APPENDIX F

Air Quality Assessment

PREFACE

The technical working papers for the proposed ILC at Enfield were prepared during the first half of 2005. These were prepared in response to the requirements for the preparation of an Environmental Impact Statement (EIS) under Part 4 of the Environmental Planning & Assessment Act, 1979 (EP&A Act). Specific requirements for the EIS were issued on 1 March 2005 by the (then) Director- General of Infrastructure, Planning and Natural Resources.

The EP& A Act was amended on 1 August 2005 by the creation of Part 3A of the Act, and the Department of Infrastructure, Planning and Natural Resources was dissolved on 26 August 2005 and replaced by the Department of Planning and the Department of Natural Resources.

The proposed ILC at Enfield has since been declared a major project, pursuant to SEPP (Major Projects) 2005 and Sydney Ports has subsequently lodged an application under Part 3A of the Act.

Editorial changes to the technical working papers to reflect the changes in legislation or changes in Government departments have not been made.

The following should be considered when reading the technical papers:

- The Director-General's requirements issued under Part 4 are now deemed to have been issued under Part 3A, and any reference to the Director-General's requirements should be read as a reference to Director-General's requirements issued under Part 3A;

- Any reference to an EIS under Part 4 of the Act should be read as a reference to an Environmental Assessment under Part 3A of the Act;

- Any reference to the Department of Infrastructure, Planning and Natural Resources should be read as a reference to either the Department of Planning or the Department of Natural Resources, as appropriate.

Intermodal Logistics Centre at Enfield
Environmental Impact Statement

AIR QUALITY ASSESSMENT

- Final
- 22 June 2005

Intermodal Logistics Centre at Enfield Environmental Impact Statement

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- Final
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Executive Summary

This air quality impact assessment, (the 'assessment'), is a part of the Environmental Impact Statement for the proposed Intermodal Logistics Centre at Enfield. The assessment has been undertaken in accordance with NSW Environment Protection Authority[1] guidelines. The assessment provides modelling predictions of the highest-risk air pollutants from the most intensive activities associated with construction and operation of the proposed Intermodal Logistics Centre (ILC).

The highest risks associated with the construction phase of the proposal were determined to be from air quality impacts due to emissions of particulate matter (dust particles); that is, elevated concentrations of airborne particulate matter and dust deposition. These impacts were assessed in accordance with NSW Environment Protection Authority guidelines by modelling the emissions and dispersion of: (1) Particulate Matter 10 ('PM_{10}', or the mass of particles with aerodynamic diameters less than 10 microns per unit volume); and (2) Total Suspended Particulates (TSP). In addition, the impacts from dust deposition were modelled.

The ILC construction phase will comprise extensive earthworks across the site, but especially in the southern portion of the site where large stockpiles and other earthworks areas will be located. The air quality assessment concludes that there is a low risk of (off-site) impacts from PM_{10} due to earthworks near residential areas to the southeast of the site, provided dust mitigation measures are put in place.

The modelling results included the effect of a halt to construction operations when the wind speeds are greater than 5 m/s or when the (incident) wind direction is in the sector 210^o to 340^o. The modelling showed this restriction was necessary to substantially mitigate the potential air quality impacts predicted for residential areas to the southeast of the site.

The highest risks associated with the operational phase of the proposal were determined to be from elevated levels of PM_{10} and oxides of nitrogen (NO_x), that would be emitted from combustion engines associated with full-capacity ILC operations. These impacts were assessed in accordance with NSW Environment Protection Authority (2001) guidelines, in turn based on the National Environment Protection (Ambient Air Quality) Measure (NEPC, 1998). The assessment uses these guidelines for modelling the emissions and subsequent dispersion of these key pollutants for the ILC: (1) PM_{10}; and (2) Nitrogen Dioxide (NO_2).

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[1] The NSW Environment Protection Authority (EPA) now falls under the umbrella of the Department of Environment and Conservation.

The air quality assessment of the ILC operational phase concludes that the risk of air quality impacts emissions of PM_{10} and NO_2 from on-site activities, are very low. There were no exceedences of the criteria for these air pollutants. The assessment of the air quality impacts from increases in off-site vehicle traffic due to an operating ILC, indicates that only marginal increases in PM_{10} and NO_2 concentrations are expected.

The air dispersion modelling results for ILC operations show compliance with NSW Environment Protection Authority ambient air quality criteria. The modelling results for ILC construction show that there is a risk of some exceedences of the NSW EPA criterion for maximum 24-hour average PM_{10} (i.e., 50 $\mu g/m^3$), and there may be one or two exceedences of the corresponding *National Environment (Ambient Air Quality) Measure* criterion.

In terms of greenhouse gas impacts the ILC project will result in the following emissions of carbon dioxide (CO_2):

- Decreased truck CO_2 = 5,818 tonne CO_2 / annum; and
- Increased locomotive CO_2 = 4,825 tonne CO_2 / annum.

For the year 2016 this equates to an annualised reduction in CO_2 emissions of 993 tonnes CO_2 per annum as a result on operation of the ILC. This represents a reduction in fuel use and greenhouse gas emissions in line with government strategies, as a result of the project.

1. Introduction

1.1 General Introduction

This study provides the air quality assessment as part of the Environmental Impact Statement (EIS) for construction and operation of the proposed Intermodal Logistics Centre (ILC) located at the former Enfield Marshalling Yards. The study comprises an assessment of the air quality and greenhouse gas impacts predicted from construction and operation of the ILC. The study was carried out in accordance with NSW Environment Protection Authority[2] guidelines provided in *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales*, NSW EPA, August 2001, based on the *National Environment (Ambient Air Quality) Measure* (NEPC, 1998).

The history and purpose of the ILC is described in the EIS. The details of the project considered relevant to undertaking calculations for the air quality assessment only, are provided below.

1.2 Description of the Proposal

1.2.1 Construction

The ILC site is approximately 60 hectares in area and aligned with the new Enfield Marshalling Yards. An air photograph of the site showing the property boundary as at July 2003 is provided in **Figure 1-1**. The site extends from the intersection of the Hume Highway and Roberts Road in the north, through to the intersection of Punchbowl Road and Cosgrove Road in the south. The eastern boundary of the site is Cosgrove Road, the western boundary is aligned with the new Enfield Marshalling Yards and the existing Port Botany to Enfield dedicated freight rail line.

A significant component of the construction activities in terms of potential air quality impacts involves substantial earthworks to level the site. In particular there are four stockpiles that would require excavation and transport of large volumes of material, and levelling. Some of this material will be used for on-site fill, and some will be transported off-site.

Construction works would be required for these primary functional components of the ILC: Warehousing and Empty Container Storage Facilities; Hardstand areas; Rail facilities on-site (turnouts to main line already exist); Warehouses; Internal access roads; Services infrastructure; Administration and maintenance buildings; Demolition of some existing buildings and structures on the site; and Remediation of areas of contaminated land.

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[2] The NSW Environment Protection Authority (EPA) now falls under the umbrella of the Department of Environment and Conservation (NSW).

■ **Figure 1-1 Proposed Site for the ILC at Enfield**

In addition, construction works would be required along Cosgrove Road for provision for light industrial / commercial use; and road access to the site. Some construction works would be required for the Ecological and Community Area but these are insignificant and as such not modelled. Off-site construction works include construction of the road-bridge over existing rail lines to connect the site to Roberts Road via Wentworth Street. This would include upgrades of access roads and intersections that may be required, to be determined during the EIS process. The wheel lathe and Toll areas will remain operating under existing lease conditions.

1.2.2 Operations

The primary function of the ILC is the transfer and storage of container freight to and from Port Botany. The ILC comprises the functional elements listed below; refer to EIS, Section 4 and also to **Figure 1-2**: [3]

- Intermodal Terminal - for the loading and unloading of containers between road and rail and short-term storage of containers;
- Warehousing - for the packing and unpacking of containers and short-term storage of cargo;
- Empty Container Storage Facilities – for the storage of empty containers for later packing or transfer by rail;
- Light Industrial / Commercial Area - for light industrial / commercial use;
- Community and Ecological Area - would provide the opportunity to incorporate ecological enhancement and community opportunities. The area would also serve as a buffer between operations on the site and residences to the south of the site; and
- Off-site works including construction of a road bridge over the existing new Enfield Marshalling Yards and dedicated freight rail line for access to Roberts Road via Wentworth Street.

[3] Figure Source: *Enfield Site Concept Design Layout (Land Use)*, Dwg. No. SEDP003N, 02/06/05.

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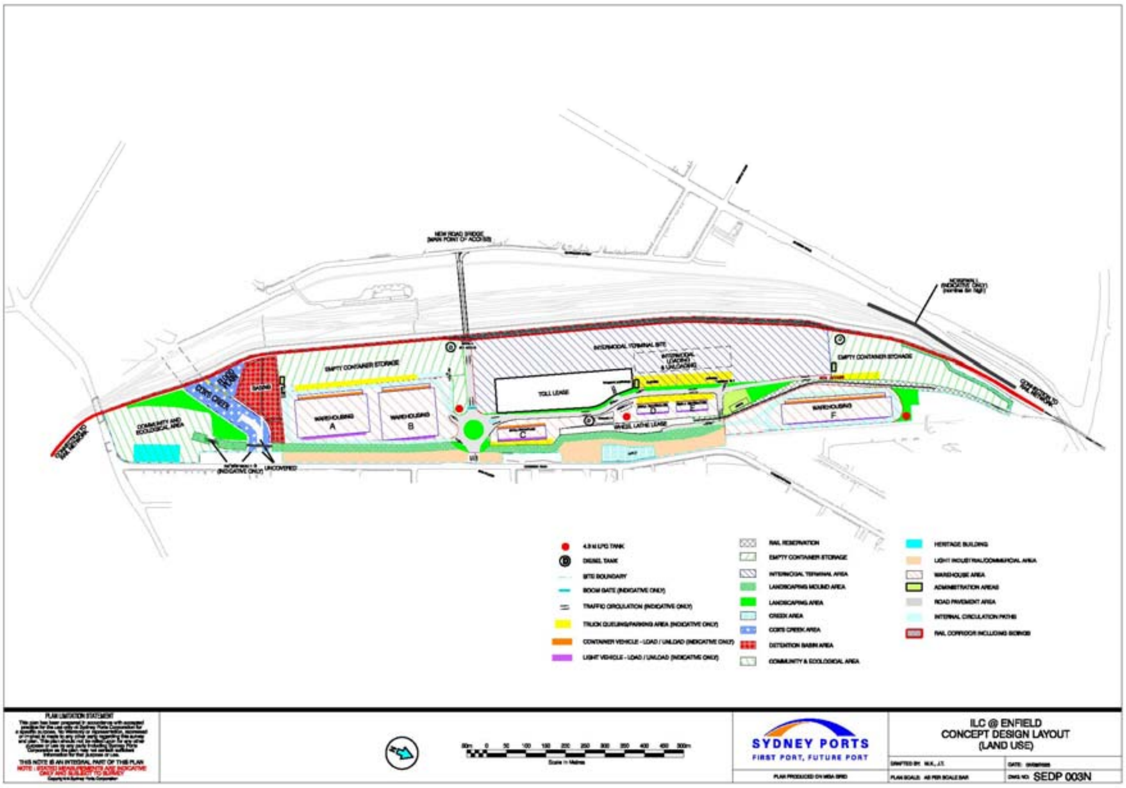
■ **Figure 1-2 Proposed Layout of Intermodal Logistics Centre**



The Intermodal Terminal within the ILC would be developed to enable throughput of 300,000 TEU[4] per year. It is anticipated that the site would have a first-year throughput of 100,000 TEU, reaching 300,000 TEU capacity within about 10 years of commencing operations. It is anticipated that the throughput would consist of 150,000 full TEU inbound from the Port and 150,000 TEU outbound to the Port with a mixture of full and empty containers.

1.3 Air Quality Assessment Objectives

The objectives of the air quality assessment are to review the existing air quality in the Enfield area and to provide an assessment of the likely future impacts on air quality during the construction and operational phases of the ILC. To achieve these objectives the following tasks have been undertaken:

- Review of air quality issues relevant to the construction and operation of the ILC;
- Outline of the ambient air quality criteria relevant to the site;

[4] One TEU is equivalent to one twenty-foot container. A forty-foot container is equivalent to two TEU.

- Description of prevailing meteorology and existing ambient air quality in Enfield;
- Calculation of emissions of particulate matter (PM_{10} and TSP) from the site during ILC construction;
- Calculation of emissions of nitrogen dioxide (NO_2) and particulate matter (PM_{10}) from ILC at its maximum expected level of operations;
- Determination of air quality impacts by air dispersion modelling for the construction and maximum operational phases;
- Recommendations for air quality monitoring and suggested measures for reducing air quality impacts have been provided; and
- Assessment of the benefits/impacts from changes in greenhouse gas emissions.

2. Project Overview and Air Quality Issues

2.1 Overview

The construction phase of the ILC involves the movement of large amounts of material, much of which currently resides in large stockpiles on the site. Given the large amounts of material to be moved, these stockpiles will be the source of most dust emissions during construction.

The highest-risk air quality impacts during the operational phase of the completed project are likely to occur from road and rail exhaust emissions and emissions from on-site diesel powered equipment with the main emissions for consideration being oxides of nitrogen (NO_x) and PM_{10}. The component of PM_{10} containing smaller 'respirable' particles with diameters less than 2.5 microns, the $PM_{2.5}$ fraction, is contained within PM_{10} emissions calculated for this study, and as such also represent some fraction of the predicted impacts from PM_{10} presented here. However the emissions data for $PM_{2.5}$ from combustion engines is not nearly as well researched or well known as PM_{10}, and as such the focus here has been on determining impacts from NO_x and PM_{10} impacts.

Comparisons of calculated air emissions with ambient air quality criteria for large construction (and mining) sites indicate the highest-risk air quality impacts from earthmoving activities will be due to emissions of larger particles – including the inhalable particle fraction, PM_{10}. The smaller respirable component of PM_{10}, $PM_{2.5}$, is a more important issue for high-volume vehicle traffic. Therefore the focus of the construction air quality assessment is on the air quality impacts caused by the emissions of larger particles from the earthworks.

A description of the construction phase of the proposal relevant for determining the expected air emissions important for the air quality assessment is provided in **Section 2.2**. Similarly a description of the operational phase of the proposal is provided in **Section 2.3**.

2.2 Construction Phase

2.2.1 Overview

The duration of construction of the ILC would be approximately 27 months and comprises these four main Construction Stages:

- 1 – Site preparation;
- 2 – Earthworks and Drainage;
- 3 – Road and Rail Infrastructure; and
- 4 – Warehousing and Final Works.

Construction traffic would include trucks involved in earthworks operations, materials delivery, and delivery or relocation of specialist plant such as cranes, pavers and excavators. Heavy construction traffic would be restricted to arterial routes. The emissions from construction trucks off-site would be insignificant compared to on-site PM_{10} emissions and the reason for this is very tight controls will be implemented for off-site haul trucks; for example, washing truck bodies, wheels and tyres and loads covered, prior to leaving the site. Light four-wheel drive vehicles would be used for survey and management purposes.

To minimise disruption to residents and businesses, construction activities would be restricted to these working periods, normally:

- Monday to Saturday 0700 to 1800 hours;
- Sunday & public holidays No works.

Working hours outside these hours may be undertaken in circumstances such as:

- Works not being audible at residences;
- Delivery of bulky items or wide loads during off peak hours to minimise disruption.
- Time-critical activities;
- Preparation of road diversions during the off peak hours and off-site road works in off-peak hours; and
- Relocation of utility services for off-site roadworks during hours of reduced traffic.

The sources of dust considered for working hours will be associated with all the construction activities such as wheel-generated dust, loading and dumping of material by excavators and trucks for example, and wind erosion, whereas the only source considered for non-working hours is wind erosion of exposed surfaces.

The following sub-sections describe the construction activities in each Stage relevant to the possible dust emissions. The calculated dust emissions for each Stage are provided in **Section 6.3**.

2.2.2 Earthworks Construction Stage 1

The main activities of Construction Stage 1, 'Site Preparation', and estimates of the periods required to complete these activities, are:

- Construct Sealed Haul Roads, 2 weeks;
- Construction of Stormwater Detention Ponds, 4 weeks;
- Removal / Land Farming of Contaminated Material, 4 weeks;
- Remove Stockpile 5 Unsuitable Material, 9 weeks; and
- Landscaping Mounds & Light Industrial / Commercial Areas, 10 weeks.

The first construction activity undertaken would be the preparation of (on-site) haul roads. Suitable materials available on site in the existing stockpiles would be utilised as road base. The roads would be sealed using a two-coat bitumen seal to assist in reducing dust emissions during construction.

Remediation of contaminated soil would be undertaken during this stage of the project. Contaminated soil would be landfarmed on-site or transported off-site. Approximately 12,000 m^3 of material from the Diesel, Electric Maintenance Facility (DELEC) site and 1,500 m^3 on the remainder of the site would require landfarming or disposal; refer to **Appendix C** for more detail.

Other materials unsuitable for use on site during construction would be sorted from stockpiles using excavators. This material would then be transported off site for disposal. The majority of unsuitable material is located in Stockpile 5, approximately 37,000 m^3 of the 132,000 m^3 in this stockpile. The remaining material in stockpile 5 would be used as fill for two proposed landscaping mounds, with cross-sections above the proposed finished level for the site. One landscaping mound is on the eastern perimeter of ILC site along Cosgrove Road, which is 17 metres wide by 2-5 metres high. The second landscaping mound is in the far northwest of site, 10 metres wide by 2.5 metres high.

A portion of stockpile 3 would be utilised for filling the area proposed for light industrial / commercial use along Cosgrove Road. Stormwater detention ponds would also be constructed during Stage 1 and would require excavation and introduction of a clay layer or plastic lining material. The detention ponds would capture runoff and sediment during both construction and operational phases of the Proposal. Stage 1 works are anticipated to take 14 weeks to complete. A summary of the Construction Stage 1 activities and estimates of equipment to be used is provided in **Table 2-1**; numbers are indicative and used for modelling purposes.

- **Table 2-1 Construction Stage 1 Activities and Equipment**

Activity	Major items of plant and equipment
Construction of sealed haul roads	Grader, roller (drum), water cart, trucks
Construction of stormwater detention ponds	Dozer, compactor (sheep's foot), excavator, water cart and trucks
Removal / landfarming contaminated material	Excavators (x2), water carts (x2), dozer and trucks
Removal of material from stockpiles, landscaping mounds / acoustic barriers, prepare light industrial / commercial area	Dozers (x3), excavators (x3), water carts (x3), compactors (sheep's foot) (x2), articulated truck (x2) (on site) and trucks (off site)

The NSW DEC approved methods for the handling of contaminated material need to be observed whenever such material may be encountered during the construction earthworks. This is important for ensuring that potential toxic releases to air are contained and are not entrained into the atmosphere, where they have the potential to impact on surrounding receiver locations.

2.2.3 Earthworks Construction Stage 2

The main activities of Construction Stage 2, 'Earthworks & Drainage', and estimates of the periods required to complete these activities, are:

- Earthworks Cut to Fill, 24 weeks;
- Stormwater Trunk Drainage, 14 weeks;
- Adjusting of Services, 12 weeks; and
- Retaining Wall / Battered Embankment, 16 weeks.

Earthworks would be undertaken by working through the site from north to south, producing a relatively flat site suitable for the introduction of pavement material. A cut-to-fill volume of 360,000 m^3 is required, which would involve the removal of stockpiles 1, 2 and 3. The flat site would drain primarily to the south, into the stormwater detention ponds. The movement of these stockpiles, by tractor scrapers, would form three new smaller mounds, some fill material for the area to the north of Stockpile 2, and some fill material to the western side of the existing cutting. The movement of material from the three mounds would be used for fill in the existing cutting on the eastern side of the site (DELEC site).

A retaining wall or battered embankment would be constructed to allow for the relocation of the existing rail access to the Wheel Lathe area. Stabilisation works would be undertaken progressively during the earthworks phase and topsoil would be stripped and utilised where possible throughout the site. The stormwater trunk drainage system would be constructed at appropriate timing during the earthworks. A summary of the Construction Stage 2 activities and estimates of equipment to be used, pertinent to the air quality study, is provided in **Table 2-2**; numbers are indicative and used for modelling purposes.

- **Table 2-2 Construction Stage 2 Activities and Equipment**

Activity	Major items of plant and equipment
Earthworks	Dozer (x3), excavators (x2), water carts (x4), compactors (sheep's foot) (x3), articulated trucks (x2) and scrapers (x3)
Stormwater trunk drainage system	Excavators (x2), water cart, rollers (drum) (x2), backhoe and crane
Relocation of services	Excavator, backhoe and trucks
Retaining walls / embankments	Excavator, roller, dozer and trucks

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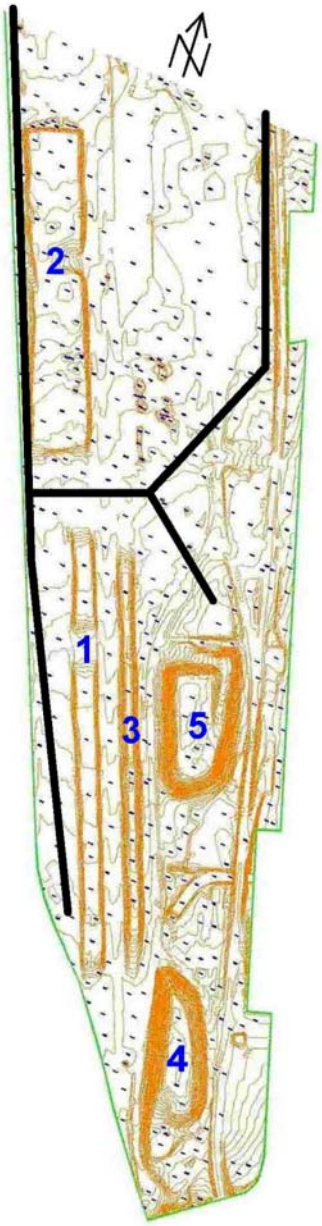
- **Figure 2-1 Construction Roads & Stockpiles**



Earthworks would be required to level, manipulate or remove existing stockpiles to design site grading. The locations of the existing stockpiles (numbered), and approximate construction haul road routes are shown in **Figure 2-1**. Further to the north, the two construction roads extend almost to the end of the site boundary, remaining close to the respective western and eastern site boundaries. The volumes and proposed uses of the stockpiles are provided in **Table 2-3**.

- **Table 2-3 Stockpile Volumes and Proposed Use**

S'pile No.	Vol. (m^3)	Proposed Use
1	37,700	Primarily for on-site fill
2	92,300	Primarily for on-site fill
3	33,800	Primarily for on-site fill
4	94,600	Retained on-site and vegetated as part of the Ecological and Community Area
5	132,500	Contains about 132,000 m^3 of mixed ash, ballast, shale and refuse materials. Unsuitable material to be removed from site to an appropriate landfill facility and material suitable for re-use would contribute to proposed landscaping mound areas.

2.2.4 Other Construction Stages

In terms of potential air quality impact, the risks associated with activities within the final two Construction Stages 3 and 4, are lower than for the first two stages. The reason for this is simply that smaller volumes of material would be moved in these latter stages compared with the preceding more substantial earthworks. A summary of the main activities in the latter two stages is provided below:

- Construction Stage 3 – 'Road & Rail Infrastructure', 160 days:
  - Over Bridge (Off Site), 20 weeks;
  - Roadworks (Off Site) , 20 weeks;
  - Reinforced Earth Wall for Road Embankment, 12 weeks;
  - Northern Bridge to Empties Area, 16 weeks;
  - Install services as required including Rail Relocation to Wheel Lathe, 12 weeks;
  - Railway Line and Sidings, 20 weeks;
  - Container Pavement Works, 20 weeks;
  - Internal Road Pavements, 20 weeks;
- Construction Stage 4 – 'Warehousing & Final Works', 260 days:
  - Warehousing and administration Areas, 52 weeks;
  - Pavement Areas, 52 weeks; and
  - Final Landscaping Works, 12 weeks.

Air dispersion modelling has not been undertaken for these latter stages, with the focus instead being on modelling worst-case air emissions scenarios by combinations of major earthworks activities occurring in the first two Construction Stages.

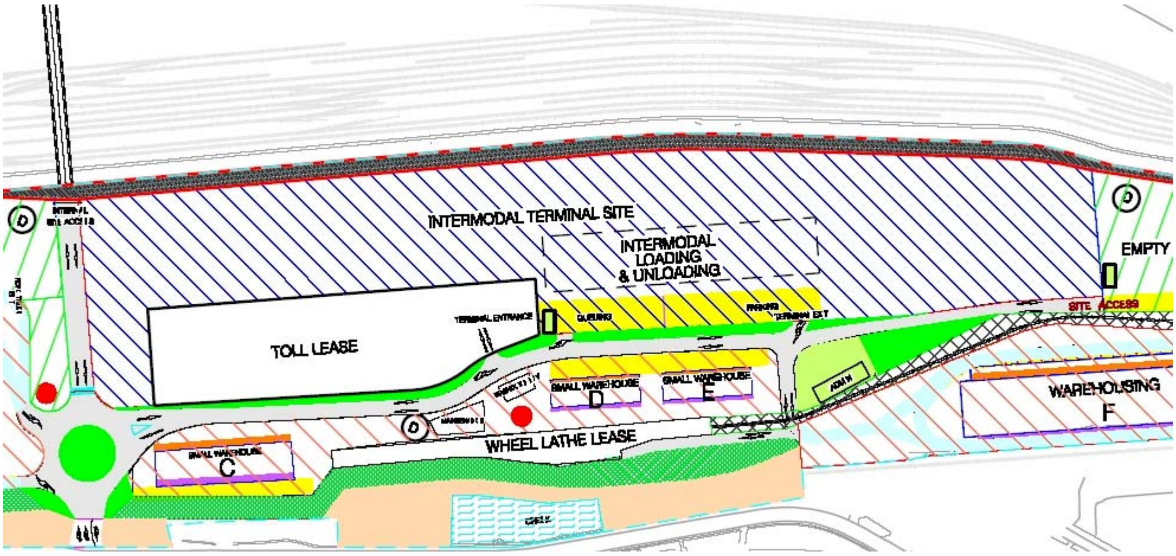
2.3 ILC Peak Operations Phase

2.3.1 Overview

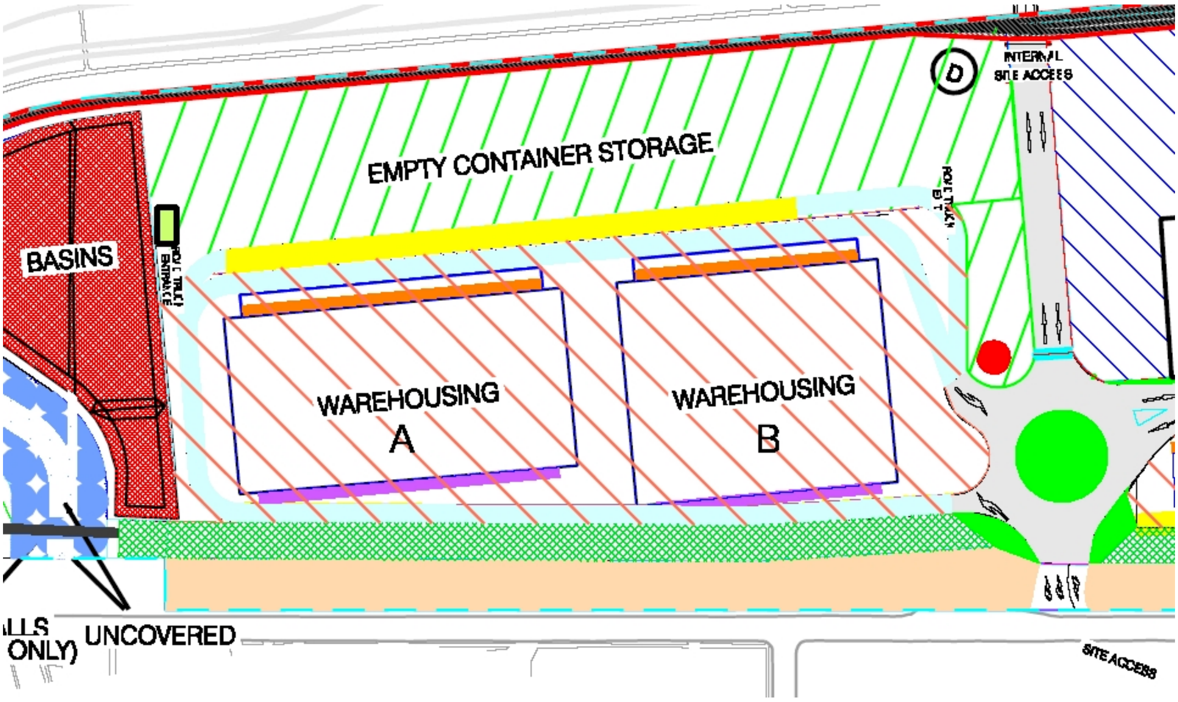
The overall layout of the proposed ILC site operation was provided as Error! Reference source not found.. The operation of the ILC involves the following two key activities in terms of emissions of air pollutants:

- **Truck movements.** In the following figures, road pavement is shown in light grey. Container trucks entering the site using the Wentworth Street overbridge and existing Cosgrove Road entry as shown in **Figure 2-2**, may travel south to a warehouse area (**Figure 2-3**), north to the Intermodal Terminal site (**Figure 2-2** again), or further north to a warehouse area (**Figure 2-4**). The trucks would collect and/or deliver containers, then exit from the site via Wentworth Street Overbridge or Cosgrove Road.

- **Figure 2-2 ILC Points of Access and Intermodal Terminal - North[5]**

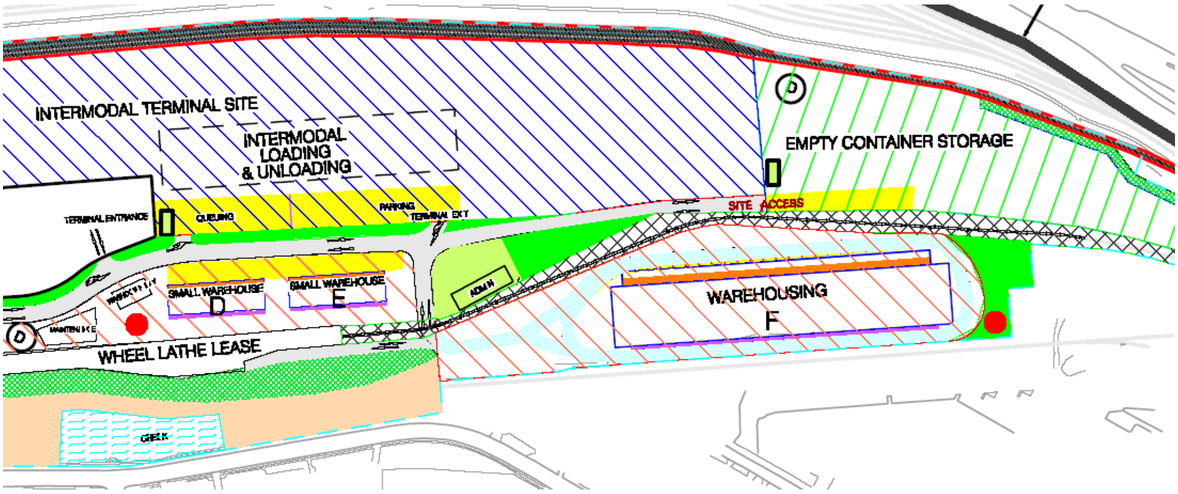


- **Figure 2-3 ILC Points of Access and Warehouses - South**



[5] The Figures 2-2 through to 2-5 were obtained from the plan *SEDP003N*.

- **Figure 2-4 Access Routes to Warehouses - Far North**



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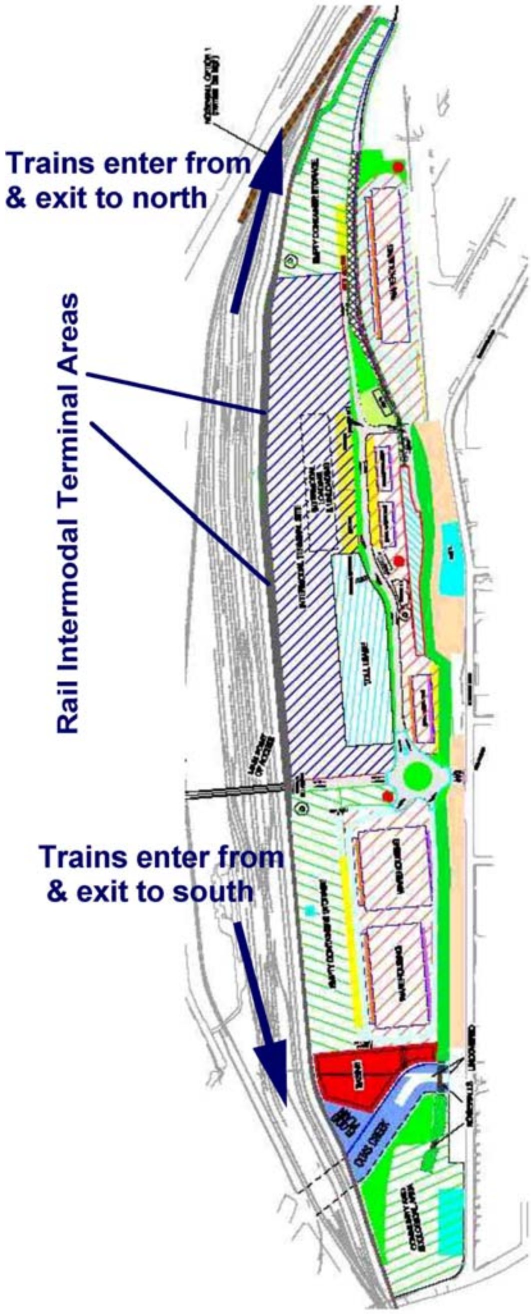
- **Rail Movements.** Most trains would enter the site from the south where containers would be loaded / unloaded, and exit the site heading south. Some trains would enter the site from the north, (an infrequent event), then head back to the north (refer to **Figure 2-5**).

In **Figure 2-5**, the existing railway lines are shown in light grey on the western side of the site. The Rail Intermodal Terminal Areas, or rail corridor/siding areas, are shown by the dark grey strip between the existing railway lines and the Intermodal Terminal Site shown by the white-and-blue diagonal lines.

Other activities involving the running of engines, besides trucks and locomotives, are:

- On-site handling of containers by gantry cranes, container forklifts, empty-container forklifts, and reach stackers;
- Trucks using ancillary facilities along Cosgrove Road;
- Interterminal Vehicles; and
- Staff cars.

- **Figure 2-5 Areas of Rail Activity for Enfield ILC**



2.3.2 Container Transport and Intermodal Terminal Operations

The Intermodal Terminal would operate 24 hours a day, seven days a week. All rail traffic would be associated with operations at the Intermodal Terminal.

In the short-term (five years of operation) it is anticipated that the facility would generate up to four to seven train movements per day (each movement is a one-way trip) increasing to 10-20 (typically 16) rail movements per day in the long-term (20 years of operation).

The essential function of the Intermodal Terminal would be the unloading of container freight, including refrigerated containers, short-term storage of container freight on-site and subsequent loading of container freight to Intra-Terminal Vehicles (ITVs) for transport to other areas of the ILC or to trucks for transport off-site. Containers would be unloaded from trains using mobile gantry cranes, forklifts and reach stackers.

Within the Intermodal Terminal, containers would be stacked for short-term storage to a maximum height of five containers (approximately 13 metres). Reach stackers and forklifts would then load containers to trucks, which would exit the site via internal access roads onto either Cosgrove Road or Wentworth Street.

Some containers would be loaded to rail from the Intermodal Terminal for transport to Port Botany and subsequent export. Containers transported to the ILC via trucks would be loaded to trains at the Intermodal Terminal.

Management of site traffic is proposed such that trucks will not queue along public roads adjacent to the site, appropriate time slots will be provided for accessing the site, and loads will be organised to achieve maximum efficiency. The system would be operated to minimise traffic congestion during peak periods and to optimise the use of trucks capable of transporting three TEUs simultaneously.

2.3.3 Warehouse Operations

Trucks may transport non-containerised freight to warehouses located on site from nearby industrial areas. Within the warehouses non-containerised freight would be packed into empty containers. Forklifts would be used to handle the containers and cargo in the warehouse areas. Full containers would be transferred to the Intermodal Terminal using ITVs for subsequent transport to Port Botany via rail. Empty containers would be brought back to site on trucks or taken from the empty container storage areas of the Intermodal Terminal.

Operations would allow for approximately 33% of containers arriving by rail at the Intermodal Terminal to be transferred to warehousing for unpacking. Unpacked freight could either be removed from site via truck as non-containerised freight or sorted and repacked into other containers that would be transferred to the intermodal terminal as export cargo to be loaded onto rail as containerised freight.

2.3.4 Empty Container Storage Operations

Two empty container storage areas would be constructed as part of the Proposal, one to the north of the Intermodal Terminal and one to the south. Forklifts would be used to handle empty containers in the empty container storage areas. Internal access roads would be constructed to connect the empty container storage areas to the Intermodal Terminal and warehouse areas.

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3. Air Pollution and Effects

3.1 Overview

This section of the report outlines the health effects of airborne particulate matter and nitrogen oxides. These pollutants are considered the most relevant of the pollutants listed in the National Environment Protection (Ambient Air Quality) Measure (NEPC, 1998), due to the nature of the works to be undertaken during the overall development and operation of the Enfield ILC; refer also to **Section 2.1**, and later to **Section 7.1**.

3.2 Effects of Air Pollution

3.2.1 Airborne Particulate Matter

Airborne particulate matter is any material, except uncombined water, that exists in the solid or liquid state in the atmosphere or gas stream at standard condition. Airborne particles cover a wide range of sizes from larger than a typical air molecule up to approximately 1 mm in diameter. The most significant particle sizes for assessing air quality range from approximately 0.1 to 10 μm in size.

Particulate matter is generated by, for example: industry, motor vehicles, refuse disposal, roadway dust, bush fires, plant pollen and seed, the sea surface, and wind erosion of the earth's surface. Particulate matter presents a health hazard to the lungs, enhances some chemical reactions in the atmosphere and reduces visibility. **Table 3-1** provides some terms for and types of particulate matter.

Table 3-1 Definition of Terms for Airborne Particulate Matter and Aerosols

Term	Description Main ref., Wark and Werner (1981)
Particulate matter	Any material, except water, that exists in the solid or liquid state in the atmosphere or gas stream
Particle	Discrete mass of solid or liquid matter
Aerosol	Microscopic solid or liquid particle suspended in a gaseous media (approx. 0.001 μm to 40 μm in diameter.
Dust	Solid particles larger than colloidal size capable of temporary suspension in air
Fly Ash	Finely divided particles of ash entrained in flue gas. Particles may contain unburned fuel
Fume	Particles formed by condensation, sublimation, or chemical reaction
Mist	A suspension of small liquid droplets
Smoke	Small gasborne particles resulting from combustion
Soot	An agglomeration of carbon particles

Common size-related terms are Total Suspended Particulate matter (TSP), PM_{10} and $PM_{2.5}$. TSP refers to the mass concentration of most of the suspended particles in the atmosphere, with sizes nominally less than 50 microns (µm) in diameter; e.g., refer to the Department of the Environment and Heritage (DEH) website[6]. PM_{10} refers to the mass concentration of all particles with aerodynamic diameters less than 10 µm, and $PM_{2.5}$ refers to the mass concentration of particles with aerodynamic diameters less than 2.5 µm.

The health effects of particles are largely related to the extent to which they can penetrate the respiratory tract. Larger particles, approximately greater than 10 µm in diameter, generally adhere to the mucus in the nose, mouth, pharynx and larger bronchi and can be removed by swallowing or expectorating.

The 'inhalable' fraction of particulate matter comprises particles with diameters between approximately 2.5 and 10 µm in diameter, are inhaled through the nose and mouth, and deposited in the trachea and bronchia section of the lung.

The 'respirable' fraction comprises particles with diameters less than approximately 2.5 µm. These particles penetrate to the lung's unciliated airways, lodging deep in the alveolar region of the lung.

The deposition of larger particles than these have the following consequences: staining and soiling of surfaces; aesthetic or chemical contamination of water bodies or vegetation; and effects on personal comfort, amenity and health (DEH, *ibid.*).

3.2.2 Oxides of Nitrogen

Oxides of nitrogen (NO_x) are dominated by the air pollutants nitric oxide (NO) and nitrogen dioxide (NO_2). Lightning and the oxidation of ammonia can form oxides of nitrogen naturally. Combustion, however, is the main source of NO_x, with the burning of fossil fuels resulting in some atmospheric nitrogen being converted to oxides, mainly nitric oxide. The nitric oxide slowly oxidises to nitrogen dioxide. In the presence of sunlight and reactive organic compounds the oxidation to NO_2 and subsequently ozone is much more rapid. This leads to what is termed photochemical smog.

Oxides of nitrogen are an important contributor to the formation of photochemical pollution in Sydney. The Ambient Air Quality NEPM, (NEPC, 1998), has established a 1-hour and a 4-hour standard for ozone (at ground level) of 0.10 and 0.08 parts per million respectively, since it is a major component of photochemical pollution with adverse effects on human health. In Sydney,

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[6] Environment Australia, 1998, Best Practice Environmental Management in Mining, ISBN 0 642 54570 7; refer to http://www.deh.gov.au/industry/industry-performance/minerals/booklets/dust/dust1.html.

particularly in the west and southwest, these standards are occasionally exceeded, sometimes by substantial amounts.

There is no standard for total NO_x since only one of its constituents, NO_2, is directly of concern for health. The main health impact of excessive NO_2 exposure is a direct effect on respiratory function. Individuals with chronic inflammatory airway disease such as bronchitis are most at risk. The NEPM standard for NO_2 is 0.12 parts per million (246 $\mu g/m^3$) for a 1-hour averaging period, and 0.03 parts per million (62 $\mu g/m^3$) for an annual averaging period.

Levels of NO_2 appear to have been declining over recent years with few exceedences of the standard now recorded in NSW.

3.2.3 Photochemical Smog

Nitrogen dioxide is an important contributor to the formation of ozone, a major component of photochemical smog. Oxides of nitrogen, in the presence of strong sunlight, follow a complex series of chemical reactions with reactive organic compounds to produce ozone. The amount of NO_x present and the availability of strong sunlight limit the total amount of ozone formed during these reactions. It therefore follows that during the summer months when there is an abundant supply of strong sunlight available to oxidise NO_x emissions within Sydney, higher ozone concentrations occur.

Transport related air emissions within the Sydney airshed are primarily responsible for regional photochemical smog formation within the Sydney basin. Photochemical smog is not a localised phenomenon, in that ozone is produced relatively slowly, over several hours, after exposure to sunlight has been sufficient for the series of reactions to be completed. Maximum ozone concentrations therefore tend to occur downwind of the main source areas of precursor emissions, and can become re-circulated within local and regional circulation patterns.

Due to this dependence of photochemical smog formation on meteorology and length of exposure to sunlight and precursor emissions, areas remote from the source of emissions can be exposed to high ozone concentrations. Consequently, an increase in precursor pollutant emissions within one area has the potential to increase ozone levels in other regions remote from the sources.

4. Air Quality Objectives in NSW

4.1 Overview

This section of the report details air quality objectives in NSW relevant to the construction and operation of the ILC.

4.2 Concentration Based Ambient Air Quality Objectives

Impact assessment criteria for air pollutants are provided in *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales*, NSW EPA August 2001, based on the criteria provided in the Ambient Air Quality NEPM (NEPC, 1998).

The ambient air quality criteria relevant to the ILC are TSP, PM_{10} and NO_2. The TSP (and PM_{10}) emissions will be due to emissions of dust from earthworks associated with construction of the ILC, and from equipment exhausts from ILC operations. The more significant NO_x emissions will occur during ILC operations.

The NEPM allows for one exceedence of the maximum hourly average NO_2 criterion and five exceedences of the maximum 24-hourly average PM_{10} criterion. The NSW EPA air quality criteria and corresponding NEPM exceedence-criteria relevant to the ILC proposal are listed in **Table 4-1**.

- **Table 4-1 Ambient Air Quality Assessment Criteria for the Enfield ILC Proposal**

Pollutant	Averaging Period	Ambient Air Quality Criteria	Number of Allowable Exceedence Days/Year
NO_2	1-hour	12 pphm* or 246 $\mu g/m^3$ #	1
NO_2	Annual	3 pphm or 62 $\mu g/m^3$	nil
TSP	Annual	90 $\mu g/m^3$	nil
PM_{10}	24-hour	50 $\mu g/m^3$	5
PM_{10}	Annual	30 $\mu g/m^3$	nil

* parts per hundred million; # micrograms per cubic metre, at 273K and 101.3 kPa

4.3 Dust Deposition

Deposited dust, if present at sufficiently high levels, can reduce the amenity of an area. The NSW EPA set limits on acceptable dust deposition levels. **Table 4-2** provides the maximum acceptable increase in dust deposition over the existing dust levels.

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- **Table 4-2 NSW Criteria for Dust Fallout**

Existing dust fallout level ($g/m^2/month$)	Maximum acceptable increase over existing fallout levels ($g/m^2/month$)	
	Residential	Other*
2	2	2
3	1	2
4	0	1

* Other refers to rural, semi-rural, urban commercial and industrial

The maximum acceptable increase in the dust deposition rate is 2 $g/m^2/month$, (calculated from an annual mean), in those areas where the existing dust deposition rate does not exceed 2 $g/m^2/month$. The aim of the dust deposition criteria is to limit the total dust deposition rate to 4 $g/m^2/month$ in suburban residential areas and to 5 $g/m^2/month$ in rural, semi-rural, commercial and industrial areas.

5. Existing Air Environment

5.1 Overview

This section of the report provides a description of the area surrounding the Intermodal Logistics Centre (ILC) site, the prevailing meteorological conditions and the meteorological data used for the dispersion modelling.

5.2 Local Setting

The ILC will be constructed on part of the former Enfield Marshalling Yards adjacent to the new Enfield Marshalling Yards, located between Cosgrove Road and Roberts Road in South Strathfield. The site is approximately 13 km west-southwest of the Sydney Central Business District and the surrounding suburbs include Strathfield, Greenacre, Lakemba and Belfield.

Land use surrounding the site varies and includes:

- Railway operations including the railway lines to the west, the DELEC facilities along the north-eastern boundary and the National Rail Corporation terminal at Chullora.
- Industrial land uses surround the majority of the site and include transport related companies on Cosgrove Road and between the site and Roberts Road to the west.
- Commercial/industrial strip development exists along Punchbowl Road to the south of the site.
- Residential areas exist to the south east of the site on Cosgrove Road, to the north west of the site along Roberts Road opposite the existing rail lines and a small residential area to the south west of the site.
- Other land uses include Strathfield Golf Course and Rookwood Cemetery to the north.
- Public open space exits adjacent to the Cooks River to the east of the site and scattered parks and ovals occur in the adjacent suburbs.
- Schools, hospitals, nursing homes and other sensitive receivers: these include: (1) In the north, residences and a school, parks, churches, golf course, and Garden Centre; (2) In the east, residences, churches, schools, and Cooks River reserve; (3) In the south, residences and parks and an Islamic Centre; and (4), In the west, residences, parks and a marketplace.

The nearest residents to the site are located on Cosgrove Road, approximately 50 m from the site to the south of Stockpile 5 and along the western side of Roberts Road to the west of the site. Light industrial areas are located to the north of the residents along Cosgrove Road, and along the eastern side of Roberts Road to the west of the site.

The site is approximately 30 m above sea level with the height of the terrain gradually increasing towards the west.

5.3 Climatology and Dispersion Meteorology

5.3.1 Overview

The impact that dust emissions from the construction earthworks and operation of the ILC will have on the surrounding area is dependent on the climate and dispersion meteorology. The climatology and dispersion meteorology of the Sydney Basin is largely driven by synoptic conditions, with the presence of sea breezes and drainage flows being important local features.

The Bureau of Meteorology has operated a meteorological station at Bankstown Airport (33^o55'05" S and 150^o59'11" E) for more than 30 years (commenced acquiring data in 1968), and this station is approximately 8 km south-west of the Enfield site. The meteorological records from Bankstown Airport have been used to describe the likely average temperature, relative humidity, rainfall and wind conditions at the Enfield site. Refer to **Appendix B** for a graphical summary of the long-term climate data.

5.3.2 Temperature

The 9am temperatures range between 9.3°C in July to 22°C in January. The 3pm mean temperature range is between 16.4°C in July and 26.7°C in January. The warmest month of the year is January, which experiences a mean daily maximum temperature of 27.9°C and a mean daily minimum temperature of 18.0^oC. July is the coolest month experiencing mean daily maximum and minimum temperatures of 17.1°C and 5.1^oC respectively. The average number of days the minimum temperature is less than 0^oC in July is 0.7 days.

5.3.3 Rainfall

The rainfall data shows the warmer months of the year (January, February and March) receive the greatest amount of rainfall. March is the wettest month of the year, receiving mean monthly rainfall of 108.5 mm. The driest month in terms of average rainfall received is September receiving 46 mm. The mean annual rainfall is 900 mm occurring over an average of 115 rain days throughout the year.

5.3.4 Humidity

The 9am and 3pm relative humidity vary throughout the year, with the 3pm relative humidity readings being lower than the 9am readings. The 9am relative humidity has an average annual range of approximately 19% with a minimum of 62% in October and a maximum of 81% in June. A maximum 3pm relative humidity of 57% is achieved in February and a minimum relative humidity of 44% occurs in August.

5.3.5 Wind Speed and Direction

The 9am wind roses for Bankstown Airport are displayed in **Appendix B.4**, where it is evident there is a predominance of light southwest to north-westerly winds during the cooler months. Winds from this sector are most dominant in August and September where 52% of winds are from the southwest, west and northwest. Westerly winds are most predominant in August and September occurring 21% of the time. During October the prevalence of winds from the southwest to northwestern sector has decreased and winds from the south, south-east and north have increased. This trend continues throughout the warmer months with southerly and southeasterly winds being most predominant in November, December, January and February, each occurring approximately 12% of the time.

The 3pm wind roses for Bankstown Airport are displayed in **Appendix B.5** where it is evident that strong to moderate winds from the northeast, east and southeast are dominant during the warmer months. Approximately 80% of winds are from this sector in December, January and February. The greater frequency of winds from the southeastern sector during the warmer months is due to the presence of a sea breeze. A sea breeze is a regular daytime onshore wind that results from the horizontal difference in surface temperature between the land and the sea. This temperature gradient is greatest during the warmer months resulting in sea breezes being most common in summer. By May the dominance of winds from this sector has subsided and winds from the west, southwest and northwest have increased. During June, winds from the south are most predominant occurring 17% of the time. During July and August, westerly winds are the most frequent, occurring approximately 20% of the time.

5.4 Meteorological Conditions and Data for The Site

5.4.1 Overview

The records of meteorological data obtained from Bankstown Airport (as described in **Section 5.3**) do not provide sufficient details for use in air dispersion modelling, as this data represents long-term (30 years) of average meteorological conditions. For air dispersion modelling, at least twelve months of hourly site representative meteorological data (which is usually an average of smaller 10-minute or 15-minute averages) must be used.

The meteorological data used in the dispersion modelling was 1999 Lidcombe data, sourced from the NSW EPA. Lidcombe is located approximately 4 km northwest of the proposed ILC site. A description of the wind speed, wind direction, mixing height and atmospheric stability class data used in the dispersion modelling is provided in the following sections.

5.4.2 Wind Speed and Wind Direction

The 9am wind roses for Lidcombe are displayed in **Figure 5-1**, where it is evident, on comparison with the wind roses in **Appendix B.4** that the 9am wind conditions at Bankstown and Lidcombe are very similar. During autumn and winter there is a predominance of light to moderate south-west to north-westerly winds with westerly winds being most predominant in winter occurring approximately 30% of the time. In autumn westerly winds are present 22% of the time. During spring the westerly winds are still dominant (occurring 19% of the time) but there is an increase in winds from the south-south-east (occurring 11% of the time). By summer the occurrence of westerly and south-south-easterly winds are approximately equal (11% of the time).

The 3pm wind roses for Lidcombe are displayed in **Figure 5-2** where it is evident, on comparison with the wind roses in **Appendix B.5** that the 3pm wind conditions at Bankstown and Lidcombe are very similar. During spring and summer, winds are predominantly from the east and southeast with easterly winds present 27% of the time in spring and 37% of the time in summer. By autumn, the easterly and southeasterly winds are still dominant, however there is an increase in winds from the south-south-east and west. During winter, moderate winds from the southwest to northwest are the most dominant.

The similarity of Bankstown and Lidcombe wind data suggests that similar conditions would be experienced at Enfield, which is located between Bankstown and Enfield. As such the Lidcombe data is considered suitable for the assessment of air quality impacts at Enfield using air dispersion modelling techniques.

5.4.3 Mixed Layer Height

The mixing layer height is the height above ground through which ground-based emissions will eventually be dispersed once the plume becomes thoroughly mixed. In general, the mixed layer height will increase during the day as the sun causes convection to deepen the turbulent layer near the ground. The depth of the mixed layer will also increase as wind speeds increase due to the generation of turbulence produced by flow over the rough ground surface.

Thus mixed layer depth is heavily influenced by wind speeds and surface roughness, and is an important consideration for determining the dispersion of ground based pollutants such as dust into the atmosphere. The mixing height in meteorological data files is calculated from surface observations.

In the Lidcombe meteorological data, the greatest mixing heights (>2,000 m) are most frequent between the hours of 1pm and 4pm. The smallest mixing heights, between 0 and 200 m, are most frequent between 1am and 8am, and 5pm and 12am.

5.4.4 Atmospheric Stability Class

Atmospheric stability class is used to categorise the rate at which a plume will disperse. The Pasquill-Gifford stability class assignment scheme uses six stability classes from A through to F. Class A refers to unstable conditions where pollutants spread rapidly throughout the mixed layer and class F refers to stable conditions where plume spreading is slow.

In the Lidcombe meteorological data, the stability of the atmosphere is largely unstable (stability class A) during the daytime and slightly stable (stability class E) to stable (stability class F) during the night. Stability class F occurs 26% of the time, stability class A occurs 22.5% of the time and stability class E occurs 17% of the time. Stability class C (slightly unstable) is the least frequent and only occurs 7.4% of the time.

In regard to this project, an atmosphere that is highly unstable during daytime conditions would provide good mixing of air parcels from the surface into higher levels of the atmosphere. Thus dust emissions from construction activities and emissions during operation would be expected to disperse rapidly, and spread into higher layers of the atmosphere.

In the opposite sense, stable conditions are expected to occur 26% of the time (stability class F), and during these conditions mixing is low. Thus emissions from operation of the Terminal would at times be expected to spread as a low plume (often referred to as a “blanket” under very still conditions), with the worst case being an entrapment of pollutants under a temperature inversion (increase of temperature with elevation).

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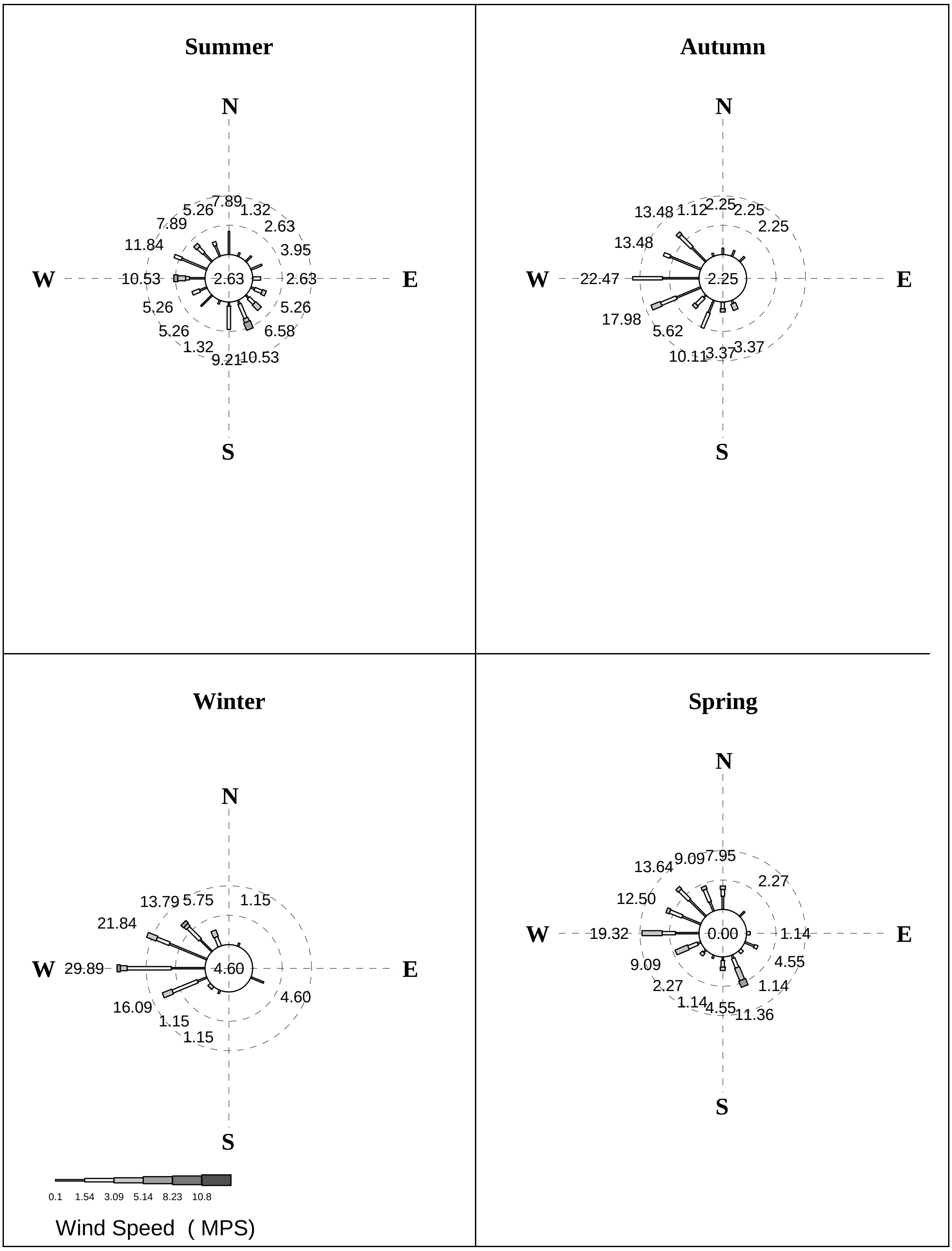
■ **Figure 5-1 Lidcombe Wind Roses – 9am**



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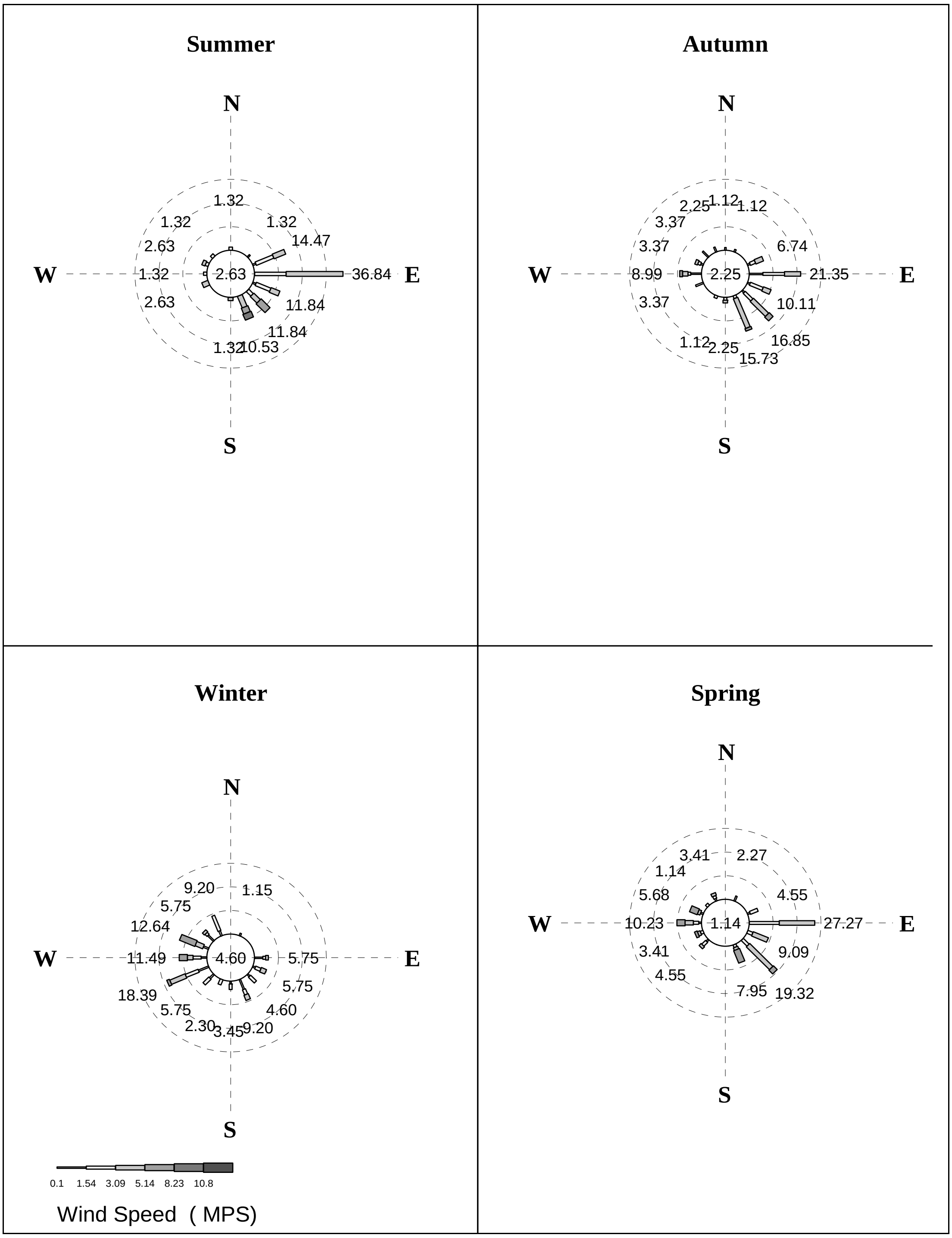
- **Figure 5-2 Lidcombe Wind Roses – 3pm**



5.5 Existing Ambient Air Quality

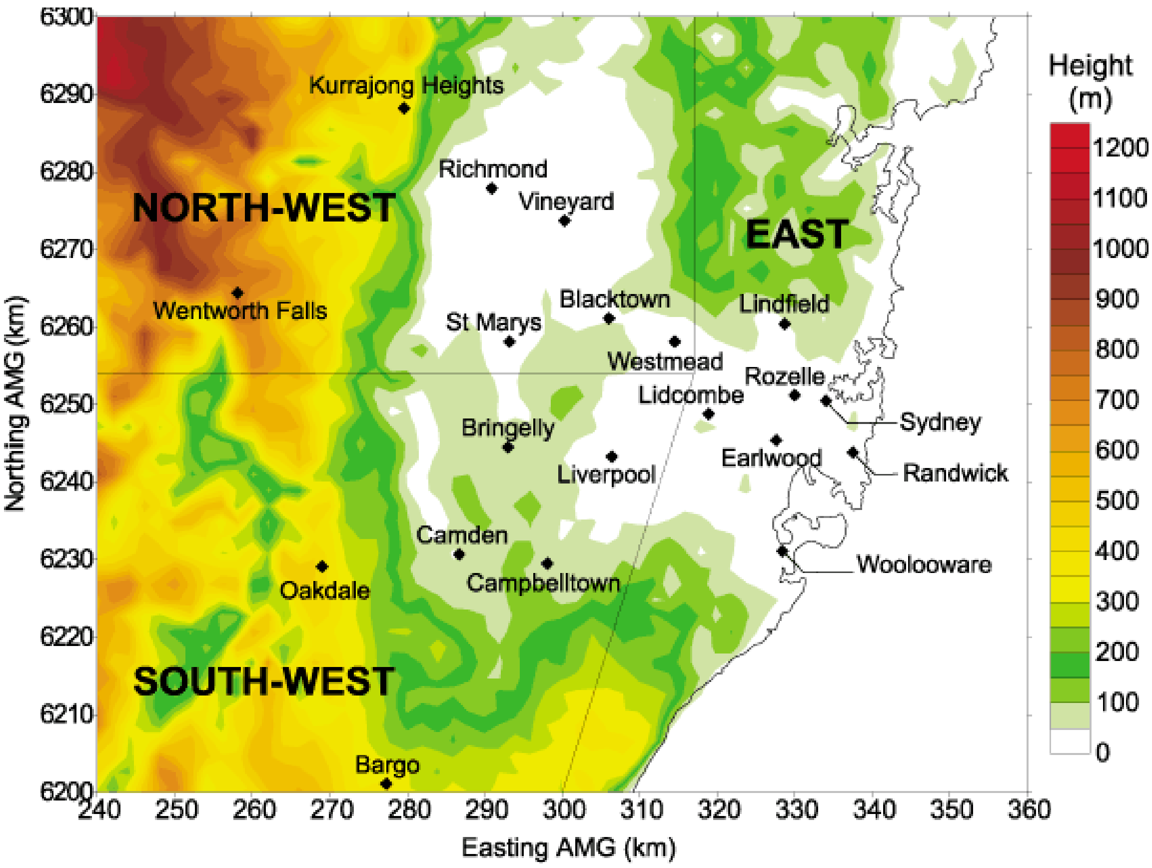
5.5.1 Overview

This section of the report provides a discussion of Enfield's air quality using data collected from nearby NSW EPA monitoring sites. Data from Earlwood and Lidcombe monitoring stations is analysed and compared with the relevant air quality criteria as outlined in **Section 4**. The relevance of Lidcombe and Earlwood air quality data to Enfield is also discussed.

5.6 Sydney's Air Quality Monitoring Network

The NSW EPA conducts an air quality monitoring program which collects accurate real time measurements of the ambient level of pollutants at over 30 sites within the air quality monitoring network, located in the greater metropolitan area of Sydney, the Illawarra, Lower Hunter and selected rural sites around NSW. The location of the stations in the Sydney Region is shown in **Figure 5-3**.

- **Figure 5-3 Air Quality Monitoring Stations in the Sydney Region (NSW EPA)**



The monitoring stations located nearest to the site of the proposed Enfield ILC are Lidcombe and Earlwood. Lidcombe is located approximately 4 km north-west of the site of the proposed Enfield

ILC and Earlwood is approximately 6 km east south-east of the site. The data relevant to the development of Enfield ILC, which is collected at these stations, is summarised in **Table 5-1**.

- **Table 5-1 Data Collected at Earlwood and Lidcombe Monitoring Stations**

Monitoring Site	Ozone	NOx, NO, NO2	PM10 (24-hour average)*	TEOM PM10 (1-hour average)**
Earlwood – Beamen Park	✓	✓	✓	✓
Lidcombe – EPA Laboratories	✓	✓	X	✓

*High Volume Air Sampler, 6-day cycle gravimetric analysis

**TEOM = continuous particle measurement by Tapered Element Oscillating Microbalance

5.7 Air Quality Monitoring Results

5.7.1 Overview

Air quality monitoring data from 1996 to 2003 at Earlwood and 1996 to 2002 at Lidcombe and has been used to describe the existing air quality in Enfield. The Lidcombe monitoring station stopped operating in May 2002, and NSW EPA data beyond 2003 was not available. Monthly average and monthly maximum NO_2 and 24-hour PM_{10} concentration data, as well as monthly maximum 1-hour average ozone data from these sites during 1996–2003 were graphed and compared with the relevant criteria.

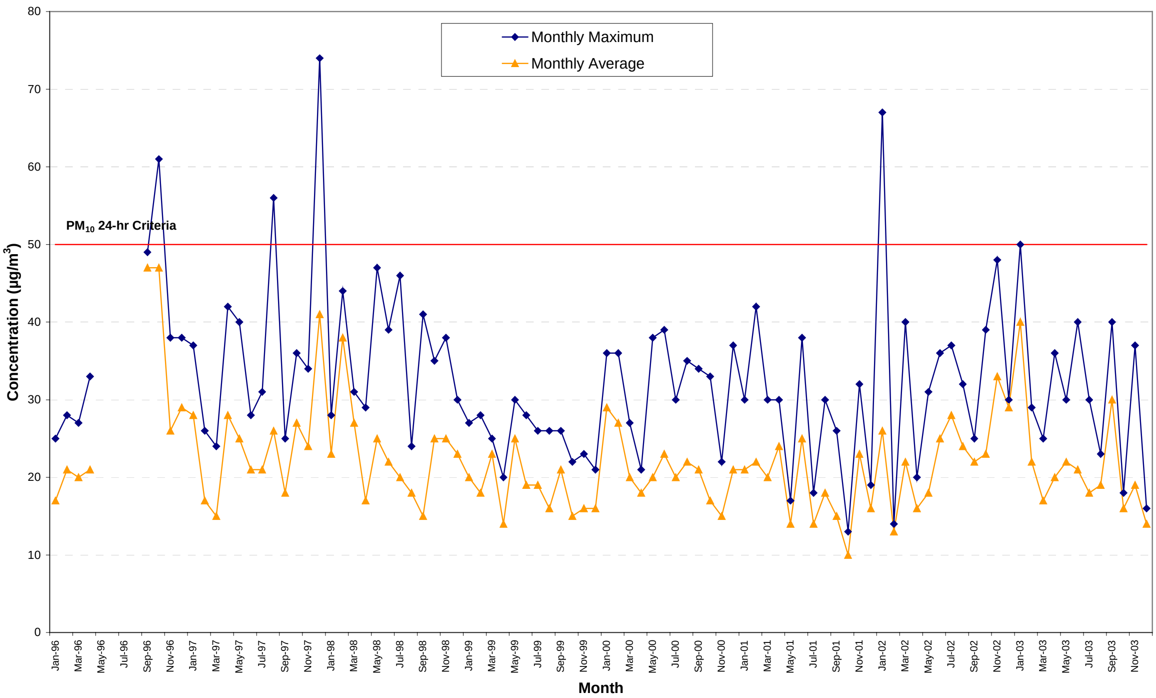
The monthly average of the maximum 1-hour Tapered Element Oscillating Microbalance (TEOM) PM_{10} data is reported for both Earlwood and Lidcombe monitoring stations. As the PM_{10} standards are for a 24-hour average an analysis of this data is not provided as no comparison can be made with the relevant criterion.

PM_{10} data recorded using a 24-hour averaging period were not available at the Lidcombe site. Particle data are therefore only presented and analysed for Earlwood, from High Volume Air Sampler (HVAS) data using 24-hour averaged PM_{10} data.

5.7.2 Background PM_{10} Levels

The monthly maximum and average 24-hour PM_{10} concentration recorded at Earlwood during 1996–2003 is displayed in **Figure 5-4**. The data for each individual year in this period is shown below in **Table 5-2**. As can be seen in **Figure 5-4** that the 50 μg/m^3 criterion was exceeded in October 1996, August 1997, December 1997 and January 2002. The exceedence of the criterion in August 1997 is likely to be a result of the use of solid fuel heaters in the area during the cooler months. In December 1997 and January 2002, bushfires were most likely the cause of the exceedence.

- **Figure 5-4 Monthly Maximum and Average 24-hour PM_{10} Concentration at Earlwood (1996–2003)**



- **Table 5-2 PM_{10} (24-hour) concentrations at Earlwood (1996-2000)**

Year	Average of Monthly Maximum (µg/m³)	Average of Monthly Average (µg/m³)
1996	37.4	28.5
1997	37.8	24.3
1998	36.0	23.2
1999	25.2	18.5
2000	32.3	21.1
2001	27.1	18.5
2002	34.9	23.3
2003	31.2	21.5
Average	32.7	22.3

5.7.3 Dust Deposition

The NSW EPA criterion for dust deposition in residential areas is 4 g/m^2/month. An estimate of the existing background dust level in the Enfield area is 2 g/m^2/month, a conservative estimate based on typical dust deposition data for NSW. This estimate allows, for the Enfield site, an increment over existing levels of 2 g/m^2/month.

5.7.4 Background NO_2 and O_3 Levels

Databases of hourly average (background) NO_2 and O_3 levels for Lidcombe (1999) were used in the AUSPLUME modelling to assist with determination of NO_2 impacts. As such, statistics for concentrations of NO_2 and O_3 are provided here to provide an appreciation of the background levels for these species.

The monthly maximum 1-hour average NO_2 concentrations for Earlwood and Lidcombe are provided in **Figure 5-5**. The 1-hour average NEPM criterion of 12 pphm is exceeded at Lidcombe in February 1998. The data for each individual year is also presented in **Table 5-3**.

- **Figure 5-5 Monthly 1-hour Maximum NO_2 Concentration at Earlwood and Lidcombe (1996–2003)**

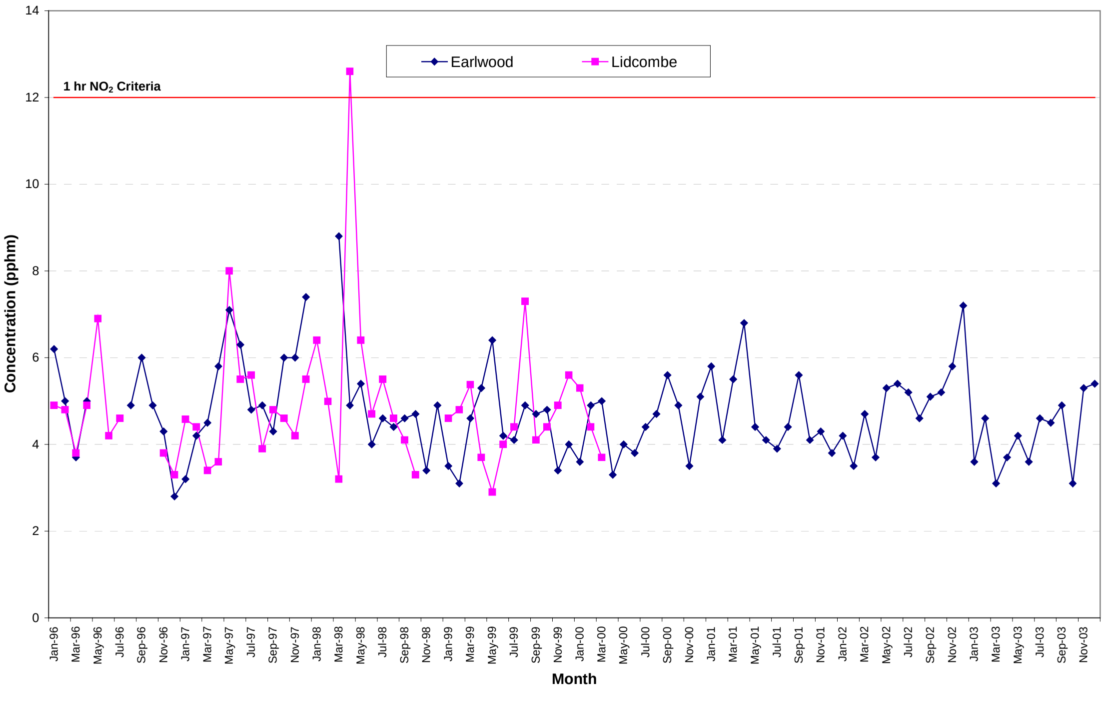


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Table 5-3 NO_2 (1-hour) concentrations at Earlwood & Lidcombe (1996-2003)

Year	Earlwood		Lidcombe	
	Average of Monthly Max (pphm)	Average of Monthly Average (pphm)	Average of Monthly Max (pphm)	Average of Monthly Average (pphm)
1996	4.8	2.4	4.6	2.5
1997	5.4	2.7	5.0	2.7
1998	5.0	2.7	5.4	2.7
1999	4.4	2.7	4.6	2.8
2000	4.4	2.6	4.9	2.6
2001	4.7	2.7	4.9	1.6
2002	5.0	1.4	3.7	1.3
2003	4.2	2.4		
Average (pphm)	4.7	2.4	4.7	2.3
Average ($\mu g/m^3$)*	96.5	49.3	96.5	47.2

*at 273 K and 101.3 kPa

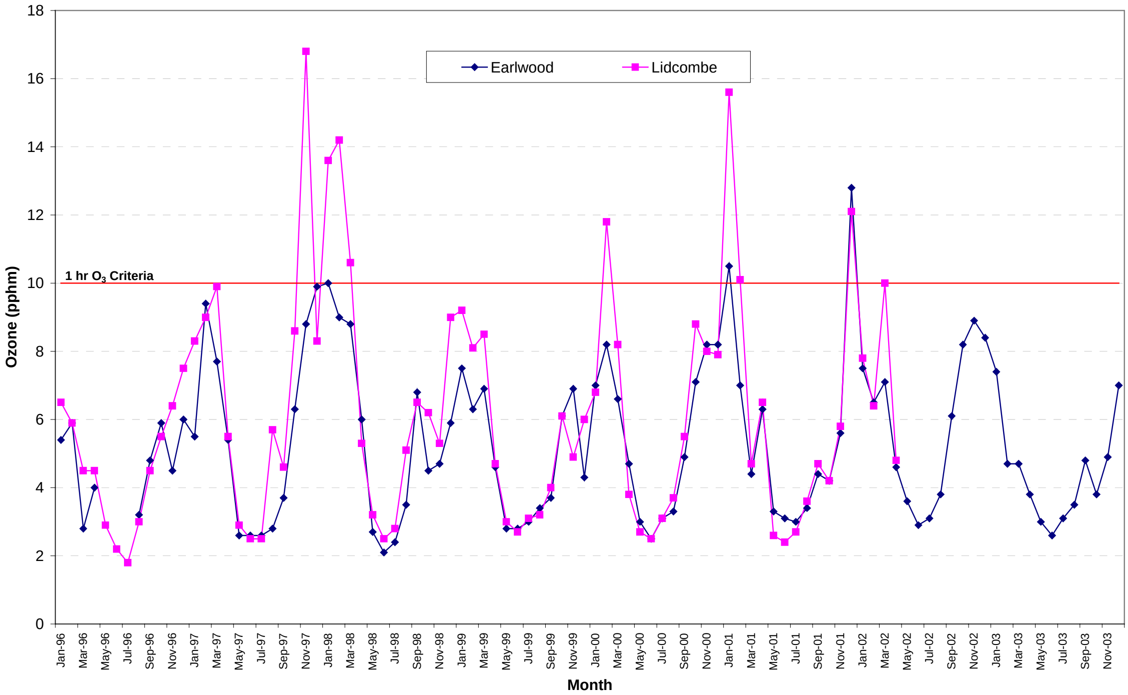
The monthly maximum 1-hour ozone (O_3) concentrations for Earlwood and Lidcombe, from 1996-2003, are provided in **Figure 5-6**. The figure shows the 1-hour criterion of 10 pphm is exceeded at both monitoring stations on several occasions during the period.

5.7.5 Relevance of Lidcombe and Earlwood Data to Enfield

The Earlwood and Lidcombe air quality monitoring stations are located within close proximity of the site (within 10 km). The surrounding topography and land uses in Enfield are similar to that at Earlwood and Lidcombe, and as such it can be concluded that the monitoring data presented above is representative of the ambient air quality at Enfield.

The most important features of the Earlwood and Lidcombe monitoring data in terms of the predicted ambient air quality at Enfield are the exceedences of NO_2 and O_3 criteria. The analysis presented above shows that the 1-hour ozone criterion was most often exceeded during the warmer months of the year. Typically elevated ozone levels in Sydney do occur in the warmer summer months when photochemical activity is most prevalent under strong sunlight.

■ **Figure 5-6 Maximum 1-hour Ozone Concentration (1996–2003)**



5.7.6 Project Specific Air Quality Objectives

The project-specific air quality objectives are equivalent to the NSW EPA (2001) criteria and NEPC (1998); that is, for a particular pollutant the background level plus the impact due to any site activities should not exceed the NSW EPA criterion for that pollutant (refer to **Table 4-1**).

For this study, detailed information on background pollutant levels was available, from the NSW EPA Lidcombe air quality monitoring station. Hourly averages for background PM_{10} and NO_x across the site were added to the model-predicted concentrations at each modelled sample point on the site, for that hour. Subsequently pollutant concentration statistics were determined from the totals for comparison with the NSW EPA criteria.

6. Construction Air Quality Assessment

6.1 Overview

This section of the report provides an assessment of air quality impacts from the construction of the proposed Enfield ILC. The section provides predicted air quality impacts from PM_{10}, TSP and dust deposition due to worst-case combinations of dust emissions from simultaneous construction activities.

6.2 Methodology of Air Quality Assessment

The methodology of the air quality assessment was a cumulative assessment approach. In the modelling all significant air pollution sources were accounted for, including an exposed area adjacent to the site (not part of the SPC proposal), and background pollutant levels.

The air quality impacts from the construction of the ILC have been assessed by predicting concentrations of particulate matter and dust deposition rates for two scenarios comprising the most intensive construction phases. Scenario 1 was developed from an estimate of the maximum level of activity planned at any time in Construction Stage 1, and similarly Scenario 2 was developed from a highest level of activity in Construction Stage 2.

‘Gridded’ and ‘discrete’ receptors have been precisely located over and around the site for comparisons of modelled air quality impacts with the relevant air quality criteria listed in **Table 4-1** and **Table 4-2**.

The assessment methodology involves incorporating emission rates for all dust sources associated with construction activities and site-representative meteorological data into the NSW EPA regulatory model AUSPLUME, a Gaussian plume dispersion model. AUSPLUME Version 6, used for this study, was developed by the Victorian EPA with assistance from CAMM[7] and Mt Isa Mines.

The annual datasets of hourly-average meteorological and background PM_{10} data used for the dispersion modelling, were constructed from NSW EPA Lidcombe station data for 1999. Small gaps in the original meteorological and background air quality monitoring datasets were filled by linear interpolation, and larger gaps (>4 hours) were filled with corresponding data from the Lidcombe 2000 datasets.

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[7] Consulting Air Pollution Modelling and Meteorology.

The processed meteorological data included hourly averages for temperature, wind speed and wind direction, mixing layer height and stability class. The annual datasets used for the modelling are expected to provide a full range of meteorological conditions for the area and background hourly PM_{10} levels.

6.3 Calculated Dust Emissions for Construction Stages

6.3.1 Overview

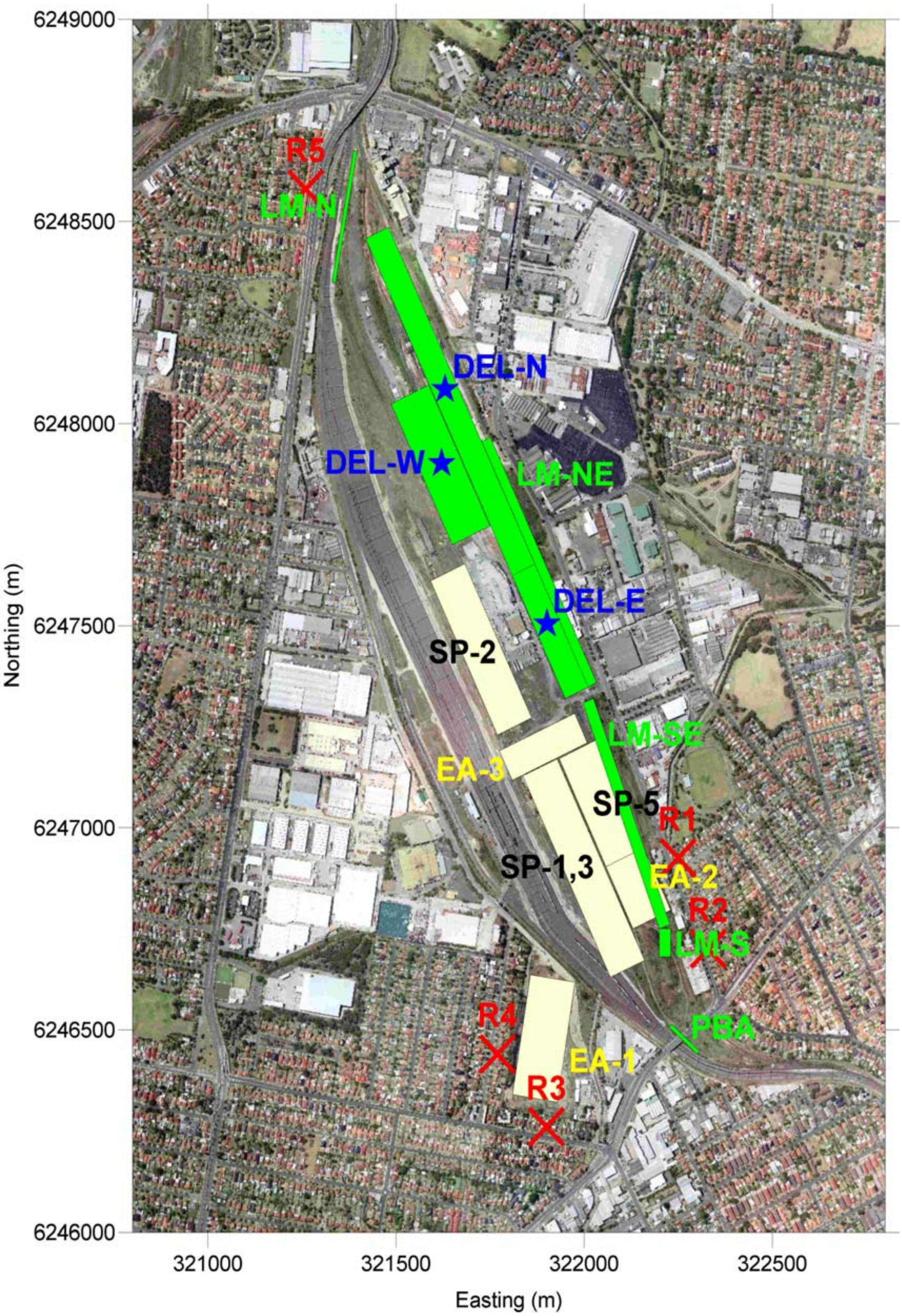
The calculated dust emissions are based on the construction activities and wind erosion expected to occur for specific mapped site areas, referred to as 'area sources'; refer to **Figure 6-1**. The figure shows main stockpile and earthworks areas (light yellow), landscaping mound areas and the DELEC site areas (green). The haul roads will be sealed so 100% control of wheel-generated dust is assumed. Five 'discrete receptors' were used to analyse off-site air quality impacts near residences and the locations of these are labelled 'R1' through to 'R5' (red).

The key data used to set up the modelled area sources are the air emission factors for mining and construction activities provided in Environment Australia (2001). In turn this reference is based in large part on the information provided in USEPA AP-42 (1998a). Using these emission factors, hourly particle emission rates were calculated for each area source, by adding the emission rates due to each construction activity and wind erosion. This was done for every hour of the meteorological dataset used as input for the modelling. The calculated hourly dust emission rates due to site works were 'switched on' only during working hours, whereas the hourly emissions due to wind erosion were 'on' for all hours.

Dust emissions increase as wind speed (u) increases, and there is evidence to suggest the dust emission rate increases proportionally to u^{α}, where α is in the range 2 to 3; for example, refer to the literature review in Lu (1999). The calculated hourly emission rates were thus modified to be proportional to u^3, with hourly average u obtained from the same meteorological file used for the modelling; i.e., NSW EPA data for Lidcombe, 1999.

The following two sections provide summaries of the calculated particle emission rates for input to the AUSPLUME model.

■ **Figure 6-1 Area Sources for Modelled Construction Scenarios**



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6.3.2 Dust Emissions for Construction Scenario 1 – Site Preparation

Summary descriptions of the area sources for Construction Scenario 1 and calculated emission rates are provided in **Table 6-1** (stockpiles and exposed areas), **Table 6-2** (primarily landscaping mounds). These emission rates are based on the activities for Construction Stage 1 being undertaken in 14 weeks, the total length of this stage.

TSP emission rates were also determined that used the corresponding TSP emission factor in each case, for each particle source. These were used for modelling the TSP and dust deposition impacts.

- **Table 6-1 Area Sources for Construction Scenario 1 - Stockpiles and Exposed Areas**

Area Source	Particle Sources	Mitigation Measures	PM_{10} Emission Rate
Stockpile 5	Working hours: Excavators loading to trucks, WGD[8]	No control specified for loaders, Level 2 watering	3.04×10^{-5} g/s/m^2
'SP5' on Fig.	All hours: Wind erosion	Combined wind break and water spray	1.94×10^{-6} g/s/m^2
Stockpile 1 & 3	Working hours: Excavators loading to trucks, WGD	No control specified for loaders, Level 2 watering	1.36×10^{-6} g/s/m^2
'SP1-3'	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2
Stockpile 2 'SP2'	Wind erosion only (all hours); no activities assumed	Dust control equivalent to 're-vegetation'	5.56×10^{-8} g/s/m^2
Exposed Area 1 Off-site in south 'EA1'	Wind erosion only (all hours); no activities assumed	Dust control equivalent to 're-vegetation'	5.56×10^{-8} g/s/m^2
Exposed Area 2 Construction area for detention pond	Working hours: Excavators loading to trucks and dozer, WGD	No specified controls for dozer and loaders, Level 2 watering	1.25×10^{-5} g/s/m^2
'EA2'	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2
Exposed Area 3 'EA3'	Wind erosion only (all hours); no activities assumed	Dust control equivalent to 'water spray'	2.78×10^{-6} g/s/m^2

It is noted the emissions from the off-site area 'EA-1' are not part of the SPC proposal, however have been accounted for in this 'cumulative' air quality assessment, including the air dispersion modelling.

[8] Wheel Generated Dust (WGD).

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Table 6-2 Area Sources Construction Scenario 1 - Landscaping and 'DELEC' Areas

Area Source	Particle Sources	Mitigation Measures	Area Emission Rate
Landscaping Mound North	Working hours: Dozer and truck dump, WGD	Water spray & Level 2 watering	6.52×10^{-5} g/s/m^2
'LM-N'	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2
Landscaping Mound South-East	Working hours: truck dump, WGD	Water spray & Level 2 watering	1.32×10^{-5} g/s/m^2
'LM-SE'	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2
Landscaping Mound South	Working hours: truck dump, WGD	Water spray & Level 2 watering	6.67×10^{-6} g/s/m^2
'LM-S'	All hours: Wind erosion	Combined wind break and water spray	1.94×10^{-6} g/s/m^2
Landscaping Mound North-East	Working hours: Dozer and truck dump, WGD	Water spray & Level 2 watering	3.93×10^{-5} g/s/m^2
'LM-NE'	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2
DELEC area South	Working hours: Dozer and truck dump, WGD	Water spray & Level 2 watering	1.05×10^{-5} g/s/m^2
'DEL-S'	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2
DELEC area North	No activities this stage	n/a	n/a
'DEL-N'	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2
DELEC area West	Working hours: loading to trucks, truck WGD	Water spray & Level 2 watering	3.65×10^{-6} g/s/m^2
'DEL-W'	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2
Punchbowl Rail Abutment	Dozer, excavator loading to trucks, WGD	Level 2 watering	2.48×10^{-4} g/s/m^2
'PBA'	All hours: Wind erosion	Combined wind break and water spray	1.94×10^{-6} g/s/m^2

6.3.3 Dust Emissions for Construction Scenario 2 - Earthworks & Drainage

The area sources for Construction Scenario 2 are provided in **Table 6-3** and **Table 6-4**, with the calculated emission rates based on the most intensive 24-week earthworks phase undertaken in Construction Stage 2. As for Construction Scenario 1, the emission rates provided are for PM_{10}. TSP emission rates were also determined that used the corresponding TSP emission factor in each case, for modelling the TSP and dust deposition impacts. The full set of calculations and results are provided separately in spreadsheet and AUSPLUME files.

Areas on which earthworks are completed from previous activities are assumed to be exposed areas in this scenario and therefore susceptible to wind erosion. In general, good dust control equivalent to water spray is assumed for these completed earthworks areas.

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Table 6-3 Area Sources for Construction Scenario 2 - Stockpiles and Exposed Areas

Area Source	Particle Sources	Mitigation Measures	PM_{10} Emission Rate
Stockpile 5	Working hours: nil, worked finished in Scenario 1	n/a	nil
'SP5'	All hours: Wind erosion	Natural wind break due derelict buildings	3.89×10^{-6} g/s/m^2
Stockpile 1 & 3	Working hours: 3x dozers, excavators loading to trucks, WGD	Level 2 watering	2.06×10^{-5} g/s/m^2
'SP1-3'	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2
Stockpile 2 'SP2'	Working hours: scrapers	'soil moist'	8.05×10^{-7} g/s/m^2
	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2
Exposed Area 1 Off-site in south 'EA1'	Working hours: nil	n/a	nil
	All hours: wind erosion	Dust control equivalent to 're-vegetation'	5.56×10^{-6} g/s/m^2
Exposed Area 2 Construction area for detention pond	Working hours: nil	n/a	nil
'EA2'	All hours: Wind erosion	Combined wind break and water spray	1.94×10^{-6} g/s/m^2
Exposed Area 3 'EA3'	Working hours: 3x dozers, excavators loading to trucks, WGD	Level 2 watering	5.13×10^{-5} g/s/m^2
	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2

Table 6-4 Area Sources Construction Scenario 2 - Landscaping and 'DELEC' Areas

Area Source	Particle Sources	Mitigation Measures	Area Emission Rate
LM-N	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2
LM-SE	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2
LM-S	All hours: Wind erosion	Combined wind break and water spray	1.94×10^{-6} g/s/m^2
LM-NE	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2
DEL-S	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2
DEL-N	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2
DELEC area West	Working hours: trucks dumping and WGD	Water spray & Level 2 watering	$1.6\ 10^{-5}$g/s/m^2
DEL-W	All hours: Wind erosion	Water spray	2.78×10^{-6} g/s/m^2

The new landscaping mounds remaining after Construction Stage 1 have been treated as wind breaks in the modelling, with relevant dust control factors obtained from Environment Australia (2001) applied to the relevant sources in Construction Scenario 2.

The works associated with the old rail bridge abutment underneath Punchbowl Road in the south were completed in Construction Stage 1, and modelled in the previous scenario (area source name 'PBA'). PBA is in a sensitive location due to its vicinity to residential areas in the southeast however it is assumed the dust emissions from this small area could be more easily managed in terms of a combination of covering, re-vegetation and watering. Therefore full dust control has been assumed for this exposed area in the latter modelling scenario.

6.4 Air Dispersion Modelling Results

6.4.1 Explanation of Modelling Scenarios

This section provides an explanation of the set of results provided as contour plots in the construction air quality assessment. Initial modelling trials included all dust mitigation measures such as use of water sprays on freshly-exposed areas, wind breaks where they existed, and water trucks applied to exposed areas used by construction vehicles. These initial trials indicated that even with the usual dust mitigation measures for a construction site, there would be significantly high levels of PM_{10}. Therefore additional trials were undertaken to determine what further management actions would be required for the modelling estimates of the PM_{10} impacts to fall to the level of the maximum 24-hourly average criterion.

In this respect, a first step was to restrict activities only to periods during which hourly average wind speed was less than 5 m/s. This was undertaken for both construction scenarios. However inspection of results showed significant exceedences of the air quality criterion for maximum 24-hourly average PM_{10}, off-site. Therefore, the additional restriction of a halt to construction operations was applied when the (incident) wind direction (for all speeds) was in the sector 210^{o} to 340^{o}. This sector was chosen primarily to reduce the PM_{10} impacts predicted for the residential areas near the southeast of the ILC site. The result of this second restriction reduces the air quality impacts to acceptable levels; i.e., there are unlikely to be more than 5 exceedences of the 50 $\mu g/m^3$ benchmark in the majority of off-site areas surrounding the ILC site.

Hence, the two sets of results from the trial-and-error approach are presented, namely dust mitigation by restricting activities when:

- Wind speed is greater than 5 m/s; and
- Wind direction is in the sector 210^o to 340^o.

With respect to construction stages 3 and 4, air quality impacts will be lower than those for stages 1 and 2, which as described above are considered acceptable. As such no dispersion modelling assessment for these stages is warranted. It is recommended, however, that the same general dust control measures described for Stages 1 and 2 be implemented for Stages 3 and 4. This does not, however, extend to the need for wind speed and directions restrictions during these later stages of construction.

6.4.2 AUSPLUME Results for Construction Scenario 1

A summary of the AUSPLUME results for Construction Scenario 1is provided in **Table 6-5** below. All these results include background levels of the various pollutants and as such direct comparisons may be made between the predicted impacts and corresponding ambient air quality criteria.

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Table 6-5 Summary of AUSPLUME Results for Construction Scenario 1

Link to Figure Caption	Discrete Receptor Result[9]	Air Quality Criterion for Off-Site Result[10]	Typical On-Site Result
Figure 6-2 Construction Scenario 1: Maximum 24-Hour Average PM_{10} Including Background, Criterion 50 µg/m^3: Wind Speed < 5 m/s	R1=110 R2=57 R3=38.5 R4=38.5 R5=52.9	50 µg/m^3	100 µg/m^3
Figure 6-3 Construction Scenario 1: Number of Exceedences of 24-Hour Average PM_{10} Criterion of 50 µg/m^3: Wind Speed < 5 m/s	R1=27 R2=3 R3=0 R4=0 R5=6	5	50
Figure 6-4 Construction Scenario 1: Maximum 24-Hour Average PM_{10} Including Background, Criterion 50 µg/m^3: Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340^o	R1=50.2 R2=47.2 R3=38.5 R4=38.5 R5=52.9	50 µg/m^3	100 µg/m^3
Figure 6-5 Construction Scenario 1: Exceedences of 24-Hour Average PM_{10} Criterion of 50 µg/m^3: Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340^o	R1=1 R2=0 R3=0 R4=0 R5=6	5	50
Figure 6-6 Construction Scenario 1: Annual Average PM_{10} Including Background, Criterion 30 µg/m^3: Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340^o	R1=20.7 R2=18.3 R3=16.3 R4=16.4 R5=21.7	30 µg/m^3	30 µg/m^3
Figure 6-7 Construction Scenario 1: Annual Average TSP Including Background, Criterion 90 µg/m^3: Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340^o	R1=40.2 R2=35.0 R3=30.6 R4=31.2 R5=49.3	90 µg/m^3	70 µg/m^3

[9] Off-site impacts are determined from model results for discrete receptors labelled 'R1'-'R5'; for discrete receptor locations refer to **Figure 6-1**.

[10] Model results include background levels.

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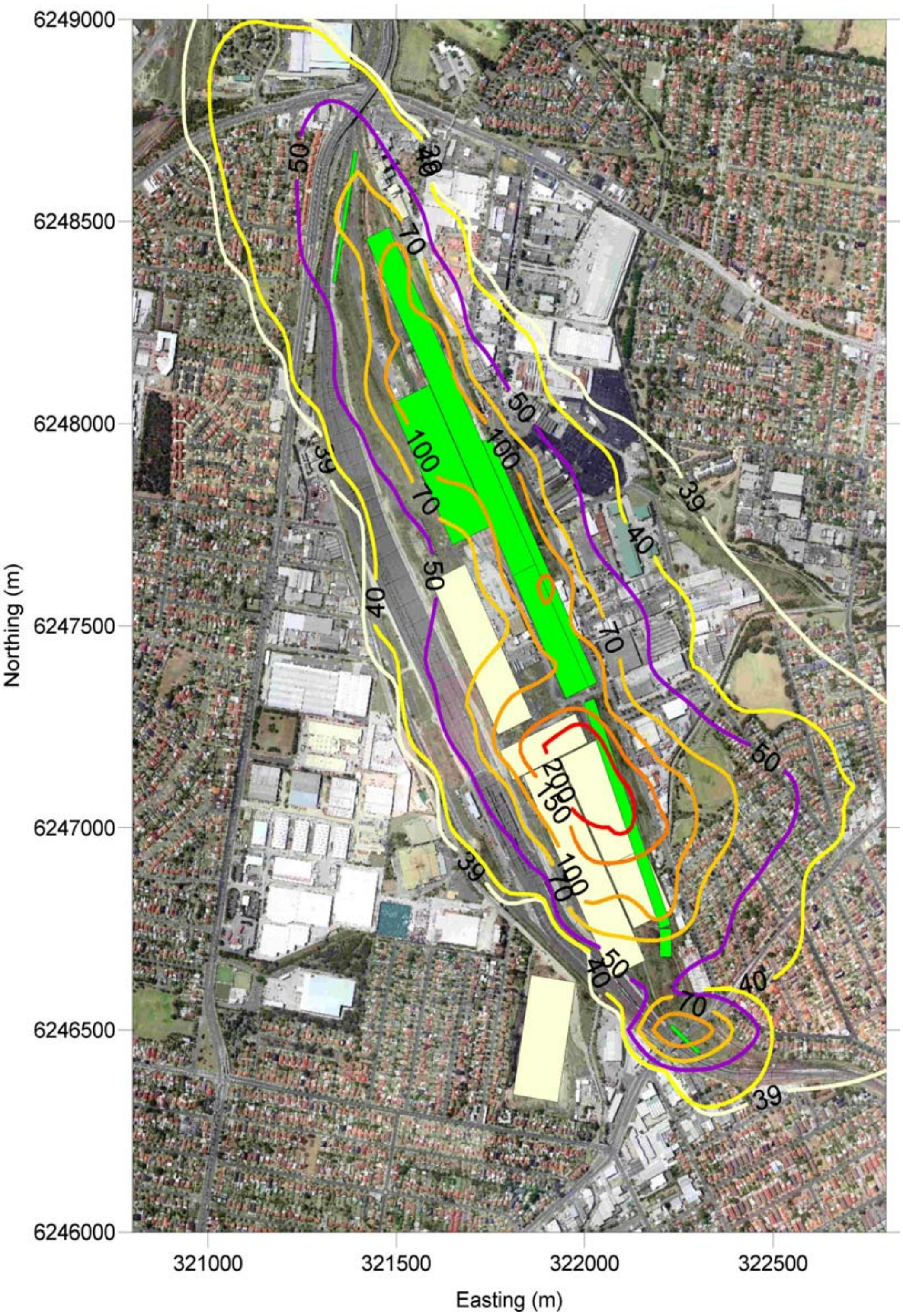
- **Figure 6-2 Construction Scenario 1: Maximum 24-Hour Average PM_{10} Including Background, Criterion 50 $\mu g/m^3$: Wind Speed < 5 m/s**



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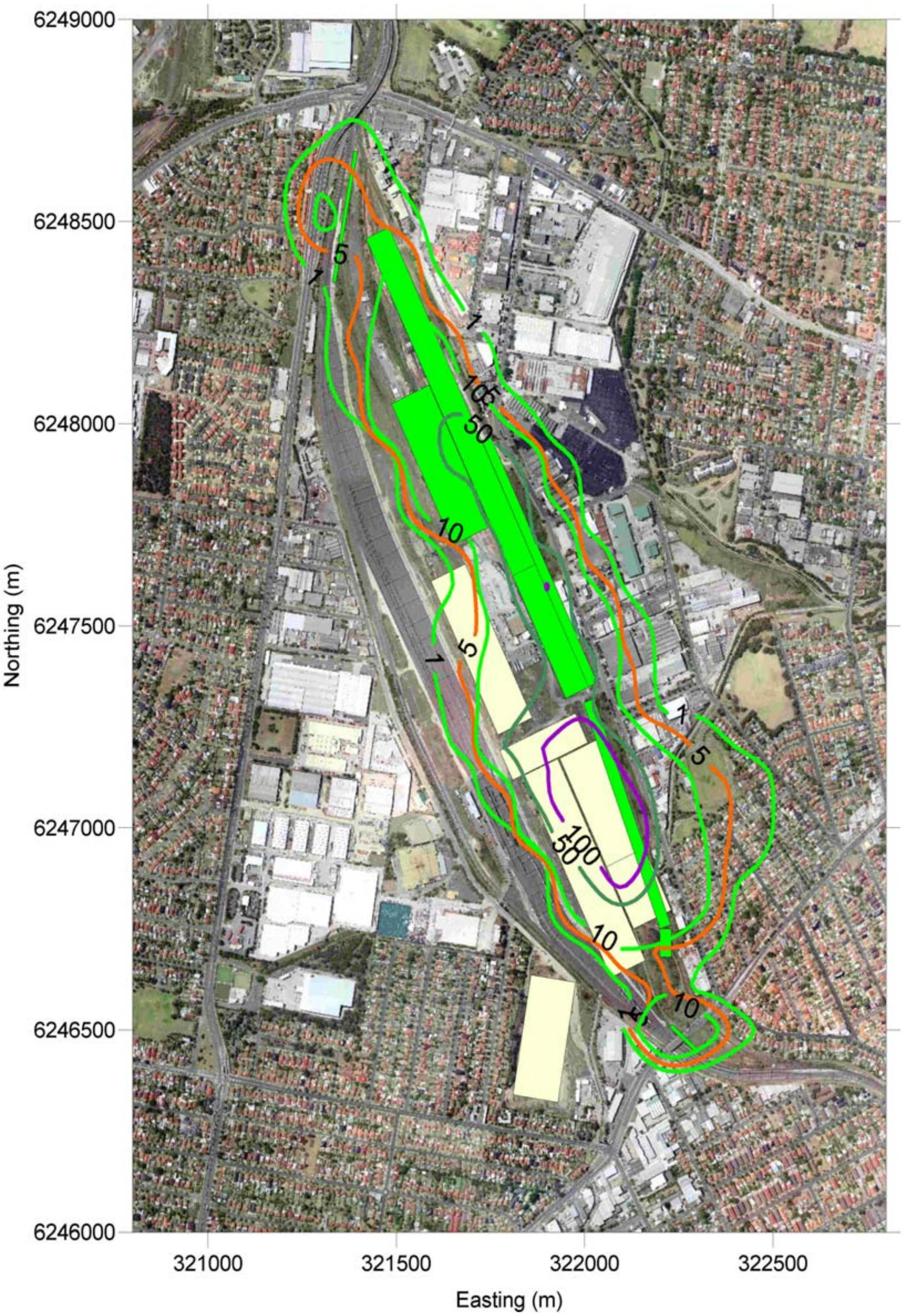
- **Figure 6-3 Construction Scenario 1: Number of Exceedences of 24-Hour Average PM_{10} Criterion of 50 $\mu g/m^3$: Wind Speed < 5 m/s**



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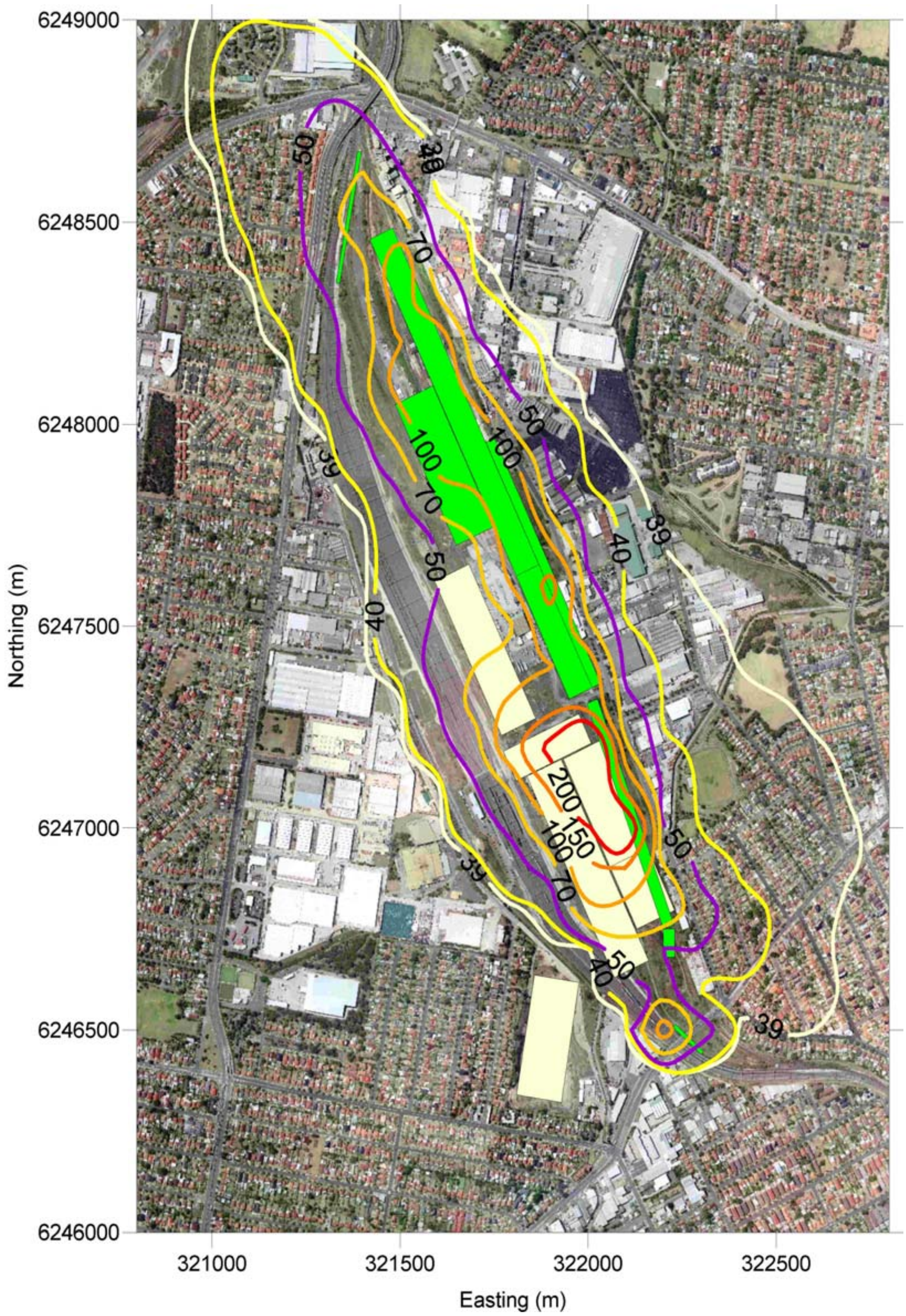
- **Figure 6-4 Construction Scenario 1: Maximum 24-Hour Average PM_{10} Including Background, Criterion 50 $\mu g/m^3$: Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340^o**



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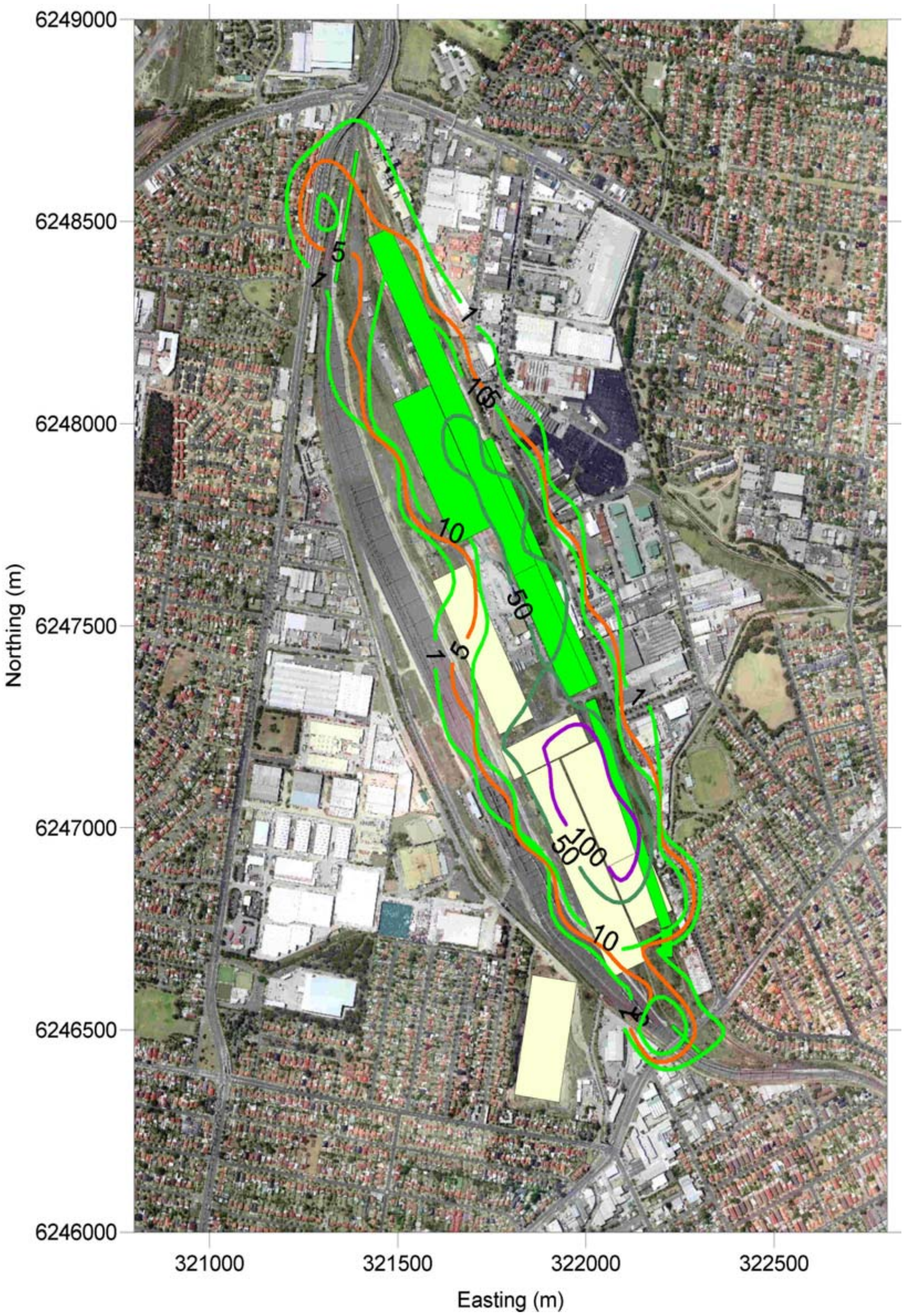
- **Figure 6-5 Construction Scenario 1: Exceedences of 24-Hour Average PM_{10} Criterion of 50 $\mu g/m^3$: Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340^o**



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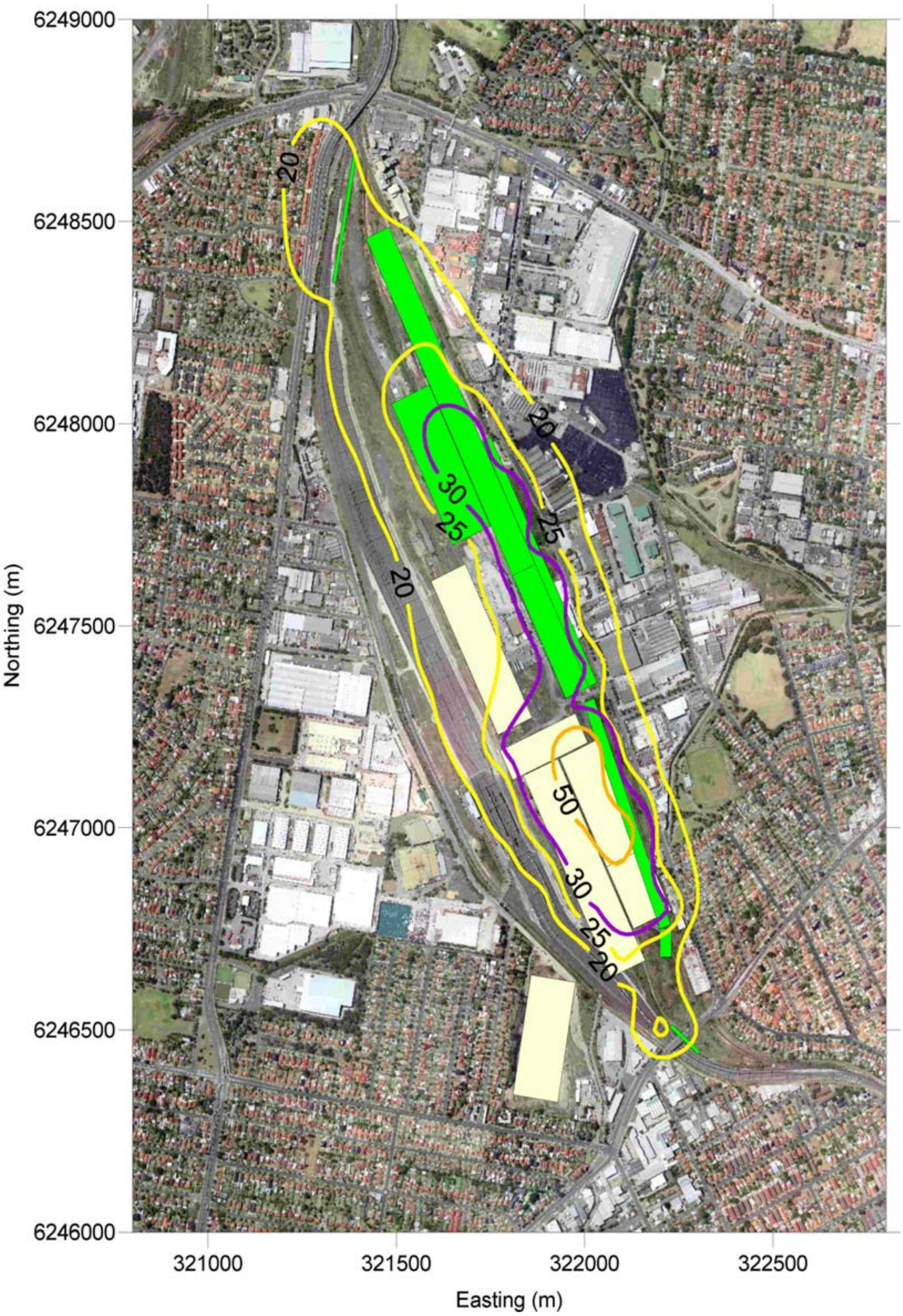
- **Figure 6-6 Construction Scenario 1: Annual Average PM_{10} Including Background, Criterion 30 $\mu g/m^3$: Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340^o**



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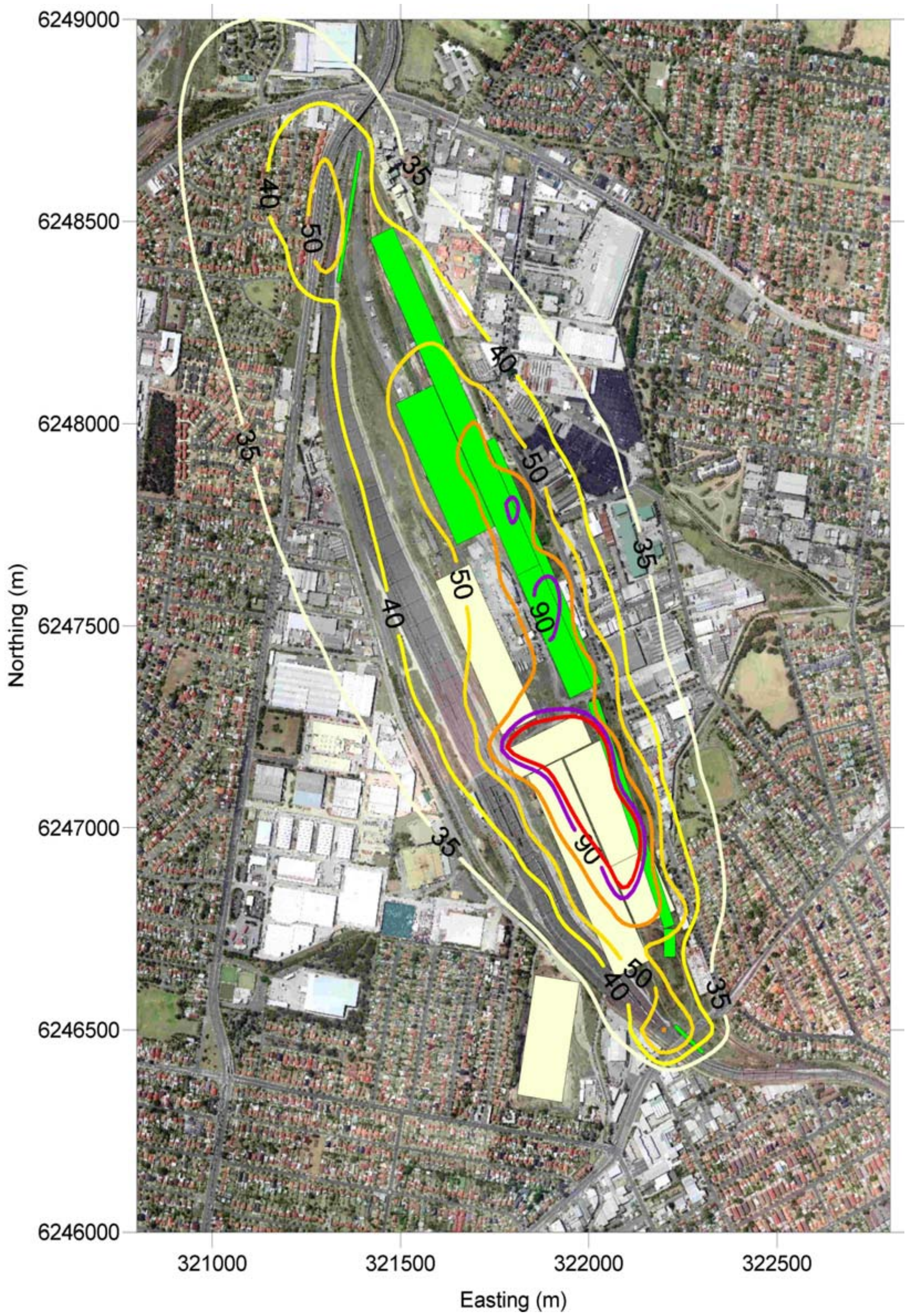
- **Figure 6-7 Construction Scenario 1: Annual Average TSP Including Background, Criterion 90 μg/m^3: Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340^o**



6.4.3 AUSPLUME Results for Construction Scenario 2

A summary of the AUSPLUME results for Construction Scenario 2 is provided in **Table 6-6**. All results include the effects of background levels of the various pollutants. The details of the modelling runs are provided in the links to the figure captions.

- **Table 6-6 Summary of AUSPLUME Results for Construction Scenario 2**

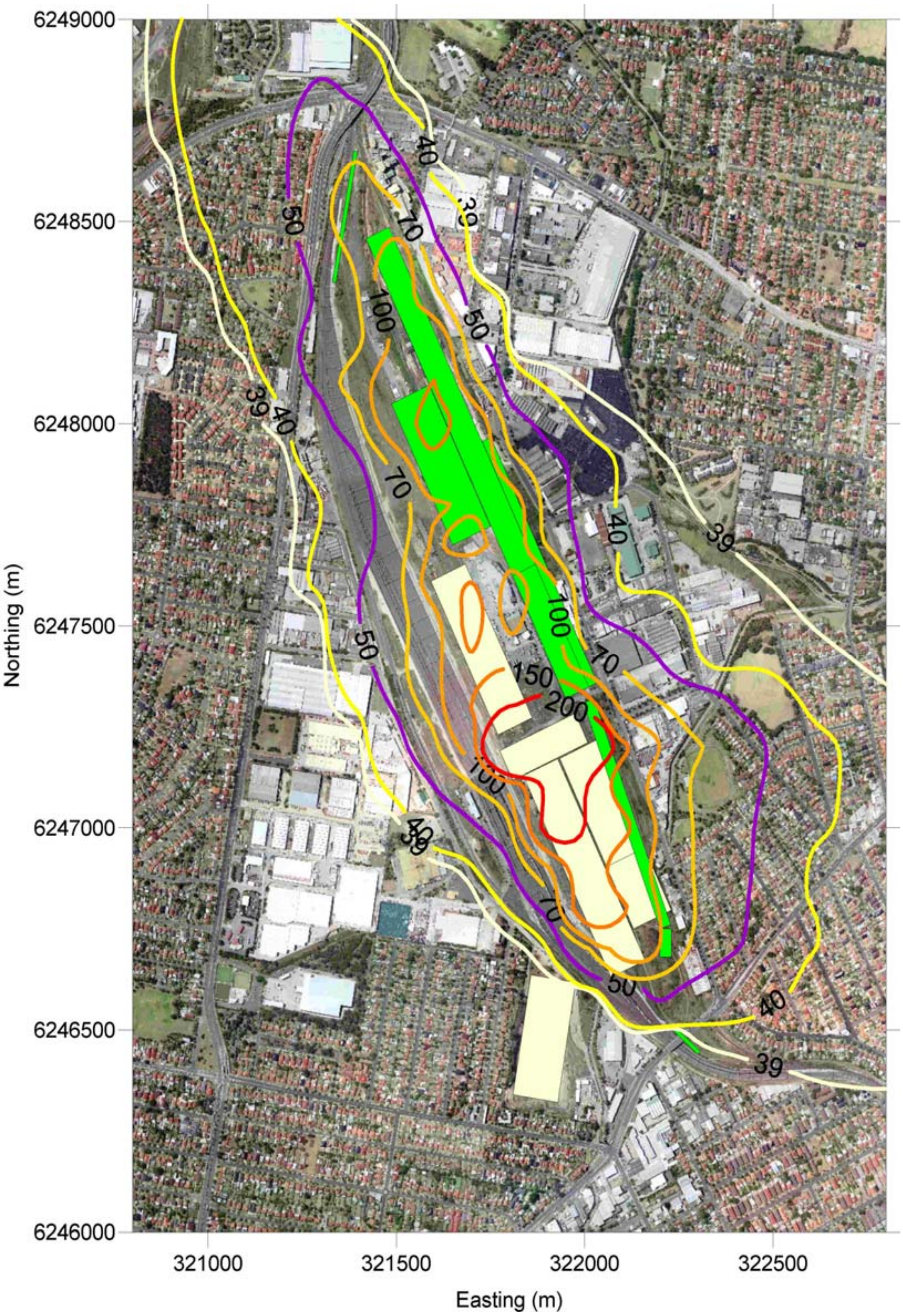
Link to Figure Caption	Discrete Receptor Result[11]	Air Quality Criterion for Off-Site Result[12]	Typical On-Site Result
Figure 6-8 Construction Scenario 2: Maximum 24-Hour Average PM10 Including Background (µg/m3), Criterion 50 µg/m3: Wind Speed < 5 m/s	R1=77.6 R2=56.5 R3=38.5 R4=38.5 R5=56.5	50 µg/m^3	100 µg/m^3
Figure 6-9 Construction Scenario 2: Exceedences of 24-Hour Average PM10 Criterion of 50 µg/m3: Wind Speed < 5 m/s	R1=17 R2=3 R3=0 R4=0 R5=2	5	50
Figure 6-10 Construction Scenario 2: Maximum 24-Hour Average PM10 Including Background (µg/m3), Criterion 50 µg/m3: Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340o	R1=62.6 R2=47.0 R3=38.5 R4=38.5 R5=56.5	50 µg/m^3	100 µg/m^3
Figure 6-11 Construction Scenario 2: Exceedences of 24-Hour Average PM10 Criterion of 50 µg/m3: Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340o	R1=7 R2=0 R3=0 R4=0 R5=2	5	50
Figure 6-12 Construction Scenario 2: Annual Average PM10 Including Background, Criterion 30 µg/m3: Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340o	R1=20.6 R2=17.9 R3=16.2 R4=16.4 R5=19.3	30 µg/m^3	30 µg/m^3

[11] Off-site impacts are determined from model results for discrete receptors labelled 'R1'-'R5'; for discrete receptor locations refer to **Figure 6-1**.

[12] Model results include background levels.

Link to Figure Caption	Discrete Receptor Result[11]	Air Quality Criterion for Off-Site Result[12]	Typical On-Site Result
Figure 6-13 Construction Scenario 2: Annual Average TSP Including Background (µg/m3), Criterion 90 µg/m3, Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340o	R1=38.1 R2=32.9 R3=30.3 R4=31.0 R5=37.4	90 µg/m^3	70 µg/m^3

- **Figure 6-8 Construction Scenario 2: Maximum 24-Hour Average PM_{10} Including Background ($\mu g/m^3$), Criterion 50 $\mu g/m^3$: Wind Speed < 5 m/s**



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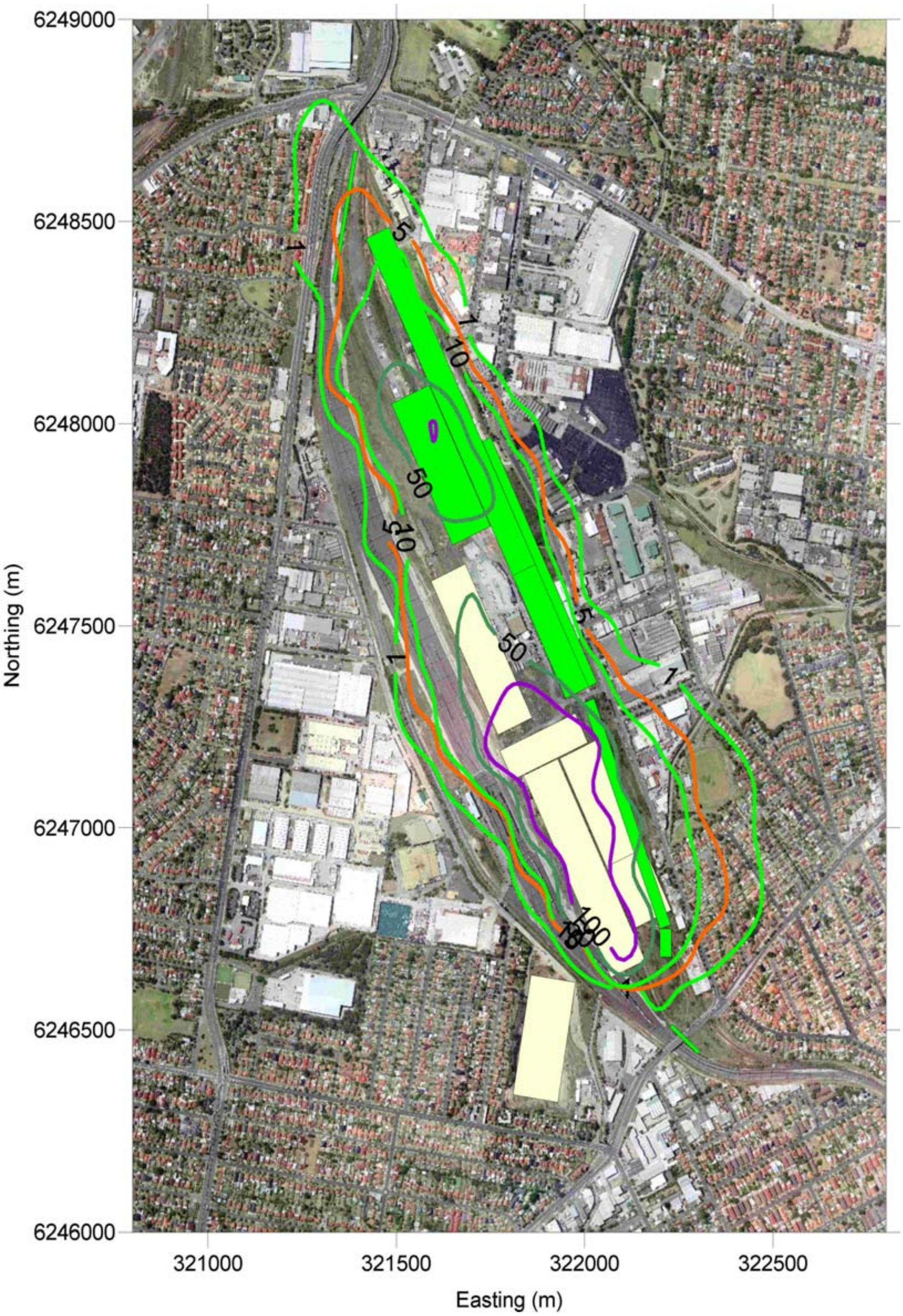
- **Figure 6-9 Construction Scenario 2: Exceedences of 24-Hour Average PM_{10} Criterion of 50 $\mu g/m^3$: Wind Speed < 5 m/s**



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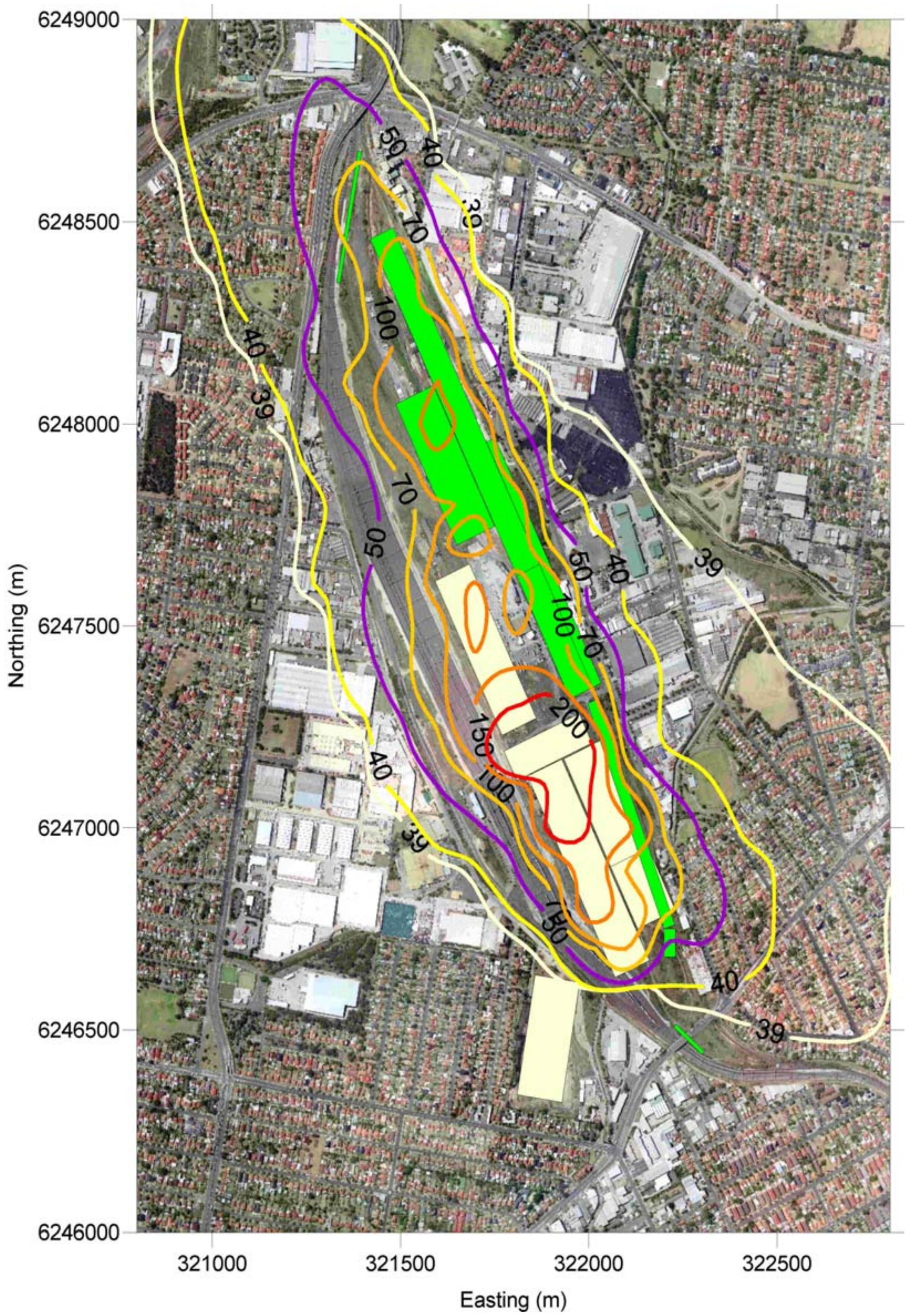
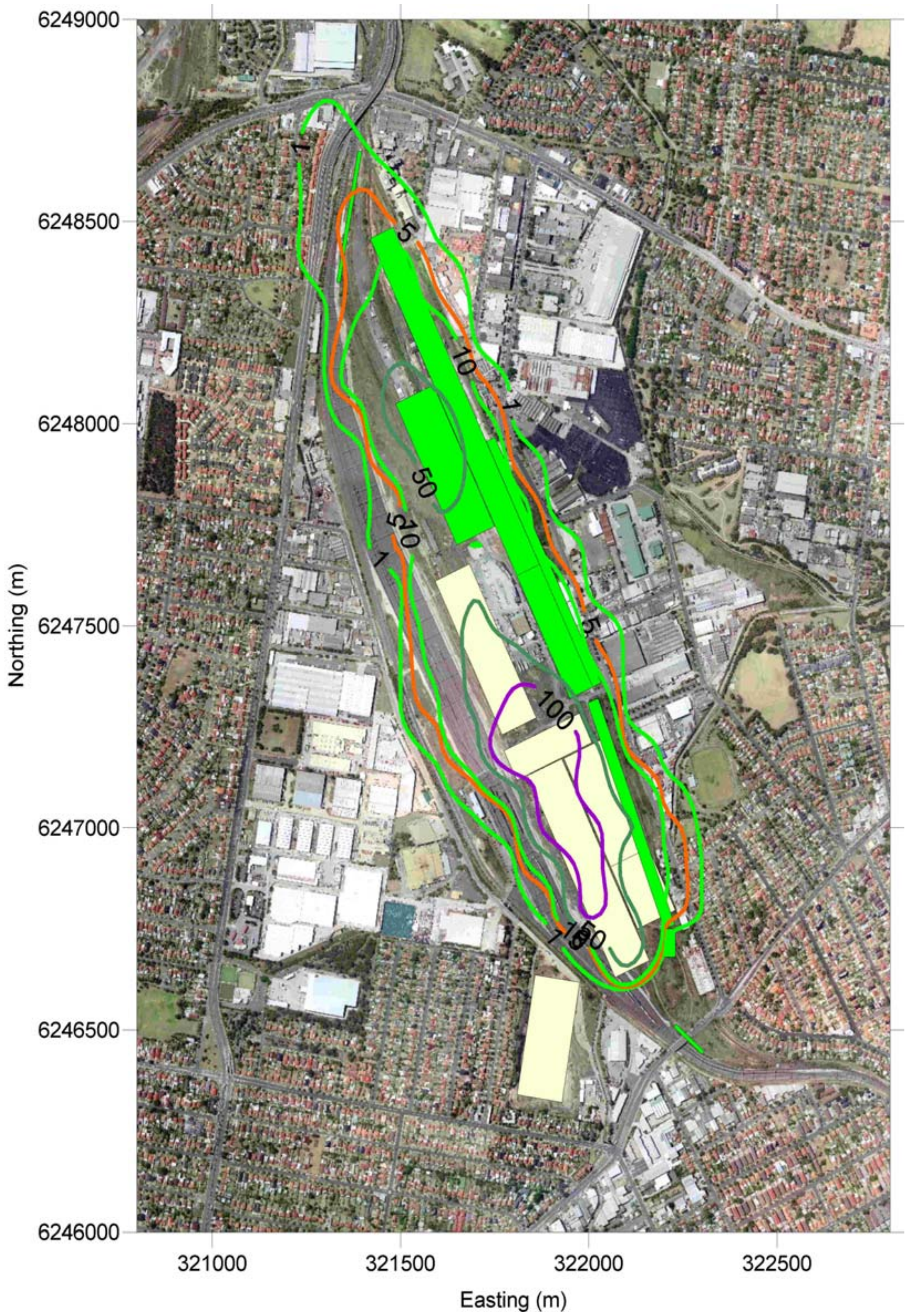
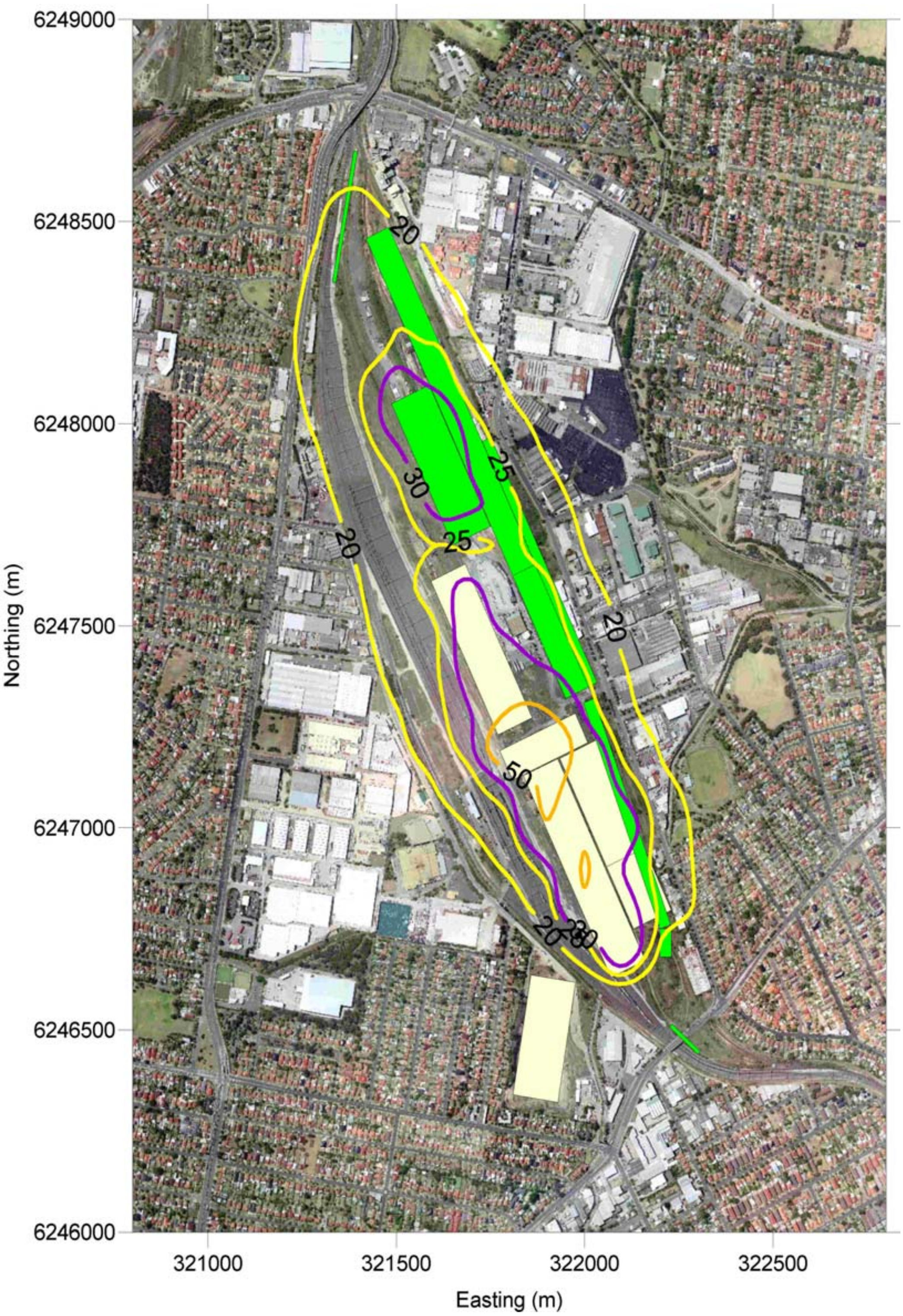
- **Figure 6-10 Construction Scenario 2: Maximum 24-Hour Average PM_{10} Including Background ($\mu g/m^3$), Criterion 50 $\mu g/m^3$: Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340^o**



- **Figure 6-11 Construction Scenario 2: Exceedences of 24-Hour Average PM_{10} Criterion of 50 $\mu g/m^3$: Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340^o**



- **Figure 6-12 Construction Scenario 2: Annual Average PM_{10} Including Background, Criterion 30 $\mu g/m^3$: Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340^o**



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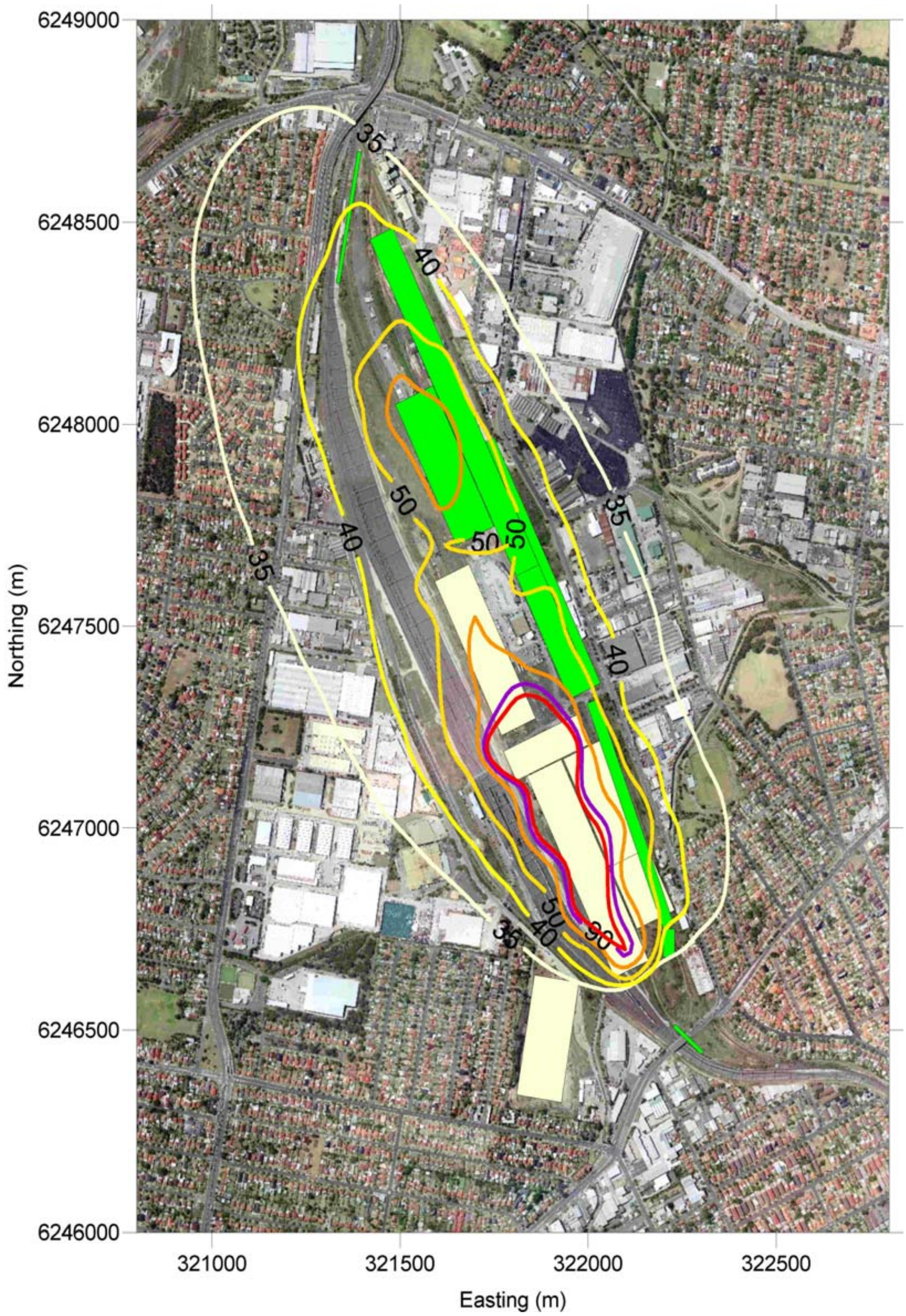
- **Figure 6-13 Construction Scenario 2: Annual Average TSP Including Background ($\mu g/m^3$), Criterion 90 $\mu g/m^3$, Wind Speed < 5 m/s & Excluding Wind Direction Sector 210-340^o**



6.4.4 Combined Dust Deposition Results

The results for dust deposition determined from each of the Construction Scenarios are provided as a single result in this section, determined from an annual statistic; this follows NSW EPA (2001) guidelines. The two annual statistics for dust deposition were modified by the dry depletion correction for dust deposition (90%) and the respective Construction Stage periods, (14 weeks/52 weeks for Scenario 1, and 24 weeks/52 weeks for Scenario 2). These values were then added together and converted to a monthly average, then added to the background dust deposition determined for the site, of 2 g/m^2/month.

The final result for monthly average dust deposition is provided in **Figure 6-14**, (grided receptors), and **Table 6-7** (discrete receptors).

- **Table 6-7 Refined Monthly Average Dust Deposition for the Discrete Receptors**

Discrete Receptor	Refined Monthly Average Dust Deposition (g/m^2/month)
R1	3.2
R2	2.5
R3	2.0
R4	2.1
R5	4.0

These results show that no significant air quality impacts are expected from dust deposition, (the site criterion is 4 g/m^2/month), with dust mitigation measures in place. However there is a risk the dust deposition criterion will be exceeded on the northwestern boundary of the site (R5).

Practically, the marginal result for discrete receptor R5 means that particular attention will need to be paid to the application of the recommended dust mitigation measures for the far northwestern part of the construction site, and monitoring of dust deposition near that part of the site. Tight management of the mitigation measures and monitoring procedures should ensure that air quality impacts from dust are kept just below the criterion.

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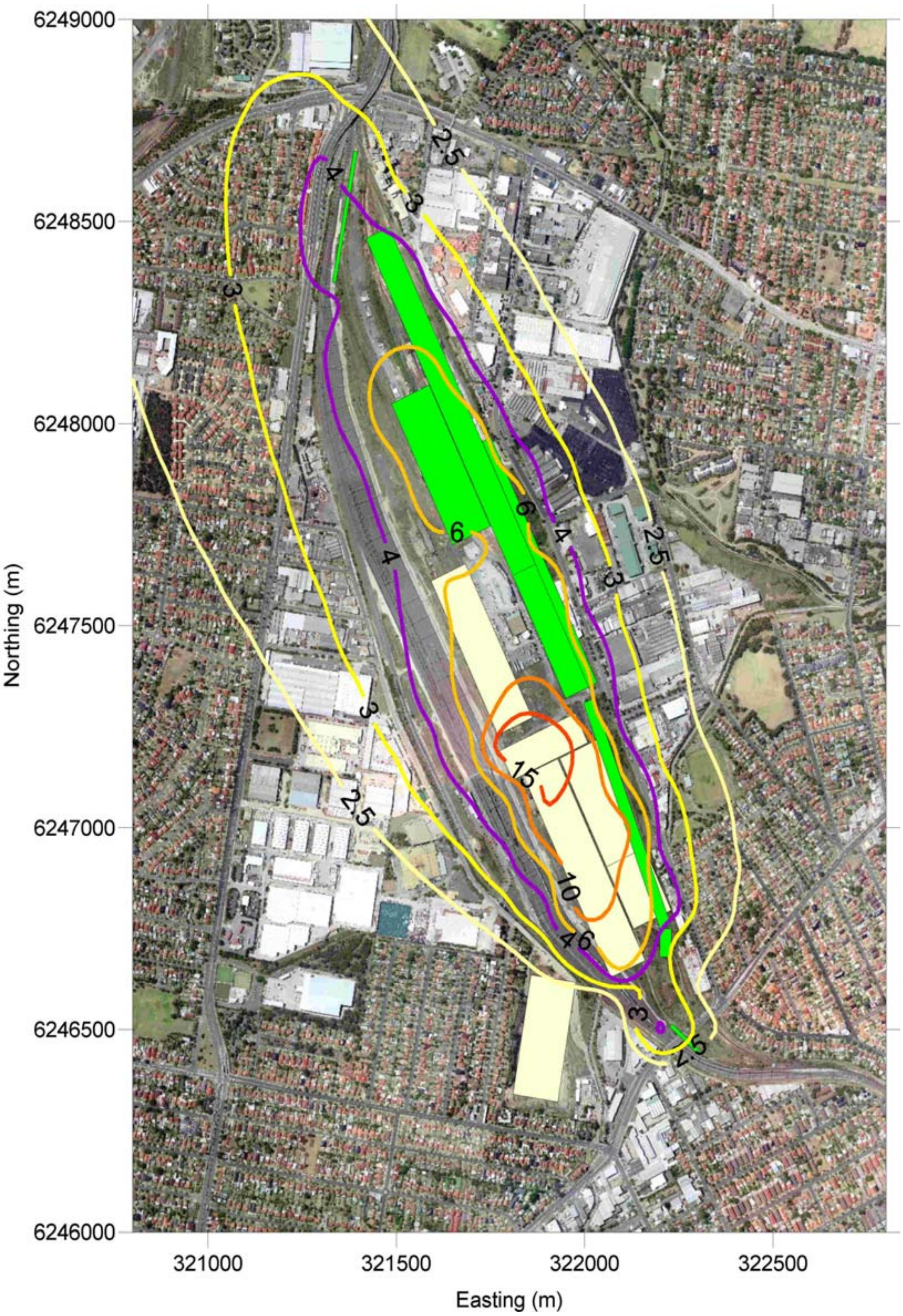
- **Figure 6-14 Monthly Average Dust Deposition Including Background from Combined Scenarios (g/m^2/month); Criterion 4 g/m^2/month**



6.5 Discussion of Results for Construction Air Quality Assessment

The AUSPLUME results for the construction air quality assessment show that the long-term air quality criteria for PM_{10} and TSP impacts (annual averages), and dust deposition impact (monthly average from annual average), will not be exceeded even by worst-case, high intensity construction activities. Therefore the focus of the air quality impacts during the construction phase of the project should be on the short-term impacts from PM_{10} concentration, where a low risk of exceedences exists. The site criterion for air quality impacts during construction is no more than 5 exceedences of the air quality criterion for maximum 24-hour average PM_{10} (50 $\mu g/m^3$ including background levels).

It can be seen that there are two areas to the southeast and northwest of the site where a very small number of residences are contained within the contour of 5 exceedences of the maximum 24-hour average PM_{10} criterion. This is evident in the results for the discrete receptors 'R1' and 'R5'. As such, monitoring of PM_{10} levels during construction in particular for these areas, and as set out in detail **Section 8** of the report, is recommended to ensure air quality impacts are adequately managed.

In summary, sealing of the construction haul roads and the other more commonly applied suite of dust mitigation measures for construction sites provides improvement to the predicted dust emissions. However, the key factors causing the elevated PM_{10} concentrations are the large volume of material that needs to be moved from the stockpiles, and that the site boundary is very close to residences. Hence, the wind speed and wind-sector restrictions need to be considered.

While wind speed and wind direction restrictions are required in the modelling to demonstrate compliance with DEC criteria this should not be interpreted to mean that construction works need to necessarily cease when wind speeds exceed 5 m/s or winds in wind directions from 210° to 340°. The reason the modelling requires such restrictions to be in place is because the prediction being made is worst case 24-hour PM_{10} impacts where the modelling typically assumes a high background level, in this case of the order 40 $\mu g/m^3$. This allows an impact of only 10 $\mu g/m^3$ to ensure compliance with the criteria. On the majority of days during construction background PM_{10} levels will be significantly less than 40 $\mu g/m^3$ and wind speed and direction restriction will generally not be required to mange air quality impacts. This is discussed further in Section 8 to follow.

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7. Operational Air Quality Assessment

7.1 Overview

This section of the report provides an assessment of air quality impacts from the maximum level of operations expected for the completed Enfield ILC. Air quality impacts are predicted from emissions of PM_{10} and NO_2 from the combustion engines of locomotives, road traffic vehicles and on-site equipment associated with ILC operations.

The component of PM_{10} containing smaller 'respirable' particles with diameters less than 2.5 microns, the $PM_{2.5}$ fraction, has recently attracted the interest of environmental authorities; for example, refer to DEC NSW (2004), and the May 2003 amendment of the NEPC (1998) 'Air NEPM'. The amended Air NEPM includes advisory reporting standards for $PM_{2.5}$ (which do not have a timeframe for compliance). Those advisory reporting standards for $PM_{2.5}$ are: maximum concentration for 1 day average, 25 $\mu g/m^3$, and maximum concentration for annual average, 8 $\mu g/m^3$.

The $PM_{2.5}$ fraction is contained within PM_{10} emissions calculated for this study, and as such also represent some fraction of the predicted impacts from PM_{10} presented here. The emissions data for $PM_{2.5}$ from combustion engines is not nearly as well researched or well known as PM_{10}, and as such the focus here has been on determining PM_{10} impacts. In future some assessment of any $PM_{2.5}$ impacts from the operating ILC should be able to be made by an examination of the PM_{10} impacts provided here.

Apart from $PM_{2.5}$, the following paragraphs provide an explanation of the lower-risk air pollutants (including CO, SO_2 and VOCs), that were not assessed for this project. First, in general, diesel engine combustion emission rates for carbon monoxide (CO) are generally lower than those for NO_x yet the air quality criteria for CO are higher. Therefore if the site meets the NO_x criteria it will meet the CO criteria. As such this assessment has focussed on the 'trigger' pollutant NO_x and does not include nor need a CO assessment.

With respect to SO_2 emissions these are a function of the sulphur content of fuel, in particular diesel as relevant to the operation of the ILC. The Fuel Quality Standards Act (the FQS Act) as administered by the Department of Environment and Heritage (DEH) provides the legislative framework for the harmonisation of Australian fuel quality standards with European standards. Standards for petrol and diesel are an important step in implementing the Australian Government's commitment to facilitate the adoption of better, cleaner emission control technology, the more effective operation of engines, and to reduce air pollution. In January 2002, national fuel quality standards for petrol and diesel were implemented. Under the FQS Act, the low sulfur fuel standards currently in place mandate a maximum of 500 ppm of sulfur in diesel. On 1 January 2006, the standard for sulfur in diesel will become 50 ppm and 10 ppm by 1 January 2009. As such by the time the ILC becomes fully operational the sulfur content of diesel fuel will have been reduced to 2 % of current levels and therefore air quality impacts from sulfur dioxide (SO_2) emissions will be negligible. Therefore this assessment does not include an assessment of SO_2 impacts.

In terms of hydrocarbon emissions these alone do not generally pose an air quality problem at the concentrations commonly experienced. However, some hydrocarbons such as benzene are known to have an adverse affect on human health, but these effects are thought to occur at concentrations higher than the levels of exposure typically occurring in urban areas. This assessment does not provide any quantitative assessment of hydrocarbon emissions associated with the ILC development.

7.2 Methodology of Air Quality Assessment

7.2.1 Overview

The air quality impacts from an operating ILC have been assessed by predicting concentrations of PM_{10} and NO_2 for a single scenario comprising the ILC running to full capacity. The same gridded and discrete receptors used for the construction air quality assessment have been used for comparisons of modelled air quality impacts with the NSW EPA (2001) and NEPC (1998) air quality criteria for PM_{10} and NO_2.

The same meteorological data used for the construction air quality assessment was used for the operational scenario. Annual datasets for hourly-average background NO_2 and ozone (O_3) were produced in a similar manner to the PM_{10} background data produced for the construction assessment. Details of the methods used to construct the datasets of hourly average meteorological and background air pollutants levels, used for the modelling, are provided in **Section 6.2**.

Air emission factors sourced from USEPA (1997a), USEPA (1998b) and Environment Australia (2003) were used to calculate pollutant emission rates from the vehicle/motor sources. These were combined with operations data associated with a maximum level of activity expected for the ILC to create a worst-case PM_{10} and NO_2 emissions scenario for the modelling. The details of the air emissions scenario and calculated emission rates are provided in **Section 7.3.**

The air emissions were formatted for input to the AUSPLUME V.6 air dispersion model for the prediction of Ground Level Concentrations (GLCs). The AUSPLUME model was run for each pollutant and the output GLCs were compared to the relevant air quality criteria.

7.2.2 Determination of NO_2 Impacts

Typically, approximately 90% of the NO_x emissions from combustion engines are in the form of NO, with the remainder as NO_2. As the NO_x gases disperse in the atmosphere the NO reacts with other gases, and in particular with ambient O_3 to form additional NO_2 and oxygen (O_2). The NEPM criteria for NO_x focus on the more harmful substance NO_2 (refer to **Section 3.2.2**).

The atmospheric chemistry of photochemical smog including NO_x, O_3 and hydrocarbons is highly complex and there are various schemes to determine the NO_2 amount in NO_x emissions accounting for ambient gas species levels. To determine NO_2 impacts from AUSPLUME-predicted NO_x, this study has utilised the 'ISC3' model Ozone Limiting Method (OLM); for example, refer to USEPA (1997b). In the OLM method, the maximum hourly average NO_2 impacts at each grid receptor are determined from the sum of the following components (mass concentrations):

1) 10% of the initial NO_x impact predicted for the receptor;
2) The minimum of:
   - 90% of predicted NO_x; and
   - $\frac{46}{48} \times O_3{}^B$; and
3) The background hourly average $NO_2{}^B$,

where the superscript *B* stands for 'Background'. These OLM calculations were performed for the first four discrete receptors, for each hour of the meteorological and background NO_2 and O_3 datasets, to determine empirical relationships that could be applied to the predicted NO_x for all the grid receptors.

The NO_2 maxima obtained from the OLM method as applied to calculations for the first four discrete receptors were used to formulate a simple linear relationship for the maximum NO_2 given the AUSPLUME-predicted NO_x. Similarly, a linear regression of the same OLM data was used to formulate a linear relationship for estimates of the annual average NO_2. The utility of these relationships should become evident by inspection of the example provided in **Figure 7-1**, which shows the empirical relationships plotted with the OLM results for the discrete receptor 'R4'. Note the estimate of maximum hourly NO_2 for this project is conservatively high.

The empirical relationships determined for the NO_2 predictions for the ILC site are, for maximum hourly NO_2,

$$NO_2 = 149\ \mu g/m^3 + 0.032578 \times NO_x{}^{(AP)}; \qquad (1)$$

and for the determination of annual average NO_2,

$$NO_2 = 50\ \mu g/m^3 + 0.093262 \times \text{predicted } NO_x{}^{(AP)}, \qquad (2)$$

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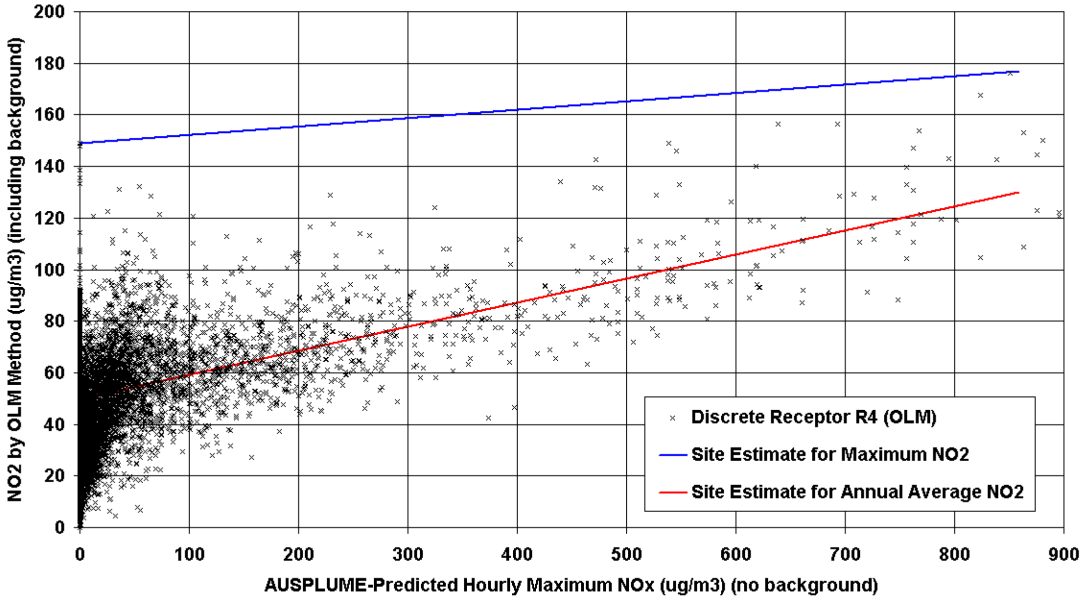
where the superscript 'AP' stands for 'AUSPLUME Predicted'. Note that background NO_2 levels are included in both cases via the OLM method, although background NO_x data was not (could not) be input to the AUSPLUME modelling runs.

■ **Figure 7-1 Predictions of NO_2 for the Site Using the OLM Method**



7.3 On-Site Operations Scenario and Air Emissions

7.3.1 Overview

A worst-case air emissions scenario was developed and based on an estimate of the busiest hourly period by a capacity fleet of road vehicles and on-site machinery, for a peak operation year. An inventory of the vehicles and machinery for this scenario is provided in **Table 7-1**. All equipment in this list uses diesel fuel unless otherwise indicated.

The air emissions sources were assigned single positions for the purpose of AUSPLUME modelling, reflecting estimates of the effective positions of those sources for the worst-case hour. The locations of the main sources (with larger combustion engines) are depicted in **Figure 7-2**. The key to the symbols is provided in the following points:

- Locomotives by black squares;
- Lots of six trucks (moving and idling), by the black spoked-circles;
- Gantry cranes and reach stackers by the yellow asterisks; and
- Large forklifts, both for full and empty containers, by the purple arrows.

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- **Table 7-1 Inventory of Site Equipment for Scenario of Busiest Hour of Operations**

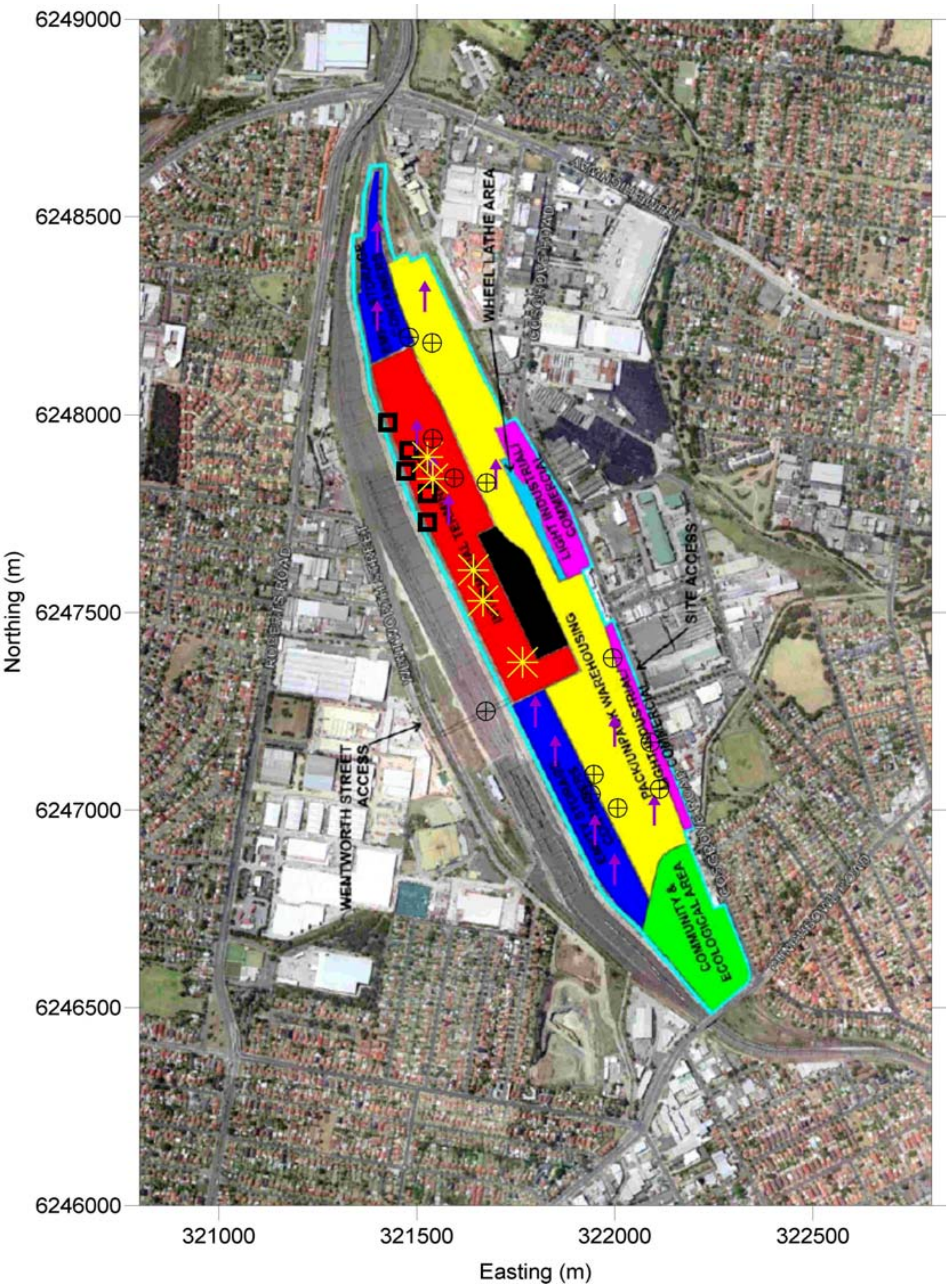
Equipment	Description / location
3x 81 Class Loco	Idling on western line, at northern end of line
2x 48 Class Loco	Idling on eastern line, at northern end of line
24x moving trucks	Divided into 6 x sources comprising 4 trucks each for AUSPLUME; sources spread evenly around on-site roads; average speed ~20 kph
24x idling trucks	As above
3x Gantry Cranes	Highest powered on-site machines (600 hp), ILC load/unload area
2x Reach Stackers	ILC load/unload area
3x Container Forklifts	ILC load/unload area
4x Large Forklifts	All warehouses
6x Empty Container Forklifts	Empty container storage areas; 2 in north, 4 in south
40x small forklifts (LPG)	All warehouses
Staff cars (ULP)	Average speed on-site assumed 20 kph
Power washer	Assumed power rating, 50 hp

The forty LPG-powered forklifts were divided amongst six warehouse locations according to floor plan areas, and the warehouses treated as ‘volume’ sources in AUSPLUME. A ‘pseudo volume’ source was also constructed for a conservatively high estimate of more than 300 staff-car movements per hour, by aligning an area source with the access road to the staff administration building.

7.3.2 Calculated Air Emissions for Site Vehicles and Equipment

The ILC is expected to reach its peak of operation in the year approximately 2015 and where possible, estimates of emission factors for this time were used in the assessment. In selecting the emission factors for road vehicles, it was assumed that on-site roads will be equivalent to congested arterial roads. The emission factors used for the on-site operations scenario are listed in **Table 7-2**.

■ **Figure 7-2 Locations of Main 'Stack' Sources**[13]



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[13] Refer to text for key to symbols.

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Table 7-2 Selected Emissions Factors for On-Site Vehicles and Equipment

Vehicle / Equipment	NO_x Emission Rate	PM_{10} Emission Rate	Source
Locomotive Yard Operations 2010-2016	35.60 g/L	1.35 g/L	Estimate[14]
Rigid Truck (Diesel)	7.836 g/km	0.523 g/km	2002 from M5 East AQMP (Congested Road)
Articulated Truck (Diesel)	16.019 g/km	0.804 g/km	2002 from M5 East AQMP (Congested Road)
Car passenger / petrol	1.513 g/km	0.031 g/km	2002 from M5 East AQMP (Congested Road)
Gantry Crane (600 hp)	2.8 g/hp-hr	0.4 g/hp-hr	USEPA Tier 3
Container Forklift (345 hp)	2.8 g/hp-hr	0.4 g/hp-hr	USEPA Tier 3
Large Forklift (345 hp)	2.8 g/hp-hr	0.4 g/hp-hr	USEPA Tier 3
Reach Stacker (320 hp)	2.8 g/hp-hr	0.4 g/hp-hr	USEPA Tier 3
Large Forklift-empty containers (200 hp)	2.8 g/hp-hr	0.4 g/hp-hr	USEPA Tier 3
Small Forklift, LPG (50 hp)	3.3 g/hp-hr	0.72 g/hp-hr	Table 8, Environment Australia (2003)
Power washer (50 hp)	5 g/hp-hr	0.6 g/hp-hr	USEPA Tier 2

The calculated emission rates for all locomotives at idle were determined with a fuel consumption rate of 14 L/hour (Pacific National, *pers. comm.*). All moving vehicles were assumed to travel 1.5 km (on-site) in the modelled worst-case hour. The PM_{10} emissions from idling trucks (i.e. no VKT), were assumed to be half those of the moving trucks. NO_x emissions were assumed the same for moving and idling trucks – the reason for this is combustion in an idling engine is not as efficient as running engine. With respect to on-site equipment eg forklifts, reach stackers and gantry cranes emissions were based on USEPA Tier 2 and 3 compression – ignition engine emission factors for equipment coming into services after 2005 – 07. All these equipment were treated as ‘stack’ sources in AUSPLUME, with the 24 moving and idling trucks divided into 6 sources of 4 vehicles each. A summary of the emission rates, calculated from the selected emission factors and operations activities, is provided in **Table 7-3**. Other stack information used for input to AUSPLUME is provided in **Table 7-4**.

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[14] Estimate for 2010-2016 from NPI1999 using USEPA420-F-97-051 Controls.

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▪ **Table 7-3 Summary of Calculated Emission Rates for Operations Scenario**

Source	Number in Modelling Scenario	PM_{10} Emission Rate (g/s)	NO_x Emission Rate (g/s)
Loco 81 Class	3	0.005	0.138
Loco 48 Class	2	0.005	0.138
Truck idling (x1)	n/a	0.003	0.102
Trucks idling (x 4)	6; i.e., 6 x 4 = 24 trucks	0.011	0.409
Truck moving (x1)	n/a	0.006	0.102
Trucks moving (x 4)	6; i.e., 6 x 4 = 24 trucks	0.023	0.409
Container forklifts	3	0.038	0.268
Large forklifts in warehouse areas	4	0.038	0.268
Large forklift on empty containers	6	0.022	0.156
Reach Stacker	2	0.036	0.249
Gantry Crane	3	0.067	0.467
Power Washer	1	0.008	0.069

▪ **Table 7-4 Stack Source Parameters for AUSPLUME – Locomotives and Trucks**

Equipment	Effective Stack Height (m)	Stack Diameter (m)	Exhaust Gas Temperature (^oC)	Exhaust Exit Velocity (m/s)
Locomotive	3	0.3	200	10
Truck	4	0.1	75	10
Gantry Crane	24	0.3	350	23.7
Forklifts (large) and Reach Stackers	3.4	0.3	350	14.6
Power washer	3	0.1	75	10

In addition to these stack sources, a ‘pseudo volume’ source was constructed to model hourly staff-car movements; the key parameters of this source are:

- 300+ car movements per hour and average 0.675 km per trip (entrance roundabout-to-administration building);
- Initial source geometry is 10 m (width) x 675 m (length) x 4 m (height), where effective height of source is 2 metres and initial vertical spread is 1 metre; and
- At 25% load, (Environment Australia, 2001):
  - The calculated PM_{10} emission rate for the source is approximately 4.4×10^{-9} g/s/m^2; i.e., insignificant; and
  - The calculated NO_X emission rate for the source is approximately 2.1×10^{-7} g/s/m^2.

The emissions from the forty LPG-powered (small) forklift emissions were divided amongst the six warehouses within which these machines will work, approximately according to warehouse floor-plan area. The PM_{10} emissions from these LPG motors is insignificant and the calculated NO_x emissions are provided in **Table 7-5**.

- **Table 7-5 Warehouse 'Volume' Sources for Small Forklifts**

Warehouse Source	No. of Small Forklifts (Based on Floor Area)	NO_X Emission Rate (g/s)
WHA	9.3	0.083
WHB	14.5	0.129
WHC	2.3	0.021
WHD	2.3	0.021
WHE	2.3	0.021
WHF	9.3	0.083

7.4 Air Quality Impact Assessment - Results

7.4.1 NO_2 Impacts from ILC Operations

The modelled NO_x concentrations were converted to NO_2 concentrations for comparisons with the air quality criteria for NO_2 by the ISC3 Ozone Limiting Method (OLM), as described in **Section 7.2.2**. The results for maximum hourly NO_2 concentration, which includes background NO_2 levels, are provided in **Figure 7-3**. There are no exceedences of the air quality criterion for maximum hourly NO_2 concentration, of 246 $\mu g/m^3$. The AUSPLUME result for all-hours average NO_2 was obtained from the same emissions scenario used to predict the maximum hourly NO_2 impact; refer to **Figure 7-4**. This is an overestimate of the annual average NO_2 concentration as it is based on the busiest hour in a year, being undertaken for every hour of the year. This result also includes background NO_2 levels, and shows no exceedences of the annual average NO_2 criterion of 62 $\mu g/m^3$ are expected to occur from a highest intensity hour of the ILC operation. A table of NO_2 results for the five discrete receptors is provided in **Table 7-6**.

- **Table 7-6 AUSPLUME Results for NO_2 Impacts at Discrete Receptors**

Discrete Receptor	Maximum Hourly NO_2 ($\mu g/m^3$) Criterion 246 $\mu g/m^3$	Annual Average NO_2 ($\mu g/m^3$) Criterion 62 $\mu g/m^3$
R1	190	56.7
R2	187	52.8
R3	171	51.0
R4	173	51.4
R5	187	51.6

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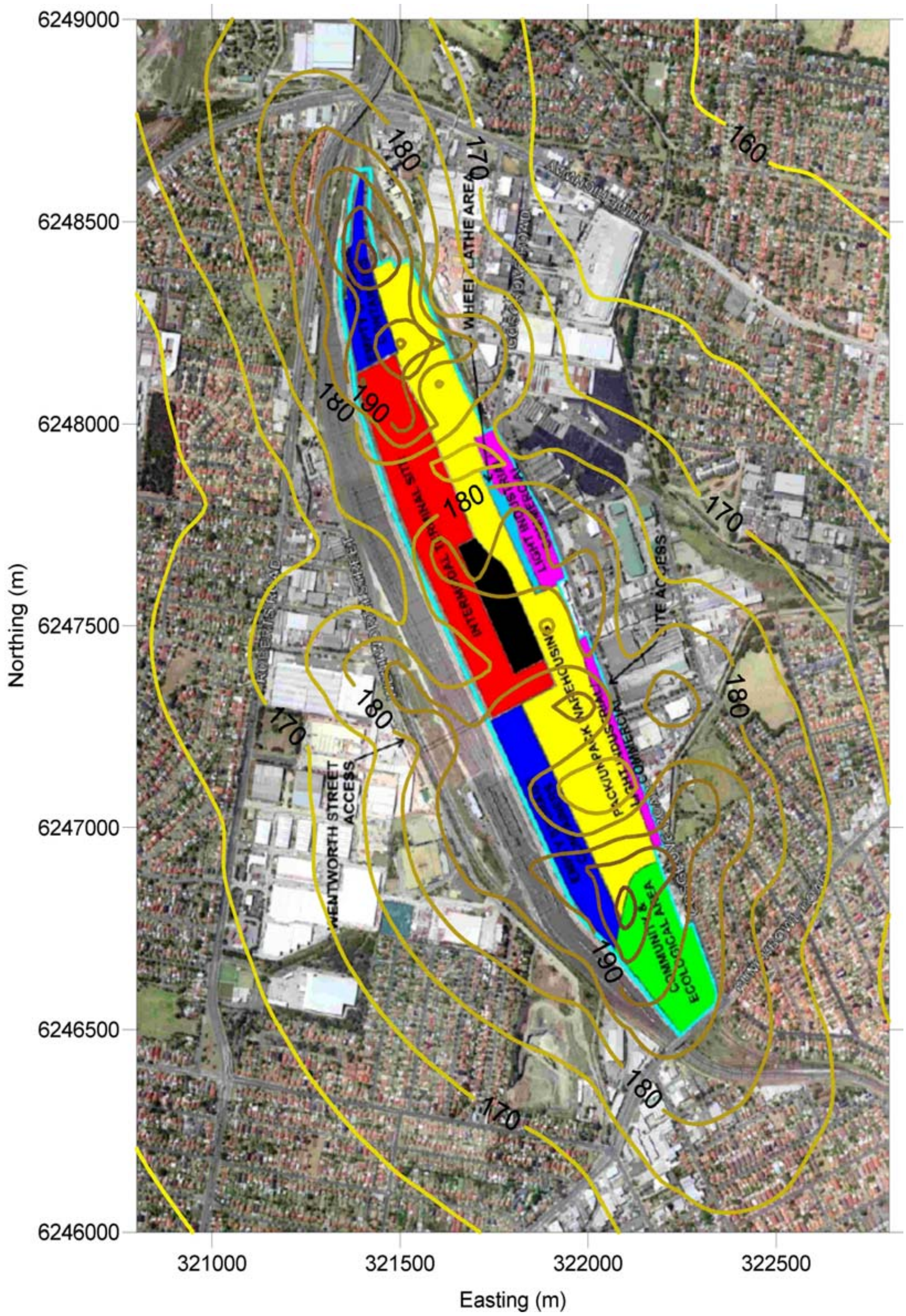
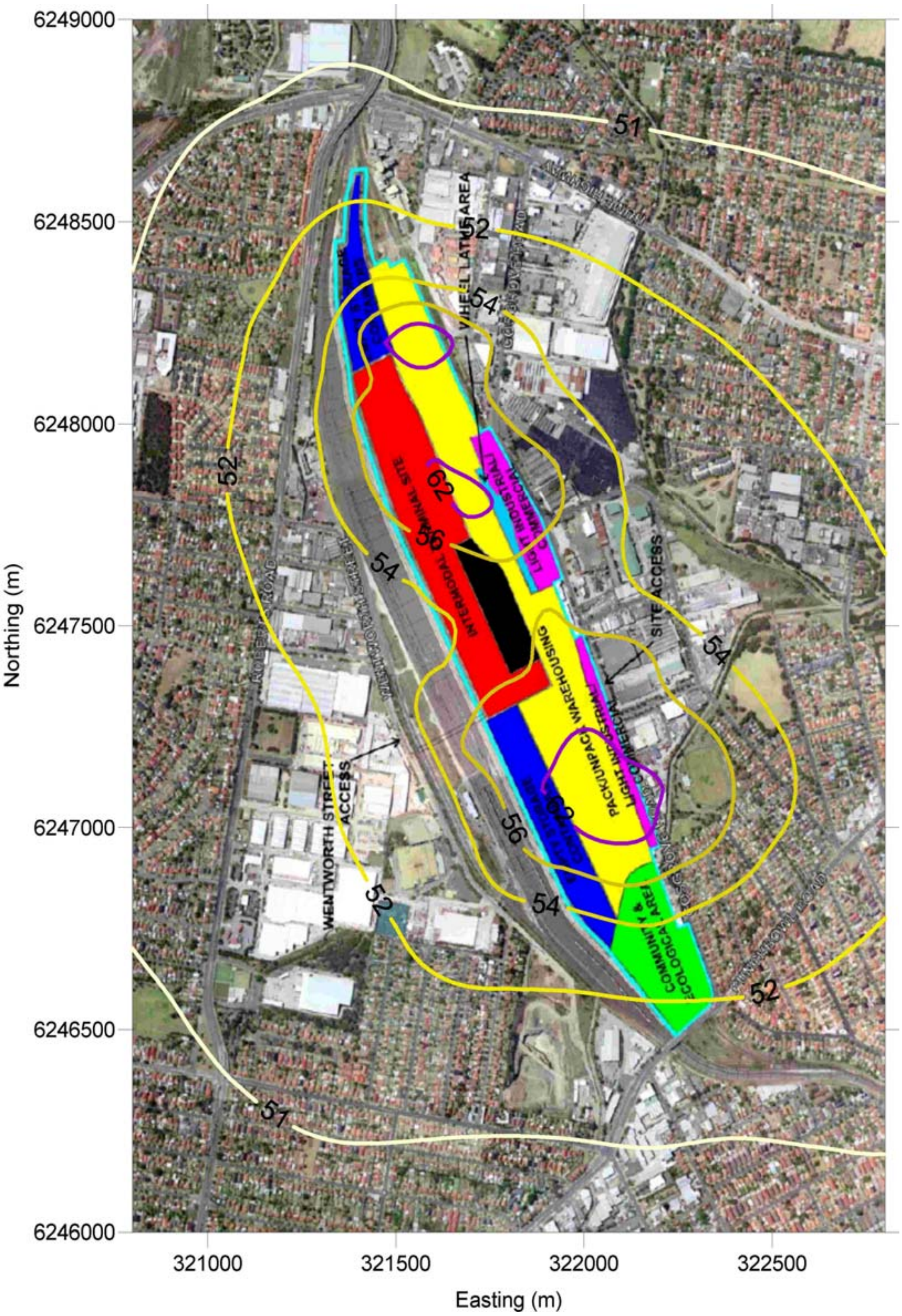
- **Figure 7-3 Maximum Hourly NO_2 Plus Background ($\mu g/m^3$) – Criterion 246 $\mu g/m^3$**



- **Figure 7-4 Average All Hours NO_2 Plus Background ($\mu g/m^3$) – Criterion 62 $\mu g/m^3$**



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7.4.2 Predicted On-Site PM_{10} Impacts from ILC Operations

The AUSPLUME results for maximum 24-hour average PM_{10} expected in a year for each location on the grid are provided in **Figure 7-5**[15]. This result for maximum 24-hour average PM_{10} shows that there is only a low risk of significant air quality impacts from exceedences of the 50 $\mu g/m^3$ level, outside the site boundary. The maximum number of exceedences of this criterion predicted for any of the 651 grid receptors, was three – for an on-site receptor near the Intermodal Terminal. Off-site exceedences did not increase above unity in a region to the southeast of the site. This is within the ambient air quality criterion for PM_{10}, of 5 allowable exceedences (NEPC, 1998). There were nil exceedences for the discrete receptors as shown above.

The AUSPLUME result for 'all hours average PM_{10}', which provides an overestimate of annual average PM_{10} because worst-case hourly emissions were modelled for each hour of a year, is provided in **Figure 7-6**. This result shows that there is virtually no risk of the annual average PM_{10} criterion of 30 $\mu g/m^3$ being exceeded from on-site operations.

The results for the discrete receptors 'R1' through to 'R5' are provided in **Table 7-7**.

- **Table 7-7 Predictions of 24-Hour Maximum PM_{10} ($\mu g/m^3$) for Discrete Receptors**

Discrete Receptor	Max. 24-Hour Average PM_{10} ($\mu g/m^3$); Criterion 50 $\mu g/m^3$	Annual Average PM_{10} ($\mu g/m^3$); Criterion 30 $\mu g/m^3$
R1	46.4	19.7
R2	42.8	17.9
R3	38.5	16.7
R4	38.5	16.9
R5	39.1	17.3

All the results include background hourly average PM_{10}.

[15] A contour plot of the exceedences of the PM_{10} criterion as provided in previous sections has not been provided for these few data. The exceedence information here is limited to the numerical results for the discrete receptors.

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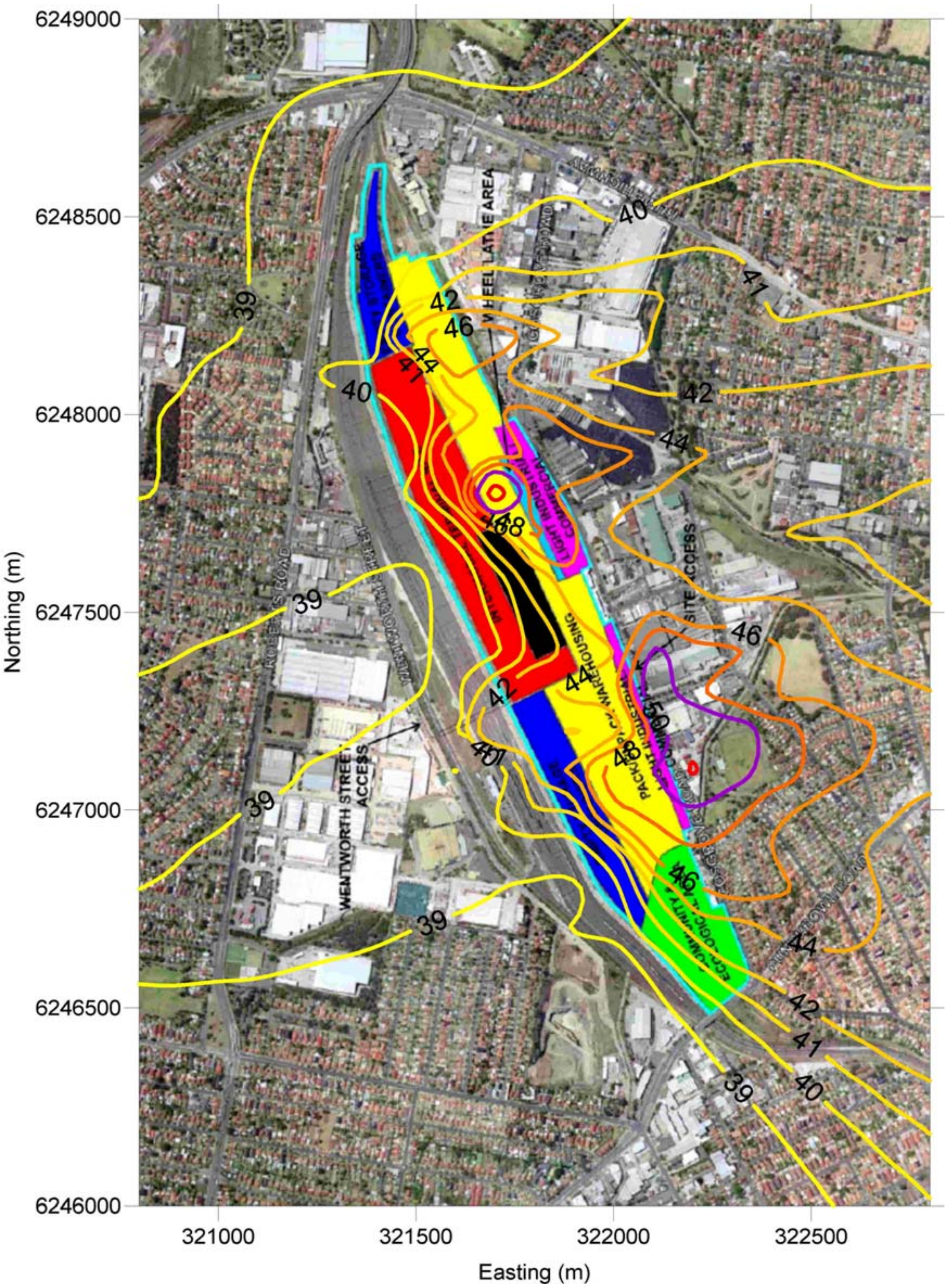
- **Figure 7-5 Enfield ILC High-Intensity Operations: Worst Case 24-Hour Average PM_{10} Plus Background – Criterion 50 $\mu g/m^3$**



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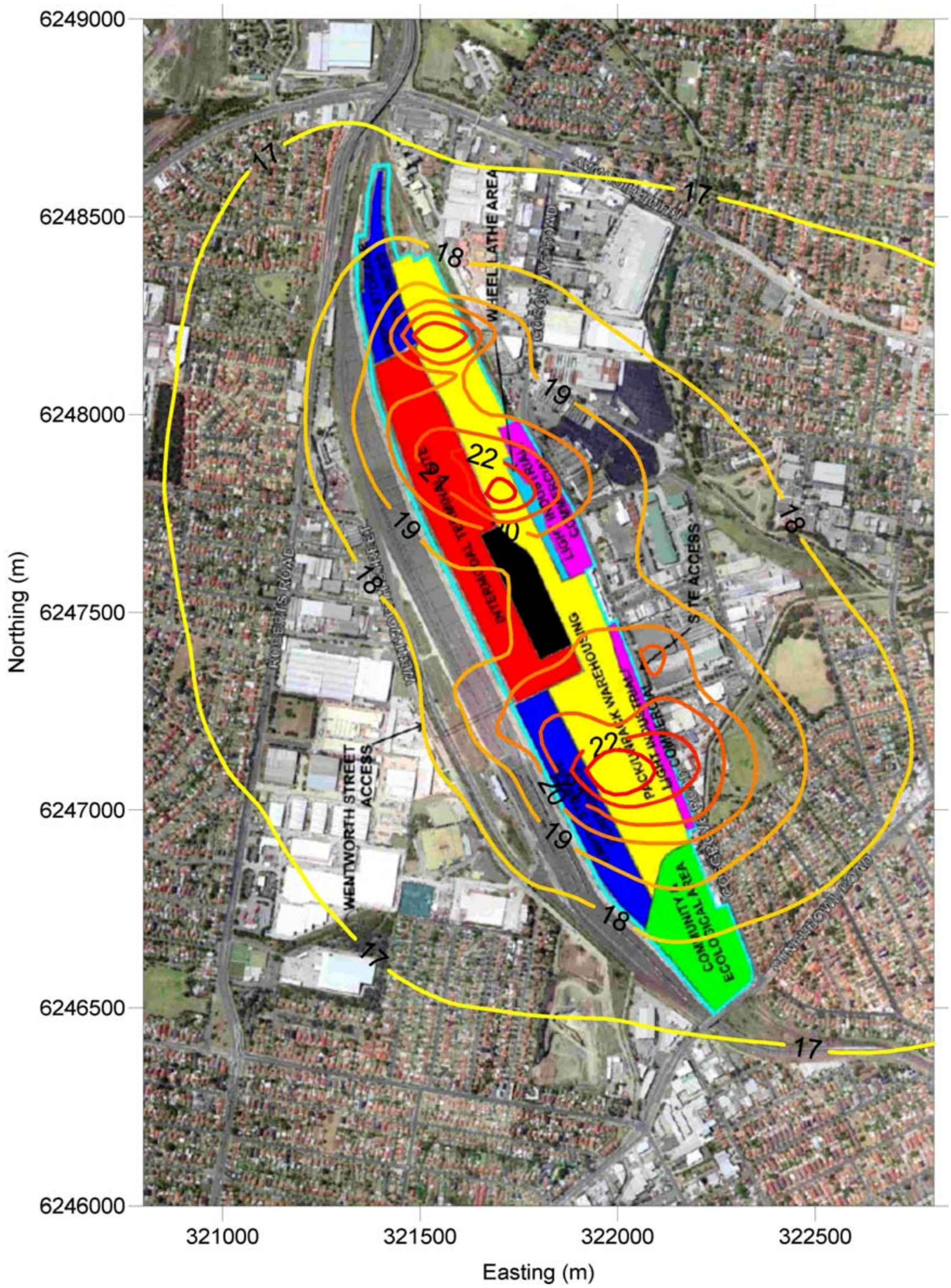
- **Figure 7-6 Enfield ILC High Intensity Operations: All Hours Average PM_{10} Plus Background – Criterion 30 $\mu g/m^3$**



7.5 Off-site Air Quality Impacts

7.5.1 Overview

This section of the report provides an assessment of potential off-site air quality impacts associated with truck movements on the road network accessing the proposed ILC.

7.5.2 Road Traffic Air Quality Impacts

The proposed operation of the ILC will change traffic movements of the surrounding road network with increases in vehicle movements on some roads and decreases on others. The assessment to follow provides a quantified analysis of changes in air quality impacts as a result of operations at the ILC.

Table 7-8 sets out 2016 traffic volumes on local roads containing sensitive receivers eg. residences around the proposed ILC site for scenarios both with and without the ILC in operations. These traffic numbers were sourced from road network traffic modelling undertaken for the EIS.

- **Table 7-8 Daily Road Network Traffic Volumes for 2016**

Road	No ILC			With ILC		
	Light Vehicles	Heavy Vehicles	Total	Light Vehicles	Heavy Vehicles	Total
Roberts Rd	58 198	7 125	65 323	58 210	7 126	65 336
Punchbowl Rd	33 094	1 723	34 817	33 625	1 749	35 374
King Georges Rd	61 524	7 583	69 107	61 789	7 616	69 405
Hume Hwy	63 910	4 208	68 118	63 635	4 185	67 820

It can be seen from **Table 7-8** traffic volumes will increase on the surrounding road network on all roads with the exception of the Hume Highway where there will be a net decrease in traffic as a result of the operation of the ILC. It should be noted that the traffic numbers quoted above do not directly correspond to traffic numbers generated by on-site operations at the ILC. The reason for this is that the road network traffic modelling assumes likely route shifts that may occur as a result of the project, that is vehicles that currently use Roberts Road may change to another route once the ILC project becomes operational.

Punchbowl Road shows the largest increase in traffic with an additional 557 vehicles per day as a result of ILC operations. This increase includes an additional 26 trucks per day on Punchbowl Road. Roadside air dispersion modelling of NO_X and PM_{10} emissions was undertaken for Punchbowl Road.

7.5.3 Road Traffic Emission Factors

General emission factors used in the assessment of Roberts Road were calculated by the EPA for the *M5 East Freeway Sub-Regional Air Quality Management Plan*, 2002. These emission rates were used for NO_x and PM_{10} and are described in **Table 7-9**.

- **Table 7-9: Vehicle Emission Factors**

Pollutant	Vehicle Category	Fuel	Highway/Freeway Emission (g/km)
NO_x	Passenger	Petrol	1.437
	Articulated Truck	Diesel	16.019
	Rigid truck	Diesel	7.836
PM_{10}	Passenger	Petrol	0.055
	Articulated Truck	Diesel	0.804
	Rigid Truck	Diesel	0.523

Hourly vehicle numbers and composite emission rates, (i.e., emission rates scaled to reflect the vehicle composition of light and heavy duty vehicles), for the existing situation as well as with the proposed development are detailed in **Table 7-10**.

7.5.4 Modelling Methodology

Air dispersion modelling has been conducted to assess potential impacts on sensitive receptors during the operational phase of the upgrade. The CAL3QHCR dispersion model has been used to predict concentrations of NO_2 and PM_{10} close to Punchbowl Road. The CAL3QHCR model can process up to one year of meteorological data and vehicle emissions that vary over a 24 hour period.

In this study the CALRoads View modelling package was used to assess the impacts of the proposed upgrade. CALRoads View is a Graphical User Interface (GUI) for the Caline series of models.

For this assessment the Lidcombe 1999 metrological data has been used along with traffic and emission data that cycles over 24 hours (refer to **Table 7-10**).

Impacts have been modelled for the existing situation as well as with the proposed Enfield ILC. The following sections describe the results of the modelling in terms of the incremental increase between the existing and proposed scenarios.

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Table 7-10: 2016 Traffic Data and Composite Emission Rates – Punchbowl Road

Hour Commencing Time	All Vehicles – No Enfield	All Vehicles – With Enfield	NO_X Composite Emission Rate (g/km)		PM_{10} Composite Emission Rate (g/km)	
			No Enfield	With Enfield	No Enfield	With Enfield
0000	413	420	1.67	1.67	0.07	0.07
0100	241	245	1.70	1.70	0.07	0.07
0200	179	182	2.00	2.00	0.09	0.09
0300	156	159	2.17	2.17	0.10	0.10
0400	243	246	2.22	2.22	0.11	0.11
0500	577	586	2.10	2.10	0.10	0.10
0600	1,523	1,545	1.99	1.99	0.09	0.09
0700	2,330	2,366	1.85	1.85	0.08	0.08
0800	2,781	2,824	1.79	1.79	0.08	0.08
0900	2,032	2,062	1.98	1.98	0.09	0.09
1000	1,600	1,625	2.07	2.07	0.10	0.10
1100	1,530	1,554	2.08	2.08	0.10	0.10
1200	1,564	1,589	2.07	2.07	0.10	0.10
1300	1,585	1,611	2.03	2.03	0.09	0.09
1400	1,856	1,886	1.94	1.94	0.09	0.09
1500	2,372	2,411	1.75	1.75	0.08	0.08
1600	2,505	2,547	1.72	1.72	0.07	0.07
1700	2,720	2,765	1.62	1.62	0.07	0.07
1800	2,463	2,504	1.58	1.58	0.07	0.07
1900	1,787	1,816	1.57	1.57	0.06	0.06
2000	1,367	1,390	1.56	1.56	0.06	0.06
2100	1,227	1,247	1.54	1.54	0.06	0.06
2200	1,011	1,027	1.55	1.55	0.06	0.06
2300	755	768	1.57	1.57	0.06	0.06

PM_{10}

Maximum 24-hour PM_{10} concentrations increase range from 0 to 0.5 μg/m^3, with maximum increases occurring immediately above the road surface. Increases at the residences range from 0 to approximately 0.3 μg/m^3 (refer to **Figure 7-7**).

Impacts of this order are insignificant and when added to background PM_{10} levels will not result in exceedance of ambient air quality criterion of 50 μg/m^3 (24-hour) or 30 μg/m^3 (annual). This demonstrates that increased vehicle movements on Punchbowl Road and all other roads surrounding ILC which may experience lesser increases and/or decreases in vehicle traffic as a result of the project will not affect overall air quality in the area.

NO_2

Modelled emission factors were for total NO_x, however, the relevant criterion is for NO_2. For the purpose of this assessment NO_2 concentrations were assumed to be 50% of the total NO_x emissions. Given that approximately 10% of initial NO_x emissions are in the form of NO_2, (refer to **Section 7.2.2**), this is a conservatively high estimate of the NO_2 emissions.

Modelled increases in maximum hourly NO_2 concentrations range from 0 to 15 $\mu g/m^3$ with the maximum increases occurring directly above the road surface. Increases at residence range from 0 to ~7 $\mu g/m^3$ (refer to **Figure 7-8**).

As was the case for PM_{10}, NO_2 impacts of this order are considered insignificant and when added to background levels will not result in exceedance of te corresponding NO_2 ambient air quality criterion (246 $\mu g/m^3$). This demonstrates that increased vehicle movements on Punchbowl Road and all other roads surrounding ILC which may experience lesser increases and/or decreases in vehicle traffic as a result of the project will not affect overall air quality in the area.

- **Figure 7-7 Incremental Increase in Maximum 24-hour PM_{10} Concentrations Punchbowl Rd**
- **Figure 7-8 Incremental Increase in Maximum 1-hour NO_2 Concentrations Punchbowl Rd**

7.6 ESD / Greenhouse Considerations

7.6.1 Greenhouse Gas Issue and Climate Change

It is widely recognised that climate change is a major global issue with human activity and the combustion of fossil fuels increasing the levels of greenhouse gases (GHG) such as carbon dioxide (CO_2) in the atmosphere. The build-up of GHGs in the atmosphere may lead to long-term changes in water availability and rising sea levels as well as to changes in weather patterns, causing more extreme events such as droughts, floods and cyclones.

The DEC (2003) reports that the global rate of increase in the atmosphere of CO_2 concentrations over the last 200 years far exceeds the rate of the previous 20,000 years. Although Australia contributes just 1% of the global GHG emissions, our per capita emissions are amongst the highest in the world (AGO 1998). Overall total net greenhouse gas emissions in Australia increased 6.3% between 1990 and 2000. Between 1999 and 2000 alone emissions increased by 2.1%. Most of the increases have come from energy generation, agriculture and motor vehicles (DEC 2003).

Major GHGs produced or influenced by human activities include the following. A brief discussion on each of these gases is presented below.

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O_2)
- Synethetic halocarbons
- Sulfur hexafluoride
- Other important gases.

7.6.2 Important Greenhouse Gases

Carbon Dioxide

Carbon dioxide is the main anthropogenic gas contributing to climate change and concentrations of this gas in the atmosphere have increased by 30% during the past 200 years (CSIRO 2000). The major anthropogenic sources of carbon dioxide emissions are fossil fuel combustion and land clearing for agriculture.

Methane

Atmospheric methane concentrations have increased by 150% during the past 200 years (CSIRO 2000) and although there is less methane in the atmosphere, it is a significantly stronger greenhouse gas. The major anthropogenic sources of methane are cattle, rice growing and leakages during natural gas production, distribution and use. Presently, natural processes remove methane from the atmosphere at almost the same rate as it is being added to it. However, over the next 100 years, methane concentrations are likely to rise.

Nitrous Oxide

Atmospheric nitrous oxide concentrations have increased by 15% during the past 200 years and it can persist in the atmosphere for up to 100 years. Major sources of nitrous oxide include industrial processes, fertiliser use and other agricultural activities, including land clearing.

Halocarbons and Sulfur Hexafluoride

HydroFluoroCarbons (HFCs) are ChloroFluoroCarbons (CFCs) with the chlorine atom removed and were introduced to replace CFCs in the refrigerant industry since they do not deplete ozone. However, HFCs can be over 11,000 times stronger greenhouse gases than CO_2.

HFCs, PerFluoroCarbons (PFCs, another CFC substitute), and sulfur hexafluoride (a gas used for electrical insulation), are powerful greenhouse gases. Technologies exist to reduce emissions of these gases to near zero over the next few decades. Thus, they represent probably the most significant, immediate opportunity to slow down the current growth of greenhouse gases in the atmosphere.

Other Important Gases

The hydroxyl radical (OH) is a highly reactive agent that helps cleanse the atmosphere of pollutants such as methane. OH will also react with carbon monoxide which, although not a GHG reduces the amount of OH in the atmosphere, thereby increasing the length of time GHG such as methane stay in the atmosphere. Carbon monoxide, hydrocarbons and oxides of nitrogen can react to form ozone, another GHG. In contrast to ozone depletion in the stratosphere, ozone in the troposphere acts as an effective GHG.

7.6.3 Greenhouse Gas Response

International Response

The international response to climate change has involved the development of an international treaty designed to limit the emissions of GHGs and ozone depleting substances: the Kyoto Protocol to the Framework Convention on Climate. Australia took an active part in negotiating the Kyoto Protocol. Signatories to the Kyoto Protocol would be required to reduce GHG emissions by at least five per cent below 1990 levels by 2008–2012 (DEC 2003).

National Response

Ratification of the Kyoto Protocol imposes binding, quantifiable emission reduction commitments on developed countries. Australia obtained special concessions under the Kyoto Protocol allowing greenhouse gas emissions to increase 8% above 1990 emission levels up to 2010. This contrasts with most other developed nations, which agreed to limit and reduce their emissions. The Australian Government has not ratified the Protocol as it currently believes it is not in the national interest to do so. However the Government still intends to develop and invest in domestic programs to meet Australia's target without formal ratification. The United States, which is responsible for around 25% of global greenhouse emissions, has also declined to ratify.

One such domestic strategy was the establishment of the Australian Greenhouse Office (AGO) to coordinate national climate change policy and drive associated programs such as the National Greenhouse Strategy (AGO 2004).

The National Greenhouse Strategy was developed to provide the strategic framework for an effective greenhouse response and for meeting current and future international commitments (Commonwealth of Australia 1998). The Strategy was endorsed by the Commonwealth and all State and Territory governments in 1998. The three goals of the National Greenhouse Strategy are:

1) To limit net GHG emissions, in particular to meet our international commitments;

2) To foster knowledge and understanding of greenhouse issues; and

3) To lay the foundations for adaptation to climate change.

Australia has developed methodologies consistent with the Intergovernmental Panel on Climate Change (IPCC) guidelines for preparing and reporting the National Greenhouse Gas Inventory (NGGIC 1996).

The Greenhouse Challenge Program was launched in October 1995, with signatories to the program aiming to cut their emissions substantially by 2000. Signatories include major industry, service sector companies and industry associations representing major greenhouse gas generators (EPA 2003).

As part of the Australian Government’s Climate Change Strategy, the Greenhouse Challenge Plus was launched in 1994 (AGO 2005). THE Greenhouse Challenge Plus Program involves the management of greenhouse gas emissions through emissions inventory reporting and through the development and implementation of action plans to achieve cost effective abatement.

State and Territory Response

Each State and Territory has developed greenhouse strategies to implement measures within the National Greenhouse Strategy and provide a basis for ongoing monitoring and reporting of progress on the Strategy. New South Wales has focused on reducing emissions from energy suppliers and has introduced the Electricity Supply Amendment (Greenhouse Gas Emission Reduction) Act 2002 to ensure emissions targets are enforceable. NSW also established the

Sustainable Energy Development Authority (SEDA) in 1996 (which has since been incorporated into the Department of Energy Utilities and Sustainability (DEUS)), to promote sustainable energy and water supply and use.

In January 2003, the NSW Greenhouse Gas Abatement Scheme (GGAS) was introduced. GGAS requires electricity retailers and certain other parties to meet mandatory targets by reducing their emissions of greenhouse gases to identified benchmark levels. Participants for whom the scheme is mandatory include retails electricity suppliers, electricity generators (where electricity is sold directly to customers) and market customers sourcing the electricity directly from the market for use in NSW. Large users of electricity (>100GWh per year) or organisations engaged in a project of State Significance may voluntarily apply to take on a benchmark (IPART 2003). As part of the EIS process for the Enfield ILC it has been estimated that the facility will use less than 50 GWh per year and therefore by this definition is not a large user of electricity.

7.6.4 Greenhouse Gases and the ILC Distribution Market

For the current study, the greenhouse impact of the ILC at Enfield is calculated by considering the decrease in truck Vehicle Kilometres Travelled (VKT) that will result from the project and the relative increase in rail VKT associated with the project.

Specifically considered is the change in GHG generated by transporting containers to/from container origin and destination points (COD-points) within the inner and middle western Sydney market via the proposal compared to the “No Change” case. The “No Change” case assumes the COD-points within the market will continue to be served by trucks direct to/from Port Botany. For the “With ILC” case these COD-points will be served by trains between Port Botany and the ILC and trucks to/from the ILC. There will also be a newly created COD-point at the ILC.

The assessment does not consider greenhouse gas emissions from container handling equipment that will operate at the Enfield ILC; e.g., reach stackers and gantry cranes, as such equipment would be operated either at Enfield or elsewhere to accommodate the finite amount of Sydney’s containerised freight in any given year. In any case the greenhouse gas emissions from these activities is considered very small when compared with changes in emissions associated with trucks and trains as calculated below.

Specifically, truck VKT will decrease as a result of more containerised freight being delivered by train from Port Botany to Enfield. The new proposed delivery point is closer to the majority of COD-points within the inner and middle western Sydney market than Port Botany. However there is an increase in relative rail VKT to the market from the additional train delivery of containers out of Port Botany to the ILC.

Traffic modelling undertaken as part of the EIS process suggests the following truck VKT in 2016 associated with container transport in Sydney:

- No Change Case (ie No ILC) 9 614 207 VKT; and
- With ILC Case 3 084 466 VKT.

The above data show the ILC will reduce truck VKT by 6 529 741 km in 2016. Based on a heavy vehicle fleet average fuel consumption rate of 0.33 litres per kilometre (AGO, 2003), this results in a reduction in diesel fuel consumption by trucks of 2 154 815 litres.

With respect to trains, the ILC project will most likely result in 16 one-way train movements each day between Enfield and Port Botany, with each train operating with an average 2 locomotives. The containerised freight on a typical train out of Port Botany and bound for Enfield would require the power of two 44-class locomotives.

The rail distance between Port Botany and Enfield is 18 km equating to 288 train VKT / day or 105 120 train VKT / year, based on 365 days operation. The estimated fuel consumption at full load for the 2 x 44 class locomotive driven trains travelling at a speed of 25 km/h, which is typical on the line between Botany and Enfield is 17 litres per kilometre. As such the calculated annual diesel fuel demand for trains hauling containers to/from the iner and middle western Sydney market is 1 787 040 litres per year. This value is calculated on the assumption that two locomotive engines operate at maximum power in both directions, to and from the ILC. This is likely to overestimate train fuel consumption and therefore GHG emissions, as trains will not always operate locomotives at maximum power, particularly trains returning to Port Botany without full container loads.

The AGO provide an emission factor for automotive diesel as consumed by both trucks and locomotives of 2.7 tonnes of CO_2 per kilolitre (kL) of fuel consumed.

Using the above data to calculate CO_2 emissions the following results from the Enfield ILC project:

- Decreased truck CO_2 = 5818 tonne CO_2 / annum; and
- Increased locomotive CO_2 = 4825 tonne CO_2 / annum.

This equates to an annualised 2016 reduction in CO_2 emissions of 993 tonne CO_2 per annum within the Sydney airshed as a result on operation of the Enfield ILC.

This demonstrates a reduction in fuel use and greenhouse gas emissions in-line with the previously discussed government strategies.

7.7 Mitigation of Operational Impacts

7.7.1 Overview

The results of this assessment show that operational impacts on air quality associated with the ILC are acceptable. On a local scale, the incremental increase in emissions of NO_2 and PM_{10} from on-site operations and offsite trucks do not result in any exceedence of the previously specified EPA air quality objectives.

In terms of greenhouse gases, the future operation of ILC is shown to result in lower emissions (quantified as CO_2) when compared with the "Do Nothing" scenario.

7.7.2 Operational Impact Mitigation

Irrespective of the fact that the ILC is shown here to result in acceptable levels of air quality impact, there will be increased numbers of trucks and trains using Sydney road and rail networks in the future, and in particular, in areas surrounding Enfield. While the operations of these modes is not the direct responsibility of Sydney Ports nor do they have any control over truck and train operations, it is considered prudent that Sydney Ports continually continue to investigate all practical means available to reduce air emissions associated with their operations.

For example, in the future, Sydney Ports could consider (support the use of) alternative energy for on-site equipment. For example diesel-engine emissions can be reduced by the installation of catalytic converters or by the use of exhaust filtration devices. Alternatively, for plant items such as gantry cranes, these can be electrically powered and small forklifts can be battery-operated.

An Operational Environmental Management Plan (OEMP) should be prepared as part of the project development. While the air quality assessment presented here does not require any specific recommendation for operational air pollution controls, future operators at the site should strive for best practice in terms of emissions from plant and equipment where reasonable and feasible.

8. Dust Mitigation Measures & Monitoring

8.1 Overview

This section of the report sets out dust-mitigation measures and ambient air quality and meteorological monitoring requirements to be implemented by Sydney Ports both prior to and during the construction earthworks. Once operational, air quality impacts will be generally restricted to exhaust emissions from trucks, trains, on-site equipment and other vehicles accessing the site. The key pollutants associated with these activities include PM_{10} and NO_x. The NSW EPA monitoring stations at Lidcombe and Earlwood, as described in **Section 5.7**, provide adequate coverage of these pollutants within the study area, and as such no air quality monitoring is considered to be required by Sydney Ports once the ILC is operational.

8.2 Dust Mitigation Measures

The following paragraphs and tables provide a summary of the other dust mitigation measures, detailed in **Section 6.3.2** and **Section 6.3.3**, which were included in the air dispersion modelling as ‘dust control’ factors as specified in Environment Australia (2001). The predictions of air quality impacts from ILC construction for the first two highest-risk Construction Stages 1 and 2, presented in this report, are dependent on the implementation of these dust mitigation measures: refer to **Table 8-1** (Construction Scenario 1) and **Table 8-2**(Construction Scenario 2).

A conclusion from the air dispersion modelling was that the dust criterion may be exceeded under two circumstances during the high volume material movements of Construction Stages 1 and 2. The circumstances were:

- When wind speed increases above 5 m/s (measured at 10 metres height); or
- When incident wind direction shifts inside the sector 210 to 340 degrees true (measured at 10 metres height).

The mitigation measures outlined in **Table 8-1** and **Table 8-2** would be implemented under all circumstances. The requirement to cease work during wind speeds in excess of 5 m/s would need to be considered if the real time monitoring devices at sensitive receivers (described below) suggest the EPA criteria are likely to be exceeded. The cease work requirement during winds inside the sector 210-340 degrees would need to be considered if the EPA criteria at the real time monitoring site in the southeastern area are likely to be exceeded.

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Table 8-1 Dust Mitigation Measures for Construction Stages 1 and 2

Works Associated with Area:	Sources of dust / PM	Mitigation Measures
Stockpile 5	Excavators loading to trucks, haul trucks, exposed areas	Level 2 watering of exposed areas, water sprays on stockpile, mounds and buildings to be left in place as wind breaks where possible
Stockpiles 1 & 3	Excavators loading to trucks, trucks on haul roads, exposed areas	No control specified for loaders, Level 2 watering for haul roads, water sprays for stockpiles and exposed areas
Stockpile 2	Exposed area	Dust control assumed to be by complete cover of vegetation; otherwise water sprays for stockpiles and exposed areas
Exposed Area 2 Construction area for detention pond	Excavators loading to trucks, dozer, haul trucks, exposed areas	No specified controls for dozer and loaders, Level 2 watering, water sprays for exposed areas
Exposed Area 3	Exposed area	Dust control by water sprays

Table 8-2 Dust Mitigation Measures for Construction Stage 2

Works Associated with Area:	Sources of dust / PM	Mitigation Measures
Landscaping Mound North	Dozer and truck dump, haul trucks and exposed areas	Water sprays for exposed areas/stockpiles and Level 2 watering
Landscaping Mound South-East	Trucks dumping, haul trucks moving on dusty roads and exposed areas	Water sprays for exposed areas/stockpiles and Level 2 watering of haul roads
Landscaping Mound South	Trucks dumping, haul trucks moving on dusty roads and exposed areas	Water sprays for exposed areas/stockpiles, Level 2 watering of haul roads, landscaping mound as wind break
Landscaping Mound North-East	Dozer, trucks dumping, haul trucks moving on dusty roads and exposed areas	Water sprays for exposed areas/stockpiles, Level 2 watering of haul roads
DELEC area South	Dozer, trucks dumping, haul trucks moving on dusty roads and exposed areas	Water sprays for exposed areas/stockpiles, Level 2 watering of haul roads
DELEC area North	Exposed areas	Water sprays for exposed areas/stockpiles
DELEC area West	Loading to trucks, trucks on haul roads	Water sprays for exposed areas/stockpiles, Level 2 watering of haul roads
Punchbowl Rail Abutment	Dozer, haul trucks moving on dusty roads and exposed areas	Level 2 watering for haul roads and water sprays for exposed areas/stockpiles

For any other construction activities and for the lower-risk activities in Construction Stages 3 and 4, standard dust control measures should be applied; they are:

- Level 1 watering of unsealed and dusty (sealed) haul roads, with Level 2 watering applied if the Level 1 watering proves insufficient as determined by raised visible dust on watered roads;
- Water sprays or covers for stockpiles and exposed areas;
- Introduction of vegetation to completed areas as rapidly as possible (where vegetation is planned);
- Consideration given to use of on-site raised areas/buildings for use as wind breaks; and
- Halt work if off-site real-time dust monitoring data indicates any of the NSW EPA ambient air quality criteria are being exceeded, or if dust plumes are observed to be tracking towards sensitive receivers.

A Dust Management Plan would be prepared as part of the Construction Environmental Management Plan.

8.3 Air Monitoring Requirements

8.3.1 Background Monitoring

Prior to the commencement of construction earthworks at the site, Sydney Ports should implement background monitoring in the vicinity of the site. This background monitoring should capture as much information on background dust levels and local meteorological conditions as possible, which can subsequently be compared with incremental dust levels as a result of construction activities.

Specifically main monitoring stations should be located within the nearest residential areas to the southeast of the site in the vicinity of Punchbowl Road and in the far northeast corner of the site. These locations are shown by dispersion modelling to be most likely to receive dust impacts during the construction period.

Monitoring at the main stations should include:

- 1 x dust deposition gauge as per AS 3580.10.1-1991 – *Particulates – deposited matter (gravimetric method)*;
- 1 x PM_{10} Tapered Element Oscillating Microbalance (TEOM) (continuous real-time monitoring)

The monitoring devices shall be located in accordance with AS 2922-1987 – *Ambient Air -Guide for Siting of Sampling Units*.

Additionally, three dust gauges should be located around the site. These should be located in the residential areas bounding the site to the southwest, northwest and northeast.

8.3.2 Construction Earthworks Monitoring

At the commencement of construction earthworks, the background monitoring, as detailed above, shall continue as specified. The purpose of the continuous monitoring system (TEOM) is to track potential dust impacts on a daily basis, to determine if earthworks contribute PM_{10} levels over and above the pre-determined background levels. Specifically where excursions above PM_{10} (24-hour) – 50 $\mu g/m^3$ are reported and shown to be attributed to the earthworks at the site, dust management measures can be implemented. Real time monitoring is important for large-scale projects where reactive management is likely to be implemented. The close proximity of site to neighbouring residential areas, and the potential requirement to cease works when wind speeds exceed 5 m/s or are from an incident wind direction (210 – 340 deg) indicates that real time monitoring will play an important role in all stages of construction.

Air monitoring should be considered to monitor the generation of airborne asbestos fibres. If this monitoring identifies that there may be a threat to human health it will be necessary to implement controls to ensure the safety of workers on site.

8.3.3 Meteorological Monitoring

A meteorological monitoring station should be installed at the site of the ILC when background monitoring commences.

The meteorological station is to be installed in accordance with:

- AS2922 – *Ambient Air – Guide for Siting of Sampling Units*; and
- AS2923 – *Ambient Air – Guide for the Measurement of Horizontal Wind for Air Quality Applications*.

Parameters to be collected include:

- wind speed;
- wind direction;
- temperature;
- humidity;
- solar radiation; and
- rainfall.

The primary purpose of the meteorological monitoring station is to collect data sufficient to identify adverse air quality impacts within nearest residential areas that can be attributed to construction earthworks.

9. Conclusions

9.1 General

This study provides the air quality assessment for construction and operation of the proposed Intermodal Logistics Centre at Enfield in accordance with the NSW Environment Protection Authority guidelines (2001) and Ambient Air Quality NEPM (NEPC, 1998). The highest risk impacts have been determined by comparisons of the modelled dispersion of site emissions against ambient air quality criteria.

Essentially the air quality assessment is an AUSPLUME air dispersion modelling study of two key air pollutants for the site: (1) Particulate matter (PM_{10}); and (2) Oxides of nitrogen (NO_x). This has included predicting the dispersion of PM_{10} from earthworks activities associated with construction of the proposed ILC and the dispersion of PM_{10} and NO_x from vehicle and machinery operations associated with the ILC operating at full capacity. The modelled NO_x impacts were converted to NO_2 impacts for comparisons with air quality criteria for NO_2.

9.2 ILC Construction Phase

The ILC construction phase will comprise extensive earthworks across the site, especially in the southern portion of the site where large stockpiles are located. The air quality assessment concludes that there is only a low risk of (off-site) impacts from PM_{10} due to earthworks, in residential areas to the southeast and far northwest of the site. This is with the caveat that dust mitigation measures are put in place, as detailed in this report.

The results of this modelling assessment were obtained by including the effects of dust mitigation measures such as maximum-rate watering for exposed areas with water trucks and water sprays on stockpiles. In addition, the modelling results include the effect of a halt to construction operations when the wind speeds are greater than 5 m/s or when (incident) wind direction is in the sector 210^o to 340^o. The modelling showed that this restriction may be necessary to reduce the risk of air quality impacts in residential areas to the southeast of the site to acceptable levels. An ‘acceptable level’ is the ‘trigger criterion’ for the site; that is, not more than 5 exceedences of 50 $\mu g/m^3$ for maximum 24-hour average PM_{10} – outside the site boundaries.

The conclusion to the construction air quality assessment is that, with the prescribed mitigation measures in place, the ambient air quality criteria for particulate matter and deposited dust would be met around the site borders. This could be shown during the construction phase by continual monitoring of 24-hourly average PM_{10} levels around the site. Showing that the 24-hourly PM_{10} criterion is met will indicate the other particulate matter and dust deposition criteria have been met also. Finally, a Dust Management Plan would be prepared as part of the Construction Environmental Management Plan, incorporating these conclusions.

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9.3 ILC Operations Phase

The air quality assessment of the ILC operations phase concludes that with emissions from a capacity ILC vehicle-and-machine fleet modelled 24 hours per day over the course of a year, the risk of air quality impact from the two key pollutants for this phase is very low.

For the assessment of on-site sources, the modelling showed that there may one day per annum on which the PM_{10} levels exceed 50 μg/m^3 in the higher risk area to the southeast of the site (due to prevailing winds). This single exceedence meets the ambient air quality NEPM criterion for PM_{10}, of 5 allowable exceedences. For the assessment of the off-site sources, the assessment of the air quality impacts from increases in vehicle traffic indicates that only marginal increases in PM_{10} and NO_2 concentrations can be expected. These are less than 1 μg/m^3 increase in the maximum 24-hour average PM_{10}, much less than the criterion of 50 μg/m^3, and approximately 7-9 μg/m^3 increase in hourly NO_2 levels, much less than the criterion of 246 μg/m^3. The modelling predicts no exceedences of the annual average criterion for PM_{10} (30 μg/m^3 criterion), and the hourly average criterion for NO_2 (246 μg/m^3), for all sources.

There are no specific mitigation measures recommended for operation of the ILC. However, an operational Environmental Management Plan (EMP) would be prepared which would include a program for the on-going management of air quality impacts associated with the ILC development.

9.4 Greenhouse Gas Assessment

The greenhouse impact of the ILC at Enfield is calculated by considering the decrease in truck Vehicle Kilometres Travelled (VKT) that will result from the project and the potential increase in rail VKT associated with the project.

Specifically considered is the change in GHG generated by transporting containers to/from container origin and destination points (COD-points) within the inner and middle western Sydney market via the proposal compared to the “No Change” case. The “No Change” case assumes the COD-points within the market will continue to be served by trucks direct to/from Port Botany. For the “With ILC” case the ILC COD-points will be served by trains from Port Botany to the ILC and trucks to/from the ILC. There will also be a newly created COD point at the ILC.

In terms of greenhouse gas impacts the Enfield ILC project will result in:

- Decreased truck CO_2 = 5,818 tonne CO_2 / annum; and
- Increased locomotive CO_2 = 4,825 tonne CO_2 / annum.

For the year 2016 this equates to an annualised reduction in CO_2 emissions of 993 tonnes CO_2 per annum within the Sydney airshed as a result on operation of the Enfield ILC. This demonstrates a greenhouse gas reduction in line with government strategies.

10. References

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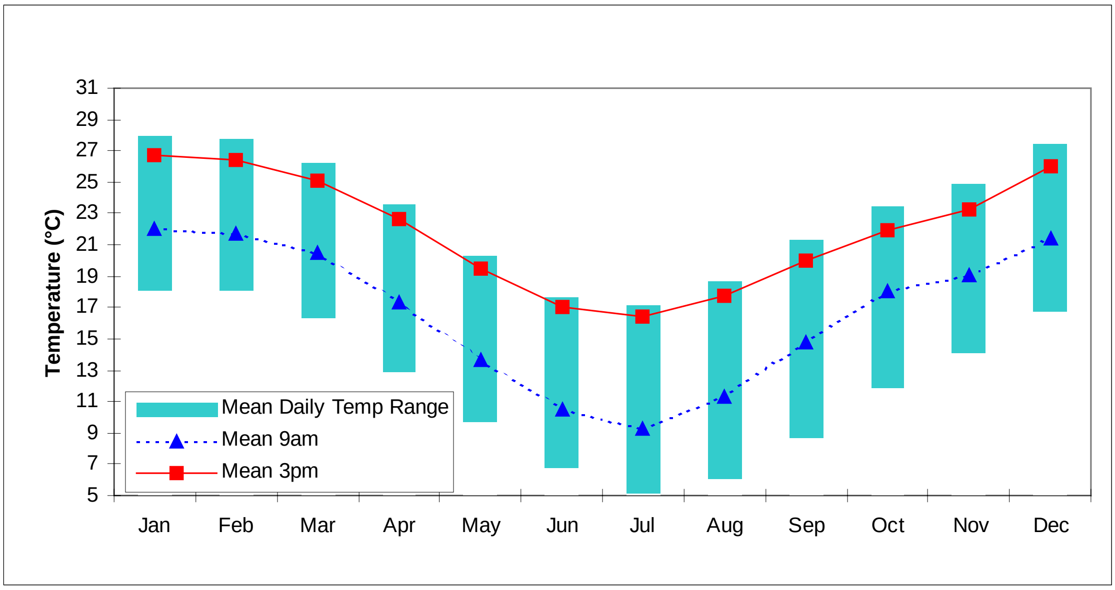
Appendix A Glossary & Abbreviations

Term / Abbreviation	Description
AP-42	Air Pollution Emission Factor Document (USEPA)
AS	Australian Standard
CFC	ChloroFluoroCarbon
CO	Carbon monoxide
DEC	Department of Environment and Conservation (NSW)
DEH	Department of the Environment and Heritage (Australian Government)
DELEC	Diesel ELECtric maintenance facility
EIS	Environmental Impact Statement
El Niño	Reversal of normal atmospheric circulation patters over the equatorial Pacific, resulting in drier than average weather along eastern Australia
EMP	Environmental Management Plan
EPA	Environment Protection Authority (NSW); now under DEC (NSW); refer to 'DEC'
FEL	Front End Loader
g/hp-hr	grams per horse power-hour
g/L	grams per litre
g/m^2/month	grams per square metre per month
HBIL	Health-Based Investigation Levels
HFC	HydroFluoroCarbon
Hp	horse power
HVAS	High Volume Air Sampler
km	Kilometres
litres/m^2/hr	Litres per square metre per hour
m/s	metres per second
mg/m^3	milligrams per cubic metre
MSB	Maritime Services Board
$\mu g/m^3$	micrograms per cubic metre (the Greek symbol 'mu' is used for 'micro')
NEPC	National Environment Protection Council
NEPM	National Environment Protection (Ambient Air Quality) Measure
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
NPI	National Pollutant Inventory
NSW EPA	Refer to 'EPA'

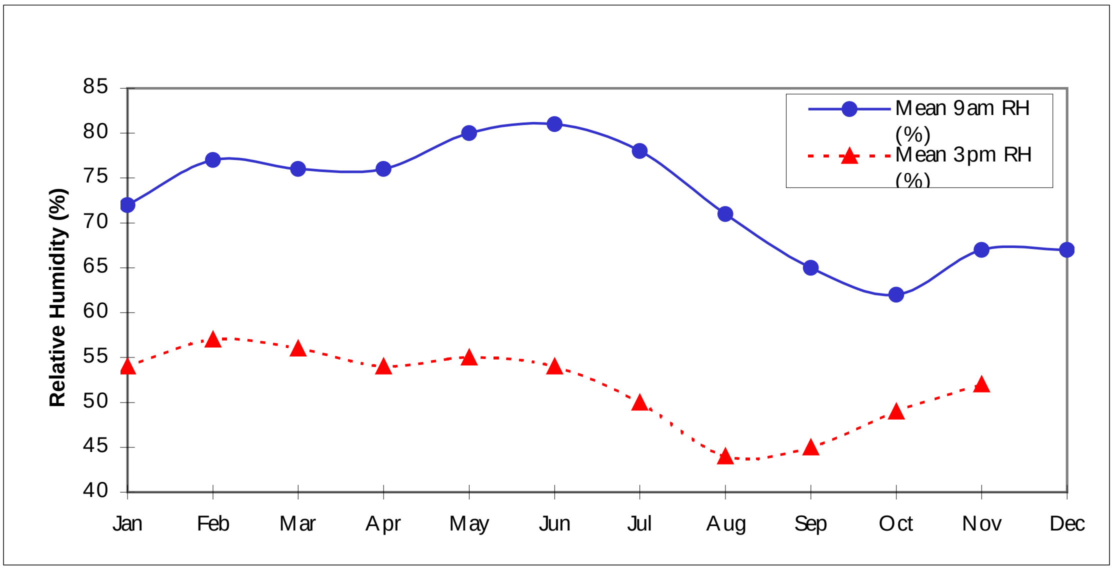
Term / Abbreviation	Description
O_3	ozone
PFC	PerFluoroCarbon
PM	Particulate Matter (no size reference)
$PM_{2.5}$	Particulate matter comprising particles aerodynamic diameters less than 2.5 µm
PM_{10}	Particulate matter with particles comprising aerodynamic diameters less than 10 µm
Pphm	parts per hundred million
Ppm	parts per million
SO_2	sulfur dioxide
SO_x	oxides of sulfur
SPC	Sydney Ports Corporation
TEOM	Tapered Element Oscillating Microbalance
Toll	Previous occupiers of part of the Enfield site
TPH	Total Petroleum Hydrocarbons
TSP	Total Suspended Particulates
USEPA	United States Environment Protection Agency
VOC	Volatile Organic Compound
VKT	Vehicle Kilometres Travelled

Appendix B Graphical Climate Summary

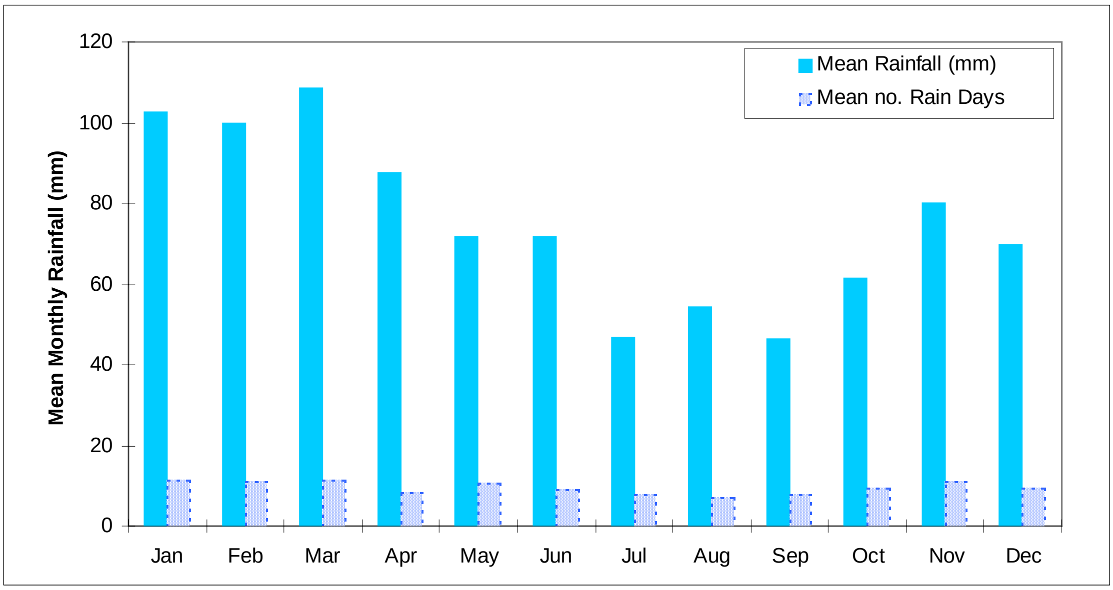
B.1 Bankstown Airport Temperature



B.2 Bankstown Airport Relative Humidity



B.3 Bankstown Airport Rainfall



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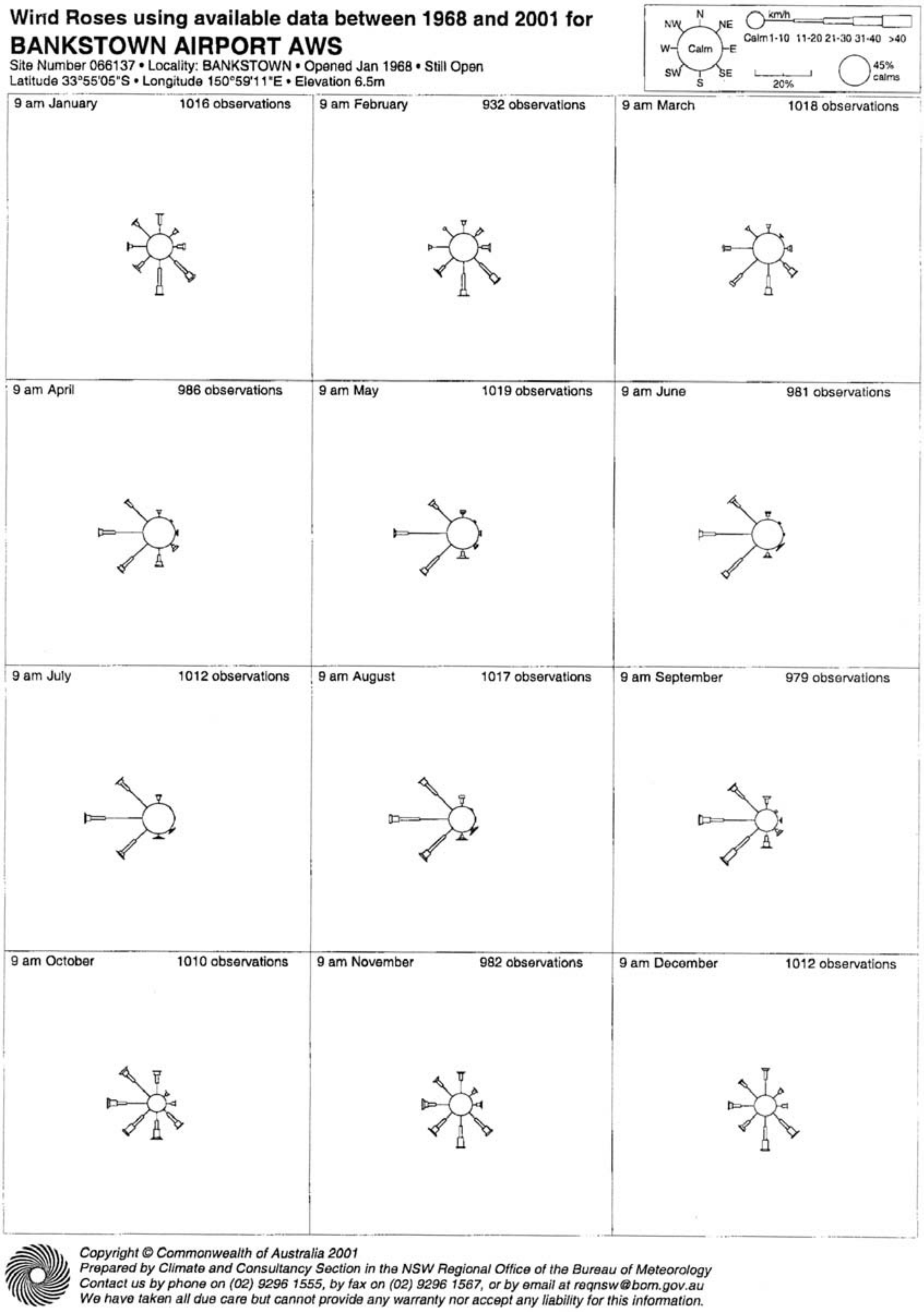
B.4 Bankstown Airport Windroses – 9am



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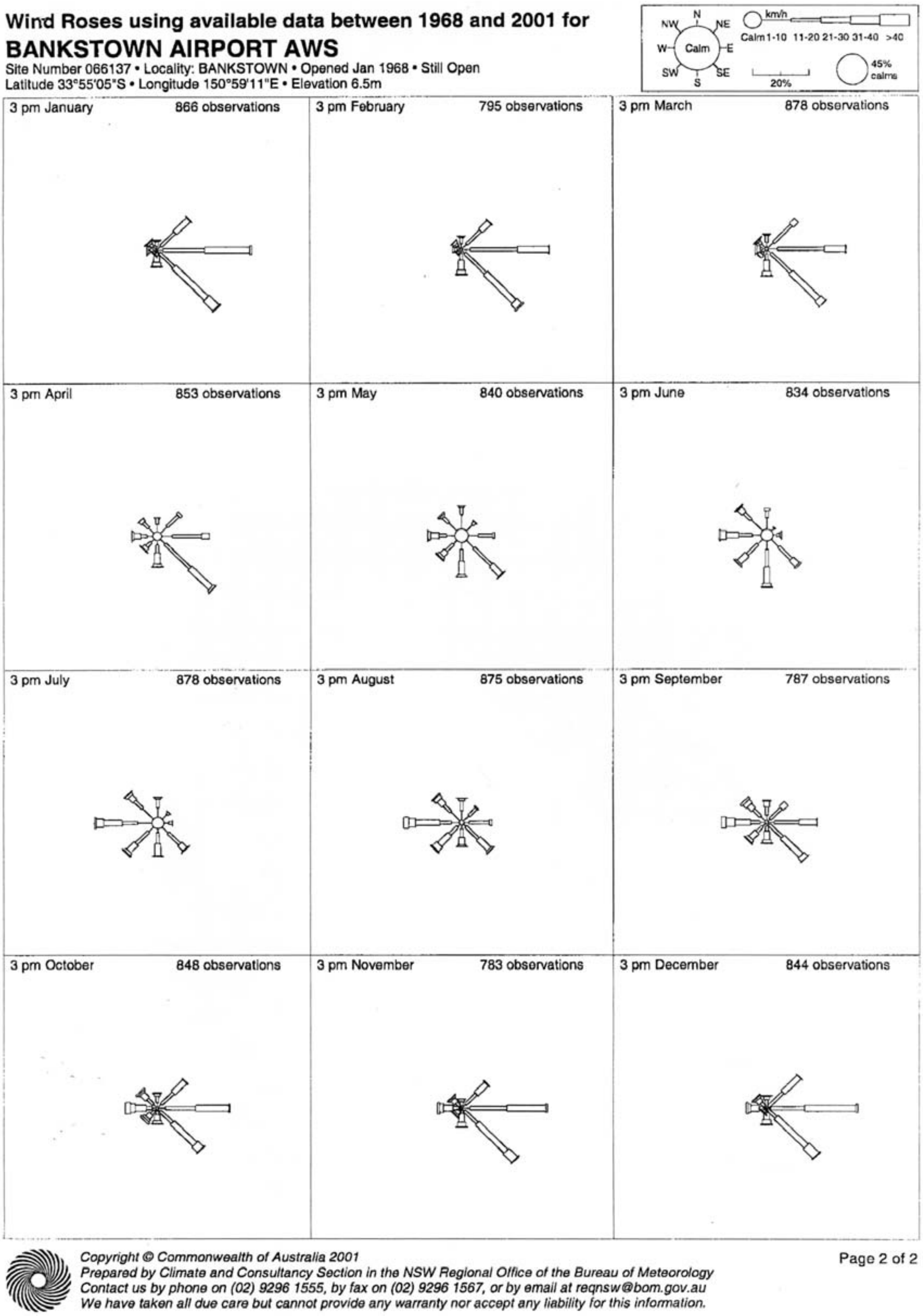
B.5 Bankstown Airport Windroses – 3pm



Appendix C Discussion of Air Quality Impacts from Remediation of Contaminated Soils

There is a risk of air quality impacts from emissions of hazardous substances within contaminated soils earmarked for remediation earthworks. The contaminants are: heavy metals, hydrocarbons and asbestos. The earthworks plan for Construction Stage 1 calls for landfarming or disposal of contaminated soils on-site or transportation off-site. The volumes involved are 12,000 m^3 (DELEC site), and 1,500 m^3 (remainder of site); refer to **Section 2.2.2**. While this air quality assessment has predicted particulate matter and dust deposition impacts from emissions of generic particle mass, there has been no quantitative assessment of the impacts of hazardous substances comprising particles lifted from contaminated soil.

Air quality impacts from emissions of contaminated soil could be modelled easily – given reliable information on the mass concentrations of the substances within the soils. However, even with analysis of soil core samples providing speciation information, it is unlikely there would be ample quality information for air dispersion modelling to provide reliable results on health and amenity impacts. The uncertainties in air dispersion modelling are large enough[16], without adding more from speciation of soils.

The solution is in two parts. The first part is applying stricter-than-usual dust mitigation measures during the remediation program. During remediation of the contaminated soil volumes, apart from all the dust mitigation measures already discussed in the report, such as Level 2 watering by trucks, and water sprays on exposed stockpiles, additional measures for an attempt for 'attempt at 100% dust control' would include:

- Undertaking contaminated soil earthworks only in the wind conditions specified in the report and only in allowable wind conditions that do not cause any visible dust emissions to occur over the ILC site and not be transported to any residential areas or other sensitive receptors;
- Water spraying of all activities involving movement of the soil; for example, spraying ahead into loaders/bulldozer/grader works;

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[16] The uncertainties in air dispersion modelling are controlled to a large extent by providing conservatively high estimates of the air quality impacts, and this is done first by calculating emission rates based on measured emissions data, and secondly by a history of cross-checking model results with air quality monitoring data.

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- Careful handling and loading (slow, and no dropping), of contaminated material to haul trucks including water sprays for this activity;
- Rapid covering of a truck load once loaded;
- Washing of truck including underside and wheels/tyres prior to its departure on a sealed road;
- Covering of freshly exposed contaminated soil stockpiles that are not being worked – perhaps by chemical spraying to congeal the soil surface; and
- Level 2 watering of all exposed areas including paved roads by water trucks to eliminate as much loose dust as possible during the works.

The second part of the solution is on-site real-time monitoring of those particles that do escape the strict dust-mitigation measures. Monitoring of PM_{10} would be undertaken by (say) TEOM or using standard laser-based particle monitoring techniques. The real-time data would be compared later with the most reliable and well-known techniques, such as HVAS.

During the soil remediation program, monitoring of the aerosol speciation of the soils should also be undertaken. This could be done, for example, by nuclear techniques applied by ANSTO. ANSTO has developed samplers to collect the $PM_{2.5}$ aerosol fraction on a thin teflon filter. The samplers and the analysis of the data are provided as a package by ANSTO to local Councils, Industry groups and State Environmental Protection Agencies. Similar work is also being performed overseas to study urban pollution problems (ANSTO).

In addition, air monitoring should be considered to monitor the generation of airborne asbestos fibres. If this monitoring identifies there may be a threat to human health it will be necessary to implement controls to ensure the safety of workers on site. A Hazard Materials Survey of buildings on site proposed to be demolished would need to be conducted to ensure any asbestos containing materials are identified and disposed of in a controlled manner.

In conclusion, the combination of very tight dust controls on-site combined with state-of-the-art monitoring of particulate matter including speciation of aerosols, should provide a workable, low-risk solution to the remediation of soils component of Construction Stage 1 for the ILC.