CHAPTER 12

Air Quality

CALVERT TO KAGARU ENVIRONMENTAL IMPACT STATEMENT

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

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12.1 Scope of chapter

In this chapter, the potential impacts arising from the Calvert to Kagaru Project (the Project) on air quality are described, and mitigation measures to manage the identified potential impacts are established. The assessment of impacts has been undertaken considering relevant legislation, historical meteorological data and ambient air quality monitoring data, and has been undertaken via dispersion modelling.

A detailed description of the Project is provided in Chapter 6: Project Description. The underpinning technical report that details the air quality impact assessment is provided in Appendix L: Air Quality Technical Report.

This assessment was undertaken based on the methodologies and guidance in the following documents:

- *Application requirements for activities with impacts to air* (DES, 2019b), a guideline document under the *Environmental Protection Act 1994* (Qld) (EP Act) to support applications for activities with impacts to air
- *Approved methods for the modelling and assessment of air pollutants in New South Wales* (EPA, 2016), which provides statutory methods for modelling and assessing emissions of air pollutants in New South Wales (NSW)
- *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods for Modelling and Assessment in New South Wales* (OEH, 2011), which provides detailed guidance on selection of CALPUFF modelling variables
- *Guidance on the assessment of dust from demolition and construction* (Institute of Air Quality Management, 2014) from the United Kingdom Institute of Air Quality Management. This document provides a qualitative risk assessment process for the potential impact of dust generated from demolition, earthmoving, and construction activities.

12.2 Terms of Reference

This chapter addresses the relevant air quality Terms of Reference (ToR) for the Project, as summarised in Table 12.1. Compliance of the environmental impact statement (EIS) against the full ToR is documented in Appendix B: Terms of Reference Compliance Table.

TABLE 12.1: TERMS OF REFERENCE COMPLIANCE TABLE—AIR QUALITY

Terms of Reference requirements		Where addressed
Existing environment		
11.128	Describe the existing air quality that may be affected by the project in the context of environmental values.	Sections 12.3.3 and 12.5.2 Appendix L: Air Quality Technical Report, Sections 2.4 and 5
11.129	Discuss the existing local and regional air shed environment.	Section 12.5 Appendix L: Air Quality Technical Report, Section 5
11.130	Provide baseline data on local meteorology and ambient levels of pollutants for modelling of air quality. Parameters should include air temperature, wind speed and directions, atmospheric stability, mixing depth and other parameters necessary for input to the model.	Sections 12.5.1 and 12.5.2 Appendix L: Air Quality Technical Report, Section 5
11.131	The assessment of environmental values must describe and map at a suitable scale the location of all sensitive air receptors adjacent to all project components. An estimate of typical background air quality levels should be based on surveys at representative sites where data from existing DEHP monitoring stations cannot be reliably extrapolated.	Sections 12.5.2 and 12.5.5 Appendix L: Air Quality Technical Report, Section 4 and Appendix G
Impact assessment		
11.132	Describe the characteristics of any contaminants or materials that may be released as a result of the construction or operations of the project, including point source and fugitive emissions. Emissions (point source and fugitive) during construction, commissioning and operations are to be listed.	Sections 12.3.2, 12.4.2, 12.4.3 and 12.4.4 Appendix L: Air Quality Technical Report, Section 2.4

Terms of Reference requirements			Where addressed
11.133	The relevant air quality goals or objectives that will be adopted for the assessment should be clearly outlined as a basis of the assessment of impacts on air.		Section 12.3.3 Appendix L: Air Quality Technical Report, Section 3.6
11.134	The assessment of impacts on air will be in accordance with the EP Act, EP Regulation and EPP (Air) 2008 and reference to appropriate Australian Standards.		Sections 12.3[a] and 12.4 Appendix L: Air Quality Technical Report, Sections 3 and 4
11.135	Predict the impacts of the releases from the activity on environmental values of the receiving environment using recognised quality assured methods. The description of impacts should take into consideration the assimilative capacity of the receiving environment and the practices and procedures that would be used to avoid or minimise impacts. The impact prediction must:		Sections 12.4 , 12.6 and 12.8 Appendix L: Air Quality Technical Report, Sections 6, 7, 8 and 10
	(a)	address residual impacts on the environmental values (including appropriate indicators and air quality objectives) of the air receiving environment, with reference to the air environment at sensitive receptors. This should include all relevant values potentially impacted by the activity, under the EP Act, EP Regulation and EPP (Air)	Section 12.8 Appendix L: Air Quality Technical Report, Section 10
	(b)	address 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 public information is available	Sections 12.5.3 and 12.6.4 Chapter 22: Cumulative Impacts, Section 22.5.5 Appendix L: Air Quality Technical Report, Section 8
	(c)	include modelling of dust deposition rates and air pollutant concentrations on surfaces that lead to potable water tanks in the vicinity of the project. This modelling is to be in accordance with the Australian Drinking Water Guidelines (Australian Government 2011, updated October 2017).	Sections 12.4.4.5, 12.5.5 and 12.6.3.2 Appendix L: Air Quality Technical Report, Sections 4.5.3 and 7.2
	(d)	predict the human health risk, including impacts from possible air pollutant concentrations on surfaces that may lead to potable water tanks, and amenity impacts associated with emissions from the project for all contaminants covered by the National Environmental Protection (Ambient Air Quality) Measure or the EPP (Air).	Section 12.6 Appendix L: Air Quality Technical Report, Sections 6 and 7
Mitigation measures			
11.136	Describe the proposed mitigation measures to manage impacts to air quality, including potential impacts from coal trains and the predicted level of effectiveness.		Section 12.7 Appendix L: Air Quality Technical Report, Section 9
11.137	Describe how the proposed activity will be consistent with best practice environmental management. Where a government plan is relevant to the activity or site where the activity is proposed, describe the activity's consistency with that plan.		Section 12.7 Appendix L: Air Quality Technical Report, Section 9
11.138	Describe any expected exceedances of air quality goals or criteria following the provision and/or application of mitigation measures, and how any residual impacts would be addressed.		Sections 12.6, 12.7 and 12.8 Appendix L: Air Quality Technical Report, Section 6, 7, 9 and 10
11.139	Describe how the achievement of the objectives would be monitored, audited and reported and how corrective actions would be managed.		Section 12.7.4 Appendix L: Air Quality Technical Report, Section 9.4

Table notes:

a. The assessment has been undertaken in accordance with the EPP (Air) 2019 (refer Section 12.3)

Early engagement on the draft ToR resulted in the EIS requiring an assessment of potential pollutants in water tanks against *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018). 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.

12.3 Legislation, policies, standards and guidelines

12.3.1 Regulatory context

The legislation, policies, standards and guidelines relevant to air quality in the context of the Project are described in Table 12.2.

TABLE 12.2: REGULATORY CONTEXT

Legislation, policy or guideline	Relevance to the Project
National Environment Protection Council, *National Environment Protection (Ambient Air Quality) Measure* 2016	Federal measure that sets standards for six major air pollutants in Australia, specifically particulate matter less than 10 micrometres in diameter (PM_{10}), particulate matter less than 2.5 micrometres in diameter ($PM_{2.5}$), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3) and sulphur dioxide (SO_2). The standards for these pollutants have been considered in this air-quality impact assessment and where relevant adopted as Project air-quality goals.
National Environment Protection Council, *National Environment Protection (National Pollutant Inventory) Measure* 1998	The National Pollutant Inventory (NPI), regulated by the Australian Government, tracks pollution across Australia, to ensure that the community has access to information about the emission and transfer of toxic substances that may affect them locally. All major polluters are required by the Australian Government to submit annual reports of their emissions to air. Information available from the NPI regarding emission sources near the Project has been considered in this air quality impact assessment.
Queensland (QLD) Government, EP Act and Environment Protection Regulation 2019	State legislation and regulation that governs protection of environmental values in QLD. This regulation has been considered in the air quality assessment for the Project.
QLD Government, Environmental Protection (Air) Policy 2019 (EPP (Air))	Statutory instrument under the EP Act, to protect the environmental values of air. The air quality objectives in the EPP Air for the pollutants of concern have been adopted as Project air-quality goals.
QLD Government, EP Act—*Guideline: Application requirements for activities with impacts to air*, Department of Environment and Science, (2019b)	Guideline on information requirements for applications for activities with impacts to air. This guideline has been used to guide the methodology of this air quality impact assessment.
NSW Environment Protection Agency, *Approved methods for the modelling and assessment of air pollutants in NSW* (EPA, 2016)	Statutory methods for modelling and assessing air quality in NSW. Developed for NSW but adopted as technical guidance for the development of dispersion models Australia-wide and is referred to by the EP Act—*Guideline: Application requirements for activities with impacts to air as the guiding document for the modelling of air pollutants*. This document has been used to guide the methodology of this air quality impact assessment.
National Health and Medical Research Council & Natural Resource Management Ministerial Council *Australian Drinking Water Guidelines* (2018)	Provides guidance and criteria to water regulators and suppliers on monitoring and managing drinking water quality. The criteria from this document have been used for the assessment of impacts to drinking water.
QLD Government, *Policy for Development on Land Affected by Environmental Emissions from Transport and Transport Infrastructure Version 2*, (Department of Transport and Main Roads, 2017a)	Outlines the Department of Transport and Main Roads (DTMR) policy position on the development of land affected by environmental emissions (noise, vibration, air emissions and particles and light) from linear transport operations and infrastructure. This document has been used to guide the methodology of this air quality impact assessment.
NSW EPA *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods for Modelling and Assessment in New South Wales* (Barclay & Scire, 2011)	Document which provides detailed guidance on selection of CALPUFF modelling variables. Developed for NSW but also applicable for assessment in QLD. This document has been used to guide the methodology for the dispersion modelling undertaken for this air quality impact assessment.
UK IAQM *Guidance on the assessment of dust from demolition and construction* (2014)	This document provides a qualitative risk assessment process for the potential impact of dust generated from demolition, earthmoving, and construction activities. The methodology within this document has been used to assess air quality impacts from the construction of the Project.

Legislation, policy or guideline	Relevance to the Project
Brisbane City Council (BCC) *Air Quality Planning Scheme Policy* (BCC AQ Planning Scheme Policy) (Brisbane City Council, 2014)	This document provides guidance on assessment methodologies and air quality goals for air quality assessments undertaken for projects in the BCC local government area (LGA). Air quality goals from this policy have been used in this assessment.
Environment Protection Authority Victoria (VIC EPA) *Recommended separation distances for industrial residual air emissions* (EPA Victoria, 2013)	The guideline provides recommended separation distances for activities with emissions to air. The guideline is written by VIC EPA but is referenced in the QLD EP Act—*Guideline: Application requirements for activities with impacts to air* and is applicable for assessments in QLD.

12.3.2 Project air emissions

Based on the review of expected Project activities, applicable NPI emission estimation manuals, and EIS literature for similar rail projects, the air pollutants expected to be generated during the construction and operation phases of the Project are listed in Table 12.3.

During the construction phase, particulate matter deposited as total suspended particulates (TSP) and airborne concentrations of PM_{10} will be of primary concern. These pollutants have the potential for nuisance impacts if not correctly managed (UK IAQM, 2014). For construction activities, $PM_{2.5}$ 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 CO) and $PM_{2.5}$ from diesel construction vehicles and mobile plant 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 for the construction phase.

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

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

The primary source of air pollution during the operation of the Project will be point-source locomotive engine exhaust. The gaseous pollutants contained in the exhaust are produced as a product of diesel combustion and include NO_x, PM_{10}, $PM_{2.5}$, VOCs, and polycyclic aromatic hydrocarbons (PAHs). In addition to diesel combustion, fugitive coal dust emissions (TSP, PM_{10}, $PM_{2.5}$ and dust deposition) are also considered to have the potential to impact sensitive receptors and have been assessed for the operation phase.

Given the uncertainty associated with timeframe for decommissioning, this phase has not been considered in this air quality impact assessment.

A detailed description of each pollutant can be found in Appendix L: Air Quality Technical Report.

TABLE 12.3: POLLUTANTS CONSIDERED DURING THE AIR QUALITY ASSESSMENT

Pollutant	Description[a]
TSP	TSP refers to airborne particles ranging from 0.1 micrometres (μm) to 100 μm in diameter. Furthermore, if the particles contain toxic materials (such as lead, cadmium, zinc), toxic effects can occur from inhalation of the dust. Also, dust can cause nuisance impacts by settling on surfaces and possessions, affecting visibility, and contaminating tank water supplies
PM_{10}	Particulate matter less than 10 μm in diameter (PM_{10})
$PM_{2.5}$	Particulate matter less than 2.5 μm in diameter ($PM_{2.5}$)
NO_x	NO_x describes a mixture of nitric oxide and NO_2. NO_x is colourless at low concentrations but has an odour
NO_2	NO_2 is a brownish gas with a pungent odour. It can cause damage to the human respiratory tract, increasing a person's susceptibility to respiratory infections and asthma. Sensitive populations, such as the elderly, children, and people with pre-existing health conditions are most susceptible to the adverse effects of NO_2 exposure

Pollutant	Description[a]
CO	CO is a colourless, odourless gas formed when substances containing carbon (such as petrol, gas, coal and wood) are burned with an insufficient supply of air. Concentrations of CO normally present in the atmosphere are unlikely to cause ill effects and therefore have not been considered in the assessment
VOCs	VOCs are carbon-based chemicals that readily evaporate at room temperature, including xylene, toluene and benzene
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 or diesel
Trace metals including arsenic, cadmium, lead, nickel and chromium VI	Heavy metals such as cadmium, lead, and mercury are common air pollutants that are typically emitted from industrial activities and fuel combustion. Fugitive coal dust emissions from rail transport along the alignment have potential to be deposited on surfaces that lead to rainwater tanks. Coal may contain many traces of these elements
Odour	Odour emissions can be either a single pollutant species or a mixture of species that have the potential to affect environmental amenity and cause nuisance
SO_2	SO_2 is a colourless gas with a sharp, irritating odour. The air quality impact assessment (AQIA) assumes low sulphur content fuel as per the requirements of Commonwealth legislation (Department of Agriculture, Water and the Environment (DAWE), *Fuel Quality Standards Act 2000* (Cth)) (DAWE, [Fuel Standard (Automotive Diesel) Determination], 2001). The regulation of low sulphur content fuel in Australia has significantly decreased the generation and concentrations of SO_2 near transport sources. Due to the low likelihood of significant impact, SO_2 has not been considered in this assessment.
O_3	O_3 is not emitted directly from fuel combustion, but rather is a secondary pollutant formed via chemical reaction of other pollutant species in the local atmosphere. Assessment of the formation of ozone and other secondary pollutants has not been considered in this assessment.

Table notes:

a. The descriptions in Table 12.3 have been derived from the information provided on the Department of Agriculture, Water and the Environment National Pollutant Inventory website and the NSW Department of Planning, Industry and Environment website (**environment.nsw.gov.au**).

12.3.3 Environmental values and air quality objectives

The EPP (Air) was prepared by the QLD Government to achieve the objectives of the EP Act in relation to the air environment. The air environment in QLD is enhanced or protected via air quality objectives for environmental values. The EPP (Air) does not apply to workplaces and the air quality objectives are intended to be progressively achieved over the long term. A summary of the air quality objectives relevant to the Project is provided in Table 12.4.

The EPP (Air) achieves the purpose of the EP Act by:

- 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**
- The qualities of the air environment that are conducive to **human health and wellbeing**
- The qualities of the air environment that are conducive to protecting the **aesthetics of the environment**, including the appearance of buildings, structures and other property
- The qualities of the air environment that are conducive to **protecting agricultural use** of the environment.

No dust deposition objectives are prescribed in the EPP (Air); however, the QLD Department of Environment and Science (DES) commonly set a guidance deposition rate of 120.0 milligrams per square metre per day (mg/m^2/day) averaged over 1 month for environmental authorities based on research into community complaints for coal-related projects. Although this deposition limit is not a legislative requirement, it is frequently used in QLD (DES 2019b) and is considered to be an appropriate criterion.

Where air quality objectives for identified pollutants are not included in the EPP (Air) and National Environment Protection Measures (NEPM) legislation, criteria has been sourced from NSW Environment Protection Authority (NSW EPA, 2016) and the Brisbane City Council's *Air Quality Planning Scheme Policy* (BCC, 2014).

The environmental values listed in Table 12.4 that are being protected by each proposed air quality goal are listed for objectives from the EPP (Air) Policy and the NEPM legislation. The environmental values protected through meeting these air quality objectives include the following:

- Health and wellbeing
- Aesthetic of the environment.

The EPP (Air) also includes air quality objectives to protect the environmental values of the health and biodiversity of ecosystems and to protect agriculture. Pollutants which have objectives to protect the health and biodiversity of ecosystems include fluoride, NO_2, O_3 and SO_2. Fluoride, O_3 and SO_2 also have objectives to protect agriculture.

Fluoride, O_3 and SO_2 are not pollutants of concern for the assessment (refer Section 12.3.2) and therefore the impact of these pollutants on the health and biodiversity of ecosystems and on agriculture does not require consideration. The EPP (Air) does have a NO_2 air quality objective for the health and biodiversity of ecosystems. As discussed in Section 12.5.5, there are no protected areas under the *Nature Conservation Act 1992* (Qld), the *Marine Parks Act 2004* (Qld) or a world heritage area located within 2 km of the alignment, and therefore the impact of NO_2 on the health and biodiversity of ecosystems has not been considered.

The air quality goals adopted for the Project are assessable against the cumulative impact of Project and non-Project air emission sources. The ToR (refer Table 12.1) also requires a cumulative assessment. Cumulative impacts have been assessed through consideration of background air quality and non-Project emission sources. Discussion of background air quality and non-Project emission sources is in Section 12.5.

TABLE 12.4: PROPOSED AIR QUALITY GOALS

Pollutant	Air quality goal (µg/m³)	Averaging period	Environmental value	Source
NO_2	250	1 hour[a]	Health and wellbeing	EPP (Air)
	62	Annual	Health and wellbeing	EPP (Air)
TSP	90	Annual	Health and wellbeing	EPP (Air)
PM_{10}	50	24 hours[b]	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/m³	Annual	Health and wellbeing	EPP (Air)
Cadmium and compounds (measured as the total metal content in PM_{10})	5 ng/m³	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/m³	Annual	Health and wellbeing	EPP (Air)
Chromium (III) compounds (as PM_{10})	9	1 hour	n/a	NSW Environment Protection Authority
Chromium (VI) compounds (as PM_{10})	0.1	1 hour	Screening health risk assessment	Brisbane City Council Air Quality Planning Scheme Policy
	0.01	Annual	Screening health risk assessment	Brisbane City Council Air Quality Planning Scheme Policy
1,3-butadiene	2.4	1 hour	Health and wellbeing	EPP (Air)
Benzene	5.4	Annual	Health and wellbeing	EPP (Air)

Pollutant	Air quality goal (µg/m³)	Averaging period	Environmental value	Source
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)
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 ng/m³	Annual	Health and wellbeing	EPP (Air)
Polychlorinated dioxins and furans	3.0×10^{-8}	Annual	Screening health-risk assessment	Brisbane City Council Air Quality Planning Scheme Policy
Dust deposition	120 mg/m²/day	Monthly	Nuisance	DES recommended[c]

Table notes:

µg/m³ microgram per cubic metre
ng/m³ nanogram per cubic meter
mg/m²/day milligram per square metre per day
a. Not to be exceeded more than one day per year
b. The 2019 version of the EPP (Air) does not allow for any exceedances of the 24-hour goal for PM_{10}. The 2008 version of the EPP (Air) allowed for exceedances for five days per year and therefore air quality assessments previously considered the 6th highest PM_{10} 24-hour average. As there are no exceedances allowed in the 2019 version of the EPP (Air), the maximum predicted PM_{10} 24-hour concentration has been considered in the assessment rather than the 6th highest.
c. Not legislative, but adopted for the Project. Referenced from DES *Guideline—Application requirements for activities with impacts to air* (DES, 2019b), as discussed before Table 12.4
n/a No environmental value listed for this goal

12.4 Methodology

The air quality impact assessment methodology for the construction, commissioning, operation and decommissioning phases of the Project included the following key elements:

- Qualitative impact assessment for the construction phase to estimate potential air quality impacts
- Potential for commissioning phase impacts are discussed in Section 12.4.3
- Primarily quantitative impact assessment for the operation phase to investigate potential air quality impacts, including cumulative air quality impacts. Some minor emissions sources are assessed qualitatively
- Potential for decommissioning phase impacts are discussed in Section 12.4.6
- Identification of mitigation measures
- Assessment of the residual impact with the inclusion of the identified mitigation measures.

Early engagement on the draft ToR resulted in the EIS requiring an 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.

The methodology used to assess air impacts during each phase of the Project is described in this section. Further information about the impact assessment methodology is available in Appendix L: Air Quality Technical Report.

12.4.1 Air quality study area

For the purpose of the assessment, the air quality study area is defined as the area within 2 km either side of the alignment, which is the proposed rail centreline.

Figure 12.1 illustrates the air quality study area for this assessment and the locations of relevant meteorological and air quality monitoring stations referenced in this air quality impact assessment. As there are no monitoring stations within the air quality study area, monitoring data from stations located outside the study area have been reliably extrapolated and considered in the assessment.

12.4.2 Construction phase impact 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, the transitory nature of many individual construction activities at particular locations and the averaging periods for air quality goals. As such, air quality impacts from the construction phase of the Project have been assessed via a qualitative risk assessment.

As discussed in Section 12.3.2, the highest proportion of construction emissions is generated from mechanical activity, e.g. material movement or mobile equipment travel, which typically generates coarser particulate emissions (PM_{10} and TSP). Airborne PM_{10} 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.

The assessment methodology used for the assessment of construction dust is the 2014 United Kingdom (UK) Institute of Air Quality Management's (IAQM) *Guidance on the assessment of dust from demolition and construction* (UK IAQM, 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 method is summarised as follows:

- 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: Determine site-specific mitigation for dust-emitting activities
- Step 4: Reassess risk of dust impacts after mitigation has been considered.

The emission sources considered include demolition, earthworks, construction and trackout, which are defined as follows:

- Demolition: any activity involved with the removal of an existing structure (or structures)
- Earthworks: the processes of soil-stripping, ground-levelling, excavation and landscaping
- Construction: any activity involved with the provision of a new structure (or structures), its modification or refurbishment
- Trackout: the transport of dust and dirt from the construction/demolition site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network.

The assessment of construction dust impacts is presented in Section 12.6.1.1.

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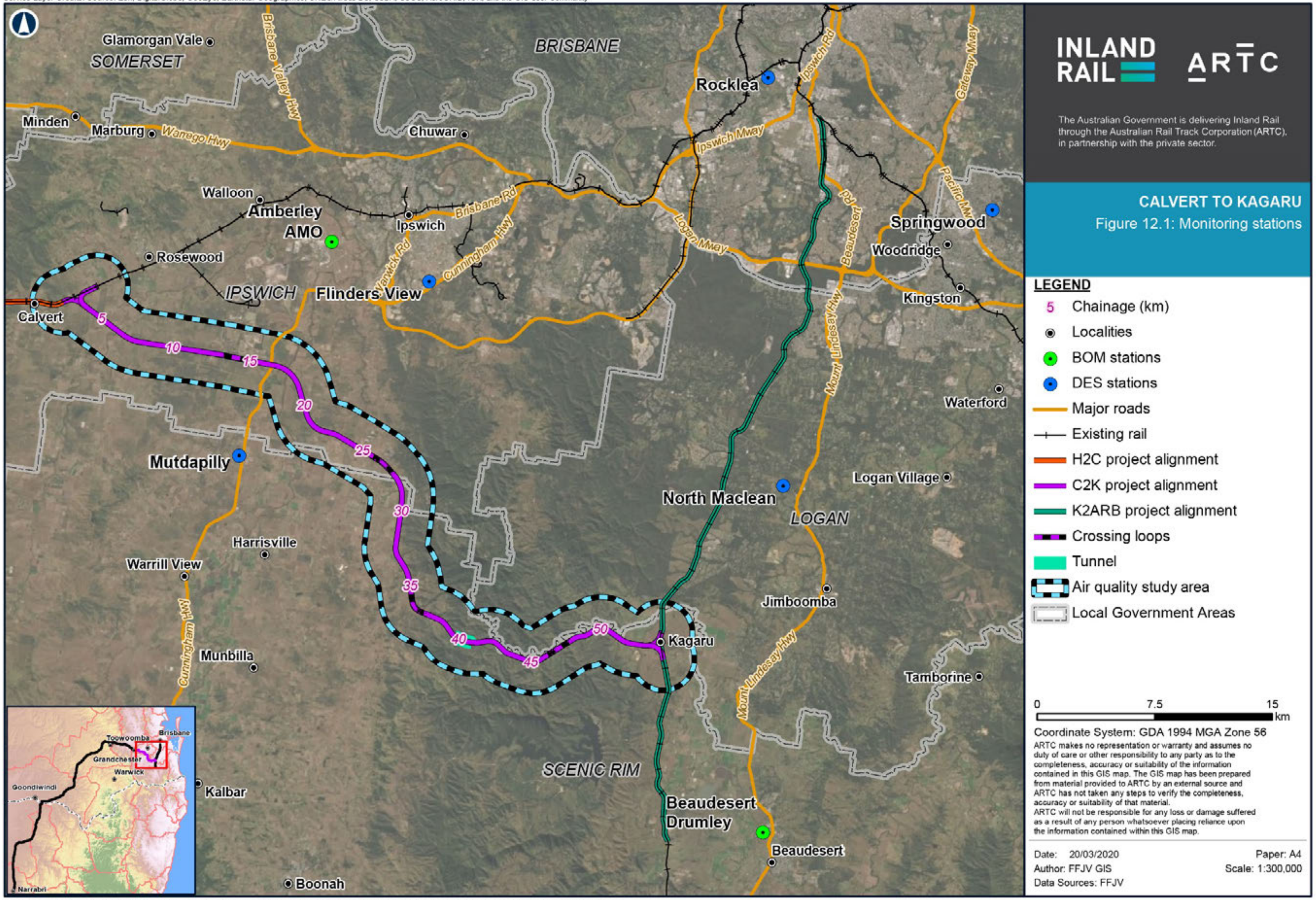

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In addition to construction dust, odour and VOCs will be emitted from fuel tanks located at laydown areas. Impacts from fuel storage have been assessed in Section 12.6.1.2. This assessment of fuel storage tanks has followed guidance from the BCC *Air Quality Planning Scheme Policy* (2014) and VIC EPA (2013) Recommended separation distances for industrial residual air emissions, which are referenced in the QLD EP Act—*Guideline: Application requirements for activities with impacts to air* and are applicable for assessments in QLD.

Detailed dispersion modelling of construction is not typically undertaken because construction activity is difficult to forecast accurately due to the transient nature of construction work and variations to the spatial location and intensity of construction activities. The qualitative assessment method applied for the assessment of construction phase impacts is considered appropriate for the Project and is consistent with industry-standard methodology.

A detailed description of each stage of the construction phase assessment, as well as a description of potential sources and impacts is in Appendix L: Air Quality Technical Report.

12.4.3 Commissioning phase impact assessment

The commissioning phase of the Project will involve testing and checking the rail line and communication and signalling systems.

Air emissions during the commissioning phase 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 train travel on the line, emissions from the commissioning phase of the Project will be significantly lower than emissions during the operational phase.

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

12.4.4 Operations phase impact assessment

12.4.4.1 Overview

Dispersion modelling addressing line-source emissions (i.e. emissions from freight trains travelling along the track) was undertaken to assess the degree to which the Project complies with the specified air quality goals at sensitive receptor locations.

The air dispersion modelling was undertaken using the CALPUFF and GRAL modelling suites. The GRAL model was developed at the Institute for Internal Combustion Engines and Thermodynamics, Technical University Graz, Austria, specifically to assess the dispersion of pollutants from roadways and tunnel portals (Oettl et al., 2002; Oettl et al., 2003; Oettl et al., 2005) and has been used to model emissions from the Teviot Range Tunnel. The CALPUFF model was used to model all other open-air sections of the alignment (e.g. outside the tunnel).

Meteorological data was prepared using The Air Pollution Model (TAPM) and data from nearby monitoring stations. The data available for this Project and a discussion of the methodologies followed for the dispersion modelling is overviewed in Section 12.4.4.3 with detailed discussion provided in Appendix L: Air Quality Technical Report.

Modelling of emissions from the tunnel considered the length and cross-sectional area of the tunnel, the emissions that would occur inside the tunnel and the proposed ventilation design. For typical operation, the tunnel will be naturally ventilated. The tunnel is sized so that fans are not required for typical operation, and train emissions will exit the portals via natural ventilation (with the movement of each freight train within the tunnel causing a piston effect). As there is no mechanical venting of train emissions from the tunnel, there will be minimal plume uplift.

Cumulative assessment of air quality impacts was undertaken by considering background air quality, NPI-listed facilities, other nearby 'State significant' or strategic' projects and modelling emissions from existing rail network traffic, the Project and 1 km of the adjoining Helidon to Calvert (H2C) and Kagaru to Acacia Ridge and Bromelton (K2ARB) projects.

The contribution from other local sources is represented by the adopted background concentrations for relevant pollutants assessed.

12.4.4.2 Emissions inventory

To quantify potential emissions from the operation of the Project, an emissions inventory was developed. The key pollutants of interest for the operational phase are TSP, PM_{10}, $PM_{2.5}$, and NO_x; however, emissions have been calculated for all pollutant species that have air quality goals (refer Table 12.4).

Train volumes

Typical weekly train movements (2040) are provided in Table 12.5. The forecast typical train volume for 2040 is 328 trains per week. The typical train volumes are based on the Inland Rail Program Business Case (ARTC 2015a) and assume Inland Rail will be at freight capacity in the year 2040. It is important to note that the typical train volumes are expected to be worst case for the Project – based on ARTC's operational train planning.

The engineering reference design train volumes (peak) are higher than the business case 2040 freight capacity train volumes (typical) to ensure the design has a suitable factor of safety when making infrastructure related decisions. For the year 2040, the adopted engineering reference design train volumes (up to 418 trains per week) are approximately 127 per cent higher than typical train volumes (328 trains per week). The engineering reference design train volumes (peak) are unlikely to be realised during operations.

However, both typical and peak train volumes have been assessed and reported, along with potential impacts for all contaminants (at all assessed receptors), in full within Appendix L: Air Quality Technical Report.

The assessment has been conservatively undertaken for 1,800 m long train sets.

TABLE 12.5: WEEKLY TRAIN MOVEMENTS BY SERVICE

	Volume of trains/week	Locomotive type				End destination	
Train type	**Typical[a]**	**NR Class**	**SCT Class**	**Class 82**	**PR22L**	**Acacia Ridge**	**Bromelton**
MB Express (Bromelton)	12	X	-	-	-	-	O
MB Express (Acacia Ridge)	11	X	-	-	-	O	-
MB Superfreighter (Bromelton)	31	-	X	-	-	-	O
MB Superfreighter (Acacia Ridge)	6	-	X	-	-	O	-
GB Superfreighter (Bromelton)	17	-	X	-	-	-	O
GB Superfreighter (Acacia Ridge)	8	-	X	-	-	O	-
New Acland Coal[b]	44	-	-	-	X	O	-
Cameby Downs/Rywung Coal[b]	44	-	-	-	X	O	-
Kogan Creek Coal[b]	33	-	-	-	X	O	-
Wilkie Creek Coal[b]	22	-	-	-	X	O	-
Ipswich Coal[b]	11	-	-	-	X	O	-
Narrabri—PoB Grain	19	-	-	X	-	O	-
Yelarbon—PoB Grain	19	-	-	X	-	O	-
Oakey—PoB Grain[b]	19	-	-	X	-	O	-
Narrabri—PoB Export Cont	9	-	-	X	-	O	-
Yelarbon—PoB Cotton	5	-	-	X	-	O	-
Toowoomba Export Containers[b]	9	-	-	-	X	O	-
Westlander[b]	0	-	-	-	-	-	-
Oakey—Rosewood Livestock[b]	0	-	-	-	-	-	-
Ebenzer IMEX	9	-	-	X	-	X	-
Total	**328**						

Table notes:

a. Typical train traffic volumes rounded to the nearest whole number
b. Indicates that this train service is an existing service that currently uses the QR rail line
X Indicates that this locomotive operates the listed train type
-- Indicates that this locomotive is not on this train type
O Indicates the end destination for each train, being either Acacia Ridge or Bromelton

TABLE 12.6: LOCOMOTIVE EMISSIONS FACTORS

Locomotive	NR Class: Cycle weighted	NR Class: Idling	SCT/LDP[b]	82 Class[c]	PR22L[d]
Locomotive max power (kW)	2,917		3,350	2,425	1,640
Rated emission standard	US EPA—Tier 0	-	US EPA—Tier 1	US EPA—Tier 0	EURO IIIA
Total particulates (g/kWhr)	0.8	1.09	0.60	0.8	0.20
NO_x (g/kWhr)	12.74	43.7	9.92	12.74	6.00
Total hydrocarbons (THC)[a] (g/kWhr)	1.34	4.66	0.74	1.34	0.50
Source	US EPA Emissions Limits—Line Haul Locomotives	*Diesel Locomotive Fuel Efficiency & Emission Testing Report* Nov 2016 by ABMARC for NSW EPA (NR121 & 93 Class)	US EPA Emissions Limits—Line Haul Locomotives		EU Emissions Standards—Non-road Engines

Table notes:

a. VOCs are a subset of THC. For this assessment 100 per cent of THC emissions are assumed to be VOCs.
b. Downer EDI SCT/LDP Class locomotive
c. Downer EDI 82 Class locomotive
d. Downer EDI/Progress Rail Services PR22L locomotive

Table 12.7 summarises the operating mode percentages of maximum engine power used for each engine notch setting to calculate average duty cycle power ratings.

To determine the time spent at each engine notch setting, data from US rail operations was used to provide a basis for average duty-cycle power ratings. Table 12.8 presents US EPA data from Ireson, Germer, and Schmid (2005), which represents duty-cycle data for line-haul diesel locomotives in the US. The line-haul data presented is the result of analysis of 63 line-haul trains and 2,475 operational hours.

TABLE 12.7: 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 5	45.4	
Notch 6	66.0	
Notch 7	87.1	
Notch 8	100.0	

TABLE 12.8: DUTY-CYCLES FOR LINE HAUL LOCOMOTIVES IN THE US (PERCENTAGE TIME IN NOTCH)

Notch setting/Operating mode	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 power consumption rates have been calculated for each locomotive type using the adopted notch-power ratings and duty-cycle information presented in Table 12.7 and Table 12.8. The calculated average hourly power consumption rates, in addition to the maximum and idling power consumption rates for each locomotive, are in Table 12.9.

TABLE 12.9: LOCOMOTIVE POWER USAGE

Power	NR Class	SCT/LDP	Class 82	PR22L
Maximum power (kWhr)	2,917	3,350	2,425	1,640
Calculated duty cycle (kWhr)	823	945	684	463
Idle (kWhr)	68	78	56	38

Diesel locomotive emissions

Emissions factors have been sourced from emissions testing completed on locomotives by the NSW EPA and rated emission standards published by the US Environmental Protection Agency (US EPA) and European Environment Agency (EEA). The US EPA and EEA emission factors are the most accurate source of available emissions data for the locomotives and are considered appropriate for use in the assessment. Table 12.6 presents the referenced emissions factors on a gram per kilowatt hour basis (g/kWhr).

Pollutant emission rates were then calculated using the following parameters:

- An average total of approximately 47 trains per day for the typical scenario (based on weekly rail traffic volumes)
- Locomotive type and configuration
- Total journey time was assumed to include travel (75 per cent) and stationary (25 per cent) operation. Stationary operation includes idling on passing loops. These journey assumptions have been used for the operational modelling for the length of the Inland Rail Program.

Table 12.10 presents the adopted maximum design line speeds along the Project alignment. For the purposes of the air quality assessment, average line speeds were estimated to be 75 per cent of the maximum line speed.

TABLE 12.10: AIR QUALITY ASSESSMENT ADOPTED LOCOMOTIVE LINE SPEEDS

Power	Direction of travel	NR Class	SCT/LDP	Class 82	PR22L
Maximum line speed (km/hr)	North	115	115	80	100
	South	115	115	80	80
Average line speed (km/hr)	North	86	86	60	60
	South	86	86	60	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 (kWhr)
- P_{loco} is the calculated average duty cycle power for each locomotive type (kWhr)
- *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, PM_{10}, $PM_{2.5}$ and Total VOCs (as THC) grams per metre per second (g/m/s)
- $EF_{pollutant}$ is the pollutant emission factor as per (g/kWhr)
- P_{total} is the total locomotive calculated power per hour for entire alignment (kWhr)
- *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, PM_{10}, $PM_{2.5}$ and Total VOCs (as THC) grams per second (g/s)
- t_{loco} is the locomotive travel time along the alignment without stopping. Idling time is assumed to be 25 per cent of the total travel time along the alignment, i.e. 1/3 of the non-stopping travel time of a locomotive to travel the alignment
- n_{loco} is the total number of locomotives of each train type
- P_{loco} is the total locomotive calculated power per hour for entire alignment from idling (kWhr)
- $EF_{pollutant}$ is the pollutant emission factor as per (g/kWhr).

To determine continuous idling emissions, it was assumed that NR class locomotives would idle for periods up to or greater than 1 hour. The idling emission rates were therefore derived from the hourly idling locomotive power usage presented in Table 12.9, and the locomotive emission factors presented in Table 12.6. The idling emission rates were applied to all modelled hours, which is a conservative assumption that locomotives are idling at the crossing loops continuously for a whole year.

Where emissions factors for specific pollutants of concern were not available, emission factors from the *NPI Emissions Estimation Manual for Railyards* (DEWHA, 2008) and the European Monitoring and Evaluation Programme (EMEP/EEA) *Air Pollutant Emission Inventory Guidebook 2016* (EMEP/EEA, 2016a; EMEP/EEA, 2016b) were used. The referenced and speciated locomotive emissions factors are presented in Table 12.11.

The derived pollutant locomotive diesel emission rates are presented in Table 12.12. The locomotive idling emissions rates for each crossing loop are also presented. The methodology for the assessment of emissions from the crossing loops is explained in Section 12.4.4.3.

TABLE 12.11: LOCOMOTIVE EMISSION FACTORS AND SPECIATION

Pollutant	Emission factor	Units	Speciation percentage	Source
Total suspended particulates				
PM_{10}	3.53	kg/kL	97.6	(NPI, 2008)
$PM_{2.5}$	3.39	kg/kL	93.7	(NPI, 2008)
Cadmium	0.01	g/tonne of fuel	0.00066	(EMEP/EEA, 2016a)
Chromium	0.05	g/tonne of fuel	0.0033	(EMEP/EEA, 2016a)
Copper	1.7	g/tonne of fuel	0.11	(EMEP/EEA, 2016a)
Nickel	0.07	g/tonne of fuel	0.004	(EMEP/EEA, 2016a)
Selenium	0.01	g/tonne of fuel	0.00066	(EMEP/EEA, 2016a)
Zinc	0.03	g/tonne of fuel	0.066	(EMEP/EEA, 2016a)
Lead	0.0005	mg/kg of fuel	0.000033	(EMEP/EEA, 2016b)
Arsenic	0.0001	mg/kg of fuel	0.0000066	(EMEP/EEA, 2016b)
Total hydrocarbons				
Non-methane VOCs	4.65	kg/tonne of fuel	100	(EMEP/EEA, 2016a)
Benzo(a)pyrene	0.03	g/tonne of fuel	0.00065	(EMEP/EEA, 2016a)
Toluene	-	-	0.01	(EMEP/EEA, 2016b)
m,p-xylenes	-	-	0.98	(EMEP/EEA, 2016b)
o-xylenes	-	-	0.40	(EMEP/EEA, 2016b)
Benzene	-	-	0.07	(EMEP/EEA, 2016b)
1,3-Butadiene	0.31	kg/kL	7.3	(NPI, 2008)
Polychlorinated dioxins and furans (toxic equivalent quotient) (TEQ)	8.35×10^{-11}	kg/kL	0.0000000020	(NPI, 2008)

TABLE 12.12: DERIVED POLLUTANT DIESEL COMBUSTION EMISSION RATES

Pollutant	Total Project emissions (g/m/s)	Short term average Project idling emissions (g/s) (per crossing loop)	Long term average Project idling emissions (g/s) (per crossing loop)
NO_x	1.95×10^{-4}	4.944	1.236
TSP	6.26×10^{-5}	0.123	0.031
PM_{10}	3.61×10^{-5}	0.120	0.030
$PM_{2.5}$	1.34×10^{-5}	0.116	0.029
Total VOCs	$\mathbf{2.98 \times 10^{-5}}$	**0.527**	**1.236**

Table notes:

a. Explanation of the scenarios modelled (long term and short term) for crossing loops is provided in Section 12.4.4.3.

Fugitive coal dust

The nature of the emissions from the coal wagons (laden and unladen) is fugitive i.e. the emissions are not released through an easily quantifiable source, such as a vent or stack. The primary mechanism for coal dust lift-off from coal wagons is the movement of air over uncovered laden wagons; therefore, the surface area open to the wind plays a pivotal role in the amount of fugitive coal dust emitted.

It is expected that all coal trains operating along the proposed rail track will use veneering to control coal dust emissions. Veneering is a best practice management measure currently applied to trains that use the Bowen Basin coal rail lines and the West Moreton System.

A detailed study into the surface wind speed across loaded wagons and their associated dust emissions has been carried out in *Environmental Evaluation of Fugitive Coal Dust Emissions from Coal Trains* (Connell Hatch, 2008). The study also presents an equation to calculate the mass emission rate of coal dust from a moving laden wagon at a particular site, using the average wind speed at each modelling location, together with the train speed data for that site:

$$m = (k_1 \times v^2) + (k_2 \times v) + k_3$$

Where:

- *m* is the mass emission rate of coal dust (as TSP) from the wagon surface in g/km/tonne of coal transported
- k_1 is a constant with a value of 0.0000378
- k_2 is a constant with a value of -0.000126
- k_3 is a constant with a value of 0.000063
- *v* is the air velocity over the surface of the train in km/hr.

This veneer acts as a binding agent to reduce the amount of surface lift-off of particulates from the laden wagons. *Environmental Evaluation of Fugitive Coal Dust Emissions from Coal Trains* (Connell Hatch, 2008) suggested that a reduction in surface lift-off of up to 85 per cent was achievable through its application. Trials completed by the BNSF Railway Company and Union Pacific Railroad Company investigated the effectiveness of coal dust suppressants in the Powder River Basin. Trials looks at seven different chemical agents in suppressing coal dust emissions from 1,633 loaded trains. The trials found the following: *'… coal dust reductions ranged from 75 to 93 percent depending on the topical treatment used in the test'* (BNSF & UP, 2010). A conservative assumption of 75 per cent reduction in the coal dust emission rates has been considered in this assessment for the laden coal trains.

Environmental Evaluation of Fugitive Coal Dust Emissions from Coal Trains (Connell Hatch, 2008) also detailed that after unloading coal at ports or terminals, a small amount of residual coal typically remained in the wagon (approximately 0.13 tonnes (t) per wagon), which was transported back to the mines. In addition, parasitic loads were found to be located on the wagon sills, shear plates and bogies, which resulted in further fugitive emissions. An additional 0.13 t of coal per wagon was added to the proposed coal train payload of 85.9 t per wagon to account for residual coal in the wagons on return trips.

Modelled coal dust emission rates assumed a:

- Travel speed of 80 km/h for a laden coal train travelling along the alignment (maximum laden coal train speed for alignment). The travel speed was used as the wind speed when calculating the mass emission rate of coal dust.
- Reduction of emissions from between 75 to 85 per cent to allow for application of direct control to coal wagons (veneering). It has been conservatively assumed that fugitive coal dust emissions will be reduced by 75 per cent based on field trials (Connell Hatch, 2008).
- Coal payload (average) per train of 5,592 t (inclusive of 0.13 t residual coal per wagon)
- Conversion factor of 0.5 from TSP to PM_{10} (US EPA, 1998)
- Conversion factor of 0.15 from PM_{10} to $PM_{2.5}$ (US EPA, 1998) based on the particle-size distributions for mechanically generated emissions from aggregate and unprocessed ores published in the *US EPA AP42 Compilation of Air Pollutant Emission Factors* (US EPA, 1998). Particle-size distribution data is not provided for coal, but size distributions for aggregate and unprocessed ores (15 per cent for $PM_{2.5}$) is considered acceptable in lieu of specific data for coal.

Modelling of coal dust emissions assumes that all coal trains travel at speed (80 km/hr) along the alignment, and do not slow down or stop to access the crossing loops. Fugitive coal dust emissions from the crossing loops have not been specifically modelled. However, at lower wind speeds across the coal wagons, emissions are estimated to be considerably lower than the modelled rate for 80 km/hr. For example, fugitive coal dust emissions from a stationary coal train with an average 10 km/hr cross wind represent 1.1 per cent of emissions from a coal train travelling at 80 km/hr. Coupled with the assumption that the coal trains travel at 80 km/hr for the entire proposed alignment results in an conservative estimate of coal dust emissions, which is expected to adequately represent fugitive coal dust emissions from the crossing loops proposed in the Project.

The derived coal dust emission rates for the Project are presented in Table 12.13.

TABLE 12.13: DERIVED COAL DUST EMISSION RATES

Pollutant	Uncontrolled coal dust emissions (g/m/s) per train	Controlled coal dust emissions (g/m/s) per train	Total Project alignment controlled coal dust emissions (g/s)
TSP	2.14×10^{-6}	5.36×10^{-7}	2.9
PM_{10}	1.07×10^{-6}	2.68×10^{-7}	1.5
$PM_{2.5}$	1.61×10^{-7}	4.01×10^{-8}	0.22

Tunnel portal emissions

Emissions from the Teviot Range Tunnel portals were calculated using specific parameters relevant to the tunnel, and are summarised as follows:

- Total tunnel length of 1,015 m
- Laden coal trains travelling only in the west to east tunnel direction.

Table 12.14 presents the average train speeds for each group of expected locomotive type, which is a result of the locomotive number and type per train, weight of trailing wagons, and gradient of the tunnel rail track. A weighted average was calculated based on the percentage of rail traffic expected to travel through the tunnel. The average speeds are broken into 'stopping' and 'non-stopping' speeds, based on operational modelling of rail traffic.

TABLE 12.14: TEVIOT RANGE TUNNEL AVERAGE LOCOMOTIVE SPEEDS (KM/HR)

	Non-stopping		Stopping	
Train type	Northbound	Southbound	Northbound	Southbound
Superfreighter	58.7	36.5	36.9	36.0
Express	68.6	47.6	48.3	45.0
Coal	22.4	60.3	22.0	58.9
Agriculture-Steel-Containers	42.8	63.0	39.8	61.8
Weighted average	**38.0**	**55.6**	**31.5**	**54.4**

Table notes:
The weighted average speed has been calculated by multiplying the speed for each train by the ratio of that train type over the total number of trains travelling in that direction.

Average duty-cycle calculations from operational modelling of Teviot Range Tunnel rail traffic are presented for each train type in Table 12.15.

TABLE 12.15: TEVIOT RANGE TUNNEL AVERAGE POWER (KW) PER TRAIN

	Non stopping		Stopping	
Train type	Northbound	Southbound	Northbound	Southbound
Superfreighter	5,338.7	5,428.1	5,386.9	4,937.6
Express	7,631.8	7,699.1	7,700.1	7,694.3
Coal	4,447.5	4,410.1	4,456.0	3,824.4
Agriculture-Steel-Containers	4,284.0	3,972.6	4,395.6	4,042.6

Table 12.16 summarises the tunnel portal emissions used in the dispersion modelling, which include the cumulative sources of locomotive diesel combustion emissions and fugitive dust emissions from coal train wagons.

TABLE 12.16: DERIVED PORTAL EMISSIONS

Pollutant	Northbound emission rate (kg/hr)		Southbound emission rate (kg/hr)	
	Non stopping	Stopping	Non stopping	Stopping
NO_x	1.56	**1.70**	0.98	**1.01**
TSP	**0.194**	0.187	0.054	**0.056**
PM_{10}	**0.223**	0.217	0.053	**0.055**
$PM_{2.5}$	**0.170**	0.166	0.051	**0.053**
THC	0.213	**0.271**	0.137	**0.141**

Table notes:
The highest emission rate for each travel direction and the emission rate used for the modelling is shown in bold.

The calculated stopping emission rates are higher than the non-stopping emission rates due to the longer durations and (generally lower average speeds and higher average power) and, as such, were used in modelling as conservative assumption. However, the emissions for the non-stopping, north-bound particulate fractions are higher due to the higher average speeds and consequently higher fugitive dust emissions from loaded coal trains. Where this is the case, the higher emission rates were used in modelling.

Adjoining Inland Rail projects

To assess the cumulative impact of the Inland Rail Program, the adjoining sections of the Inland Rail Program adjacent to the Project, namely the Helidon to Calvert (H2C) and the Kagaru to Acacia Ridge and Bromleton (K2ARB) sections, have been included in the dispersion modelling undertaken for the assessment of operational phase impacts.

One kilometre of the H2C rail Section has been modelled at the western end of the alignment. The emission rates used for the modelling of this Section were assumed to be equivalent to that calculated for the Project.

At the eastern end of the alignment, the Kagaru to Acacia Ridge (K2AR) and Kagaru to Bromelton (K2B) spurs were modelled to assess the impact of emissions from these rail segments. The emission rates used for modelling the spurs were assumed to be equivalent to that calculated for the Project but separated for each spur based on the expected split of train traffic in each direction.

Existing rail network traffic

West Moreton System

For the purpose of the assessment it has been assumed that there will be no train travel along the existing Queensland Rail (QR) West Moreton System. It is expected that all existing trains that currently use the West Moreton System will use the Inland Rail alignment. The Project has provided connectivity for future livestock and future passenger trains that may travel between Ipswich and Calvert. However, no trips are confirmed at the time of the assessment.

It is highlighted that veneering is currently applied to coal trains that use the Bowen Basin coal rail lines and the West Moreton System. Therefore, existing coal trains that currently use the West Moreton System and are assumed for this assessment to use the Project, will already be implementing veneering.

Interstate Line

Existing train traffic along the Interstate Line has been included in the dispersion modelling undertaken for the assessment of operational phase impacts. Existing train traffic volumes for 2018 have been assumed for the year of assessment (2040). A total of 32 trains per week were modelled: 14 Sydney to Brisbane express trains, 6 SB Superfreighter trains, and 12 Bromelton IMEX trains. The emission rates for train traffic along the Interstate Line were calculated following the methodology described in this section.

Where the K2AR and K2B spurs join with the Interstate Line, emissions from these sections of the Interstate Line have been calculated considering the cumulative train volumes for the Section modelled (spur plus Interstate Line train volumes).

12.4.4.3 Dispersion modelling

The air dispersion modelling conducted for this assessment used TAPM as a meteorological pre-processor to the CALPUFF and GRAL models. The CALPUFF model was used primarily for the modelling assessment; however, for pollutant impacts from the Teviot Range Tunnel portal sources the GRAL model was used.

The data available for this Project and a discussion of the data processing methodologies required to implement both CALPUFF and GRAL are discussed in the following sections, with further details in Appendix L: Air Quality Technical Report. All modelling was undertaken in accordance with relevant guidance documents and appropriate literature (EPA, 2016; Barclay & Scire, 2011).

Figure 12.2 presents the modelling methodology undertaken for air quality impact assessment.

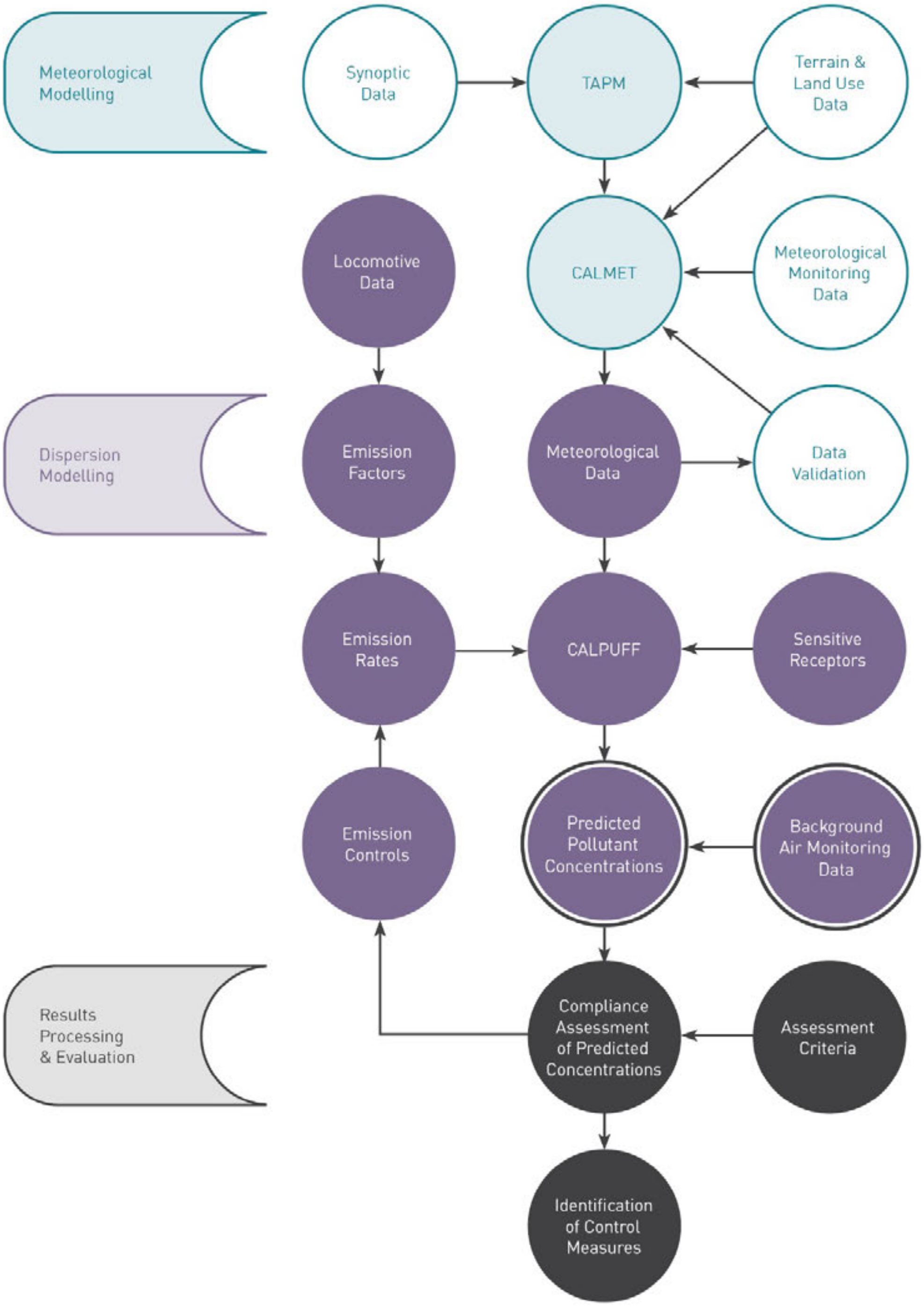

FIGURE 12.2: DIAGRAMMATIC REPRESENTATION OF THE CALPUFF MODELLING METHODOLOGY

Selection of meteorological year

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. Using the SEI, ONI, and MEI measures for ENSO, consistency in which years represent periods of El Niño or La Niña are present. The three indices show that the year 2013 was relatively neutral in terms of ENSO. The year 2013 was adopted for the assessment.

Further discussion on the selection of the meteorological year is provided in Appendix L: Air Quality Technical Report.

TAPM and meteorological data

Meteorological data used in the dispersion model is of fundamental importance, as this drives the atmospheric transport, dispersion and prediction of the air pollutants. Key parameters include:

- Wind direction, which determines the initial direction, and changes, 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.

Meteorological data from the Bureau of Meteorology (BoM) and DES meteorological stations has been used in the assessment, in addition to prognostic meteorological data generated by TAPM. Pseudo upper air stations were generated from TAPM model runs for the air quality study area. The use of pseudo upper air stations allows the CALMET modelling to be driven primarily by surface observations.

A total of three pseudo upper air stations were generated from TAPM, with individual runs undertaken for each station. The model setup for TAPM for each of the runs undertaken is presented in Table 12.17.

TABLE 12.17: TAPM INPUT PARAMETERS

Parameter	Input
TAPM version	4.0.4
Number of grids (spacing)	5 (30 km, 10 km, 3 km, 1 km, 0.3 km)
Number of grid points	41
Number of vertical levels	25
Terrain height database	9 second digital elevation model (DEM)
Year of analysis	January to December 2013
Grid centre point	Refer Table 12.18 for each station

BoM meteorological data was sourced from the Amberley Aeronautical Meteorological Office (AMO) and Beaudesert stations, with DES meteorological data sourced from the Mutdapilly and North Maclean stations. A summary of the meteorological stations considered, including the prognostic stations, is presented in Table 12.18.

TABLE 12.18: METEOROLOGICAL STATIONS INCLUDED IN MODELLING

Station	Coordinates (GDA zone 56 m)	Variables	Source
Amberley AMO	471,498 m, 6,943,783 m	Wind direction, wind speed, temperature, rainfall pressure relative humidity	BoM
Beaudesert Drumley Street	498,997 m, 6,906,043 m		
Mutdapilly	465,597 m, 6,930,132 m	Wind direction, wind speed	DES
North Maclean	502,956 m, 6,928,187 m	Wind direction, wind speed, temperature, rainfall, pressure, relative humidity	
UA1	475,832 m, 6,921,235 m	Upper air	TAPM
UA2	495,078 m, 6,916,643 m	Upper air	
UA3	455,636 m, 6,935,025 m	Upper air	

CALPUFF

The CALPUFF suite of programs, including meteorological (CALMET), dispersion (CALPUFF), and post-processing modules (CALPOST) is a non-steady state modelling system designed for meteorological and air quality modelling. DES does not require the use of any particular dispersion model (e.g. CALPUFF or AERMOD models); however, within the DES *Guideline: Application Requirements for Activities with Impacts to Air* (DES, 2019b) reference is made to the NSW EPA guidance document *Approved methods and guidance for the modelling and assessment of air pollutants in NSW* (EPA, 2016). 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 air quality study area, the CALPUFF model is preferred over the more commonly used Gaussian models of AERMOD or AUSPLUME, which are less reliable in the aforementioned conditions.

GRAL

In order to investigate the air quality impacts from the railway tunnel portal emissions, the GRAL dispersion model has been used. GRAL has been extensively evaluated against experimental data from five different existing tunnel portals both in flat and complex terrain, with high and low traffic volumes: the Enrei, Hitachi and Ninomiya tunnels in Japan (Oettl et al., 2003) and the Kaisermuehlen (Oettl et al., 2004) and Enrentalerberg tunnels in Austria (Oettl et al., 2002). The GRAL model was specifically used to assess emissions from the Teviot Range Tunnel portals.

The results of the GRAL modelling have been combined with the results from the CALPUFF modelling to determine the total concentrations at modelled receptors.

Crossing loops

Locomotive diesel emissions from crossing loops have been modelled as follows:

- Emissions have been modelled from locomotives idling directly at the crossing loops. Emissions from the stopping and starting of trains at each crossing loop has not been modelled
- Locomotives have been modelled at each end of each crossing loop as three point sources, resulting in six emission source points per loop
- Two different approaches (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 (1 hour average): continuous idling of NR Class locomotives assumed throughout the year
  - 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
- For the short-term version, the six point sources represent two Express trains with six NR Class locomotives. The long-term version represents emissions from a calculated composite emission of all trains travelling along the alignment
- No split of idling time has been assumed for each end of the loop to allow for a worst-case assessment of idling for both the northbound and southbound travel directions
- 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.

Modelling scenario

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 of the scenario (short term and long term) have been run to assess emissions from the crossing loops against both short-term and long-term air quality goals (refer Section 12.3.3). The modelled scenario and crossing loop versions assessed are summarised in Table 12.19.

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.

In addition to the short- and long-term versions, the requirement for veneering has also been investigated by modelling particulate emissions from coal trains with and without the inclusion of veneering (75 per cent reduction to fugitive coal dust emissions).

TABLE 12.19: DISPERSION MODELLING SCENARIO

Scenario	Crossing loop version	Crossing loop idling description	Air quality goal averaging periods assessed
Typical 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% of the travel time	Annual

Table notes:
For each version listed in Table 12.19, two variations have been run, one with the inclusion of veneering and one without veneering.

All data and parameters used as input for the dispersion modelling, including additional scenarios and model outputs, is provided in Appendix L: Air Quality Technical Report.

Influence of climate change on meteorological modelling data

The meteorological modelling undertaken for the air quality study area has been undertaken using prognostic meteorological data generated by TAPM and observational data from BoM stations for the year 2013. The purpose of meteorological modelling is to develop representative dispersion modelling inputs based on long term historical meteorological data.

Changing climatic conditions due to climate change have 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 *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2016) (which is the guidance used for air quality modelling in the Qld *Guideline: Application requirements for activities with impacts to air*), site-representative meteorological data is to be used based on a comparison against long-term historical meteorological data (presented in Section 12.5.1). The potential influence of changing climatic conditions in the future has therefore not been considered in this assessment.

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, based on our understanding of the processes involved, their interactions and available input data.

Simulating complex atmospheric process can 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 metres per second (m/s)) or for low-level, non-buoyant sources, tend to over-estimate pollutant concentrations.

While the models contain a large number of variables that can be modified to improve precision, a range of default values are typically adopted for model variables that are applicable under most modelling circumstances. These default values are recommended for use unless there is sufficient evidence to support their modification.

The results of dispersion modelling therefore provides an indication of the likely level of pollutants within the modelling domain. While the models, when used appropriately and with appropriate 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 considered to be representative of exact pollutant concentrations at any given location or point in time.

The model predictions are also typically conservative and tend to over-predict maximum pollutant concentrations at receiver locations.

12.4.4.4 Conversion of NO_x to NO_2

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 nitric oxide (NO) and NO_2. 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 NO_2. The conversion of NO to NO_2 requires ozone (O_3) to be present in the air, as ozone is the catalyst for the conversion. Ultimately, all NO emitted into the atmosphere is oxidised to NO_2 and then further to other higher oxides of nitrogen.

The USEPA's Ozone Limiting Method was used to predict ground-level concentrations of NO_2. The Ozone Limiting Method assumes that approximately 10 per cent of the initial NO_X emissions are emitted as NO_2. If the O_3 concentration is greater than 90 per cent of the predicted NO_X concentrations, all the NO_X is assumed to be converted to NO_2, otherwise NO_2 concentrations are predicted using the equation:

$$NO_2 = 46/48 \text{ x } O_3 + 0.1 \text{ x } NO_x$$

This method assumes instant conversion of NO to NO_2 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 Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (EPA, 2016). It should be noted that the Ozone Limiting Method is a conservative approach as explained in Appendix L: Air Quality Technical Report (Appendix C). Due to its proximity to the Project, background ozone data from the Mutdapilly monitoring station were used to convert the modelled NO_2 concentrations in accordance with the Ozone Limiting Method methodology presented in *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2016).

12.4.4.5 Tank water quality

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).

The potential for the operation of the Project to impact tank water quality collected via roof catchment was investigated. For the purpose of the assessment, the following assumptions were made:

- 'First flush' systems were not installed on water tanks at any receptor location
- The average roof area was 200 m² (typical for a large house).

Fugitive coal dust deposition

Fugitive coal dust emissions from rail transport along the proposed alignment have potential to be deposited on surfaces that lead to rainwater tanks. Coal may contain many trace elements, some of which include sulphur, chlorine, arsenic, boron, cadmium, lead, mercury, molybdenum, selenium, chromium, copper, fluorine, nickel, vanadium, and zinc. Several of these compounds can have toxic and chronic health effects, depending on exposure length, concentration, and path of ingestion. A leaching test study completed by (Lucas, 2009) showed, through experimentation, that even though these compounds exist within coal and coal dust, they have a low potential for leaching into receiving water, and measured concentrations were well below the 2004 *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018). Therefore, it is expected that coal dust will not pose significant health impacts from exposure to toxic trace elements and its health impacts will be primarily related to exposure to particulate in the form of PM_{10} and $PM_{2.5}$.

Assessing impacts to water tank quality

Using the emissions inventory developed for assessment of impacts to air quality, dust deposition modelling was also completed using CALPUFF to determine the impact of diesel and fugitive coal dust emissions on tank water quality. Dust deposition was predicted for all receptors within the air quality study area. The methodology for predicting the potential impact to water tank quality includes:

- Annual average dust deposition rates were predicted for every receptor in the air quality study area for adopted train operations using the long-term model version for crossing loops as discussed in Section 12.4.4.3. Every receptor was assumed to have a water tank.
- It was assumed that all deposited dust at each receptor was collected by a 10,000 litre (L) rainwater tank, which was 10 per cent full resulting in a receiving water volume of 1,000 L. This conservative assumption allows for periods where there may be prolonged periods of drought and short rainfall events that wash deposited pollutants into rainwater tanks.
- Based on the predicted annual average dust deposition rate, the concentration of particulates and other pollutant species with water quality guideline concentrations was determined by speciating the deposited dust using diesel locomotive emission factors and fugitive coal emission factors (refer Section 12.4.4.2).

The outcome of this method was pollutant concentrations in tank water which could be compared against the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018).

Detailed dispersion modelling is not typically undertaken for construction activity and has not been undertaken for the construction phase assessment for the Project. Construction dust has therefore not been considered for the assessment of tank water quality.

Similarly, fugitive emissions from fuel storage tanks required for the construction phase have not been considered for the assessment of tank water quality. Fugitive emissions from fuel storage tanks will be gaseous and will not be a significant issue with respect to deposition and tank water quality. Drinking water quality goals

The *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018) include guideline values on allowable contaminants within drinking water, such as from rainwater tanks. Table 12.20 presents the drinking water criteria for the pollutants of interest which have been used in the assessment.

TABLE 12.20: DRINKING WATER QUALITY GUIDELINES

Pollutant	Guideline value (mg/L)	Environmental Value	Source
Arsenic	0.01	Health	(NHMRC & NRMMC, 2018)
Cadmium	0.002	Health	
Lead	0.01	Health	
Nickel	0.02	Health	
Chromium as Cr (VI)	0.05	Health	

12.4.5 Cumulative impact assessment

As required by the ToR for the Project and as typically necessary for air quality impact assessments, a cumulative impact assessment has been undertaken. Air quality impact assessments are inherently cumulative assessments as they are required to consider background air quality when assessing against air quality goals. Background air quality includes non-Project emission sources.

In addition to consideration of background air quality (refer Section 12.5.2) this assessment has also considered cumulative impacts to sensitive receptors in the operational phase of the Project by assessing emissions from the adjoining Inland Rail projects (H2C and K2ARB) as discussed in Section 12.4.4. The results of the operational phase assessment are discussed in Section 12.6.1.

Key existing emission sources in the air quality study area are discussed in Section 12.5.3. Based on publicly reported emissions, none of the existing emission sources require inclusion in the assessment of the operational phase of the Project. An existing quarry (Boral Purga Quarry) is considered in the assessment of the construction phase of the Project.

In addition to the assessment of the H2C and K2ARB projects and the Boral Purga Quarry, a qualitative cumulative impact assessment (CIA) has been undertaken via review of other 'State significant' or 'strategic' projects. Assessment of 'State significant' or 'strategic' projects is provided in Chapter 22: Cumulative Impacts; however, a summary of the assessable projects impact to air quality is provided in Section 12.6.4.

12.4.6 Decommissioning phase

Given the uncertainty associated with timeframe for decommissioning, this phase has not been considered in this air quality impact assessment.

12.5 Existing environment

The existing environmental values of the air environment that may be affected by the Project are described in a manner discussed in Section 12.3.3 whereby existing ambient pollutant concentrations are compared to the nominated air quality goals. Aspects of the ambient environment relevant to this assessment of the existing environmental values of the air environment include:

- Existing air quality due to regional and local sources of air pollution (natural and anthropogenic) that emit similar air pollutants as those being assessed
- Meteorological conditions
- 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 within the vicinity of the Project, which have been used in establishing the environmental values of the air environment considered in the assessment.

12.5.1 Meteorology and climate

The air quality study area is located in South East Queensland (SEQ), and spans across the Ipswich City Council (ICC), Scenic Rim Regional Council (SRRC), and Logan City Council (LCC) LGAs. SEQ generally experiences a sub-tropical climate with distinct wet and dry seasons.

BoM operates a network of weather monitoring stations around Australia that have long-term climatic data available for analysis. A number of the air quality stations operated in SEQ by DES also record meteorological data. As the alignment spans a relatively significant distance laterally, local meteorological conditions may differ across this distance, especially at areas further inland and/or away from notable terrain features. Five stations (three BoM-operated and two DES-operated) have been considered in the assessment to provide a greater regional coverage of climatic conditions. The monitoring stations are described in Table 12.21 with the locations shown in Figure 12.1.

TABLE 12.21: LOCATION OF METEOROLOGICAL MONITORING STATIONS

Operator	Name	Coordinates	Distance from Project (closest point, km)	Direction from Project	Period operational	Elevation (m)
BoM	Amberley AMO	-27.6297, 152.7111	8.5	N–NE	1941–Present	24
BoM	Beaudesert Drumley Street	-27.9707; 152.9898	12.8	SE	2007–Present	48
BoM	Beaudesert Cryna	-28.0206; 153.0131	12.8	SE	1887–2014	106
DES	Mutdapilly	-27.7530, 152.6510	5.0	S–W	1995–Present	-
DES	North Maclean	-27.7708, 153.0301	14.4	E	1994–Present	-

Table notes:
The BoM Beaudesert Cryna station is only used to present wind roses. The BoM Beaudesert Drumley Street station has more recent meteorological data but does not have wind roses.

The Mutdapilly DES station and Amberley AMO BoM station are located on the western side of the alignment, while the North Maclean DES station and the Beaudesert BoM stations (Beaudesert Drumley Street and Beaudesert Cryna) are located to the east (refer Figure 12.1).

In addition to the measured meteorological data from the BoM and DES stations, output data from CALMET (refer Section 12.4.4.3) has also been analysed and presented in this Section to describe atmospheric stability and mixing height.

12.5.1.1 Temperature

Mean minimum and maximum temperatures have been collected from the two currently active BoM stations, andare displayed in Table 12.22. Temperatures recorded at the two stations are very similar: the annual mean minimum temperature only higher by 0.1 °C in Amberley, and the annual mean maximum is 26.8 °C at both locations. Temperature data is unavailable from the Mutdapilly station, and at North Maclean only average temperature (based on hourly values) is available. Average monthly temperature measurements at North Maclean are presented Table 12.23.

In winter (June, July and August), mean minimum temperatures are slightly lower at Amberley (7.1 °C, 5.4 °C and 6.2 °C respectively) than in Beaudesert (7.7 °C, 6.1 °C and 6.6 °C). Mean maximum temperatures for winter however are slighter higher in Beaudesert (22.0 °C) than in Amberley (21.9 °C).

In summer (December, January and February) mean minimum temperatures are higher in Amberley (18.4 °C, 19.6 °C and 19.5 °C) than in Beaudesert (18.1 °C, 19.2 °C and 19.0 °C). The mean maximum for summer is only slighter higher in Amberley (30.8 °C) than in Beaudesert (30.7 °C).

Overall, temperatures across the air quality study area are consistent with a warm sub-tropical climate.

TABLE 12.22: MEAN MINIMUM (BLUE) AND MAXIMUM (RED) MONTHLY TEMPERATURES FOR AMBERLEY AMO AND BEAUDESERT BUREAU OF METEOROLOGY MONITORING STATIONS

	Mean minimum and mean maximum temperature (°C)												
Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Amberley AMO[a]	19.6	19.5	17.8	14.0	10.0	7.1	5.4	6.2	9.5	13.3	16.3	18.4	13.1
	31.2	30.4	29.4	27.2	24.1	21.6	21.3	22.8	25.6	27.8	29.6	30.8	26.8
Beaudesert Drumley Street[b]	19.2	19.0	17.8	14.0	9.4	7.7	6.1	6.6	9.9	12.8	16.3	18.1	13.0
	31.3	30.6	29.1	26.8	24.2	21.5	21.5	23.1	26.1	28.1	29.7	30.3	26.8

Table notes:
a. Mean maximum and minimum temperature values have been calculated based on 77 years of data (1941 to 2018).
b. Mean maximum and minimum temperature values have been calculated based on 12 years of data (2007 to 2018).

TABLE 12.23: MEAN MONTHLY TEMPERATURES FOR NORTH MACLEAN DEPARTMENT OF ENVIRONMENT AND SCIENCE MONITORING STATION

	Average temperature (°C)												
Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
North Maclean[a]	24.7	24.3	23.3	20.1	17.0	14.9	13.7	14.7	17.6	20.2	22.4	23.8	19.7

Table notes:
a. Average temperature values have been calculated using hourly temperature data available for download from QLD Government (2012 to 2017).

12.5.1.2 Rainfall

Mean monthly rainfall values for the Amberley AMO and Beaudesert Drumley Street BoM stations and the North Maclean DES station are presented in Table 12.24. A distinct wet (summer) and dry (winter) season is experienced by the region annually.

Of the three stations, Beaudesert Drumley Street receives the highest amount of rainfall annually (926.5 mm), followed closely by Amberley AMO (864.0 mm) and then North Maclean (604.5 mm).

In Amberley and Beaudesert over 40 per cent of average annual rainfall occurs during the three months of summer. Summer is also the distinct wet season for North Maclean, with a third of the average annual rainfall occurring. The months of winter are the driest at all stations: rainfall over winter accounts for approximately 13 per cent of annual average rainfall in Amberley (113.4 mm), 12 per cent in Beaudesert (107.2 mm), and 11 per cent in North Maclean (57 mm). It should be noted that the monthly mean rainfall values from the North Maclean station may not be as robust at the other stations due to the smaller dataset.

TABLE 12.24: MEAN MONTHLY AND ANNUAL RAINFALL FOR SELECTED MONITORING STATIONS

Station	Mean rainfall (mm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Amberley AMO[a]	116.9	121.2	85.5	54.5	52.8	46.9	37.6	28.9	33.6	73.3	81.5	119.4	864.0
Beaudesert Drumley[b]	152.4	121.4	121.4	46.8	54.6	51.3	24.4	31.5	33.1	69.1	91.2	121.1	926.5
North Maclean[c]	86.9	59.6	138.0	30.6	43.0	43.0	7.1	17.0	13.7	29.0	82.0	54.5	604.5

Table notes:

a. Mean rainfall values have been calculated based on 73 years of data (1941–2010)
b. Mean rainfall values have been calculated based on 12 years of data (2007–2018)
c. Mean rainfall values have been calculated based on 5 years of data (2013–2017)

12.5.1.3 Wind speed and direction

Long-term annual wind roses for morning and afternoon conditions at the Amberley AMO BoM station were available for review. Annual wind roses were not available for the BoM Beaudesert Drumley Street Station and therefore available data from the BoM Beaudesert Cryna station has been presented. The 9.00 am and 3.00 pm annual wind roses for Amberley AMO are displayed with the 9.00 am annual wind rose for the Beaudesert Cryna station in Figure 12.3.

Morning winds at the Amberley AMO location are variable in direction and of low-to-moderate strength when not calm. Calm conditions represent 31 per cent of 9.00 am wind observations. At 9.00 am the most frequent wind direction is south and north-west (both approximately 15 per cent of observations). Winds at 3.00 pm in Amberley are predominately from the east and north-east and are considerably stronger. Calm conditions account for only 9 per cent of afternoon wind observations.

Morning wind conditions at the Beaudesert Cryna station location differ greatly to those recorded at Amberley. Winds are most frequently from the south-west followed by south, and generally of low speed. Although 23 per cent of observations are classified as calm, unlike at Amberley, strong gusts of wind (>= 40 km/h) are also recorded. It should be noted that the Beaudesert Cryna station elevation of 106 m is greater than the elevations of the Beaudesert Drumley Street and Amberley AMO stations.

For Mutdapilly and North Maclean, annual wind conditions for morning (9.00 am) and afternoon (3.00 pm) are presented in Figure 12.4. Wind speed is measured in meters per second (m/s), as opposed to kilometres per hour (km/hr) for the BoM stations.

Morning winds at North Maclean are most frequently from the south-west direction (>30 per cent) and of low strength. At 3.00 pm, wind is mostly from the east followed by north-east, and of greater strength than the morning (mostly above 3 m/s). At the Mutdapilly station location, morning wind is variable in direction and strength. Winds from the south-east are most common with moderate to strong speeds. North-westerly winds are also common in the morning (approximately 20 per cent of observations) but are generally weaker. In the afternoon, stronger winds are more prevalent and are from the north-east and easterly directions.

Comparison of the annual wind conditions at the four station locations reveals some geographic trends. Morning conditions at the stations east of the alignment (North Maclean and Beaudesert Cryna) are very similar in both direction and speed. Similarities are also noted when comparing morning wind conditions at the two stations west of the alignment (Mutdapilly and Amberley AMO). Almost 20 per cent of winds at both stations are from the north-west. However, wind direction at the Amberley AMO station is more variable than Mutdapilly, where south easterly winds are most common. In the afternoon, strong winds from the north-east (most frequent at Mutdapilly) and east (most frequent direction at Amberley) prevail at both stations.

Overall, analysis of the annual wind roses for the four 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 12.5.4.

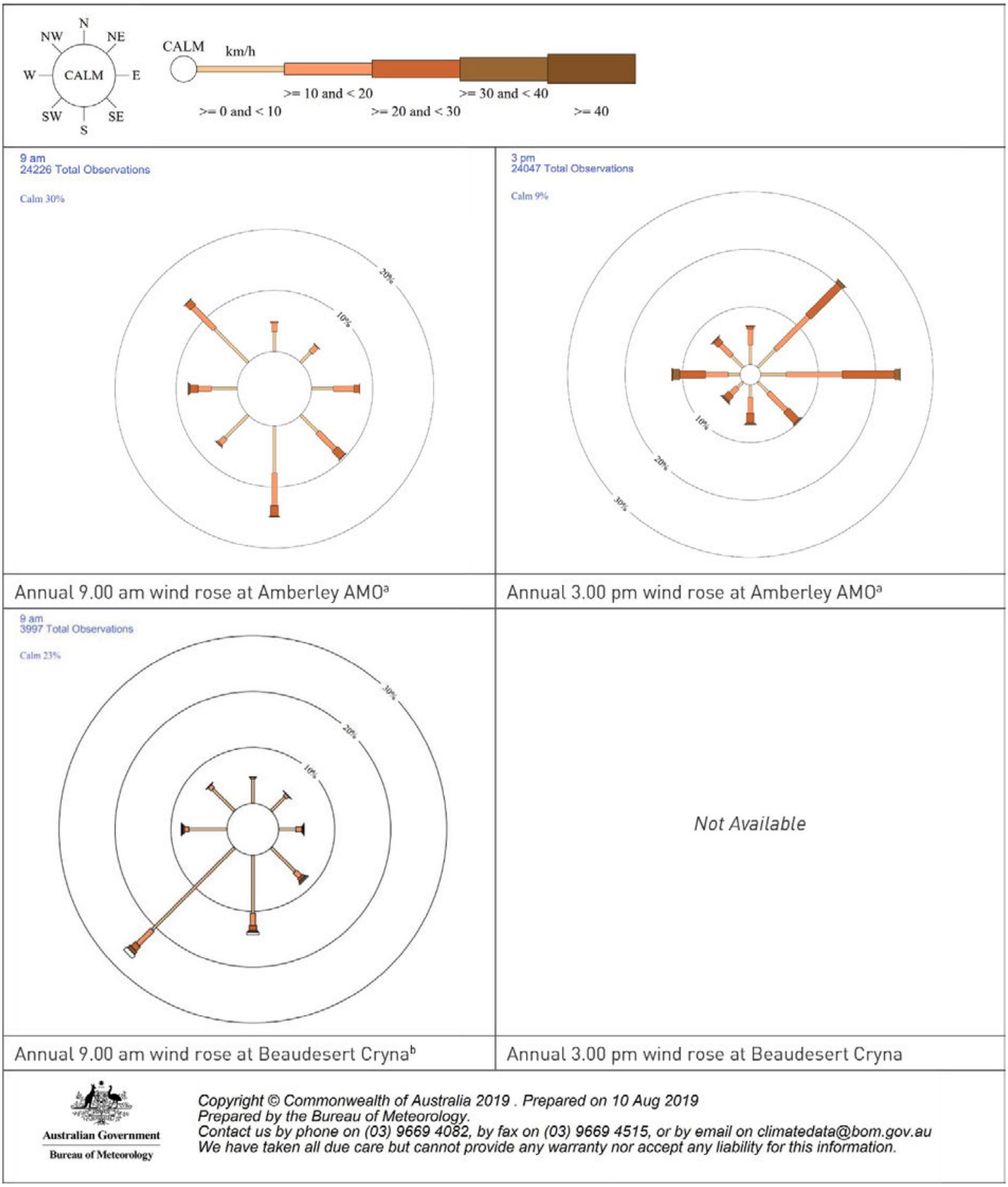

FIGURE 12.3: WIND ROSES FOR BUREAU OF METEOROLOGY MONITORING STATIONS AMBERLEY AMO AND BEAUDESERT CRYNA

Figure notes:

a. Annual wind rose of wind direction versus wind speed based on observations from 1952 to 2018.
b. Annual wind rose of wind direction versus wind speed based on observations from 1967 to 1979.

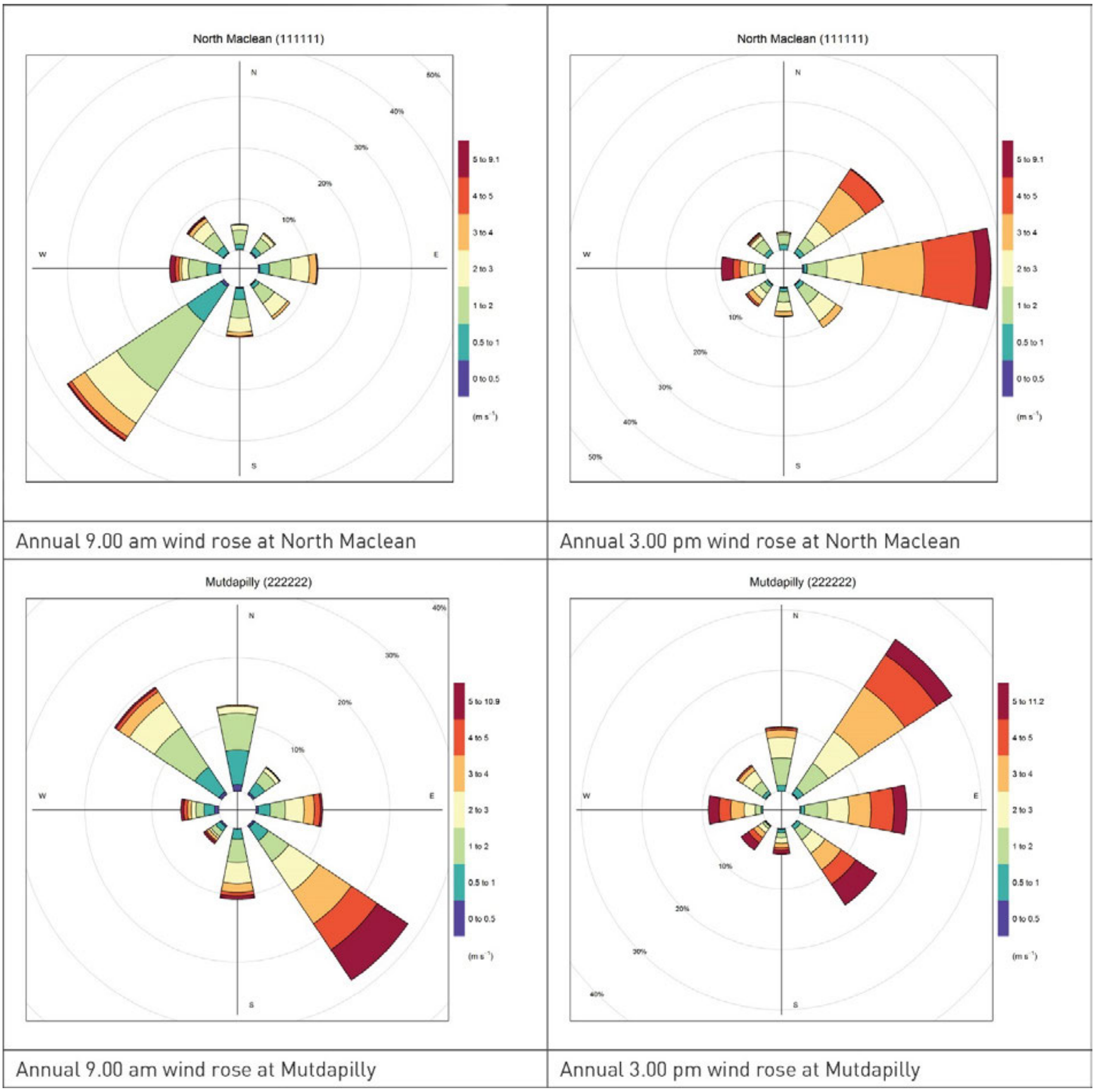

FIGURE 12.4: WIND ROSES FOR THE DEPARTMENT OF ENVIRONMENT AND SCIENCE MONITORING STATIONS AT NORTH MACLEAN AND MUTDAPILLY

12.5.1.4 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 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.

Stability class data extracted from the CALMET files for locations representing the Mutdapilly DES station, Beaudesert Drumley Street BoM station and the Teviot Range Tunnel western portal locations are presented in Figure 12.5 to Figure 12.7. As expected, Figure 12.5 to Figure 12.7 indicate stable conditions during the night hours and neutral and unstable conditions during the day.

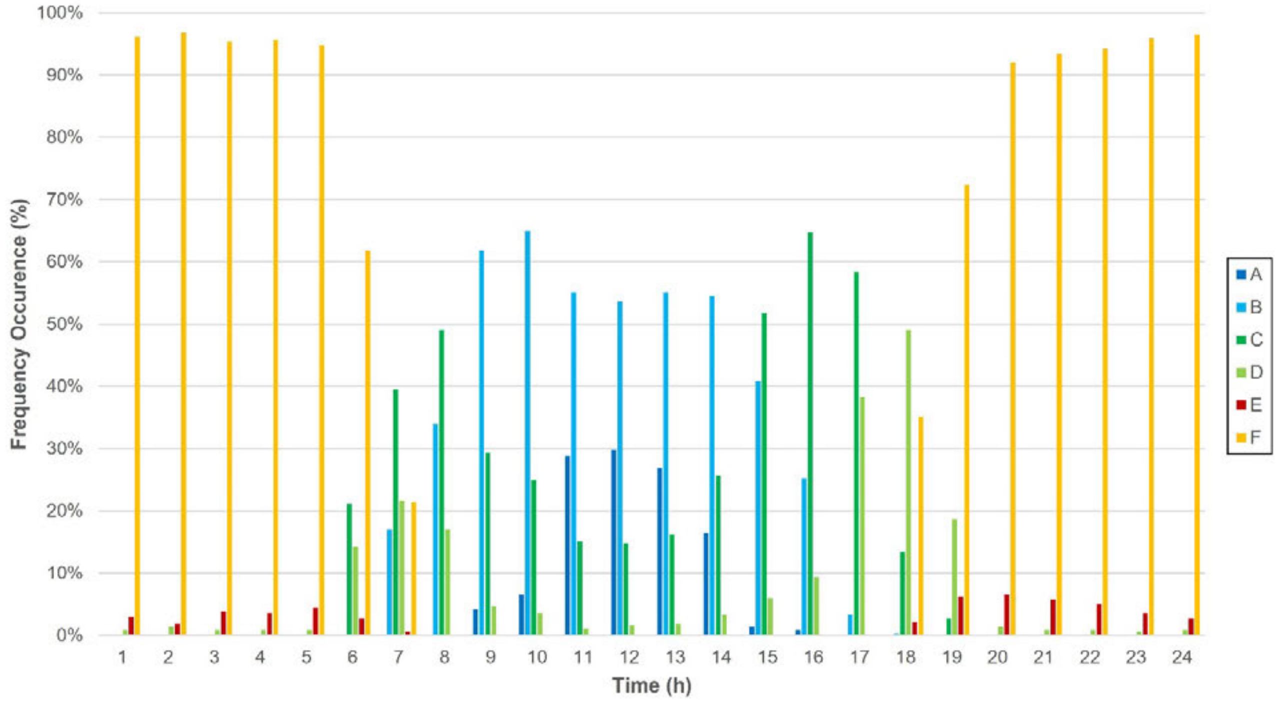

FIGURE 12.5: HOURLY STABILITY CLASS FREQUENCY FOR MUTDAPILLY DEPARTMENT OF ENVIRONMENT AND SCIENCE STATION (CALMET GENERATED)

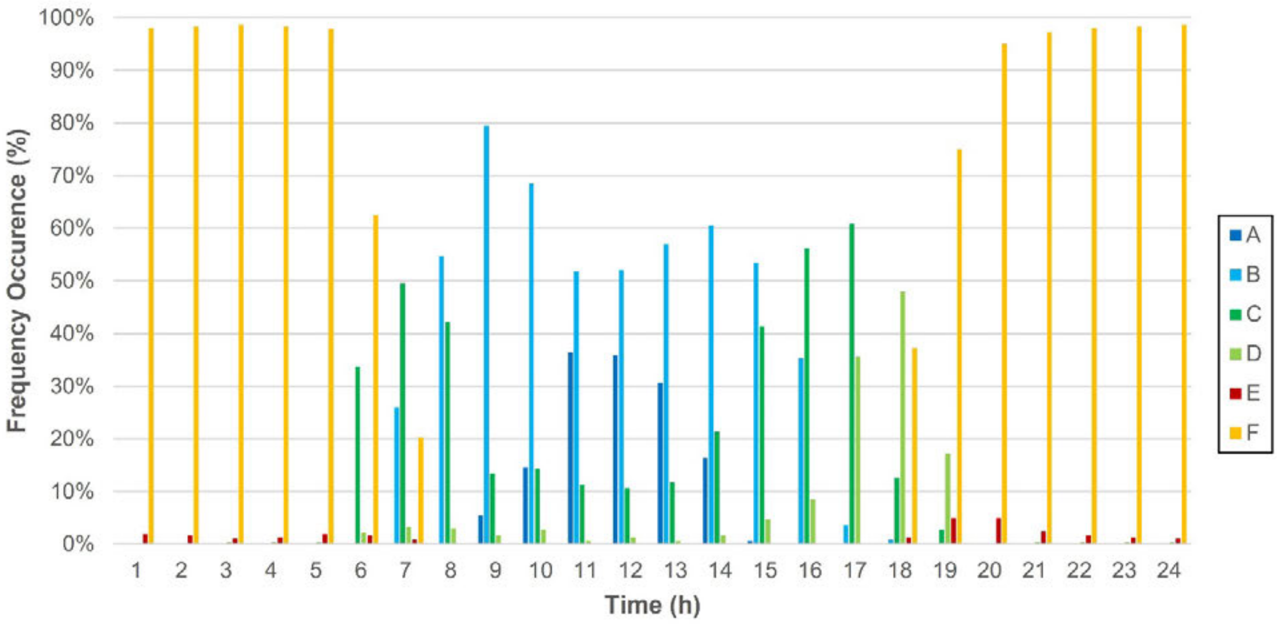

FIGURE 12.6: HOURLY STABILITY CLASS FREQUENCY FOR BEAUDESERT DRUMLEY STREET BUREAU OF METEOROLOGY STATION (CALMET GENERATED)

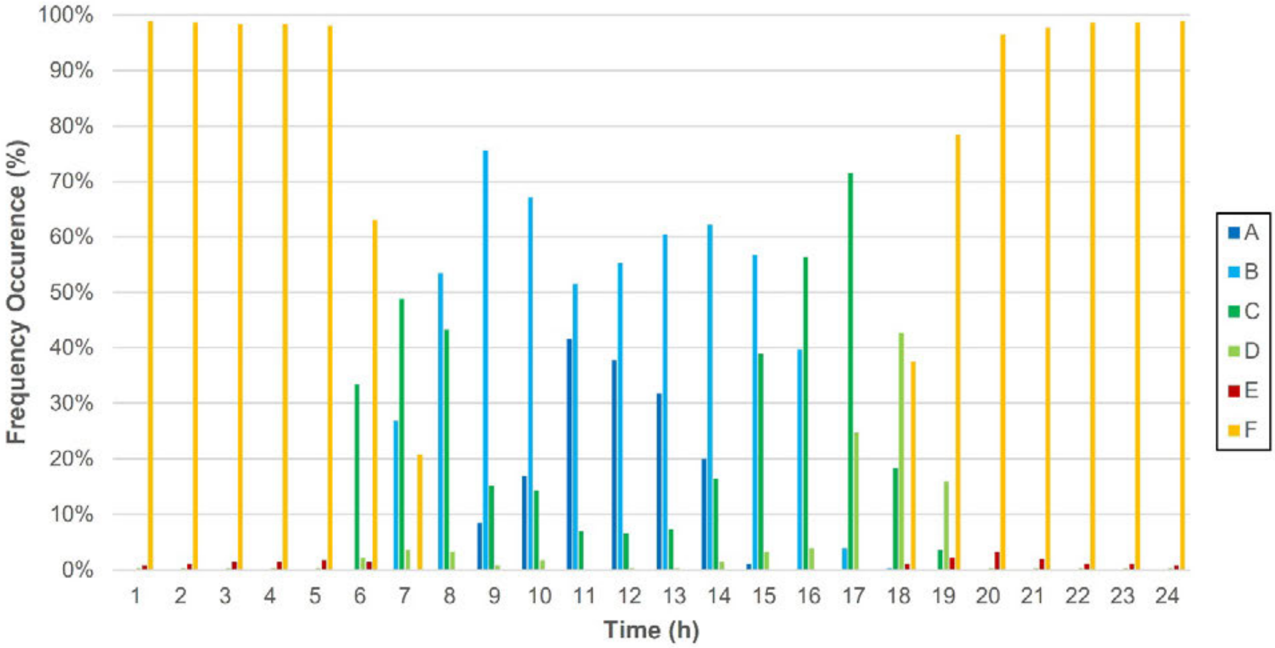

FIGURE 12.7: HOURLY STABILITY CLASS FREQUENCY FOR TEVIOT RANGE TUNNEL WESTERN PORTAL (CALMET GENERATED)

12.5.1.5 Mixing height

Mixing height is estimated within CALMET for stable and convective conditions with a minimum mixing height of 50 m. Figure 12.8 to Figure 12.10 present mixing height statistics by hour of day across the meteorological dataset (2013) as generated by CALMET at the Mutdapilly DES station, Beaudesert Drumley Street BoM station and the Teviot Range Tunnel western portal locations. 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. In addition, peak mixing heights are consistent with typical ranges.

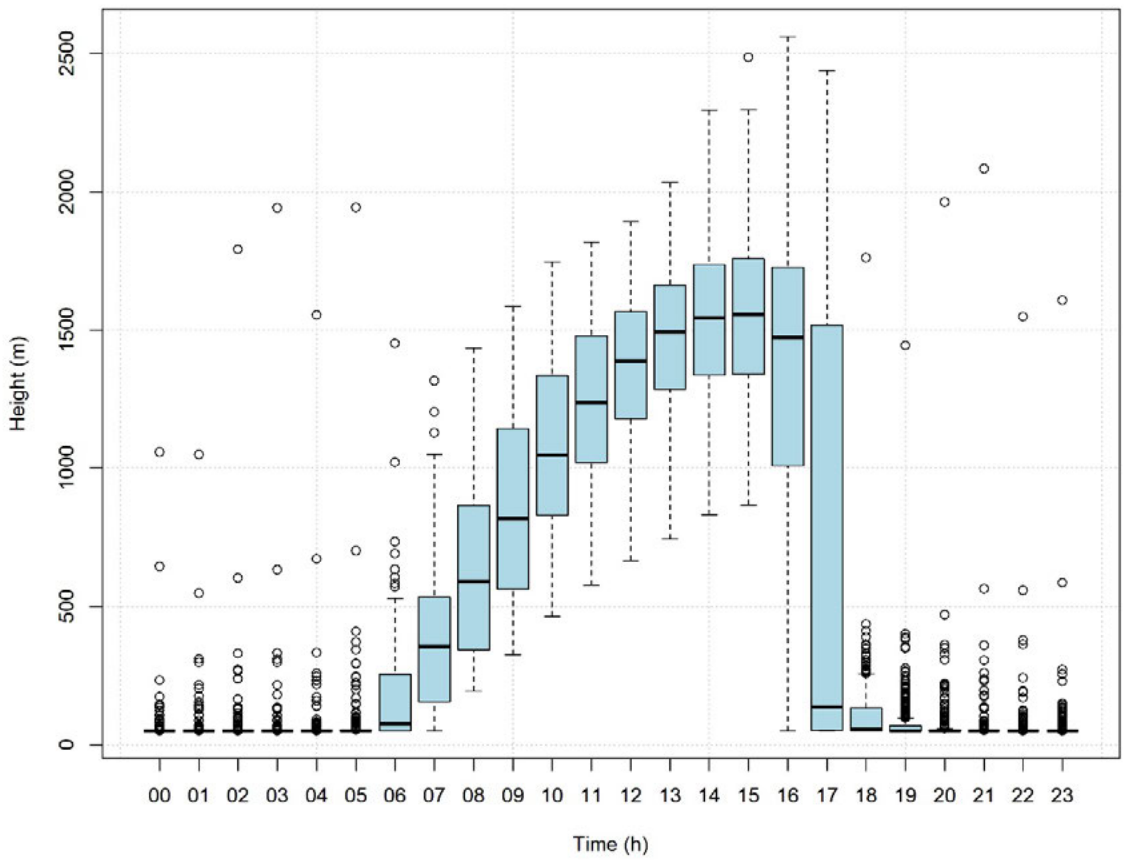

FIGURE 12.8: MIXING HEIGHT STATISTICS BY HOUR OF DAY FOR MUTDAPILLY DEPARTMENT OF ENVIRONMENT AND SCIENCE STATION (CALMET GENERATED)

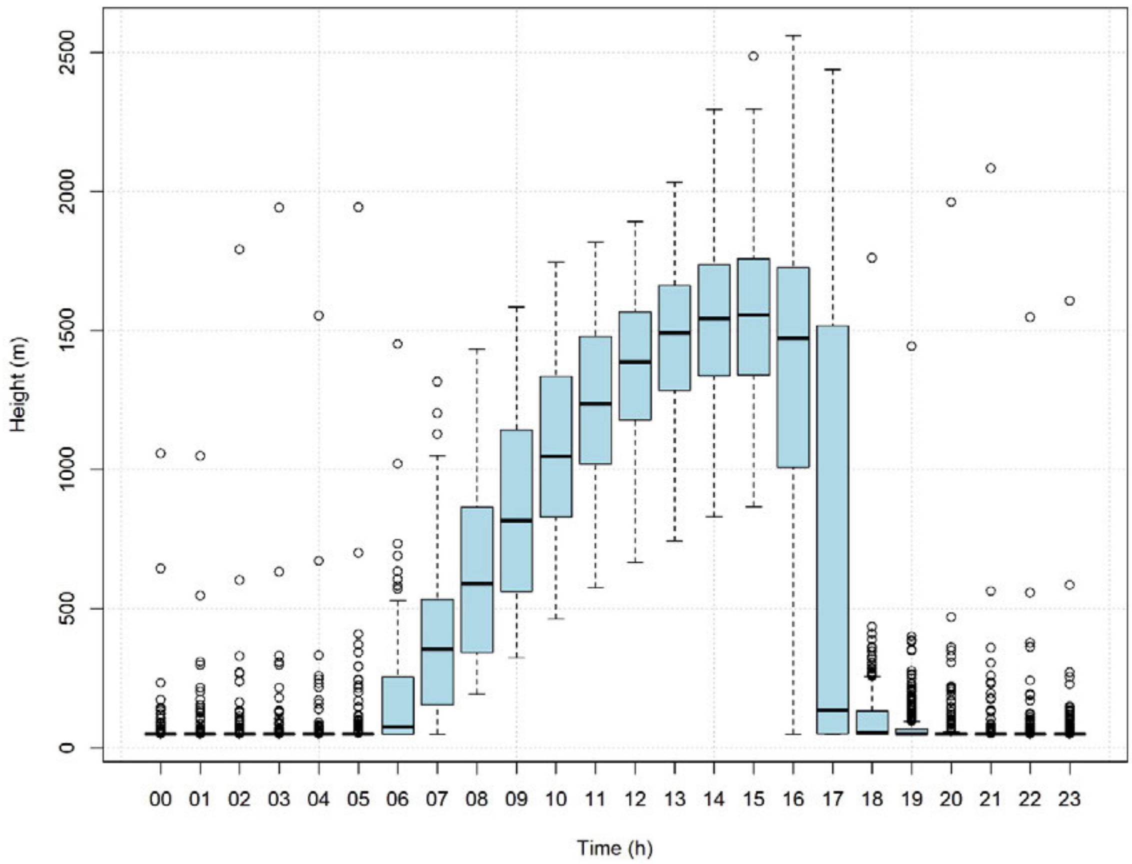

FIGURE 12.9: MIXING HEIGHT STATISTICS BY HOUR OF DAY FOR BEAUDESERT DRUMLEY STREET BUREAU OF METEOROLOGY STATION (CALMET GENERATED)

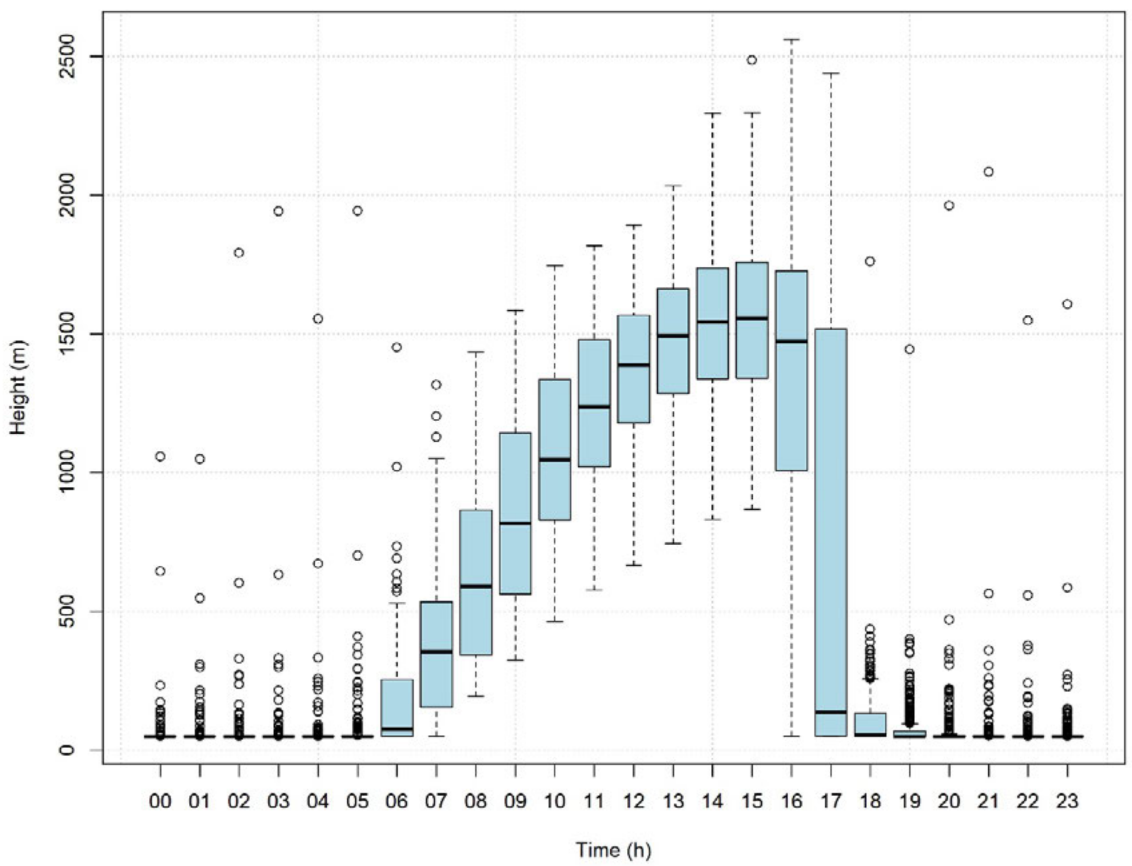

FIGURE 12.10: MIXING HEIGHT STATISTICS BY HOUR OF DAY FOR TEVIOT RANGE TUNNEL WESTERN PORTAL (CALMET GENERATED)

12.5.2 Background air quality

12.5.2.1 Sources of available monitoring data

To characterise the existing air quality environmental values in the air quality study area, a review of available air quality monitoring data was conducted using publicly available data from DES (DES, 2019c) and dust deposition monitoring data from monitoring undertaken for the Inland Rail Project in 2016.

DES has an ambient monitoring network across QLD that monitors for controlled pollutants in areas with large population bases or heavy industry adjacent to residential areas. There are no DES monitoring stations in the air quality study area. However, due to the length of the Project, there are five DES monitoring stations located in the surrounding regional area. These stations are Flinders View, Mutdapilly, North Maclean, Rocklea and Springwood, all of which are situated to the east of Toowoomba. Due to their location, monitoring data from these five stations can be reliably extrapolated for the assessment of background air quality for the study area. The locations of the DES monitoring stations are shown in Figure 12.1.

Preference was given to the stations closest to the alignment and in a similar environment; however, not all pollutants species of interest are measured at each monitoring station. The Rocklea and Springwood stations are located a significant distance (35 km) from the alignment but have been considered because they are both neighbourhood-type monitoring stations and provide an indication of the potential background air quality in the air quality study area. The Springwood monitoring station is the only suitable monitoring station that monitors VOCs, and, therefore, it has been considered to provide background concentrations for VOC species.

Monitoring data from DES stations from 2010 to 2017 has been reviewed. The details of the DES stations considered in the assessment, including the pollutants monitored are presented in Table 12.25.

TABLE 12.25: DEPARTMENT OF ENVIRONMENT AND SCIENCE MONITORING STATIONS

Station name	Location	Location relative to alignment	Pollutants monitored
Flinders View	27.6528° S, 152.7741° E	10 km NW, in a residential area near a major roadway	NO_x, O_3, SO_2, PM_{10}
Mutdapilly	27.7528° S, 152.6509° E	5 km, between Calvert and Kagaru	NO_x, O_3
North Maclean	27.7708° S, 153.0030° E	15 km NE of Kagaru	NO_x, O_3
Rocklea	27.5358° S, 152.9934° E	35 km NE of Kagaru, in a light industrial and residential area	NO_x, O_3, PM_{10}, $PM_{2.5}$ and visibility-reducing particles.
Springwood	27.6125° S, 153.1356° E	35 km ENE of Kagaru, in the grounds of a high school	NO_x, O_3, SO_2, PM_{10}, $PM_{2.5}$ and VOCs (organic pollutants)

Table 12.25 shows that the pollutant species of interest which are monitored at the DES monitoring stations include NO_x, PM_{10}, $PM_{2.5}$ and VOCs. Monitoring of metals (e.g. arsenic, cadmium, etc.) is not undertaken at any of the identified DES stations, but is undertaken at stations located in Townsville (Townsville Coast Guard) and Mt Isa (The Gap). However, the monitoring stations are located in these areas due to the presence of heavy industrial activities that emit metals. Therefore, these monitoring stations are not considered representative of background air quality and the monitoring data from these stations has not been considered in the assessment.

VOC monitoring at Springwood is undertaken specifically for benzene, toluene, xylene and formaldehyde. Monitoring of PAHs, 1,3-butadiene, dioxins and furans is not undertaken at Springwood or at any other DES monitoring stations in QLD, and therefore no background air quality data is available for these species.

The Project is not expected to emit significant quantities of metals, PAHs, 1,3-butadiene, dioxins and furans and the risk of exceeding the air quality goals for these species is considered to be low. Therefore, monitoring of these pollutants has not been undertaken.

A three-month deposited dust monitoring program was conducted for the Project in 2016, as part of the Yelarbon to Gowrie (Y2G) Preliminary Environmental Assessment Report. The monitoring was conducted at four sites in according with Australian Standard AS/NZS 3580.10.1:2003 (Standards Australia, 2003). The locations of each site are presented in Figure 12.1. The highest measured rate of 50 mg/m2/day (measured at Site 3 during May/June 2016) has been adopted as the background concentration for the AQIA.

In addition to the dust deposition monitoring undertaken for the Project, an automatic air quality monitoring station (Inland Rail air quality monitoring station (AQMS)) was installed at the InterLinkSQ site at Leeson Road, Gowrie, in September 2018. The station is located immediately adjacent to the northern end of the NSW Border to Gowrie (B2G) phase of the Inland Rail Program. The DES air quality monitoring stations described in Table 12.25 are located closer to the Project than the Inland Rail AQMS and therefore monitoring data from the Inland Rail AQMS has not been considered in the assessment.

12.5.2.2 Adopted background air quality

Table 12.26 summarises the existing environment background concentrations adopted for the air quality assessment. Where appropriate, the 70th percentile concentration was selected as the adopted background concentration.

TABLE 12.26: SUMMARY OF ADOPTED EXISTING POLLUTANT CONCENTRATIONS COMPARED TO AIR QUALITY GOALS

Pollutant	Averaging time and statistic	Air quality goal (µg/m³)	Adopted background concentration (µg/m³)	Monitoring location
Deposited dust	30 day, maximum	120 mg/m²/day	50	4 locations west of Toowoomba (Y2G Preliminary Environmental Assessment)
NO_2	1 hour, maximum	246	57.5	Mutdapilly
	Annual average	62	7.8	
TSP	Annual average	90	40.5[a]	Flinders View
PM_{10}	24 hours, 70th percentile	50	18.7	
	Annual average	25	16.2	
$PM_{2.5}$	24 hours, 70th percentile	25	6.4	Springwood
	Annual average	8	5.7	
Benzene	Annual average	5.4	5.2[b]	
Toluene	1 hour, 70th percentile	1,100	23.0	
	24 hours, 70th percentile	4,100	21.7	
	Annual average	410	18.5	
Xylenes	24 hours, 70th percentile	1,200	31.5	
	Annual average	950	26.0	

Table notes:

a. Calculated from PM_{10} concentrations measured at Flinders View using a ratio of 2.5, which is based on a PM_{10}:TSP ratio of 0.4 as reported by the Australian Coal Association Research Program (ACARP, 1999).

b. The background concentration for the Springwood monitoring station for 2017 had been previously reported by DES as 5.5 µg/m³. FFJV were advised by DES on 17/01/2020 that as part of the review of the 2018 Springwood hourly dataset, DES identified that an incorrect offset had been applied to part of the 2017 Springwood benzene dataset (DES, 2020b). The corrected 2017 Springwood dataset results in an annual average of 5.2 µg/m³.

12.5.2.3 Assimilative capacity of the receiving environment

The assimilative capacity of the receiving air environment can be quantified through the difference between these adopted background concentrations and the air goals defined in Table 12.4. For most pollutants and averaging times, the background concentrations represent less than half of the criteria, indicating a moderate assimilative capacity of the receiving environment. Pollutants that show lower levels of assimilative capacity include the following:

- PM_{10} 16.2 µg/m³ annual average, representing 65 per cent of the 25 µg/m³ criterion
- $PM_{2.5}$ 5.7 µg/m³ annual average, representing 71 per cent of the 8 µg/m³ annual criterion
- Benzene 5.2 µg/m³ annual average, representing 96.3 per cent of the 5.4 µg/m³ annual criterion.

12.5.2.4 Data validation

The DES datasets are sourced as validated datasets; however, the data do contain gaps that are either missing monitoring data or subsequently invalidated by DES. The referenced data sets are 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 technical paper Data Collection and Handling (NEPC, 2001).

12.5.2.5 Influence of climate change on background air quality

Changing climatic conditions have the ability to influence ambient air quality via increased frequency of atypical events such as bushfires and dust storms. However, confidently predicting the influence of climate change on the duration, frequency and magnitude of extreme air quality events is challenging. It is also highlighted that in comparative terms, emissions from the operation of the Project is not significant in comparison to major regional air quality events such as bushfires and dust storms. Due to the uncertainty present in assessing the influence of changing climatic conditions on the background air quality, climate change has not been considered beyond the bushfires and dust storms that are already present in the adopted background datasets.

12.5.3 Existing emission sources

An NPI search conducted for the assessment determined that two nearby facilities are required to report emissions annually:

- Boral quarry located at Purga
- Bartter Enterprises poultry farms.

The location of these nearby facilities is shown in Figure 12.11. A description of each existing emission source is identified and its approximate distance from the Project alignment is described in Table 12.27.

TABLE 12.27: NATIONAL POLLUTANT INVENTORY LISTED FACILITIES IN THE AIR QUALITY STUDY AREA

Facility name	Industry	Distance from alignment (km)	Direction from alignment
Boral Purga Quarry	Gravel and sand quarrying	0.4	North
Bartter Enterprises Poultry Farms	Poultry farming	0.55	North

On 15 February 2017, Boral lodged a request to ICC to alter the existing development approval (Approval Council Ref: 943/98) for the Purga Quarry. The request included a proposed amendment to the approved time period for the operation of the quarry, and proposed to extend extractive activities until 23 December 2023, and extend associated sales and rehabilitation works until 23 June 2025. The purpose of the request was to allow Boral sufficient time to extract and sell the remaining resource within the site.

Following the submission from Boral, ICC approved the minor alteration to the approval (Council Letter Ref: 945/2017/MA:NM) and approved the proposed end dates for extractive activities and sales and rehabilitation works.

Based on the approved operating period for the quarry, the quarry will be operational (extraction, sales and rehabilitation) during the construction phase of the Project, but will not be active during the operation phase of the Project, which is anticipated to begin in 2026.

Due to the location of the quarry, emissions from the quarry have been considered when assessing the impact of the construction phase of the Project. It is expected that due to emissions from the quarry, particulate concentrations at sensitive receptors near the quarry may be higher than the background particulate concentrations adopted for the assessment (refer Table 12.26) as measured by the DES monitoring stations. The influence of higher background concentrations for receptors near the quarry has been considered in the assessment of construction phase impacts for these receptors.

Emissions from the quarry during the operational phase of the Project have not been considered as the quarry will not be active in 2026 when the operation phase of the Project is anticipated to begin.

Significant emissions to air from the Bartter Enterprises poultry farms would be limited to odour only. Odour is not assessed cumulatively unless the emission sources under assessment emit the same type of odorant with similar odour characteristics (DES, 2013). The character of odour emissions from the Project will be different to the character of odour emissions from the poultry farms and it is not expected that Project emissions could contribute to cumulative odour impacts. Therefore, the existing Bartter Enterprises poultry farms emission source has not been considered specifically.

In addition to the NPI sources listed in Table 12.27 the Jeebropilly open-cut coal mine is located approximately 3.5 km to the north of the alignment. Emissions from the Jeebropilly open-cut coal mine were not considered specifically due to the mines location outside the air quality study area, and as it is anticipated that assumed background concentrations of particulate matter would adequately represent emissions from this source at sensitive receptors due to the separation distance to receptors. It is also noted that local reporting (Richter, J., 2019) states that the Jeebropilly open-cut coal mine closed operations in December 2019.

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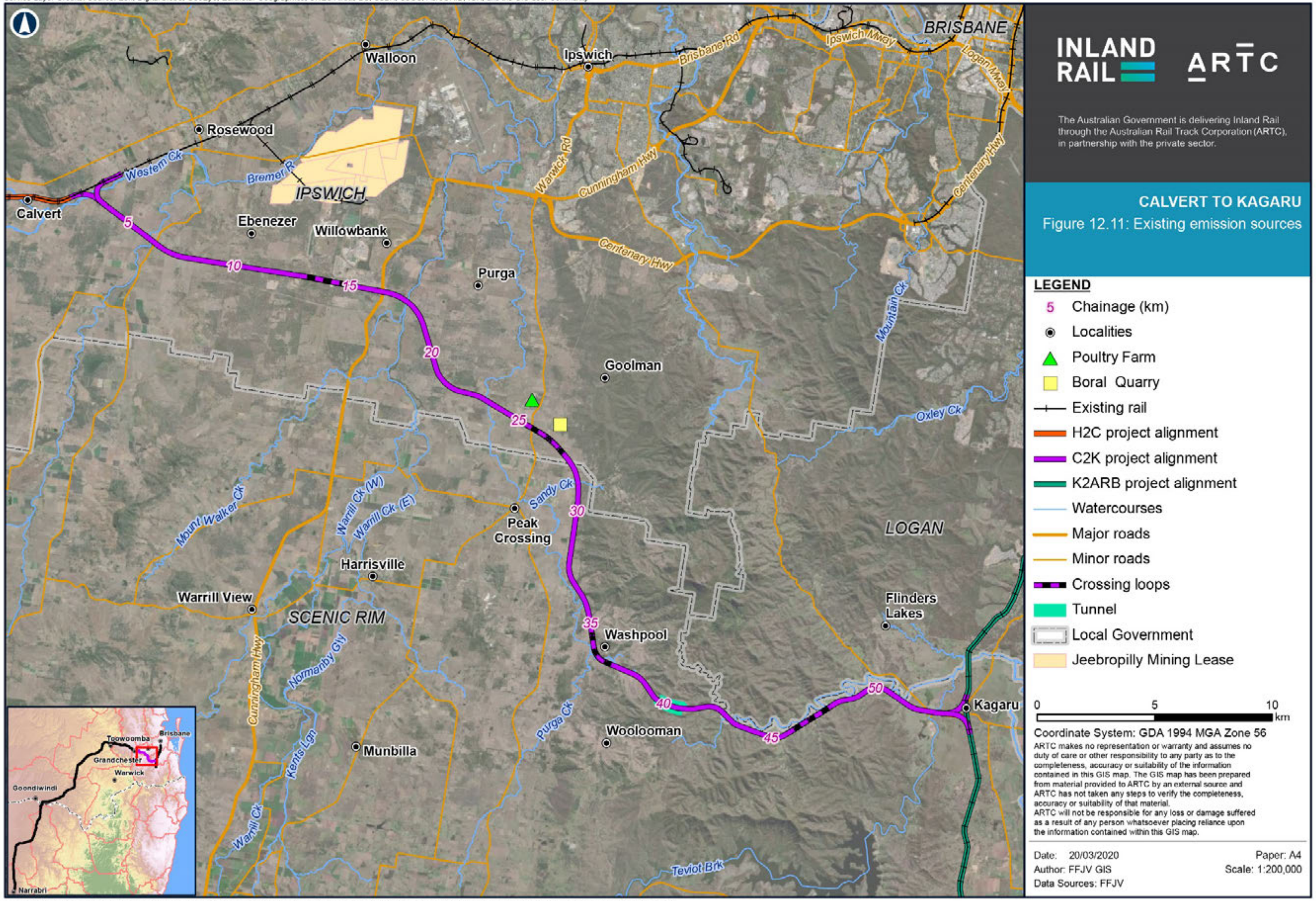

Figure 12.11: Existing emission sources

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In addition to the NPI sources listed in Table 12.27, other local emission sources will include environmentally relevant activities (ERA) and vehicle traffic. Generally, sites classified as an ERA emit lower quantities of pollutant than those land uses that are required to report to the NPI. As such, it is expected that emissions from local ERAs and vehicle traffic will be adequately represented by the assumed background concentrations.

Based on a review of the existing emission sources within and near the air quality study area, no existing emission sources are required to be modelled for the assessment of cumulative impacts.

12.5.4 Terrain and land use

Terrain features and land use can influence meteorological conditions on both a local and regional scale. The terrain along the proposed alignment running east to west begins at an elevation of 50 m at Kagaru and gradually increases as it crosses through the Teviot Range. Approximately 12 km west of Kagaru elevation increases to 220 m; this point is where the proposed Teviot Range Tunnel will be constructed. After the tunnel, elevation slowly drops as the alignment moves north-west from the Teviot Range. The alignment ends in the west at Calvert, an elevation of approximately 50 m, with the Little Liverpool Range to the immediate west.

The land uses in the air quality study area and surrounding area are predominately agricultural with some industry (i.e. Purga Quarry and Jeebropilly Coal Mine). Several small townships exist within 5 km of the alignment, including Calvert, Rosewood, Willowbank, Peak Crossing, Mutdapilly, Washpool, and Kagaru.

The influence of terrain on wind flows and dispersion has been considered in the meteorological modelling undertaken for the assessment discussed in Section 12.4.4.3. The effect of land use on surface roughness and dispersion has also been included in the meteorological model developed for the air quality study area. The height of the train emission source included in the model was based on the proposed Project vertical alignment.

12.5.5 Sensitive receptors

Sensitive air quality receptors in the air quality study area were identified as per the DES Guideline Application requirements for activities with impacts to air (DES, 2019b). 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*, the *Marine Parks Act 2004* or a world heritage area
- A public park or garden
- A place used as a workplace including an office for business or commercial purposes.

The Project is located in a predominantly rural setting, a significant distance away from major population centres. There are no World Heritage Areas or areas protected under the *Nature Conservation Act 1992* or the *Marine Parks Act 2004* located within the air quality study area and there are no pollutant species considered in this assessment, which require assessment of impacts to agricultural uses. The primary sensitive receptor types in the air quality study area are residential dwellings. As per the ToR, surfaces that lead to potable water tanks in the vicinity of the Project are also considered sensitive receptors and have been considered in the assessment.

Figure 12.12 shows the location of sensitive receptors considered during the air quality impact assessment. The sensitive receptors were identified via a desktop review and no field verification was undertaken. Only sensitive receptors within the air quality study area were considered for inclusion in dispersion modelling.

Discrete receptors points have been included for sensitive receptors and have been modelled at ground level (0 m above ground). 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 contours plots.

The total number of sensitive receptors included in the air quality impact assessment may be inconsistent with other technical assessments due to variations in the definition of sensitive receptors (e.g. land use) and the separation distance (between emission sources and receptors) at which significant impacts could occur. Due to the large spatial extent required to model the Project and the significant computing resource required to run large-scale models, the number of sensitive receptors included in the modelling of operational impacts was reduced to those located closest to the Project and which, therefore, have the highest potential to be impacted.

In addition to discrete receptors, which have been used to represent residential dwellings, receptor grids have also been used to allow for the presentation of concentration contour plots.

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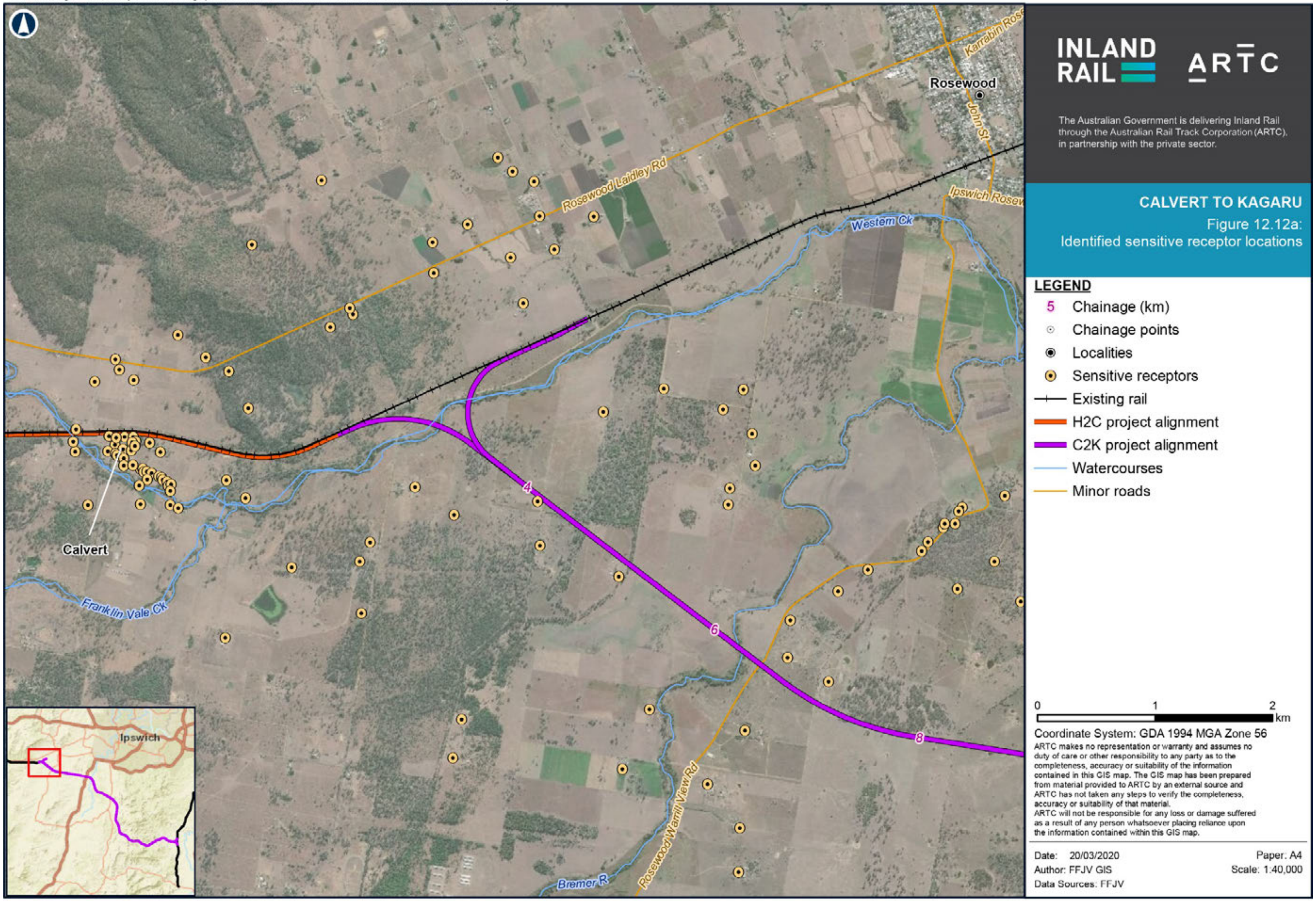

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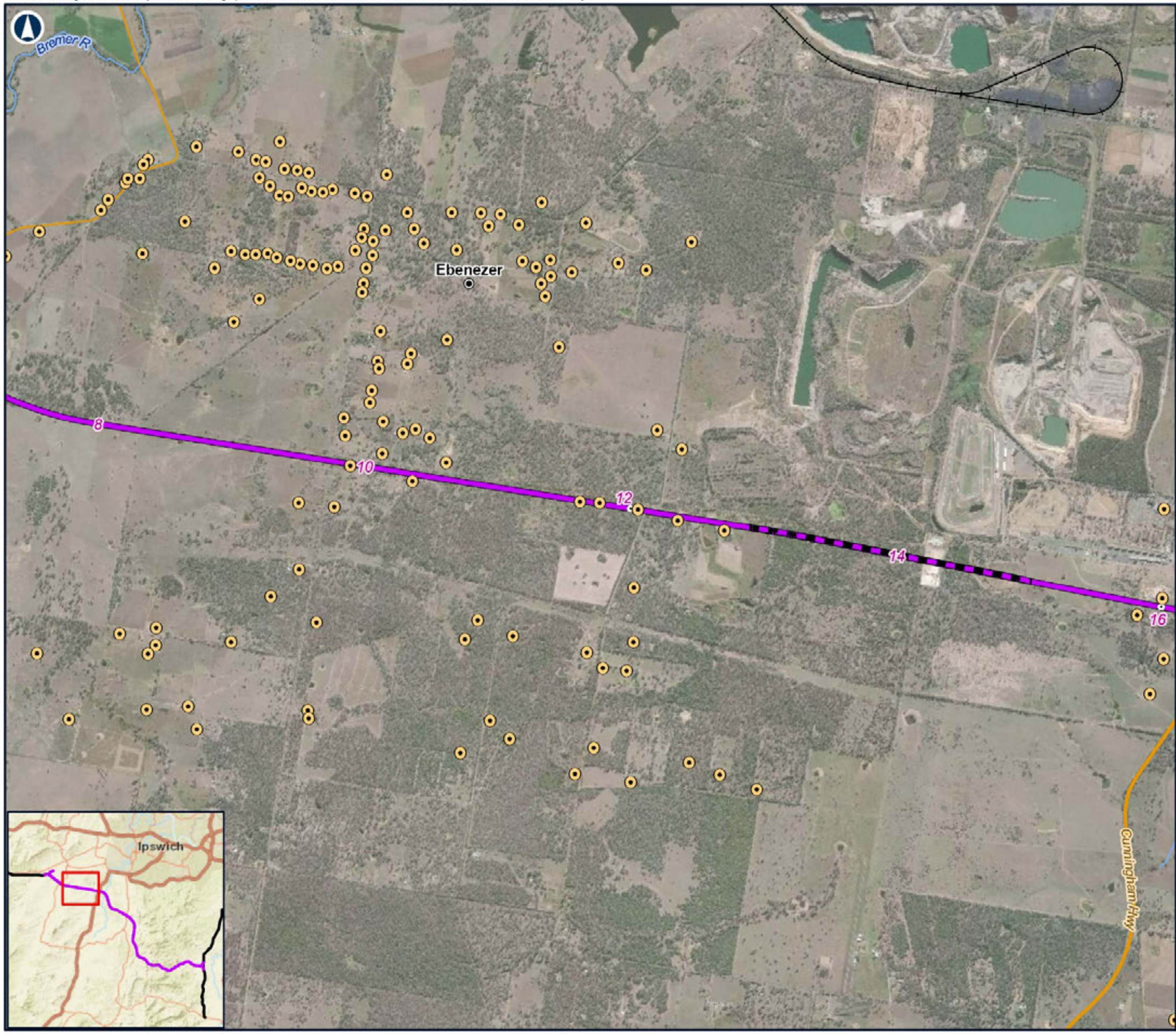

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CALVERT TO KAGARU

Figure 12.12b:
Identified sensitive receptor locations

LEGEND

- 5 Chainage (km)
- Chainage points
- Localities
- Sensitive receptors
- Existing rail
- C2K project alignment
- Crossing loops
- Watercourses
- Major roads
- Minor roads

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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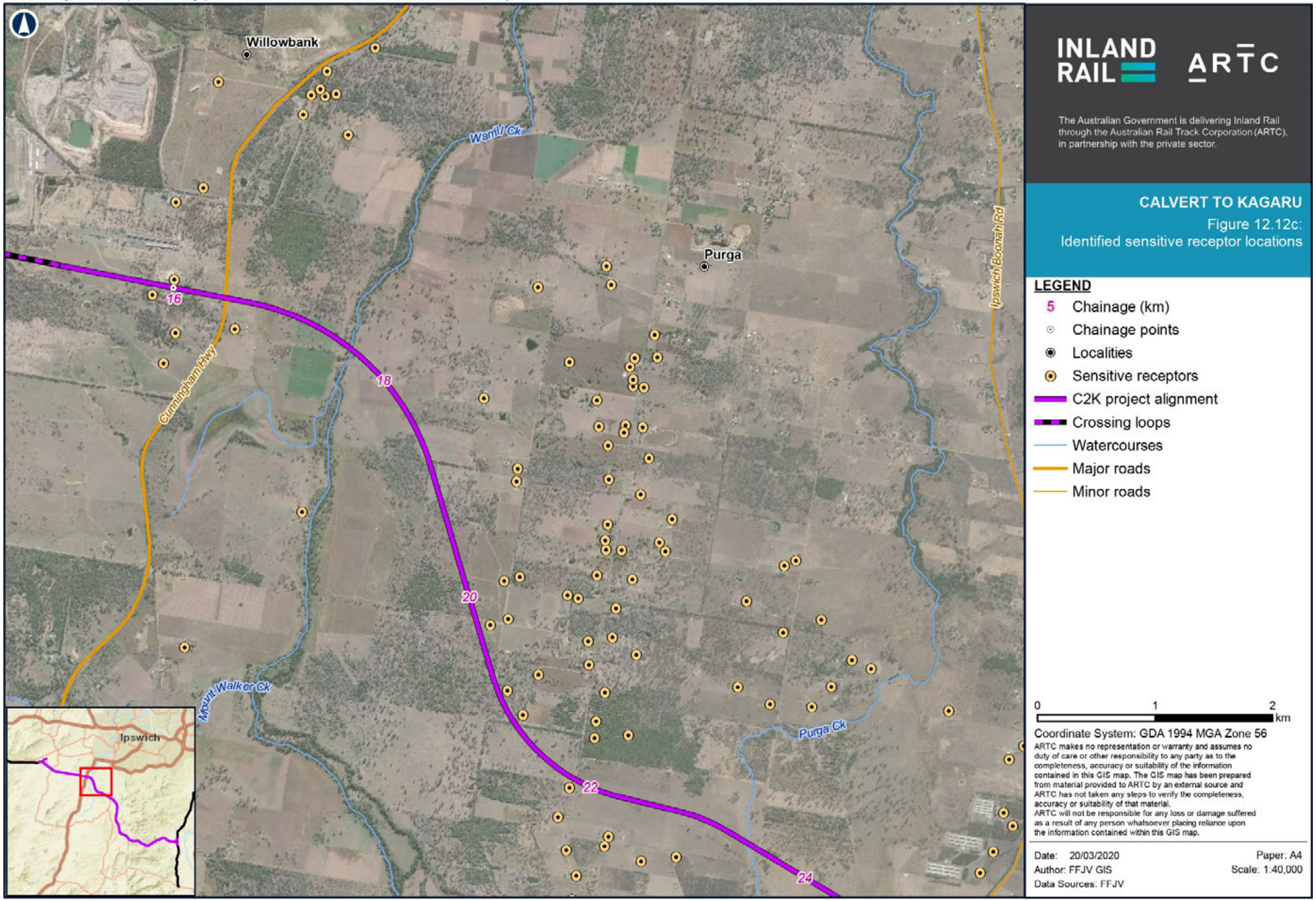

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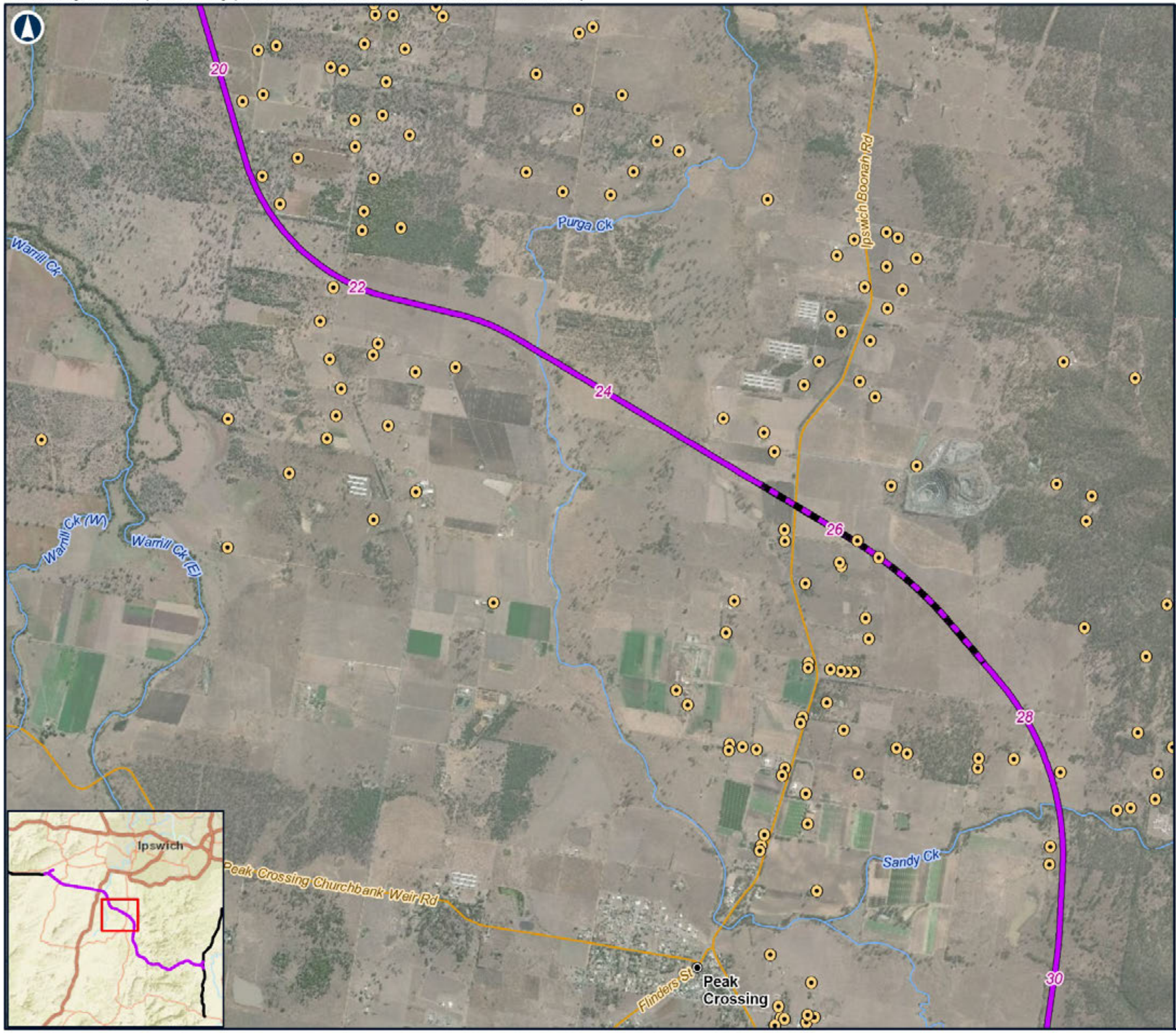

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CALVERT TO KAGARU

Figure 12.12d:
Identified sensitive receptor locations

LEGEND

- 5 Chainage (km)
- Chainage points
- Localities
- Sensitive receptors
- C2K project alignment
- Crossing loops
- Watercourses
- Minor roads

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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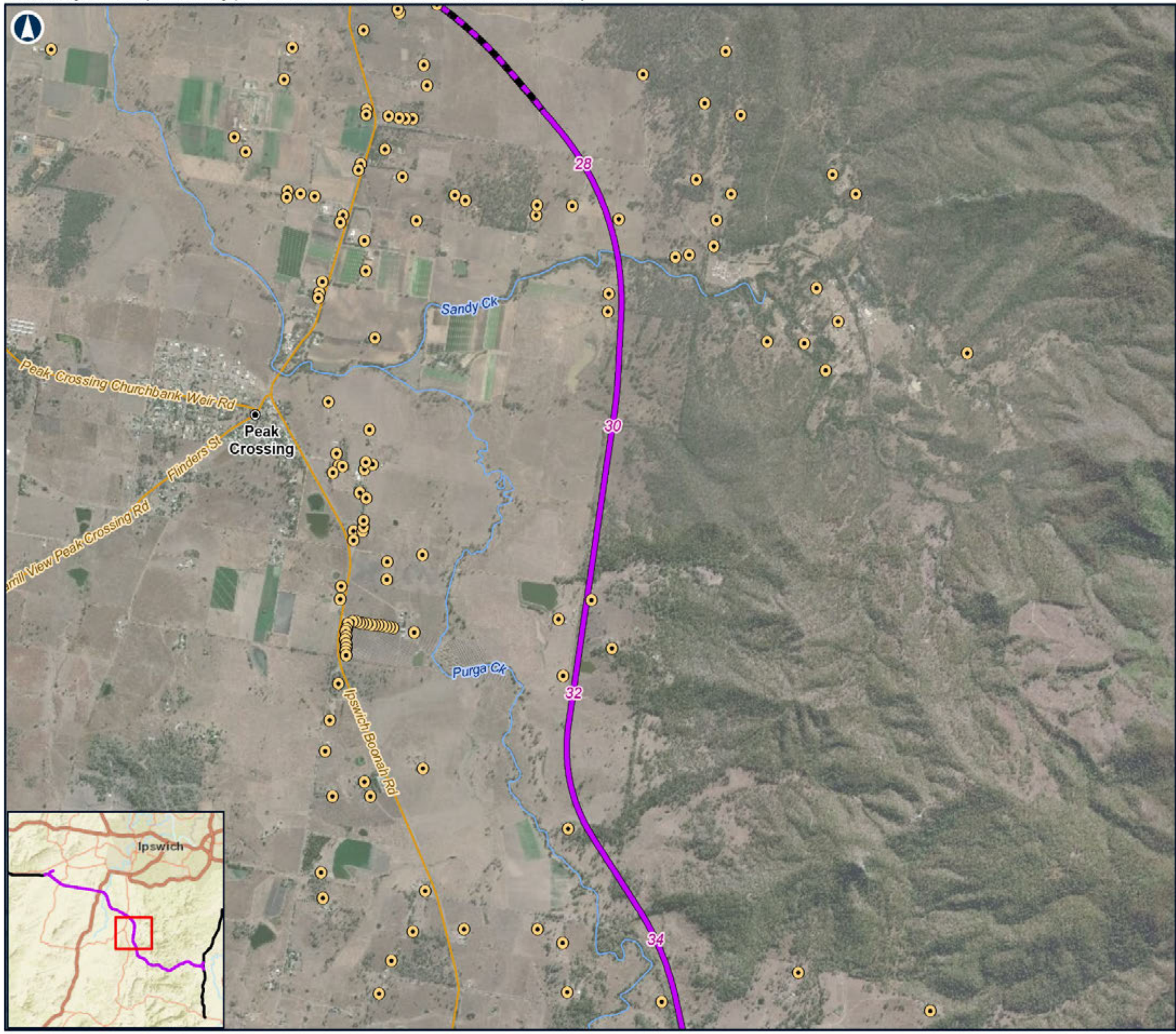

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CALVERT TO KAGARU

Figure 12.12e:
Identified sensitive receptor locations

LEGEND

- 5 Chainage (km)
- Chainage points
- Localities
- Sensitive receptors
- C2K project alignment
- Crossing loops
- Watercourses
- Minor roads

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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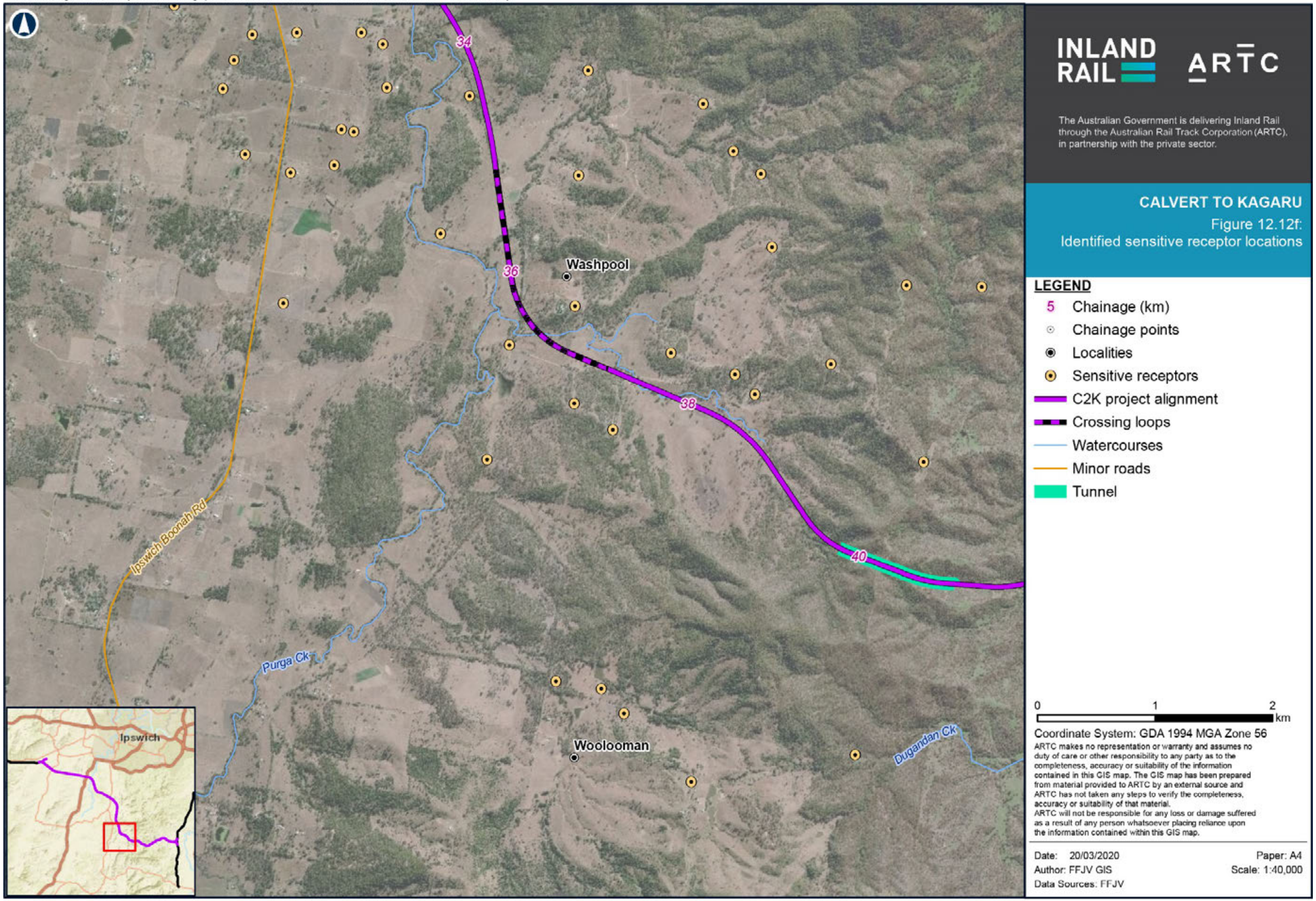

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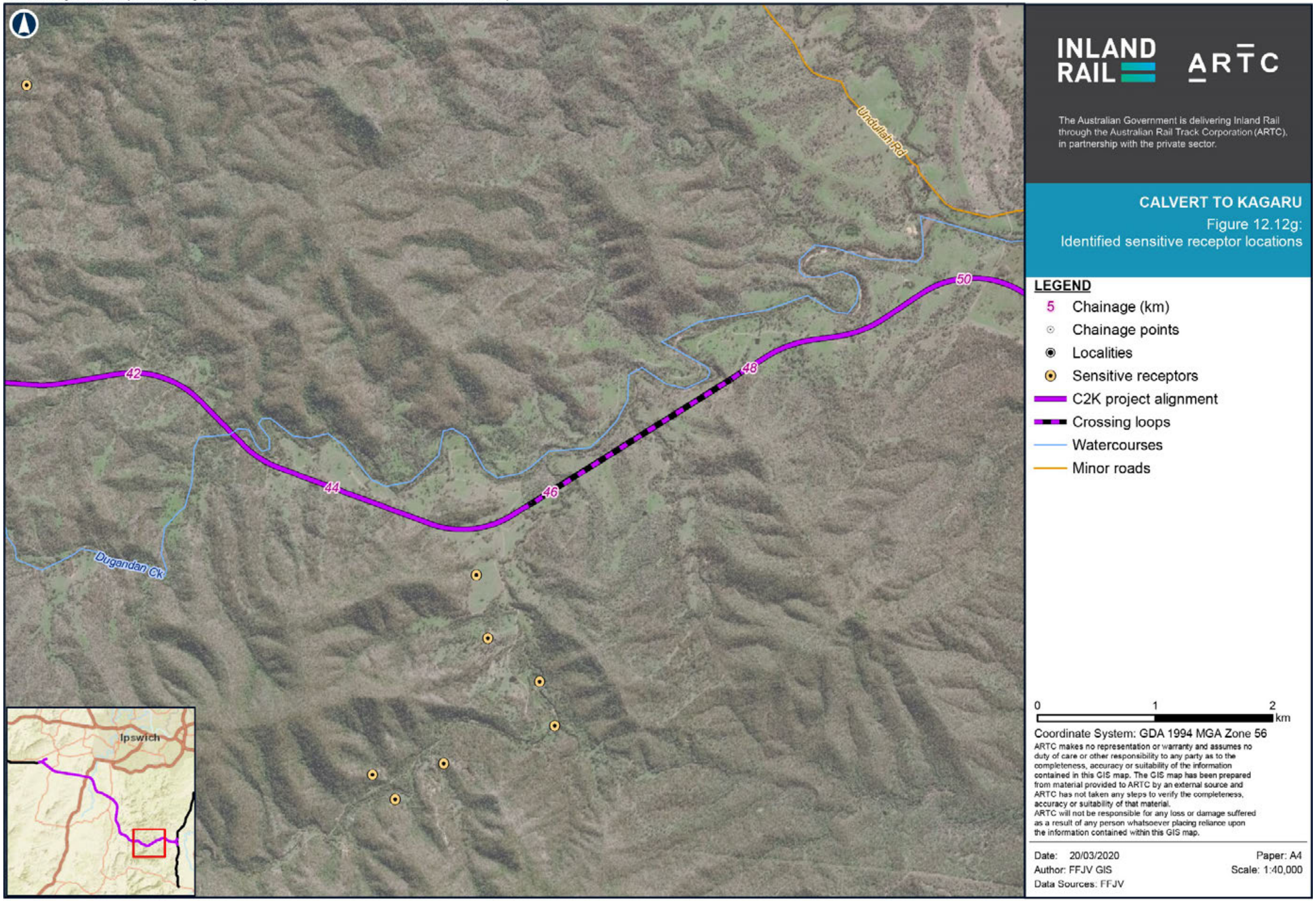

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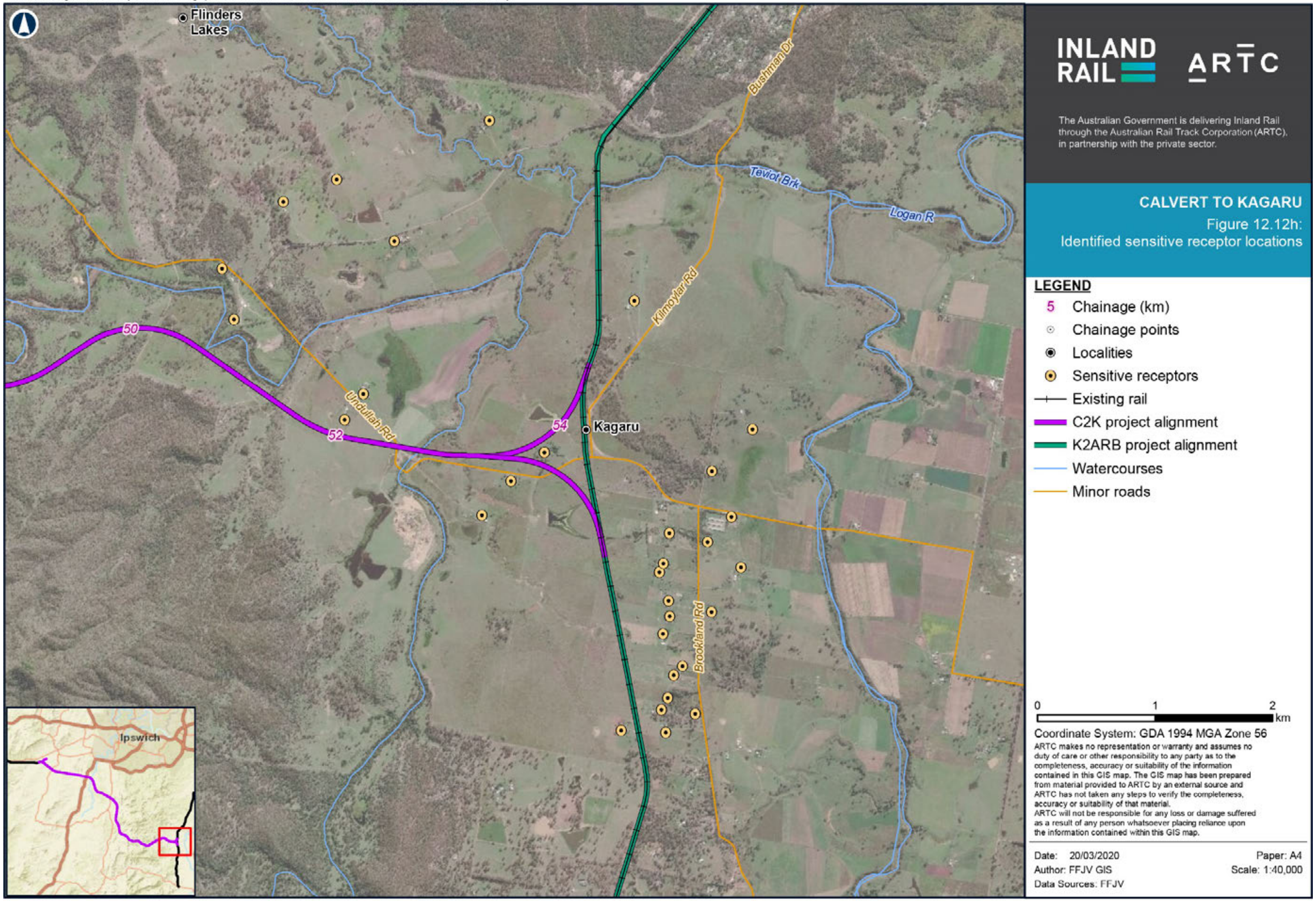

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12.6 Potential impacts

The following sections summarise the potential air quality impacts that may arise at each phase of the Project.

12.6.1 Construction dust

The highest proportion of construction emissions are generated by mechanical activity, e.g. material movement or mobile equipment activity, which typically generate coarser particulate emissions (PM_{10} and TSP). Airborne PM_{10} and deposited dust are the main pollutants of concern for construction activities and these pollutant species are the focus of the assessment for construction dust. Airborne PM_{10} has the potential to impact human health due to inhalation of particulate matter, while deposited dust has the potential to cause nuisance impacts but does not directly impact human health.

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. NO_x and CO) and $PM_{2.5}$ from diesel construction vehicles and mobile plant 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 for the construction phase.

In addition to construction dust, odour and VOCs will be emitted as fugitive emissions from fuel tanks located at laydown areas. Impacts from fuel storage have been assessed in Section 12.6.1.2.

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

12.6.1.1 Construction dust

A qualitative impact assessment of the construction of the Project was completed using United Kingdom IAQM's *Guidance on the assessment of dust from demolition and construction* (IAQM, 2014). The IAQM guidance provides a method for the assessment of airborne PM_{10} and deposited dust, which are the main pollutants of concern from construction. The outcomes of the assessment of construction dust impacts are presented in this section.

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 more than 500 m from the site entrance.

There are 548 sensitive receptors within the air quality study area. Of the 548 receptors, 159 are located within 350 m of the disturbance footprint, and seven of the 159 receptors are located less than 20 m away. Based on the location of sensitive receptors, further assessment of potential impacts is required.

Step 2—Dust risk assessment

Step 2 in the IAQM is a risk-assessment tool designed to appraise the potential for dust impacts due to unmitigated dust emissions from a construction project. 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.

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: Example definitions for demolition are:
  - Large: Total building volume >50,000 m³, potentially dusty construction material (e.g. concrete), onsite 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
  - 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 t
  - Medium: Total site area 2,500 m² to10,000 m², moderately dusty soil type (e.g. silt), 5 to10 heavy earth moving vehicles active at any one time, formation of bunds 4 m to 8 m in height, total material moved 20,000 t to 100,000 t
  - 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 t, earthworks during wetter months
- Construction: The key issues when determining the potential dust emission magnitude during the construction phase include the size of the buildings/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 to 100,000 m³, potentially dusty construction material (e.g. concrete), on site concrete batching
  - Small: Total building volume <25,000 m³, construction material with low potential for dust release (e.g. metal cladding or timber)
- Trackout: Factors that 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
  - 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.

Potential dust emission magnitudes for the Project were estimated based on the IAQM examples listed above. Justification and the factors used in determining the magnitudes are presented in Table 12.28. Multiple work fronts will be active at any one time along the alignment.

TABLE 12.28: 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 m^3 ▸ Possible demolition and realignment of existing roads—to be confirmed in detailed design phase of the Project
Earthworks	Large	▸ Multiple work fronts at any one time along the alignment ▸ Vegetation clearing along the alignment for new access tracks and laydown areas will occur where necessary—no known quantities at this stage. Clearing is staged to limit size of disturbance area at any one time ▸ Topsoil along entire alignment (53 km long) will be stripped (approximate depth of 0.3 m) and stockpiled. Wherever possible and appropriate material will be reused within the Project ▸ 18 laydown areas along the alignment, primarily to act as locations for excavation stockpiling. Stockpiles to be located as close as possible to the excavation source ▸ The total cut across the disturbance area, excluding the tunnel, has been estimated to be 5,768,166 m^3 ▸ Approximately 4,255,382 m^3 of fill material will be needed for the construction of embankments in the disturbance area. The current construction methodology includes using the material from the cuts in the embankments work ▸ Of the 18 laydown areas, it is assumed six will act as Laydown Area Delivery Points (LADP). One will store <10,000 t of ballast and the other five will store <20,000 t of ballast each. Up to 110,000 t of ballast material movement in total ▸ Drilling and blasting may occur to create tunnel portals—to be confirmed during the detailed design phase of the Project ▸ Utility relocations—more information to be provided in the detailed design phase ▸ Earthworks material likely to be dusty especially during dry season. Soil types along the alignment are to be confirmed
Construction	Large	▸ Construction period of approximately four years, with multiple work fronts at any one time along the alignment ▸ Installation of approximately 53 km of railway utilising steel rail, sleepers, ballast and concrete. Concrete and ballast present high dust risk ▸ Construction of railway tunnel approximately 1,015 m long ▸ Construction of 27 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 LADP ▸ Potential for onsite batching plant and material handling facility assumed to be located at LADP (ID C2K-LDN053.8)—high dust risk materials ▸ Construction of six fuel storage facilities: two <40,000 L, and four <20,000 L ▸ Laydown areas to also include temporary parking facilities for construction workers ▸ Construction of temporary and permanent fencing—total lengths to be determined during detailed design phase
Trackout	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 via 18 t dump trucks ▸ After construction, access tracks are expected to be reinstated or only used for maintenance activities ▸ Total length of unpaved road/access tracks unknown until design is finalised but will be >100 m due to the size of the Project

Step 2B—Sensitivity of surrounding area

The IAQM methodology allows the sensitivity of an area to dust deposition and human health impacts due to PM_{10} 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 PM_{10} concentrations (only applicable to the human health impact matrix)
- Number of receptors in the area
- Proximity of receptors to dust sources.

Table 12.29 details the IAQM guidance sensitivity levels from dust deposition effects on people and property. As detailed in Section 12.5.5, the total number of receptors identified in the land resources study area is 548. All 548 receptors are classified as high sensitivity as they are residential dwellings. Of the 548 receptors, 159 are located within 350 m of a construction dust source and seven of the 159 receptors are located less than 20 m away. As such, the air quality study area sensitivity level to dust deposition effects is expected to be 'Medium'.

TABLE 12.29: 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 12.30. For high- and medium-sensitivity receptors, the IAQM methods takes the existing background concentrations of PM_{10} (as an annual average) experienced in the area of interest (e.g. air quality study area). As the UK goals for PM_{10} differ from the ambient air quality goals adopted for use in this assessment (QLD air quality goals) the annual mean concentration categories used in the assessment (refer Table 12.30) have been modified from those presented in the IAQM method. This approach is consistent with the IAQM guidance, which states that in using the tables to define the sensitivity of an area, professional judgement may be used to determine alternative sensitivity categories.

TABLE 12.30: IAQM GUIDANCE FOR CATEGORISING THE SENSITIVITY OF AN AREA TO HUMAN HEALTH IMPACTS

Receptor sensitivity	Annual mean PM_{10} concentration[a]	Number of receptors	Distance from the source				
			<20	<50	<100	<250	<350
High	> 25 µg/m³	> 100	High	High	High	Medium	Low
		10–100	High	High	Medium	Low	Low
		1–10	High	Medium	Low	Low	Low
	21–25 µg/m³	> 100	High	High	Medium	Low	Low
		10–100	High	Medium	Low	Low	Low
		1–10	High	Medium	Low	Low	Low
	17–21 µg/m³	> 100	High	Medium	Low	Low	Low
		10–100	High	Medium	Low	Low	Low
		1–10	Medium	Low	Low	Low	Low
	< 17 µg/m³	> 100	Medium	Low	Low	Low	Low
		10–100	Low	Low	Low	Low	Low
		1–10	Low	Low	Low	Low	Low
Medium	> 25 µg/m³	> 10	High	Medium	Low	Low	Low
		1–10	Medium	Low	Low	Low	Low
	21–25 µg/m³	> 10	Medium	Low	Low	Low	Low
		1–10	Low	Low	Low	Low	Low
	17–21 µg/m³	> 10	Low	Low	Low	Low	Low
		1–10	Low	Low	Low	Low	Low
	< 17 µg/m³	> 10	Low	Low	Low	Low	Low
		1–10	Low	Low	Low	Low	Low
Low	Any	>1	Low	Low	Low	Low	Low

Table notes:

a. The annual mean PM_{10} concentration categories have been modified from the IAQM guidance to adjust for assessment of a site in QLD.

As detailed in Section 12.5.2, the adopted annual average PM_{10} background concentration (Flinders View monitoring station) is 16.2 µg/m³, which falls within the <17 µg/m³ category. As there are less than ten receptors within 20 m of a disturbance area (dust source), the sensitivity of the air quality study area to human health impacts is determined to be low.

As discussed in Section 12.5.3, the Boral Purga Quarry will be operational during the construction phase of the Project, and as a result, background concentrations of PM_{10} may be higher at receptors located near the quarry. The two nearest sensitive receptors to the quarry are located 70 m and 120 m from the quarry, with these receptors located in excess of 180 m from the boundary of the nearest disturbance area (laydown area LDN026.0). Due to the significant separation distance between the nearest Project disturbance area and sensitive receptors, the sensitivity for receptors in this area would still be classified as low if elevated background PM_{10} concentrations were assumed.

Although receptors located near the quarry have a higher risk of significant impact due to the presence of the quarry, the sensitivity of the entire air quality study area to human health impacts is determined to be low. Mitigation measures and considerations for receptors located near the quarry are included in Section 12.7.3.

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 area (refer Table 12.29 and Table 12.30) 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 construction activity, which is presented in Table 12.31. The 'without mitigation' dust risk impacts determined for each activity are summarised in Table 12.32.

TABLE 12.31: 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
Construction	High	High risk	Medium risk	Low risk
	Medium	Medium risk	Medium risk	Low risk
	Low	Low risk	Low risk	Negligible
Trackout	High	High risk	Medium risk	Low risk
	Medium	Medium risk	Low risk	Negligible
	Low	Low risk	Low risk	Negligible

TABLE 12.32: WITHOUT MITIGATION DUST RISK IMPACTS FOR PROJECT CONSTRUCTION ACTIVITIES

Potential impact	Risk			
	Demolition	Earthworks	Construction	Trackout
Scale of activity (IAQM Table 4)	Small	Large	Large	Large
Dust deposition	Low	Medium	Medium	Medium
Human health	Negligible	Low	Low	Low

The result of the qualitative air quality risk assessment shows that the unmitigated air emissions from the construction of the Project poses a low risk of human health impacts but a medium risk of dust deposition impacts.

Step 3—Management strategies

The purpose of Step 2 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. A high- or medium-level risk rating means that suitable management measures must be implemented during the Project.

A Construction Environmental Management Plan (CEMP) will be developed to mitigate and manage potential impacts during the construction. The implementation of proposed site-specific and in-principle management measures listed in Section 12.7.3 and in Chapter 23: Draft Outline Environmental Management Plan will mitigate construction dust emissions.

Step 4—Reassessment

Step 4 of the IAQM method requires reassessment to determine whether there are likely to be significant residual impacts, post mitigation, arising from a proposed development. The 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".'*

The dust risk assessment in Table 12.32 shows that without mitigation, there is an anticipated low risk of human health impacts but a medium risk of dust deposition impacts.

Mitigation measures proposed to mitigate construction impacts are presented in Section 12.7.3. The construction dust sources associated with the Project are common emission sources. Industry standard best practice measures to reduce dust emissions exist for all the identified sources and it is expected that emissions can be well managed through diligent implementation of best practice controls.

An assessment of the residual significance of impact from construction with the implementation of the proposed mitigation measures is presented in Section 12.8.1.

12.6.1.2 Tank fuel storage

Fuel storage is expected to be undertaken at six locations (laydown areas) along the proposed alignment during the construction of the Project. Fuel storage has the potential to impact nearby sensitive receptors due to the emission of VOCs and odour. Table 12.33 presents the proposed laydown areas that may include diesel fuel storage, the volumes proposed to be stored, and the distance from each area to the closest identified sensitive receptor.

TABLE 12.33: FUEL TANK STORAGE LOCATIONS

Laydown area ID	Chainage (km)	Location	Fuel storage proposed (L)	Distance from boundary of laydown area to closest sensitive receptor (m)
C2K-LDN004.8	4.8	Hayes Road	<20,000	175
C2K-LDN012.1	12.1	Paynes Road	<20,000	8
C2K-LDN021.8	21.8	Middle Road	<40,000	41
C2K-LDN026.0	26.0	Ipswich–Boonah Road	<20,000	25
C2K-LDN036.6	36.6	Washpool Rd	<20,000	159
C2K-LDN053.8	53.8	Undullah Road	<40,000	98

Table 12.33 shows that for the largest fuel storage tanks of 40,000 L, the distance to the closest receptor is 41 m, while for the for the smaller tanks of 20,000 L the distance to the closest receptor is 8 m.

The EPA Victoria guideline *Recommended Separation Distances for Industrial Residual Air Emissions* (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), but this guidance is for tanks exceeding 2,000 tonnes, which is far greater than the size of the tanks proposed for the Project.

The BCC Service Station Code provides performance outcomes and acceptable outcomes for service stations to ensure that service station developments are located at '*sufficient distance from dwellings to maintain residential amenity in adjoining, adjacent or surrounding areas*'. Acceptable Outcome AO7.2 specifies acceptable separation distances based on annual fuel throughput. For service stations with an annual fuel throughput of less than 1.2 megalitres (ML) the acceptable separation distance is 10 m, while for service stations with annual fuel throughput of between 1.2 to 9 ML, the accepted distance is 50 m. 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 these buffers is considered conservative for diesel.

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), while the 40,000 L tanks would need to be refilled more than once every two days (225 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.

All construction areas with the exception of C2K-LDN012.1, C2K-LDN021.8, and C2K-LDN026.0 have separation distances from the nearest boundary to the closest receptor of greater than 50 m. However, the dimensions of C2K-LDN012.1 (1,400 m x 30 m), C2K-LDN021.8 (400 m x 550 m), and C2K-LDN026.0 (290 m x 680 m) will allow for the fuel tanks in these construction areas to be located at a position that is further than 50 m from the nearest receptor.

It is recommended that at a 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 Australian Standard AS 1940:2017 (Standards Australia, 2017). The storage and handling of flammable and combustible liquids is expected to result in negligible impacts to sensitive receptors based on the recommendations of the BCC Service Station Code.

12.6.2 Commissioning

Air emissions during the commissioning phase 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.

Air emissions from the commissioning phase of the Project are expected to be insignificant. Any potential incremental impacts are unlikely to generate nuisance or risk exceedance of the Projects air quality goals

Commissioning phase impacts have not been assessed.

12.6.3 Operation

12.6.3.1 Impacts to air quality

Dispersion modelling results

The results of the air quality dispersion modelling of operational impacts are presented in this section. increments considered are described below in Table 12.34.

TABLE 12.34: MODELLING INCREMENT DESCRIPTIONS

Increments	Description
Project only contribution	Represents the predicted concentrations from modelled Project locomotive emissions. Different versions of the model have been run to assess emissions from the crossing loops as discussed in 12.4.4.3.
Background concentration	Adopted background concentrations
Total cumulative concentration	The cumulative concentration of the Project contribution and the adopted background concentration
With veneering	Contribution from trains with veneering (75 per cent reduction to emissions from coal wagons) (only applicable for TSP, PM_{10}, $PM_{2.5}$ and deposited dust)
Without veneering	Contribution from trains without veneering (no reduction to coal wagon emissions) (only applicable for TSP, PM_{10}, $PM_{2.5}$ and deposited dust)

The results of the dispersion modelling for the worst affected receptor are shown in Table 12.35 for typical train volume scenarios (based on the *Inland Rail Program Business Case* (ARTC 2015a). Table 12.35 also presents the air quality goals for each pollutant of concern.

Table 12.35 shows that compliance is predicted for all pollutant species for the typical traffic volume scenarios with the inclusion of veneering. Without veneering, the annual PM_{10} and $PM_{2.5}$ goals are predicted to be exceeded. This is with conservative modelling and conservatively adopted background concentrations – at the worst case affected sensitive receptor.

With the inclusion of veneering, the Project contribution to concentrations at sensitive receptors is reduced and compliance with the Project air quality goals is predicted to be achieved for typical operations.

As discussed in Section 12.3.3 the air quality goals adopted for the assessment are prescribed to protect or enhance the environmental values of health and wellbeing and protecting the aesthetic environment. Assessment of the Projects impact to these environmental values is discussed in the following sections.

Environmental value: human health and wellbeing

All of the pollutant species considered in detail for the assessment of operational impacts have goals that are set for the protection of human health with the exception of dust deposition and toluene (30-minute average). With the inclusion of veneering, the predicted cumulative concentrations for all pollutants assessed are below the adopted goals for train volumes assessed.

The assessment has adopted representative (and conservative) background air quality in the prediction of cumulative concentrations, and therefore the results of the assessment can be used to assess the impact on human health. As predicted cumulative concentrations are compliant with the adopted air quality goals, the operation of the Project is not expected to significantly impact the environmental value of health and wellbeing.

Environmental value: aesthetics of the environment

The pollutant species that have air quality goals set for the protection of the aesthetic environment are toluene (30-minute average) and dust deposition. Table 12.35 shows that the Project contribution to toluene (30-minute average) is 0.0061 ug/m^3 for the typical operations, which represents less than 0.1 per cent of the 30-minute average goal of 1,100 ug/m^3.

The predicted maximum Project contribution to deposited dust for the typical operations is 0.04 mg/m^2/day with veneering and 0.15 mg/m^2/day without veneering. The predicted contributions represent less than 0.2 per cent of the adopted goal of 120 mg/m^2/day.

Based on the magnitude of the predicted Project contributions, and as the predicted cumulative concentrations are well below the air quality goals for toluene and deposited dust, the operation of the Project is not expected to significantly adversely impact the environmental values of aesthetic environment and the risk of amenity impacts as a result of the operation of the Project is considered to be low.

TABLE 12.35: HIGHEST PREDICTED GROUND LEVEL CONCENTRATIONS AT THE WORST-AFFECTED SENSITIVE RECEPTORS FOR TYPICAL OPERATIONS

Pollutant	Receptor	Average period	Highest predicted ground level pollutant concentration at identified sensitive receptor locations (µg/m³) – Project only contribution (A)	Background concentration (B)	Total cumulative concentration (Project + Background) (A + B)	Assessment goal (µg/m³)	Environmental value protected
TSP	sr461	Annual average (with veneering)	7.9	40.5	48.4	90	Health and wellbeing
	sr461	Annual average (*without* veneering)	28.3		68.8		
PM_{10}	sr461	24 hour maximum (with veneering)	7.4	18.7	26.1	50	Health and wellbeing
	sr503	24 hour maximum (*without* veneering)	23.7		42.4		
	sr461	Annual average (with veneering)	4.5	16.2	20.7	25	Health and wellbeing
	sr461	Annual average (*without* veneering)	14.6		**30.8**		
$PM_{2.5}$	sr503	24 hour maximum (with veneering)	4.1	6.4	10.5	25	Health and wellbeing
	sr503	24 hour maximum (*without* veneering)	5.4		11.8		
	sr461	Annual average (with veneering)	1.5	5.7	7.2	8	Health and wellbeing
	sr461	Annual average (*without* veneering)	3.1		**8.8**		
Deposited dust	sr461	30 day (with veneering)	0.04	50	50.0	120 mg/m²/day	Nuisance
	sr461	30 day (*without* veneering)	0.15	50	50.2		
NO_2	sr503	1 hour maximum	149.0	26.7	175.7	250	Health and wellbeing
	sr461	Annual average	16.6	7.8	24.4	62	Health and wellbeing
Arsenic and compounds	sr461	Annual average	2.94×10^{-4} ng/m³	-a.	-a.	6 ng/m³	Health and wellbeing
Cadmium and compounds	sr461	Annual average	2.94×10^{-2} ng/m³	-a.	-a.	5 ng/m³	Health and wellbeing
Chromium III and compounds	sr503	1 hour maximum	7.79×10^{-4}	-a.	-a.	9	n/a
Chromium VI and compounds	sr503	1 hour maximum	7.79×10^{-4}	-a.	-a.	0.1	Screening health risk assessment
	sr461	Annual average	1.47×10^{-4}	-a.	-a.	0.01	Screening health risk assessment

Pollutant	Receptor	Average period	Highest predicted ground level pollutant concentration at identified sensitive receptor locations (µg/m³) Project only contribution (A)	Background concentration (B)	Total cumulative concentration (Project + Background) (A + B)	Assessment goal (µg/m³)	Environmental value protected
Lead and compounds	sr461	Annual average	2.59 x 10^{-6}	-a.	-a.	0.5	Health and wellbeing
Nickel and compounds	sr461	Annual average	0.36 ng/m³	-a.	-a.	20 ng/m³	Health and wellbeing
Dioxins and furans	sr461	Annual average	5.72 x 10^{-11}	-a.	-a.	3 x 10^{-8}	Screening health risk assessment
Polycyclic aromatic hydrocarbon (as benzo[a]pyrene)	sr461	Annual average	0.018 ng/m³	-a.	-a.	0.3 ng/m³	Health and wellbeing
1,3-butadiene	sr461	Annual average	0.21	-a.	-a.	2.4	Health and wellbeing
Benzene	sr461	Annual average	0.0020	5.2	5.2	5.4	Health and wellbeing
Toluene	sr503	30-minute maximum	0.0061	23.0	23.0	1,100	Protecting aesthetic environment
	sr503	24-hour maximum	0.0015	21.7	21.7	4,100	Health and wellbeing
	sr461	Annual average	0.00029	18.5	18.5	410	Health and wellbeing
Xylenes	sr503	24-hour maximum	0.21	31.5	31.7	1,100	Health and wellbeing
	sr461	Annual average	0.039	26.0	26.0	950	Health and wellbeing

Table notes:

a. No background monitoring data available for modelled pollutant.

b. 30-minute averages calculated from 1-hour modelling results as per (Turner, 1970).

n/a No environmental value listed for this goal in the NSW EPA Approved methods for the modelling and assessment of air pollutants in NSW.

Predicted concentrations which exceed the air quality goal are shown in **bold**.

Impacts to the assimilative capacity of the air environment

The assessment has adopted representative (and conservative) background air quality in the prediction of cumulative concentrations and deposition levels at sensitive receptors and has therefore considered the assimilative capacity of the air environment in determining compliance with the adopted air quality goals.

The remaining assimilative capacity of the receiving environment with the operation of the Project has been calculated for TSP, PM_{10}, $PM_{2.5}$ and NO_2, which are the pollutants emitted in the highest quantities by the operation of the Project. The remaining assimilative capacity for typical train operations have been calculated for the worst-affected receptor with the results presented in Table 12.36. It is highlighted that this is a conservative assessment of the assimilative capacity of the receiving environment as predicted concentrations vary significantly at different receptors.

Table 12.36 shows that the pollutant with the highest predicted change to the assimilative capacity of the air environment is NO_2, which is predicted to change by 60 per cent for 1-hour predictions and 27 per cent for annual average predictions at the worst-affected receptor. However, it is noted that even at the worst-affected receptor, the remaining assimilative capacity is 30 per cent for 1-hour concentrations, and 61 per cent for annual average concentrations.

For particulates, Table 12.36 shows that with veneering included the maximum change to the assimilative capacity of the receiving environment for typical train volumes is 25 per cent for annual average $PM_{2.5}$, with a maximum change of 22 per cent calculated for annual average $PM_{2.5}$ for typical train volumes.

Concentration contours

Predicted cumulative pollutant concentration contours for PM_{10} (24 hour), $PM_{2.5}$ (annual) and NO_2 (1 hour) for the typical train operations are presented in Figure 12.13 to Figure 12.15. The concentration contours presented are cumulative, and therefore can be compared directly against the adopted air quality goals. The figures do not represent particular dispersion patterns but rather the extent of potential impacts.

TABLE 12.36: REMAINING ASSIMILATIVE CAPACITY FOR TYPICAL OPERATIONS FOR WORST-AFFECTED RECEPTOR

Pollutant	Averaging period	Project only contribution (µg/m³)	Total cumulative concentration (µg/m³)	Air quality goal (µg/m³)	Remaining assimilative capacity at worst affected receptor (per cent)[a, b]	Change to assimilative capacity at worst affected receptor (per cent)
TSP	Annual average (with veneering)	7.9	48.4	90	46	9
	Annual average (*without veneering*)	28.3	68.8	90	24	31
PM_{10}	24-hour maximum (with veneering)	7.4	26.1	50	48	15
	24-hour maximum (*without veneering*)	23.7	42.4	50	15	47
	Annual average (with veneering)	4.5	20.7	25	17	18
	Annual average (*without veneering*)	14.6	30.8	25	-23	58
$PM_{2.5}$	24-hour maximum (with veneering)	4.1	10.5	25	58	16
	24-hour maximum (*without veneering*)	5.4	11.8	25	53	22
	Annual average (with veneering)	1.5	7.2	8	10	19
	Annual average (*without veneering*)	3.1	8.8	8	-10	39
NO_2	1 hour	149.0	176.0	250	30	60
	Annual average	16.6	24.4	62	61	27

Table notes:

a. The remaining assimilative capacity of the receiving environment at the worst-affected receptor considering contributions from the operation of the Project.

b. Negative percentage values occur for pollutants where the goal is exceeded.

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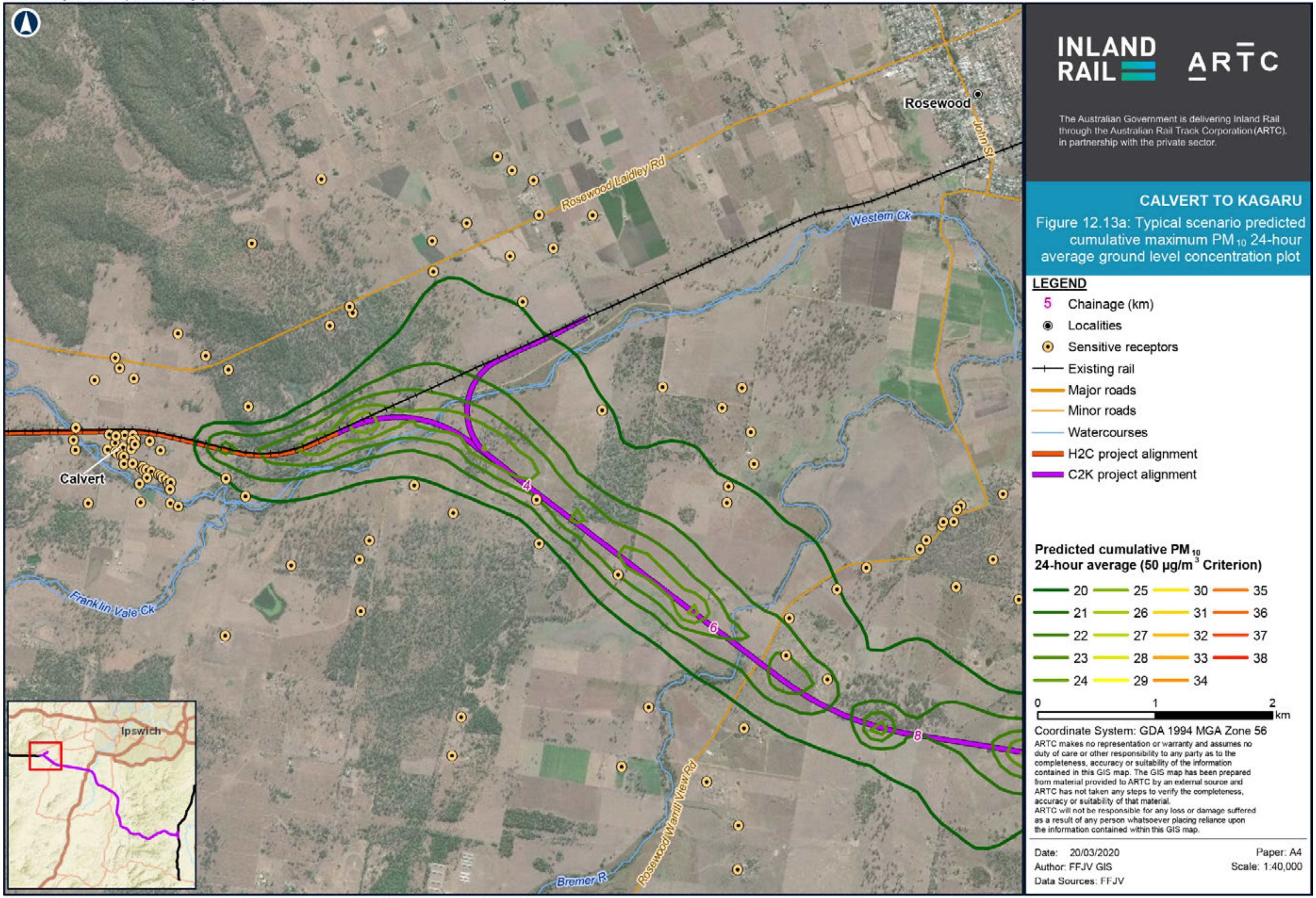

Figure 12.13a: Typical scenario predicted cumulative maximum PM_{10} 24-hour average ground level concentration plot

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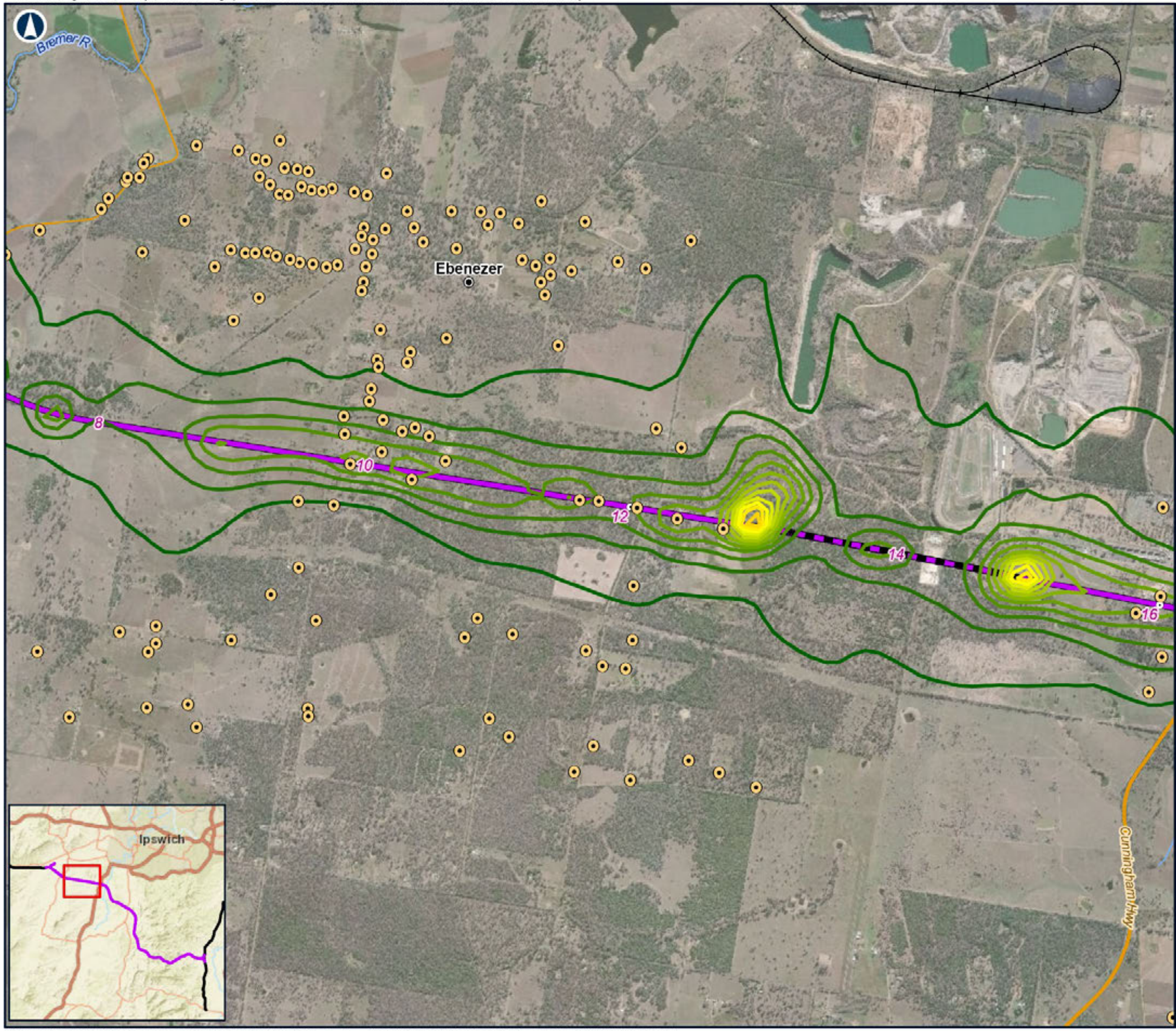

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Figure 12.13b: Typical scenario predicted cumulative maximum PM_{10} 24-hour average ground level concentration plot

LEGEND

- 5 Chainage (km)
- Localities
- Sensitive receptors
- Existing rail
- Major roads
- Minor roads
- Watercourses
- C2K project alignment
- Crossing loops

Predicted cumulative PM_{10} 24-hour average (50 µg/m^3 Criterion)

20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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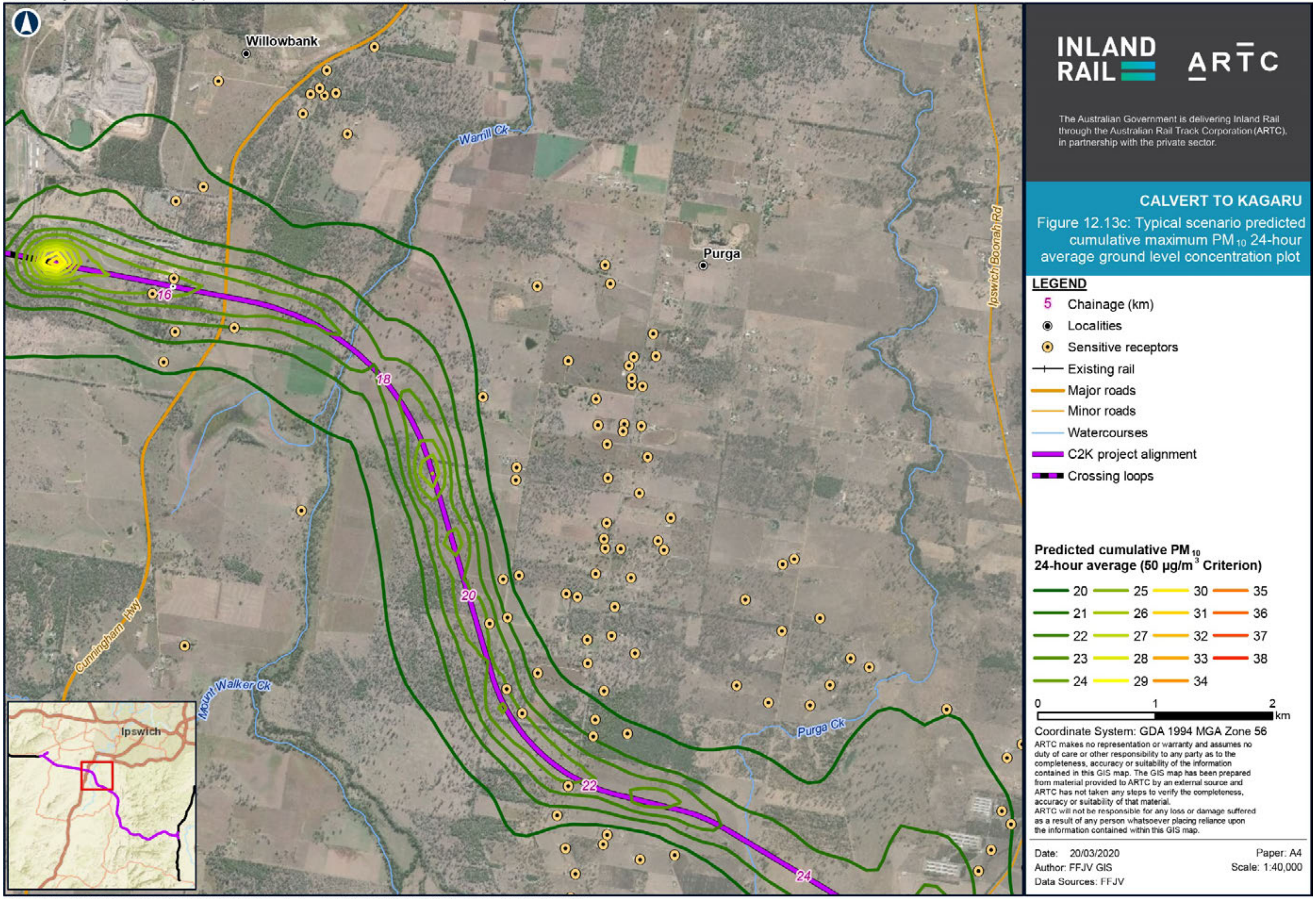

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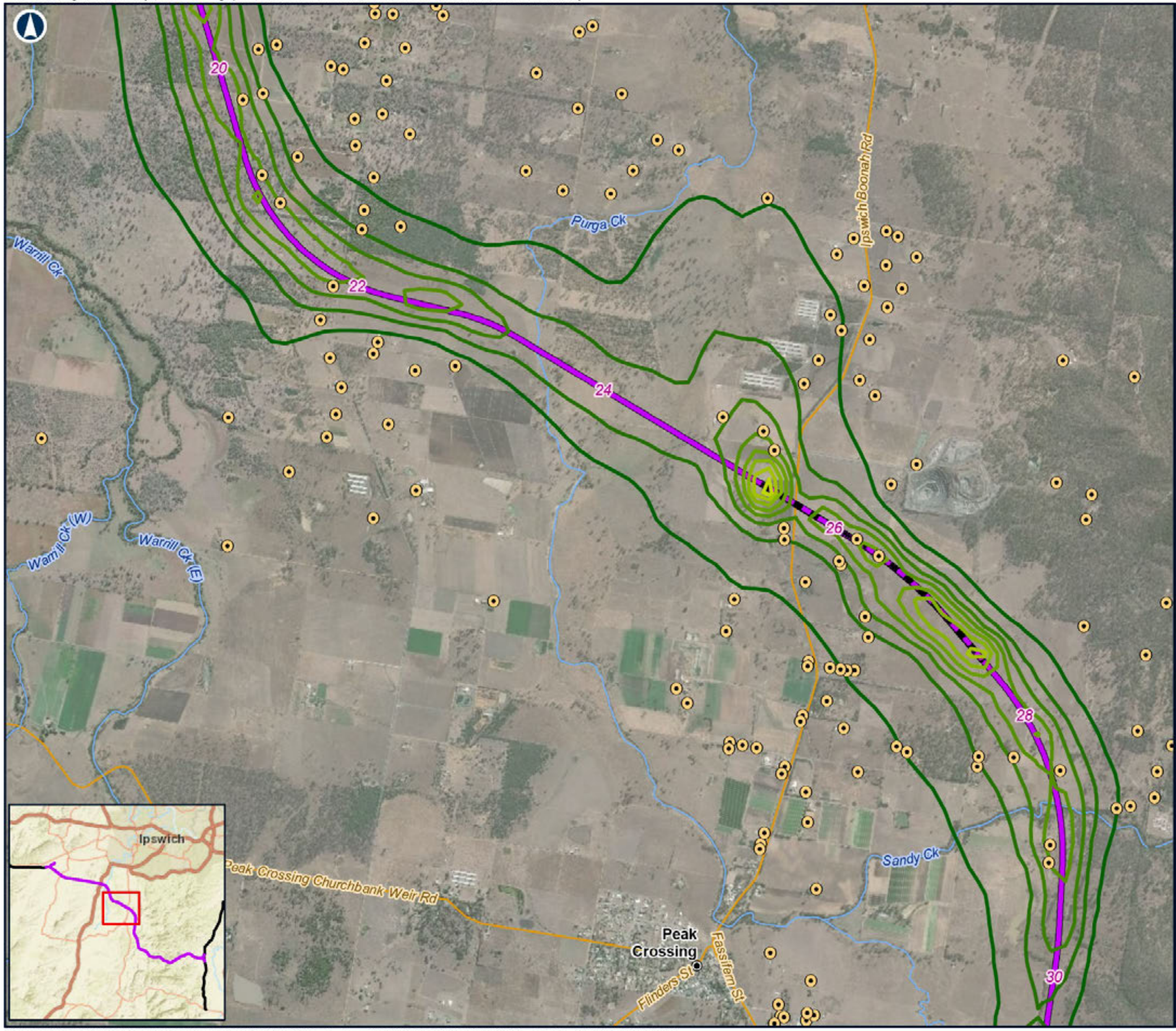

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Figure 12.13d: Typical scenario predicted cumulative maximum PM_{10} 24-hour average ground level concentration plot

LEGEND

- 5 Chainage (km)
- Localities
- Sensitive receptors
- Existing rail
- Major roads
- Minor roads
- Watercourses
- C2K project alignment
- Crossing loops

Predicted cumulative PM_{10} 24-hour average (50 µg/m³ Criterion)

20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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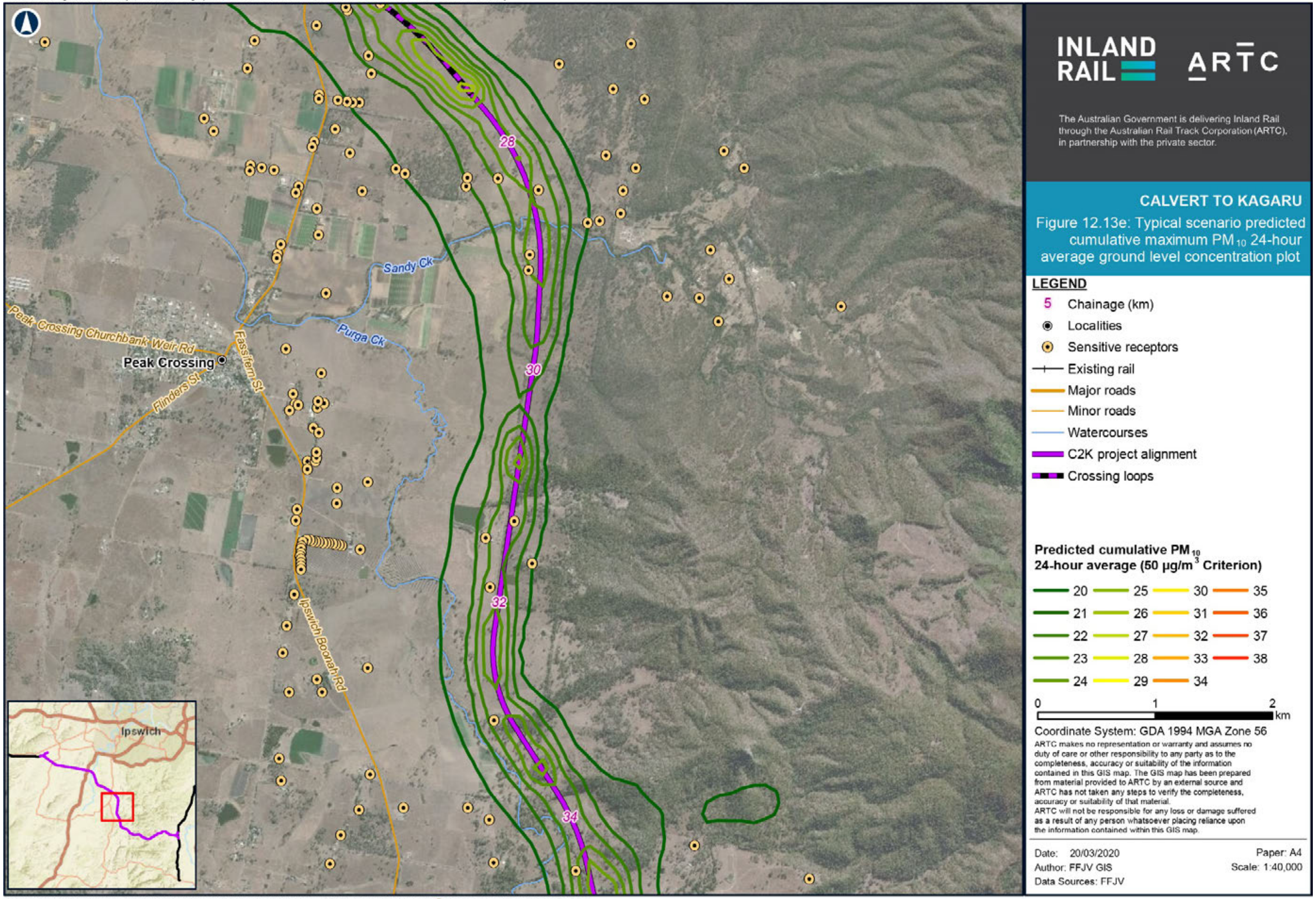

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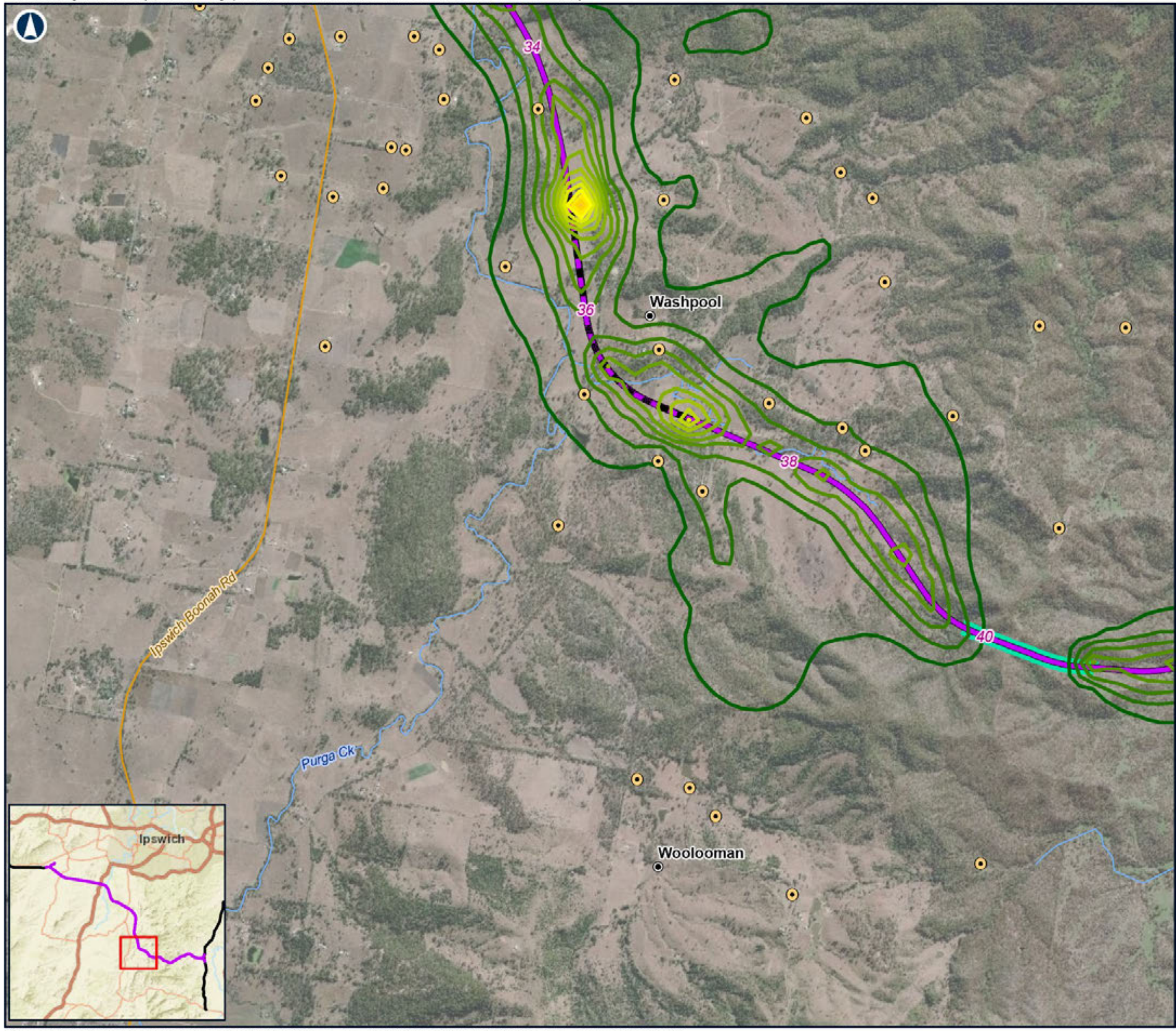

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Figure 12.13f: Typical scenario predicted cumulative maximum PM_{10} 24-hour average ground level concentration plot

LEGEND

- 5 Chainage (km)
- Localities
- Sensitive receptors
- Existing rail
- Major roads
- Minor roads
- Watercourses
- C2K project alignment
- Crossing loops
- Tunnel

Predicted cumulative PM_{10} 24-hour average (50 µg/m^3 Criterion)

20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38

0 1 2 km

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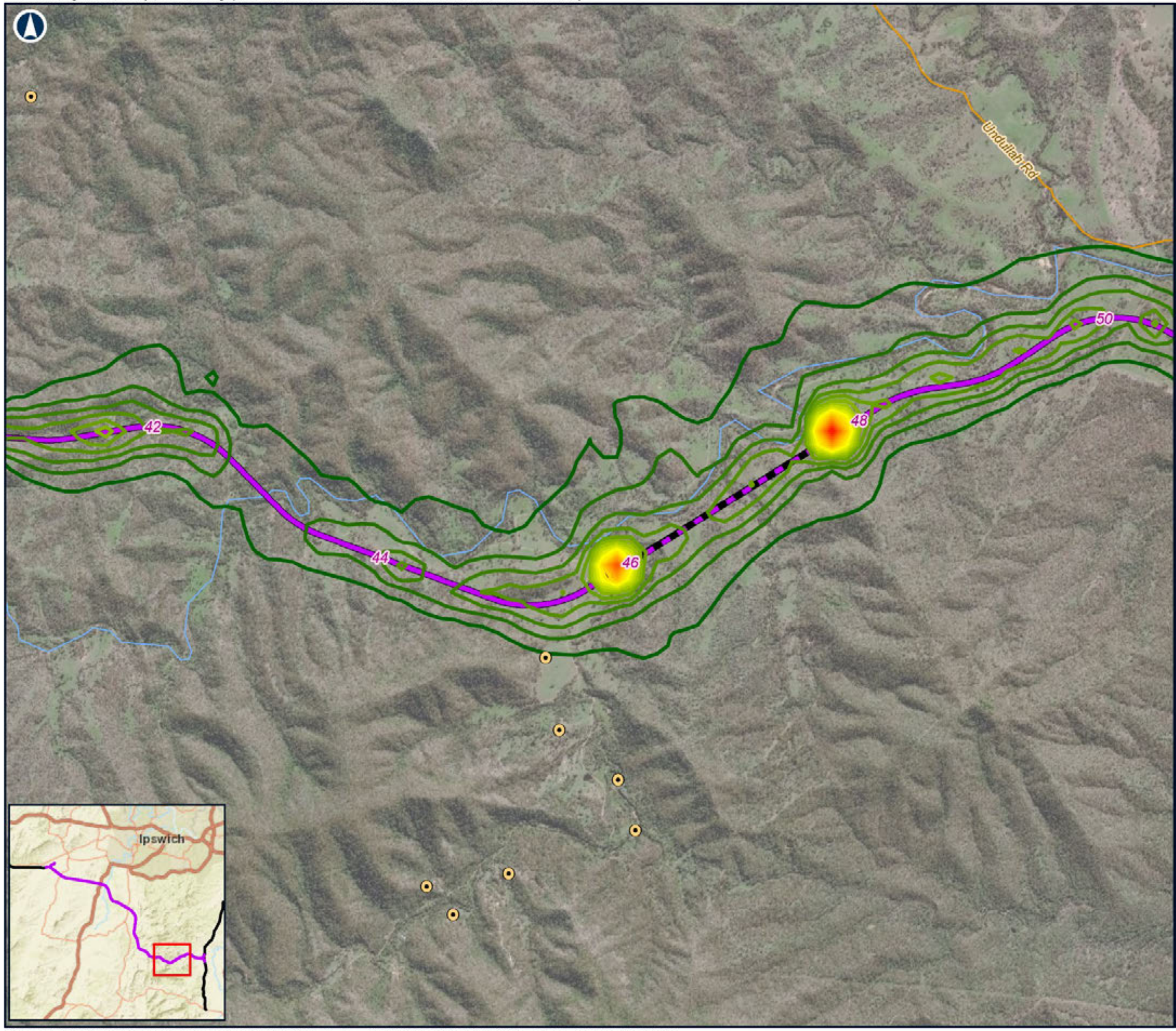

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Figure 12.13g: Typical scenario predicted cumulative maximum PM_{10} 24-hour average ground level concentration plot

LEGEND

- 5 Chainage (km)
- Localities
- Sensitive receptors
- Existing rail
- Major roads
- Minor roads
- Watercourses
- C2K project alignment
- Crossing loops

Predicted cumulative PM_{10} 24-hour average (50 µg/m^3 Criterion)

20	25	30	35
21	26	31	36
22	27	32	37
23	28	33	38
24	29	34	

0 1 2 km

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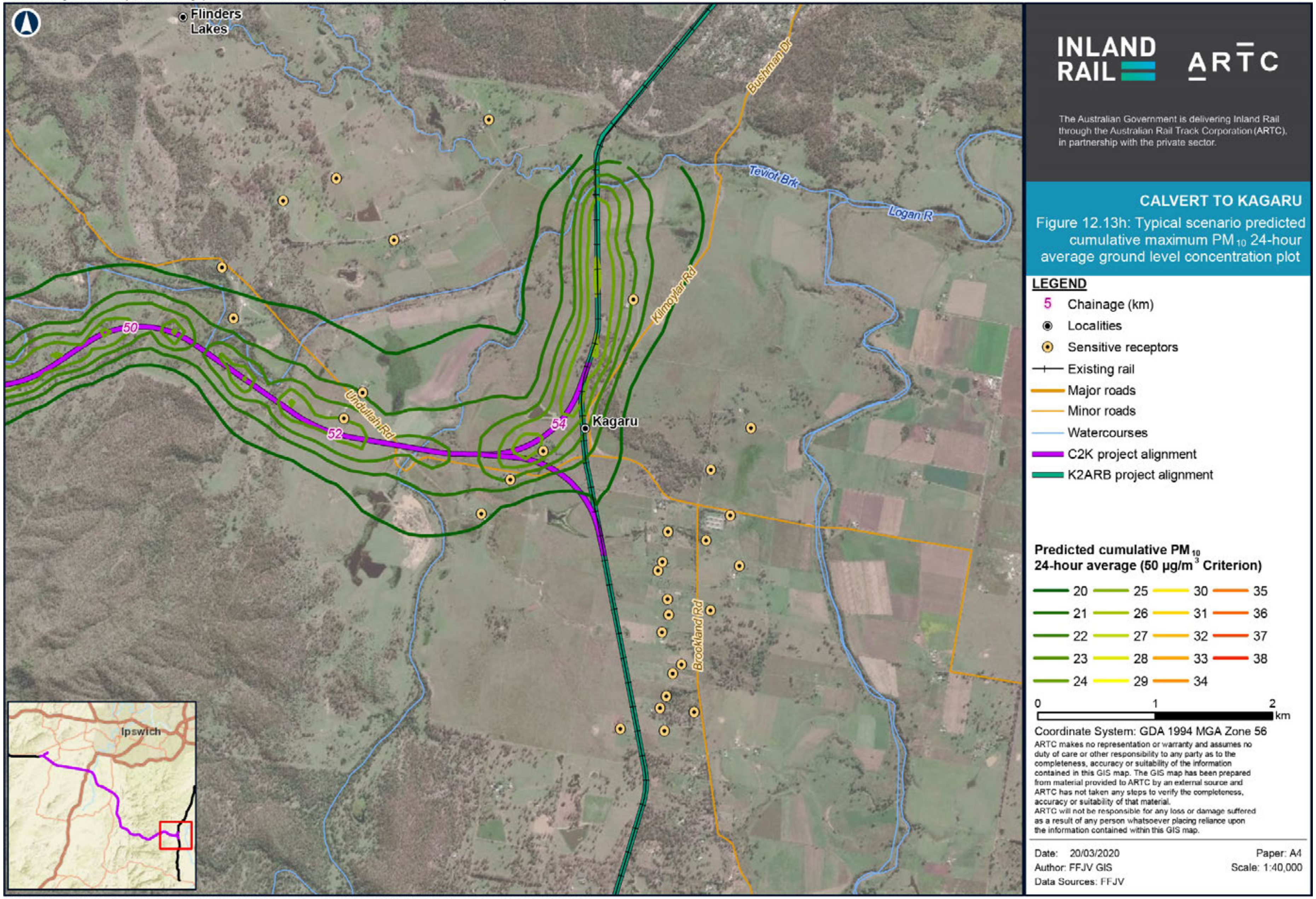

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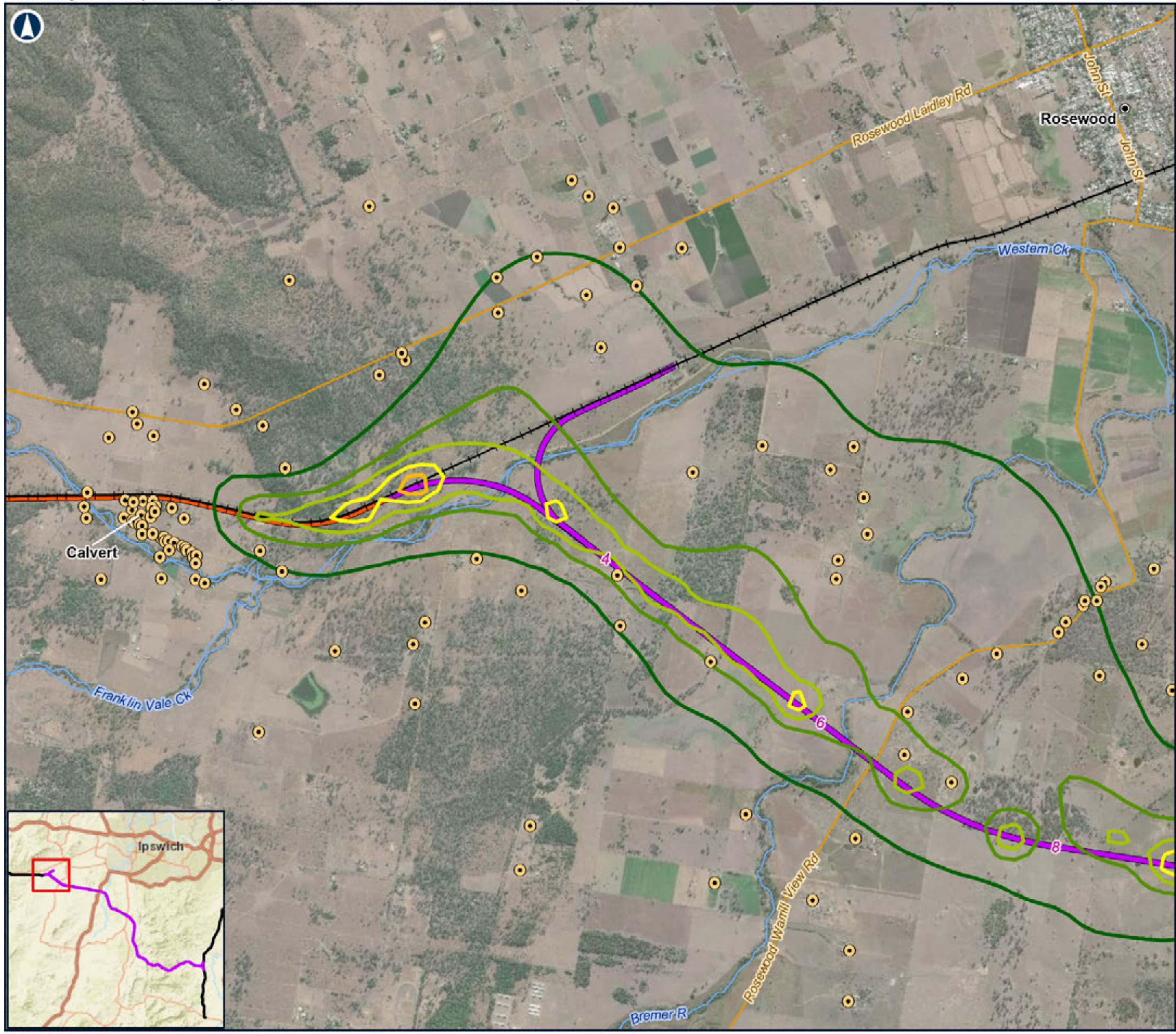

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Figure 12.14a: Typical scenario predicted cumulative $PM_{2.5}$ annual average ground level concentration plot

LEGEND

- 5 Chainage (km)
- Localities
- Sensitive receptors
- Existing rail
- H2C project alignment
- C2K project alignment
- Watercourses
- Minor roads

Predicted cumulative $PM_{2.5}$ annual average ground level concentrations (8 μg/m^3 Criterion)

- 5.8
- 6
- 6.2
- 6.4
- 6.6
- 6.8
- 7

0 1 2 km

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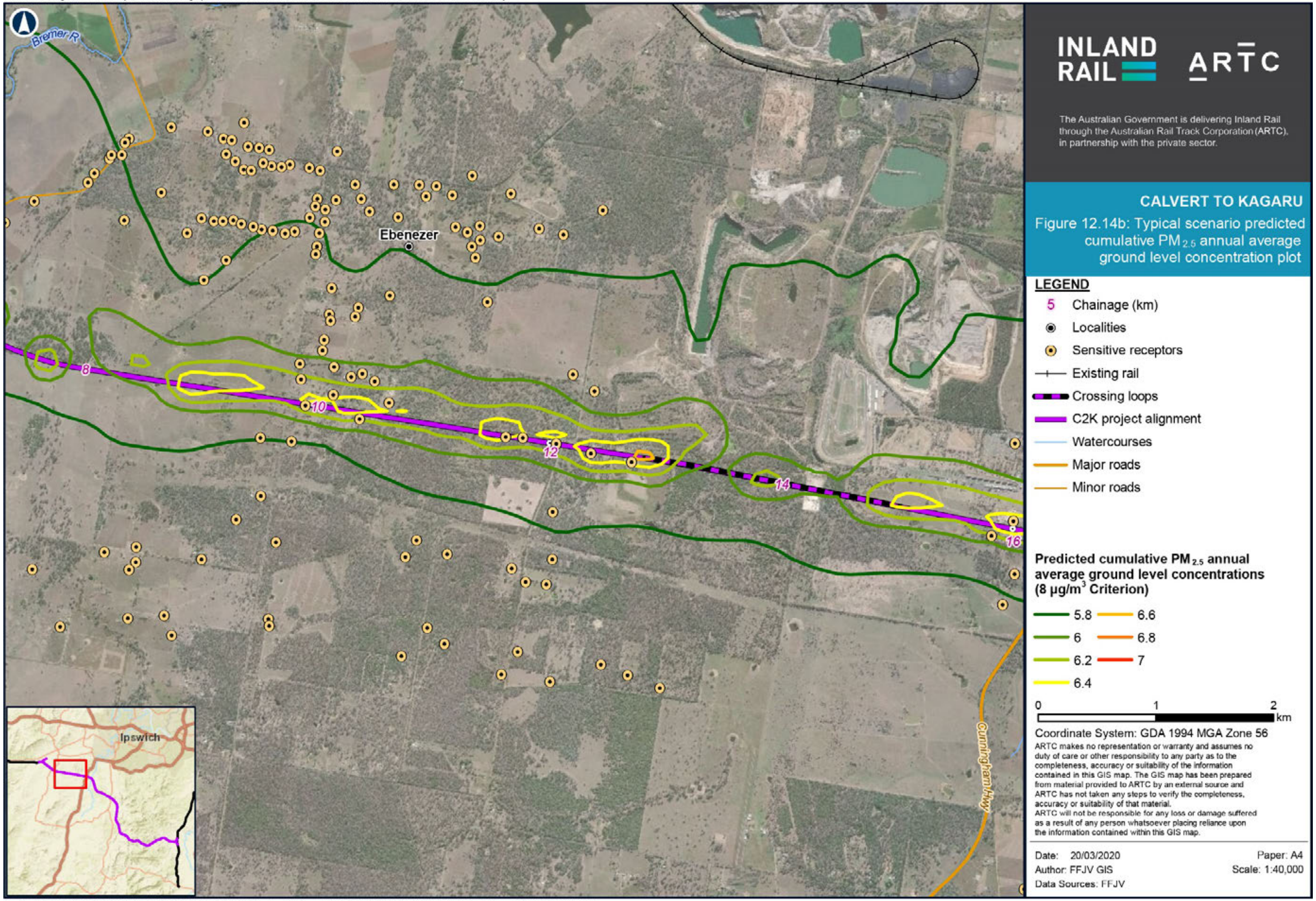

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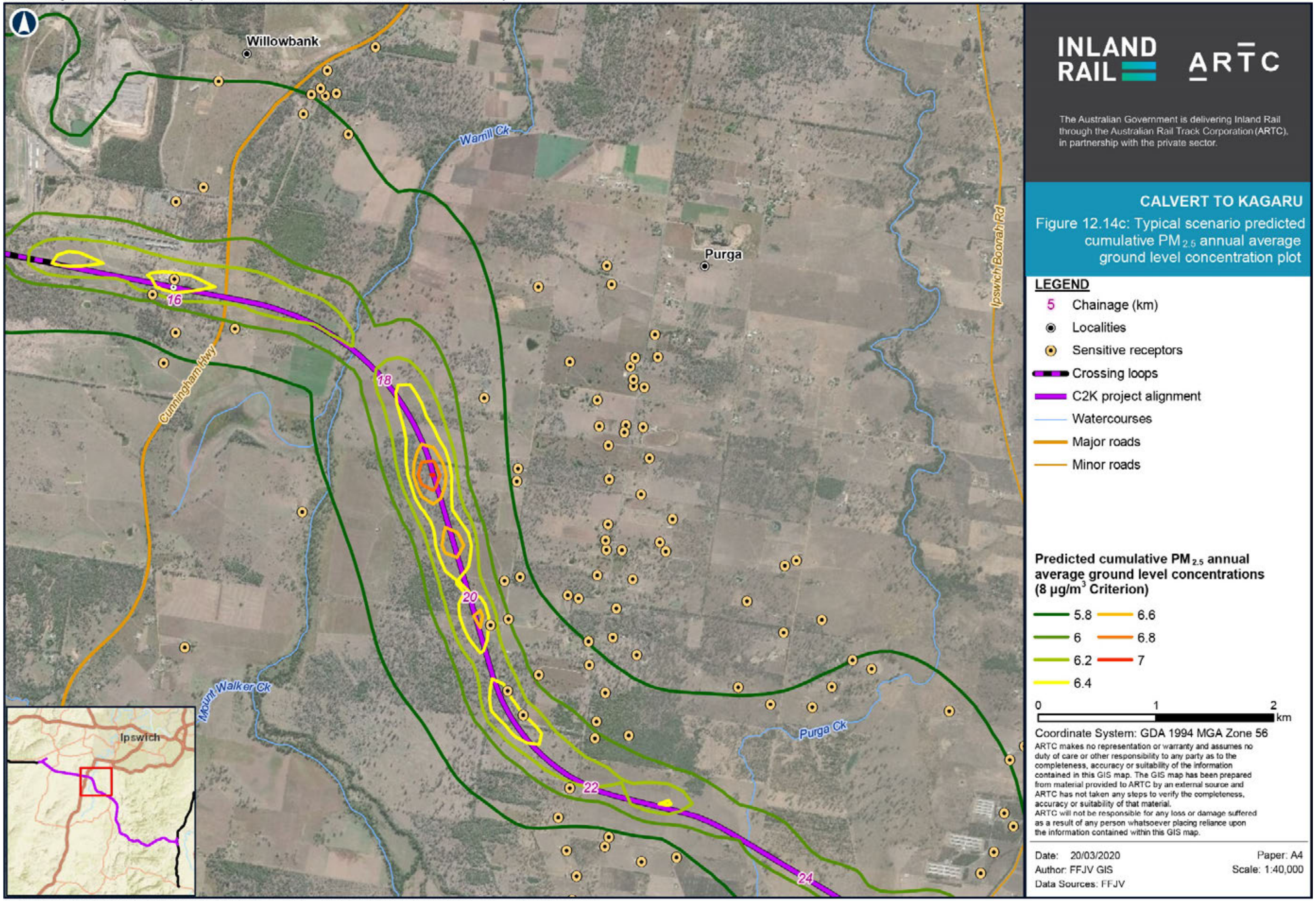

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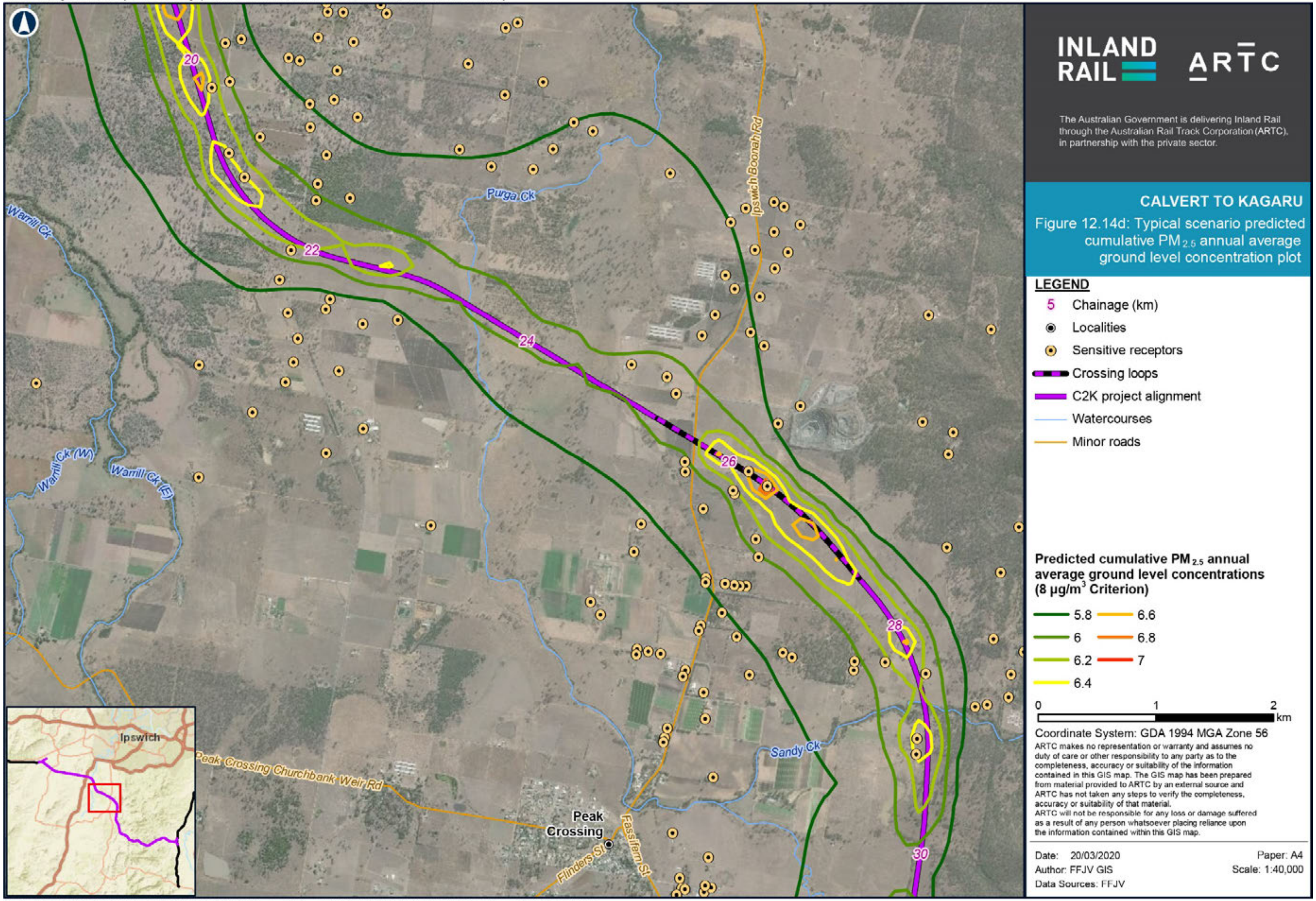

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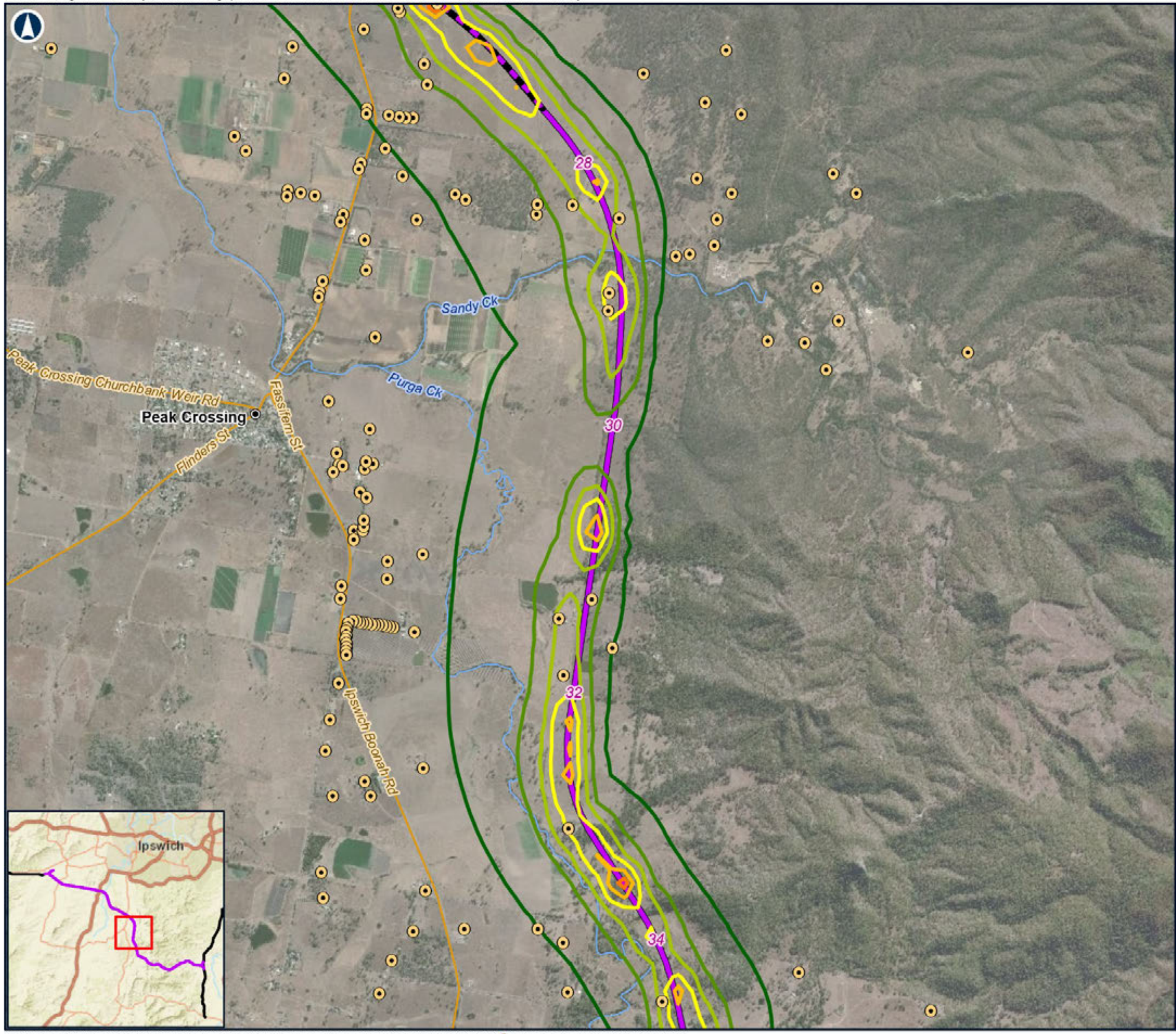

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Figure 12.14e: Typical scenario predicted cumulative $PM_{2.5}$ annual average ground level concentration plot

LEGEND

- 5 Chainage (km)
- Localities
- Sensitive receptors
- Crossing loops
- C2K project alignment
- Watercourses
- Minor roads

Predicted cumulative $PM_{2.5}$ annual average ground level concentrations (8 µg/m^3 Criterion)

- 5.8
- 6
- 6.2
- 6.4
- 6.6
- 6.8
- 7

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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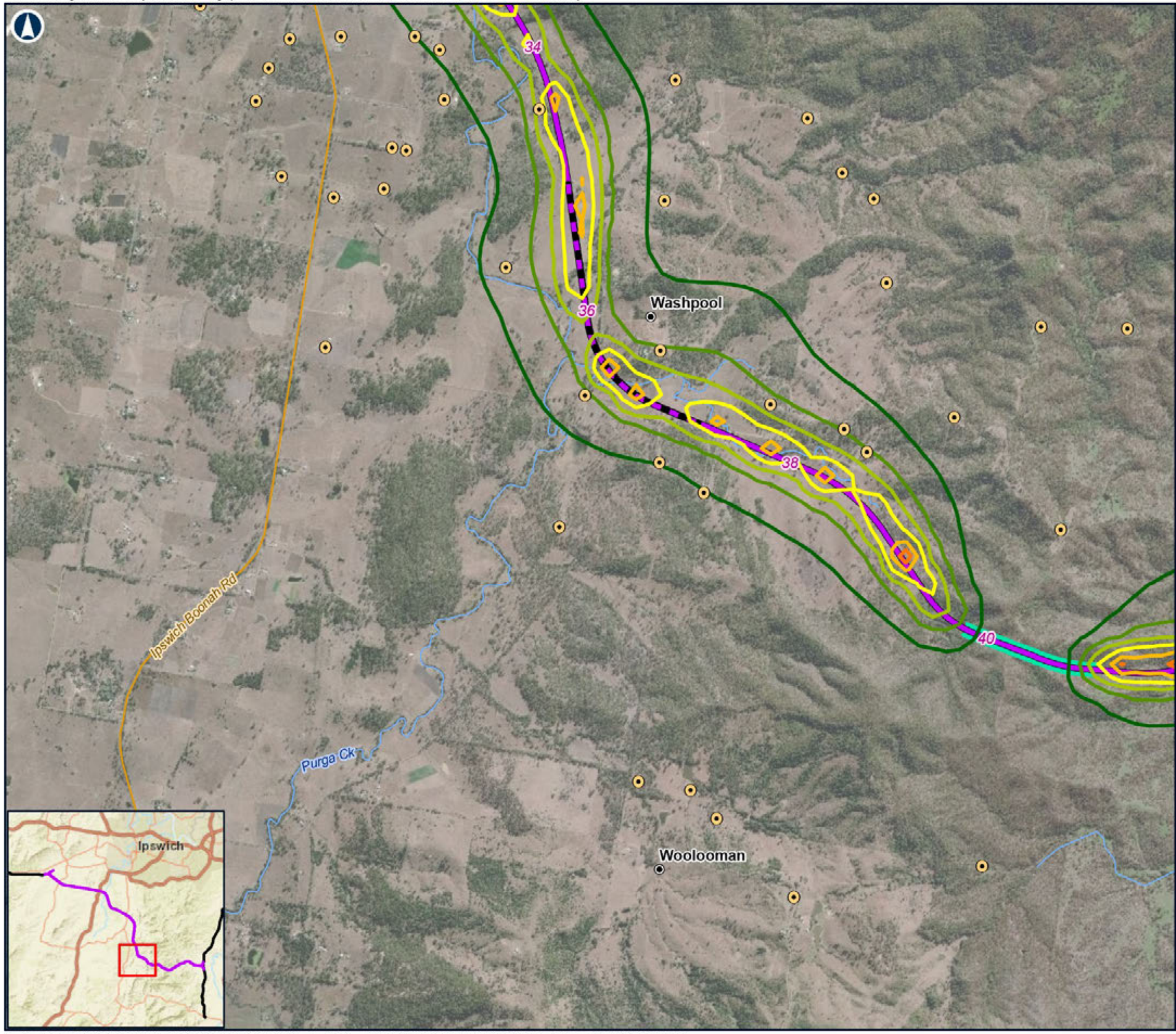

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Figure 12.14f: Typical scenario predicted cumulative $PM_{2.5}$ annual average ground level concentration plot

LEGEND

- 5 Chainage (km)
- Localities
- Sensitive receptors
- Crossing loops
- C2K project alignment
- Watercourses
- Minor roads
- Tunnel

Predicted cumulative $PM_{2.5}$ annual average ground level concentrations (8 μg/m³ Criterion)

- 5.8
- 6
- 6.2
- 6.4
- 6.6
- 6.8
- 7

0 1 2 km

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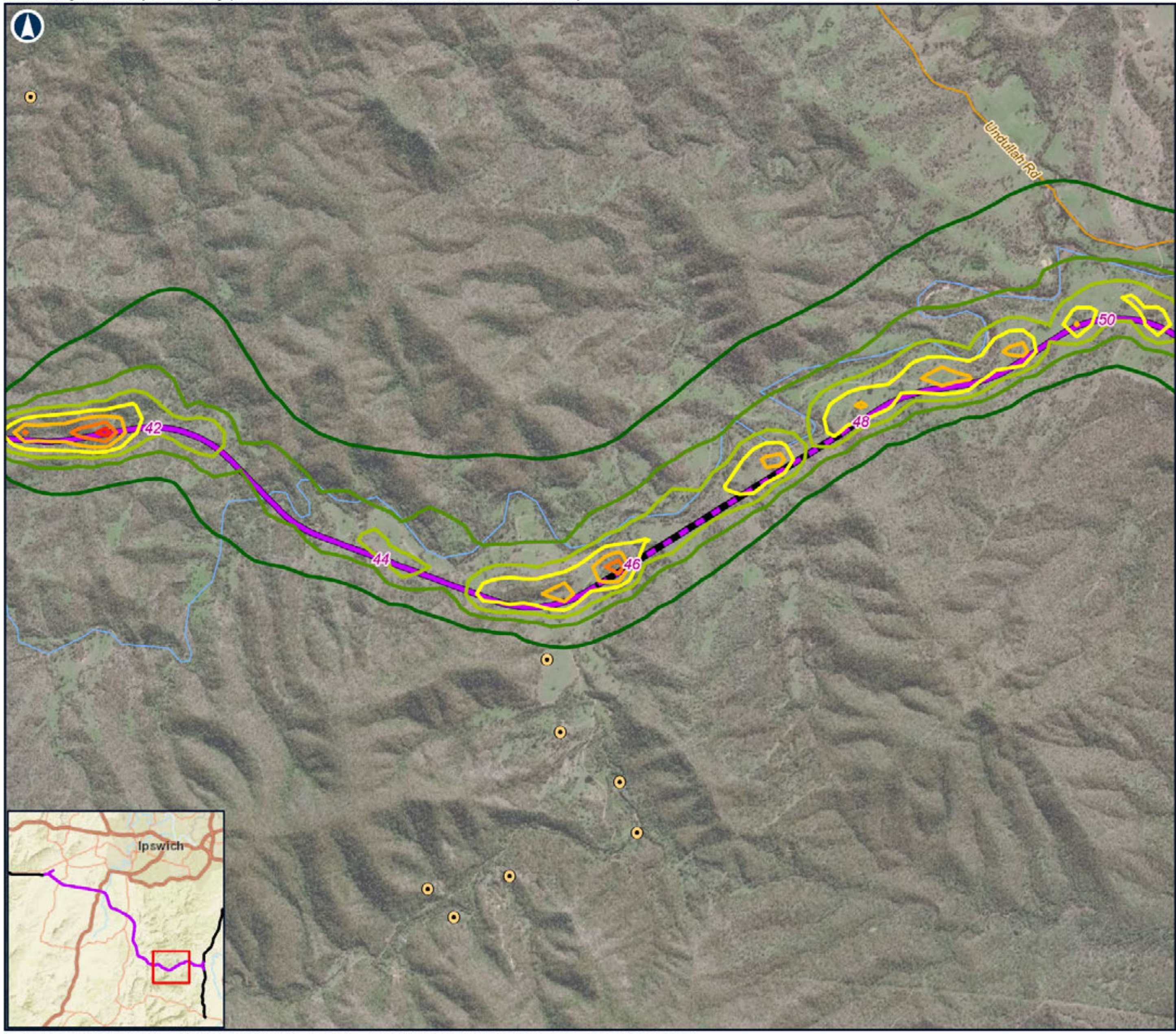

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Figure 12.14g: Typical scenario predicted cumulative $PM_{2.5}$ annual average ground level concentration plot

LEGEND

- 5 Chainage (km)
- Localities
- Sensitive receptors
- Crossing loops
- C2K project alignment
- Watercourses
- Minor roads

Predicted cumulative $PM_{2.5}$ annual average ground level concentrations (8 µg/m^3 Criterion)

- 5.8
- 6
- 6.2
- 6.4
- 6.6
- 6.8
- 7

0 1 2 km

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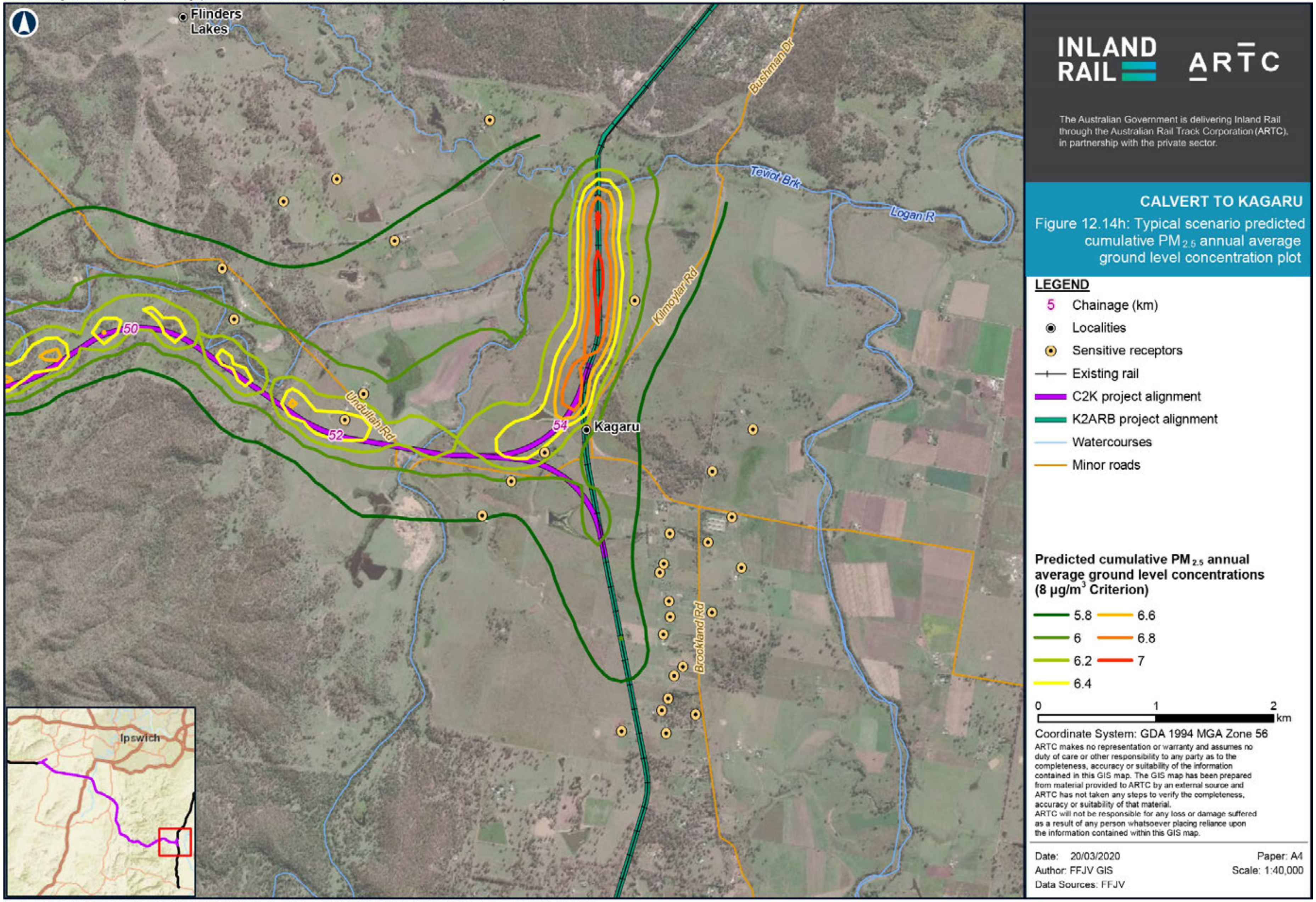

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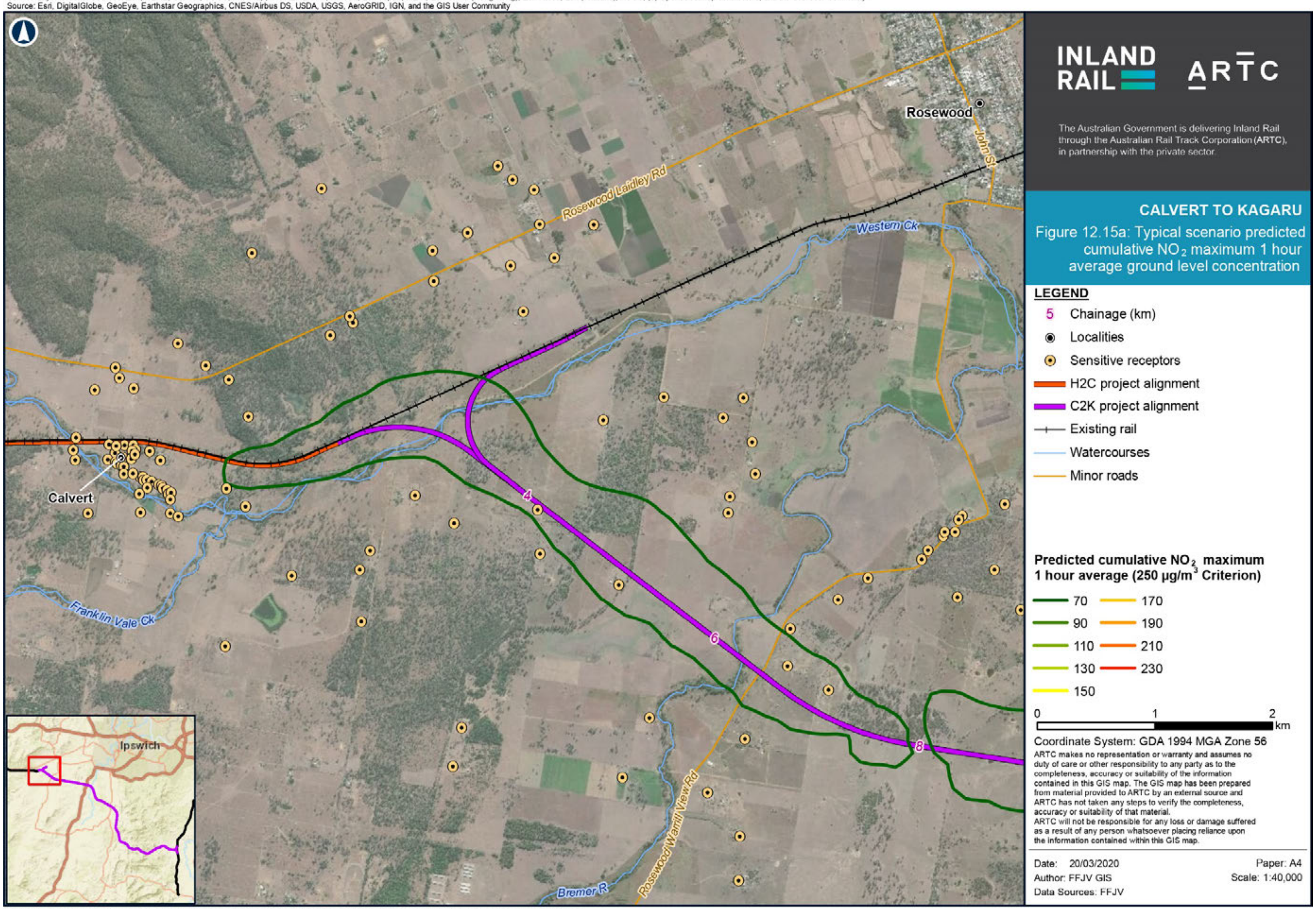

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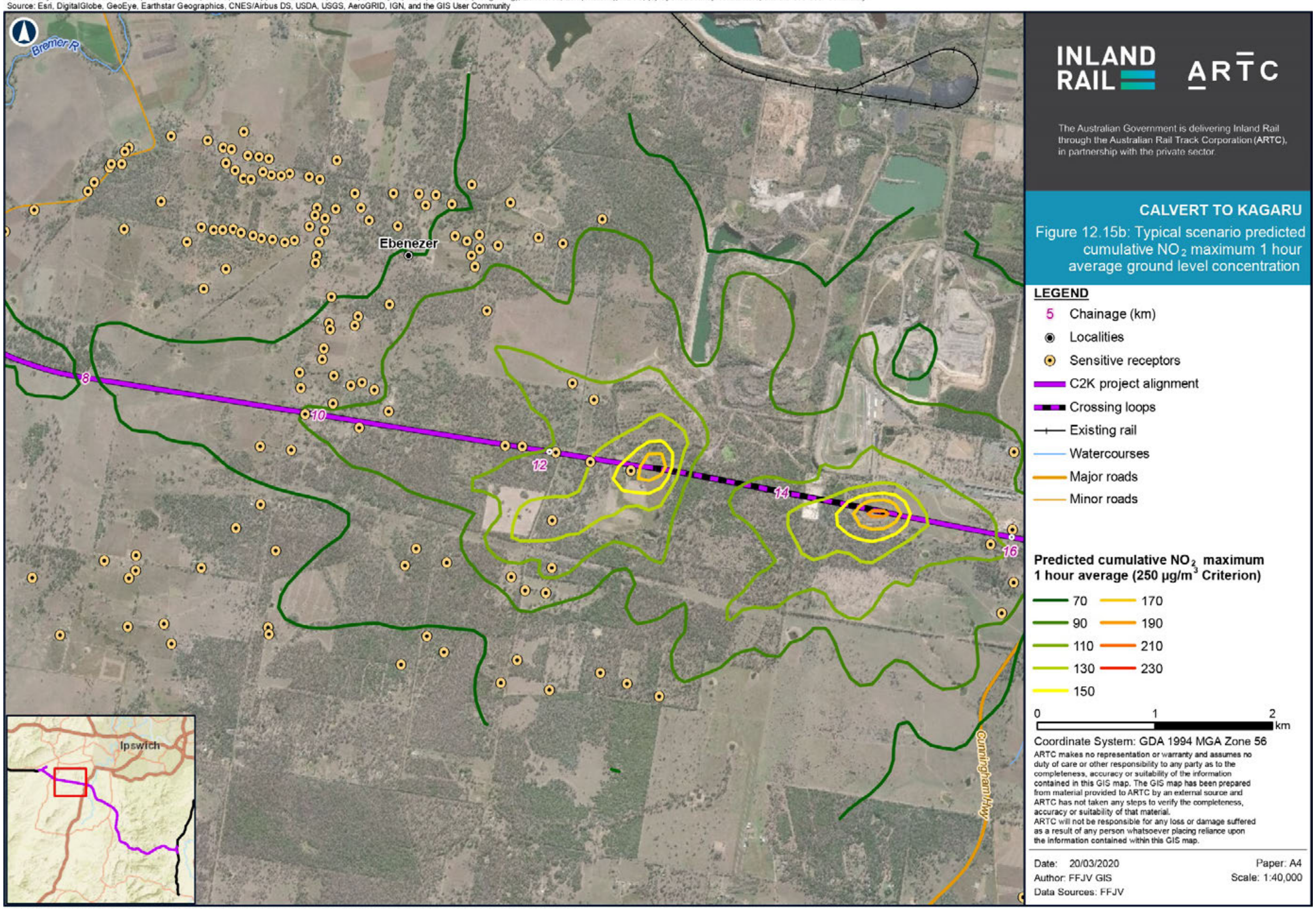

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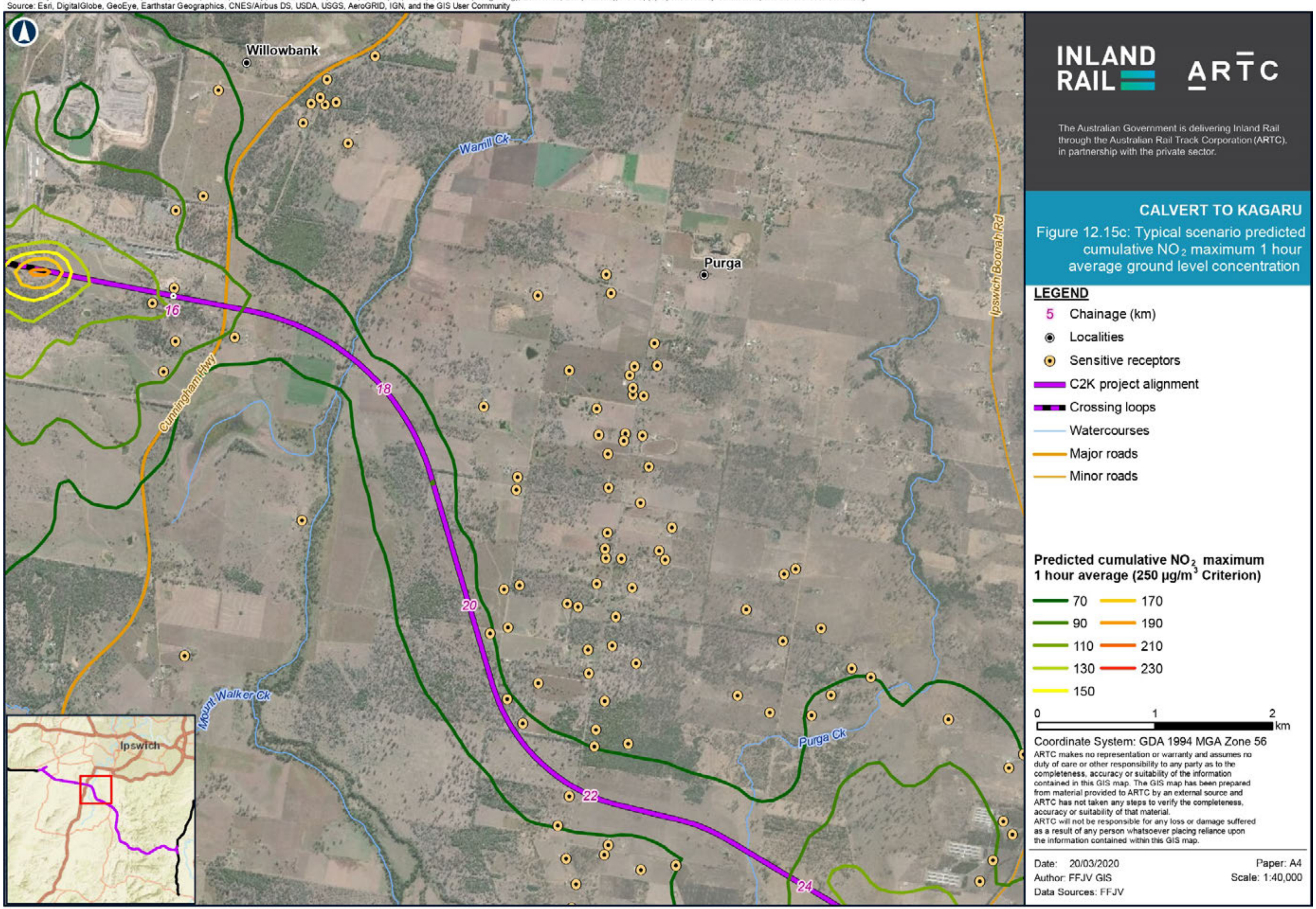

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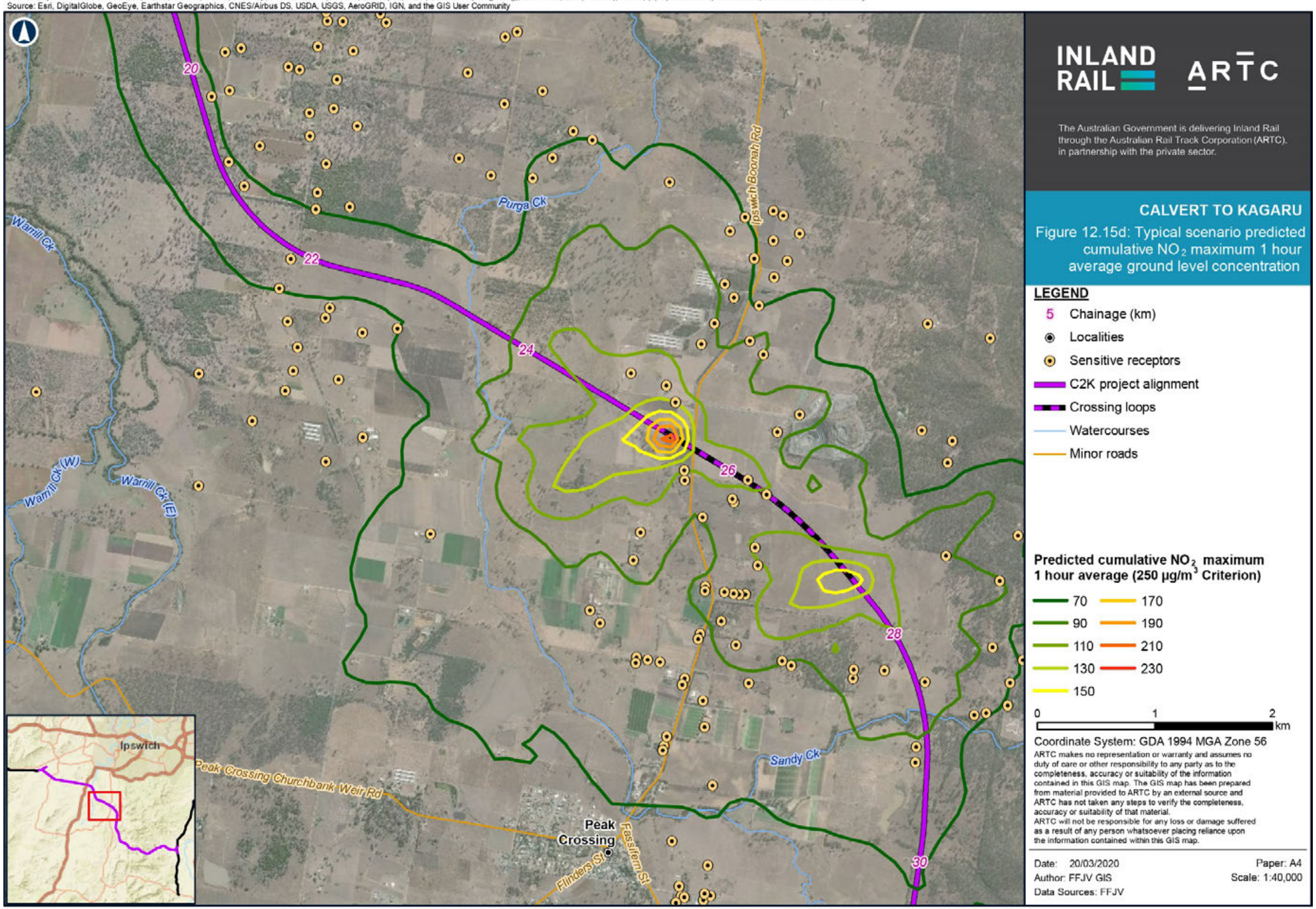

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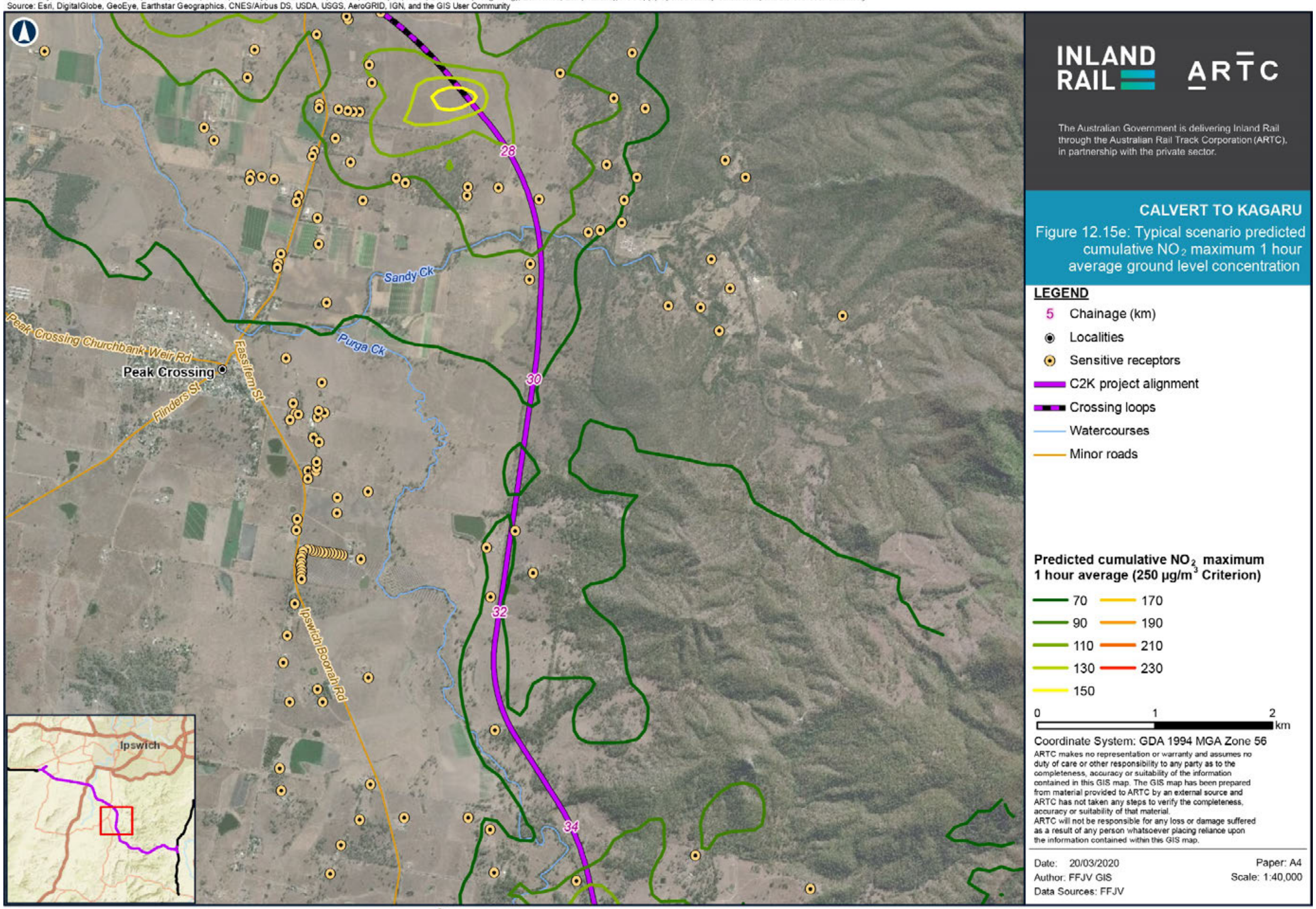

CALVERT TO KAGARU

Figure 12.15e: Typical scenario predicted cumulative NO_2 maximum 1 hour average ground level concentration

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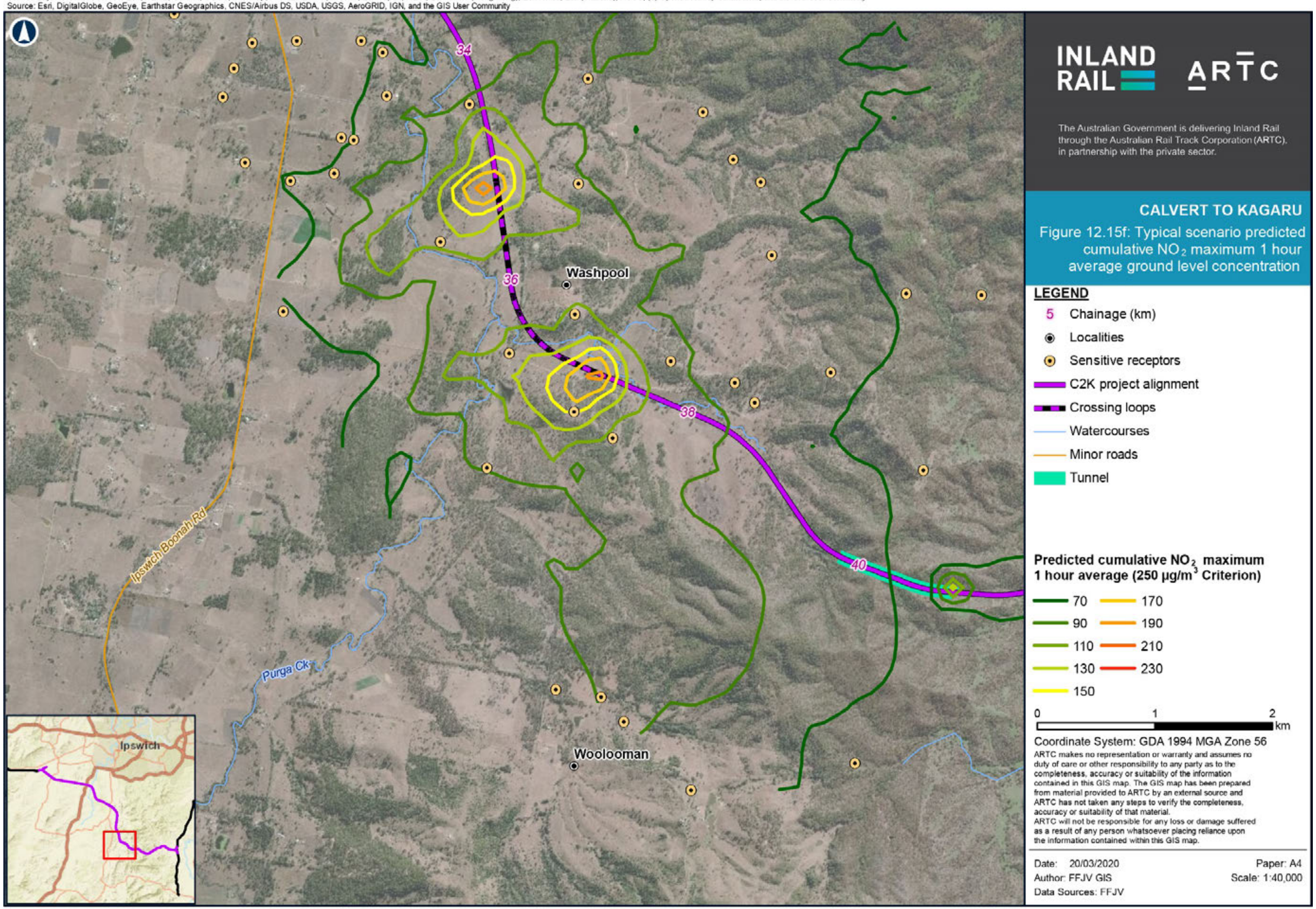

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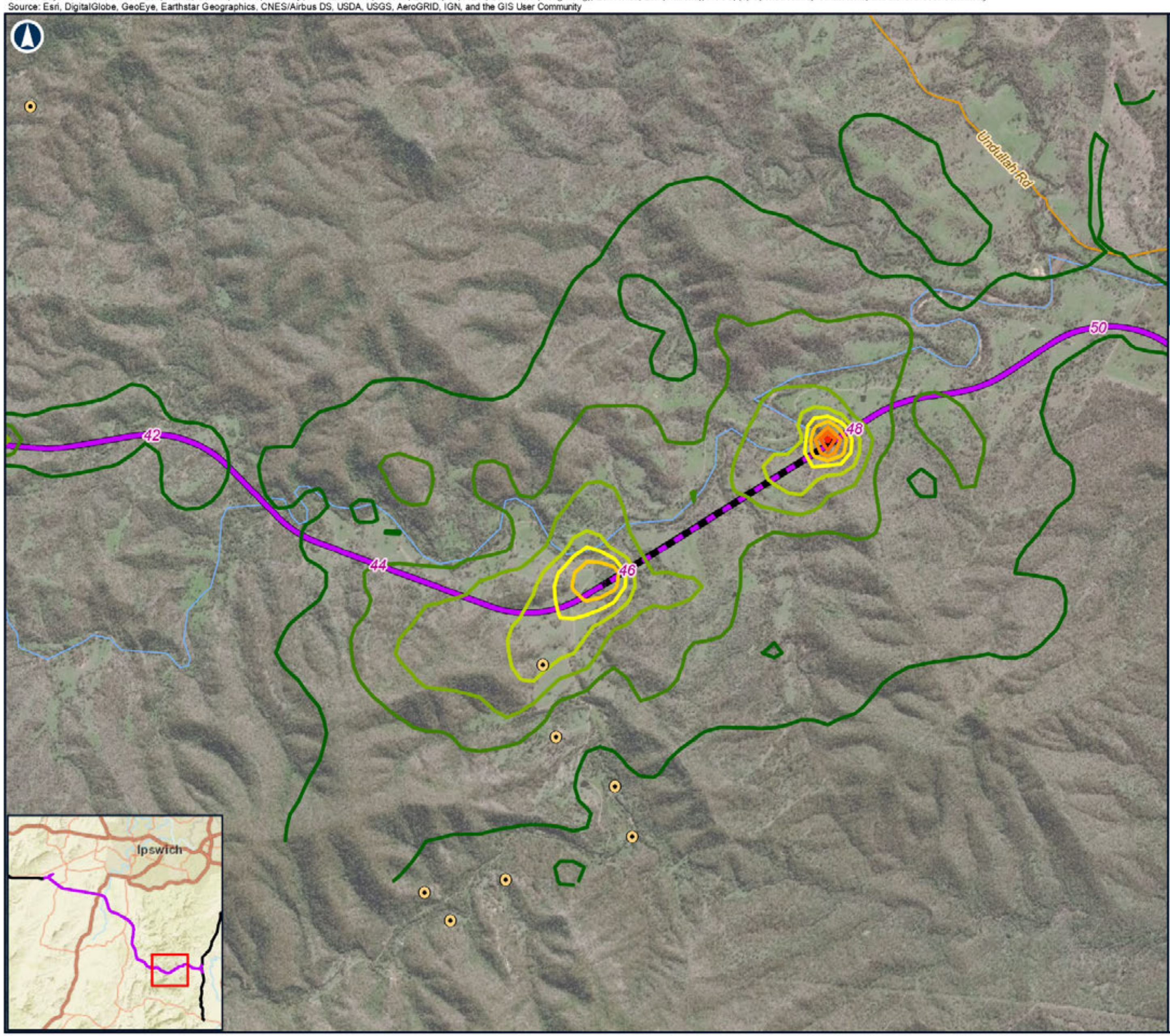
CALVERT TO KAGARU

Figure 12.15g: Typical scenario predicted cumulative NO_2 maximum 1 hour average ground level concentration



Coordinate System: GDA 1994 MGA Zone 56

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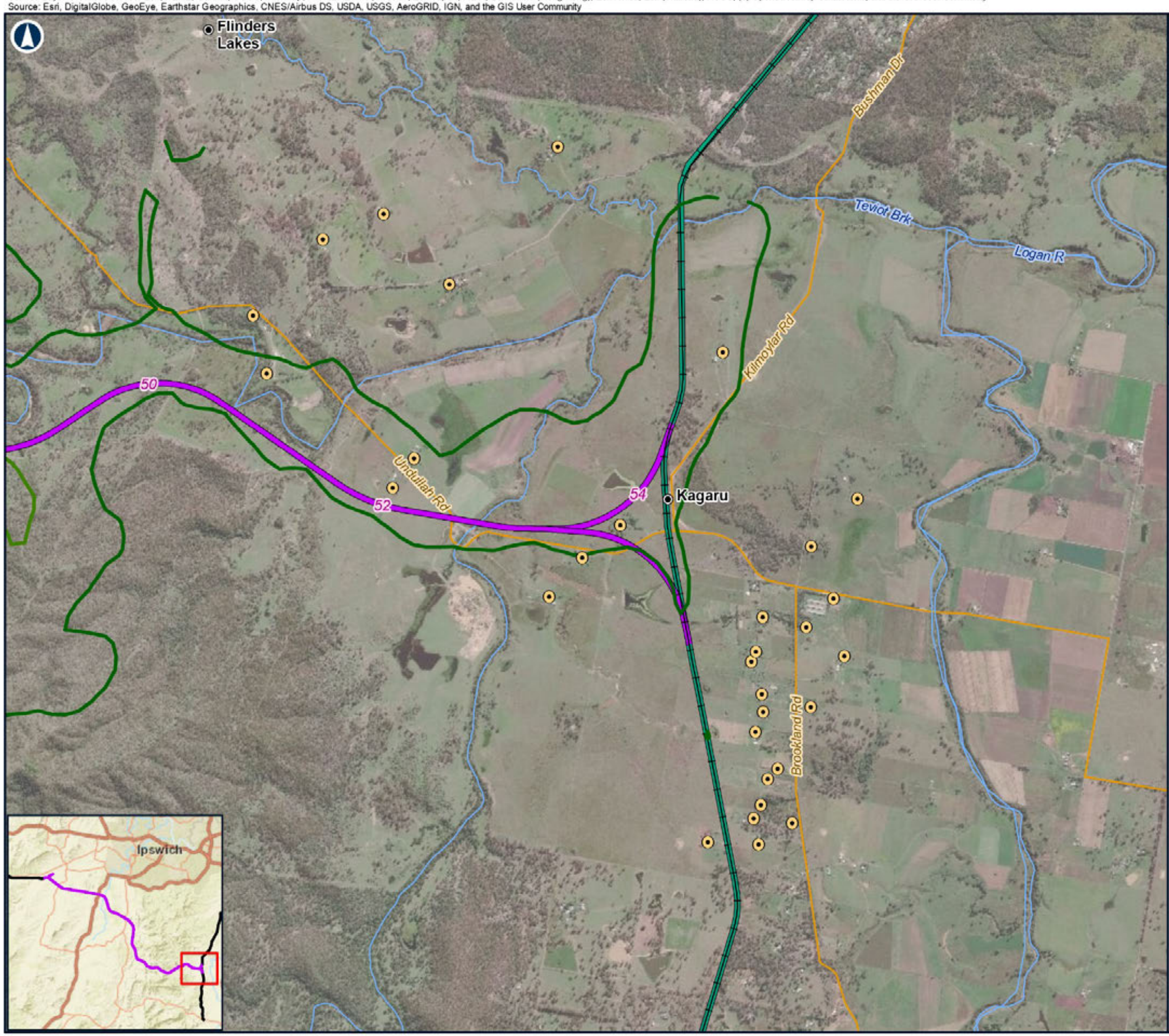

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CALVERT TO KAGARU

Figure 12.15h: Typical scenario predicted cumulative NO_2 maximum 1 hour average ground level concentration

LEGEND

- 5 Chainage (km)
- Localities
- Sensitive receptors
- C2K project alignment
- K2ARB project alignment
- Existing rail
- Watercourses
- Minor roads

Predicted cumulative NO_2 maximum 1 hour average (250 µg/m^3 Criterion)

- 70
- 90
- 110
- 130
- 150
- 170
- 190
- 210
- 230

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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12.6.3.2 Impacts to tank water quality

Table 12.37 shows the predicted pollutant concentrations for the water tank of the worst-affected sensitive receptor. Table 12.37 also shows the drinking water guideline values prescribed by the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018).

Table 12.37 shows that at the worst-affected receptor compliance is predicted for all pollutants by a significant margin.

As compliance with the drinking water guideline values prescribed by the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018) is predicted by a significant margin, the residual impact to drinking water is expected to be insignificant.

TABLE 12.37: HIGHEST PREDICTED WATER TANK CONCENTRATIONS AT SENSITIVE RECEPTORS

Pollutant	Maximum predicted annual deposition rate (μg/m²/s)	Estimated roof area (m²)	Maximum predicted total deposited mass (μg)	Tank water volume (L)	Highest predicted concentration (mg/L)	Criteria (mg/L)[c]
Arsenic	4.2×10^{-12}	200[a]	0.026	1,000[b]	2.6×10^{-8}	0.01
Cadmium	4.2×10^{-10}		2.6		2.6×10^{-6}	0.002
Lead	2.1×10^{-11}		0.13		1.3×10^{-7}	0.01
Nickel	2.9×10^{-9}		18		1.8×10^{-5}	0.02
Chromium VI	2.1×10^{-9}		13		1.3×10^{-5}	0.05

Table notes:

a. Based on the average surface area of a typical large house.

b. Assumption of a 10,000 L water tank at 10 per cent capacity, with a resultant water volume of 1,000 L.

c. Source: *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018)

12.6.4 Cumulative impacts

When numerous projects occur within close proximity to each other they can cause cumulative impacts. It is a requirement of the Project ToR that cumulative impacts associated with the Project are considered.

As discussed in Section 12.4.4, dispersion modelling undertaken for the assessment of operational phase air quality impacts included emissions from the adjoining sections of the Inland Rail Program adjacent to the Project, namely the H2C and K2ARB sections. Assessment of the modelling results has considered the background concentrations and deposition levels estimated for the relevant pollutants (refer 12.5.2.2) to assess cumulative impacts.

Due to the location of the Boral Purga Quarry, emissions from the quarry and the potential for elevated background concentrations for particulates at receptors near the quarry were also considered when assessing the impact of the construction phase of the Project (refer Section 12.6.1.1). The quarry will not operate concurrently with the operation of the Project and, therefore, there is no risk of cumulative impacts with the quarry for the operational phase of the Project.

Although the H2C, K2ARB and Boral Purga Quarry projects have already been considered in the assessment of the construction and operational phases of the Project, they have been included in this cumulative impact risk assessment for completeness.

The potential significance of cumulative impacts that may arise as a result of the Project, in combination with other impacts, has been assessed following the risk matrix method in Chapter 22: Cumulative Impacts, adapted to consider individual projects. The significance of the potential cumulative impact has been determined using professional judgement to select the most appropriate relevance factor for each aspect (low, medium or high). Details on the assessment methodology for cumulative impacts is also in Appendix L: Air Quality Technical Report.

Nine projects were considered in the cumulative impact risk assessment. These projects will either be currently operational, will be constructed and/or operational during the life of the Project, or are currently going through an approval process.

A number of the projects considered in the cumulative impact risk assessment are expected to have limited potential for cumulative impacts. However, these projects have been included due to their location within or near the air quality study area, or their status as a 'State significant' or 'strategic' project. The Jeebropilly open-cut coal mine has not been considered in the cumulative impact risk assessment as it closed operations in December 2019 (Richter, 2019).

The projects considered in the cumulative impact assessment are listed in Table 12.38. The locations of these projects are shown in Figure 12.16.

TABLE 12.38: PROJECTS CONSIDERED FOR THE CUMULATIVE IMPACT ASSESSMENT

Project and proponent	Location	Description	Construction dates
K2ARB (ARTC)	Rail corridor from Kagaru to Acacia Ridge and Bromelton	Enhancing and connecting the existing rail corridor (approximately 49 km) from north-east of Kagaru to Acacia Ridge and from south of Kagaru to Bromelton.	2023 to 2025
H2C (ARTC)	Rail alignment from Helidon to Calvert	The H2C project will include 47 km of single-track, dual-gauge freight rail line, a tunnel through the Little Liverpool Range and connection to the existing West Moreton Railway Line.	2021 to 2026
Purga Quarry (Boral)	Peak Crossing	The operation of the quarry for extractive activities is approved until 23 December 2023, at which time it will have exhausted all extractable resource. Associated sales and rehabilitation works will continue until 23 June 2025.	Approved for extraction until 23 December 2023, approved for sales until 23 June 2025
Greater Flagstone Priority Development Area (PDA) (QLD Government)	Located within Logan City, west of Jimboomba and the Mount Lindesay Highway, along the Brisbane–Sydney rail line	When fully developed, it is anticipated that the Greater Flagstone PDA will provide approximately 50,000 dwellings to house a population of up to 120,000 people.	2011 to 2041
Bromelton State Development Area (SDA) (QLD Government)	South of Kagaru in Bromelton	Delivery of critical infrastructure within the Bromelton SDA will support future development and economic growth. This includes a trunk water main and the Beaudesert Town Centre Bypass. This infrastructure provides opportunities to build on the momentum of current development activities by major landowners in the SDA.	2016 to 2031
Ripley Valley PDA (QLD Government)	Approximately 5 km south-west of the Ipswich CBD and south of the Cunningham Highway	The Ripley Valley PDA covers a total area of 4,680 ha and is an opportunity to provide approximately 50,000 dwellings to house a population of approximately 120,000 people. It is located in one of the largest industry growth areas in Australia and offers opportunities for further residential growth to meet the region's affordable housing needs.	2009 to 2031
South West Pipeline: Bulk Water Connection to Beaudesert (Seqwater)	Pipeline alignments sits east of Kagaru, running north from Beaudesert	The proposal is investigating a bulk water pipeline connection from the Southern Regional Water Pipeline to Beaudesert, connecting Beaudesert to the South East Queensland Water Grid. The pipeline will pass through the site of the future Wyaralong Water Treatment Plant.	2021
RAAF Base Amberley future works (Department of Defence)	RAAF Base Amberley	A white paper has been issued dedicated to future upgrades to RAAF Base Amberley. The total cost of the upgrade work is anticipated to be approximately $1 billion.	2016 to 2022
Remondis Waste to Energy Facility (Remondis)	Swanbank Industrial Estate	Remondis has announced plans to build a $400 million Waste to Energy Facility in Swanbank, south of Ipswich.	Project not yet approved

The results of the assessment of cumulative impacts are presented in Table 12.39. Table 12.39 also presents discussion with respect to the requirements for mitigating potential cumulative impacts.

The projects considered in the cumulative impact assessment have been included due to the potential for cumulative impacts arising from emissions during the construction phase of these projects. With the exception of the H2C and K2ARB projects, which have been included in the operational assessment for the Project, emissions from the operation of the assessed projects are not considered to have the potential to generate significant cumulative impacts. Where relevant, comment on anticipated operational emissions from the assessed projects is provided in Table 12.39.

The relevance factor for the sensitivity of the receiving environment has been assigned as low for all projects. This factor has been assigned considering the number of sensitive receptors that may be affected by cumulative impacts with the assessed project, the sensitivity to the emissions that will cause the impact (e.g. dust) and the mostly isolated nature of construction phase emissions from the Project.

Table 12.39 shows that cumulative air quality impacts are expected to be of low significance for all assessed projects.

Mitigation measures for the construction phase of the Project are recommended in Section 12.7.3. The recommended mitigation measures for the Project will reduce the potential for cumulative impacts at sensitive receptors.

In addition to the mitigation measures recommended, visual and quantitative dust monitoring will be undertaken at sensitive receptor locations near the Boral Purga Quarry (refer Section 12.7.4.2) to assist in managing cumulative impacts at these receptors.

Implementation of the recommended mitigation measures in combination with the implementation of a CEMP is expected to be sufficient to minimise the risk of significant cumulative impacts.

TABLE 12.39: CUMULATIVE IMPACT ASSESSMENT OF ASSESSABLE PROJECTS

Project	Potential cumulative impact	Aspect	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
K2ARB (ARTC)	The construction and operation of the Project will occur concurrently with the construction and operation of K2ARB. Air emissions could impact receptors located near both projects. Air emissions from the operation of K2ARB have been assessed as part of the assessment of the operation of the Project.	Probability of the impact	Medium (2)	6	Low	The significance of cumulative impacts during construction of the Project is considered to be low. Recommended mitigation measures for the construction phase of the Project are presented in Section 12.7.3. Mitigation measures will also be recommended for the K2ARB project in the projects EIS. It is expected that the potential for cumulative impacts will be appropriately managed through the implementation of mitigation measures and a CEMP. Cumulative impacts as a result of the operation of both projects has been assessed in detail, with the results of the operational phase assessment presented in Section 12.6.3.
		Duration of the impact	Medium (2)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Low (1)			
H2C (ARTC)	The construction and operation of the Project will occur concurrently with the construction and operation of H2C. Air emissions could impact receptors located near both projects. Air emissions from the operation of H2C have been assessed as part of the assessment of the operation of the Project.	Probability of the impact	Medium (2)	6	Low	▸ The significance of cumulative impacts during construction of the Project is considered to be low. ▸ Recommended mitigation measures for the construction phase of the Project are presented in Section 12.7.3. Mitigation measures will also be recommended for the H2C project in the projects EIS. It is expected that the potential for cumulative impacts will be appropriately managed through the implementation of mitigation measures and a CEMP. ▸ Cumulative impacts as a result of the operation of both projects has been assessed in detail, with the results of the operational phase assessment presented in Section 12.6.3.
		Duration of the impact	Medium (2)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Low (1)			

Project	Potential cumulative impact	Aspect	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
Boral Purga Quarry	The construction of the Project will occur concurrently with the operation of the quarry. Air emissions from the operation of the quarry and the construction of the Project could impact receptors located near both projects. The quarry will not be operational concurrently with the operation of the Project, and therefore there is no risk of cumulative impacts for the operational phase of the Project.	Probability of the impact	Medium (2)	6	Low	▸ The significance of cumulative impacts during construction of the Project is considered to be low. Risk of cumulative impacts is present during the construction phase of the Project only. ▸ The background concentrations adopted for the air quality study area (refer Section 12.5.2.2) may not be representative of background air quality local to the area near the quarry. However, the presence of the quarry and elevated background dust concentrations as a result of the quarry were considered in the qualitative assessment for the construction phase of the Project (refer Section 12.6.1). ▸ Recommended mitigation measures for the construction phase of the Project will reduce the potential for cumulative impacts at sensitive receptors near the Boral Purga Quarry. To further manage potential cumulative impacts, visual and quantitative dust monitoring will be undertaken at sensitive receptor locations near the quarry (refer Section 12.7.4.2).
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Medium (2)			
		Sensitivity of the receiving environment	Low (1)			
Greater Flagstone Priority Development Area (PDA) (QLD Government)	The construction and operation of the Project may overlap with the construction and operation of the PDA. Significant emissions related to the PDA are anticipated for the construction phase only. No significant emissions are anticipated from the operation of the PDA.	Probability of the impact	Low (1)	5	Low	▸ The significance of cumulative impacts during construction is considered to be low. ▸ It is considered unlikely that construction for each project will occur in the same localised area simultaneously to the extent that would cause significant impacts to existing receptors. Increased traffic volumes may occur at times in Kagaru during construction of each project, but this is not expected to result in significant impacts. ▸ No additional mitigation measures are required further to those recommended for the Project.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Medium (2)			
		Sensitivity of the receiving environment	Low (1)			

Project	Potential cumulative impact	Aspect	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
Bromelton State Development Area (SDA) (QLD Government	The construction and operation of the Project may overlap with the construction and operation of the SDA. Significant emissions related to the SDA are anticipated for the construction phase only. No significant emissions are anticipated from the operation of the SDA. The eastern end of the Project at Kagaru is located within the SDA. With the exception of the northern end of the SDA (at Kagaru), the majority of the SDA has significant separation distance to the Project.	Probability of the impact	Low (1)	5	Low	▸ The significance of cumulative impacts during construction is considered to be low. ▸ It is considered unlikely that intensive construction for each project will occur in the same localised area simultaneously to the extent that would cause significant impacts to existing receptors. Increased traffic volumes may occur at times in Kagaru during construction of each project, but this is not expected to result in significant impacts. ▸ No additional mitigation measures are required further to those recommended for the Project.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Medium (2)			
		Sensitivity of the receiving environment	Low (1)			
Ripley Valley PDA (QLD Government)	The construction and operation of the Project may overlap with the construction and operation of the PDA. Significant emissions related to the PDA are anticipated for the construction phase only. No significant emissions are anticipated from the operation of the PDA. The PDA is located approximately 5.5 km from the Project at its closest point.	Probability of the impact	Low (1)	4	Low	▸ The significance of cumulative impacts during construction is considered to be low. ▸ Due to separation distance no significant cumulative impacts are anticipated due to simultaneous construction activities. ▸ No additional mitigation measures are required.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Low (1)			
South West Pipeline: Bulk Water Connection to Beaudesert (Seqwater)	The construction of the Project may overlap with the construction of the pipeline. Emissions from the operation of the pipeline are not expected to be significant The pipeline alignment travels to the east of Kagaru.	Probability of the impact	Low (1)	4	Low	▸ The significance of cumulative impacts during construction is considered to be low. ▸ The only potential for cumulative impacts is when construction for both projects occurs near in Kagaru resulting in increased traffic volumes. Increased traffic volumes are not expected to result in significant impacts. ▸ No additional mitigation measures are required.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Low (1)			

Project	Potential cumulative impact	Aspect	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
RAAF Base Amberley future works (Department of Defence)	Overlap of construction of the Project with construction to upgrade RAAF Base Amberley. RAAF Base Amberley is located approximately 5 km to the north of the Project at its closest point.	Probability of the impact	Low (1)	4	Low	▸ The significance of cumulative impacts during construction is considered to be low. ▸ Due to separation distance no significant cumulative impacts are anticipated due to simultaneous construction activities. Ongoing development at RAAF Base Amberley may see an increase in localised road traffic, but this is not expected to result in significant impacts. ▸ No additional mitigation measures are required.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Low (1)			
Remondis Waste to Energy Facility (Remondis)	Subject to the approval of the Waste to Energy Facility, there is potential for overlap of construction and operation of the Waste to Energy Facility with the construction and operation of the Project. The construction and operation phases of the Waste to Energy Facility will generate emissions to air. The proposed Waste to Energy Facility is located approximately 12.5 km to the north-east of the Project at the closest point on the alignment.	Probability of the impact	Low (1)	4	Low	▸ The significance of cumulative impacts during construction is considered to be low. ▸ Existing sensitive receptors (at which compliance with air quality goals will be required for operation) are located within 2.5 km to the south-west of the proposed location of the facility, the same orientation as the Project from the facility. ▸ In addition to the significant separation distance, significant height topography is also present between the two sites. Due to the dispersion of emissions as a result of separation distance and topography, it is expected that emissions from the facility will have negligible impact on air quality at sensitive receptors near the Project. ▸ No additional mitigation measures are required.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		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:

1. Low (1–6): Negative impacts need to be managed by standard environmental management practices. Monitoring to be part of general Project monitoring program.
2. Medium (7–9): Mitigation measures likely to be necessary and specific management practices to be applied. Targeted monitoring program required, where appropriate.
3. High (10–12): Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Targeted monitoring program necessary, where appropriate.

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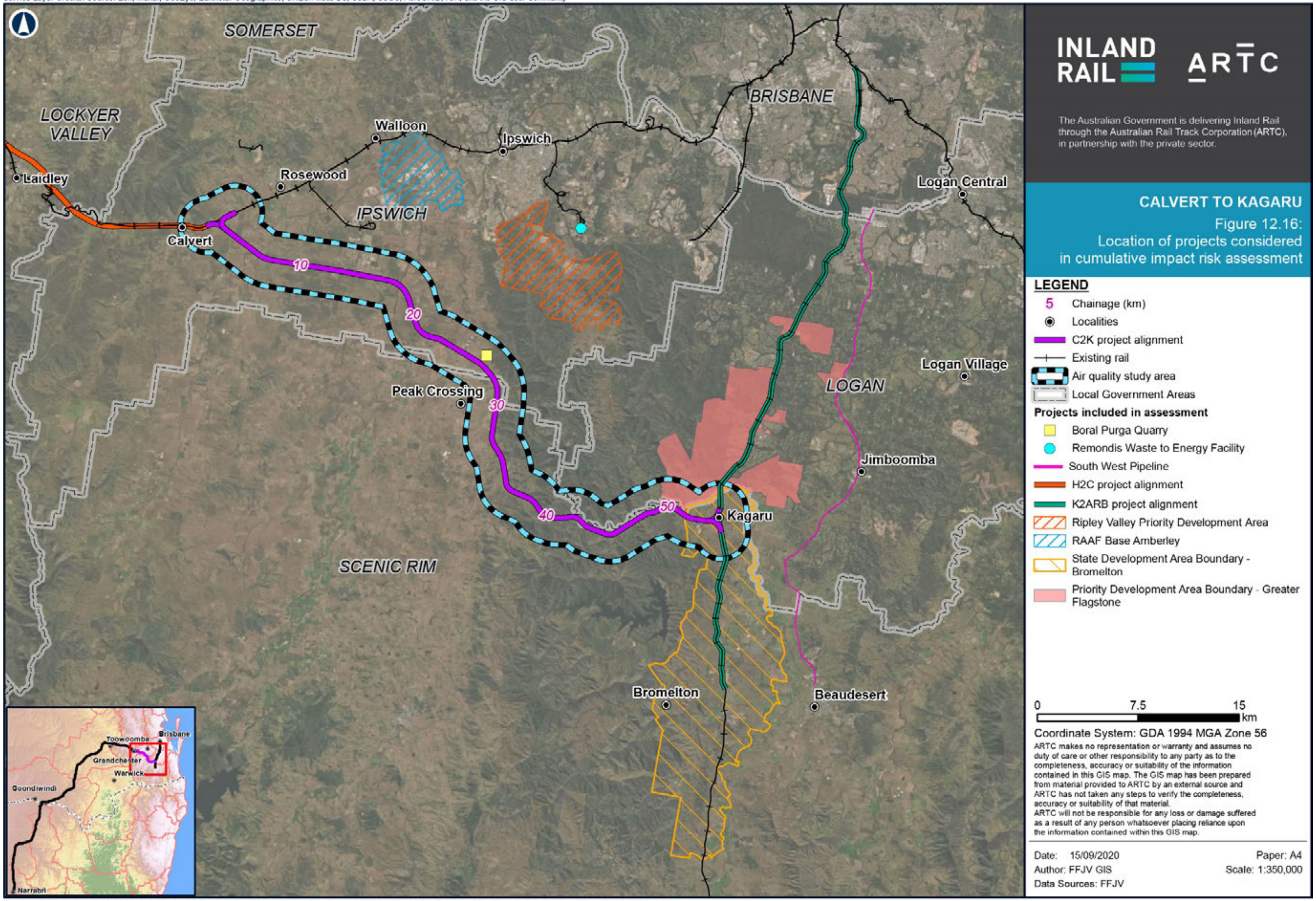

Map by: MF / DTH Z:\GIS\GIS_3400_C2K\Tasks\340-EAP-201902130629_Air_Quality_Figures\ARTC_A4_Fig12_16_C2K_Cumulative_Impact_Projects_v5.mxd Date: 15/09/2020 15:48

12.6.5 Decommissioning

Given the uncertainty associated with timeframe for decommissioning, this phase has not been considered in this air quality impact assessment.

12.7 Mitigation

This Section outlines the mitigation measures included in the Project design and identifies proposed mitigation measures to manage potential air quality during relevant Project phases.

No comprehensive guideline information is currently available for best practice environmental management measures for the emissions of air pollutants from construction-related emissions in QLD or Australia. Guidance on management measures are provided within the UK IAQM *Guideline for the Assessment of dust from demolition and construction* (UK IAQM, 2014); however, many of these measures are tailored to the United Kingdom and are not necessarily applicable to Australia. Where similar conditions do exist, the recommended mitigation measures do align with the suggested mitigation measures from the UK IAQM guideline document. Mitigation measures prescribed in the NPI *Emissions Estimation Manual for Mining* (NPI, 2012) are also considered applicable for the construction phase and select mitigation measures from this document have been recommended.

The identified mitigation measures represent best practice environmental management of air emissions.

12.7.1 Design considerations

The mitigation measures incorporated in the Project design are presented in Table 12.40. These design measures have been identified through collaborative development of the design and consideration of environmental constraints and issues, including proximity to potentially affected sensitive receptors. These design measures are relevant to both construction and operational phases of the Project.

TABLE 12.40: MITIGATION MEASURES INHERENT IN THE DESIGN

Aspect	Initial mitigations
Emissions from refuelling activities during construction	▸ The planning, siting and assessment of potential fuel storage locations has taken into consideration the location of existing potentially affected sensitive receptors.
Emissions from construction vehicles	▸ The horizontal and vertical alignment has been established to optimise the earthworks and minimise excess spoil (where possible). By minimising the material deficit for construction of the Project, the volume of material required to be handled and transported has been reduced. Less material handling reduces potential road transport truck movements and vehicular emissions. ▸ Construction phase haulage routes that provide the shortest journey time between origin and destination have been considered. These routes restrict fuel consumption and vehicular emissions. These routes have been assessed as part of the traffic impact assessment in the EIS.
Fugitive dust emissions (windborne erosion) during construction and operation	▸ Planning of the Project has aimed to minimise clearing extents to that required to safely and efficiently construct and operate the rail corridor. ▸ Laydown areas and other construction-phase facilities have been located to avoid impacts to environmental and social receptors. ▸ Batters, embankments and exposed surfaces have been designed with regard to slope and stabilisation. This will reduce potential fugitive dust emissions.
Emissions from operational locomotives	▸ 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	▸ The planning and siting of crossing loops at Ebenezer, Purga Creek, Washpool Road and Undullah have been positioned to avoid, where possible, impacts of diesel emissions from idling trains to the nearest existing potentially affected sensitive receptors.

12.7.2 Operational management measures

Dust and air quality management measures will be incorporated into the environmental risk management frameworks that will apply to third-party freight train operators. These will be implemented as part of future network access agreements. The access agreements established will require train operators to prepare suitably detailed environmental and risk management plans for their operations. The plans will include clear performance requirements and traceable corrective measures. The plans will be subject to verification and auditing.

The assessment of the operational phase has assumed that a number of the operational management measures as required by the South West Supply Chain's (QR West Moreton System) *Coal Dust Management Plan* (South West Supply Chain, 2019), such as veneering, are applied to the Project. The mitigation measures aim to minimise surface lift-off of materials in transit and establishes protocols to minimise spillage onto external areas of wagons to reduce potential emissions. Additional measures currently implemented through the South West Supply Chain include:

- Coal washing and moisture management
- Load profiling and use of 'garden bed profile'
- Monitoring of performance.

The assessment of the operational phase has determined that veneering will minimise and reduce potential particulate matters impacts based on the assessed volume of coal trains. The implementation of veneering has been assumed to reduce coal dust emissions from coal-laden trains by 75 per cent as discussed in Section 12.4.4.2. With veneering, the assessment of the operational phase of the Project for impacts to air quality and water tank quality (refer Section 12.6.3) as determined that compliance is predicted for all adopted air quality and water quality goals.

Veneering is currently applied to coal trains that use the rail corridor of the West Moreton System. Therefore, existing coal trains that currently use the West Moreton System and would use the Project in the future will already implement veneering.

Prior to operation of the Project, engagement will be undertaken with existing stakeholders and members of the South West Supply Chain (including DTMR, DES Queensland Resources Council and Local Councils) with regards to coal dust management and monitoring requirements necessary to maintain the integrity of the existing South West Supply Chain Coal Dust Management Plan.

Commissioning and maintenance activities with the potential to generate dust or air quality impacts will be governed by ARTC's Environmental Management System and managed in accordance with the measures described in Chapter 23: Draft Outline Environmental Management Plan.

12.7.3 Proposed mitigation measures

To manage Project risks during construction and operation, mitigation measures have been proposed. The air quality mitigation measures have been identified to address: Project-specific issues, and opportunities; legislative requirements; and, accepted government plans, policy and practice.

Table 12.41 identifies the relevant Project phase, the aspect to be managed, and the proposed potential mitigation measures. 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 *Emissions Estimation Manual for Mining* (NPI, 2012) and *Environmental Evaluation of Fugitive Coal Dust Emissions from Coal Trains* (Connell Hatch, 2008).

For a number of emission sources, there are multiple available mitigation measures. In the pre-construction and construction phases of the Project, dust sources will be variable and transitory in nature and the potential for impacts will vary with proximity to sensitive receptors. The exact method of mitigation implemented will be determined during construction phase planning and following confirmation of the availability and suitability of water supply sources.

Chapter 23: Draft Outline Environmental Management Plan, provides further context and the framework for implementation.

TABLE 12.41: AIR QUALITY MITIGATION MEASURES

Delivery phase	Aspect	Proposed mitigation measures
Detailed design	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.
	Emissions from refuelling activities during construction	▸ 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.
	Fugitive dust emissions (windborne erosion) during construction and operation	▸ Project clearing extents are limited to the disturbance footprint that must be minimised to that required to safely construct, operate and maintain the Project. ▸ Laydown areas and other construction-phase facilities will be designed and arranged to minimise emissions and reduce the potential for air quality impacts to sensitive receptors. Design considerations will include the locations of stockpiles, activity areas, travel routes, rumble grids and truck washdown areas, etc. ▸ Earthworks and landscape design of railway batters and other exposed surfaces will be designed to incorporate treatments and enable stabilisation to reduce wind erosion.
	Emissions reporting requirements	▸ Emissions reporting requirements for the construction phase will be confirmed during detailed design and respond to National Greenhouse and Energy Report (NGERS) requirements and the Sustainability Management Plan.
Pre-construction and construction	Dust generation from pre-construction activities	▸ Vehicle travel on unsealed roads will be minimised as far as practical. Sealed roads will be used where possible, in accordance with the Construction Traffic Management Plan. ▸ Disturbed areas will be rehabilitated and stabilised as soon as practical upon completion of works.
Construction and commissioning	Dust generation from earthworks, clearing and grubbing, mobile plant activity and wind erosion of exposed areas within the construction disturbance footprint	▸ Limit clearing to the disturbance footprint as identified during the detailed design constructability assessment and planning. ▸ Limit clearing to that required to safely construct and operate the Project. ▸ Where practical, stage clearing and grubbing and construction activities to limit the size of exposed areas. ▸ Adequate precautions to effectively minimise the generation of dust, which may affect the safety and general comfort of the travelling public, the contractor's employees and/or occupants of adjacent buildings, during the construction of the work will be undertaken. ▸ This will involve regular applications of water or other measures along the sections of the work traversed by the travelling public, as required, to minimise dust. ▸ Implement water sprays or other measures to reduce dust emissions from excavation or disturbance of soils or vegetation, or handling ballast. ▸ Implement water sprays or other measures to reduce dust emissions from trucks unloading material (anticipated emission reduction of 70 per cent). ▸ Implement water sprays or other measures to reduce dust emissions for mobile plant loading to or from material stockpiles (anticipated emission reduction of 50 per cent).

Delivery phase	Aspect	Proposed mitigation measures
Construction and commissioning (continued)	Dust generation from earthworks, clearing and grubbing, mobile plant activity and wind erosion of exposed areas within the construction disturbance footprint (continued)	▸ 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, such as tunnel excavation stockpiles. ▸ Disturbed areas and exposed surfaces will be stabilised as a soon as practical. 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, etc) (anticipated emission reduction of 100 per cent). ▸ Long-term stockpiles will be avoided where possible. However, where necessary (e.g. topsoil), long-term stockpiles will be established in locations with suitable separation from sensitive receptors. During periods of inactivity, stockpiles will be stabilised appropriately. ▸ Establish and communicate the protocol for notifying relevant stakeholders when potentially dust generating activities are planned to be carried out, with contact details for queries or complaints.
	Emissions from combustion engines (construction vehicles and generators)	▸ Construction plant, vehicles and machinery will be maintained and operated in accordance with manufacturers' recommendations.
	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 hardstand areas be risk assessed prior to adoption.
	Dust generated by traffic on access tracks	▸ To reduce emissions from construction vehicle movements on unsealed roads, road watering or other appropriate measures will be applied. Water additives used to improve dust suppression effectiveness will be considered.
	Fugitive dust emissions from vehicles transporting materials to and from site	▸ Vehicles transporting potentially dust and/or spillage generating material to and from the construction site will have their loads covered immediately after loading (prior to traversing public roads). ▸ Rumble grids and the operation of truck washdown areas will be maintained to reduce trackout of material onto public roads where it may become resuspended. ▸ Site based construction traffic is limited to identified haul routes as per the Project Construction Traffic Management Plan.

Delivery phase	Aspect	Proposed mitigation measures
Construction and commissioning (continued)	Cumulative effects of dust emissions from construction and external land uses or activities	▸ Sensitive receptors near the existing Boral Purga Quarry may be impacted by the operation of the quarry and the construction phase of the Project. The cumulative impact of both sources on sensitive receptors and the effectiveness of the proposed mitigation measures for Project construction activity near the quarry will be monitored via visual monitoring and air quality monitoring as discussed in 12.7.4.2 and in Chapter 23: Draft Outline Environmental Management Plan. In the event of validated complaints or measured exceedances of the Project air quality objectives, enhanced mitigation will be implemented. ▸ Project construction activities to be undertaken near the quarry that have the highest potential to generate air emissions include excavation works and material handling for the construction of the alignment, activity within the laydown area nearest the quarry and vehicle travel on unsealed roads.
	Dust generation and deposition as a result of adverse weather conditions	▸ Avoid ground-disturbing activities including excavation and vegetation clearing during windy conditions where practical. ▸ When avoidance of ground-disturbing activities is not practical, implement enhanced management measures, such as water application and/or implementation of temporary stabilisation treatments
Operations	Emissions from the operation of the rail corridor	▸ Prior to commencement of operational activities, engagement will be undertaken with existing stakeholders and members of the South West Supply Chain (including QR, DES, etc.) with regards to coal dust management and monitoring requirements necessary to maintain the integrity of the existing South West Supply Chain Coal Dust Management Plan. ▸ The assessment of the operational phase has assumed that a number of the operational mitigation measures as required by the South West Supply Chain Coal Dust Management Plan, such as veneering are applied to the Project. ▸ Monitor air quality during operation of the Project and report and audit monitoring results as discussed in Section 12.7.4.3 and in Chapter 23: Draft Outline Environmental Management Plan. ▸ Monitor, record and audit complaints about dust and emissions in accordance with the relevant complaints management handling procedures.

12.7.4 Monitoring, reporting and auditing

This Section describes how the Project will monitor, report and audit compliance with the Project's air quality goals. The methodology and deliverables for reporting for the Project are also discussed in Chapter 23: Draft Outline Environmental Management Plan.

12.7.4.1 Construction phase—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 > 36 km/hr or 20 knots) will be observed during the construction phase of the Project using existing BoM weather stations.

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.

12.7.4.2 Construction phase—air quality monitoring

Visual monitoring of dust generation (visible plumes) will be undertaken throughout construction. Daily onsite inspections of dust generation will be undertaken by construction staff to monitor dust being generated onsite to inform mitigation measures. In addition, routine offsite inspection will be undertaken at sensitive receptors located near high-intensity construction areas such as heavily trafficked haul roads, excavation areas and laydown areas.

Quantitative air quality monitoring will be undertaken via monitoring of dust deposition. Dust deposition monitoring will be undertaken at sensitive receptor locations near the Boral Purga Quarry that have the potential to be impacted by emissions from the construction phase of the Project and emissions from the operation of the quarry.

Selection of the exact location(s) for the installation of dust deposition gauges will be undertaken by a suitably qualified air quality professional. The dust deposition monitoring will be undertaken in accordance with Australian Standard AS3580.10.1:2016 *Methods for sampling and analysis of ambient air Determination of particulate matter - Deposited matter - Gravimetric method.*

In the event that dust deposition monitoring determines exceedance of the Projects air quality goal (120 mg/m^2/day – insoluble solids, monthly average, project influence) at selected monitoring location(s), additional monitoring, including monitoring of airborne particulate concentrations (e.g. TSP or PM_{10}), may be required.

If legitimate air quality complaints are received from locations that are not represented by the location of air monitoring stations, additional monitoring stations may be deployed.

All relevant results (inspections, monitoring, corrective measures and follow-up) will be included in environmental monitoring reports prepared by the construction contractor.

12.7.4.3 Operational phase—air quality monitoring

Requirements for an air quality monitoring station along the alignment will be discussed with the stakeholders of the South West Supply Chain, including DTMR, DES, Queensland Resources Council and local councils. It is expected that should an air quality monitoring station be employed within the Project alignment; it will be equivalent in nature to the existing monitoring stations (including pollutants monitored) operating as part of the South West Supply Chain Coal Dust Management Plan.

The duration of operation for the air quality monitoring station, the responsibility for the maintenance and ongoing operation of the monitoring station and the responsibility for reporting (including frequency) will be discussed and agreed on with stakeholders of the South West Supply Chain.

If a complaint related to air quality is received, during operations, investigations will be undertaken to verify the cause and nature of the complaint. Response and corrective measures will be consistent with ARTC's Environmental Management System.

Requirements for operational phase monitoring will be included in an Operational Environmental Management Plan which will be developed in future stages of the Inland Rail Program.

12.7.4.4 Operational phase—emissions reporting

Emissions reporting will be undertaken, where applicable.

12.8 Residual impact assessment

12.8.1 Construction

Impacts to sensitive receptors and the environmental values of human health and the aesthetic environment as a result of the construction phase of the Project have been assessed qualitatively as discussed in Section 12.6.1. Assessment of the residual impact of the construction phase of the Project following the implementation of the recommended mitigation measures (refer Section 12.7.3) is presented in this section.

The assessment of residual impacts to sensitive receptors during the construction of the Project is presented in Table 12.42. The methodology for the residual impact assessment includes:

- Receptor sensitivity, initial emission magnitude and initial significance for each construction activity category (demolition, earthworks, construction and trackout) presented in Table 12.42 is the assessed risk of impacts without mitigation as presented Section 12.6.1.1 and summarised in Table 12.32
- Residual emission magnitude has been determined qualitatively based on the anticipated reduction to construction dust emissions considering the available mitigation measures and the expected control efficiencies
- Residual significance (residual impact) has been determined using the IAQM risk matrix for each construction activity (refer Table 12.31) considering the residual emission magnitudes assigned for each activity and receptor sensitivity.

Table 12.42 shows that following the IAQM risk matrix, the residual significance with the proposed mitigation measures is low or negligible.

The IAQM construction dust assessment guidance states:

> *'For almost all construction activity, the aim should be to prevent significant effects on sensitive receptors through the use of suitable and effective mitigation. Experience shows that this is normally possible. Hence the residual effect will normally be "not significant".'*

It is expected that with proposed mitigation measures implemented, potential air quality impacts (dust deposition and human health) will not be significant.

12.8.2 Operation

A quantitative (compliance) assessment has been undertaken for potential operational impacts, as predicted concentrations at sensitive receptors have been assessed against legislative and other nominated goals.

The assessment of the operational phase of the Project for residual impacts to air quality and water tank quality (refer Section 12.6.3) indicates that compliance will be readily achieved. This assumes existing veneering of coal trains (consistent with current use of the QR West Moreton System rail corridor) will continue.

The Project is not expected to significantly (or adversely) impact identified environmental values, including human health and the aesthetic environment.

TABLE 12.42: INITIAL AND RESIDUAL SIGNIFICANCE 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[4]	Medium	Small	Low	Small	Low
		Human health	Low	Small	Negligible	Small	Negligible
Earthworks associated with pre-construction and construction phase	All dust generating sources associated with pre-construction and construction phase earthworks	Dust deposition[4]	Medium	Large	Medium	Small	Low
		Human health	Low	Large	Low	Small	Negligible
Construction	All dust generating sources associated with construction phase for the Project	Dust deposition[4]	Medium	Large	Medium	Small	Low
		Human health	Low	Large	Low	Small	Negligible
Trackout associated with pre-construction and construction phase.	All dust generating sources associated with pre-construction and construction phase traffic associated with the Project	Dust deposition[4]	Medium	Large	Medium	Medium	Low
		Human health	Low	Large	Low	Medium	Low

Table notes:

1. Refer to Table 12.41 for reference to the proposed additional mitigation measures relevant to each aspect.
2. Assumes the inclusion of the initial mitigations specified in Table 12.40.
3. Assessment of residual risk of impact once the additional mitigation measures identified in Table 12.41 have been applied.
4. Dust deposition addresses nuisance and the potential impact to the environmental value of the aesthetic environment.

12.9 Conclusions

An air quality impact assessment has been conducted to determine the potential impacts of the Project on air quality. The air quality impact assessment was undertaken to satisfy the ToR for the EIS, which are listed in Section 12.2.

The air quality impact assessment comprised:

- Identification of operational train movements for the year 2040
- Analysis of the expected construction and operational activities with the potential to adversely impact air quality
- Identification of relevant environmental values for the air environment and establishment of air quality goals to protect or enhance the identified environmental values
- Discussion of existing air quality and local meteorology
- Identification of potential sources of Project air emissions
- Identification of nearby existing potentially affected sensitive receptors
- A qualitative risk assessment of air emissions resulting from the construction phase
- A quantitative dispersion modelling assessment of operational emissions associated with freight rail movements, including prediction of potential pollutant concentrations in rainwater water tanks
- Identification of appropriate mitigation and management measures to minimise potential air quality impacts
- Discussion of the Project-specific monitoring, reporting and auditing practices which will be implemented
- Assessment of the residual impact with the implementation of the recommended mitigation measures.

A qualitative construction dust risk assessment was undertaken using the UK IAQM *Guidance on the assessment of dust from demolition and construction* (UK IAQM, 2014). The risk of dust deposition and human health impacts due to particulate matter (PM_{10}) on surrounding areas has been determined based on the scale of activities and proximity to sensitive receptors. The outcome of the assessment showed that the residual risk with the proposed mitigation measures is expected to be low or negligible. 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.

A quantitative dispersion modelling assessment was undertaken for the operational phase using the dispersion models CALPUFF and GRAL. Twelve months of meteorological input data representative for the study area was developed for use in CALPUFF. Diesel exhaust emissions from locomotives and fugitive emissions from coal trains were estimated for projected train volumes for the Project in 2040. Ground-level concentrations for all pollutant species of interest including TSP, PM_{10}, $PM_{2.5}$, NO_2, VOCs and heavy metals were predicted at sensitive receptors using CALPUFF and GRAL.

The results showed that compliance is predicted with the application of direct dust control (veneering—consistent with current use of the QR West Moreton System rail corridor) to coal trains.

An investigation into the deposition of dust emissions at sensitive receptor locations showed that predicted pollutant water concentrations would be significantly lower than *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2018).

The air quality impact assessment undertaken for the Project demonstrated that with appropriate mitigation in place, the construction and operation of the Project can be managed in a way that air quality impacts to nearby sensitive receptors are minimised to an acceptable level where the nominated environmental values of the air environment are protected. A CEMP will be required for the construction of the Project to manage potential impacts from dust emissions.