessment determines the potential for significant impact, mitigation and management measures would be recommended to reduce the likelihood of and potential for significant impacts to occur. - Quantitative assessment of potential dust impacts from major construction works areas in proximity to sensitive receptors will be completed prior to construction when more detailed construction information is available, which will inform the Air Quality and Dust Management Plan. The assessment will include the following: - An estimate of construction emissions, with a focus on major earthworks, as earthworks activities typically generate the highest quantities of dust. The assessment will be limited to activities occurring along the alignment. - A focus on construction work required near Yelarbon (Ch 25 km), Brookstead (Ch 154 km) and Pittsworth (Ch 173 km), which are the most populated locations adjacent to the alignment - Activity rates based on the expected average earthworks intensity, as dust deposition has a monthly average criterion. - Design of fuel storage areas will ensure that fuel tanks will be located at least 50 m from the nearest sensitive receptor, with separation distances maximised as far as practical within site restrictions.
	Availability of water for dust suppression and stabilisation during construction	- Prior to construction, quantities of water required for dust suppression, construction, landscaping and stabilisation activities will be confirmed. The availability and suitability of water supply sources will be determined and where water supply is deemed insufficient or in high demand for other uses, other dust suppression and stabilisation methods will be implemented. These alternative methods may include: - Chemical dust suppressants - Covering stockpiles - Construction of wind breaks.
	Emissions from construction vehicles	- Haulage routes and access roads will be confirmed for construction of the Project based on the shortest and safest trafficable route for each vehicle type, in consultation with relevant road managers, to minimise vehicular emissions - Planning of access and haulage routes will seek to maximise the use of sealed trafficable surfaces, where appropriate, and to locate access and haulage routes away from sensitive receptors - Additional geotechnical data will be used to refine the earthworks balance for the Project by providing further confirmation on the expected quantities of suitable and unsuitable material. The objective of refinement will be to further minimise the material deficit for construction of the Project, thereby reducing the number of vehicular movements as part of the mass haul task. - Opportunities to treat and re-use otherwise unsuitable materials will be identified and assessed for applicability with the objective of minimising vehicular movements, and emissions, for offsite disposal - Opportunities for the use of ethanol blend fuels during construction will be investigated. These opportunities will be adopted if found through investigation to be beneficial and if it is practical to do so.

Delivery stage	Aspect	Mitigation and management measures
	Fugitive dust emissions (windborne erosion) during construction and operation	■ Baseline dust deposition data will be acquired during detailed design in proximity to Commodore Mine (e.g. from Ch 120.0 km to Ch 28.0 km) post EIS approval. This baseline data will enable comparison with dust deposition data obtained during construction of the Project. Dust deposition monitoring will be completed at a small number of locations (< 5) adjacent to the Commodore Mine and nearby sensitive receptor locations. Monitoring will occur for a period of at least three months, and will aim to collect data representative of dust generating activities that occur at the mine to provide baseline data on the existing air environment. This data will provide an indication of the impact on the local air quality from the nearby Commodore Mine and Millmerran Power Station. Dust deposition monitoring will be conducted in accordance with <i>AS/NZ 3580.10.1:2016 – Method 10.1: Determination of particulate matter - Deposited matter - Gravimetric method</i> (Standards Australia and Standards New Zealand, 2016c). ■ During the construction works stage, additional monitoring for dust and other pollutants will be maintained in key locations adjacent to sensitive and susceptible urban and semi-urban locations, including Yelarbon, Brookstead and Pittsworth. Detailed monitoring plans will be developed in conjunction with construction planning and informed by water availability studies. ■ Development of an Air Quality and Dust Management Plan prior to construction commencing. The Air Quality and Dust Management Plan will include the following measures, tailored to be specific to the construction methodology, once confirmed: – Minimise major dust generating activities, (e.g. blasting or material loading/unloading), during high wind speeds where practicable – Routing roads away from sensitive areas wherever practically possible: ■ Residential dwellings and caravan parks ■ Motels/hotels ■ Schools and kindergartens ■ Medical centres ■ Public parks and recreation areas – Restricting vehicle speeds on unsealed haul roads to reduce dust generation, (e.g. to sign-posted speeds on public roads or to construction site speed limits on construction tracks), nominally 40 km/hr – to be determined through consultation with the relevant local government and documented in the Project Traffic Management Plan. – Further speed restrictions on construction tracks (e.g. from 40 km/hr to 20 km/hr) where the trafficable surface is within 200 m of a sensitive receptor – Long-term stockpiled material will be covered or seeded to prevent wind erosion from the prevailing wind – Regular cleaning of machinery and vehicle tyres to prevent track-out of dust onto public roads – Installation of rumble grids or similar at locations where construction traffic departs from the construction site and joins the public road network – Internal construction roads will be appropriately surfaced as soon as possible after the commencement of site activities – Revegetating disturbed areas as soon as practicable, in accordance with the Rehabilitation and Landscaping Management Plan – Vehicles and equipment will be appropriately maintained to maximise fuel efficiency – Visual monitoring of the effectiveness of dust controls will occur on a daily basis. ■ Define and design temporary access tracks to minimise dust generation, (e.g. appropriate surface treatments for the predicted construction traffic movements, installation of rumble grids, concrete pads or other physical measures to reduce track-out

Delivery stage	Aspect	Mitigation and management measures
		- Establish designated stockpile locations within the Project corridor - If required, ensure use of lime in construction does not create lime dust nuisance by way of targeted mitigations. Dust mitigation will be implemented by storage of lime in enclosed containers when not in use, not applying in windy conditions, and controlled application near sensitive receptors.
	Carbon emissions reporting requirements	Emissions reporting requirements for the construction works stage will be confirmed during the detailed design stage and will respond to National Greenhouse and Energy Reporting requirements and the Sustainability Management Plan.
	Emissions from operational locomotives	The vertical alignment of the rail will be subject to refinement and confirmation through the detailed design. Opportunities to further optimise the track geometry will be assessed to reduce operational fuel consumption.
	Emissions from idling locomotives	- Detailed design of the railway corridor will be developed to minimise impacts to sensitive receptors from emissions from idling locomotives, through consideration of topography, gradients, landscaping treatments and other surface treatments where practical - The confirmation of the location of the five crossing loops for the Project will seek to minimise the number of receptors in proximity to each loop.
Pre-construction activities and early works and construction works ¹	Impacts to sensitive receptors	- If on-site wastewater treatment systems are required for non-resident workforce accommodation, these systems will be planned and positioned in accordance with separation distances consistent with the EPA Victoria guideline <i>Recommended separation distances for industrial residual air emissions</i> (2013) and operated and maintained in accordance with conditions of approval (sought separately to approval sought through the EIS). Based on the anticipated requirement for a treatment system with a capacity of 300 EP, and assuming that a mechanical or biological wastewater treatment system will be used, a minimum separation distance of 67 m to sensitive receptors will be provided. - Laydown areas and other construction facilities (e.g. concrete batching plant, flash-butt welding facility, stockpiles) will be planned so that sources of emissions, such as temporary fuel tanks, generator sets, stockpiles, travel routes, are positioned as far as possible from neighbouring sensitive receptors, within the confines of the construction footprint and considering prevailing wind directions. - Determine placement of workforce accommodation camps to consider nearby Project related emissions sources e.g. fuel tank storage, concrete batching plant, locomotive emissions from non-Project existing rail, fugitive emissions from construction, and considering the prevailing wind directions.
	Dust generation from earthworks, blasting, clearing and grubbing, construction activities, concrete batching and exposed areas within the construction footprint	- Limit clearing to the extent required to construct the works, in accordance with the Project footprint defined during detailed design - Stage clearing and grubbing activities to limit the size and duration of exposed areas - Implement controls to prevent or minimise dust generation during activities involving excavation or disturbance of soils or vegetation, or handling ballast e.g.: - Use of water sprays or water carts for dust suppression as required (anticipated emission reduction of 50 per cent for water sprays when loading to or from material stockpiles, anticipated emission reduction of 70 per cent when water sprays applied to trucks unloading material) - Installation of hoardings or barriers on worksite perimeters, where appropriate - Polymer sealing of access roads, or similar, where practicable within the construction worksites and ensuring sealed access roads into worksites are kept relatively dust free by regular sweeping and washing, wherever needed (significant emissions reduction can be achieved by polymer sealing subject to the method adopted, emission reduction of up to 100 per cent is claimed in technical literature but performance to this level is unrealistic in real-world application)

Delivery stage	Aspect	Mitigation and management measures
		– Conducting demolition activities using appropriate dust controls, such as water sprays – Installing truck wheel wash stations in designated laydown areas, to control the spread of unsuitable materials from worksites – Concrete batching plant to employ appropriate dust controls, such as water sprays, covering exposed areas as much as practical, and designing the orientation of the batching plant to limit the potential for impacts to the nearest sensitive receptors. The installation of fabric filters to cement silos would also significantly reduce fugitive dust emissions. Provide a minimum separation distance of 100 m to the boundary of sensitive receptors for concrete batching plants. ■ Will incorporate best practice policies with respect to spoil haulage including covering of loads when traversing roads to minimise and where possible avoid loss of loaded materials, rock debris and dust in the CEMP ■ Water used in dust suppression will be consistent with the quality requirements specified for irrigation and general water use in the <i>Australian and New Zealand Guidelines for Fresh and Marine Water Quality</i> (Australian and New Zealand Governments, 2018). Investigate suitable additives to the water to improve dust suppression effectiveness and minimise water usage. Adopt the use of additives where appropriate and compliant with relevant approvals and legislation (i.e. the addition of soil binders to water for dust suppression on roads or hard stand areas). ■ Stabilise disturbed areas and exposed surfaces as soon as practical following the completion of works in each area, in accordance with the Rehabilitation and Landscaping Management Plan. The following mitigation methods may be used subject to final purpose of the exposed area: – Initial establishment of vegetation (anticipated emission reduction of 30 per cent) – Maintained revegetation (anticipated emission reduction of 90 per cent) – Establishment of self-sustaining rehabilitation vegetation (anticipated emission reduction of 100 per cent) – Sealing of exposed surface (i.e. concrete, asphalt) (anticipated emission reduction of 100 per cent). ■ Long-term stockpiles will be avoided wherever possible. However, where necessary (e.g. topsoil), long-term stockpiles will be established in designated locations. Stockpiles will be positioned to minimise erosion by the prevailing wind. ■ Stabilise and protect long-term stockpiles from erosive processes whilst not in use, such as through impermeable cover or seeding. ■ To reduce wind erosion from stockpiles, the following mitigation methods may be used subject to water availability and stockpile activity: – Water sprays (anticipated emission reduction of 50 per cent) – Wind breaks or earthworks profiling (anticipated emission reduction of 30 per cent) – Application of rock armour/covering (anticipation emission reduction of 30 per cent) – Covering of the stockpile with an impermeable covering (i.e. tarpaulin) or binding agent (anticipated emission reduction of 100 per cent). If water sprays are implemented for stockpiles, the application rate of water will be increased for stockpiles which will receive new material regularly. ■ Dust emissions from blasting will be managed through avoiding blasting during adverse wind conditions. Blasting will not be undertaken if the prevailing wind direction and size of the blast is likely to transport dust emissions towards sensitive receptors within 500 m of the blast location. Blasting during periods of high wind speeds (>36 km/hr) will be avoided where practical as per the CEMP (EIS Chapter 24: Draft Outline Environmental Management Plan). To determine potential for impact at sensitive receptors, risk assessments will be undertaken prior to blasting events.

Delivery stage	Aspect	Mitigation and management measures
		- Direct exposure of construction workers to respirable silica and other airborne contaminants will be controlled through the use of appropriate Personal Protective Equipment in line with ARTC's procedure for <i>Personal Protective Equipment</i> (WHS-PR-009) (ARTC, 2022) (available on the ARTC extranet). - Construction speed limits will apply to all unsealed routes used by construction vehicles. Applicable speed limits for local government roads will be determined through consultation with the relevant local government and documented in the Project Traffic Management Plan - Minimising the requirement for vehicle movement outside worked areas, where practically possible. - Landowners will be notified in advance of the commencement of construction activities in an area proximal to them. This notification will be in accordance with community notification procedures established for the Project and will provide information on the types of activities that will occur, indicative scheduling and the potential impacts that may be experienced (e.g. generation of dust). - A complaint hotline for the Project will be established and advertised to enable members of the public to notify ARTC of issues, including the generation of excessive dust or other air emissions during construction. - In the event of a dust complaint, ARTC will: - In the first instance, investigate cause of the complaint and confirm details of the complaint with respect to the nature and severity of impact - Determine appropriate remedial action, where appropriate - Liaise with complainant over remedial action, liaise with administering authority if required - Implement appropriate remedial action, if required. - Maintain a complaints register relating to air quality, including record of remedial actions.
	Dust generation and deposition as a result of adverse weather conditions	- Avoid ground-disturbing activities during sustained windy conditions (i.e. winds > 36 km/hr over a period of 10 minutes or more, where appropriate). When this is not practical, implement additional management measures, such as enhanced watering of access roads (anticipated emission reduction of 50 to 75 per cent) and works areas to minimise the potential increase in dust generation as per the CEMP (EIS Chapter 24: Draft Outline Environmental Management Plan). - Monitor meteorological conditions at worksites and designated stockpile locations, particularly wind speed and direction. Implement additional dust suppression controls prior to the onset of adverse weather, including covering of stockpiles (anticipated emission reduction of 100 per cent for impermeable cover) and additional watering of access roads (anticipated emission reduction of 50 to 75 per cent). - Maintain and improve (if necessary) weather monitoring protocols to enable dust suppression activities to occur prior to the onset of adverse weather. - Will increase application of water to stockpiles and access roads where necessary during extended dry conditions.
	Cumulative effects of dust emissions from construction and external land uses or activities.	- Undertake dust deposition monitoring during the active period of construction in proximity to Commodore Mine, at locations where baseline data was collected (above), to determine if construction results in significant dust impacts. Dust deposition monitoring to be in accordance with AS/NZ 3580.10.1:2016 – <i>Method 10.1: Determination of particulate matter - Deposited matter - Gravimetric method</i> (Standards Australia and Standards New Zealand, 2016c). The results of construction dust deposition monitoring will be included in construction environmental reporting. - Advise the operators of the Commodore Mine of proposed construction activities scheduled to occur in proximity to the mine to enable coordinated consultation with potentially impacted stakeholders.

Delivery stage	Aspect	Mitigation and management measures
	Emissions from combustion engines (construction vehicles and generators)	■ Avoid queuing of the construction traffic vehicle fleet on public roads, which in turn would minimise the amount of exhaust emissions generated during construction works. ■ Marshalling and queuing of trucks and worksite vehicles to occur away from residential areas and other sensitive receptors, where possible. ■ Direct exhaust emissions from mobile and stationary plant away from the ground and sensitive receptors, where possible. ■ When locating temporary fuel storage, provide a minimum separation distance of 50 m from sensitive receptors and compliance with <i>AS 1940:2017 The storage and handling of flammable and combustible liquids</i> (Standards Australia, 2017). This is of particular relevance where laydown facilities are in proximity to sensitive receptors, (e.g. B2G-LDN006.3 on Yelarbon-Kurumbul Road). ■ Will minimise the use and intensity of use of diesel powered engines and vehicles, as much as practicable. ■ For stationary plant and equipment, ensure all diesel motors are fitted with emission control measures and are regularly maintained to manufacturer's specifications. ■ Turn off idling plant, equipment and vehicles when not in use. ■ Minimise haul distances between construction sites to spoil sites. ■ Implement a regular maintenance program to ensure equipment and construction fleet are maintained to manufacturer's specifications. ■ Use appropriately sized equipment for construction activities. ■ Procure energy efficient construction equipment, when appropriate and subject to availability. ■ Minimise waste from construction by procuring pre-fabricated products, where possible. ■ Where possible, use low energy intensity materials instead of high energy intensity building materials. ■ Implement a regular maintenance program so that equipment and construction fleet are maintained to manufacturer's specifications.
	Use of non-potable water for dust suppression	■ Water used in dust suppression will be of suitable quality and not result in environmental or human health risks, or impact rehabilitation outcomes. Water additives used to improve dust suppression effectiveness (e.g. the addition of soil binders to water for dust suppression on roads or hard stand areas) will be risk assessed prior to adoption.
	Fugitive dust emissions from vehicles transporting materials to and from site	■ Vehicles transporting material to and from the works site on public roads will cover loads to minimise the potential for wind-blown dust emissions and spillages. ■ Will implement road sweeping and washing of public road sections where earthen material has been deposited by construction vehicles to minimise dust generation. The need for sweeping and washing will be identified via visual observation. ■ Visually inspect vehicles entering/exiting the site and implement additional controls if corrective actions are required. ■ Install rumble grids, or similar, at the entry and exit points of laydown areas. ■ Site based construction traffic is limited to identified haul routes as per the Project Traffic Management Plan.

Delivery stage	Aspect	Mitigation and management measures
	Greenhouse gas emissions	■ Maintain construction equipment and vehicles to ensure engine efficiency and minimise fuel use and resulting emissions ■ Procure energy efficient construction equipment, when appropriate and subject to availability ■ Minimise waste from construction by procuring pre-fabricated products, where possible ■ Where possible, use low energy intensity materials instead of high energy intensity building materials ■ Reduce third party (Scope 3) emissions by sourcing imported materials from local areas, minimising travel distances ■ Reduce travel distances and fuel consumption on-site by planning construction haul roads and staging of related activities efficiently ■ Require minimising, as much as possible, the idling time of plant and equipment and switch engines off when not in use ■ Minimise the extent of vegetation cleared during construction to the clearing limits required ■ Recycle any waste produced where feasible.
Operations	Operation of and emissions from freight trains along the alignment	■ Before a train travels on the Inland Rail network, operators will make sure that the classes of dangerous goods, and the identification numbers of vehicles carrying dangerous goods, are recorded in the train consist documentation. Dangerous goods will be loaded, labelled, and marshalled in accordance with the <i>Australian Code for the Transport of Dangerous Goods by Road & Rail</i> (National Transport Commission, 2024). ■ If coal is to be transported in future operation years, the potential for coal dust generation will require management via a CDMP. The measures included in the CDMP will aim to minimise surface lift-off of materials in transit and establish protocols to minimise spillage onto external areas of wagons. The plan will be prepared in consultation with the relevant regulatory agency at the time. ■ If coal is to be transported as part of future operations, prior to transportation of coal, engagement would be undertaken with existing stakeholders and members of the South-West Supply Chain regarding coal dust management and monitoring requirements necessary to maintain the integrity of the existing South West Supply Chain CDMP (2019) and maintain compliance with the air quality objectives as prescribed in the EPP (Air).
	Emissions from combustion engines (maintenance vehicles and generators)	■ Maintenance plant, vehicles and machinery will be maintained and operated in accordance with manufacturer's recommendations to maximise fuel efficiency. ■ Minimise unnecessary travel between maintenance locations. ■ Turn off idling plant, equipment and vehicles when not in use.
	Stakeholder communication	■ Landowners will be notified in advance of the commencement of maintenance activities in an area proximal to them. This notification will be in accordance with community notification procedures established for the Project and will provide information on the types of activities that will occur, indicative scheduling and the potential impacts that may be experienced (e.g. generation of dust). ■ A complaint hotline for the Project will be established and advertised to enable members of the public to notify ARTC of issues, including the generation of excessive dust during operation and maintenance. ■ In the event of a complaint regarding air quality, ARTC will: – In the first instance, investigate cause of the complaint and confirm details of the complaint with respect to the nature and severity of impact – Determine appropriate remedial action, where appropriate – Liaise with complainant over remedial action, liaise with administering authority if required – Implement appropriate remedial action, if required.

Delivery stage	Aspect	Mitigation and management measures
		■ Maintain a complaints register relating to air quality, including remedial actions. ■ Monitor, record and audit complaints about dust and emissions in accordance with the relevant complaints management handling procedures.
	Fugitive dust emissions from vehicles transporting materials to and from site (e.g. for maintenance)	■ Awareness of operational personnel of the sensitivities with regard to elevated dust levels within and adjacent to the Project footprint. ■ Vehicles transporting material to and from the maintenance works site on public roads will cover loads to prevent wind-blown dust emissions and spillages. ■ Implementation of road sweeping and washing of public road sections where earthen material has been deposited by maintenance vehicles to minimise dust generation. The need for sweeping and washing will be identified via visual observation. ■ Visually inspect vehicles entering/exiting the permanent footprint and implement additional controls if corrective actions are required ■ During adverse wind conditions or extended dry conditions, visual inspection of stockpiles will be conducted and mitigation procedures implemented if required, such as increased watering.
	Greenhouse gas emissions	■ Investigate opportunities for reducing fuel consumption, for example through the use of electric vehicles ■ Maintain support vehicles and equipment to increase engine efficiency and minimise fuel use and resulting emissions ■ Plan and stage maintenance activities considering efficiency and fuel consumption ■ Investigate opportunities to reduce greenhouse emissions through the use of renewable energy ■ Regular auditing of operational performance with a view to progressively improving efficiency and reducing emissions through reduced fuel consumptions (e.g. reduced train idling time at crossing loops) ■ Periodic energy audits with a view to progressively improving energy efficiency ■ Monitor, audit and report on greenhouse gas emissions from relevant significant activities and emission sources, and the success of abatement measures ■ Develop a greenhouse gas emissions reduction plan, which may include the above recommendations, and a process for regularly reviewing new technologies to identify opportunities to further reduce emissions and energy use, consistent with best practice environmental management.

Table note:

1 Combined, as there is no distinction between mitigation measures applicable for pre-construction activities and early works and construction works stages of the Project

8.4 Monitoring

This section discusses the monitoring which has been undertaken for the Project (Section 8.4.1), and monitoring which is recommended as part of the construction works (Section 8.4.2) and operations (Section 8.4.3) stages of the Project.

Prior to the start of construction, an Air Quality and Dust Management Plan will be developed as a component of the CEMP.

The Air Quality and Dust Management Plan will be informed by a quantitative dispersion modelling assessment of potential construction dust impacts from major construction works areas. This quantitative assessment will be completed prior to construction when more detailed construction information is available. The scope of the assessment will be focused as follows:

- The focus of the assessment will be airborne particulates, PM₁₀, PM_{2.5} and deposited dust (derived from TSP)
- The focus of the modelling will be major earthworks, as earthworks activities typically generate the highest quantities of dust
- The assessment will focus on construction work required near Yelarbon (Ch 25 km), Brookstead (Ch 154 km) and Pittsworth (Ch 173 km), which are the most populated locations adjacent to the alignment
- Dust deposition monitoring will be undertaken at three locations as part of the assessment. This will be in Yelarbon, Brookstead and Pittsworth.
- Emission sources considered will be limited to those along the alignment. For example, haul vehicles would be assumed to be travelling along the alignment (e.g. up and back), and individual haul routes away from the alignment (e.g. to quarries) would not be considered.
- The focus of the assessment will be pollutants with 24-hour (PM₁₀ and PM_{2.5}) and monthly average (dust deposition) goals. It is expected that activity rates will be based on the expected average earthworks intensity (average determined by dividing quantity of earthworks by the length of program in working days) rather than maximum activity rates, as it is uncertain if realistic maximum activity information will be available.
- Annual average predictions are not proposed as there will be significantly greater uncertainty in long-term predictions due to the transitional nature of construction
- Models will be prepared for Yelarbon, Brookstead and Pittsworth, with two scenarios of these models investigated for each location: an unmitigated scenario and a mitigated scenario (six scenarios in total) considering the likely mitigation measures to be employed based on those presented in Section 8.3.

The outcomes of the quantitative assessment will be used to inform the implementation of mitigation measures and the deployment of dust monitoring during the construction works stage.

The Air Quality and Dust Management Plan will include commitments and requirements for air quality monitoring, including for dust deposition monitoring, real-time dust monitoring, reporting and the complaints and resolution process. It will also describe the corrective actions and additional mitigations that may be undertaken in response to an exceedance or complaint. ARTC will seek input from relevant stakeholders during the drafting of the Air Quality and Dust Management Plan regarding the process of establishing AQMSs and the auditing of complaints related to air quality.

8.4.1 Existing particulate matter monitoring

As discussed in Section 4.2, an air quality monitoring program was conducted for the Project consisting of the Inland Rail AQMS and Millmerran AQMS which both monitor PM₁₀ and PM_{2.5}. These monitoring stations were established near the alignment to assist the AQIA and provide monitoring data to understand air quality in the AQIA area.

The monitoring data obtained by the Inland Rail AQMS and Millmerran AQMS has been used in this AQIA. The monitoring data obtained by the Millmerran AQMS has been used to understand air quality in the area local to the Commodore Mine and Millmerran Power Station and guide the assessment of these existing emission sources, as discussed in Section 5.3.1.2. The monitoring data from the Inland Rail AQMS has been adopted as background for the assessment of cumulative impacts.

Monitoring data from Inland Rail AQMS and Millmerran AQMS will be used in the quantitative assessment of construction dust impacts to determine baseline concentrations (which would be added to predicted Project construction activity contributions to allow for cumulative assessment). Monitoring data from the Inland Rail AQMS and Millmerran AQMS may also be used to estimate the contribution of the Project in the event that airborne particulate monitoring is undertaken during the Construction Works stage (i.e. in response to a complaint).

8.4.2 Construction works stage monitoring

8.4.2.1 Weather conditions monitoring

To aid in the avoidance of dust generation during adverse weather conditions, weather forecasts and observations for adverse weather (e.g. winds greater than 36 km/h) will be monitored during the construction works stage of the Project.

During adverse weather conditions, enhanced management measures, such as increased water application and/or implementation of temporary stabilisation treatments will be implemented. Where these measures are ineffective, and where practical to do so ground-disturbing activities including excavation and vegetation clearing will be avoided during adverse wind conditions to limit the potential for significant dust generation and impacts off-site.

To assist with auditing and the analysis of air quality monitoring and complaints (if received), periods of adverse weather periods will be recorded in monthly environmental reports. Weather monitoring stations could be deployed along the alignment to assist in providing information on weather conditions.

8.4.2.2 Baseline dust deposition monitoring

Baseline dust deposition monitoring will be conducted prior to the commencement of construction. Baseline monitoring will be undertaken at Yelarbon, Brookstead, Pittsworth and in proximity to the Commodore Mine. This baseline data will enable comparison with dust deposition data obtained during construction of the Project.

Baseline monitoring is recommended for the area near Commodore Mine as this area has a higher potential for dust impacts due to the presence of an existing dust source (the mine). Baseline dust deposition monitoring data obtained will only be applicable to the area near the mine for the purpose of evaluating construction dust impacts, and will not be applied across the alignment.

Dust deposition monitoring will be completed at a small number of locations (< 5) adjacent to the Commodore Mine and nearby sensitive receptor locations. The exact locations of the monitoring will be determined following review of land access requirements. Monitoring will occur for a period of at least three months, and will aim to collect data representative of dust generating activities that occur at the mine, such as blasting, to provide baseline data on the existing air environment. This data will provide indication of existing (baseline) dust deposition at locations which may be impacted by the Commodore Mine and Millmerran Power Station.

Baseline dust deposition monitoring undertaken at Yelarbon, Brookstead and Pittsworth will be undertaken at a single location for each town as part of the quantitative dust modelling assessment discussed in Section 8.4.2.3. The dust monitoring at these locations will be undertaken for a period of at least one month. The results of the one month of monitoring will be referred to when evaluating predicted dust deposition levels from quantitative modelling.

Dust deposition monitoring will be conducted in accordance with AS/NZ 3580.10.1:2016 – *Method 10.1: Determination of particulate matter - Deposited matter - Gravimetric method* (Standards Australia and Standards New Zealand, 2016c).

8.4.2.3 Construction works stage monitoring

Monitoring near Commodore Mine

Dust deposition monitoring will continue to be conducted during the active period of construction in proximity to Commodore Mine, at locations where baseline data was collected (above), to determine if construction activity is resulting in significant dust impacts. Dust deposition monitoring will be undertaken in accordance with AS/NZ 3580.10.1:2016 – *Method 10.1: Determination of particulate matter - Deposited matter - Gravimetric method* (Standards Australia and Standards New Zealand, 2016c). The results of construction works stage dust deposition monitoring will be included in construction environmental reporting, as specified in EIS Chapter 24: Draft Outline Environmental Management Plan.

Monitoring near urban and semi-urban areas

In addition to air quality monitoring near the Commodore Mine, dust deposition monitoring will also be undertaken in urban and semi-urban areas including, but not limited to, the areas of Inglewood, Yelarbon, Pittsworth, Brookstead, Pampas and Gowrie Mountain. These more urban areas are of higher sensitivity for air quality impacts due to the increased density of sensitive receptors located near construction activity areas and associated dust emission sources. The monitoring locations used for the baseline monitoring (refer above) will be maintained if land access agreements allow. Where new locations are required, the exact locations for monitoring in urban and semi-urban areas will be determined after detailed design has commenced and following confirmation of land access requirements. Selection of the exact locations for the installation of dust deposition gauges will be undertaken by a suitably qualified air quality professional.

Further quantitative assessment of potential dust deposition at sensitive receptors from construction activity will be completed in future stages (prior to construction) when more detailed construction information is available as discussed in Table 8.2. The outcomes of this further assessment will be used to guide requirements for the locations of dust deposition monitoring in urban and semi-urban areas. For example, where quantitative assessment determines that construction activity in an area has the potential to exceed the Project's dust deposition goal (120 mg/m²/day – insoluble solids, monthly average), dust deposition monitoring will be undertaken at sensitive receptors near this activity area. Where multiple receptors are present at different orientations from the construction area, multiple dust deposition gauges will be deployed.

The Air Quality and Dust Management Plan will include commitments and requirements for air quality monitoring, including for dust deposition monitoring in urban and semi-urban areas.

In the event that dust deposition monitoring determines exceedance of the Project's air quality goal (120 mg/m²/day) at sensitive receptors, additional monitoring, including monitoring of airborne particulate concentrations (e.g. TSP or PM₁₀), may be required. If legitimate air quality complaints are received from locations which are not represented by the location of air monitoring stations, additional monitoring stations may be deployed or existing monitoring stations may be relocated.

In the event that dust deposition or airborne air quality monitoring determines exceedance of the Project air quality goals, corrective actions will be required to mitigate impacts and the minimise the risk of further exceedances. As a minimum, the corrective actions will include the following:

- Review of the air quality monitoring data to determine the period/s of exceedance, along with local weather conditions
- Review of Project and non-Project related emission sources that may have been responsible for, or contributed too, the measured exceedance
- Estimate the contribution of the Project to the measured exceedance using the baseline monitoring data collected

- Upon identification of Project related emission source, undertake a review of the mitigation measures implemented at the time when the exceedance was recorded
- Evaluate the effectiveness of mitigation measures and standard working procedures and adjust or enhance the application of mitigation measures to reduce construction emissions and minimise the risk of future exceedances
- Monitor the effectiveness of enhanced mitigation measures, and if required, reduce the intensity of construction works.

8.4.3 Operations stage monitoring

Quantitative air quality monitoring will be undertaken during the operations stage at a yet to be confirmed location(s) along the Queensland section of the Inland Rail alignment. This location may not be along the Project alignment.

Requirements for the AQMS, including the location of any monitoring stations will be discussed with the stakeholders of the South West Supply Chain, including DESI and DTMR. It is expected that the pollutant species monitored will include dust deposition and airborne concentrations of PM₁₀ and TSP. It is also expected that the monitoring station will be generally equivalent in nature to the existing monitoring stations operating as part of the South West Supply Chain CDMP.

The existing monitoring stations operating as part of the South West Supply Chain CDMP currently include continuous monitoring of airborne concentrations of TSP, PM₁₀ and PM_{2.5} at Cannon Hill, and dust deposition monitoring at Cannon Hill, Fairfield and Toowoomba.

The purpose of the operations stage air quality monitoring will be to ensure that the Project is meeting, and will continue to meet, its air quality goals (Table 3.1). The data collected will be compared against the Project's air quality goals and may also be analysed to measure trends over time, such as identifying train services or conditions leading to higher than typical concentrations of air pollutants.

The ongoing need for monitoring program and operation of the station will be reviewed after 3 years. The complexity of the monitoring may be reduced at that time to fewer pollutants, or ceased, if the following conditions are demonstrated:

- Measured concentrations are consistently low and consistent with predictions
- Measured concentrations are not expected to change significantly based on freight service forecasts
- Agreement is reached with stakeholders and relevant environmental regulators.

The location for the AQMS will be selected in accordance with the requirements of *AS/NZS 3580.1.1:2016 Part 1.1: Guide to siting air monitoring equipment* (Standards Australia and Standards New Zealand, 2016b). For example, the following are minimum requirements for a peak monitoring station measuring PM₁₀ or PM_{2.5}:

- Sample inlet height between 1.5 m and 15 m
- Unrestricted airflow of 180° around sample inlet with no obstruction between the major source and the sample inlet
- 10 m from any object with a height exceeding 2 m below the height of the sample inlet (trees are measured from the dripline)
- No extraneous sources nearby
- No trees between sampling inlet and source.

Other site considerations for monitoring stations include security from vandalism, access for transporting and maintaining equipment and electricity supply, if required. The site should also have regard to the local influence of meteorology and topography.

Coal trains will join the Inland Rail alignment east of the Project at Toowoomba (travelling eastbound). It is therefore likely that a monitoring site east of Toowoomba (i.e. not within the Project of the alignment, will be the most appropriate location as it will measure the impact of a higher number of freight services), covering the full range of potential sources including coal services.

The responsibility for the reporting of the monitoring data and the maintenance and ongoing operation of the monitoring station will be discussed with the stakeholders of the South West Supply Chain.

If a complaint related to air quality is received during the operations stage, additional monitoring may occur to investigate the complaint. Further actions will be undertaken following monitoring. Actions may include reporting the results of the monitoring, engaging with the complainant, reviewing the conditions which led to the complaint and which occurred during monitoring, and reviewing available mitigation measures.

In the event that exceedances of the Projects air quality goals are measured during the operations stage, corrective actions will be required to mitigate impacts and the minimise the risk of further exceedances.

Corrective actions which may be undertaken include:

- Review of the air quality monitoring data to determine the period/s of exceedance
- Review of Project and non-Project related emission sources which may have been responsible for, or contributed too, the measured exceedance
- Upon identification of Project related emission source, undertake a review of operational activities at the time when the exceedance was recorded
- Evaluation of the effectiveness of mitigation measures and standard operational procedures with respect to the potential for future exceedances.

Requirements for operations stage monitoring will be included in an Operational Environmental Management Plan which will be developed in future stages of the Inland Rail Program.

8.4.4 Operations stage – emissions reporting

Emissions reporting is to be undertaken where applicable. Emissions reporting requirements will be determined during the detailed design stage to be consistent with Infrastructure Sustainability Council and National Greenhouse and Energy Reporting requirements.

9 Impact assessment summary

Potential construction works stage impacts to air quality and sensitive receptors have been assessed qualitatively as presented in Section 6. Assessment of the residual impact of the construction works stage of the Project following the implementation of the recommended mitigation measures (Section 7.2) is presented in this section, with the outcomes presented in Table 9.1.

This section provides a summary of the potential significance of construction works stage impacts to air quality and sensitive receptors, before and after the application of mitigation measures. A quantitative (compliance) assessment has been undertaken for potential operations stage impacts, as predicted concentrations at sensitive receptors have been assessed against legislative and other nominated air quality goals (Section 3.5). Therefore, operations stage impacts are omitted from discussion in this section. The results of the quantitative assessment of potential operations stage impacts are detailed in Section 7 and mitigation measures for the operations stage are included in Section 8.3.

The initial significance assessment in Table 9.1 is undertaken on the assumption that the design considerations (or initial mitigation measures) factored into the revised reference design stage have been implemented.

Additional mitigation and management measures (Table 8.2) were then applied to future stages of the Project to further reduce the level of potential impact and derive a residual significance of impact.

The initial and residual significance of potential impacts are presented in Table 9.1 to demonstrate the effectiveness of mitigation measures. This table has been structured to maintain consistency with the IAQM methodology which is activity based and as such earthworks and track-out are assessed across both the pre-construction activities and early works and the construction works stage.

The IAQM construction dust assessment guidance states:

For almost all construction activity, the aim should be to prevent significant effects on receptors through the use of effective mitigation. Experience shows that this is normally possible. Hence the residual effect will normally be 'not significant'.

Consistent with the IAQM statement, it is expected that with effective implementation of the proposed mitigation measures the impacts to air quality with respect to dust deposition and human health will not be significant. Therefore, with effective implementation of the proposed mitigation measures the construction of the Project is not anticipated to significantly adversely impact the environmental values of human health and the aesthetic environment.

Table 9.1 Impact assessment for potential air quality impacts associated with construction

Activity	Aspect ¹	Potential impact	Receptor sensitivity	Initial significance ²		Residual significance ³	
				Emission magnitude	Significance	Emission magnitude	Significance
Demolition	All dust generating sources associated with demolition	Dust deposition	Medium	Small	Low	Small	Low
		Human health	Medium	Small	Low	Small	Negligible
Earthworks associated with pre-construction activities and early works and construction works stage	All dust generating sources associated with pre-construction activities and early works and construction works stage earthworks	Dust deposition	Medium	Large	Medium	Small	Low
		Human health	Medium	Large	Medium	Small	Low
Construction works stage	All dust generating sources associated with construction works stage for the Project	Dust deposition	Medium	Large	Medium	Small	Low
		Human health	Medium	Large	Medium	Small	Low
Track-out associated with pre-construction activities and early works and construction works stage.	All dust generating sources associated pre-construction activities and early works and construction works stage traffic associated with the Project	Dust deposition	Medium	Large	Medium	Medium	Low
		Human health	Medium	Large	Medium	Medium	Low

Table notes:

- 1 Refer to Table 8.2 for reference to the proposed additional mitigation measures relevant to each aspect.
- 2 Includes implementation of initial mitigation measures specified in Table 8.1.
- 3 Assessment of residual risk once the mitigation measures identified in Table 8.1 and Table 8.2 have been applied.

10 Cumulative impact assessment

It is a requirement for the Project that the potential for cumulative impacts be considered. This section provides a discussion on the potential for cumulative impacts in relation to air quality during the construction works stage of the Project. As stated in Section 5.4, the assessment of operations stage air quality impacts has incorporated the emission contributions of existing or planned developments that are, or are expected to be, a significant source of pollutants of interest that are also relevant to the Project (Section 5.3.1.2). The potential cumulative impacts to air quality during operation of the Project are presented in Section 7. Therefore, the cumulative impact discussion in this section is confined to construction works stage impacts.

10.1 Assessment matrix

The significance of construction works stage cumulative impacts has been determined by using professional judgement to select the most appropriate relevance factor for each aspect in Table 10.1. The sum of the relevance factors determines the impact significance and managing or monitoring requirement which are summarised in Table 10.2. For example, if an environmental value (such as air quality) is considered to have a probability of impact of 2, duration of impact of 3, magnitude/intensity of impact of 1 and a sensitivity of receiving environment of 1, the significance of impact would be classified as Medium ($2+3+1+1 = 7$), for which mitigation measures and specific management practices will likely be required.

Table 10.1 Assessment matrix

Aspect	Relevance factor		
	Low	Medium	High
Probability of impact	1	2	3
Duration of impact	1	2	3
Magnitude/Intensity of impact	1	2	3
Sensitivity of receiving environment	1	2	3

Table 10.2 Impact significance

Impact significance	Sum of relevant factors	Management or monitoring requirement
Low	1-6	Negative impacts need to be managed by standard environmental management practices. Monitoring to be part of general project monitoring program
Medium	7-9	Mitigation measures likely to be necessary and specific management practices to be applied. Targeted monitoring program required, where appropriate
High	10-12	Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Targeted monitoring program necessary, where appropriate

10.2 Cumulative impacts

A number of projects were initially identified as having potential to contribute to the cumulative impacts in combination with the Border to Gowrie Project. These projects are either currently operational, expected to under future expansion or are currently going through an approval process. A full list of projects, with a description of each, is presented in EIS Chapter 23: Cumulative Impacts. Dust is expected to be the primary pollutant emitted during construction. The IAQM guidance document specifies that receptors located 350 m or more from a dust generation source are expected to have a sensitivity to human health impacts that is 'Low' (Section 6.1). Therefore, for the purposes of this cumulative assessment, only projects that directly interface the Project and will have temporal overlap in construction or expansion activities have been considered. Only four projects have been identified to meet these criteria. These projects are listed in Table 10.3.

Table 10.3 Projects considered for the cumulative impact assessment

Projects	Location	Description	Construction dates
InterLinkSQ	13 km west of Toowoomba The northern limit of the Project is situated adjacent to the InterLinkSQ site	A 200 ha transport, logistics and business hub. Located on the narrow gauge regional rail network and interstate network. Located at the junction of the Gore, Warrego and New England Highways	First quarter 2022 to last quarter 2022 Assumed to continue development until Inland Rail is operational
Commodore Mine and Millmerran Power Station	Domville, Queensland Intersects the Project footprint, located primarily to the east	The Commodore Mine is an open cut coal mine which provides coal for the 850 MW Millmerran Power Station The Millmerran Power Station is a coal-fired power station that supplies enough electricity to power approximately 1.1 million homes	Operational Subject to annual maintenance shutdown and continual pit expansion. Also potential for coal reserves to be accessed beyond the current footprint
NS2B (Inland Rail)	Rail alignment from North Star, NSW to the NSW/QLD border Adjoins the Project at its southern limit	New 37 km rail corridor to connect North Star (NSW) to the QR South West Rail Line just over the NSW/QLD border	2021 to 2024
G2H (Inland Rail)	Rail alignment from Gowrie to Helidon, Queensland Adjoins the Project at its northern limit	New 26 km dual gauge track between Gowrie (north-west of Toowoomba) and Helidon (east of Toowoomba), extending through the Local Government Areas of Toowoomba and Lockyer Valley. The Project includes a 6.38 km tunnel to create an efficient route through the steep terrain of the Toowoomba Range	2024 to 2028

An assessment of cumulative impacts that may arise from the projects listed in Table 10.3 in combination with the construction of the Project is presented in Table 10.4, with a summary of how potential cumulative impacts would be managed.

This assessment has concluded that the construction works stage cumulative air quality impacts of the Project are expected to be of Low Significance. The following factors contributed to this determination:

- Impact assessment for the Project has concluded that mitigated air emissions from the construction of the Project pose a 'Low' risk of human health and dust deposition impacts (Section 9, Table 9.1)
- The emission sources of air pollutants during construction of the Project are expected to be activities that are reasonably short in duration and mobile. Therefore, no single sensitive receptor is expected to be subject to be medium- or long-term impacts.

Table 10.4 Cumulative impact assessment for air quality

Project	Potential cumulative impact	Impact characteristic	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
InterLinkSQ	Emissions of air pollutants, specifically dust (construction)	Probability of the impact	Medium (2)	6	Low	The potential for cumulative impacts during construction to air quality is considered to be low, therefore specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through the development and implementation of an Air Quality and Dust Management Plan, as a component of the CEMP for the Project ARTC will consult with InterLinkSQ regarding scheduling of construction activities to avoid the simultaneous undertaking of dust generating activities, where possible
		Duration of the impact	Medium (2)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Low (1)			
Commodore Mine and Millmerran Power Station	Emissions of air pollutants, specifically dust (construction)	Probability of the impact	Medium (2)	6	Low	The potential for cumulative impacts during construction to air quality is considered to be low, therefore specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through: - Development and implementation of an Air Quality and Dust Management Plan, as a component of the CEMP for the Project - Establish a local baseline for particulate matter, using data collected from the Millmerran AQMS - Undertake dust deposition (total suspended particulate [TSP]) monitoring, at locations where baseline data is collected, whilst construction activities occur in proximity to the Commodore Mine (e.g. where dust generating activities occur between Ch 120.0 km to Ch 128.0 km) - Consultation with InterGen regarding scheduling of construction activities to avoid the simultaneous undertaking of dust generating activities, where possible
		Duration of the impact	Medium (2)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Low (1)			

Project	Potential cumulative impact	Impact characteristic	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
NS2B (Inland Rail)	Emissions of air pollutants, specifically dust (construction)	Probability of the impact	Low (1)	6	Low	The potential for cumulative impacts during construction to air quality is considered to be low, therefore specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through the development and implementation of an Air Quality and Dust Management Plan, as a component of the CEMP for the Project A complaint hotline for the Project will be established and advertised to enable members of the public to notify ARTC of issues, including the generation of excessive dust or other air emissions during construction, either from a single project or a combination of adjoining Inland Rail projects
		Duration of the impact	Medium (2)			
		Magnitude/intensity of the impact	Medium (2)			
		Sensitivity of the receiving environment	Low (1)			
G2H (Inland Rail)	Emissions of air pollutants, specifically dust (construction)	Probability of the impact	Low (1)	6	Low	The potential for cumulative impacts during construction to air quality is considered to be low, therefore specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through the development and implementation of an Air Quality and Dust Management Plan, as a component of the CEMP for the Project A complaint hotline for the Project will be established and advertised to enable members of the public to notify ARTC of issues, including the generation of excessive dust or other air emissions during construction, either from a single project or a combination of adjoining Inland Rail projects
		Duration of the impact	Medium (2)			
		Magnitude/intensity of the impact	Medium (2)			
		Sensitivity of the receiving environment	Low (1)			

Table notes:

Relevance factors between 1 and 3 were determined using professional judgement to select most appropriate relevance factor for each aspect and summing the relevance factors

Sum of relevant factors definition:

- Low (1-6): Negative impacts need to be managed by standard environmental management practices. Monitoring to be part of general project monitoring program
- Medium (7-9): Mitigation measure likely to be necessary and specific management practices to be applied. Targeted monitoring program required, where appropriate
- High (10-12): Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Targeted monitoring program necessary, where appropriate

11 Conclusion

The objective of this AQIA has been to outline how the Project will be designed, constructed, operated and maintained in a manner to ensure protection of the environment, in particular air quality and environmental values which may be adversely impacted by air quality.

The AQIA consisted of the following tasks:

- Identification of typical and peak operation train movements for the year 2040
- An analysis of the expected construction and operation activities from an air quality perspective
- Identification of the relevant ambient air quality objectives that protect or enhance the environmental values of the air environment, and the adoption of air quality goals for the assessment
- Discussion of existing air quality and local meteorology
- Identification of potential sources of air emissions associated with the Project
- Identification of sensitive receptors within the AQIA area
- Identification of potential air quality impacts, through:
 - A qualitative risk assessment of particulate emissions from construction works
 - A quantitative dispersion modelling assessment of operational emissions associated with freight rail movements for peak train operations, including prediction of pollutant concentrations in water tanks.
- Identification of mitigation and management measures to minimise potential air quality impacts, and assessment of the residual impact with the implementation of these measures.

For the assessment of construction works stage impacts, a qualitative construction dust risk assessment was undertaken in reference to the *Guidance on the assessment of dust from demolition and construction* (UK IAQM, 2014). The risk of dust deposition and human health impacts resulting from particulate matter emissions was assessed based on the scale of construction activities and the proximity to sensitive receptors. The outcome of the assessment showed that the residual risk with the proposed mitigation measures is low or negligible. Consistent with the IAQM guidance, it is expected that with effective implementation of the proposed mitigation measures the impacts to air quality with respect to dust deposition and human health will not be significant. Therefore, with effective implementation of the proposed mitigation measures the construction of the Project is not anticipated to significantly adversely impact environmental values related to air quality

An Air Quality and Dust Management Plan, as a component of the CEMP, will be prepared for the construction works stage of the Project to manage potential impacts from dust emissions. The Air Quality and Dust Management Plan will nominate mitigation measures and outline requirements for air quality monitoring. The Air Quality and Dust Management Plan will be provided to relevant local government authorities for review. It is expected that implementation of mitigation measures and monitoring of the effectiveness of these mitigation measures will prevent exceedance of air quality goals and that the residual impact of construction dust with respect to dust deposition and human health will not be significant.

For the assessment of operations stage impacts, a quantitative dispersion modelling assessment was undertaken using the dispersion model CALPUFF. Diesel exhaust emissions from locomotives were estimated for projected peak train movements for the Project in the year 2040. Twelve months of representative meteorological input was developed for use in CALPUFF. Ground level concentrations of particulate matter, NO₂, VOCs, and heavy metals were predicted using CALPUFF at nearby sensitive receptors. The assessment predicted that cumulative pollutant concentrations and deposition levels would be below the relevant air quality goals at all identified sensitive receptors for all pollutants of concern. Based on the intention of the EPP (Air), the operation of the Project is not expected to impact environmental values significantly adversely, including human health.

Investigation into the deposition of pollutants at sensitive receptors and potential contamination of water tanks showed that predicted pollutant concentrations in tank water would be significantly lower than *Australian Drinking Water Guidelines* (NHMRC & NRMCC, 2011).

The impact of odour from agricultural trains has been assessed qualitatively using FIDOL factors. Odour emissions from agriculture freight are considered unlikely to result in significant impact to neighbouring sensitive receptors due to the frequency and duration of the odour generating event (train pass-by) and the predominantly rural nature of the AQIA area. The assessment has also found that based on the guidance provided by EPA Victoria (2020), the Project and the transport of livestock along the Inland Rail Program alignment presents a low level risk for Q-Fever.

Mitigation measures have been recommended for the construction works and operations stages of the Project. For the construction of the Project, emission sources will be transient and variable in nature and with differing proximity to sensitive receptors. Appropriate mitigation strategies are needed to address this variability. Key mitigation measures will be incorporated into the detailed design, construction works and operations stages of the Project.

The AQIA undertaken for the Project showed that with appropriate mitigation in place, the construction and operation of the Project can be managed in a way that air quality impacts to environmental values and sensitive receptors are maintained at an acceptable level.

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