Dellara

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Orchard Hills Waste and Resource Management Facility

Air Quality Assessment

Prepared by:

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EXECUTIVE SUMMARY

This report has been prepared by PAEHolmes for R.W. Corkery & Co. Pty Limited who are in turn acting for Dellara Pty Ltd. The purpose of the study is to assess the likely air quality impacts of the proposed 'Orchard Hills' Waste and Resource Management Facility located in the western suburbs of Sydney, New South Wales. The proposed development would incorporate a waste recycling and recovery centre, an ancillary waste emplacement area and a clay/shale extraction operation.

The dust modelling results showed that the predicted 24-hour average PM_{10} concentrations for the modelled Scenario 1 showed exceedances at two sensitive receptors. Further analysis of these impacts showed that the exceedances occurred only one day throughout the year.

For all other modelled scenarios the predicted 24-hour and annual average PM_{10}, TSP and deposition levels at nearest sensitive receptors would be below the New South Wales Department of Environment, Climate Change and Water assessment criteria, even when existing background levels are included. The dust modelling has taken a conservative approach and impacts are likely to be less than predicted.

Odour levels at the nearest sensitive receptors were predicted to be below the most stringent assessment criterion noted by the DECCW. The results therefore suggest that there would be no adverse odour impacts associated with the project.

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1. INTRODUCTION

This report has been prepared by PAEHolmes for R.W. Corkery & Co. Pty Limited who are in turn acting for Dellara Pty Ltd (hereafter referred to as "the Proponent"). The purpose of the study is to assess the likely air quality impacts of the proposed 'Orchard Hills' Waste and Resource Management Facility (hereafter referred to as "the Project") located in the western suburbs of Sydney, New South Wales. The proposed development would incorporate a waste recycling and recovery centre, an ancillary waste emplacement area and a clay/shale extraction operation.

In summary, this report provides information on the following:

- Relevant air quality goals;
- Meteorological and climatic conditions in the area;
- A discussion of the existing air quality conditions in the area;
- The methods used to estimate dust and odour emissions from on-site activities;
- The expected dust and odour impacts due to emissions from the Project; and
- Greenhouse gas assessment.

2. LOCAL AREA AND PROJECT DESCRIPTION

The Project is located on the site of the former Erskine Park Quarry, in the western suburbs of Sydney. The Project Site is approximately 3km to the west of St Clair and Erskine Park and approximately 6km north of Badgerys Creek. (see **Figure 1**).

The environment surrounding the site is predominantly rural landscape comprised of grazing land and low density housing. To the immediate west of the Project Site is a densely vegetated reserve owned by the Commonwealth and used by the Australian Defence Force. To the north of the project is a residential subdivision referred to as "The Vines". The locations of all nearby sensitive receptors are shown in **Figure 1**. The topography surrounding the Project is relatively flat as presented in the pseudo-3D plot in **Figure 2**.

The Proponent is proposing to:

- accept an average of 300 000tpa of waste and a maximum of 600 000tpa;
- emplace an average of 140 000tpa to 200 000tpa of waste and a maximum of 450 000tpa;
- despatch an average of 100 000tpa to 160 000tpa of recycled / re-processed materials; and
- despatch an average of 200 000tpa of clay /shale and a maximum of 400 000tpa.

For the purposes of this assessment the following combinations of material receipt, emplacement and despatch have been assumed.

	Waste Received	Waste Emplaced	Recycled/re-processed Products Despatched	Clay/Shale Despatched
Typical:	300 000tpa	200 000tpa	100 000tpa	200 000tpa
Worst Case:	600 000tpa	450 000tpa	150 000tpa	nil

3. AIR QUALITY GOALS

3.1 Dust Assessment Criteria

When assessing any project with significant air emissions, it is necessary to compare the impacts of the project with relevant air quality goals. Air quality standards or goals are used to assess the potential for ambient air quality to give rise to adverse health or nuisance effects.

In its modelling and assessment guidelines, the New South Wales Department of Environment, Climate Change and Water (NSW DECCW) specifies air quality assessment criteria relevant for assessing impacts from dust generating activities (**NSW DEC, 2005**).

These criteria are consistent with the National Environment Protection Measures for Ambient Air Quality (referred to as the Ambient Air-NEPMs (see **NEPC, 1998**)). However, the NSW DECCW's criteria include averaging periods, which are not included in the Air-NEPMs, and references to other measures of air quality, namely dust deposition and total suspended particulate matter (TSP).

Table 3.1 summarises the air quality goals for dust that are relevant to the Project.

Table 3.1
Air quality impact assessment criteria for particulate matter concentrations

Pollutant	Standard / Goal	Averaging Period	Agency
Total suspended particulate matter (TSP)	90 $\mu g/m^3$	Annual mean	NSW DECCW
Particulate matter < 10 μm (PM_{10})	50 $\mu g/m^3$	24-hour maximum	NSW DECCW
	30 $\mu g/m^3$	Annual mean	NSW DECCW

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces and possibly on vegetation/crops. **Table 3.2** shows the dust deposition criteria set out in the DECCW Approved Methods for modelling and assessment (**NSW DEC, 2005**).

Table 3.2
NSW DECCW criteria for dust (insoluble solids) fallout

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

3.2 Odour Assessment Criteria

3.2.1 Measuring Odour Concentration

There are no instrument-based methods that can measure an odour response in the same way as the human nose. Therefore “dynamic olfactometry” is typically used as the basis of odour management by regulatory authorities.

Dynamic olfactometry is the measurement of odour by presenting a sample of odorous air to a panel of people with decreasing quantities of clean odour-free air. The panellists then note when the smell becomes detectable. The correlations between the known dilution ratios and the panellists’ responses are then used to calculate the number of dilutions of the original sample required to achieve the odour detection threshold. The units for odour measurement using dynamic olfactometry are “odour units” (ou) which are dimensionless and are effectively “dilutions to threshold”.

Olfactometry can involve a “forced choice” end point where panellists identify from multiple sniffing ports the one where odour is detected, regardless of whether they are sure they can detect odour. There is also a “yes/no” or “free choice” endpoint where panellists are required to say whether or not they can detect odour from one sniffing port. Forced choice olfactometry generally detects lower odour levels than yes/no olfactometry and is the preferred method for use in Australia.

In both cases, odorous air is presented to the panellists in increasing concentrations. For the forced-choice method, where there are multiple ports for each panellist, the concentration is increased until all panellists consistently distinguish the port with the sample from the blanks. For a yes/no olfactometer (which has only one sniffing port) one method used is to increase the concentration of odour in the sample until all panellists respond. The sample is then shut off and once all panellists cease to respond, the sample is introduced again at random dilutions and the panellists are asked whether they can detect the odour.

During the 1990s significant research was undertaken in Europe to refine the olfactometry method. This led to considerable improvements in panellist management and standardisation and, importantly, clear criteria for repeatability and reproducibility of results.

The draft Committé Européen de Normalisation (CEN) odour measurement standard (**CEN, 1996)** is a performance based standard with strict criteria for repeatability and reproducibility. The Australian standard AS4323.3 (introduced in September 2001) (**Standards Australia, 2001**) is based upon the CEN standard.

As with all sensory methods of identification there is variability between individuals. Consequently the results of odour measurements depend on the way in which the panel is selected and the way in which the panel responses are interpreted.

Relevant odour data has been obtained from odour testing conducted on a Class 2 landfill similar to the Project (**Holmes Air Sciences, 2007**).

3.3 Odour Performance Criteria

3.3.1 Introduction

The determination of air quality goals for odour and their use in the assessment of odour impacts is recognised as a difficult topic in air pollution science. The topic has received considerable attention in recent years and the procedures for assessing odour impacts using dispersion models have been refined considerably. There is still considerable debate in the scientific community about appropriate odour goals as determined by dispersion modelling.

The DECCW has developed odour goals and the way in which they should be applied with dispersion models to assess the likelihood of nuisance impacts arising from the emission of odour.

There are two factors that need to be considered:

1. what "level of exposure" to odour is considered acceptable to meet current community standards in NSW and
2. how can dispersion models be used to determine if a source of odour meets the goals which are based on this acceptable level of exposure

The term "level of exposure" has been used to reflect the fact that odour impacts are determined by several factors the most important of which are:

- the **F**requency of the exposure
- the **I**ntensity of the odour
- the **D**uration of the odour episodes and
- the **O**ffensiveness of the odour (the so-called FIDO factor)

In determining the offensiveness of an odour it needs to be recognised that for most odours the context in which an odour is perceived is also relevant. Some odours, for example the smell of sewage, hydrogen sulfide, butyric acid, landfill gas etc., are likely to be judged offensive regardless of the context in which they occur. Other odours such as the smell of jet fuel may be acceptable at an airport, but not in a house, and diesel exhaust may be acceptable near a busy road, but not in a restaurant.

In summary, whether or not an individual considers an odour to be a nuisance will depend on the FIDO factors outlined above and although it is possible to derive formulae for assessing odour annoyance in a community, the response of any individual to an odour is still unpredictable. Odour goals need to take account of these factors.

3.3.2 Complex Mixtures of Odorous Air Pollutants

The DECCW Approved Methods include ground-level concentration (glc) criterion for complex mixtures of odorous air pollutants. They have been refined by the DECCW to take account of population density in the area. **Table 3.3** lists the odour glc criterion to be exceeded not more than 1% of the time, for different population densities.

The difference between odour goals is based on considerations of risk of odour impact rather than differences in odour acceptability between urban and rural areas. For a given odour level there will be a wide range of responses in the population exposed to the odour. In a densely populated area there will therefore be a greater risk that some individuals within the community will find the odour unacceptable than in a sparsely populated area.

The Project Site is considered urban. Therefore, as shown in **Table 3.3**, the relevant impact assessment criterion for the site is 2ou **(NSW DEC, 2005)**.

Table 3.3
Odour Performance Criteria for the Assessment of Odour

Population of affected community	glc criterion for complex mixtures of odorous air pollutants (ou)
≤ ~2	7
~10	6
~30	5
~125	4
~500	3
Urban (2000) and/or schools and hospitals	2

3.3.3 Peak-to-mean Ratios

It is common practice to use dispersion models to determine compliance with odour goals. This introduces a complication because Gaussian dispersion models are only able to directly predict concentrations over an averaging period of 3-minutes or greater. The human nose, however, responds to odours over periods of the order of a second or so. During a 3-minute period, odour levels can fluctuate significantly above and below the mean depending on the nature of the source.

To determine more rigorously the ratio between the one-second peak concentrations and three-minute and longer period average concentrations (referred to as the peak-to-mean ratio) that might be predicted by a Gaussian dispersion model, the DECCW commissioned a study by **Katestone Scientific Pty Ltd (1995, 1998)**. This study recommended peak-to-mean ratios for a range of circumstances. The ratio is also dependent on atmospheric stability (discussed in **Section 4.2**) and the distance from the source. For area sources in the near-field, as applies in this case, the peak to-mean ratio is 2.5 for neutral conditions (stability class A-D) and 2.3 for stable conditions (stability class E-F). A summary of the factors is provided in **Appendix 3**.

The DECCW Approved Methods take account of this peaking factor and the goals shown in **Table 3.3** are based on nose-response time.

4. CLIMATE AND METEROLOGY

This section describes the local area, dispersion meteorology, local climatic conditions and existing dust levels in the area.

4.1 Climate Data

Climatic data collected over a 39-year period are available from the Bureau of Meteorology monitoring station located at Orchard Hills Treatment Works (The Chase - Station Number 067084), approximately 3.6km west of the Project.

Table 4.1 presents temperature and rainfall data collected at Orchard Hills Treatment Works. Temperature data cover a period of 19 years between 1970 and 1989, rainfall data cover a period of 39 years between 1970 and 2009 (**Bureau of Meteorology, 2009**). Temperature data consist of monthly averages of 9am and 3pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean and median monthly rainfall and the average number of raindays per month.

The annual average maximum and minimum temperatures experienced at Orchard Hills Treatment Works are 23.4°C and 11.6°C respectively. On average December is the hottest month with an average maximum temperature of 28.5°C. July is the coldest month, with an average minimum temperature of 5.3°C.

Rainfall data collected at the Orchard Hills Treatment Works site shows that February is the wettest month, with an average rainfall of 110.6mm. The driest month is September with an average monthly rainfall of 38.1mm. The average annual rainfall is 812.8mm.

Table 4.1
Temperature and rainfall data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9am Mean Temperature (□C) – Orchard Hills Treatment Works (The Chase)													
Mean	21.1	20.8	20.2	17.4	13.7	10.4	9.5	11.1	14.7	17.5	18.8	20.9	16.3
3pm Mean Temperature (°C) - Orchard Hills Treatment Works (The Chase)													
Mean	26.8	26.3	25.2	22.5	19.2	16.3	16.0	17.8	20.3	22.1	24.4	26.9	22.0
Daily Maximum Temperature (°C) - Orchard Hills Treatment Works (The Chase)													
Mean	28.3	27.8	26.5	23.8	20.4	17.3	17.2	18.9	21.8	23.9	25.8	28.5	23.4
Daily Minimum Temperature (°C) - Orchard Hills Treatment Works (The Chase)													
Mean	16.9	17.4	16.0	13.0	9.6	7.0	5.3	5.9	8.7	11.1	13.2	15.5	11.6
Rainfall (mm) - Orchard Hills Treatment Works (The Chase)													
Monthly mean -mm	103.6	110.6	90.2	65.7	65.4	51.4	38.3	40.7	38.1	59.0	78.2	70.9	812.8
Median -mm	96.0	99.2	72.9	43.0	46.6	31.8	21.0	17.0	31.9	44.2	61.9	50.0	743.5
Mean -days	8.4	8.7	7.8	6.1	5.9	4.8	4.4	3.8	5.2	6.8	7.8	7.0	76.7
Station number: 067084 Commenced 1970; Last record 2009; Elevation: 93m; Latitude:-33.80; Longitude: 150.71 Source: **Bureau of Meteorology (2009).**													

4.2 Meteorological Data

The dispersion model used for this assessment requires information about the dispersion characteristics of the area. In particular, data are required on wind speed, wind direction, atmospheric stability[1] categories expected in the area and mixing height[2]. Mixing height was determined using a scheme defined by **Powell (1976)** for day time conditions and an approach described by **Venkatram (1980)** for night time conditions.

The closest meteorological station to the Project that collects data suitable for modelling purposes is located at St Marys (St Marys DECCW monitoring station – Mamre Road) approximately 2.5km north-east of the Project (see **Figure 1**). **Figure 3** shows the annual and seasonal windroses compiled from the St Marys data for the period January 2007 to December 2007. On an annual basis, the data show a high frequency of winds from the south-southwest and to a lesser extent the south. In the summer, winds are predominantly from the south-southwest and south with a relatively even portion of winds ranging from east-northeast through to the south-southeast. In autumn and winter, the dominant wind occurs from the south-southwest, with minor winds from other directions. Winds during the winter months are from the south and south-southwest. On an annual basis, the mean wind speed for the St Marys site is 1.87m/s and the percentage of calms (wind speeds less than 0.5m/s) is 15.9 percent.

4.3 Atmospheric Stability

To use the wind data to assess dispersion, it is necessary to also have available data on atmospheric stability. **Table 4.2** presents a summary of the frequency of atmospheric stability classes at the site.

Class A (which occur 21.6% of the time) relates to unstable conditions such as might be found on a sunny day with light winds. In such conditions, the dispersion of pollutants is good. Class F (which occur 32.8% of the time) relates to stable conditions, such as occur at night time when the sky is clear, the winds are light and an inversion is present. Pollutant dispersion is slow in these circumstances.

Table 4.2
Frequency of atmospheric stability classes

Pasquill Gifford Stability Class	Frequency (%)
A	21.6
B	5.7
C	10.3
D	20.4
E	9.2
F	32.8
TOTAL	100.0

[1] In dispersion modelling stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford stability class assignment scheme, as used in this study, there are six stability classes A through to F. Class A relates to unstable conditions such as might be found on a sunny day with light winds. In such conditions plumes will spread rapidly. Class F relates to stable conditions, such as occur when the sky is clear, the winds are light and an inversion is present. Plume spreading is slow in these circumstances. The intermediate classes B, C, D and E relate to intermediate dispersion conditions.

[2] The term mixing height refers to the height of the turbulent layer of air near the earth's surface into which ground-level emissions will be rapidly mixed. A plume emitted above the mixed-layer will remain isolated from the ground until such time as the mixed-layer reaches the height of the plume. The height of the mixed-layer is controlled mainly by convection (resulting from solar heating of the ground) and by mechanically generated turbulence as the wind blows over the rough ground.

Joint wind speed, wind direction and stability class frequency tables for the St Marys meteorological station are presented in **Appendix 1**.

5. EXISTING AIR QUALITY

Air quality standards and goals refer to pollutant levels which include the project and existing sources. To fully assess impacts against all the relevant air quality standards and goals (detailed in **Section 3**), it is necessary to have information or estimates on existing dust concentration and deposition levels for the area in which the project is likely to contribute to these levels.

There has been no air quality monitoring undertaken specifically for this project however there is a DECCW monitoring site that measures particulate matter (PM_{10}) concentrations at St Marys (Mamre Road), approximately 2.5km northeast of the Project, using a Tapered Element Oscillating Microbalance (TEOM). Dust deposition monitoring is not available for this project; however estimates are made from the monitoring results obtained from the St Marys monitoring site.

Sources of particulate matter in the area would include traffic on unsealed roads, local building and construction activities, animal grazing activities and to a lesser extent traffic from the M4 motorway.

5.1.1 PM_{10} Concentration

Monitoring data from the DECCW monitoring station at St Marys have been reviewed to obtain information on PM_{10} concentrations. **Table 5.1** below summarises the TEOM measurements recorded at St Marys for 2007.

Table 5.1
Summary of DECCW PM_{10} monitoring data for St Marys 2007

Date	**Measured PM_{10} concentration ($\mu g/m^3$)**	
	Monthly average	**Maximum 24-hour average**
January	25	45
February	19	27
March	17	28
April	19	38
May	18	41
June	10	20
July	12	28
August	13	27
September	16	32
October	26	47
November	15	36
December	16	22
Average	**17**	**-**
Maximum	-	**47**

The TEOM measurements of PM_{10} show that, in 2007, 24-hour averages were below the 50μg/m^3 criterion. The highest 24-hour average PM_{10} concentration was 47μg/m^3, measured in October 2007. The annual average PM_{10} concentration (17μg/m^3) was below the 30μg/m^3 criterion.

Annual average TSP concentrations can be estimated from measured PM_{10} concentrations by assuming that 40% of the TSP is PM_{10}. This relationship was obtained from data collected by co-located TSP and PM_{10} monitors operated for reasonably long periods of time in the Hunter Valley (**NSW Minerals Council, 2000**). Use of this relationship indicates that annual average TSP concentrations are of the order of 42.5μg/m^3, which is less than the DECCW assessment criterion of 90μg/m^3.

Annual average dust deposition levels can be estimated in a similar process to the method used to estimate TSP concentrations by assuming a TSP concentration of 90μg/m^3 will have a corresponding dust deposition value of 4g/m^2/month. The use of this relationship indicates an annual average dust deposition of 1.9g/m^2/month for the area surrounding the Project.

The estimated value for dust deposition shown above has been compared to values obtained from monitoring presented in an air quality impact assessment prepared by Heggies Australia (**Heggies, 2006**) for Hanson Construction Materials Pty Limited. The Hanson site is located approximately 8km east-northeast of the Project Site. Dust deposition was measured at two locations (“Wonderland” and “Freeway”) to monitor activities at the quarry adjacent to the Hanson site. The precise location of the monitors could not be determined. The monitoring results for the period between January 2004 and July 2006 are shown below in **Table 5.2**.

Table 5.2
Dust deposition data for Hanson Construction Materials

Site	Monitoring period	Average insoluble solids (g/m^2/month)
“Wonderland”	January 2004 to July 2006	2.4
“Freeway”	January 2004 to July 2006	0.9
Average	-	**1.6**
Source: **Heggies Australia (2006)**		

Measured dust deposition levels were below the DECCW’s total dust deposition criterion of 4g/m^2/month. The average for both sites was 1.6g/m^2/month and this level has been assumed as representative of the existing dust deposition levels at the Project Site. However, for this assessment, we have taken a worst-case approach and used the estimated value of 1.9g/m^2/month.

From the monitoring data available, it has been assumed that the following background concentrations apply at the nearest sensitive receptors surrounding the Project Site.

- Annual average TSP of 42.5μg/m^3;
- Annual average PM_{10} of 17μg/m^3; and
- Annual average dust deposition of 1.9g/m^2/month

6. APPROACH TO ASSESSMENT

6.1 Dust Assessment

The approach taken for the dust assessment was as follows:

- Estimate annual dust emissions of each activity associated with typical and worst case operations;
- Provide emissions and meteorological information to a computer-based dispersion model to predict dust concentrations in the region and at nearest sensitive receptors; and
- Compare predicted concentrations with relevant air quality criteria.

This section is provided so that technical reviewers can appreciate how the modelling of different particle size categories was carried out.

Off-site dust levels due to the proposed facility have been predicted using AUSPLUME. AUSPLUME (Version 6.0) is an advanced Gaussian dispersion model developed on behalf of the Victorian EPA (**VEPA, 1986**) and is based on the United States Environmental Protection Agency's Industrial Source Complex (ISC) model. It is widely used throughout Australia and is regarded as a "state-of-the-art" model. AUSPLUME is the model required for use by the DECCW unless project characteristics dictate otherwise (**NSW DEC, 2005**).

The modelling has been based on the use of three particle-size categories (0 to 2.5 μm - referred to as FP (fine particulate matter), 2.5 to 10 μm - referred to as CM (coarse matter) and 10 to 30 μm - referred to as the Rest). Mass emission rates in each of these size ranges have been determined using the factors derived from the **SPCC (1986)** study and TSP emission rates calculated using emission factors derived primarily from **US EPA (1985)** work (see **Appendix 2**).

The distribution of particles in each particle size range is as follows:

- $PM_{2.5}$ (FP) is 4.7% of the TSP;
- $PM_{2.5-10}$ (CM) is 34.4% of TSP; and
- PM_{10-30} (Rest) is 60.9% of TSP.

Modelling was completed using three AUSPLUME source groups with each group corresponding to a particle size category. Each source in the group was assumed to emit at the full TSP emission rate and to deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mean of the limits of the particle size range, except for the $PM_{2.5}$ group, which was assumed to have a particle size of 1 μm. The predicted concentrations in the three plot output files for each group were then combined according to the weightings above (see bullet points preceding this paragraph) to determine the concentration of PM_{10} and TSP.

The AUSPLUME model also has the capacity to take into account dust emissions that vary in time, or with meteorological conditions. This has proved particularly useful for simulating emissions for operations where wind speed is an important factor in determining the rate at which dust is generated.

For the current study, six operational scenarios were modelled with the operations represented by a series of volume sources located according to the positions of the dust sources as they would be for the scenario being modelled. The location of the modelled dust sources for each of the scenarios modelled are presented in **Figure 5** to **Figure 9**. Estimates of emissions for each source were developed on an hourly time step taking into account the activities that would take place at that location. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of activity and the wind speed. It is important to do this in the AUSPLUME model to ensure that long-term average emission rates are not combined with worst-case dispersion conditions which are associated with light winds. Light winds at a Project Site such as this would correspond with periods of low dust generation (because wind erosion and other wind dependent emissions rates will be low) and also correspond with periods of poor dispersion. If these measures are not taken then the model has the potential to significantly overstate impacts.

Dust concentrations and deposition rates have been predicted over the area shown in **Figure 1**. Terrain has been considered in the modelling.

The modelling has been performed using the meteorological data discussed in **Section 4** and the dust emission estimates from **Section 7**. It has been assumed that each activity will occur between 7 am and 6 pm every day, except for wind erosion sources which have been modelled for 24 hours per day. Model predictions have been made at 195 discrete receptors (including nearest sensitive receptors) located in the study area. The location of these receptors has been chosen to provide finer resolution closer to the dust sources and nearby receptors. The AUSPLUME model input files can be provided in electronic form on request.

Dust impacts and model predictions using the AUSPLUME model are presented as contour plots in **Figure 10** to **Figure 58** and are discussed in **Section 8.**

6.2 Odour Assessment

The approach taken for the odour assessment was to use odour emissions data presented in **Section 7** and the meteorological information discussed in **Section 4** in the dispersion model AUSPLUME (Version 6.0) to predict off-site odour levels from the facility. Model predictions were then compared with the DECCW's odour assessment criteria.

The 99th percentile nose-response 1-hour average ground-level odour concentrations have been predicted at a set of receptors arranged in a grid of 100m spacing. Additional discrete receptors have been placed at nearby sensitive receptors to determine the impact at these locations.

Odour impacts and model predictions using the AUSPLUME model are presented as contour plots in **Figure 59** and are discussed in **Section 8**.

7. EMISSION ESTIMATION

7.1 Estimated Dust Emissions

Dust emissions arise from various activities at the site. Total dust emissions have been estimated by analysing the activities taking place at the Project for five stages of proposed operations.

- Scenario 1: Site establishment
- Scenario 2: Initial waste placement and recycling – typical operations
- Scenario 3a: Stage 2A waste operations – typical operations
- Scenario 3b: Stage 2A waste operations – worse case operations
- Scenario 4: Stage 3B operations – typical operations
- Scenario 5: Early morning operations

For Scenario 1, operations will occur over a six month period. However, to ensure the worst-case impacts are captured, it has been assumed that these activities occur for an entire year, and as such all emission estimations have been doubled.

Scenario 3b was chosen to represent the impacts when worst case operations are active. Activities occurring in this scenario predominantly take place within the northern side of the site, closest to the nearest sensitive receptors. It is expected that this scenario would represent the worst-case scenario for worse case operations and therefore should worst case operations occur during other scenarios these predictions would be considered conservative.

The operations which apply in each case have been combined with emission factors developed, both locally and by the US EPA, to estimate the amount of dust produced by each activity. The emission factors applied are considered to be the most up-to-date methods for determining dust generation rates. The fraction of fine, inhalable and coarse particles for each activity has been taken into account for the dispersion modelling.

The plans for the Project have been analysed and detailed emissions inventories have been prepared for the six scenarios considered.

The most significant dust generating activities from the proposed operations have been identified and the dust emission estimates for each scenario modelled are presented below in **Table 7.1** to **Table 7.6**. It should be noted that a proportion of material received and re-processed will have a low propensity for dust generation.

Details of the calculations of the dust emissions are presented in **Appendix 2**. The estimated emissions take account of proposed air pollution controls including active controls such as watering of haul routes to minimise dust emissions.

Table 7.1
Estimated dust emission due to proposed operations Scenario 1: Site establishment

ACTIVITY	TSP emission (kg/year)
A - Excavator (Recycling reprocessing area)	453
A - Compactor (Recycling reprocessing area)	453
A - Loading material to truck	453
A - Hauling material (unsealed road)	1,333
A - Hauling material (sealed road)	109
A - Dumping material	453
C - Scraper (Cell 1A) removing material	18,096
B - Scraper travelling	8,069
B - Scraper (Cell 1A) unloading material	24,960
C - Excavator (Audio-visual Mounds)	453
C - Loading material to truck	453
C - Hauling material (unsealed road)	854
C - Dumping material	453
D - Excavator (Dam 2)	453
D - Loading material to truck	453
D - Hauling material (unsealed road)	638
D - Dumping material	453
E - FEL (clay/shale in Cell 2)	73
E - Hauling clay/shale material (unsealed road)	555
E - Hauling clay/shale material (sealed road)	50
G - Hauling drainage aggregates (unsealed road)	44
G - Hauling drainage aggregates (sealed road)	4
G - Dumping drainage aggregates	11
Wind erosion from exposed areas	94,608

Table 7.2
Estimated dust emission due to proposed operations
Scenario 2: Initial waste placement and recycling

ACTIVITY	TSP emission (kg/year)
A - Hauling waste (Recycling reprocessing area) (unsealed road)	108
A - Hauling waste (Recycling reprocessing area) (sealed road)	73
A - Dumping waste	2,003
B - Compacting waste (Cell 1A)	1,335
C - Dozer Ripping (Cell1B)	5,538
C - Scraper (Cell 1A) removing material	18,096
C - Scraper travelling	5,259
C - Scraper (Cell 1A) unloading material	12,480
D - FEL (clay/shale)	73
D - Hauling clay/shale material (unsealed road)	277
D - Hauling clay/shale material (sealed road)	25
E - FEL (Recycling plant in Recycling reprocessing area)	1,335
F - Excavator (Recycling reprocessing area)	227
F - Loading material to truck	227
F - Hauling material (unsealed road)	744
F - Dumping material	227
G - Hauling drainage aggregates (unsealed road)	166
G - Hauling drainage aggregates (sealed road)	14
G - Dumping drainage aggregates	5
I - FEL (Perimeter bund walls in Cell 2)	8,307
I - Loading material to truck	227
I - Hauling material (unsealed)	752
I - Hauling material (sealed)	54
I - Dumping material (Recycling reprocessing area)	227
J - Compacting waste (Recycling reprocessing area)	2,003
K - FEL (Recycled product)	668
K - Hauling recycled product (unsealed road)	36
K - Hauling recycled product (sealed road)	24
Wind erosion from exposed area	77,088

Table 7.3
Estimated dust emission due to proposed operations Scenario 3a: Stage 2A waste operations

ACTIVITY	TSP emission (kg/year)
A - Hauling waste (Cell 2) (unsealed road)	150
A - Dumping waste	1,335
B - Hauling waste for recycling (Recycling reprocessing area) (unsealed road)	390
B - Hauling waste for recycling (Recycling reprocessing area) (sealed road)	75
B - Dumping waste for recycling	2,003
C - Compacting waste (Cell 2)	1,335
C - Scraper (Cell 2A) removing material	18,096
D - Scraper travelling	7,773
D - Scraper (Cell 2A) unloading material	12,480
E - Excavator (Cell 3)	227
F - FEL (clay/shale in Cell 3)	1,335
F - Hauling clay/shale material (unsealed road)	128
F - Hauling clay/shale material (sealed road)	16
H - Hauling drainage aggregates (unsealed road)	234
H - Hauling drainage aggregates (sealed road)	28
H - Dumping drainage aggregates	5
I - FEL (Recycling plant)	2,003
J - Hauling Clay-capping (Cell 1) (unsealed road)	128
J - Hauling Clay-capping (Cell 1) (sealed road)	4
J - Dumping Clay-capping (Cell 1)	21
K - Compactor (Cell 1)	227
K - Dozer shaping (Cell 1)	5,538
Wind erosion from exposed area	87,600

Table 7.4
Estimated dust emission due to proposed operations Scenario 3b: Stage 2A waste operations (worst case operations)

ACTIVITY	TSP emission (kg/year)
A - Hauling waste (Cell 2) (unsealed road)	338
A - Dumping waste	3,004
B - Hauling waste for recycling (Recycling reprocessing area) (unsealed road)	780
B - Hauling waste for recycling (Recycling reprocessing area) (sealed road)	150
B - Dumping waste for recycling	4,005
C - Compacting waste (Cell 2)	3,004
C - Scraper (Cell 2A) removing material	18,096
D - Scraper travelling	7,773
D - Scraper (Cell 2A) unloading material	12,480
E - Excavator (Cell 3)	227
F - FEL (clay/shale in Cell 3)	1,335
F - Hauling clay/shale material (unsealed road)	0
F - Hauling clay/shale material (sealed road)	0
H - Hauling drainage aggregates (unsealed road)	234
H - Hauling drainage aggregates (sealed road)	28
H - Dumping drainage aggregates	5
I - FEL (Recycling plant)	4,005
J - Hauling Clay-capping (Cell 1) (unsealed road)	128
J - Hauling Clay-capping (Cell 1) (sealed road)	4
J - Dumping Clay-capping (Cell 1)	21
K - Compactor (Cell 1)	227
K - Dozer shaping (Cell 1)	5,538
Wind erosion from exposed area	87,600

Table 7.5
Estimated dust emission due to proposed operations Scenario 4: Stage 3B operations

ACTIVITY	TSP emission (kg/year)
A - Hauling waste (Cell 3) (unsealed road)	136
A - Dumping waste (Cell 3)	1,335
B - Hauling waste for recycling (Recycling reprocessing area) (unsealed road)	307
B - Hauling waste for recycling (Recycling reprocessing area) (sealed road)	73
B - Dumping waste for recycling (Recycling reprocessing area)	2,003
C - Compacting waste (Cell 3)	1,335
D - Excavator (Cell 3)	227
D - Dozer (Cell 3)	5,538
D - Loading material to truck	227
D - Hauling material	382
D - Dumping material	227
E - FEL (clay/shale in Cell 3)	1,335
E - Hauling clay/shale material (unsealed road)	118
E - Hauling clay/shale material (sealed road)	18
F - FEL (Recycling plant in Recycling reprocessing area)	2,003
G - Hauling Clay-capping (Cell 3) (unsealed road)	68
G - Dumping Clay-capping (Cell 3)	21
H - Compactor (Cell 3)	227
H - Dozer (Cell 3)	5,538
Wind erosion from exposed area	49,056

Table 7.6
Estimated dust emission due to proposed operations Scenario 5: Early morning operations

ACTIVITY	TSP emission (kg/year)
A - Hauling waste for recycling (Recycling reprocessing area) (unsealed road)	1,644
A - Hauling waste for recycling (Recycling reprocessing area) (sealed road)	400
A - Dumping waste for recycling (Recycling reprocessing area)	2003
A - Hauling waste for recycling (Cell 1A) (unsealed road)	1,428
A - Dumping waste for recycling (Cell 1A)	2003
B - FEL (Recycled product)	2,003
B - Hauling (Recycled product) (off-site from Recycling reprocessing area) (unsealed road)	200
B - Hauling (Recycled product) (off-site from Recycling reprocessing area) (sealed road)	25
Wind erosion from exposed area	38,544

7.2 Estimated Odour Emissions

Odour emissions from area sources are probably the most difficult to measure for a variety of reasons. Firstly the source is often heterogeneous. For example in the case of landfill sites, there will be different odour emission rates from different sections of the landfill. Secondly, unlike stack emissions, area emission rates are dependent upon atmospheric conditions including wind speed, degree of turbulence, temperature, etc. This clearly adds another level of complexity to odour assessments.

The landfill will be categorised as a Class 2 landfill, signifying that no putrescible waste will be accepted. Nevertheless, odours can be produced over time from biodegradable material. In practice, Class 2 landfills have historically accepted a wider range of materials than those proposed to be accepted as part of this project. However, it has been assumed, for the purposes of this assessment, that odour emissions for historical Class 2 landfills are relevant. These emissions will be referred to as “standard” Class 2 odour emissions.

There are limited odour emissions data available for Class 2 landfills. Measurements made for a non-putrescible landfill site after six months (**CEE, 1994**) have indicated levels of approximately 0.5 $ou.m^3/m^2/min$ (certainty units). Odours from the site will reach their maximum after a number of years (perhaps 4 years), when it is estimated that emissions may increase by a factor of 14. That is, to model for a worst-case scenario it is necessary to take into account the potential increase in odour over time to approximately 7 $ou.m^3/m^2/min$ (or 0.117 $ou.m^3/m^2/s$). These worst-case emissions however, will not occur over the whole area. As the landfill progresses, emissions from the previously capped cells will rise to a peak and then fall again.

This variation in emission rates may occur in a similar fashion to that suggested by the **Maunsell (1994)** model in **Figure 4**. Assuming that the peak for the proposed landfill operation will be approximately 0.117 $ou.m^3/m^2/s$, the profile of this landfill gas model was used to estimate the emissions for the time period specified on the graph (30 years). An average emission rate was then taken to apply for the landfill area.

As the proportion of biodegradable material accepted to landfill for this project will be low (and substantially lower than that accepted by Class 2 landfills in the 1990s), a proportionate reduction to the standard Class 2 odour emissions is considered to be appropriate. At a similar landfill site operated by Dial-a-dump Industries in Alexandria, the total amount of organic or biodegradable material received in 2006 was 5,282 tonnes (**Holmes Air Sciences, 2007**). In the past, all of this would have been landfilled at a standard Class 2 operation. However, under the modern operating conditions most of the materials were recovered or recycled and, of the 5,282 tonnes of organic and potentially biodegradable materials, only 32 tonnes actually went to landfill. Thus, less than 1% was landfilled [32 / 5282 = 0.6%]. As a conservative approach, odour emissions from capped areas have therefore been taken to be 5% of the standard historical Class 2 odour emissions.

In addition to odours from capped areas, there may be small quantities of odour emitted from the active tipping face and the initial leachate evaporation pond and initial stormwater leachate dam. Odour measurements from the active tipping face and leachate pond at the Englands Road Waste Management Facility in Coffs Harbour (**Holmes Air Sciences, 2008**) have been used to estimate the odour impact. Odour emissions from two different active tipping surfaces were measured; no cover and temporary cloth cover. The cloth cover has been assumed as a suitable representation of the Virgin Excavated Natural Material cover that will be used on-site.

The odour sources within the initial leachate evaporation pond and initial stormwater leachate dam (located in Cell 3) would be removed once the long-term leachate evaporation pond and final stormwater leachate dam become operational mid way through the operational life of Cell 3.

Once the long-term leachate evaporation pond and final stormwater leachate dam are in operation, the odour sources from the pond and dam will be located further from the sensitive receptors in “The Vines” estate, thus reducing the overall odour impact at these locations.

Preliminary odour modelling (completed as part of sensitivity testing undertaken to ensure assessment of the worst-case operations) confirmed that operation of the long-term leachate pond and final stormwater leachate dam has lower odour impacts at the sensitive receptors to the north within “The Vines” estate. It is unlikely that odour generated from the pond and dam would have significant odour impacts, regardless of their location.

Table 7.7 provides the quantitative information on each odour source used in the dispersion modelling. Odour emissions in the dispersion model have been multiplied by the recommended peak-to-mean ratios for different source types (see **Appendix 3**) to predict odour levels for nose response times. Peak-to-mean factors for the near-field have been applied for the purposes of this assessment. For area sources, these factors have numerical values of 2.5 for unstable and neutral atmospheric conditions and 2.3 for stable conditions in the near field.

Table 7.7
Odour sources and emissions used in the dispersion modelling

Source	**Area (m^2)**	**SOER ($ou.m^3/m^2/s$)**	**SOER with peak-to-mean ($ou.m^3/m^2/s$)**	
			Neutral (2.5)	**Stable (2.3)**
Capped areas – Cell 1	118,363	0.00255*	0.00637	0.00586
Capped areas – Cell 2A	44,104	0.00255*	0.00637	0.00586
Active Tipping (Daily Cover) – Cell 2B	44,363	0.062	0.155	0.1426
Active Tipping (No Cover)– Cell 2B	1,600	0.428	1.07	0.9844
Initial leachate evaporation pond and initial stormwater leachate dam	9,337	0.022	0.055	0.0506

** 5% of estimated average odour emissions from standard Class 2 landfills*
SOER = Specific Odour Emission Rate.
Actual areas may be smaller than modelled

The odour emissions shown in **Table 7.7** have been taken to represent the "upper limit" of emissions from the landfill activities, given the tight controls on materials that will be accepted for landfill, the low proportion of biodegradable materials and the assumed maximum extents of odour emitting surfaces.

This assessment has considered that Cells 1 and 2A have been filled and capped. Active waste emplacement is occurring in Cell 2B with an active tipping face of 1,600m^2 located at the northern end of the cell; the remainder of the cell is covered daily with a temporary cover as the cell is progressively filled (see **Figure 10**). It is anticipated that this scenario will represent a possible *worst-case* impact from the Project at the sensitive receptors located to the north and is applicable to both typical and worse-case operations.

8. ASSESSMENT OF IMPACTS

8.1 Assessment of Dust Impacts

The air quality criteria used for identifying which properties are likely to experience air quality impacts are those specified by the DECCW as well as in the DECCW's modelling guidelines. These are discussed in **Section 3**.

The following sections provide a summary of the modelling results for each year at each of the sensitive receptors in the proximity of the Project. The locations of these receptors are shown in **Figure 1**. These results include predicted impacts from the Project alone and cumulative impacts from the Project plus existing background levels.

Dust concentrations due to operations on-site have been presented in isopleth diagrams showing the following:

1. Predicted maximum 24-hour average PM_{10} concentration;
2. Predicted annual average PM_{10} concentration;
3. Predicted annual average TSP concentration; and
4. Predicted annual average dust deposition.

To assess predicted concentrations over a 24-hour period, it is more complicated than simply adding a constant average 24-hour background concentration to the model results. PM_{10} averages vary considerably from day-to-day as they are subject to the local meteorological conditions at the time. Adding the maximum measured 24-hour average PM_{10} concentration to the predicted maximum 24-hour average concentration over a year would represent a very conservative approach as it is unlikely that the worst-case emissions from the Project would occur at the same time as the highest background concentrations.

The predicted 24-hour PM_{10} cumulative impacts have been modelled with concurrent PM_{10} and meteorological data from the DECCW monitoring station at St Marys.

It should be noted that vegetation reduces TSP and PM_{10} emissions by up to 30% (**Warren, 1973**). However the air quality modelling has not taken into account the screening impact of the vegetation that exists between the proposed operations and the sensitive receptors, and as such the predicted concentrations of TSP and PM_{10} represent a conservative approach.

In examining the maximum 24-hour average contour plot it should be noted that this does not represent the dispersion pattern for any particular day, but shows the highest predicted 24-hour average concentrations that occurred at each location for the worst day in the year. The maxima are used to show concentrations which can possibly be reached under the modelled conditions.

It is important to note that the isopleth figures are presented to provide a visual representation of the predicted impacts. To produce the isopleths it is necessary to make interpolations, and as a result the isopleths will not always match exactly with predicted impacts at any specific location. The actual predicted impacts at the sensitive receptors are presented in tabular form.

8.1.1 Scenario 1 – Site Establishment

Figure 10 to **Figure 14** show the predicted 24-hour and annual average PM_{10}, annual average TSP and dust deposition levels for the Project alone and **Figure 15** to **Figure 18** show the 24-hour and annual average PM_{10}, annual average TSP and dust deposition including background impacts during Scenario 1.

Table 8.1 presents a summary of the Scenario 1 predicted concentrations at each of the nearby sensitive receptors due to the operations of the Project.

Modelling results for Scenario 1 show exceedances of the DECCW PM_{10} 24-hour average goal at two sensitive receptors, "V" and "W" as shown in **Figure 15**.

Table 8.1
Dispersion modelling predictions for Scenario 1

Sensitive receptors ID	Scenario 1							
	PM_{10} 24-hour (µg/m^3)		PM_{10} Annual (µg/m^3)		TSP Annual (µg/m^3)		Dust Deposition (g/m^2/month)	
	Project only	Cumulative	Project only	Cumulative	Project only	Cumulative	Project only	Cumulative
	Criteria 50		*Criteria 30*		*Criteria 90*		*Criteria 2.0*	*Criteria 4.0*
A	12.3	47	0.6	18	0.7	43	0.1	2.0
B	16.2	47	0.6	18	0.8	43	0.1	2.0
C	4.4	47	0.3	17	0.3	43	0.1	2.0
D	4.8	47	0.3	17	0.3	43	0.0	1.9
E	4.4	47	0.2	17	0.3	43	0.0	1.9
F	4.0	47	0.2	17	0.3	43	0.0	1.9
G	3.5	47	0.2	17	0.3	43	0.0	1.9
H	3.1	47	0.2	17	0.2	43	0.0	1.9
I	3.6	47	0.2	17	0.2	43	0.0	1.9
J	3.6	47	0.2	17	0.2	43	0.0	1.9
K	3.6	47	0.2	17	0.3	43	0.0	1.9
L	3.6	47	0.2	17	0.3	43	0.0	1.9
M	3.6	47	0.2	17	0.3	43	0.0	1.9
N	3.6	47	0.2	17	0.3	43	0.0	1.9
O	3.6	47	0.2	17	0.3	43	0.0	1.9
P	3.6	47	0.2	17	0.3	43	0.0	1.9
Q	3.7	47	0.2	17	0.3	43	0.0	1.9
R	3.9	47	0.2	17	0.3	43	0.0	1.9
S	4.1	47	0.2	17	0.3	43	0.0	1.9
T	4.2	47	0.2	17	0.3	43	0.0	1.9
U	14.2	48	1.5	18	1.8	44	0.2	2.1
V	32.5	51	3.2	20	4.1	47	0.4	2.3
W	33.5	51	4.6	22	6.0	48	0.5	2.4
X	23.9	50	2.7	20	3.4	46	0.3	2.2

Further analysis of the impacts at receptors "V" and "W" are shown in **Table 8.2** and **Table 8.3** respectively. The left side of the table shows the total predicted concentration on days with the highest background, and the right side shows the total predicted concentration on days with the highest predicted incremental ground-level concentrations. This single exceedance occurs on a day when the background is high (45µg/m^3) and the predicted increment from the project alone is relatively low (5µg/m^3).

These data show that there are no predicted exceedances due to the operation of the Project alone and that exceedance of the 24-hour average goal is only predicted to occur on one occasion throughout the year at both receptors "V" and "W".

It is important to note that the air quality modelling has not taken into account the screening impact of the vegetation that exists between the Project location and the sensitive receptors; as such the predicted PM_{10} concentrations represent a conservative approach.

Table 8.2
Further analysis for sensitive receptor "V"

Date	PM_{10} 24-hour average (µg/m^3)			Date	PM_{10} 24-hour average (µg/m^3)		
	Background	Predicted increment	Total		Background	Highest predicted increment	Total
22/10/2007	46.9	2.1	48.9	23/06/2007	10.2	31.9	42.1
12/01/2007	45.3	5.5	50.8	13/06/2007	8.1	18.9	27.0
20/10/2007	44.6	1.2	45.8	16/05/2007	25.7	18.1	43.8
4/05/2007	40.7	0.7	41.4	11/06/2007	12.6	16.4	28.9
23/01/2007	40.4	0.3	40.6	8/06/2007	8.2	15.6	23.8
30/01/2007	40.3	0.0	40.3	22/06/2007	7.8	14.4	22.2
21/04/2007	38.4	1.1	39.5	5/09/2007	9.7	14.0	23.6
23/10/2007	37.3	0.8	38.1	29/03/2007	22.7	13.6	36.3
8/01/2007	36.7	2.6	39.2	26/06/2007	7.2	13.4	20.6
23/06/2007	10.2	32.0	42.2	14/07/2007	9.5	12.0	21.6

Table 8.3
Further analysis for sensitive receptor "W"

Date	PM_{10} 24-hour average (µg/m^3)			Date	PM_{10} 24-hour average (µg/m^3)		
	Background	Predicted increment	Total		Background	Highest predicted increment	Total
22/10/2007	46.9	2.9	49.7	11/06/2007	33.5	12.6	46.0
12/01/2007	45.3	5.4	50.6	19/08/2007	25.6	10.0	35.6
20/10/2007	44.6	3.1	47.7	6/06/2007	23.3	18.0	41.3
4/05/2007	40.7	4.7	45.4	14/07/2007	22.7	9.5	32.2
23/01/2007	40.4	0.3	40.6	9/04/2007	22.4	7.7	30.1
30/01/2007	40.3	0.4	40.6	21/08/2007	19.6	10.4	30.0
30/10/2007	39.1	1.6	40.6	18/08/2007	19.3	14.3	33.5
21/04/2007	38.4	1.1	39.5	24/06/2007	18.5	13.9	32.3
23/10/2007	37.3	1.0	38.3	20/08/2007	17.7	8.2	26.0
8/01/2007	36.7	1.5	38.1	19/04/2007	17.5	25.1	42.6

8.1.2 Scenario 2 – Initial Waste Emplacement and Recycling (Typical Operations)

Figure 19 to **Figure 22** show the predicted 24-hour and annual average PM_{10}, annual average TSP and dust deposition levels for the Project alone and **Figure 23** to **Figure 26** show the predicted 24-hour and annual average PM_{10}, annual average TSP and dust deposition levels including background impacts during Scenario 2.

Table 8.4 presents a summary of the Scenario 2 predicted concentrations at each of the nearby sensitive receptors due to the operations of the Project.

Modelling results for Scenario 2 show no exceedances of the NEPM and DECCW goals at any of the sensitive receptors.

Table 8.4
Dispersion modelling predictions for Scenario 2

Sensitive receptors ID	Scenario 2							
	PM_{10} 24-hour ($\mu g/m^3$)		PM_{10} Annual ($\mu g/m^3$)		TSP Annual ($\mu g/m^3$)		Dust Deposition (g/m^2/month)	
	Project only	Cumulative	Project only	Cumulative	Project only	Cumulative	Project only	Cumulative
	Criteria 50		*Criteria 30*		*Criteria 90*		*Criteria 2.0*	*Criteria 4.0*
A	7.7	47	0.4	17	0.5	43	0.0	1.9
B	9.5	47	0.5	18	0.7	43	0.1	2.0
C	4.1	47	0.2	17	0.3	43	0.0	1.9
D	3.4	47	0.2	17	0.3	43	0.0	1.9
E	3.5	47	0.2	17	0.3	43	0.0	1.9
F	2.9	47	0.2	17	0.3	43	0.0	1.9
G	2.1	47	0.2	17	0.2	43	0.0	1.9
H	2.0	47	0.2	17	0.2	43	0.0	1.9
I	2.7	47	0.2	17	0.2	43	0.0	1.9
J	2.8	47	0.2	17	0.2	43	0.0	1.9
K	3.0	47	0.2	17	0.2	43	0.0	1.9
L	3.1	47	0.2	17	0.2	43	0.0	1.9
M	3.2	47	0.2	17	0.3	43	0.0	1.9
N	3.4	47	0.2	17	0.3	43	0.0	1.9
O	3.6	47	0.2	17	0.3	43	0.0	1.9
P	3.9	47	0.2	17	0.3	43	0.0	1.9
Q	4.2	47	0.2	17	0.3	43	0.0	1.9
R	4.4	47	0.2	17	0.3	43	0.0	1.9
S	4.8	47	0.2	17	0.3	43	0.0	1.9
T	5.2	47	0.2	17	0.3	43	0.0	1.9
U	7.8	47	0.8	18	1.0	44	0.1	2.0
V	14.4	48	1.7	19	2.2	45	0.3	2.2
W	15.5	49	2.2	19	2.9	45	0.3	2.2
X	8.8	48	1.5	18	1.9	44	0.2	2.1

8.1.3 Scenario 3a – Stage 2A Waste Operations (Typical Operations)

Figure 27 to **Figure 30** show the predicted 24-hour and annual average PM_{10}, annual average TSP and dust deposition levels for the Project alone and **Figure 31** to **Figure 34** show the predicted 24-hour and annual average PM_{10}, annual average TSP and dust deposition levels including background impacts during Scenario 3a.

Table 8.5 presents a summary of the Scenario 3a predicted concentrations at each of the nearby sensitive receptors due to the operations of the Project.

Modelling results for Scenario 3a show no exceedances of the NEPM and DECCW goals at any of the sensitive receptors.

Table 8.5
Dispersion modelling predictions for Scenario 3a

Sensitive receptors ID	Scenario 3a							
	PM_{10} 24-hour ($\mu g/m^3$)		PM_{10} Annual ($\mu g/m^3$)		TSP Annual ($\mu g/m^3$)		Dust Deposition (g/m^2/month)	
	Project only	Cumulative	Project only	Cumulative	Project only	Cumulative	Project only	Cumulative
	Criteria 50		*Criteria 30*		*Criteria 90*		*Criteria 2.0*	*Criteria 4.0*
A	7.7	47	0.5	17	0.6	43	0.1	2.0
B	11.0	47	0.7	18	0.8	43	0.1	2.0
C	4.0	47	0.3	17	0.4	43	0.1	2.0
D	4.0	47	0.3	17	0.4	43	0.1	2.0
E	3.6	47	0.2	17	0.3	43	0.0	1.9
F	3.1	47	0.2	17	0.3	43	0.0	1.9
G	2.5	47	0.2	17	0.3	43	0.0	1.9
H	2.2	47	0.2	17	0.2	43	0.0	1.9
I	2.6	47	0.2	17	0.2	43	0.0	1.9
J	2.6	47	0.2	17	0.2	43	0.0	1.9
K	2.8	47	0.2	17	0.3	43	0.0	1.9
L	2.9	47	0.2	17	0.3	43	0.0	1.9
M	3.1	47	0.2	17	0.3	43	0.0	1.9
N	3.3	47	0.2	17	0.3	43	0.0	1.9
O	3.6	47	0.2	17	0.3	43	0.0	1.9
P	3.9	47	0.2	17	0.3	43	0.0	1.9
Q	4.2	47	0.2	17	0.3	43	0.0	1.9
R	4.5	47	0.2	17	0.3	43	0.1	2.0
S	4.9	47	0.3	17	0.3	43	0.1	2.0
T	5.4	47	0.3	17	0.4	43	0.1	2.0
U	8.2	48	0.7	18	0.9	43	0.1	2.0
V	10.7	48	1.2	18	1.6	44	0.2	2.1
W	17.8	49	2.0	19	2.7	45	0.3	2.2
X	13.1	48	1.7	19	2.2	45	0.2	2.1

8.1.4 Scenario 3b – Stage 2A Waste Operations (Worst-Case Operations)

Figure 35 to **Figure 38** show the predicted 24-hour and annual average PM_{10}, annual average TSP and dust deposition levels for the Project alone and **Figure 39** to **Figure 42** show the predicted 24-hour and annual average PM_{10}, annual average TSP and dust deposition levels including background impacts during Scenario 3b.

Table 8.6 presents a summary of the Scenario 3b predicted concentrations at each of the nearby sensitive receptors due to the operations of the Project.

Modelling results for Scenario 3b show no exceedances of the NEPM and DECCW goals at any of the sensitive receptors.

Table 8.6
Dispersion modelling predictions for Scenario 3b

Sensitive receptors ID	Scenario 3b							
	PM_{10} 24-hour ($\mu g/m^3$)		PM_{10} Annual ($\mu g/m^3$)		TSP Annual ($\mu g/m^3$)		Dust Deposition (g/m^2/month)	
	Project only	Cumulative	Project only	Cumulative	Project only	Cumulative	Project only	Cumulative
	Criteria 50		*Criteria 30*		*Criteria 90*		*Criteria 2.0*	*Criteria 4.0*
A	8.2	47	0.5	18	0.6	43	0.1	2.0
B	11.8	47	0.7	18	0.9	43	0.1	2.0
C	4.2	47	0.3	17	0.4	43	0.1	2.0
D	4.2	47	0.3	17	0.4	43	0.1	2.0
E	3.7	47	0.3	17	0.3	43	0.1	2.0
F	3.3	47	0.2	17	0.3	43	0.0	1.9
G	2.7	47	0.2	17	0.3	43	0.0	1.9
H	2.3	47	0.2	17	0.2	43	0.0	1.9
I	2.7	47	0.2	17	0.3	43	0.0	1.9
J	2.7	47	0.2	17	0.3	43	0.0	1.9
K	2.8	47	0.2	17	0.3	43	0.0	1.9
L	3.0	47	0.2	17	0.3	43	0.0	1.9
M	3.2	47	0.2	17	0.3	43	0.0	1.9
N	3.5	47	0.2	17	0.3	43	0.0	1.9
O	3.7	47	0.2	17	0.3	43	0.0	1.9
P	4.1	47	0.2	17	0.3	43	0.0	1.9
Q	4.4	47	0.3	17	0.3	43	0.1	2.0
R	4.8	47	0.3	17	0.3	43	0.1	2.0
S	5.1	47	0.3	17	0.4	43	0.1	2.0
T	5.7	47	0.3	17	0.4	43	0.1	2.0
U	8.5	48	0.7	18	0.9	43	0.1	2.0
V	11.6	48	1.3	18	1.7	44	0.3	2.2
W	18.4	49	2.1	19	2.8	45	0.3	2.2
X	13.3	48	1.8	19	2.3	45	0.2	2.1

8.1.5 Scenario 4

Figure 43 to **Figure 45** show the predicted 24-hour and annual average PM_{10}, annual average TSP and dust deposition levels for the Project alone and **Figure 47** to **Figure 50** show the predicted 24-hour and annual average PM_{10}, annual average TSP and dust deposition levels including background impacts during Scenario 4.

Table 8.7 presents a summary of the Scenario 4 predicted concentrations at each of the nearby sensitive receptors due to the operations of the Project.

Modelling results for Scenario 4 show no exceedances of the NEPM and DECCW goals at any of the sensitive receptors.

Table 8.7
Dispersion modelling predictions for Scenario 4

Sensitive receptors ID	Scenario 4							
	PM_{10} 24-hour ($\mu g/m^3$)		PM_{10} Annual ($\mu g/m^3$)		TSP Annual ($\mu g/m^3$)		Dust Deposition (g/m^2/month)	
	Project only	Cumulative	Project only	Cumulative	Project only	Cumulative	Project only	Cumulative
	Criteria 50		*Criteria 30*		*Criteria 90*		*Criteria 2.0*	*Criteria 4.0*
A	3.4	47	0.2	17	0.3	43	0.0	1.9
B	6.8	47	0.3	17	0.3	43	0.0	1.9
C	2.3	47	0.1	17	0.2	43	0.0	1.9
D	2.0	47	0.1	17	0.2	43	0.0	1.9
E	1.9	47	0.1	17	0.2	43	0.0	1.9
F	1.6	47	0.1	17	0.1	43	0.0	1.9
G	1.2	47	0.1	17	0.1	43	0.0	1.9
H	1.1	47	0.1	17	0.1	43	0.0	1.9
I	1.4	47	0.1	17	0.1	43	0.0	1.9
J	1.5	47	0.1	17	0.1	43	0.0	1.9
K	1.6	47	0.1	17	0.1	43	0.0	1.9
L	1.7	47	0.1	17	0.1	43	0.0	1.9
M	1.7	47	0.1	17	0.1	43	0.0	1.9
N	1.8	47	0.1	17	0.1	43	0.0	1.9
O	1.9	47	0.1	17	0.1	43	0.0	1.9
P	2.0	47	0.1	17	0.1	43	0.0	1.9
Q	2.2	47	0.1	17	0.2	43	0.0	1.9
R	2.3	47	0.1	17	0.2	43	0.0	1.9
S	2.4	47	0.1	17	0.2	43	0.0	1.9
T	2.5	47	0.1	17	0.2	43	0.0	1.9
U	3.0	47	0.3	17	0.4	43	0.0	1.9
V	5.2	47	0.5	17	0.6	43	0.1	2.0
W	6.3	48	0.8	18	1.0	43	0.1	2.0
X	6.0	47	0.7	18	0.9	43	0.1	2.0

8.1.6 Scenario 5 – Early Morning Operations

Figure 51 to **Figure 54** show the predicted 24-hour and annual average PM_{10}, annual average TSP and dust deposition levels for the Project alone and **Figure 55** to **Figure 58** show the predicted 24-hour and annual average PM_{10}, annual average TSP and dust deposition levels including background impacts during Scenario 5.

Table 8.8 presents a summary of the Scenario 5 predicted concentrations at each of the nearby sensitive receptors due to the operations of the Project.

Modelling results for Scenario 5 show no exceedances of the NEPM and DECCW goals at any of the sensitive receptors.

Table 8.8
Dispersion modelling predictions for Scenario 5

Sensitive receptors ID	Scenario 5							
	PM$_{10}$ 24-hour (µg/m^3)		PM$_{10}$ Annual (µg/m^3)		TSP Annual (µg/m^3)		Dust Deposition (g/m^2/month)	
	Project only	Cumulative	Project only	Cumulative	Project only	Cumulative	Project only	Cumulative
	Criteria *50*		*Criteria* *30*		*Criteria* *90*		*Criteria* *2.0*	*Criteria* *4.0*
A	2.1	47	0.1	17	0.1	43	0.0	1.9
B	3.0	47	0.1	17	0.1	43	0.0	1.9
C	1.7	47	0.1	17	0.1	43	0.0	1.9
D	1.5	47	0.1	17	0.1	43	0.0	1.9
E	1.4	47	0.1	17	0.1	43	0.0	1.9
F	1.2	47	0.1	17	0.1	43	0.0	1.9
G	1.0	47	0.1	17	0.1	43	0.0	1.9
H	0.9	47	0.0	17	0.1	43	0.0	1.9
I	1.1	47	0.0	17	0.1	43	0.0	1.9
J	1.1	47	0.0	17	0.1	43	0.0	1.9
K	1.2	47	0.0	17	0.1	43	0.0	1.9
L	1.2	47	0.1	17	0.1	43	0.0	1.9
M	1.3	47	0.1	17	0.1	43	0.0	1.9
N	1.3	47	0.1	17	0.1	43	0.0	1.9
O	1.4	47	0.1	17	0.1	43	0.0	1.9
P	1.4	47	0.1	17	0.1	43	0.0	1.9
Q	1.5	47	0.1	17	0.1	43	0.0	1.9
R	1.6	47	0.1	17	0.1	43	0.0	1.9
S	1.6	47	0.1	17	0.1	43	0.0	1.9
T	1.7	47	0.1	17	0.1	43	0.0	1.9
U	2.4	47	0.2	17	0.3	43	0.0	1.9
V	4.6	47	0.4	17	0.5	43	0.1	2.0
W	5.3	47	0.6	18	0.7	43	0.1	2.0
X	4.6	47	0.4	17	0.6	43	0.1	2.0

8.2 Assessment of Odour Impacts

Odour modelling results are shown in **Figure 59**. The contour plot presented shows the 99th percentile odour levels averaged over 1-hour periods.

At the 99th percentile the model results show that the 2 ou criterion does not extend into any residential areas.

Table 8.9 outlines the results for the maximum odour concentrations at twenty-four discrete receptors as seen in **Figure 1**.

Table 8.9
99^{th} percentile 1-hour average predicted ground level odour concentrations at the sensitive receptors

Sensitive receptors ID	Easting (m)	Northing (m)	99^{th} percentile 1-hour average (ou)
A	292284	6256897	0.4
B	292218	6256492	0.5
C	292609	6255580	0.2
D	292484	6255422	0.2
E	292639	6255439	0.2
F	292615	6255271	0.2
G	292610	6255090	0.2
H	292798	6255010	0.1
I	292823	6255204	0.1
J	292840	6255252	0.1
K	292833	6255307	0.1
L	292828	6255355	0.1
M	292817	6255400	0.2
N	292807	6255460	0.2
O	292808	6255501	0.2
P	292790	6255554	0.2
Q	292779	6255597	0.2
R	292768	6255645	0.2
S	292754	6255690	0.2
T	292746	6255743	0.2
U	291025	6257911	0.4
V	290968	6257412	0.8
W	291254	6257366	1.1
X	291525	6257501	0.8

The type of odour likely to be generated from the Project would smell significantly different to the odour generated from a putrescible waste landfill due to the lack of organic material emplaced. It is anticipated that the presence of methanethiol, the pungent odour reminiscent of bad eggs, would be minimal (**Young and Parker, 1984**).

As a conservative assessment, the model output has not considered the progressive filling sequence of each cell. It is therefore assumed that the whole site would be emitting odour at the maximum rate. With this taken into consideration the impact would be further reduced.

9. MITIGATION AND MONITORING OF DUST

9.1 Mitigation of Dust

The following procedures are proposed to manage dust emissions from the Project. The aim of these procedures is to minimise the emission of dust from the various dust generating activities taking place. The effect of these measures has been included in the model simulations.

Dust from the proposed project can be generated from two primary sources, these being:

- Windblown dust from exposed areas; and
- Dust generated by operational activities.

Table 9.1
Control procedures for dust

Source	**Control procedures**
Exposed areas	Disturb the minimum area necessary for operations to take place. Rehabilitate completed areas as soon as practical.
Operational activities	Use of water cart to minimise dust generation where applicable.

9.2 Monitoring of Dust

The Proponent has proposed to establish a network of deposited dust gauges around the Project Site. This network would enable the Proponent to validate the predicted modelled impacts presented in this assessment.

In total, seven gauges are proposed near the residences V, W, Y, A, B, C and T. The exact location of the gauges would be established in consultation with the respective landowners.

In the unlikely event that the deposited dust gauges identify incremental deposited dust levels attributed to the facility approaching 1 g/m^2/month or 50% of the criteria value, the Proponent would install a high volume air sampler to record PM_{10} concentrations in the vicinity of the gauge(s) with elevated levels.

The proposed air quality monitoring network would be reviewed throughout the life of the Project to ensure that only meaningful data is collected. All results of the dust monitoring program would be provided to the respective land owners, and presented in full with an evaluation of the results in each AEMR.

9.3 Impacts of Dust on Vegetation and Animals

Dust can have both physical and chemical effects on plants. Of particular concern are the physical effects; including blockage and damage to stomata, shading, and abrasion of leaf surface or cuticle. A study by **Yang (1988)** noted that dust deposition levels of 0.75 to 1.5 g/m^2/day (i.e. 22 to 45g/m^2/month) would not result in adverse effects on plant production.

Hence, the maximum predicted dust deposition levels are well below this level of impact and no adverse effect on nearby vegetation is expected to occur.

Studies have also shown that in the normal course of events, cattle ingest up to 1kg of dust per year without detrimental impacts on their health (**Healy, 1968**) and a trial conducted in the Hunter Valley (**Andrews and Sirskandarajah, 1992**) have demonstrated that the production of dairy cows is not impacted by the presence of coal dust on pasture.

Husbandry animals located in the area surrounding the Project Site are not expected to experience greater detrimental effects due to dust from the Project than would be otherwise experienced by horses and other mammals kept and raced in Sydney and other cities where PM_{10} concentrations are likely to be higher.

10. GREENHOUSE GAS ASSESSMENT

10.1 International Framework

10.1.1 Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) is a panel established in 1988 by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP), to provide independent scientific advice on climate change. The panel was asked to prepare, based on available scientific information, a report on all aspects relevant to climate change and its impacts and to formulate realistic response strategies. This first assessment report of the IPCC served as the basis for negotiating the United Nations Framework Convention on Climate Change (UNFCCC).

Since the UNFCCC has entered into force, the IPCC remains the pivotal source for its scientific, technical and socio-economic information.

The stated aims of the IPCC are to assess scientific information relevant to:

- Human-induced climate change;
- The impacts of human-induced climate change; and
- Options for adaptation and mitigation.

The fourth IPCC assessment report was released in 2007 (**IPCC, 2007**). IPCC reports are widely cited in climate change debates and policies, and are generally regarded as authoritative.

10.1.2 United Nations Framework Convention on Climate Change (UNFCCC)

The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognises that the climate system is a shared resource, the stability of which can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys near universal membership, with 183 countries (Parties) having ratified the contained treaty, the Kyoto Protocol – see **Section 10.1.2.1**. Australia ratified the Kyoto Protocol in December 2007.

Under the UNFCCC, governments:

- Gather and share information on greenhouse gas emissions, national policies and best practices;
- Launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries; and
- Cooperate in preparing for adaptation to the impacts of climate change.

10.1.2.1 Kyoto Protocol

The Kyoto Protocol entered into force on 16 February 2005.

The Kyoto Protocol builds upon the UNFCC by committing Annex I Parties to individual, legally-binding targets to limit or reduce their GHG emissions for the following gases:

- Carbon dioxide (CO2);
- Methane (CH4);
- Nitrous oxide (N2O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs); and
- Sulfur hexafluoride (SF6)

The emission reduction targets are calculated based on a Party's domestic emission greenhouse inventories (which include the sectors land use change and forestry clearing, transportation, stationary energy, etc). Domestic inventories require approval by the Kyoto Enforcement Branch. The Kyoto Protocol requires developed countries to meet national targets for greenhouse gas emissions over a five year period between 2008 and 2012.

To achieve their targets, Annex I Parties must put in place *domestic policies and measures.* The Kyoto Protocol provides an indicative list of policies and measures that might help mitigate climate change and promote sustainable development.

Under the Kyoto Protocol, developed countries can use a number of flexible mechanisms to assist in meeting their targets. These are trading-based market mechanisms which include:

- Joint Implementation (JI) – where developed countries invest in GHG emission reduction projects in other developed countries; and
- Clean Development Mechanism (CDM) – where developed countries invest in GHG emission reduction projects in developing countries.

Annex I countries that fail to meet their emissions reduction targets during the 2008-2012 period may be liable for a 30 percent penalty, to be made up in the post 2012 commitment period.

10.2 Australian Context

10.2.1 Australia and the Kyoto Protocol

The Kyoto Protocol is an international agreement under the United Nations Framework on Climate Change (UNFCC) that was agreed in 1997. As of January 2009 it has been ratified by 183 countries. Australia ratified the protocol in December 2007.

The aim of the Protocol is to reduce global greenhouse gas emissions by requiring developed countries to meet national targets for greenhouse gas emissions over the five year period from 2008 to 2012. Australia's annual target is 108% of the 1990 emissions.

Countries are required to take on a range of monitoring and reporting commitments, which are designed to ensure they remain on track to meet their obligations and to measure the overall success of the Protocol. Australia is in the process of developing a Carbon Pollution Reduction Scheme to ensure compliance with its Kyoto targets and successive international agreements to constrain greenhouse emissions.

10.2.1.1 National Greenhouse and Energy Reporting Act

The *National Greenhouse and Energy Reporting (NGER) Act 2007* was passed in September 2007. The NGER Act establishes a mandatory corporate reporting system for greenhouse gas emissions, energy consumption and production. The NGER scheme consolidates existing greenhouse reporting schemes.

The NGER Act is underpinned by a number of legislative instruments that provide greater detail about obligations, which in conjunction with the NGER Act, form the National Greenhouse and Energy Reporting System, as follows:

- The National Greenhouse and Energy Reporting Regulations 2008;
- The National Greenhouse and Energy Reporting (Measurement) Determination 2008; and
- The proposed External Audit Legislative Instrument which is still under development.

NGER is seen as an important first step in the establishment of a domestic emissions trading scheme. This intention is explicitly stated in the objectives for the NGER scheme, as follows:

- Establish a baseline of emissions for participants in a future Australian emissions trading scheme;
- Inform the Australian public;
- Meet international reporting obligations;
- Assist policy formulation of all Australian governments while avoiding duplication of similar reporting requirements.

Companies must register and report if they emit greenhouse emissions or produce/consume energy at or above the following trigger thresholds:

- If they own facilities that emit greater than 25kt greenhouse emissions (expressed as CO_2-e) or produce/ consume greater than 100 TJ of energy;
- If the corporate group emits greater than 125kt of greenhouse emissions (expressed as CO_2-e) or produce/ consume greater than 500TJ of energy.

A project is required to report to the NGER system if it will emit greater than 25kt of greenhouse emissions. As such, the Project would not be subject to the reporting under the system in Year 1. However it is predicted that in Year 31 the Project may be subject to the system based on initial estimates (see **Section 10.5**).

10.2.1.2 Carbon Pollution Reduction Scheme

A green paper detailing Australia's plans to implement a domestic emissions trading scheme was released on the 16 July 2008 (**DCC, 2008a**). A subsequent white paper was released in December 2008 (**DCC, 2008b**) with the intent that a Carbon Pollution Reduction Scheme (CPRS) would commence in July 2010. Due to the global financial crisis, the start date has been deferred to July 2011. Legislation was introduced to Parliament in May 2009, but at the time of writing had not been finalised.

The CPRS is 'cap and trade' emissions trading mechanism scheme whereby emitters of greenhouse gases greater than 25,000t carbon dioxide-equivalent (CO_2-e) are required to purchase a permit for every tonne of greenhouse gas that they emit. As such, the Project would not be subject to the scheme (see **Section 10.5**).

10.3 Greenhouse Gas Inventories

Greenhouse gas inventories are calculated according to a number of different methods. The procedures specified under the Kyoto Protocol United Nations Framework Convention on Climate Change are the most common.

The protocol nominates the following greenhouse gases:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)

From the point of view of the proposed development, there will be no residual CH_4 emissions due to the proposed collection and oxidation of the small quantities of CH_4 likely to be generated, N_2O emissions will be minimal, and there will be no release of HFCs or PFCs. Therefore, only CO_2 emissions have been considered.

CO_2 would be the most significant gas for the project which would be formed and released during the combustion of diesel fuel. It would be liberated when fuels are burnt in diesel powered equipment and in the generation of the electrical energy that will be used at the site.

Inventories of greenhouse gas emissions can be calculated using published emission factors. Different gases have different greenhouse warming effects (referred to as warming potentials) and emission factors take into account the global warming potentials of the gases created during combustion.

The estimated emissions are referred to in terms of CO_2-equivalent (CO_2-e) emission by applying the relevant global warming potential.

10.4 Greenhouse Emission Calculation Methodology

10.4.1 Introduction

The following formula (**DCC, 2009a**) was used to estimate the greenhouse gas emissions from fuel usage:

$$GHG\ Emissions\ (tCO_2 - e) = \frac{Q \times EC \times EF}{1000}$$

$$GHG\ Emissions\ (tCO_2 - e) = \frac{Q \times EC \times EF}{1000}$$

Equation 1

Where:

Q = quantity of fuel in tonnes or thousands of litres
EC = energy content of the fuel in GJ/tonne or GJ/kL
EF = relevant emission factor in kg CO_2-e/GJ

To calculate emissions from electricity usage, the following equation was used:

$$GHG\ Emissions\ (tCO_2 - e) = Q \times \frac{EF}{1000}$$

Equation 2

Where:

Q = electricity consumed in GJ
EF = relevant emission factor in kg CO_2-e/GJ

10.4.2 Emission Factors

Data provided in the National Greenhouse Accounts (NGA) Factors, published by the Department of Climate Change (**DCC, 2009a**) were used. DCC defines three 'scopes' (or emission categories):

- Scope 1 covers direct emissions from sources within the project boundary such as fuel combustion and manufacturing processes
- Scope 2 covers indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation.
- Scope 3 includes all other indirect emissions that are a consequence of the organisations activities but are not from sources owned or controlled by the organisations, for example, production of diesel fuel, off-site transport of the product, or staff travel etc.

For the purposes of this assessment, a full fuel cycle emission factor (that is the sum of scope 1, scope 2 and 3 emission factors, where applicable) has been used.

Table 10.1 provides a summary of the emission factors used.

Table 10.1
Summary of emission factors for greenhouse gas assessment

Type of Fuels and Electricity	Emission factor		Scope	Source
Diesel - Non-transport activities	69.5	kg CO_2-e/GJ	1	Table 3 (**DCC, 2009a**)
	5.3	kg CO_2-e/GJ	3	Table 38 (**DCC, 2009a**)
Diesel - Transport activities	69.9	kg CO_2-e/GJ	1	Table 3 (**DCC, 2009a**)
	5.3	kg CO_2-e/GJ	3	Table 38 (**DCC, 2009a**)
Electricity	0.89	kg CO_2-e/kWh	2	Table 39 (**DCC, 2009a**)
	0.18	kg CO_2-e/kWh	3	Table 3 (**DCC, 2009a**)

10.4.3 Fuel and Electricity Usage

Based on information provided by the Proponent, **Table 10.2** presents a summary of annual on-site diesel fuel usage.

Table 10.2
Summary of on-site diesel usage (L/y)

Equipment type	No. in use	Fuel consumption rate (L/h)	Equipment usage per day (hours)	Diesel usage per year (L/y)
D9 Bulldozer	1	25	5	39,000
Excavator	1	17	5	26,520
Compactor	1	36	5	56,160
Utility	1	1	12	3,744
Articulated truck	2	23	3	43,056
Generator	1	5	10	15,600
Impact crusher	1	45	4	56,160
Trommel	1	17	5	26,520
Jaw crusher	1	30	3	28,080
			Total per year (L/y)	**294,840**

Source: Dellara Pty Ltd

There will also be diesel consumption in the transport of the product clay / shale to customers. Based on the assumption that an average of 200,000tpa of product will be transported from the site in 30t trucks with an average return travel distance of 24km per load and the average fuel consumption of articulated trucks being 54.6 litres per 100 kilometres (**ABS, 2007**), the annual fuel usage to transport the product is 87,360L/y ((200,000 [t/y] / 30 [t/trip]) * 24 [km/trip] * 0.546 [L/km]).

The energy content of diesel was taken to be 38.6GJ/kL (**DCC, 2009a**).

Hours of operation for the Project are assumed to be 65 hours per week and 52 weeks per year. Recycling equipment usage is estimated at 60% of the hours of operation. **Table 10.3** presents a summary of annual on-site electricity usage.

Table 10.3
Summary of on-site electricity usage (kWh/y)

Equipment type	No. in use	Power rating (kWh)	Power usage per year (kWh/y)
Shredder	1	264	535,392
Picking Station	1	15	30,420
Secondary Shredder	1	110	223,080
		Total per year (kWh/y)	**788,892**

Source: Dellara Pty Ltd

Therefore, based on the information provided by the Proponent, electricity consumption on-site will be approximately 790MWh/y.

10.4.4 Gas Generation

There is potential for the site to generate a small amount of methane from the decomposition of biodegradable material emplaced on site. Estimations of the amount of methane generated from the waste emplaced have been calculated by Aquaterra Consulting Pty Ltd in the *Cell Design and Groundwater Assessment* prepared for the Project. Method 1 of the National Greenhouse and Energy Reporting System Measurement Technical Guidelines was used as it does not require any field data.

It has been estimated that over the life of the Project, methane generation will start at 220t in Year 1 of the Project and will gradually increase to a peak of 6,500t in Year 31 before quickly declining as no more waste is emplaced.

To manage the amount of methane released from the Project, the waste emplacement cells will incorporate a gas collection layer. As the generated methane makes its way to the surface, the gas will be directed to a gas distribution layer within the vegetation layer. It is estimated that 40% methane oxidation via natural processes can be achieved with this technique (**Aquaterra, 2010**).

The amount of methane generated has been converted to a carbon dioxide equivalent amount by multiplying by a factor of 21 (**DCC, 2009a**).

10.5 Greenhouse Gas Emissions Results

Based on the usage fuel and electricity usage presented in **Section 10.4.3** and methane generated presented in **Section 10.4.4**, the annual CO_2-e emissions for Year 1 are summarised in **Table 10.4**. The annual CO_2-e emissions for Year 31 are summarised in **Table 10.5** assuming 40% methane oxidation.

Table 10.4
Summary of estimated CO_2-e emissions (t CO_2-e/y) – Year 1

Type of fuel	Scope 1	Scope 2	Scope 3	TOTAL (t CO2-e)
Diesel – non-transport	791	-	60	851
Diesel – transport	6,106	-	463	6,569
Electricity usage	-	702	142	844
Methane generation	4,620	-	-	4,620
Total	**11,517**	**702**	**665**	**12,885**

Note: some figures not exact due to rounding

Table 10.5
Summary of estimated CO_2-e emissions (t CO_2-e/y) – Year 31

Type of fuel	Scope 1	Scope 2	Scope 3	TOTAL (t CO2-e)
Diesel – non-transport	791	-	60	851
Diesel - transport	6,106	-	463	6,569
Electricity usage	-	702	142	844
Methane generation	81,900	-	-	81,900
Total	**88,797**	**702**	**665**	**90,165**

Note: some figures not exact due to rounding

In Year 1 it has been estimated that the development would release approximately 0.013Mt/y CO_2-e. The annual greenhouse emissions in NSW for 2007 were 162.7Mt (**DCC, 2009b**). Therefore, the proposed development represents approximately 0.008% of the total NSW greenhouse gas emissions. At the peak in Year 31, it has been estimated that the release would reach 0.09Mt/y CO_2-e. Comparing to emissions in NSW for 2007, the proposed development would represent 0.055% of the total NSW greenhouse gas emissions. The majority of these emissions (approximately 80%) are associated with transportation of wastes and clay/shale.

It is recommended that when the Project is operational, methane emissions are recalculated using actual emission measurements taken on-site as the actual amount of biodegradable material emplaced may differ.

11. CONCLUSION

This report has assessed the dust and odour impacts associated with the proposed Project at Orchard Hills. Dispersion modelling has been used to predict off-site dust and odour levels due to the proposed activities.

The dust modelling results showed that the predicted 24-hour average PM_{10} concentrations for the modelled Scenario 1 showed exceedances at the sensitive receptors “V” and “W” (see **Figure 15**). Further analysis of these impacts showed that the exceedances occurred only one day throughout the year.

For all other modelled scenarios the predicted 24-hour and annual average PM_{10}, TSP and deposition levels at nearest sensitive receptors would be below the DECCW’s assessment criteria, even when existing background levels are included. The dust modelling is conservative and impacts are likely to be less than predicted.

Odour levels at the nearest sensitive receptors were predicted to be below the most stringent assessment criterion noted by the DECCW. The results therefore suggest that there would be no adverse odour impacts associated with the project.

It is concluded that the proposed facility could be operated without causing adverse dust or odour impacts at the nearest sensitive receptors.

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Appendices

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Appendix 1

Joint Wind Speed, Wind Direction and Stability Class Frequency Tables

(No. of pages excluding this page = 4)

STATISTICS FOR FILE: C:\Jobs\Orchard_Hills\met\StMary07.aus
MONTHS: All
HOURS : All
OPTION: Frequency

PASQUILL STABILITY CLASS 'A'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.006198	0.007691	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.013889
NE	0.005739	0.003788	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.009527
ENE	0.003788	0.004821	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008609
E	0.002640	0.005280	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007920
ESE	0.002755	0.004477	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007231
SE	0.003558	0.003903	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007461
SSE	0.007231	0.004821	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.012052
S	0.009871	0.006198	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.016070
SSW	0.008724	0.003099	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.011823
SW	0.005854	0.001377	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007231
WSW	0.002640	0.001148	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003788
W	0.001951	0.000918	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002870
WNW	0.003099	0.000803	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003903
NW	0.009183	0.002984	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.012167
NNW	0.014463	0.011249	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.025712
N	0.012397	0.017792	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.030188
CALM									0.035239
TOTAL	0.100092	0.080349	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.215680

MEAN WIND SPEED (m/s) = 1.35
NUMBER OF OBSERVATIONS = 1879

PASQUILL STABILITY CLASS 'B'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000230	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000230
NE	0.000000	0.000000	0.000230	0.000000	0.000000	0.000000	0.000000	0.000000	0.000230
ENE	0.000459	0.000344	0.002984	0.000000	0.000000	0.000000	0.000000	0.000000	0.003788
E	0.000000	0.001492	0.002755	0.000000	0.000000	0.000000	0.000000	0.000000	0.004247
ESE	0.000000	0.001837	0.002984	0.000000	0.000000	0.000000	0.000000	0.000000	0.004821
SE	0.000115	0.001263	0.001722	0.000000	0.000000	0.000000	0.000000	0.000000	0.003099
SSE	0.000344	0.001722	0.001951	0.000000	0.000000	0.000000	0.000000	0.000000	0.004017
S	0.001951	0.003673	0.002410	0.000000	0.000000	0.000000	0.000000	0.000000	0.008035
SSW	0.001722	0.002640	0.001033	0.000000	0.000000	0.000000	0.000000	0.000000	0.005395
SW	0.000689	0.001607	0.001263	0.000000	0.000000	0.000000	0.000000	0.000000	0.003558
WSW	0.000115	0.000574	0.001263	0.000000	0.000000	0.000000	0.000000	0.000000	0.001951
W	0.000115	0.000574	0.001377	0.000000	0.000000	0.000000	0.000000	0.000000	0.002066
WNW	0.000230	0.000574	0.001837	0.000000	0.000000	0.000000	0.000000	0.000000	0.002640
NW	0.000344	0.000918	0.000459	0.000000	0.000000	0.000000	0.000000	0.000000	0.001722
NNW	0.001492	0.004247	0.000689	0.000000	0.000000	0.000000	0.000000	0.000000	0.006428
N	0.001033	0.002296	0.001148	0.000000	0.000000	0.000000	0.000000	0.000000	0.004477
CALM									0.000230
TOTAL	0.008838	0.023760	0.024105	0.000000	0.000000	0.000000	0.000000	0.000000	0.056933

MEAN WIND SPEED (m/s) = 2.63
NUMBER OF OBSERVATIONS = 496

PASQUILL STABILITY CLASS 'C'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000115	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000115
NE	0.000000	0.000000	0.000115	0.000000	0.000000	0.000000	0.000000	0.000000	0.000115
ENE	0.000000	0.000000	0.001377	0.001148	0.000000	0.000000	0.000000	0.000000	0.002525
E	0.000000	0.000230	0.003558	0.001148	0.000000	0.000000	0.000000	0.000000	0.004936
ESE	0.000000	0.000574	0.008724	0.007920	0.000000	0.000000	0.000000	0.000000	0.017218
SE	0.000230	0.001377	0.007117	0.004936	0.000000	0.000000	0.000000	0.000000	0.013659
SSE	0.000459	0.000803	0.005969	0.003214	0.000000	0.000000	0.000000	0.000000	0.010445
S	0.002181	0.006428	0.004936	0.001263	0.000000	0.000000	0.000000	0.000000	0.014807
SSW	0.001492	0.004936	0.003788	0.000918	0.000000	0.000000	0.000000	0.000000	0.011134
SW	0.000918	0.001033	0.002755	0.002066	0.000000	0.000000	0.000000	0.000000	0.006772
WSW	0.000230	0.000230	0.001607	0.000689	0.000000	0.000000	0.000000	0.000000	0.002755
W	0.000000	0.000000	0.001033	0.001033	0.000000	0.000000	0.000000	0.000000	0.002066
WNW	0.000000	0.000115	0.002066	0.003558	0.000000	0.000000	0.000000	0.000000	0.005739
NW	0.000230	0.000344	0.000918	0.001607	0.000000	0.000000	0.000000	0.000000	0.003099
NNW	0.000803	0.003329	0.001492	0.000459	0.000000	0.000000	0.000000	0.000000	0.006084
N	0.000230	0.000459	0.000918	0.000230	0.000000	0.000000	0.000000	0.000000	0.001837
CALM									0.000115
TOTAL	0.006887	0.019858	0.046373	0.030188	0.000000	0.000000	0.000000	0.000000	0.103421

MEAN WIND SPEED (m/s) = 3.79
NUMBER OF OBSERVATIONS = 901

PASQUILL STABILITY CLASS 'D'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000230	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000230
NE	0.000344	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000344
ENE	0.000000	0.000115	0.001492	0.000115	0.000000	0.000000	0.000000	0.000000	0.001722
E	0.000115	0.001148	0.002066	0.000000	0.000000	0.000000	0.000000	0.000000	0.003329
ESE	0.000115	0.002296	0.004591	0.002066	0.000459	0.000115	0.000000	0.000000	0.009642
SE	0.000689	0.003673	0.007346	0.002984	0.000689	0.000115	0.000000	0.000115	0.015611
SSE	0.004821	0.004362	0.004706	0.001377	0.001492	0.000000	0.000115	0.000000	0.016873
S	0.015381	0.015840	0.009757	0.004821	0.001033	0.000115	0.000000	0.000000	0.046947
SSW	0.014463	0.030992	0.011019	0.003214	0.000689	0.000000	0.000000	0.000000	0.060376
SW	0.004936	0.004591	0.003673	0.000574	0.000689	0.000000	0.000000	0.000000	0.014463
WSW	0.000000	0.000689	0.001263	0.000344	0.000230	0.000000	0.000000	0.000000	0.002525
W	0.000000	0.000230	0.001148	0.000115	0.000689	0.000000	0.000000	0.000000	0.002181
WNW	0.000000	0.000344	0.002296	0.000689	0.001951	0.000344	0.000000	0.000000	0.005624
NW	0.000574	0.001492	0.003444	0.001377	0.000803	0.000000	0.000230	0.000000	0.007920
NNW	0.000803	0.004936	0.003444	0.000344	0.000574	0.000344	0.000000	0.000000	0.010445
N	0.000803	0.002755	0.001492	0.000230	0.000000	0.000000	0.000000	0.000000	0.005280
CALM									0.000230
TOTAL	0.043274	0.073462	0.057736	0.018251	0.009298	0.001033	0.000344	0.000115	0.203742

MEAN WIND SPEED (m/s) = 2.96
NUMBER OF OBSERVATIONS = 1775

PASQUILL STABILITY CLASS 'E'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000115	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000115
NE	0.000918	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000918
ENE	0.000115	0.000689	0.000803	0.000000	0.000000	0.000000	0.000000	0.000000	0.001607
E	0.000574	0.001722	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002296
ESE	0.000230	0.001377	0.000115	0.000000	0.000000	0.000000	0.000000	0.000000	0.001722
SE	0.000344	0.002181	0.000230	0.000000	0.000000	0.000000	0.000000	0.000000	0.002755
SSE	0.004706	0.003214	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007920
S	0.017332	0.006084	0.000459	0.000000	0.000000	0.000000	0.000000	0.000000	0.023875
SSW	0.017218	0.005624	0.000115	0.000000	0.000000	0.000000	0.000000	0.000000	0.022957
SW	0.005739	0.001951	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007691
WSW	0.001377	0.001837	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003214
W	0.000230	0.000803	0.000230	0.000000	0.000000	0.000000	0.000000	0.000000	0.001263
WNW	0.000230	0.001377	0.000230	0.000000	0.000000	0.000000	0.000000	0.000000	0.001837
NW	0.000803	0.001492	0.000115	0.000000	0.000000	0.000000	0.000000	0.000000	0.002410
NNW	0.001722	0.001837	0.000574	0.000000	0.000000	0.000000	0.000000	0.000000	0.004132
N	0.002525	0.001951	0.000459	0.000000	0.000000	0.000000	0.000000	0.000000	0.004936
CALM									0.002181
TOTAL	0.054178	0.032140	0.003329	0.000000	0.000000	0.000000	0.000000	0.000000	0.091827

MEAN WIND SPEED (m/s) = 1.51
NUMBER OF OBSERVATIONS = 800

PASQUILL STABILITY CLASS 'F'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.010445	0.000344	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.010790
NE	0.010445	0.004247	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.014692
ENE	0.006198	0.007920	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.014118
E	0.003903	0.002984	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006887
ESE	0.001722	0.001263	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002984
SE	0.003673	0.002410	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006084
SSE	0.013085	0.001263	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.014348
S	0.029270	0.003673	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.032943
SSW	0.030188	0.005739	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.035927
SW	0.017218	0.001148	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.018365
WSW	0.007461	0.001033	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008494
W	0.003558	0.001951	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005510
WNW	0.002755	0.000918	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003673
NW	0.003444	0.000918	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004362
NNW	0.008953	0.002296	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.011249
N	0.013889	0.002984	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.016873
CALM									0.121097
TOTAL	0.166208	0.041093	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.328398

MEAN WIND SPEED (m/s) = 0.89
NUMBER OF OBSERVATIONS = 2861

ALL PASQUILL STABILITY CLASSES

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.017332	0.008035	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.025367
NE	0.017447	0.008035	0.000344	0.000000	0.000000	0.000000	0.000000	0.000000	0.025826
ENE	0.010560	0.013889	0.006657	0.001263	0.000000	0.000000	0.000000	0.000000	0.032369
E	0.007231	0.012856	0.008379	0.001148	0.000000	0.000000	0.000000	0.000000	0.029614
ESE	0.004821	0.011823	0.016414	0.009986	0.000459	0.000115	0.000000	0.000000	0.043618
SE	0.008609	0.014807	0.016414	0.007920	0.000689	0.000115	0.000000	0.000115	0.048669
SSE	0.030647	0.016185	0.012626	0.004591	0.001492	0.000000	0.000115	0.000000	0.065657
S	0.075987	0.041896	0.017562	0.006084	0.001033	0.000115	0.000000	0.000000	0.142677
SSW	0.073806	0.053030	0.015955	0.004132	0.000689	0.000000	0.000000	0.000000	0.147612
SW	0.035354	0.011708	0.007691	0.002640	0.000689	0.000000	0.000000	0.000000	0.058081
WSW	0.011823	0.005510	0.004132	0.001033	0.000230	0.000000	0.000000	0.000000	0.022727
W	0.005854	0.004477	0.003788	0.001148	0.000689	0.000000	0.000000	0.000000	0.015955
WNW	0.006313	0.004132	0.006428	0.004247	0.001951	0.000344	0.000000	0.000000	0.023416
NW	0.014578	0.008150	0.004936	0.002984	0.000803	0.000000	0.000230	0.000000	0.031680
NNW	0.028237	0.027893	0.006198	0.000803	0.000574	0.000344	0.000000	0.000000	0.064050
N	0.030877	0.028237	0.004017	0.000459	0.000000	0.000000	0.000000	0.000000	0.063590
CALM									0.159091
TOTAL	0.379477	0.270661	0.131543	0.048439	0.009298	0.001033	0.000344	0.000115	1.000000

MEAN WIND SPEED (m/s) = 1.87
NUMBER OF OBSERVATIONS = 8712

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 21.6%
B : 5.7%
C : 10.3%
D : 20.4%
E : 9.2%
F : 32.8%

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Appendix 2

Estimated Dust Emissions

(No. of pages excluding this page = 13)

Orchard Hills Waste Management Facility Emissions Inventory

Description of operations

The dust emission inventories have been prepared using the operational description of the proposed activities provided by R.W. Corkery on behalf of the Proponent.

Establishment of the site will involve the use of excavators and scrapers to prepare the floor topography of each of the cells. Material extracted from the cells will be either re-processed and recycled or used to construct the bund walls. Material will be transported on-site with 35 tonne articulated trucks. Drainage aggregate will be delivered and placed at the base of each cell.

Clay and shale stockpiles will be loaded from a front-end loader into 30 tonne trucks for dispatch off-site. Additional clay and shale material will be excavated on-site with an excavator and dozer.

A water-cart will service all on-site haul roads to assist with dust-suppression.

All waste received will be delivered to the recycling reprocessing area, where the recycling facility will be located. From this location, sorted waste will be re-processed and recycled, loaded by front-end loader to 30 tonne trucks for delivery off-site. Material deemed waste will be loaded to 35 tonne trucks and delivered to the active dumping cell. Waste cells will be maintained by a compactor.

Emission estimates

Estimated emissions are presented for all significant dust generating activities associated with the operations. The relevant emission factors used for the study are described below.

All activities occurring on-site are assumed to occur between the 6am and 6pm, 6 days a week. Dust from wind erosion is assumed to occur over 24 hours per day, however, wind erosion is also assumed to be proportional to the third power of wind speed. This will mean that most wind erosion occurs during the day when wind speeds are highest.

Loading / dumping material using shovels / excavators / front-end loaders
Emissions from this activity have been calculated from the US EPA emission factor equation (**US EPA 1985, and updates**). Each tonne of material moved will generate a quantity of TSP that will depend on the wind speed and moisture content. **Equation 1** shows the relationship between these variables.

Equation 1

$$E_{TSP} = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \right) \frac{kg}{t}$$

Where,
E_{TSP} = TSP emissions
k = 0.74
U = wind speed (m/s)
M = moisture content (%)
[where $0.25 \leq M \leq 4.8$]

The wind speed value was taken from the 2007 meteorological dataset described in **Section 4**. The moisture content was assumed to be 4% for general material. For activities involving waste material a moisture content of 0.5% was assumed. For activities involving drainage aggregates, a moisture content of 3% was assumed.
(**US EPA, AP42, Section 13.2.4**)

Moving material with compactor and bulldozer
Emissions from compacting and bulldozing operations have been calculated using the US EPA emission factor equation (**US EPA, 1985 and updates**). **Equation 2** shows the relationship involved.

Equation 2

$$E_{TSP} = 2.6 \times \frac{s^{1.2}}{M^{1.3}}$$

Where,
E_{TSP} = TSP emissions
s = silt content (%)
M = moisture content (%)

Based on the information provided by the Proponent, it was assumed the silt content of the material is 5% and the moisture content is 4%. For activities involving waste material, a silt content of 5% and moisture content of 0.5% was assumed. It has been assumed water carts will be used to control dust. For activities involving clay / shale material, a silt content of 5% and moisture content of 6% was assumed.

Hauling material / product on unsealed surfaces
Before the application of water to road surface, the emission factor used for trucks hauling material on unsealed surfaces is 4 kg per vehicle kilometre travelled (kg/VKT). Use of dust-suppression water cart constitutes 75% control. (**SPCC 1983**)

Hauling material / product on sealed surfaces
The emission factor used for trucks hauling material on sealed surfaces is 0.2 kg per vehicle kilometre travelled (kg/VKT). (**SPCC 1983**)

Scraper removing material

Emissions from this activity have been estimated from the US EPA emission factor document (**US EPA 1985, and updates**). The emission factor used for scrapers removing material is 0.029 kg / tonne. (**US EPA, AP42, Section 11.9, Table 11.9-4**)

Scrapers unloading material

Emissions from this activity have been estimated from the US EPA emission factor document (US EPA 1985, and updates). The emission factor used for the scraper unloading (batch drop) is 0.02 kg / tonne.
(**US EPA, AP42, Section 11.9, Table 11.9-4**)

Scrapers in travel mode

Emissions from this activity have been calculated from the US EPA emission factor equation (**US EPA 1985, and updates**). Emissions are estimated from the silt and moisture content of the unpaved road. Equation 3 shows the relationship between these variables.

Equation 3

$$E_{TSP} = k \times \left(\frac{s}{12}\right)^{a} \times \left(\frac{W}{3}\right)^{b} \frac{lb}{VMT}$$

Where,
E_{TSP} = TSP emissions
S = silt content (%)
W = mean vehicle weight (tons)
k = 4.9
a = 0.7
b = 0.45

Based on the information provided by the Proponent, it was assumed the silt content of the material is 5%. Use of dust-suppression water cart constitutes 75% control.
(**US EPA, AP42, Section 13.2.2, Equation 1(a)**)

Table A2.1
Scenario 1 – Detailed Emission Estimation

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units
A - Excavator (Recycling reprocessing area)	453	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
A - Compactor (Recycling reprocessing area)	453	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
A - Loading material to truck	453	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
A - Hauling material (unsealed road)	1,333	17,829	trips/year	0.14949	kg/t	35	t/truck load	1.31	km/return trip	4.0	kg/VKT	75	% control
A - Hauling material (sealed road)	109	17,829	trips/year	0.00305	kg/t	35	t/truck load	0.53	km/return trip	0.2	kg/VKT		
A - Dumping material	453	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
C - Scraper (Cell 1A) removing material	18,096	624,000	t/y	0.029	kg/Mg								
B - Scraper travelling	8,069	5,741	km	2.8	kg/vkt	56.79	tons (US)	5	silt content %			75	% control
B - Scraper (Cell 1A) unloading material	24,960	624,000	t/y	0.02	kg/Mg								
C - Excavator (Audio-visual Mounds)	453	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
C - Loading material to truck	453	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
C - Hauling material (unsealed road)	854	17,829	trips/year	0.09577	kg/t	35	t/truck load	0.84	km/return trip	4.0	kg/VKT	75	% control
C - Dumping material	453	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
D - Excavator (Dam 2)	453	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
D - Loading material to truck	453	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
D - Hauling material (unsealed road)	638	17,829	trips/year	0.07154	kg/t	35	t/truck load	0.63	km/return trip	4.0	kg/VKT	75	% control
D - Dumping material	453	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
E - FEL (clay/shale in Cell 2)	73	200,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
E - Hauling clay/shale material (unsealed road)	555	6,667	trips/year	0.16640	kg/t	30	t/truck load	1.25	km/return trip	4.0	kg/VKT	75	% control
E - Hauling clay/shale material (sealed road)	50	6,667	trips/year	0.00372	kg/t	30	t/truck load	0.56	km/return trip	0.2	kg/VKT		
G - Hauling drainage aggregates (unsealed road)	44	500	trips/year	0.17787	kg/t	30	t/truck load	1.33	km/return trip	4.0	kg/VKT	75	% control
G - Hauling drainage aggregates (sealed road)	4	500	trips/year	0.00372	kg/t	30	t/truck load	0.56	km/return trip	0.2	kg/VKT		
G - Dumping drainage aggregates	11	15,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
Wind erosion from exposed areas	94,608	27.0	ha	0.4	kg/ha/h	8,760	h						

Table A2.2
Scenario 1 - Source Allocation

Activity	Source ID					
A Excavator (Recycling reprocessing area)	4	5				
A Compactor (Recycling reprocessing area)	4	5				
A Loading material to truck	4	5				
A Hauling material (unsealed road)	4	5	6	7	8	9
A Hauling material (sealed road)	2	3				
A Dumping material	9					
B Scraper (Cell 1A) removing material	10	11				
B Scraper (Cell 1A) unloading material	9					
B Scraper travelling	9	10				
C Excavator (Audiovisual Mounds)	9	12	13			
C Loading material to truck	9					
C Hauling material (unsealed road)	9	12	13			
C Dumping material	12	13				
D Excavator (Dam 2)	14					
D Loading material to truck	14					
D Hauling material (unsealed road)	9	14				
D Dumping material	9					
E FEL (clay/shale in Cell 2)	15	16				
E Hauling clay/shale material (unsealed road)	6	7	8	15	16	
E Hauling clay/shale material (sealed road)	1	2				
G Hauling drainage aggregates (unsealed road)	6	10	11	21		
G Hauling drainage aggregates (sealed road)	1	2				
G Dumping drainage aggregates	10	11				
Wind erosion from exposed areas	4-21					

Table A2.3
Scenario 2 - Detailed Emission Estimation

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units
A - Hauling waste (Recycling reprocessing area) (unsealed road)	108	10,000	trips/year	0.04320	kg/t	30	t/truck load	0.32	km/return trip	4.0	kg/VKT	75	% control
A - Hauling waste (Recycling reprocessing area) (sealed road)	73	10,000	trips/year	0.00728	kg/t	30	t/truck load	1.09	km/return trip	0.2	kg/VKT		
A - Dumping waste	2,003	300,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
B - Compacting waste (Cell 1A)	1,335	200,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %			75	% control
C - Dozer Ripping (Cell1B)	5,538	1,872	h/y	3.0	kg/h	5	silt content in %	4	moisture content (%)				
C - Scraper (Cell 1A) removing material	18,096	624,000	t/y	0.029	kg/Mg								
C - Scraper travelling	5,259	7,484	km	2.8	kg/vkt	56.79	tons (US)	5	silt content %			75	% control
C - Scraper (Cell 1A) unloading material	12,480	624,000	t/y	0.02	kg/Mg								
D - FEL (clay/shale)	73	200,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
D - Hauling clay/shale material (unsealed road)	277	6,667	trips/year	0.16640	kg/t	30	t/truck load	1.25	km/return trip	4.0	kg/VKT	75	% control
D - Hauling clay/shale material (sealed road)	25	6,667	trips/year	0.00372	kg/t	30	t/truck load	0.56	km/return trip	0.2	kg/VKT		
E - FEL (Recycling plant in Recycling reprocessing area)	1,335	200,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
F - Excavator (Recycling reprocessing area)	227	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
F - Loading material to truck	227	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
F - Hauling material (unsealed road)	744	17,829	trips/year	0.16686	kg/t	35	t/truck load	1.46	km/return trip	4.0	kg/VKT	75	% control
F - Dumping material	227	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
G - Hauling drainage aggregates (unsealed road)	166	3,744	trips/year	0.17787	kg/t	30	t/truck load	1.33	km/return trip	4.0	kg/VKT	75	% control
G - Hauling drainage aggregates (sealed road)	14	3,744	trips/year	0.00372	kg/t	30	t/truck load	0.56	km/return trip	0.2	kg/VKT		
G - Dumping drainage aggregates	5	15,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
I - FEL (Perimeter bund walls in Cell 2)	8,307	2,808	h/y	3.0	kg/h	5	silt content in %	4	moisture content (%)				
I - Loading material to truck	227	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
I - Hauling material (unsealed)	752	17,829	trips/year	0.16869	kg/t	35	t/truck load	1.48	km/return trip	4.0	kg/VKT	75	% control
I - Hauling material (sealed)	54	17,829	trips/year	0.00305	kg/t	35	t/truck load	0.53	km/return trip	0.2	kg/VKT		
I - Dumping material (Recycling reprocessing area)	227	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
J - Compacting waste (Recycling reprocessing area)	2,003	300,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %			75	% control
K - FEL (Recycled product)	668	100,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
K - Hauling recycled product (unsealed road)	36	3,333	trips/year	0.04320	kg/t	30	t/truck load	0.32	km/return trip	4.0	kg/VKT	75	% control
K - Hauling recycled product (sealed road)	24	3,333	trips/year	0.00728	kg/t	30	t/truck load	1.09	km/return trip	0.2	kg/VKT		
Wind erosion from exposed area	77,088	22.0	ha	0.4	kg/ha/	8,760	h						

Table A2.4
Scenario 2 – Source Allocation

Activity	Source ID					
A Hauling waste (Recycling reprocessing area) (unsealed road)	4					
A Hauling waste (Recycling reprocessing area) (sealed road)	1	2	3			
A Dumping waste	4					
B Compacting waste (Cell 1A)	13	14				
C Dozer Ripping (Cell1B)	11	12				
C Scraper (Cell 1A) removing material	13	14				
C Scraper (Cell 1A) unloading material	16	17				
C Scraper travelling	6	13	14	15	16	17
D FEL (clay/shale)	9	10				
D Hauling clay/shale material (unsealed road)	6	7	8	9	10	
D Hauling clay/shale material (sealed road)	1	2				
E FEL (Recycling plant in Recycling reprocessing area)	4	5				
F Excavator (Recycling reprocessing area)	16	17				
F Loading material to truck	16	17				
F Hauling material (unsealed road)	6	13	14	15	16	17
F Dumping material	13	14				
G Hauling drainage aggregates (unsealed road)	6	13	14	15		
G Hauling drainage aggregates (sealed road)	1	2				
G Dumping drainage aggregates	13	14				
I FEL (Perimeter bund walls in Cell 2)	9	10				
I Loading material to truck	9	10				
I Hauling material (unsealed)	6	7	8	9	10	
I Hauling material (sealed)	2	3				
I Dumping material (Recycling reprocessing area)	4	5				
J Compacting waste (Recycling reprocessing area)	4	5				
K FEL (Recycled product)	4	5				
K Hauling recycled product (unsealed road)	4	5				
K Hauling recycled product (sealed road)	1	2	3			
Wind erosion from exposed area	4-21					

Table A2.5
Scenario 3a – Detailed Emission Estimation

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units
A - Hauling waste (Cell 2) (unsealed road)	338	12,857	trips/year	0.10514	kg/t	35	t/truck load	0.92	km/return trip	4.0	kg/VKT	75	% control
A - Dumping waste	3,004	450,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
B - Hauling waste for recycling (Recycling reprocessing area) (unsealed road)	780	20,000	trips/year	0.15600	kg/t	30	t/truck load	1.17	km/return trip	4.0	kg/VKT	75	% control
B - Hauling waste for recycling (Recycling reprocessing area) (sealed road)	150	20,000	trips/year	0.00752	kg/t	30	t/truck load	1.13	km/return trip	0.2	kg/VKT		
B - Dumping waste for recycling	4,005	600,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
C - Compacting waste (Cell 2)	3,004	450,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %			75	% control
C - Scraper (Cell 2A) removing material	18,096	624,000	t/y	0.029	kg/Mg								
D - Scraper travelling	7,773	11,060	km	2.8	kg/vkt	56.79	tons (US)	5	silt content %			75	% control
D - Scraper (Cell 2A) unloading material	12,480	624,000	t/y	0.02	kg/Mg								
E - Excavator (Cell 3)	227	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
F - FEL (clay/shale in Cell 3)	1,335	200,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
F - Hauling clay/shale material (unsealed road)	0	0	trips/year	0.07707	kg/t	30	t/truck load	0.58	km/return trip	4.0	kg/VKT	75	% control
F - Hauling clay/shale material (sealed road)	0	0	trips/year	0.00235	kg/t	30	t/truck load	0.35	km/return trip	0.2	kg/VKT		
H - Hauling drainage aggregates (unsealed road)	234	7,488	trips/year	0.12480	kg/t	30	t/truck load	0.94	km/return trip	4.0	kg/VKT	75	% control
H - Hauling drainage aggregates (sealed road)	28	7,488	trips/year	0.00372	kg/t	30	t/truck load	0.56	km/return trip	0.2	kg/VKT		
H - Dumping drainage aggregates	5	15,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
I - FEL (Recycling plant)	4,005	600,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
J - Hauling Clay-capping (Cell 1) (unsealed road)	128	2,857	trips/year	0.17966	kg/t	35	t/truck load	1.57	km/return trip	4.0	kg/VKT	75	% control
J - Hauling Clay-capping (Cell 1) (sealed raod)	4	2,857	trips/year	0.00137	kg/t	35	t/truck load	0.24	km/return trip	0.2	kg/VKT		
J - Dumping Clay-capping (Cell 1)	21	100,000	t/y	0.00021	kg/t	0.81	average (ws/2.2)^1.3	6	moisture content - %				
K - Compactor (Cell 1)	227	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
K - Dozer shaping (Cell 1)	5,538	1,872	h/y	2.95841683	kg/hr	5.00	silt content in %	4	moisture content (%)				
Wind erosion from exposed area	87,600	25.0	ha	0.4	kg/ha/h	8,760	h						

Table A2.6
Scenario 3b – Detailed Emission Estimation

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units
A - Hauling waste (Cell 2) (unsealed road)	338	12,857	trips/year	0.10514	kg/t	35	t/truck load	0.92	km/return trip	4.0	kg/VKT	75	% control
A - Dumping waste	3,004	450,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
B - Hauling waste for recycling (Initial Cell) (unsealed road)	780	20,000	trips/year	0.15600	kg/t	30	t/truck load	1.17	km/return trip	4.0	kg/VKT	75	% control
B - Hauling waste for recycling (Initial Cell) (sealed road)	150	20,000	trips/year	0.00752	kg/t	30	t/truck load	1.13	km/return trip	0.2	kg/VKT		
B - Dumping waste for recycling	4,005	600,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
C - Compacting waste (Cell 2)	3,004	450,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %			75	% control
C - Scraper (Cell 2A) removing material	18,096	624,000	t/y	0.029	kg/Mg								
D - Scraper travelling	7,773	11,060	km	2.8	kg/vkt	56.79	tons (US)	5	silt content %			75	% control
D - Scraper (Cell 2A) unloading material	12,480	624,000	t/y	0.02	kg/Mg								
E - Excavator (Cell 3)	227	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
F - FEL (clay/shale in Cell 3)	1,335	200,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
F - Hauling clay/shale material (unsealed road)	0	0	trips/year	0.07707	kg/t	30	t/truck load	0.58	km/return trip	4.0	kg/VKT	75	% control
F - Hauling clay/shale material (sealed road)	0	0	trips/year	0.00235	kg/t	30	t/truck load	0.35	km/return trip	0.2	kg/VKT		
H - Hauling drainage aggregates (unsealed road)	234	7,488	trips/year	0.12480	kg/t	30	t/truck load	0.94	km/return trip	4.0	kg/VKT	75	% control
H - Hauling drainage aggregates (sealed road)	28	7,488	trips/year	0.00372	kg/t	30	t/truck load	0.56	km/return trip	0.2	kg/VKT		
H - Dumping drainage aggregates	5	15,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
I - FEL (Recycling plant)	4,005	600,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
J - Hauling Clay-capping (Cell 1) (unsealed road)	128	2,857	trips/year	0.17966	kg/t	35	t/truck load	1.57	km/return trip	4.0	kg/VKT	75	% control
J - Hauling Clay-capping (Cell 1) (sealed raod)	4	2,857	trips/year	0.00137	kg/t	35	t/truck load	0.24	km/return trip	0.2	kg/VKT		
J - Dumping Clay-capping (Cell 1)	21	100,000	t/y	0.00021	kg/t	0.81	average (ws/2.2)^1.3	6	moisture content - %				
K - Compactor (Cell 1)	227	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
K - Dozer shaping (Cell 1)	5,538	1,872	h/y	2.95841683	kg/hr	5.00	silt content in %	4	moisture content (%)				
Wind erosion from exposed area	87,600	25.0	ha	0.4	kg/ha/h	8,760	h						

Table A2.7

Scenario 3a and b – Source allocation

Activity	Source ID						
A Hauling waste (Cell 2) (unsealed road)	5	6	7	8	9		
A Dumping waste	9	10					
B Hauling waste for recycling (Recycling reprocessing area) (unsealed road)	4	5	6				
B Hauling waste for recycling (Recycling reprocessing area) (sealed road)	1	2	3				
B Dumping waste for recycling	4	5					
C Compacting waste (Cell 2)	9	10					
D Scraper (Cell 2A) removing material	11	12					
D Scraper (Cell 2A) unloading material	4	5					
D Scraper travelling	4	5	6	7	8	10	
E Excavator (Cell 3)	13	14					
F FEL (clay/shale in Cell 3)	13	14					
F Hauling clay/shale material (unsealed road)	13	14					
F Hauling clay/shale material (sealed road)	1	2					
H Hauling drainage aggregates (unsealed road)	6	7	8	9	10		
H Hauling drainage aggregates (sealed road)	1	2					
H Dumping drainage aggregates	9	10					
I FEL (Recycling plant)	4	5					
J Hauling Clay-capping (Cell 1) (unsealed road)	6	7	13	14	15	16	17
J Hauling Clay-capping (Cell 1) (sealed road)	2						
J Dumping Clay-capping (Cell 1)	15	16					
K Compactor (Cell 1)	15	16					
K Dozer shaping (Cell 1)	15	16					
Wind erosion from exposed area	4-17						

Table A2.8
Scenario 4 – Detailed Emission Estimation

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units
A - Hauling waste (Cell 3) (unsealed road)	136	5,714	trips/year	0.09486	kg/t	35	t/truck load	0.83	km/return trip	4.0	kg/VKT	75	% control
A - Dumping waste (Cell 3)	1,335	200,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
B - Hauling waste for recycling (Recycling reprocessing area) (unsealed road)	307	10,000	trips/year	0.12267	kg/t	30	t/truck load	0.92	km/return trip	4.0	kg/VKT	75	% control
B - Hauling waste for recycling (Recycling reprocessing area) (sealed road)	73	10,000	trips/year	0.00728	kg/t	30	t/truck load	1.09	km/return trip	0.2	kg/VKT		
B - Dumping waste for recycling (Recycling reprocessing area)	2,003	300,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
C - Compacting waste (Cell 3)	1,335	200,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %			75	
D - Excavator (Cell 3)	227	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
D - Dozer (Cell 3)	5,538	1,872	h/y	2.95841683	kg/hr	5.00	silt content in %	4	moisture content (%)				
D - Loading material to truck	227	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
D - Hauling material	382	17,829	trips/year	0.08571	kg/t	35	t/truck load	0.75	km/return trip	4.0	kg/VKT	75	% control
D - Dumping material	227	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
E - FEL (clay/shale in Cell 3)	1,335	200,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
E - Hauling clay/shale material (unsealed road)	118	5,714	trips/year	0.08274	kg/t	35	t/truck load	0.72	km/return trip	4.0	kg/VKT	75	% control
E - Hauling clay/shale material (sealed road)	18	5,714	trips/year	0.00319	kg/t	35	t/truck load	0.56	km/return trip	0.2	kg/VKT		
F - FEL (Recycling plant in Recycling reprocessing area)	2,003	300,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
G - Hauling Clay-capping (Cell 3) (unsealed road)	68	2,857	trips/year	0.09486	kg/t	35	t/truck load	0.83	km/return trip	4.0	kg/VKT	75	% control
G - Dumping Clay-capping (Cell 3)	21	100,000	t/y	0.00021	kg/t	0.81	average (ws/2.2)^1.3	6	moisture content - %				
H - Compactor (Cell 3)	227	624,000	t/y	0.00036	kg/t	0.81	average (ws/2.2)^1.3	4	moisture content - %				
H - Dozer (Cell 3)	5,538	1,872	h/y	2.95841683	kg/hr	5.00	silt content in %	4	moisture content (%)				
Wind erosion from exposed area	49,056	14.0	ha	0.4	kg/ha/	8,760	h						

Table A2.9
Scenario 4 – Source allocation

Activity	Source ID							
A Hauling waste (Cell 3) (unsealed road)	8	9	10	11	14	15	16	
A Dumping waste (Cell 3)	14	15	16					
B Hauling waste for recycling (Recycling reprocessing area) (unsealed road)	7	8	9	10				
B Hauling waste for recycling (Recycling reprocessing area) (sealed road)	1	2	3	4	5	6		
B Dumping waste for recycling (Recycling reprocessing area)	7	8						
C Compacting waste (Cell 3)	15	16						
D Excavator (Cell 3)	12	13						
D Dozer (Cell 3)	12	13						
D Loading material to truck	12	13						
D Hauling material	8	9	10	11	12	13		
D Dumping material	8							
E FEL (clay/shale in Cell 3)	8							
E Hauling clay/shale material (unsealed road)	8	9	10					
E Hauling clay/shale material (sealed road)	1	2	3	4				
F FEL (Recycling plant in Recycling reprocessing area)	7	8	9					
G Hauling Claycapping (Cell 3) (unsealed road)	8	9	10	11	14	16	17	18
G Dumping Claycapping (Cell 3)	17	18	22					
H Compactor (Cell 3)	17	18	22					
H Dozer (Cell 3)	17	18	22					
Wind erosion from exposed area	7-22							

Table A2.10
Scenario 5 – Detailed Emission Estimation

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units
A - Hauling waste for recycling (Recycling reprocessing area) (unsealed road)	1,644	54,912	trips/year	0.11973	kg/t	30	t/truck load	0.90	km/return trip	4.0	kg/VKT	75	% control
A - Hauling waste for recycling (Recycling reprocessing area) (sealed road)	400	54,912	trips/year	0.00728	kg/t	30	t/truck load	1.09	km/return trip	0.2	kg/VKT		
A - Dumping waste for recycling (Recycling reprocessing area)	2003	300,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
A - Hauling waste for recycling (Cell 1A) (unsealed road)	1,428	54,912	trips/year	0.10400	kg/t	35	t/truck load	0.91	km/return trip	4.0	kg/VKT	75	% control
A - Dumping waste for recycling (Cell 1A)	2003	300,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
B - FEL (Recycled product)	2,003	300,000	t/y	0.00668	kg/t	0.81	average (ws/2.2)^1.3	0.5	moisture content - %				
B - Hauling (Recycled product) (off-site from Recycling reprocessing area) (unsealed road)	200	6,667	trips/year	0.11973	kg/t	30	t/truck load	0.90	km/return trip	4.0	kg/VKT	75	% control
B - Hauling (Recycled product) (off-site from Recycling reprocessing area) (sealed road)	25	6,667	trips/year	0.00372	kg/t	30	t/truck load	0.56	km/return trip	0.2	kg/VKT		
Wind erosion from exposed area	38,544	11.0	ha	0.4	kg/ha/	8,760	h						

Table A2.11
Scenario 5 – Source Allocation

Activity	Source ID				
A Hauling waste for recycling (Recycling reprocessing area) (unsealed road)	6	7	8		
A Hauling waste for recycling (Recycling reprocessing area) (sealed road)	1	2	3	4	5
A Dumping waste for recycling (Recycling reprocessing area)	6	7			
A Hauling waste for recycling (Cell 1A) (unsealed road)	6	7	8	9	10
A Dumping waste for recycling (Cell 1A)	10				
B FEL (Recycled product)	6	7			
B Hauling (Recycled product) (offsite from Recycling reprocessing area) (unsealed road)	6	7	8		
B Hauling (Recycled product) (offsite from Recycling reprocessing area) (sealed road)	1	2	3		
Wind erosion from exposed area	6-14				

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Appendix 3

Peak-to-Mean Ratios

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Peak-to-Mean Ratios

The following table shows the recommended factors for estimating peak concentrations from different source types, stabilities and distances.

Source Type	**Pasquill-Gifford Stability Class**	**Near-field P/M 60***	**Far-field P/M 60**
Area	A,B,C,D	2.5	2.3
	E,F	2.3	1.9
Line	A-F	6	6
Surface Point	A,B,C	12	4
	D,E,F	25	7
Tall wake-free point	A,B,C	17	3
	D,E,F	35	6
Wake-affected point	A-F	2.3	2.3
Volume	A-F	2.3	2.3

*Ratio of peak one second average concentrations to mean 1-hour average concentrations.

Appendix 4

Coverage of Director-General's Requirements

(No. of pages excluding this page = 1)

Coverage of Director-General's Requirements

AIR QUALITY		
Department of Environment & Climate Change (15/04/09)	Identify all sources of air emissions from the development.	Section 7
	Provide details of the project that are essential for predicting and assessing air impacts including; a. the quantities and physio-chemical parameters (eg construction, moisture content, bulk density, particle sizes etc) of materials to be used, transported, produced or stored;	Section 7
	b. an outline of procedures for handling, transport, production and storage;	Section 7
	c. the management of solid, liquid and gaseous waste streams with potential for significant air impacts.	Section 7
	Provide a description of existing air quality and meteorology, using existing information and site representative ambient monitoring data.	Section 5
	Identify all pollutants of concern and estimate emissions by quantity (and size for particles), source and discharge point.	Section 6
	Estimate the resulting ground level concentrations of all pollutants. Use an appropriate dispersion model to estimate ambient pollutant concentrations.	Section 8
	Describe the effects and significance of pollutant concentration on the environment, human health, amenity and regional ambient air quality standards or goals.	Section 8
	Describe the contribution that the development will make to regional and global pollution, particularly in sensitive locations.	Section 8
	For potentially odorous emissions provide the emission rates in terms of odour units (determined by techniques compatible with EPA/DECC procedures). Use sampling and analysis techniques for individual or complex odours and for point or diffuse sources, as appropriate. Note: with dust and odour, it may be possible to use data from existing similar activities to generate emissions rates. Reference should be made to relevant guidelines eg *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW* (EPA, 2001), *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (EPA, 2001), *Assessment and Management of Odour from Stationary Sources in NSW* (EPA, 2001), *Technical Notes: Draft Policy: Assessment and Management of Odour from Stationary Sources in NSW* (EPA, 2001).	Section 7
	Outline specifications of pollution control equipment (including manufacturer's performance guarantees where available) and management protocols for both point and fugitive emissions. Where possible, this should include cleaner production processes.	Section 9
	Describe surrounding buildings that may effect plume dispersion, if relevant. Provide and analyse site representative data on following meteorological parameters: a. Temperature and humidity. b. Rainfall, evaporation and direction. c. Wind speed and direction. d. Atmospheric stability class. e. Mixing height (the height that emissions will be ultimately mixed in the atmosphere). f. Katabatic air drainage. g. Air re-circulation.	Section 4

FIGURES

(No. of pages excluding this page = 59)

Note: All Figures in this report are presented in colour on the Project CD.

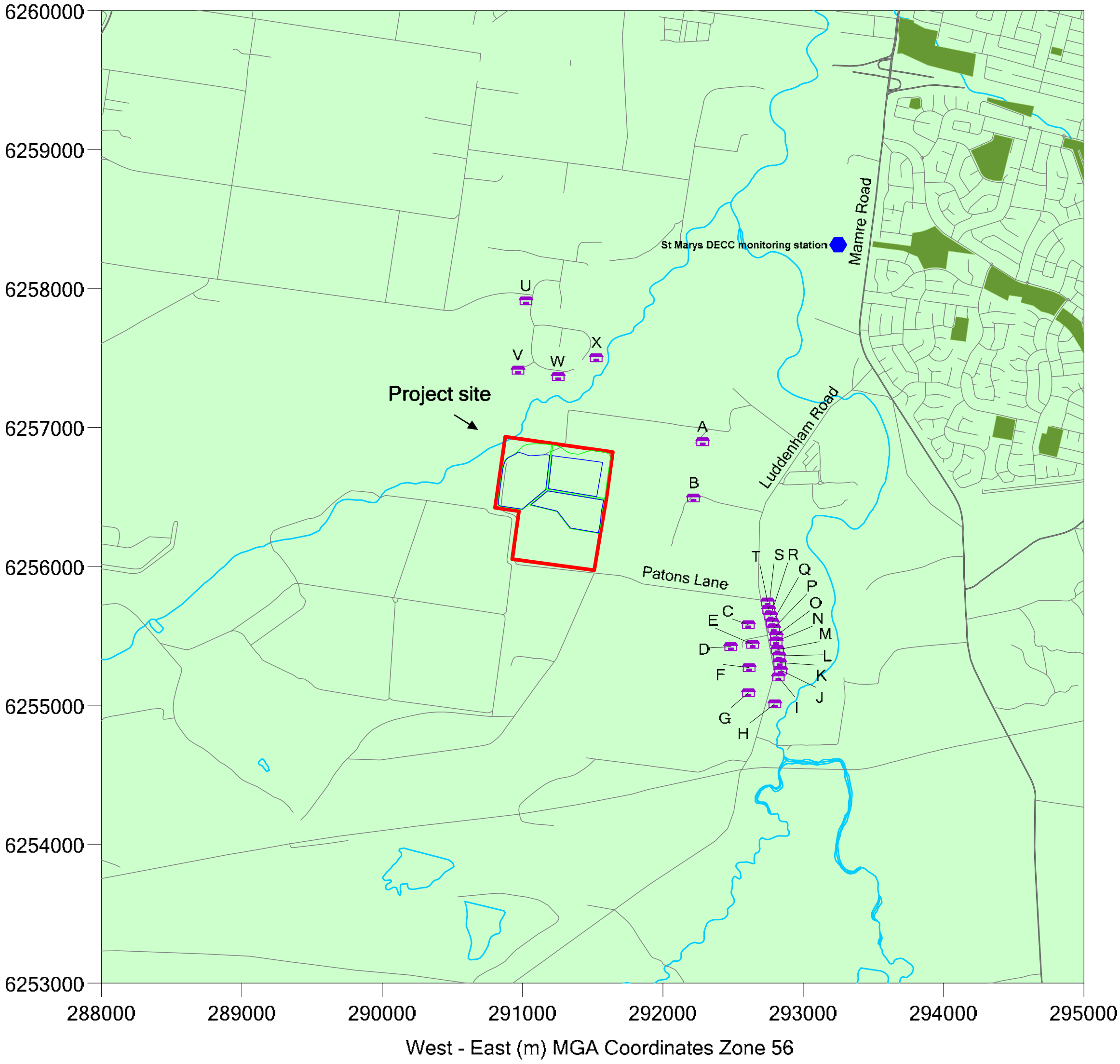

Figure 1: Site location and location of sensitive receptors

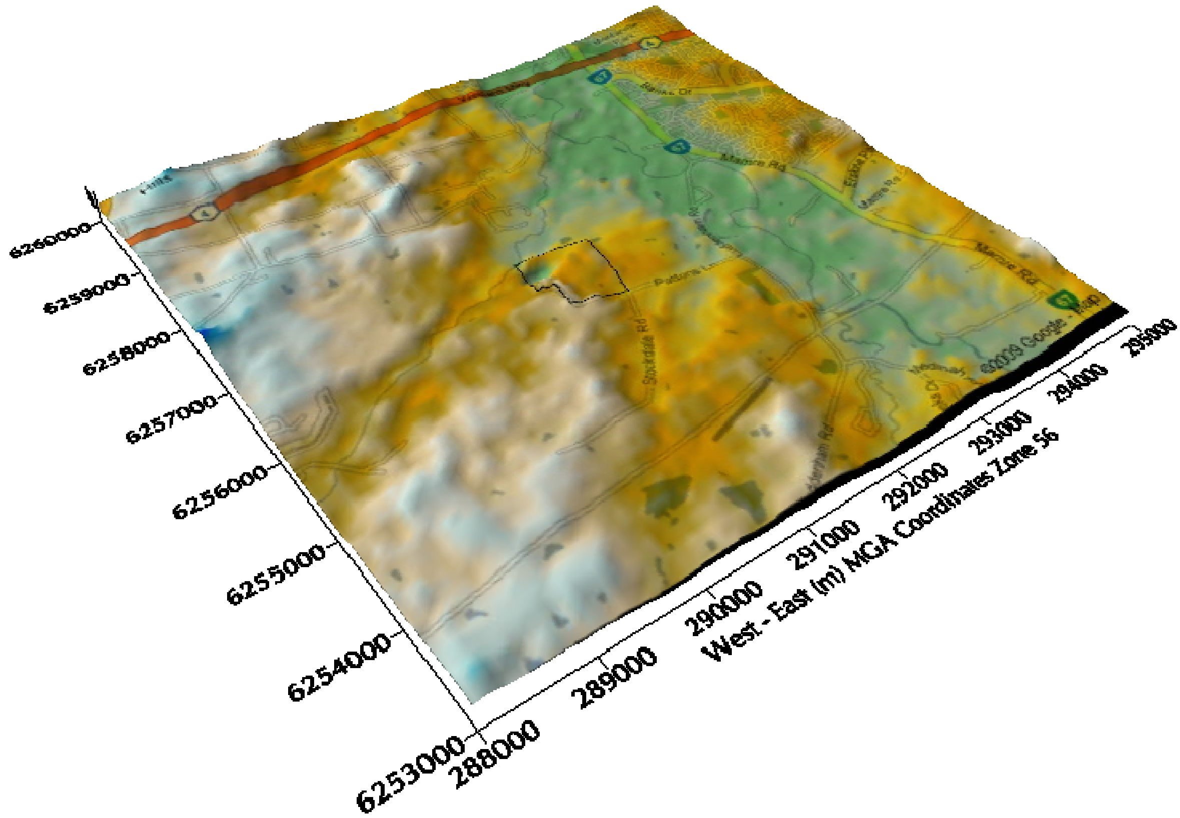

Figure 2: Pseudo-3D terrain of the Project Site and surrounding area

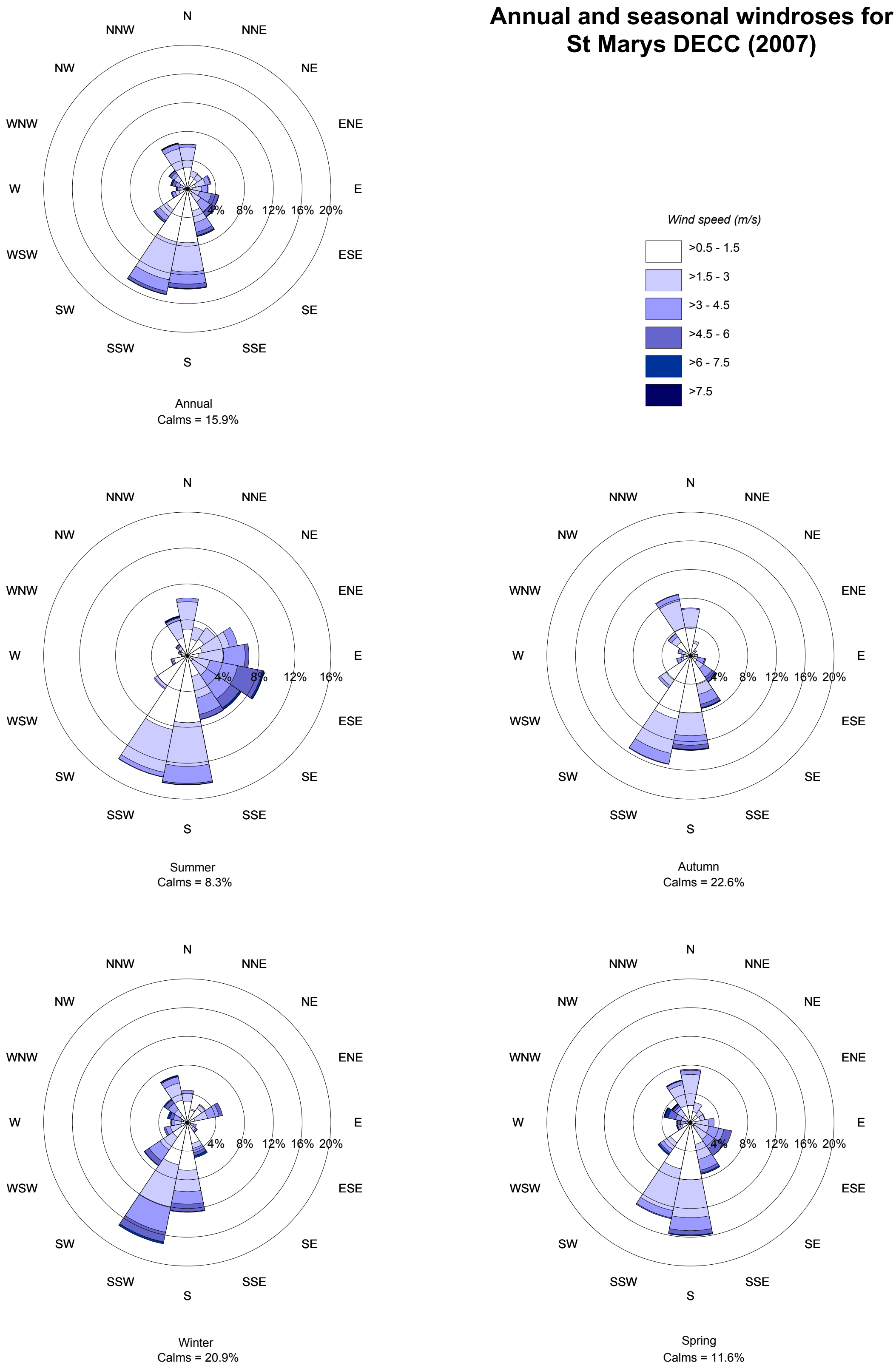

Figure 3: Annual and seasonal windroses for St Marys DECCW

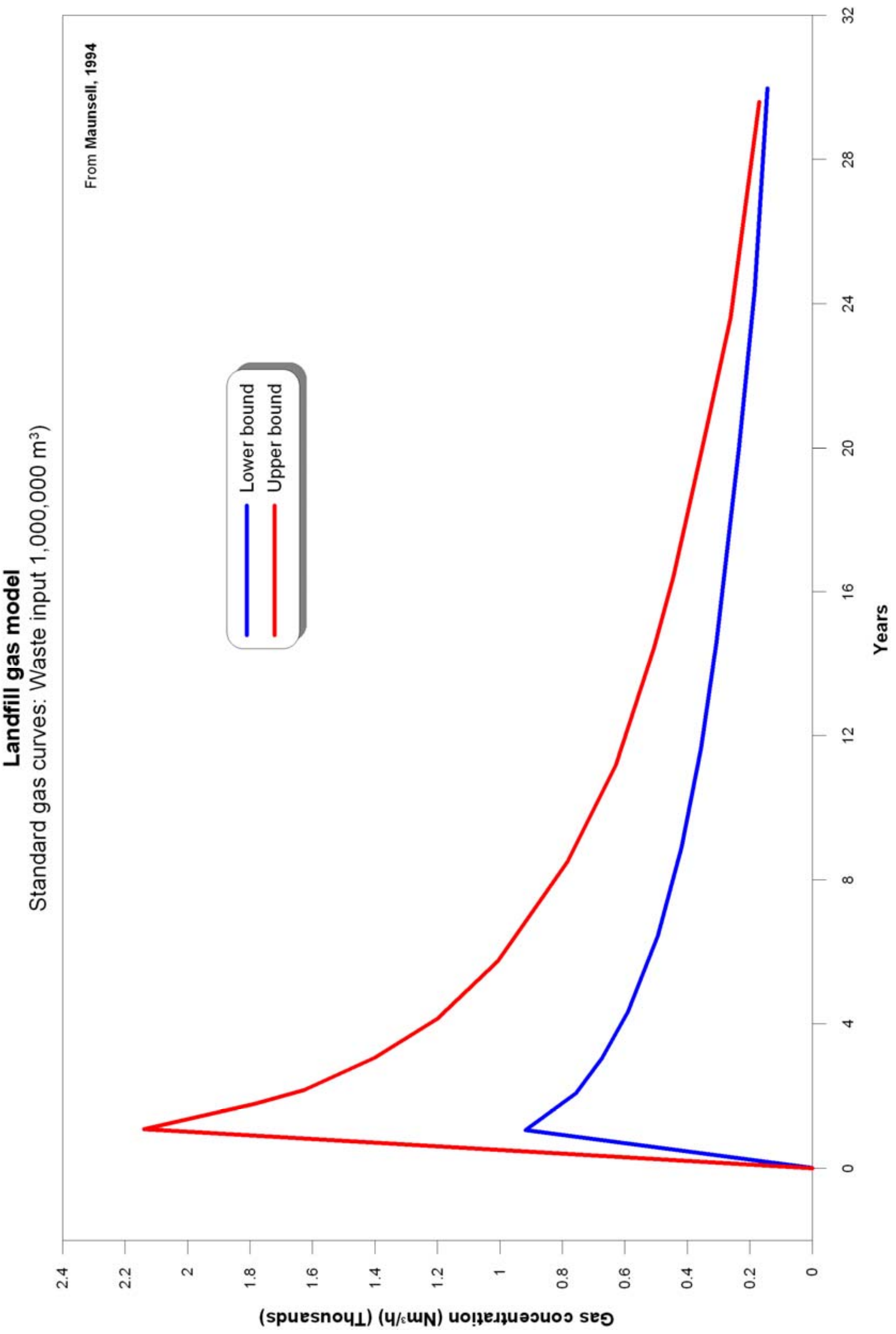

Figure 4: Landfill Gas Model

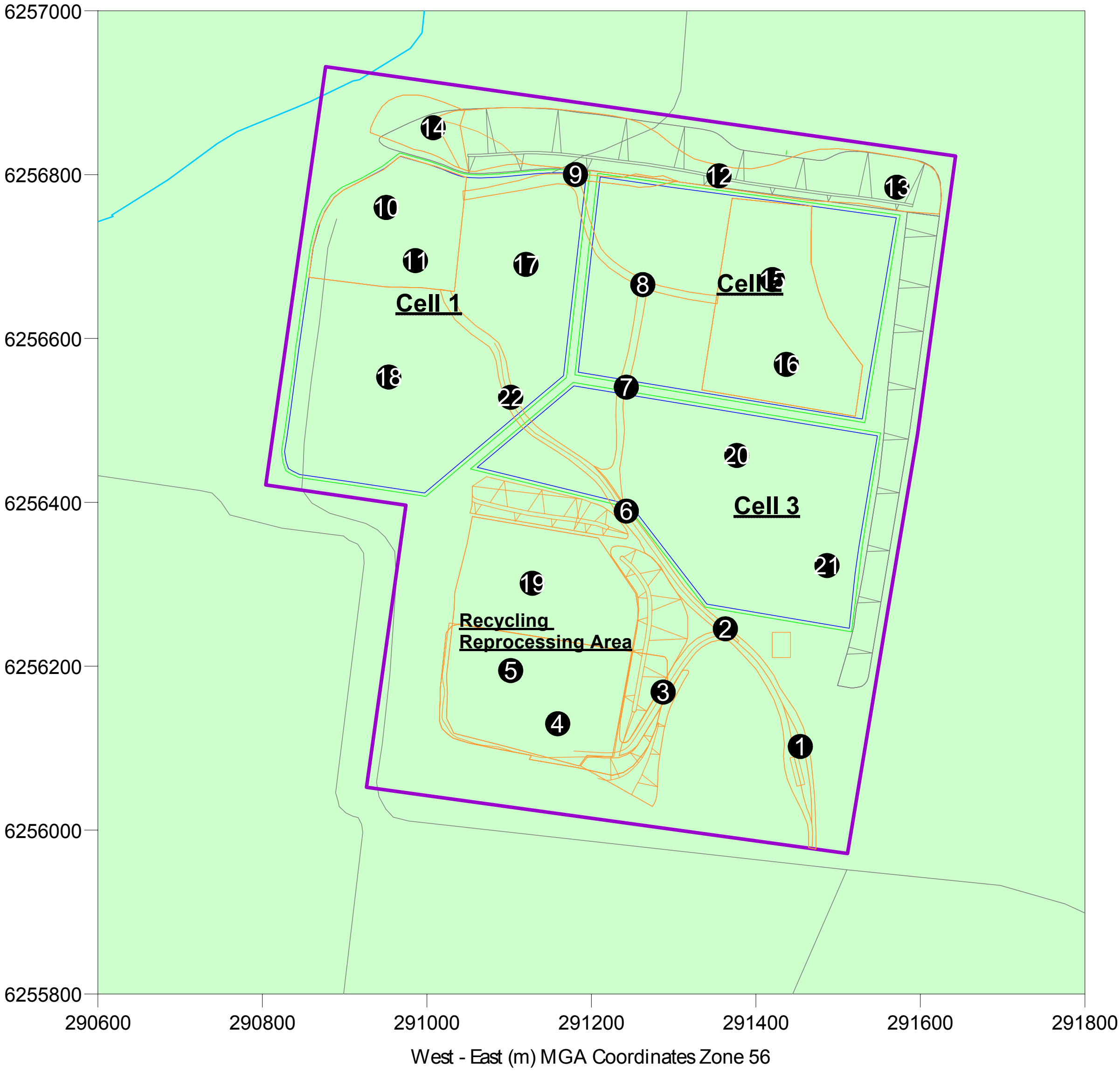

Figure 5: Modelled dust source location for Scenario 1

Figure 6: Modelled dust source location for Scenario 2

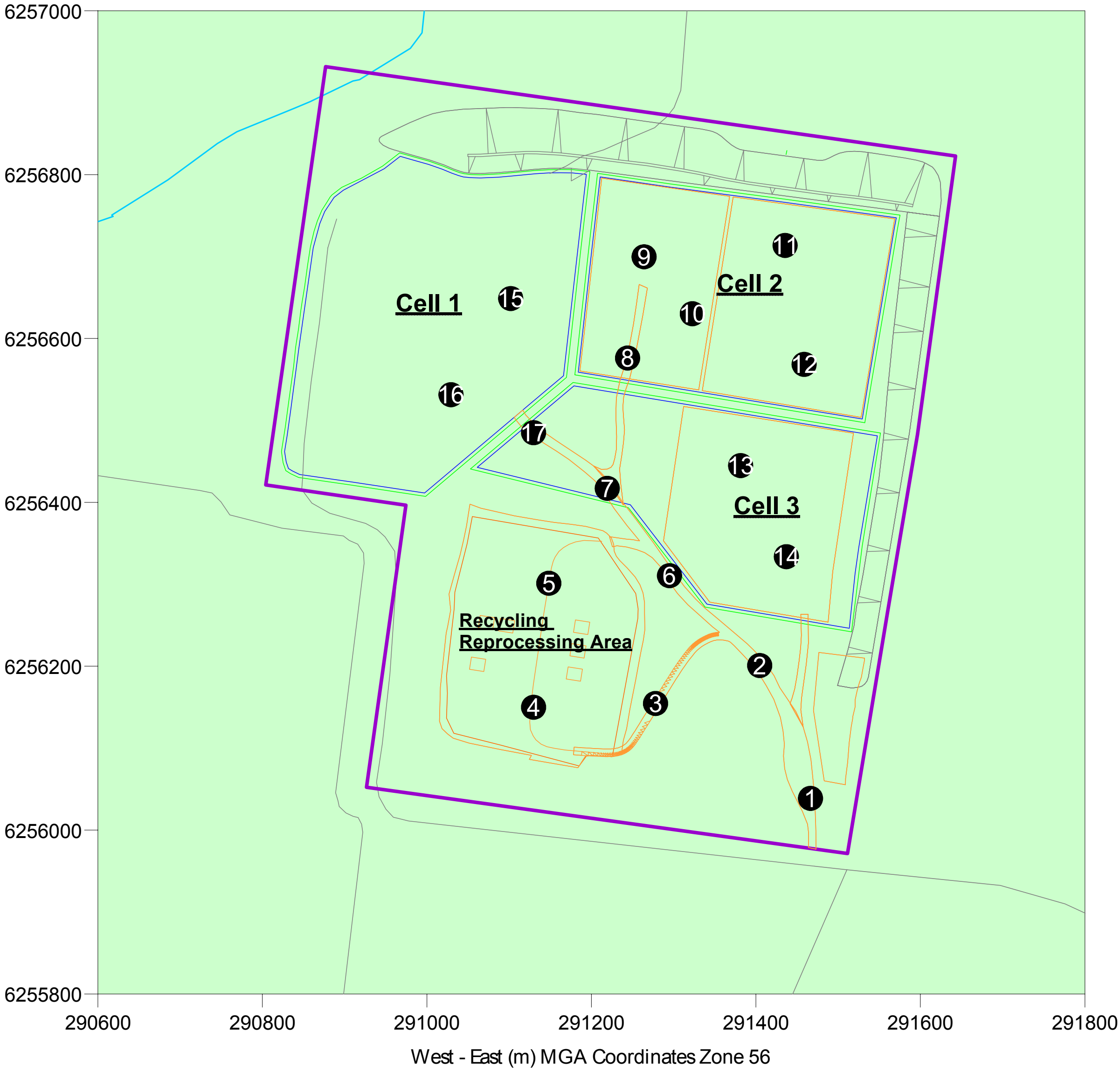

Figure 7: Modelled dust source location for Scenario 3a and 3b

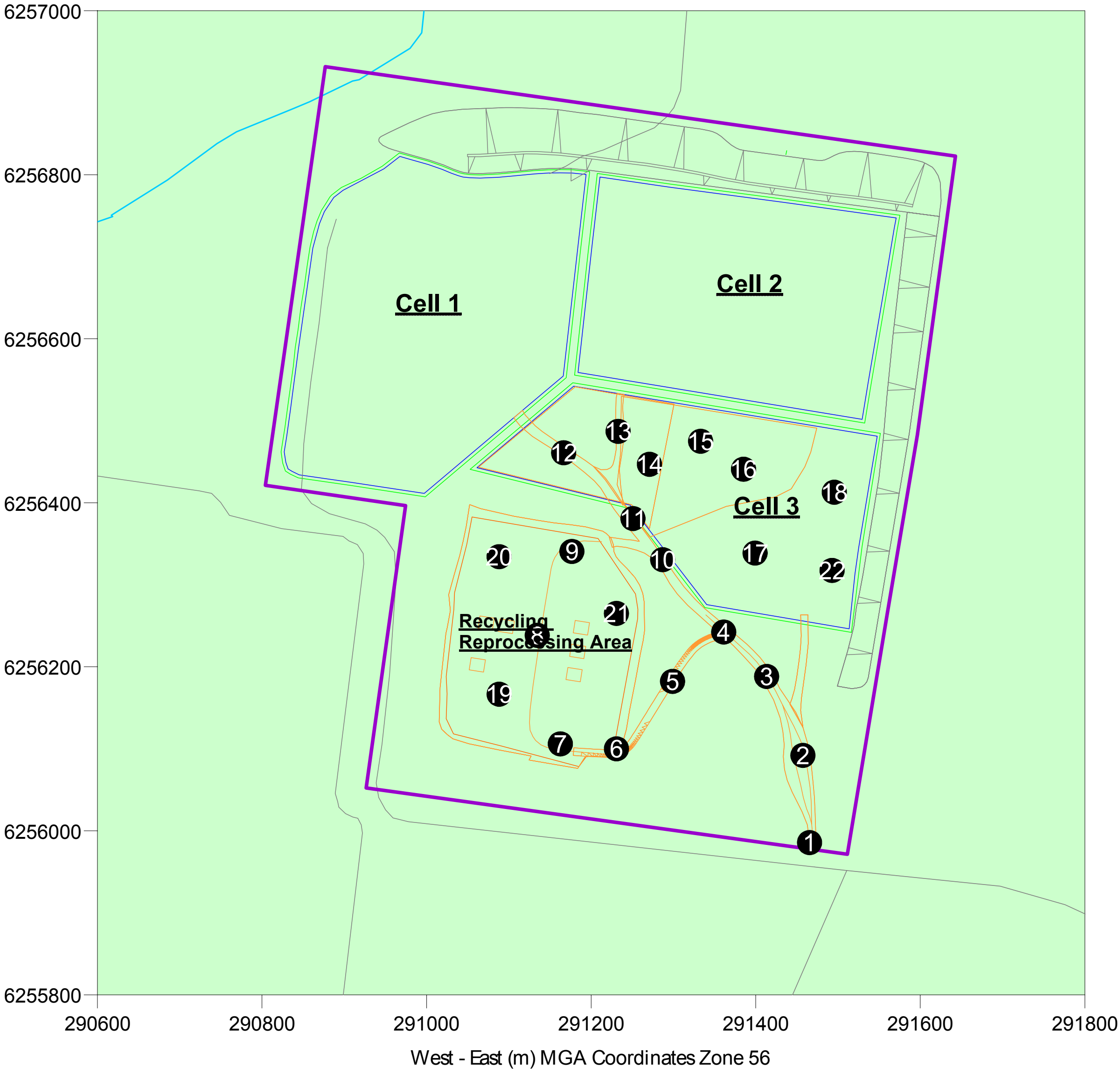

Figure 8: Modelled dust source location for Scenario 4

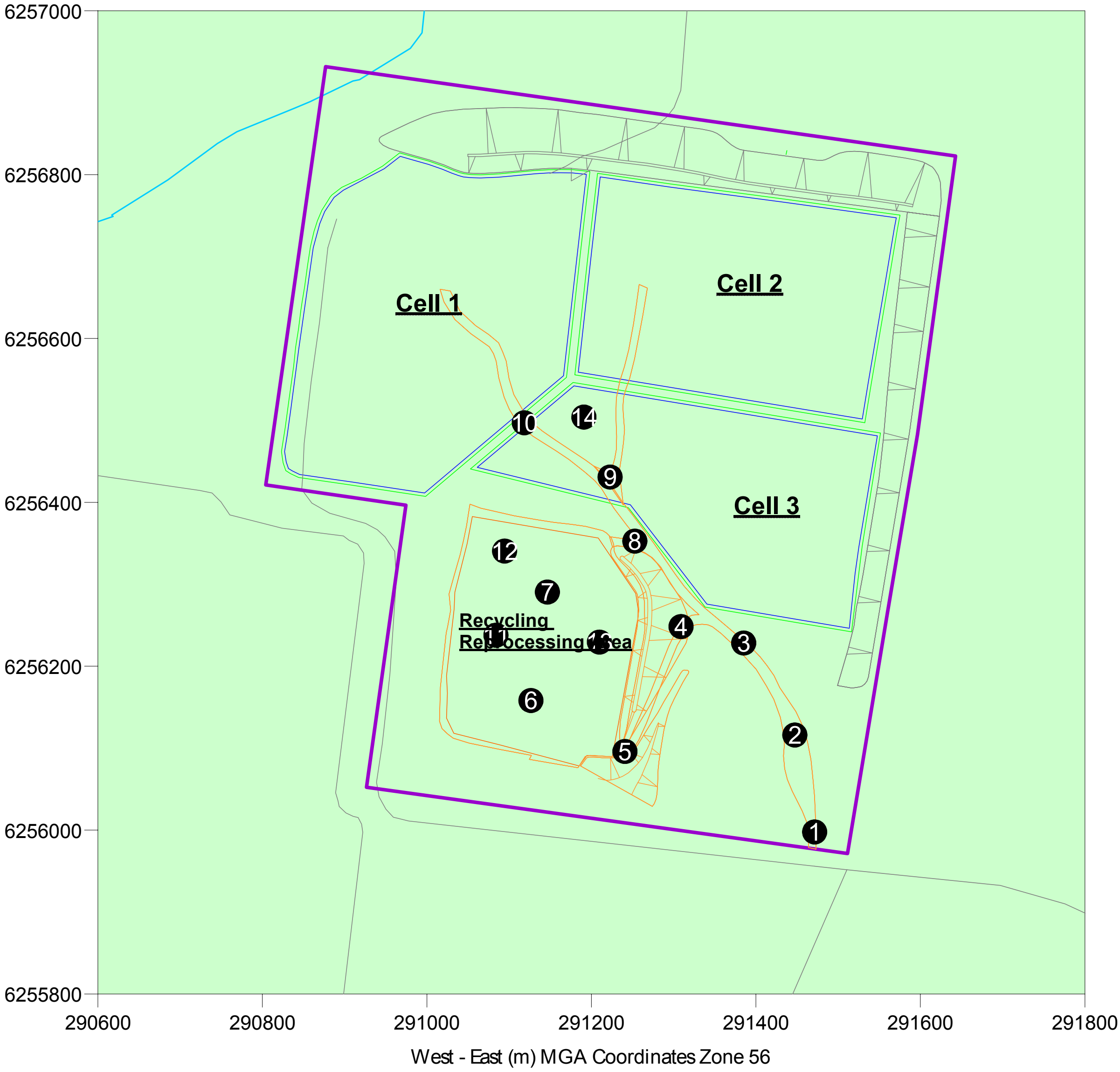

Figure 9: Modelled dust source location for Scenario 5

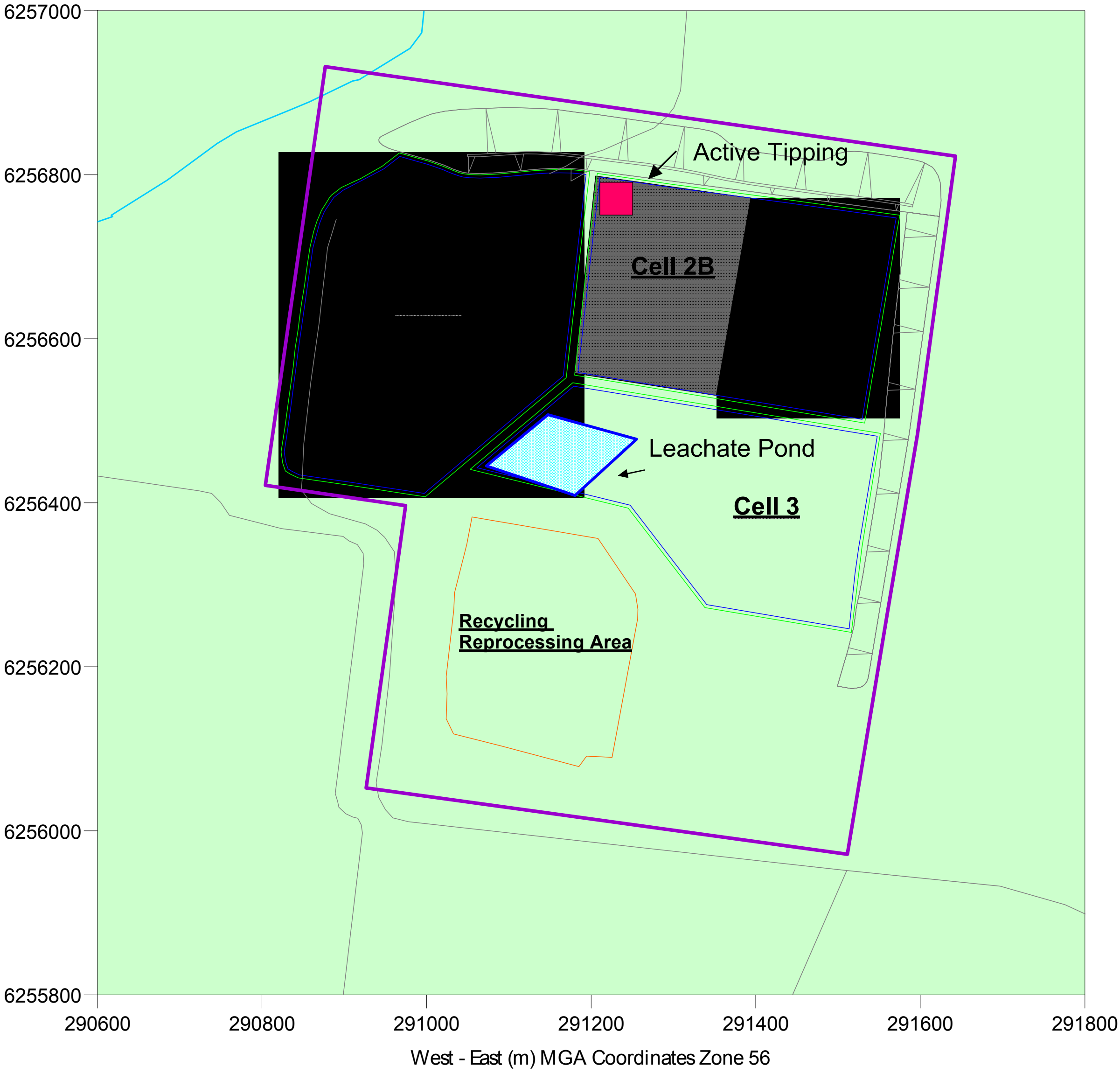

Figure 10: Modelled odour sources

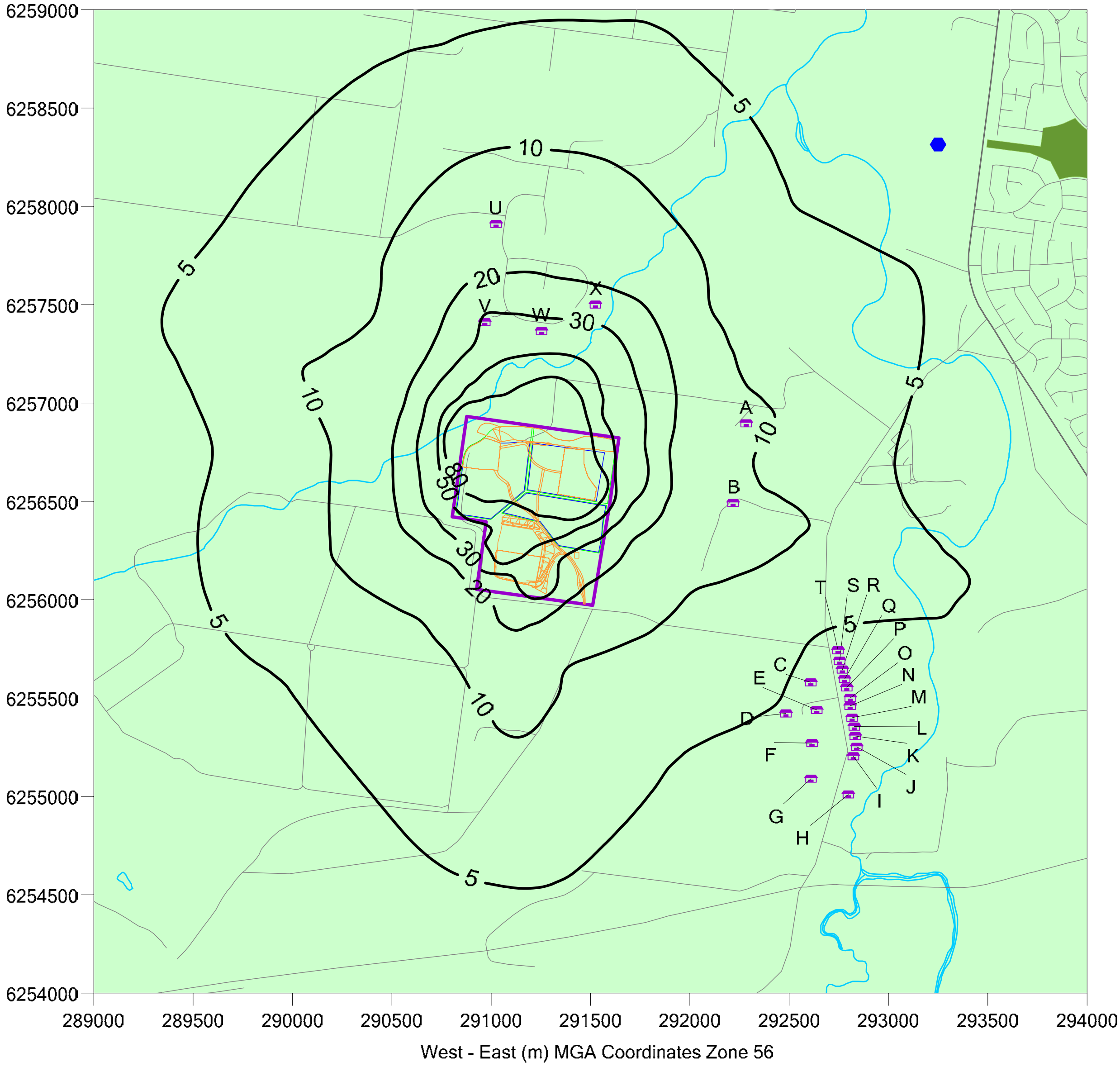

Figure 11: Scenario 1 - Predicted 24-hour average PM_{10} concentrations (μg/m^3) due to emissions from the Project

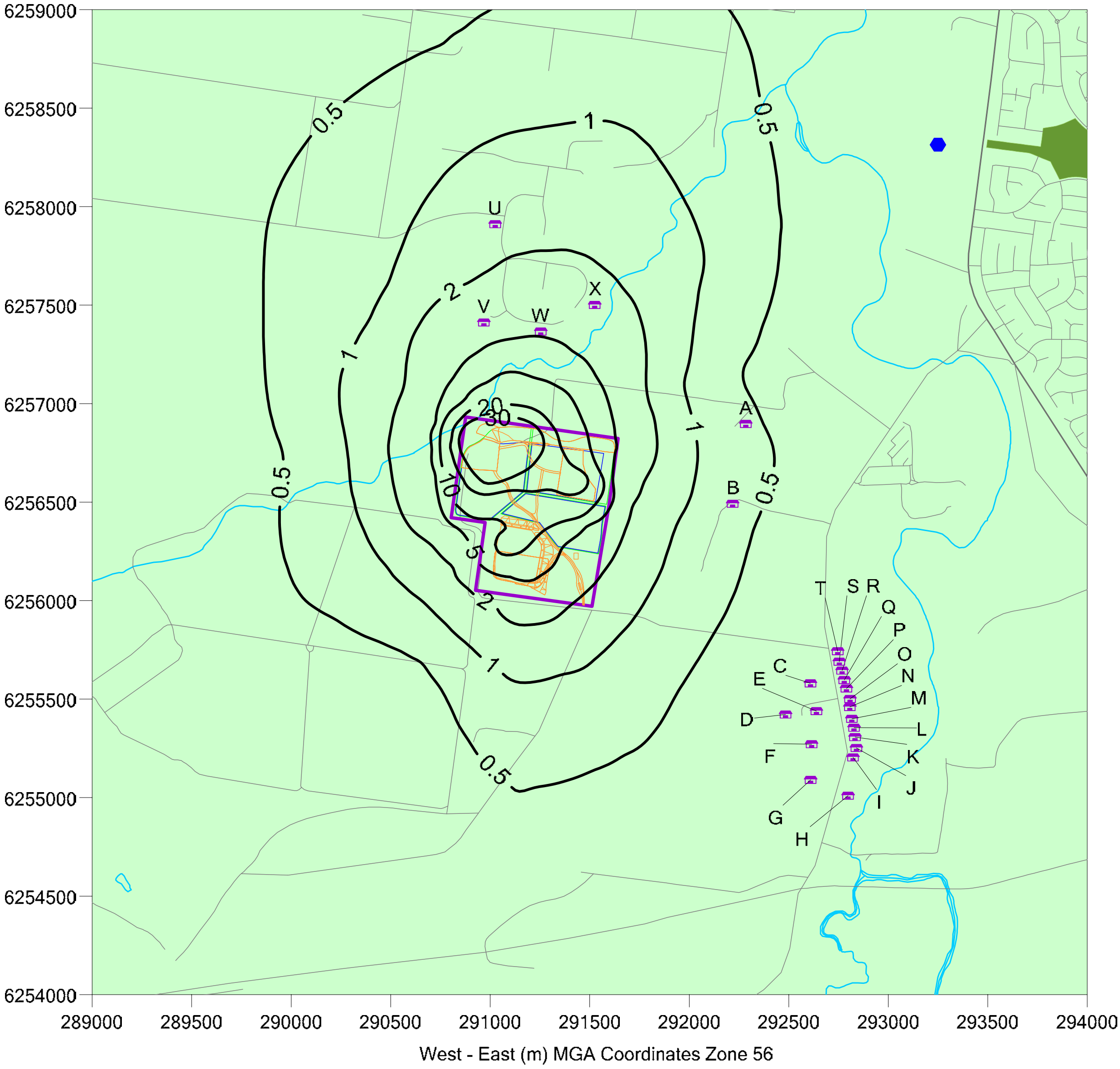

Figure 12: Scenario 1 - Predicted annual average PM_{10} concentrations (µg/m^3) due to emissions from the Project

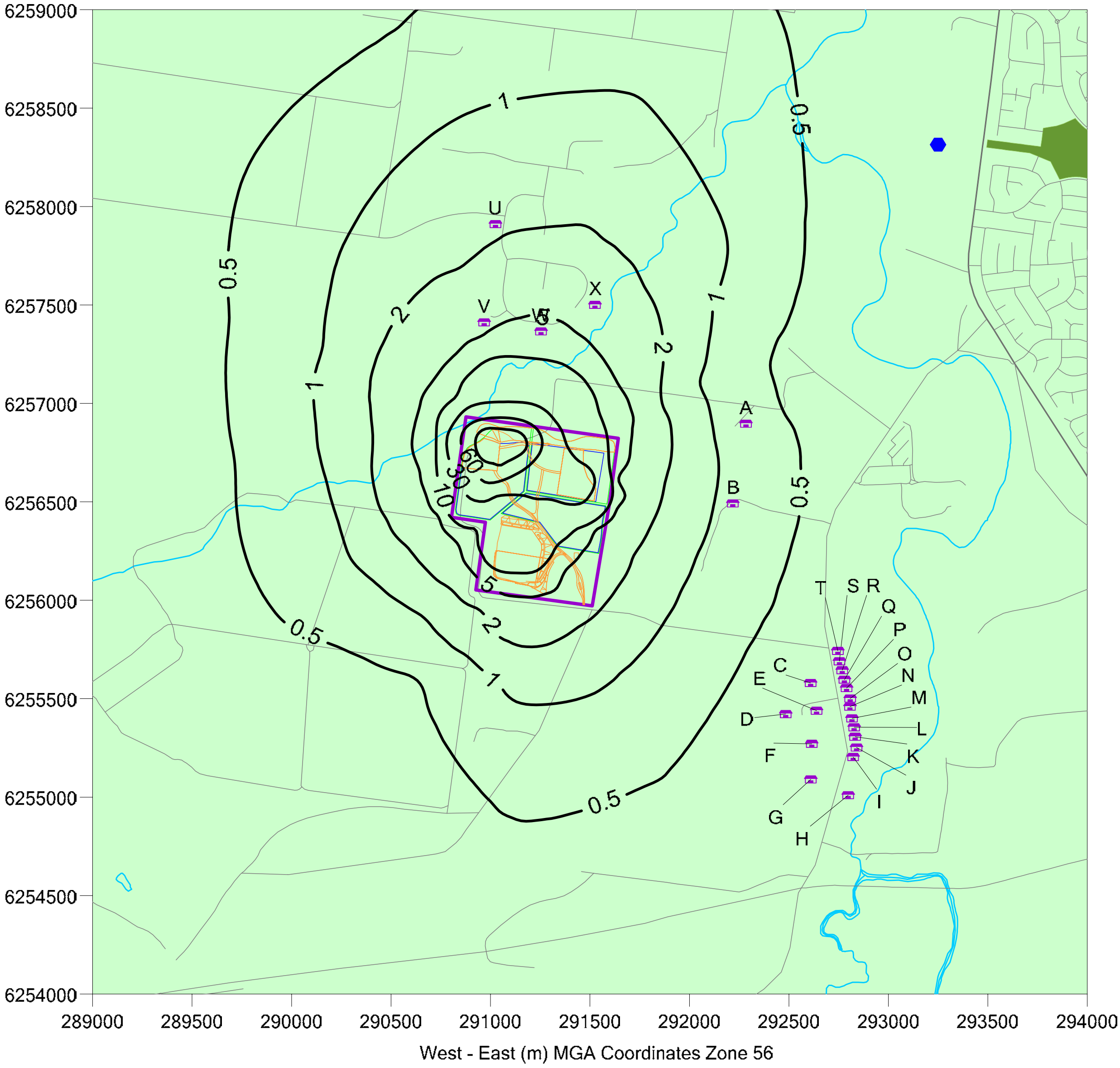

Figure 13: Scenario 1 - Predicted TSP concentrations (µg/m³) due to emissions from the Project

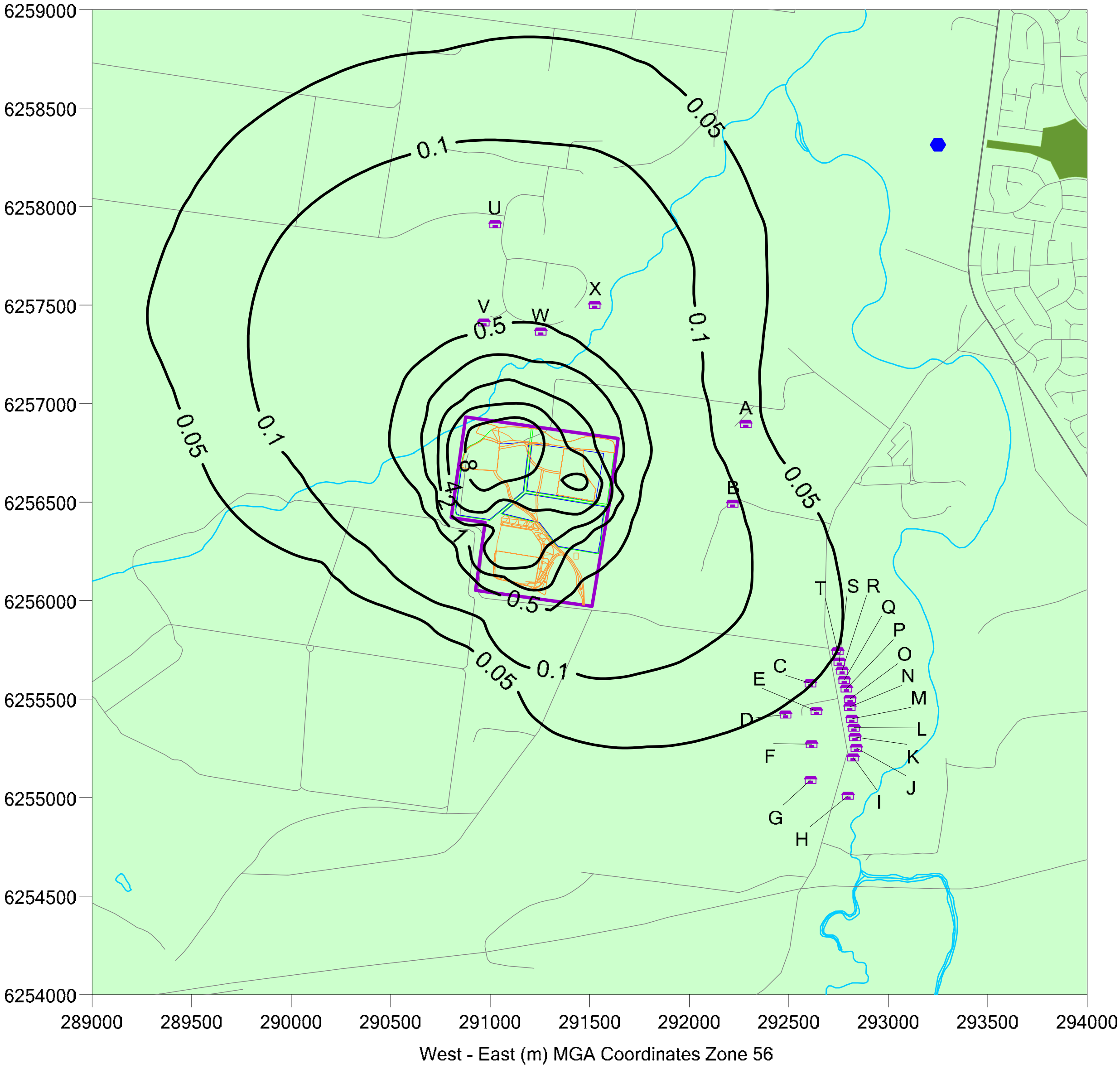

Figure 14: Scenario 1 - Predicted dust deposition levels (g/m^2/month) due to emissions from the Project

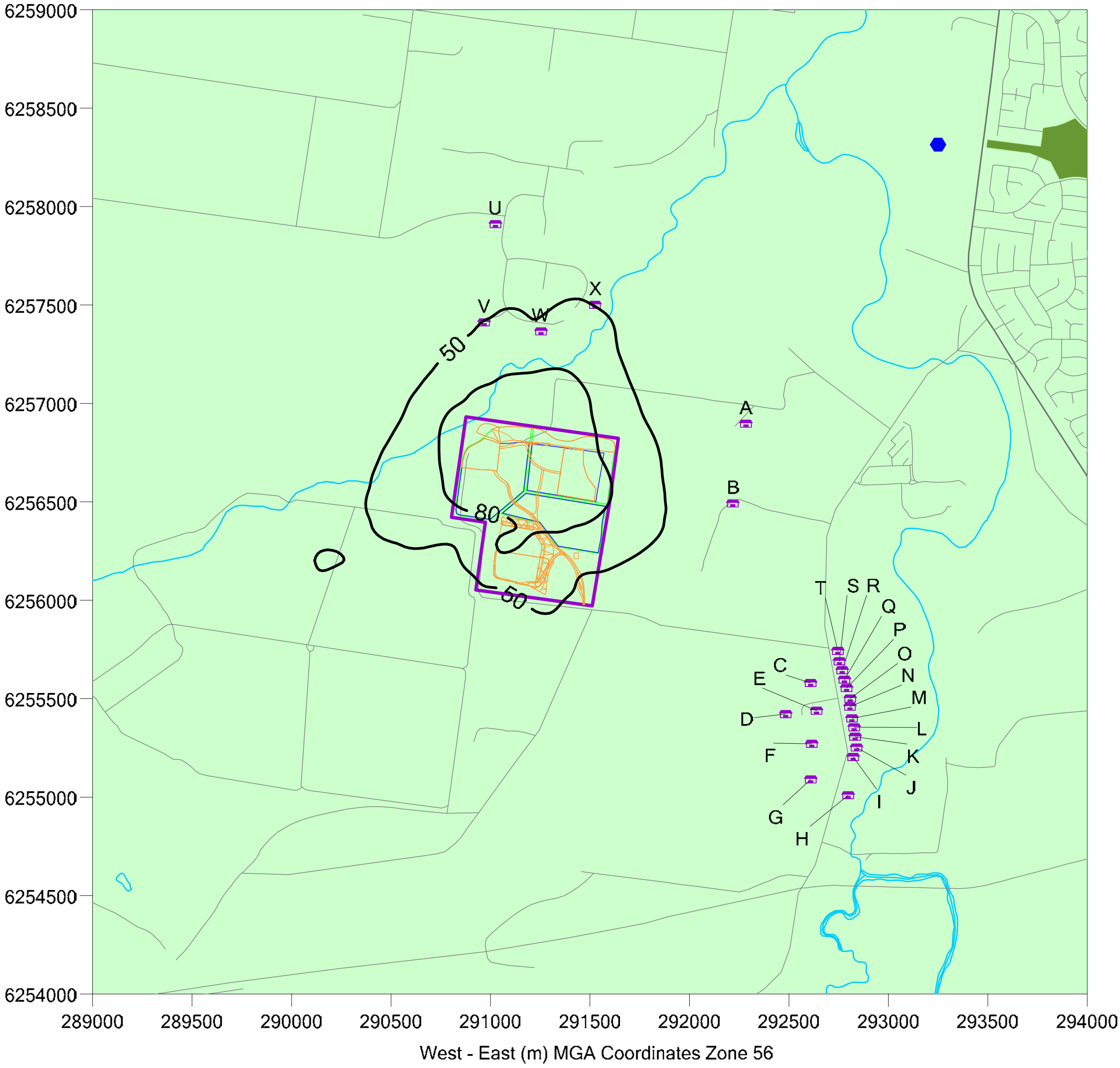

Figure 15: Scenario 1 - Predicted 24-hour average PM_{10} concentrations (µg/m^3) due to emissions from the Project including background

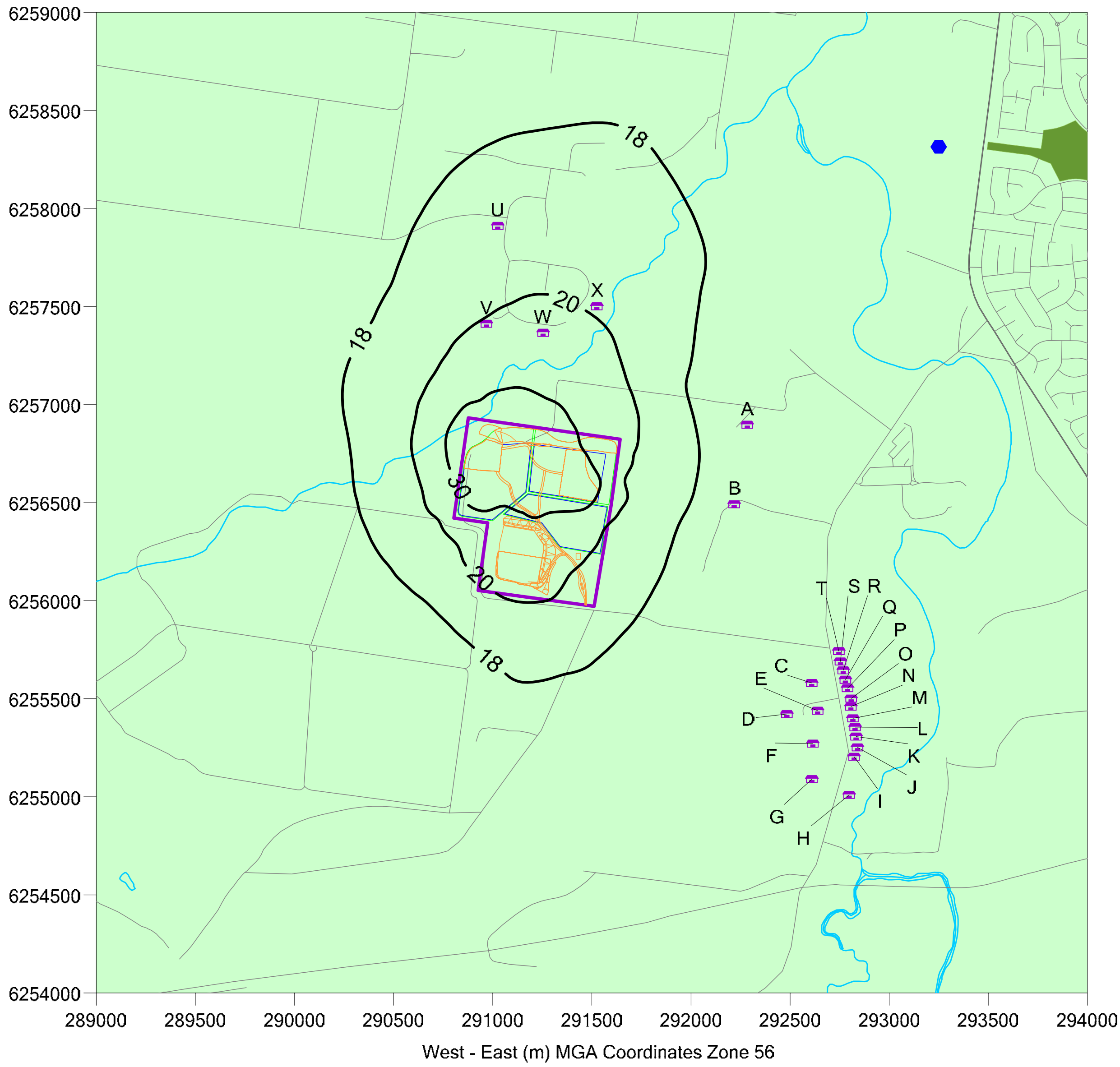

Figure 16: Scenario 1 - Predicted annual average PM_{10} concentrations (µg/m^3) due to emissions from the Project including background

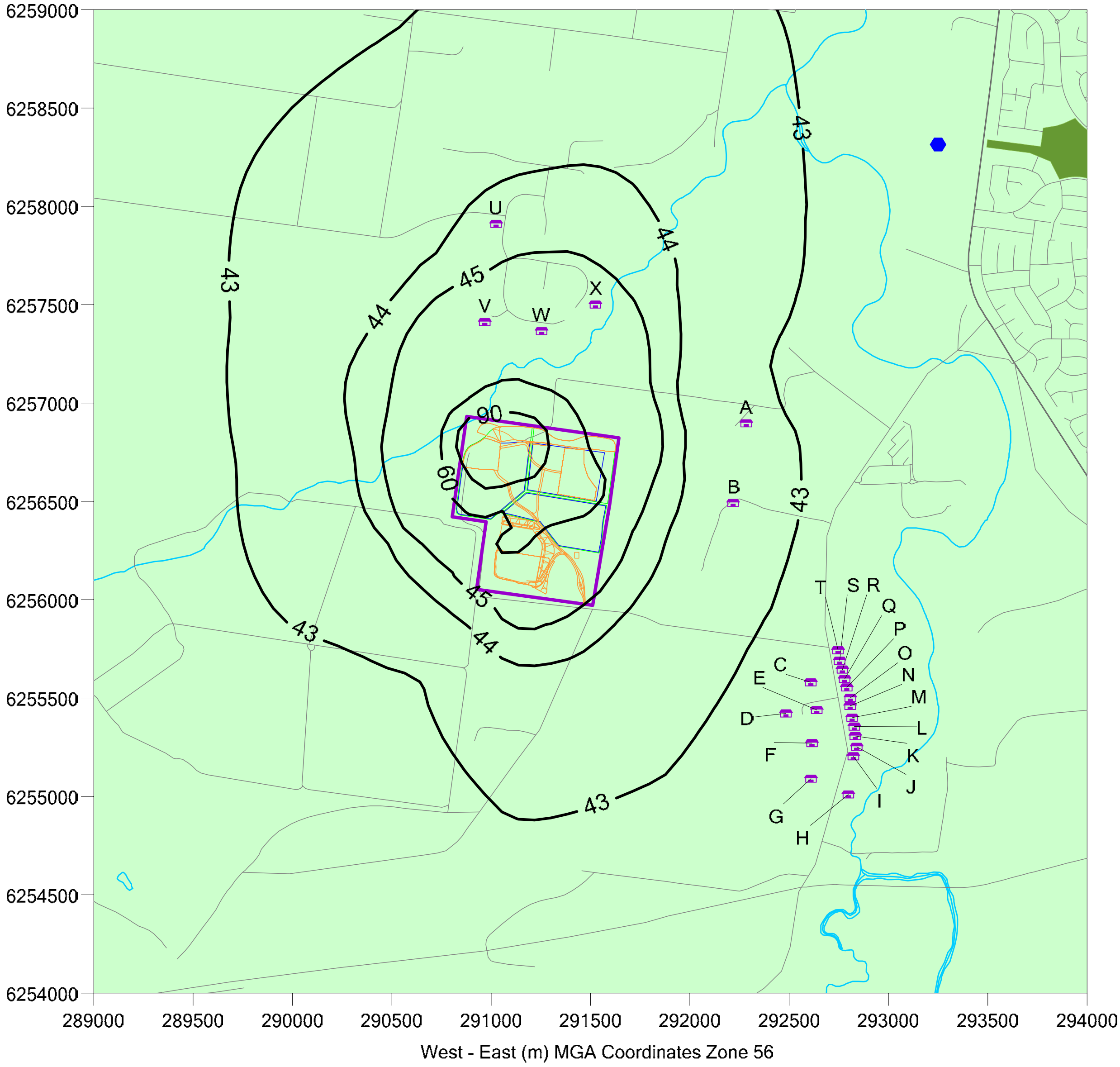

Figure 17: Scenario 1 - Predicted TSP concentrations (µg/m³) due to emissions from the Project including background

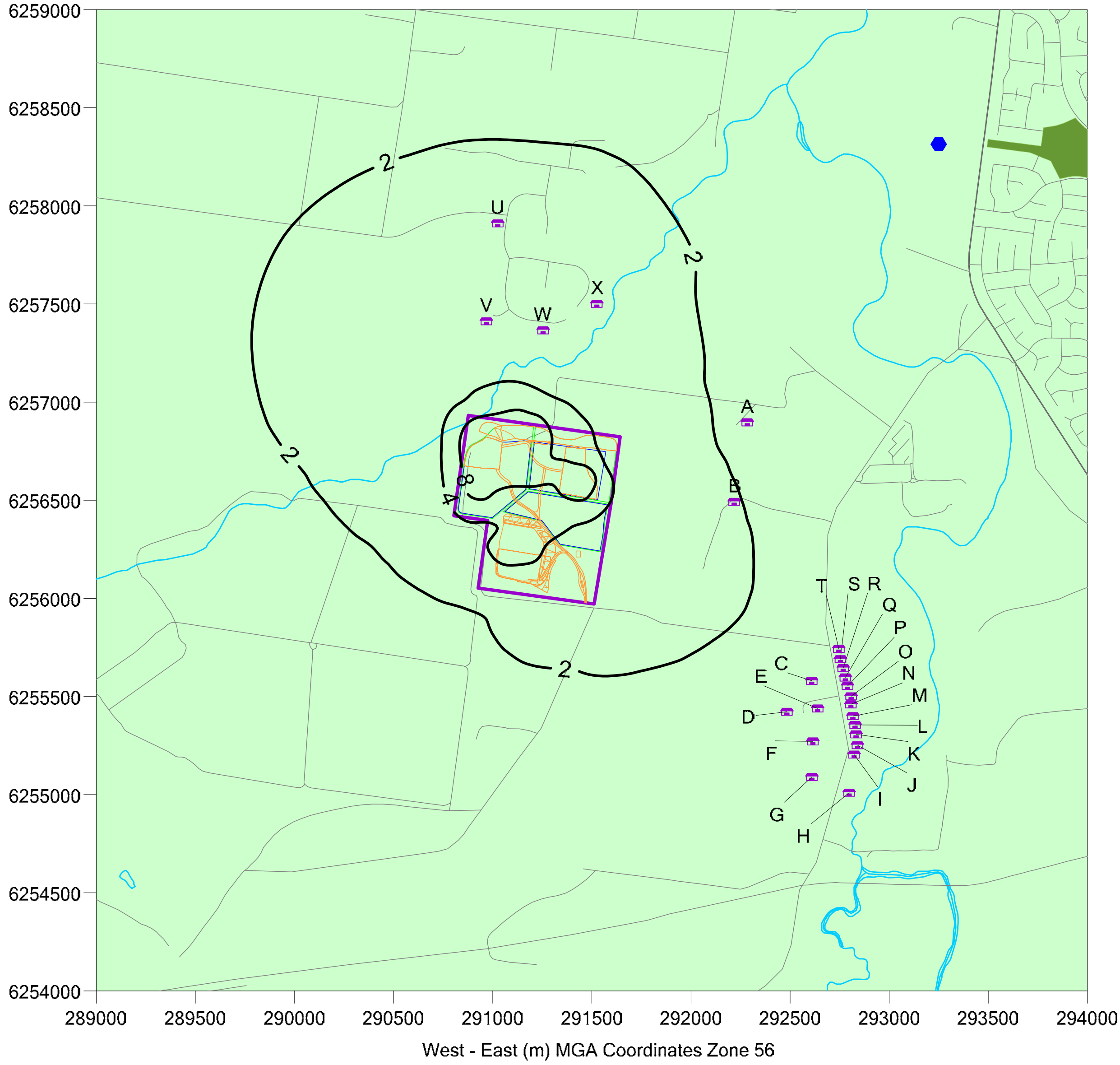

Figure 18: Scenario 1 - Predicted dust deposition levels (g/m²/month) due to emissions from the Project including background

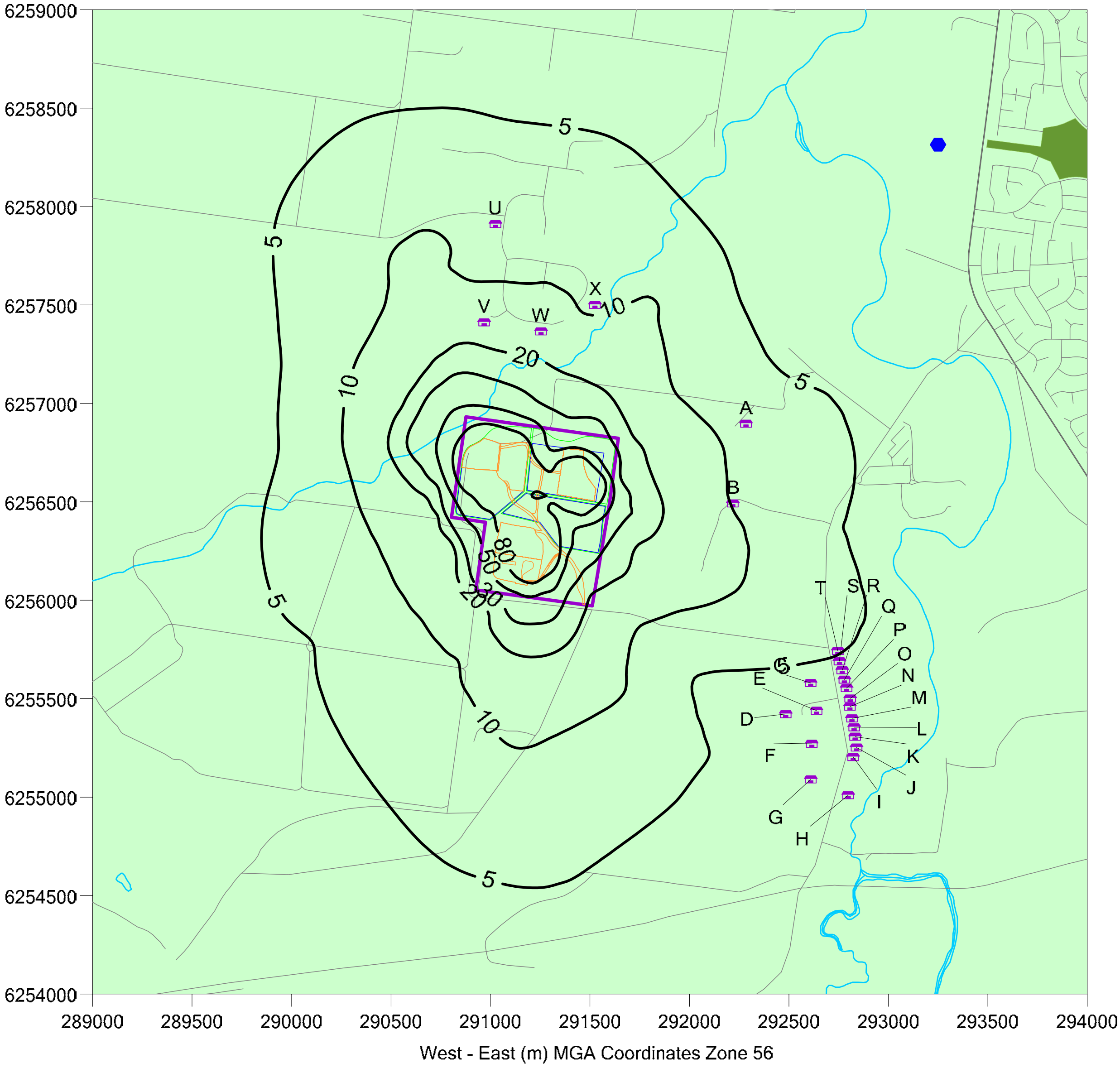

Figure 19: Scenario 2 - Predicted 24-hour average PM_{10} concentrations (µg/m^3) due to emissions from the Project

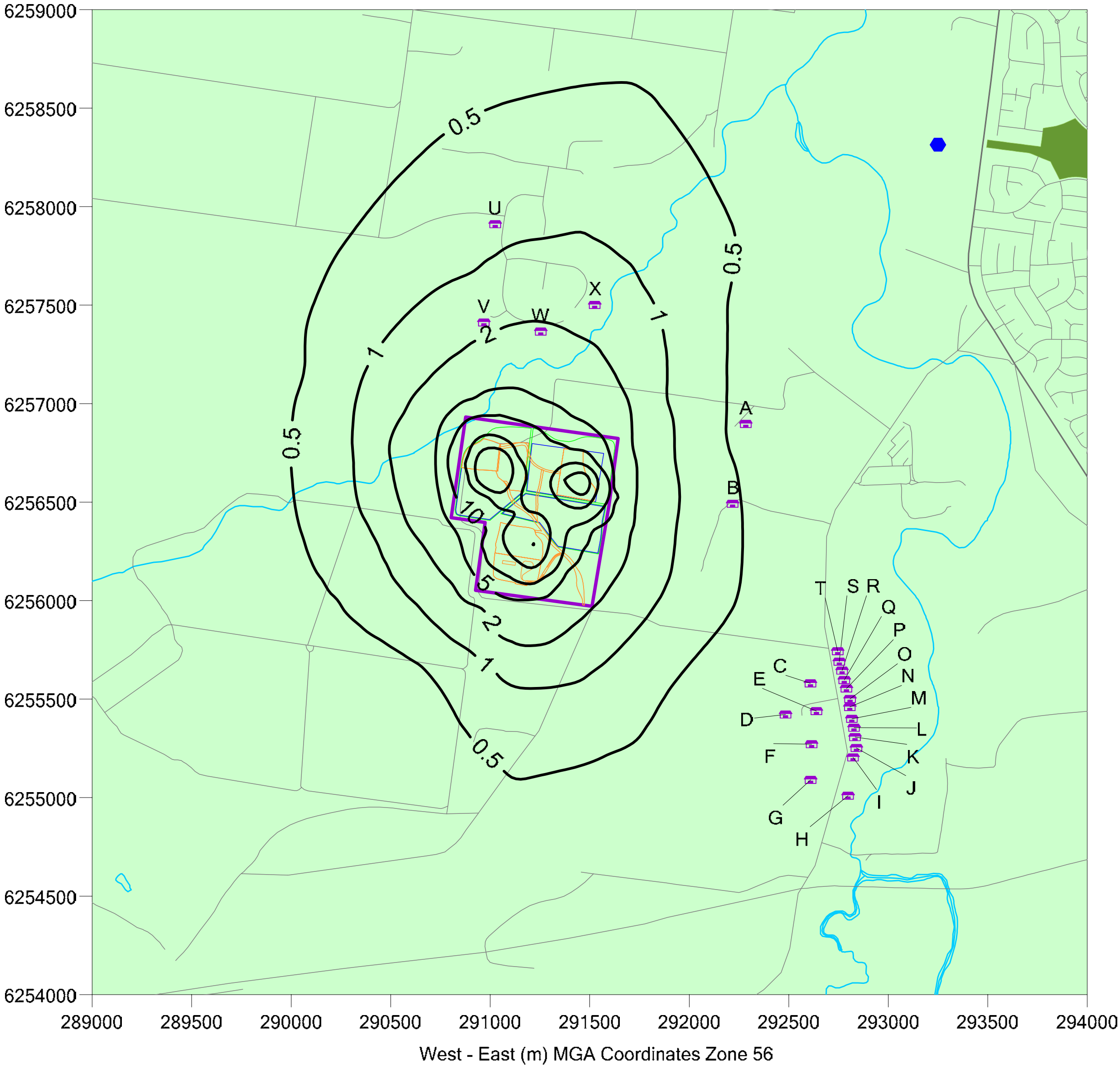

Figure 20: Scenario 2 - Predicted annual average PM_{10} concentrations (µg/m^3) due to emissions from the Project

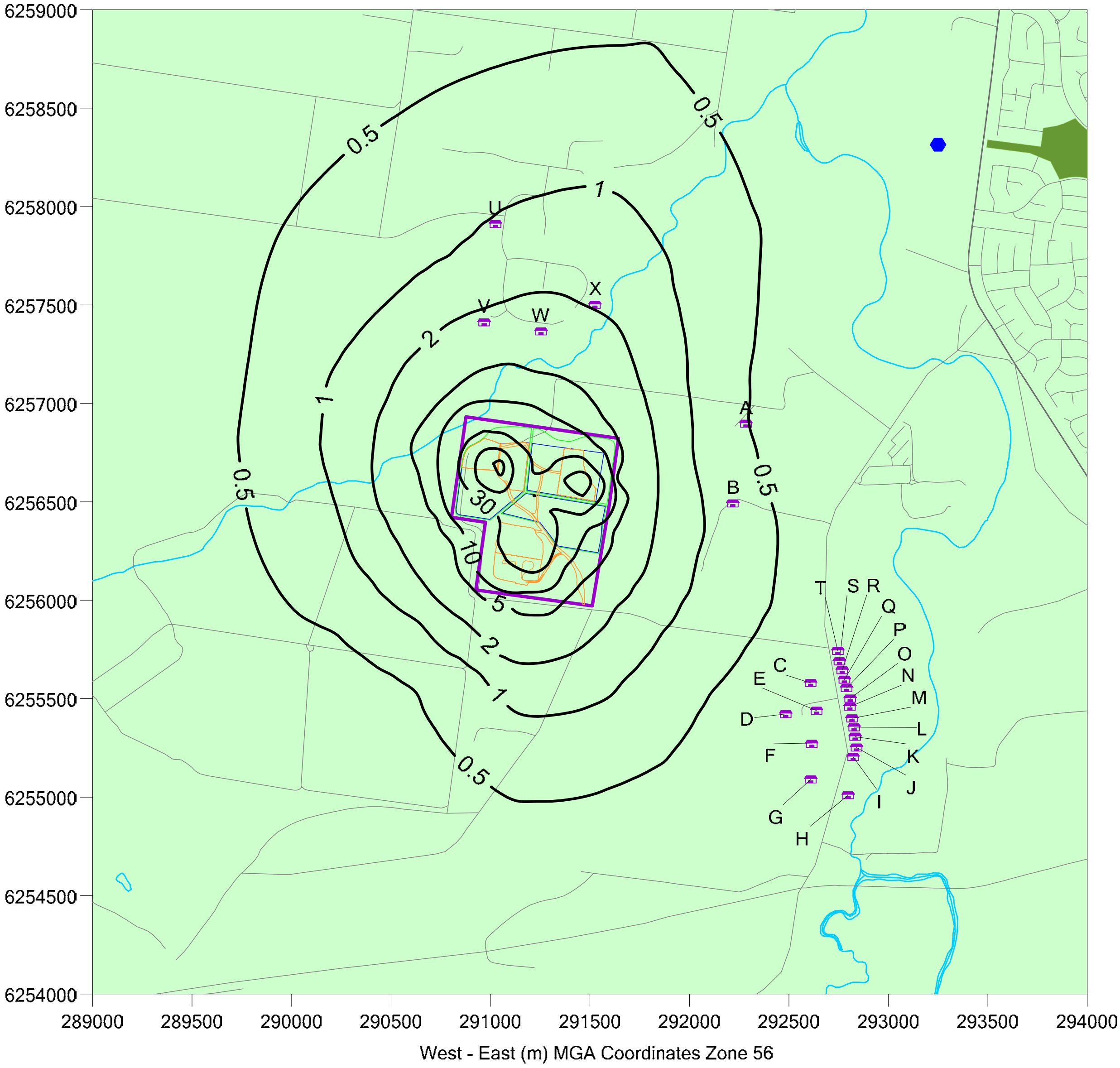

Figure 21: Scenario 2 - Predicted TSP concentrations (µg/m^3) due to emissions from the Project

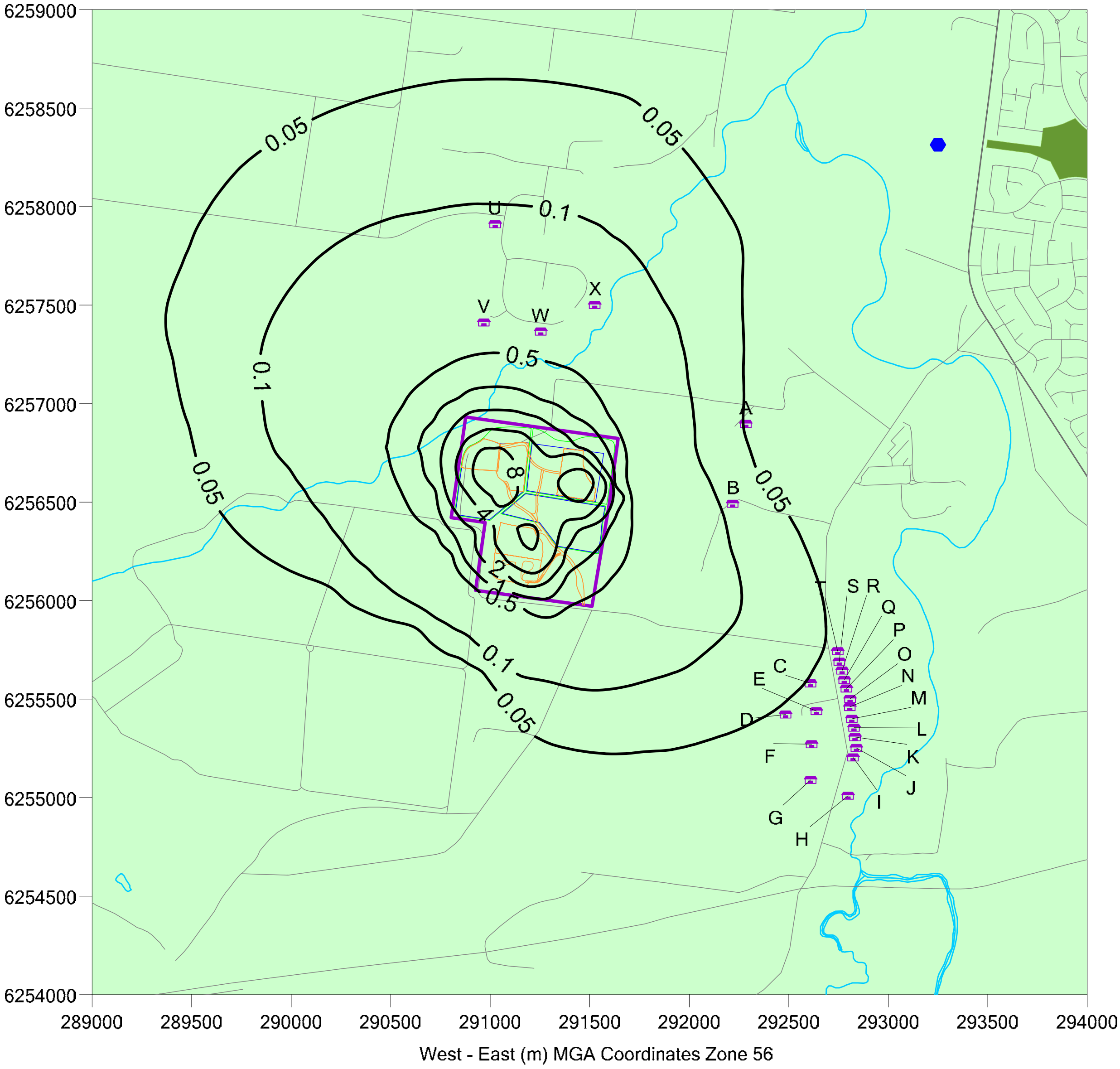

Figure 22: Scenario 2 - Predicted dust deposition levels (g/m²/month) due to emissions from the Project

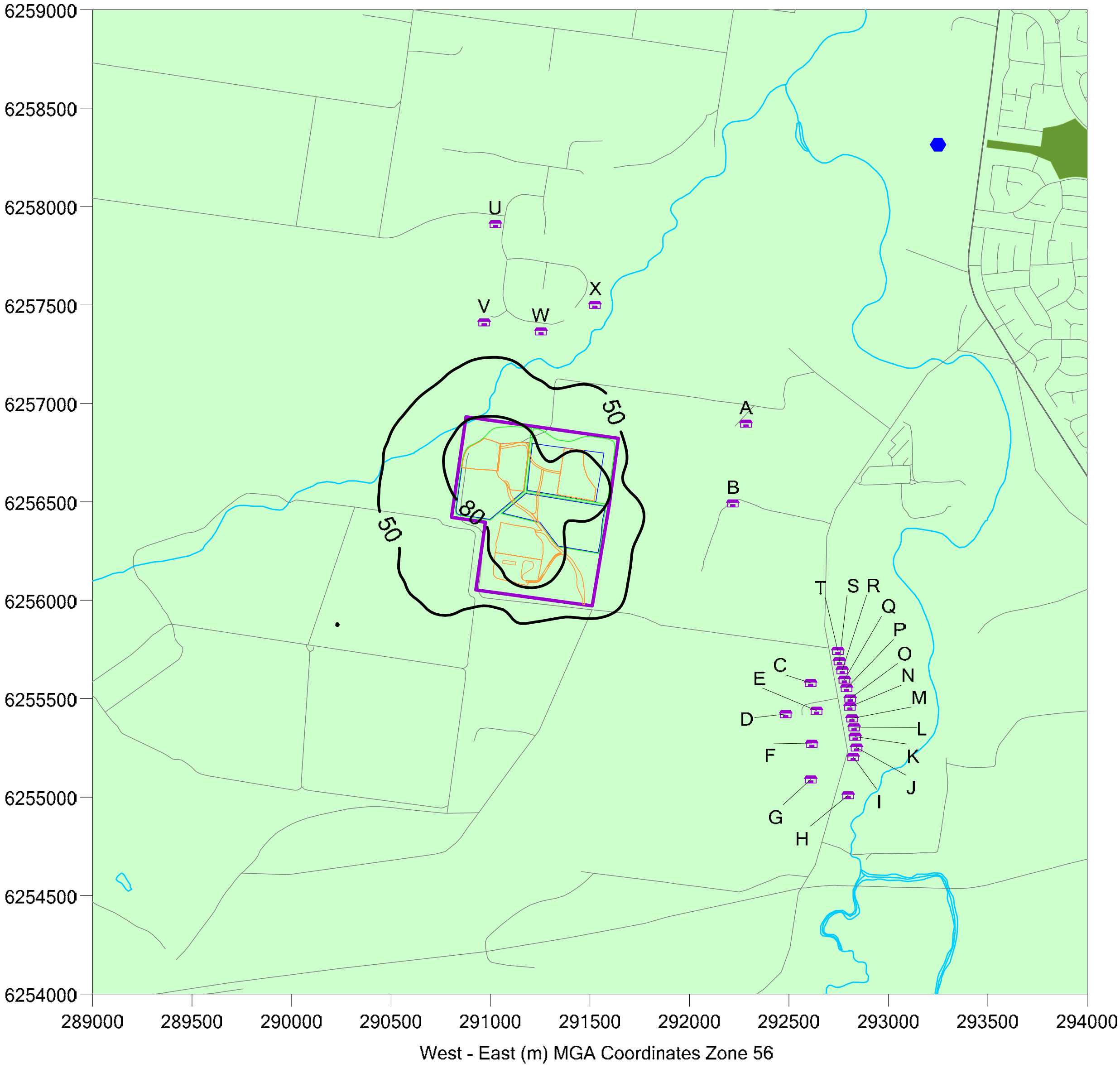

Figure 23: Scenario 2 - Predicted 24-hour average PM_{10} concentrations (µg/m^3) due to emissions from the Project including background

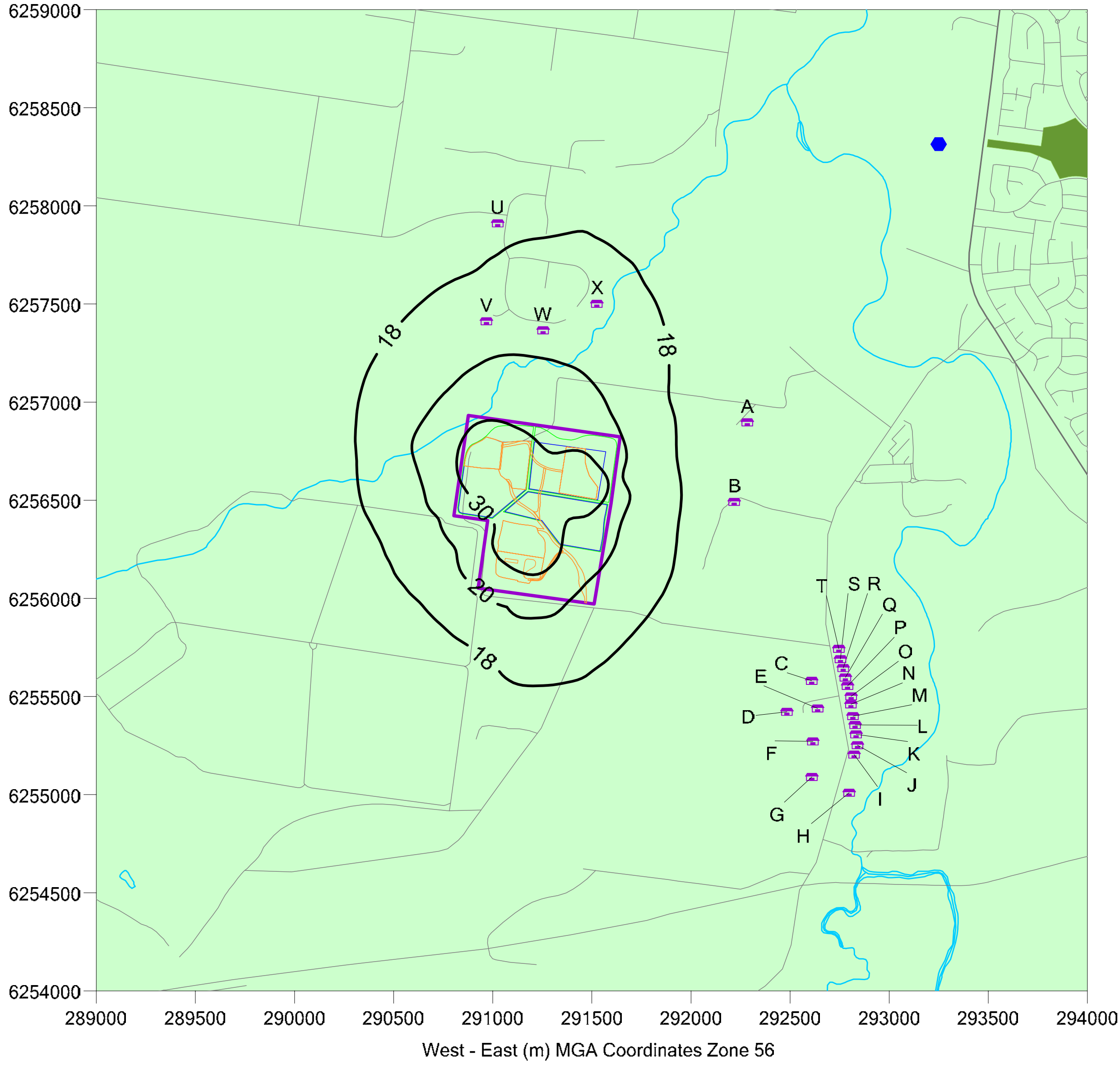

Figure 24: Scenario 2 - Predicted annual average PM_{10} concentrations (µg/m^3) due to emissions from the Project including background

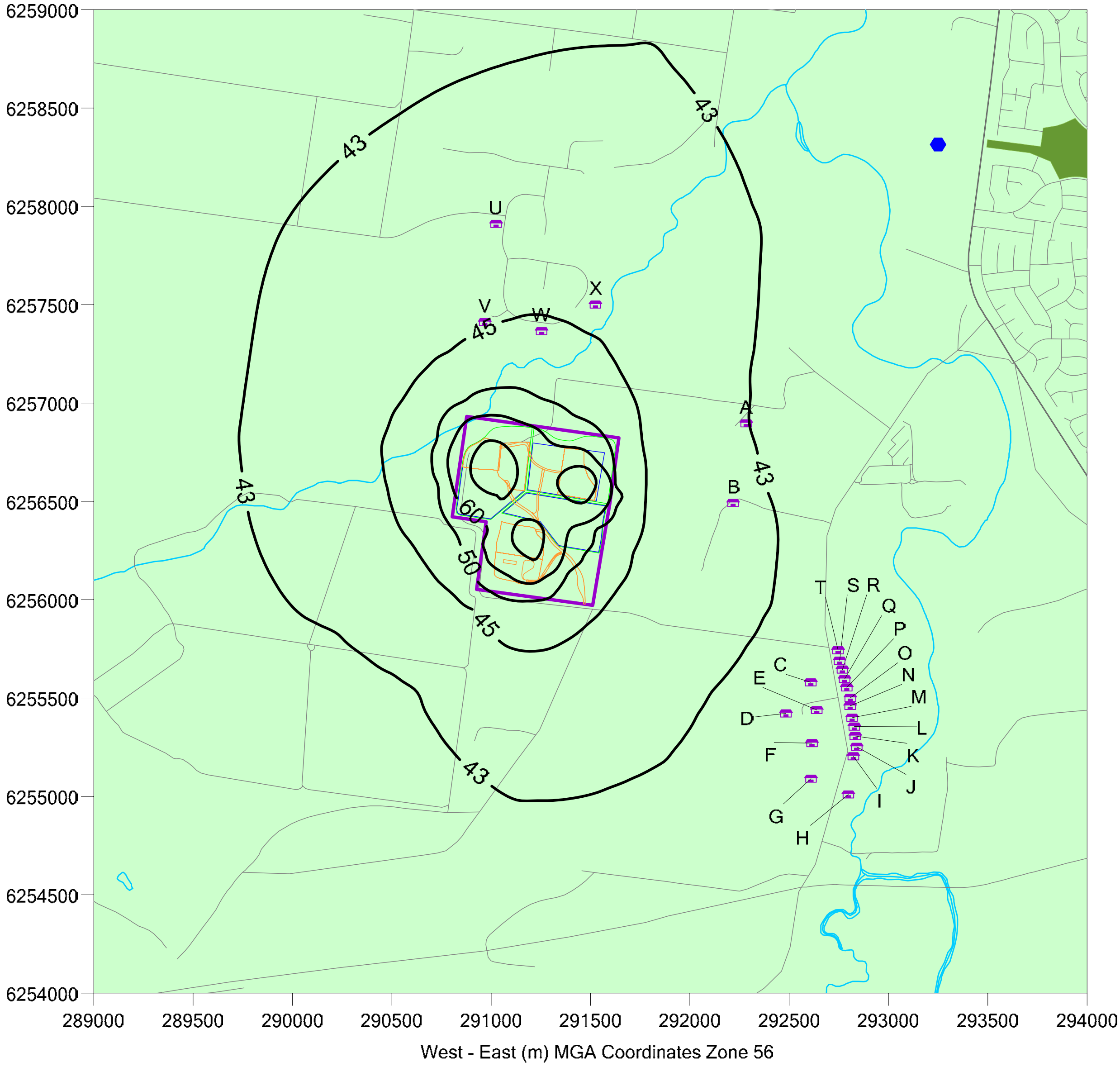

Figure 25: Scenario 2 - Predicted TSP concentrations (µg/m^3) due to emissions from the Project including background

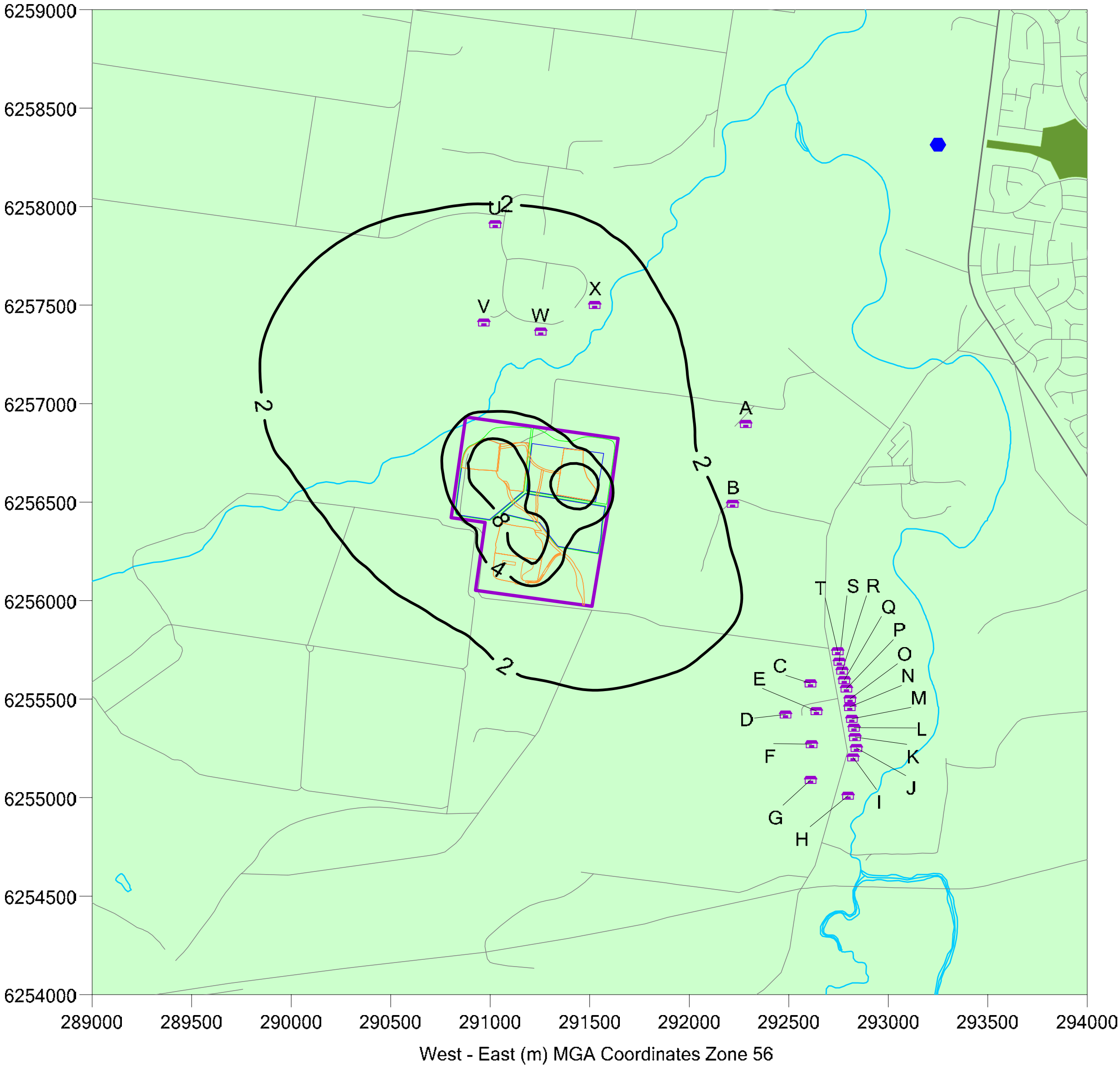

Figure 26: Scenario 2 - Predicted dust deposition levels (g/m^2/month) due to emissions from the Project including background

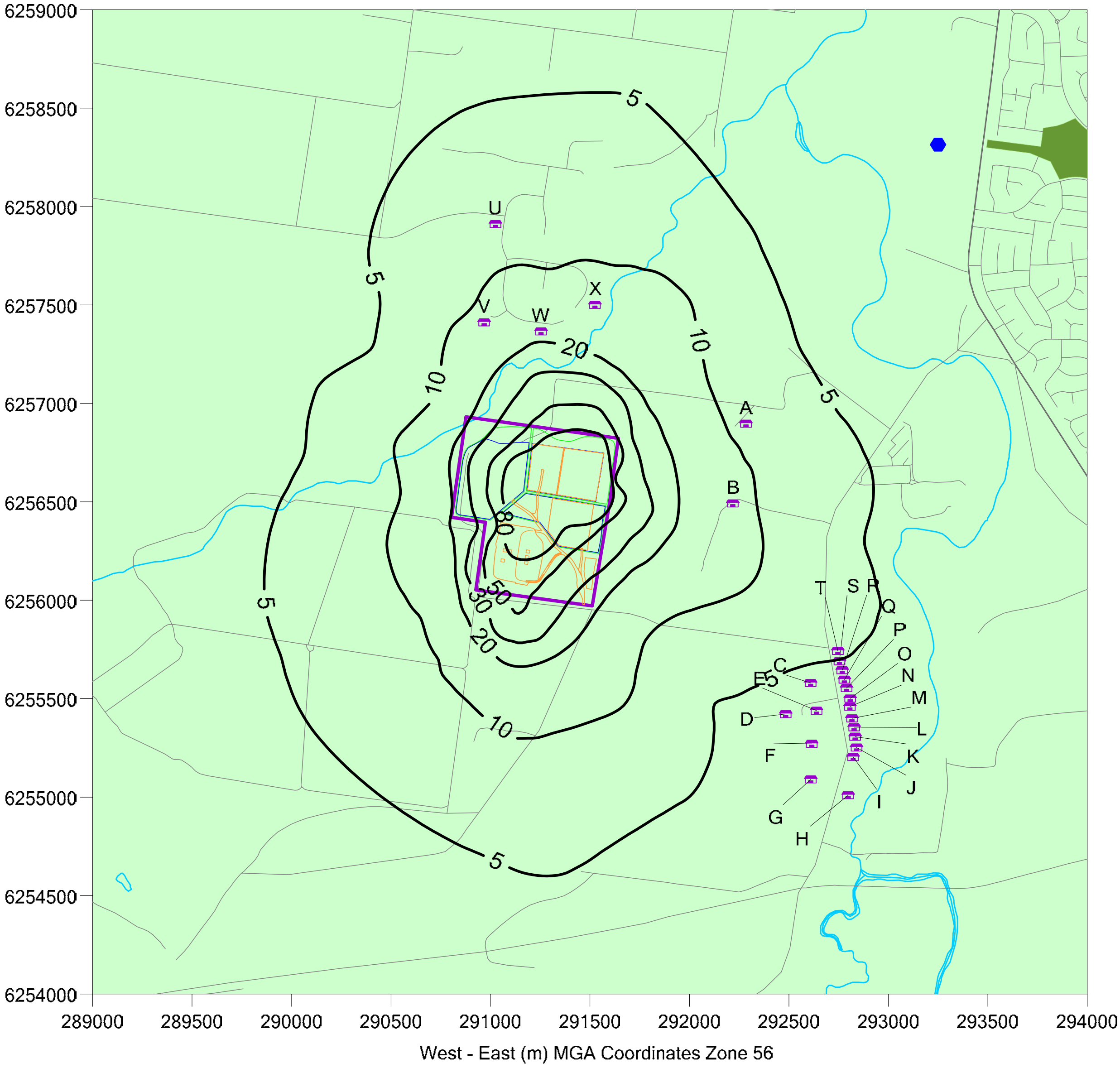

Figure 27: Scenario 3a - Predicted 24-hour average PM_{10} concentrations (µg/m^3) due to emissions from the Project

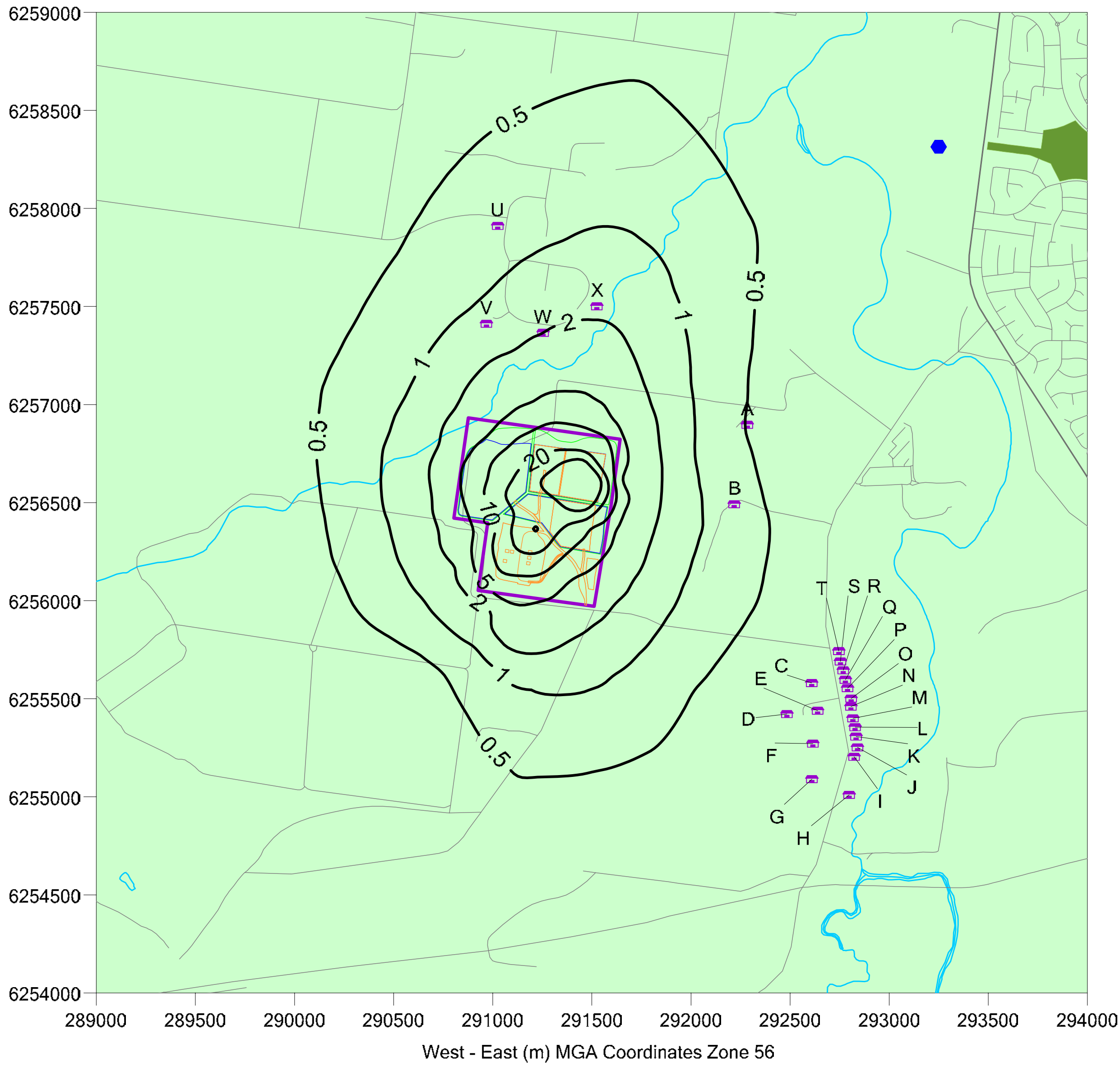

Figure 28: Scenario 3a - Predicted annual average PM_{10} concentrations ($\mu g/m^3$) due to emissions from the Project

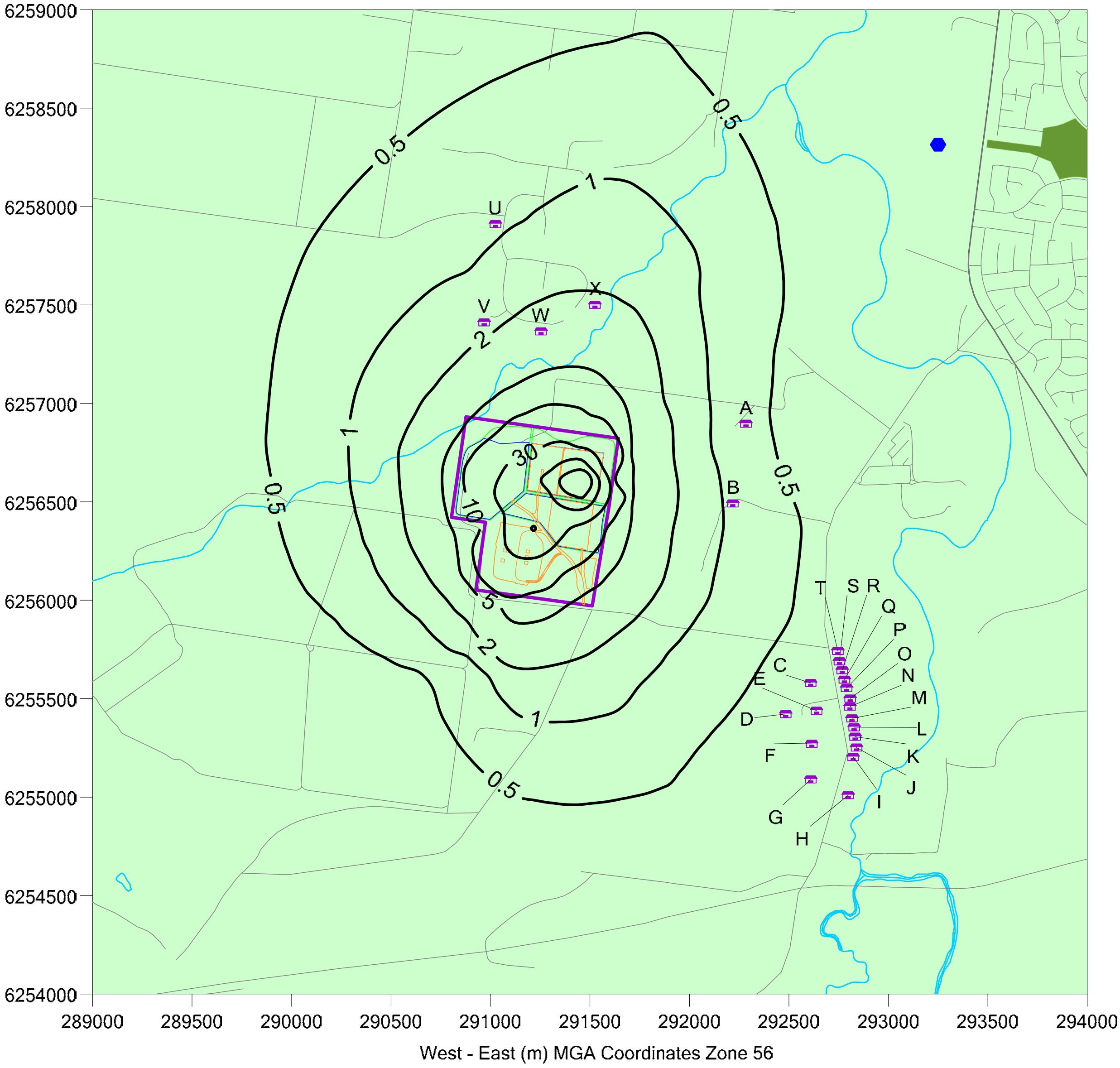

Figure 29: Scenario 3a - Predicted TSP concentrations (µg/m^3) due to emissions from the Project

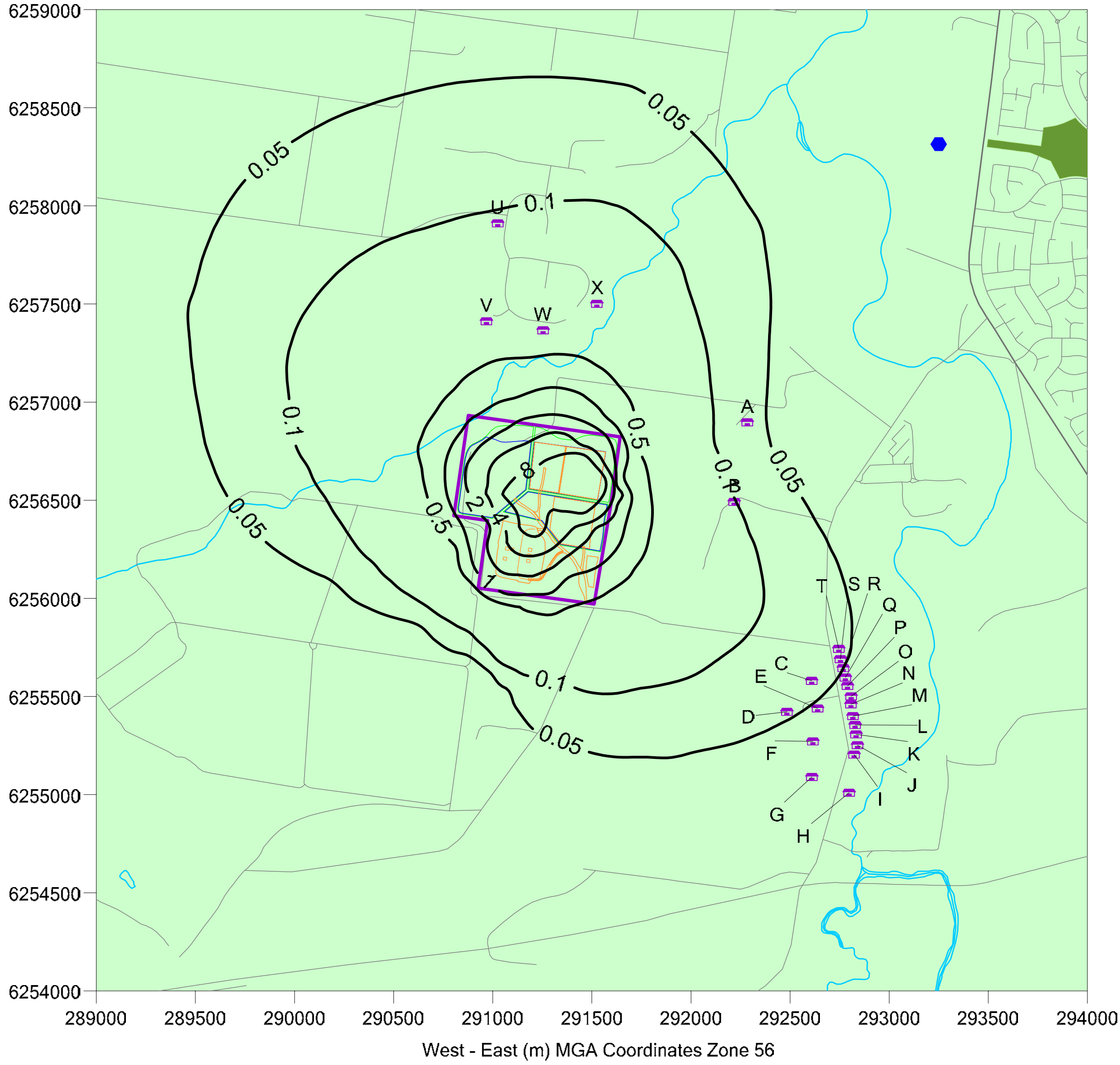

Figure 30: Scenario 3a - Predicted dust deposition levels (g/m^2/month) due to emissions from the Project

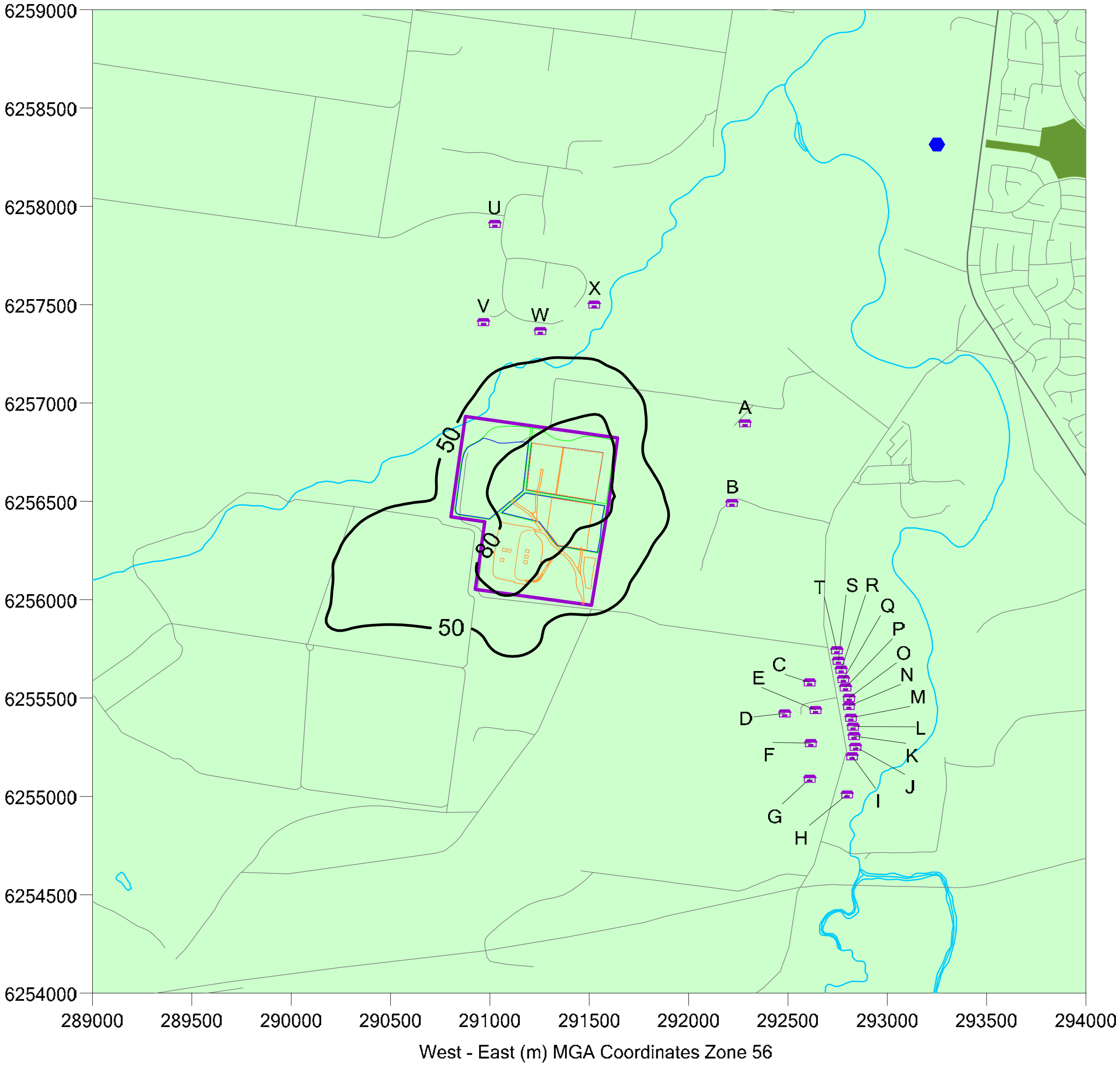

Figure 31: Scenario 3a - Predicted 24-hour average PM_{10} concentrations ($\mu g/m^3$) due to emissions from the Project including background

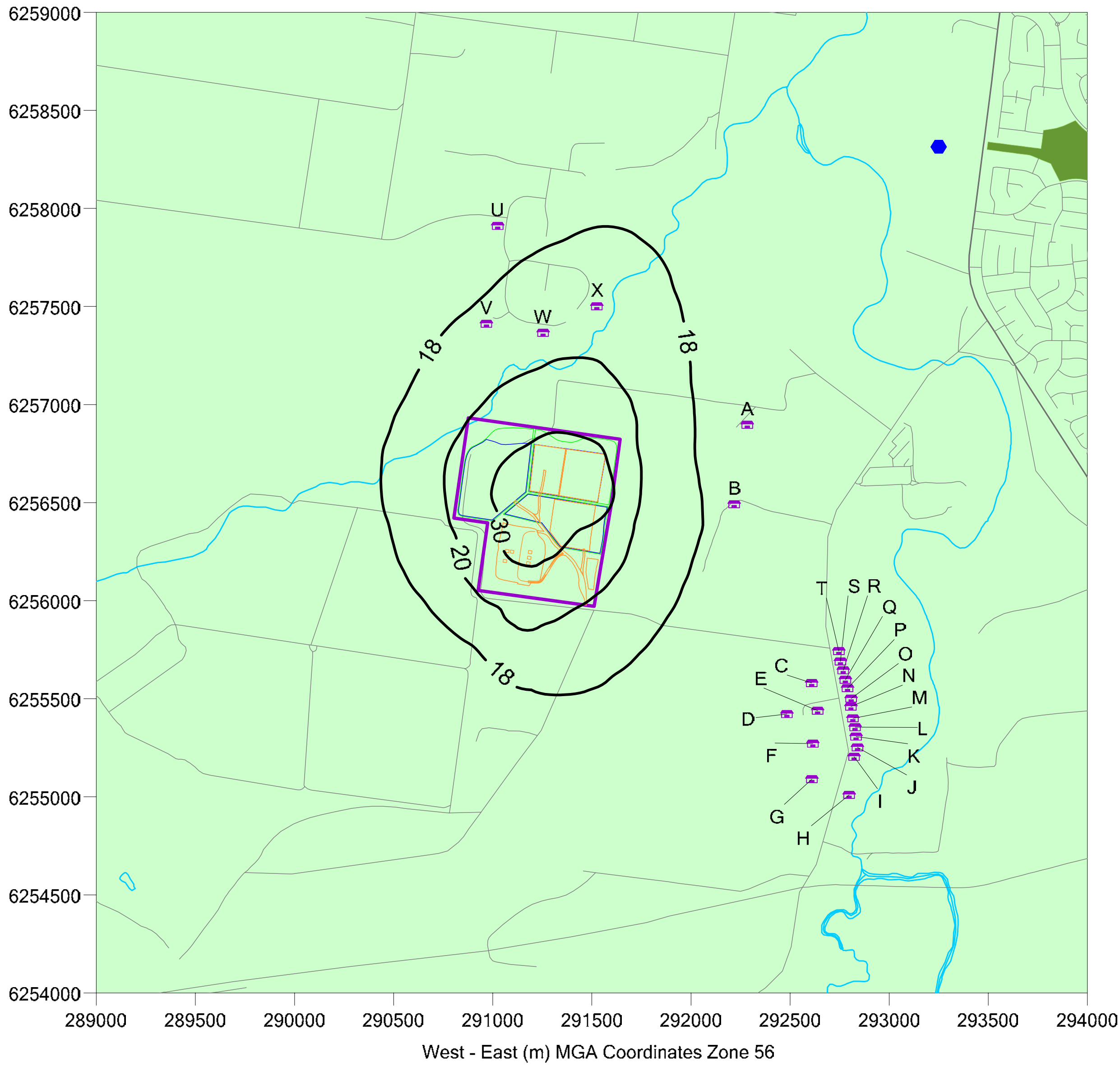

Figure 32: Scenario 3a - Predicted annual average PM_{10} concentrations ($\mu g/m^3$) due to emissions from the Project including background

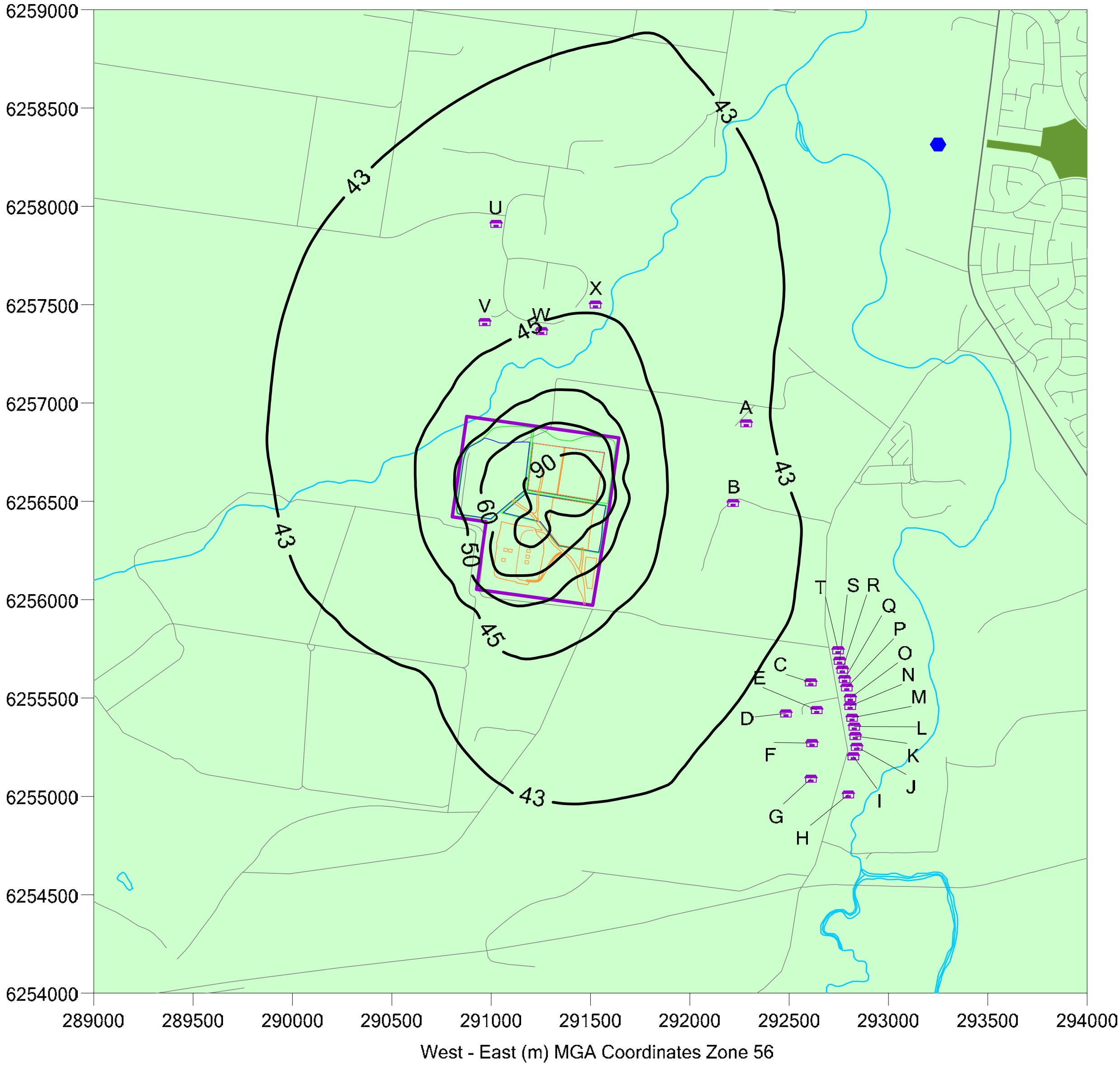

Figure 33: Scenario 3a - Predicted TSP concentrations (µg/m^3) due to emissions from the Project including background

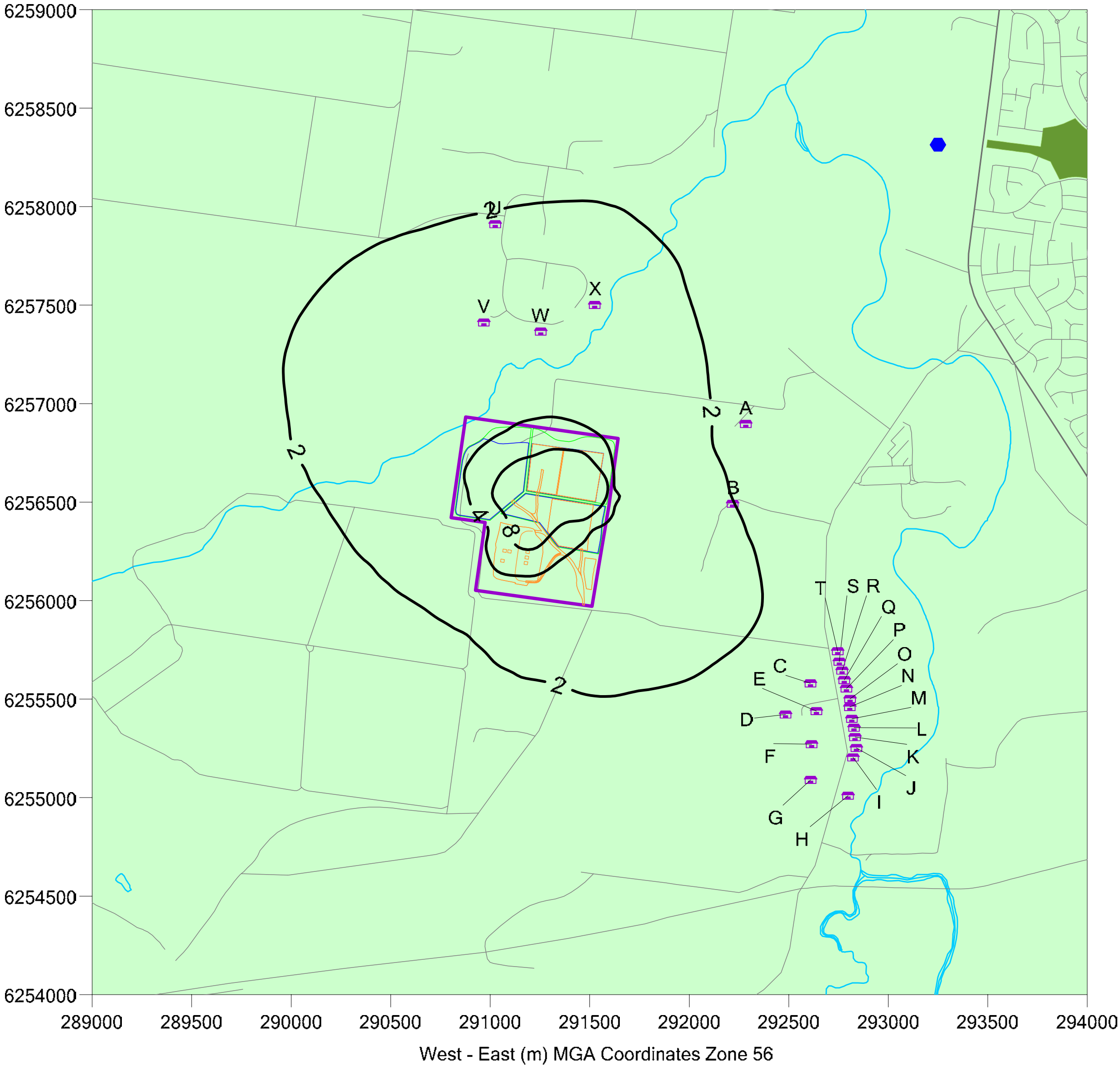

Figure 34: Scenario 3a - Predicted dust deposition levels (g/m^2/month) due to emissions from the Project including background

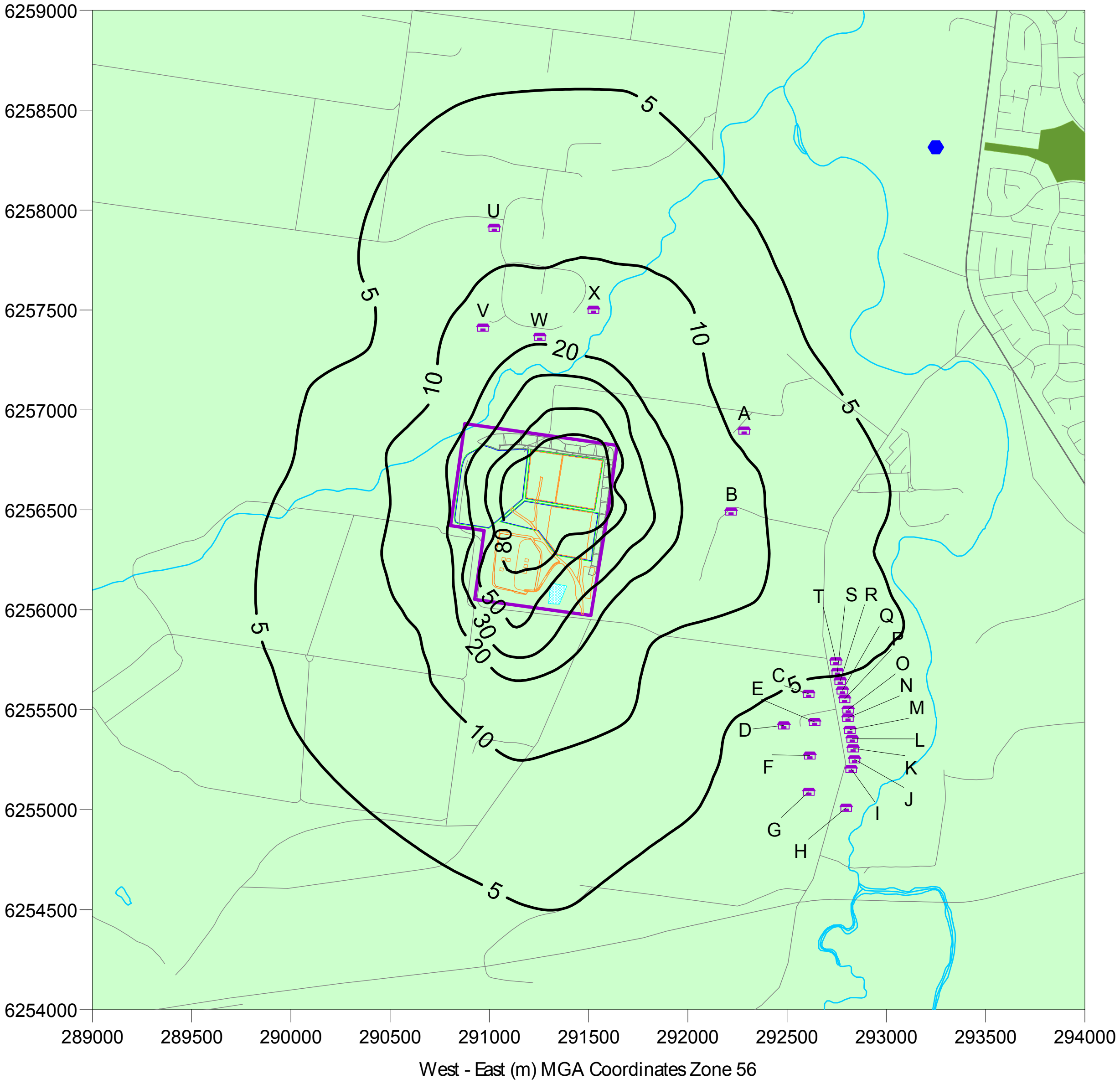

Figure 35: Scenario 3b –Predicted 24-hour average PM_{10} concentrations (µg/m^3) due to emissions from the Project

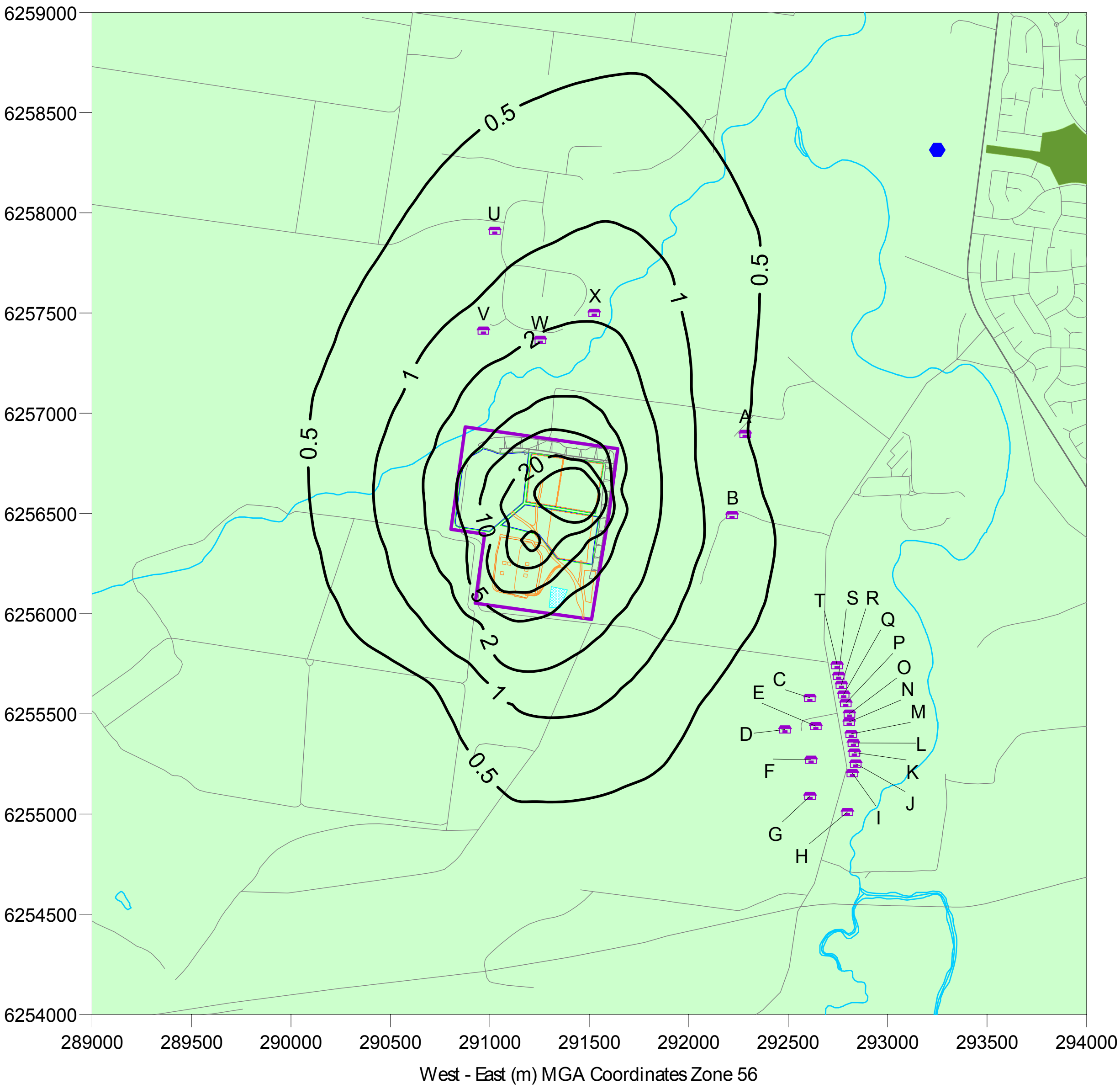

Figure 36: Scenario 3b –Predicted annual average PM_{10} concentrations (µg/m^3) due to emissions from the Project

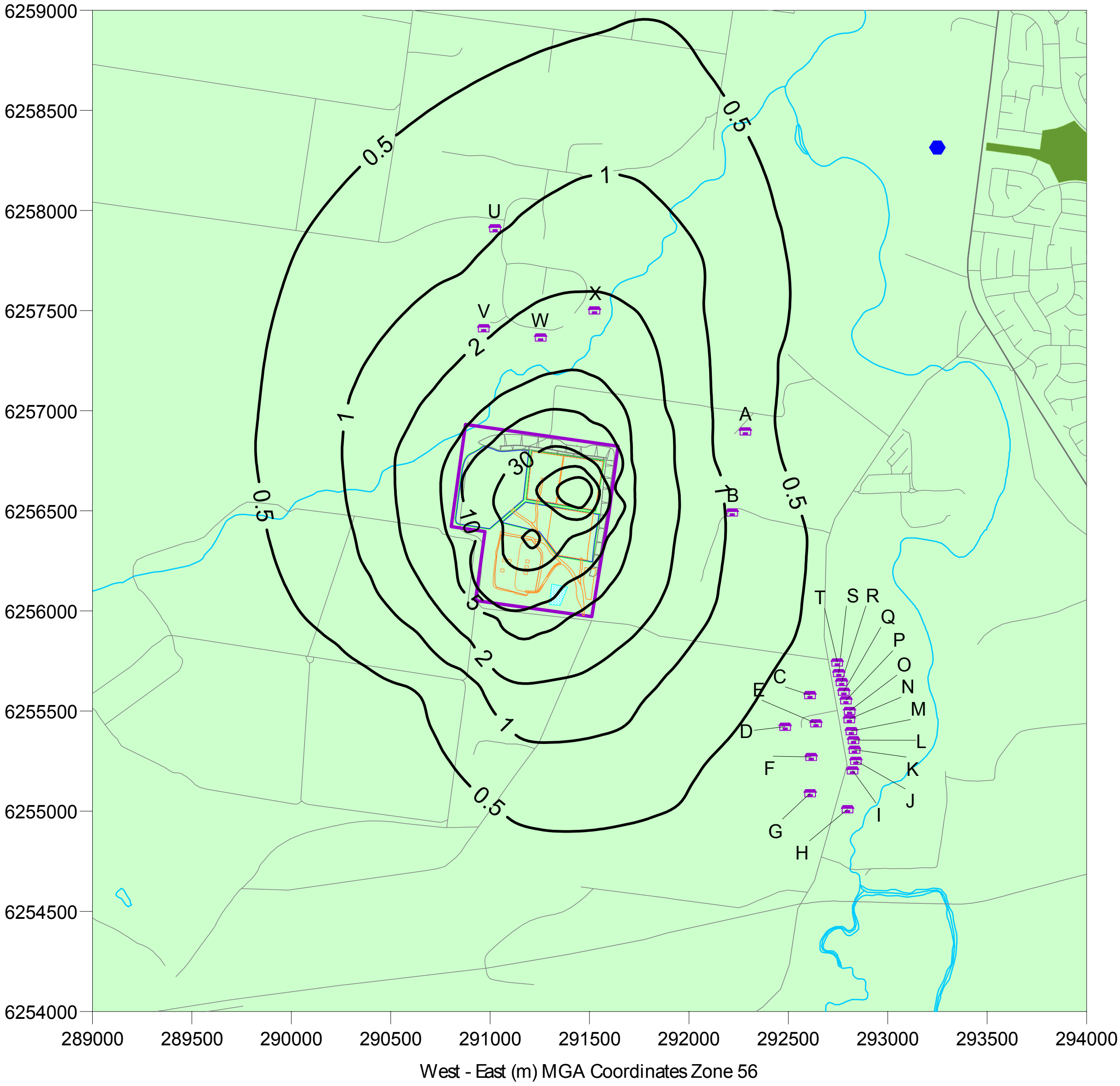

Figure 37: Scenario 3b –Predicted TSP concentrations (µg/m³) due to emissions from the Project

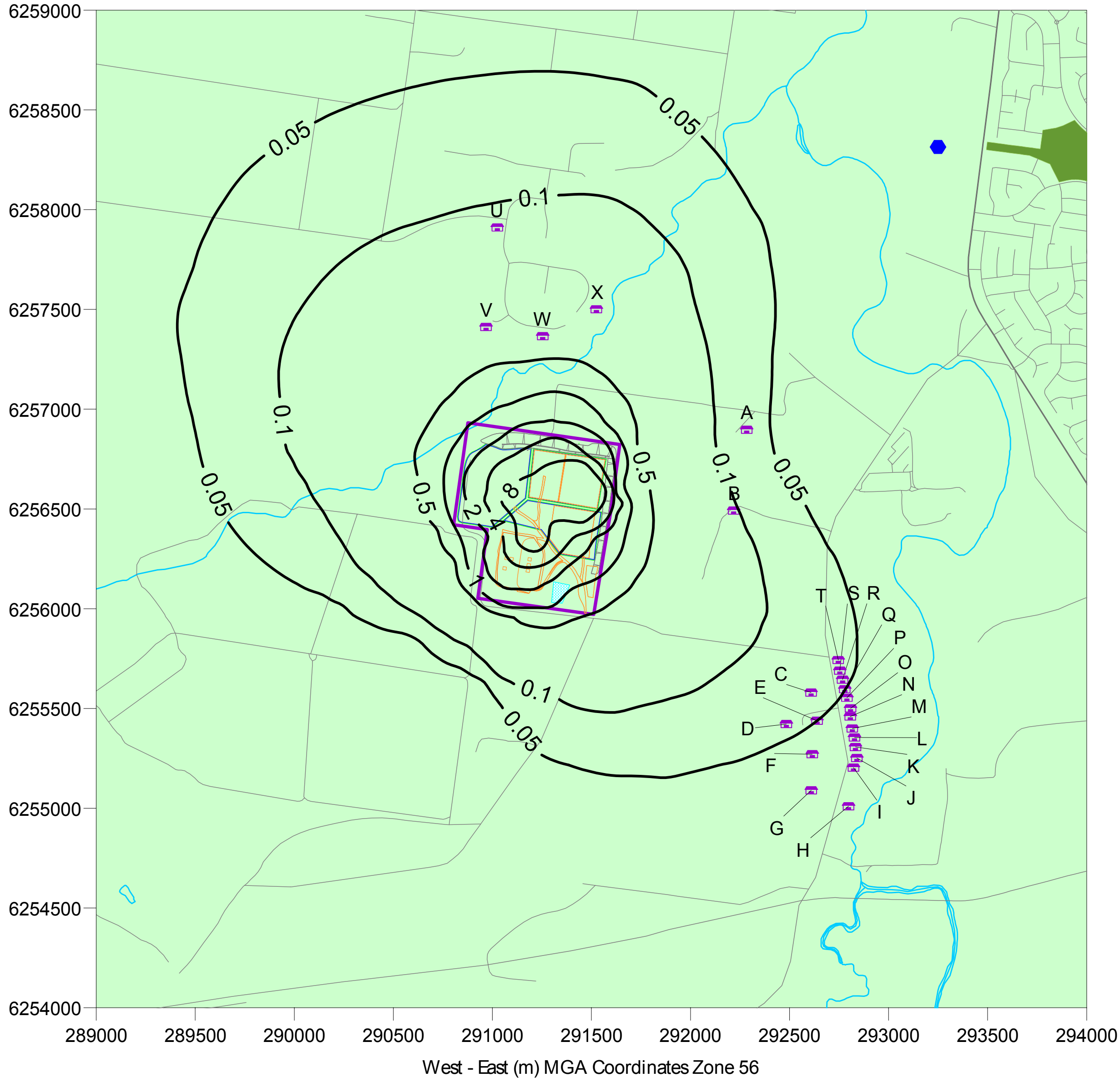

Figure 38: Scenario 3b –Predicted dust deposition levels (g/m^2/month) due to emissions from the Project

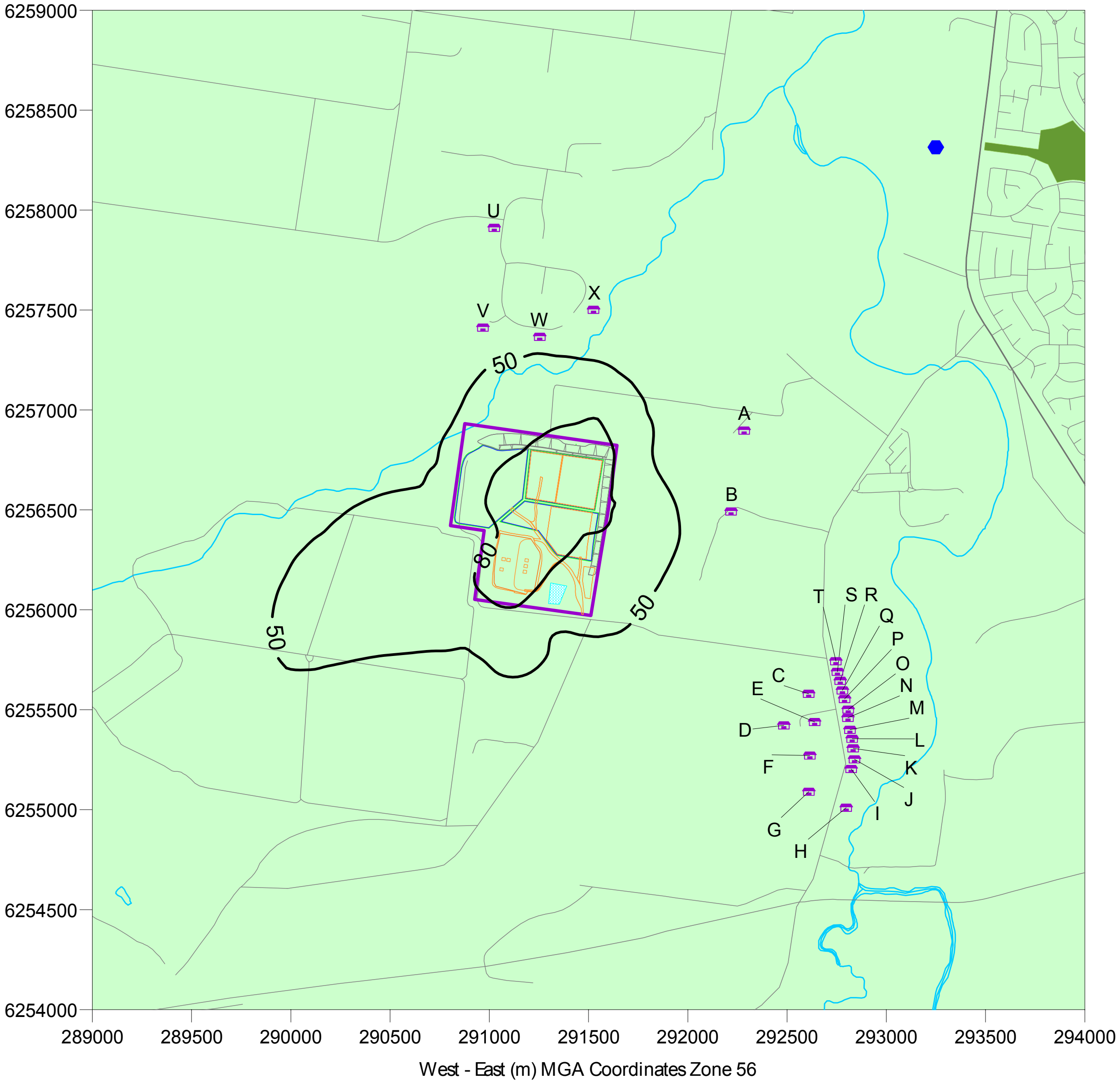

Figure 39: Scenario 3b –Predicted 24-hour average PM_{10} concentrations (µg/m^3) due to emissions from the Project including background

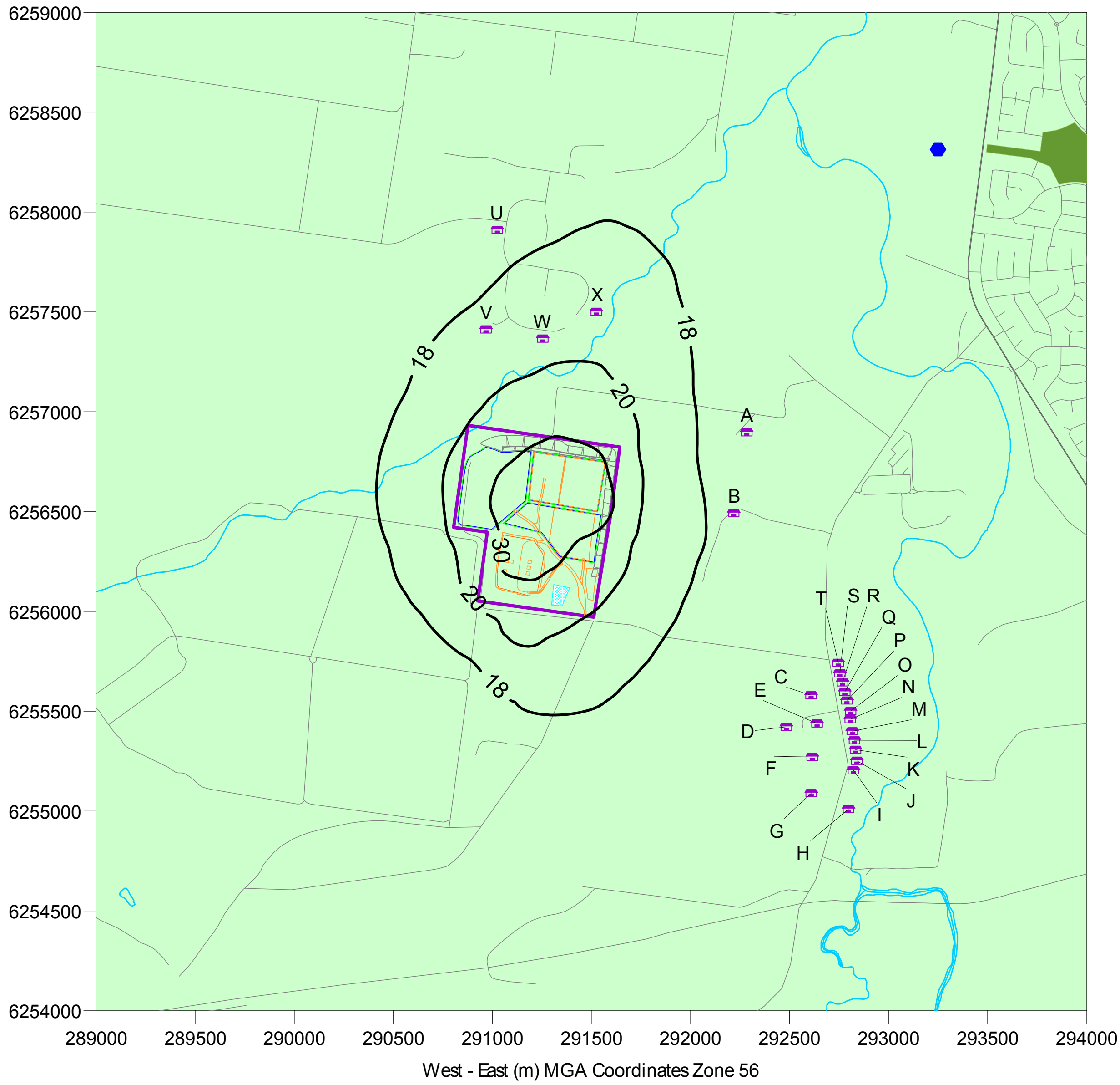

Figure 40: Scenario 3b –Predicted annual average PM_{10} concentrations (µg/m^3) due to emissions from the Project including background

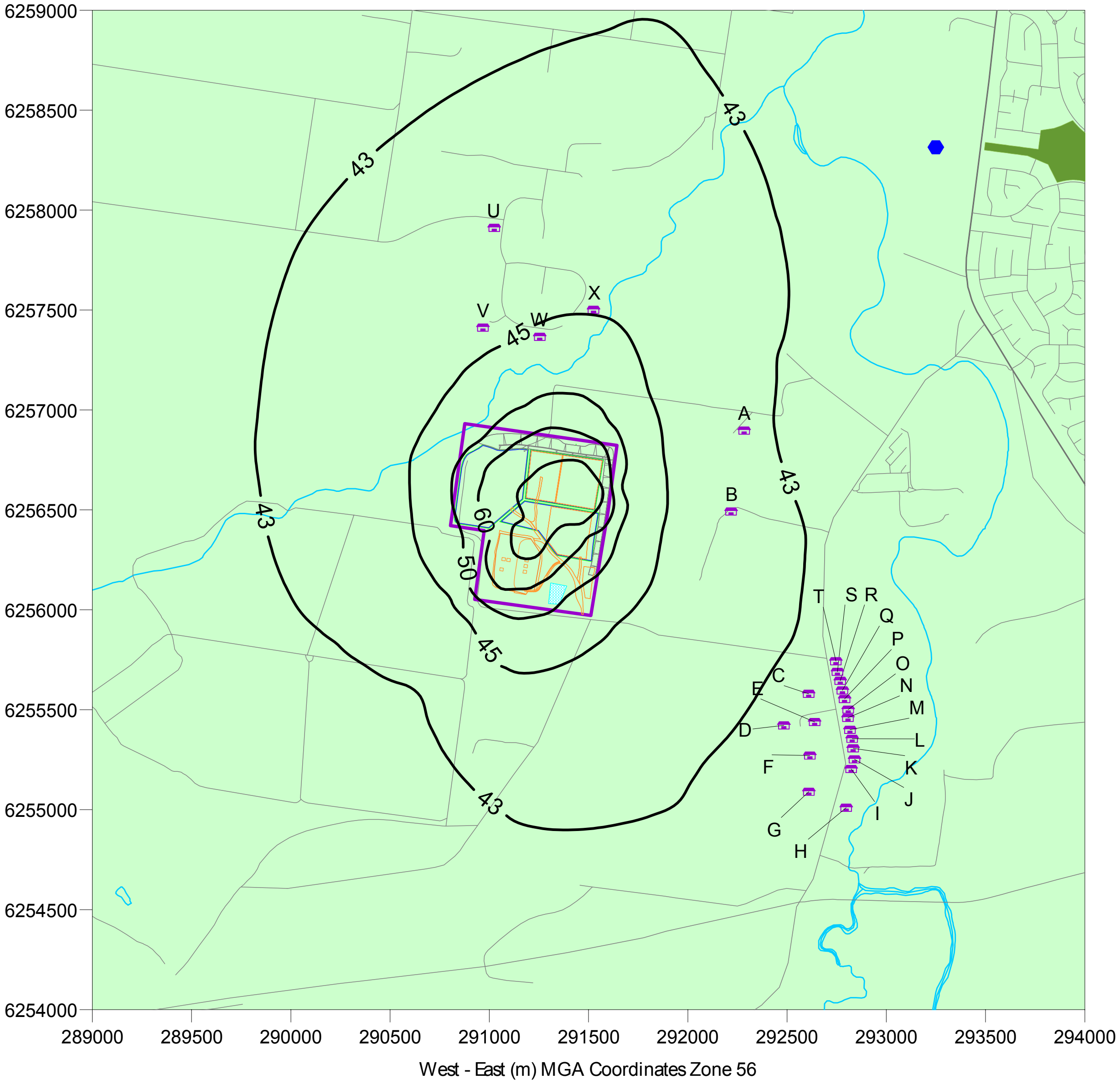

Figure 41: Scenario 3b –Predicted TSP concentrations (µg/m^3) due to emissions from the Project including background

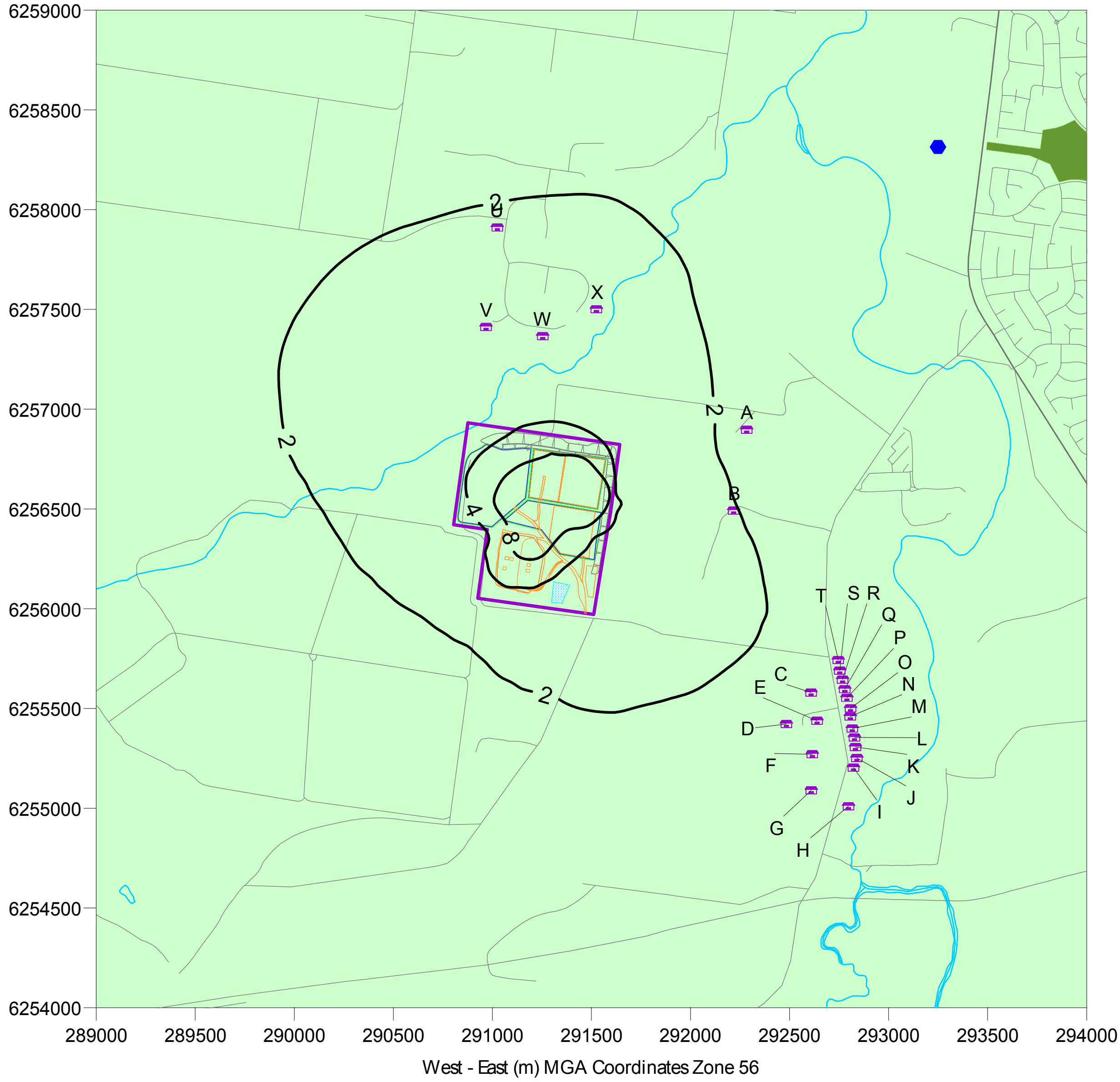

Figure 42: Scenario 3b –Predicted dust deposition levels (g/m²/month) due to emissions from the Project including background

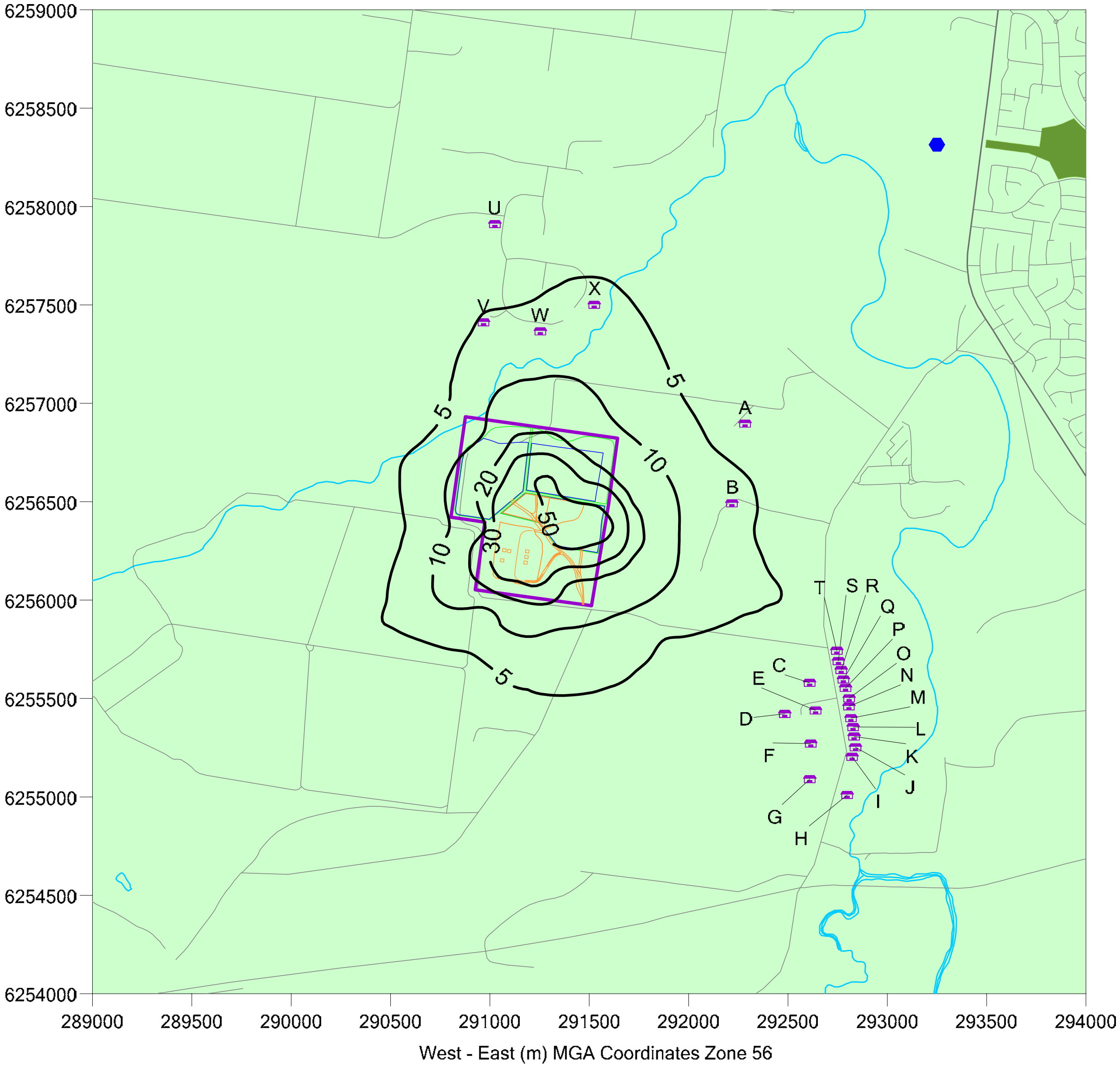

Figure 43: Scenario 4 - Predicted 24-hour average PM_{10} concentrations (µg/m^3) due to emissions from the Project

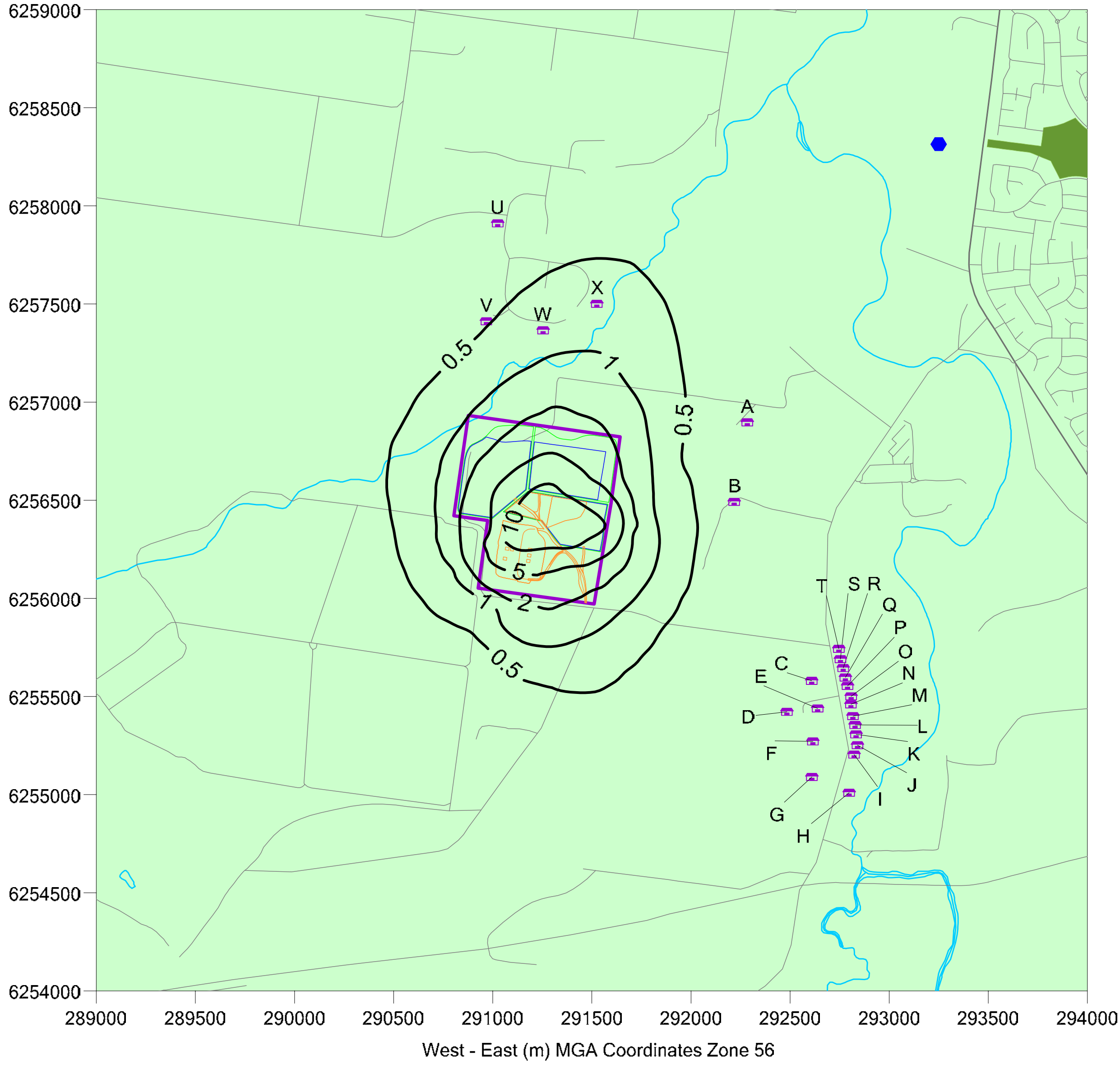

Figure 44: Scenario 4 - Predicted annual average PM_{10} concentrations (µg/m^3) due to emissions from the Project

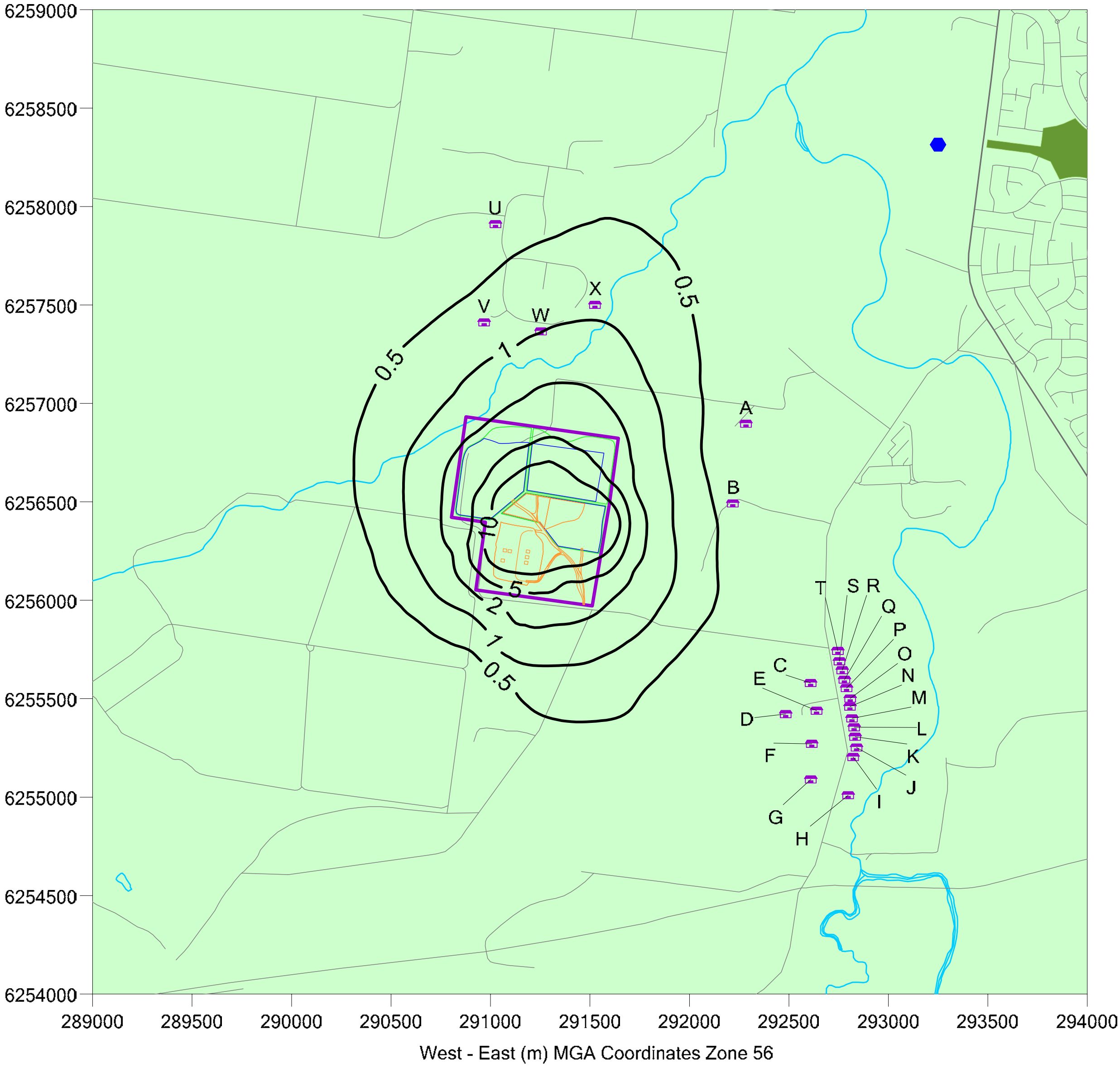

Figure 45: Scenario 4 - Predicted TSP concentrations (µg/m^3) due to emissions from the Project

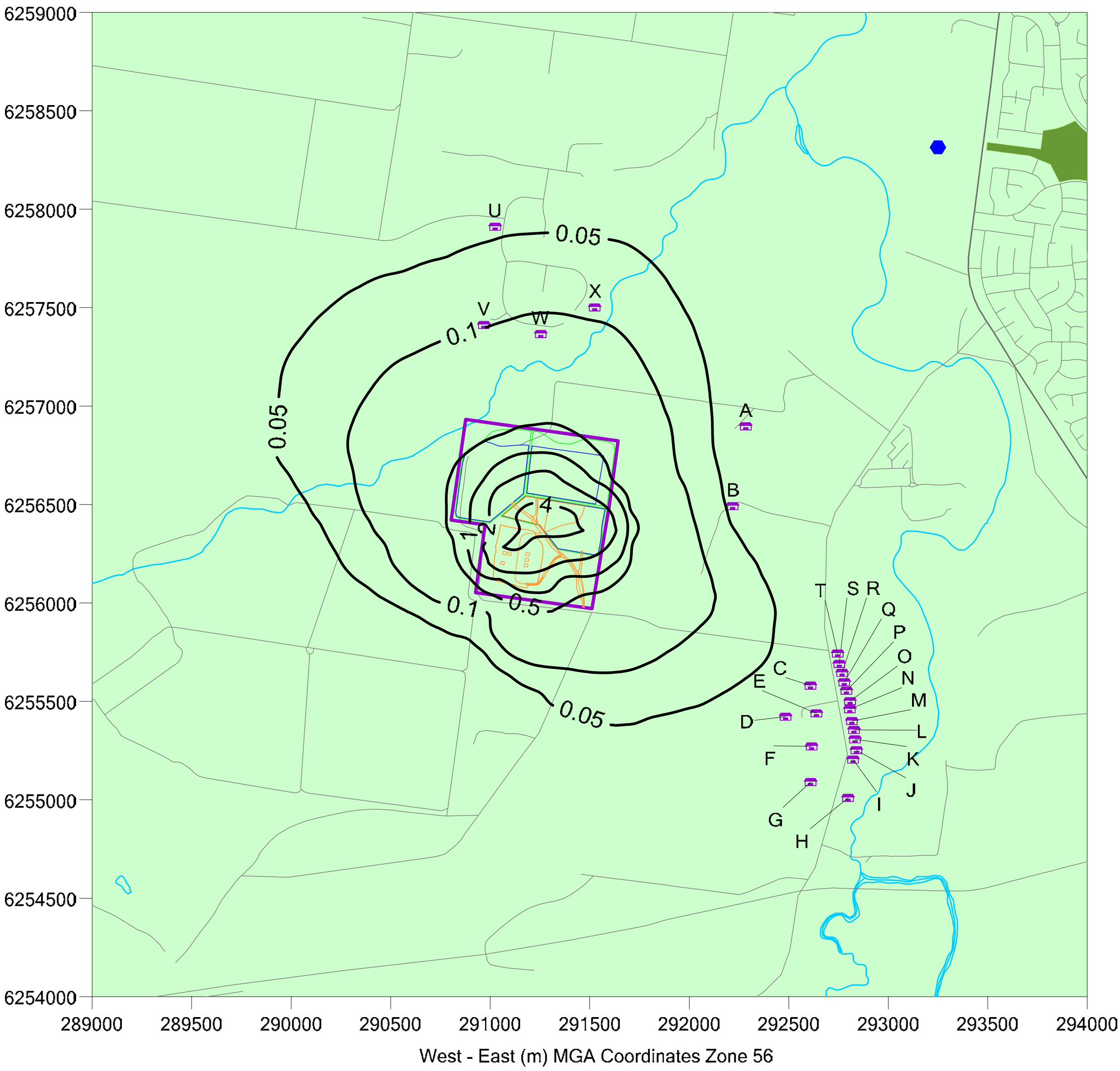

Figure 46: Scenario 4 - Predicted dust deposition concentrations (g/m²/month) due to emissions from the Project

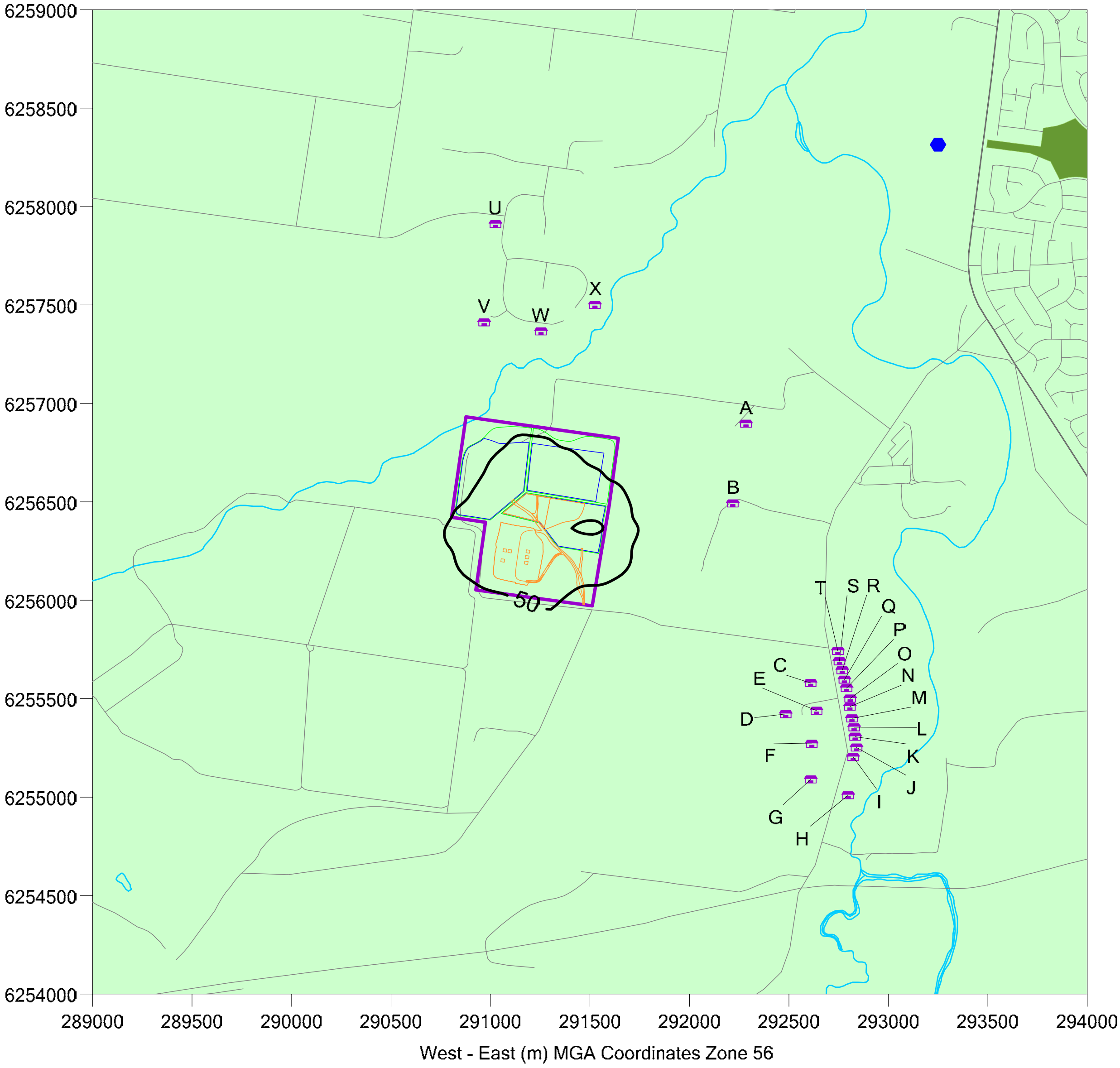

Figure 47: Scenario 4 - Predicted 24-hour average PM_{10} concentrations (µg/m^3) due to emissions from the Project including background

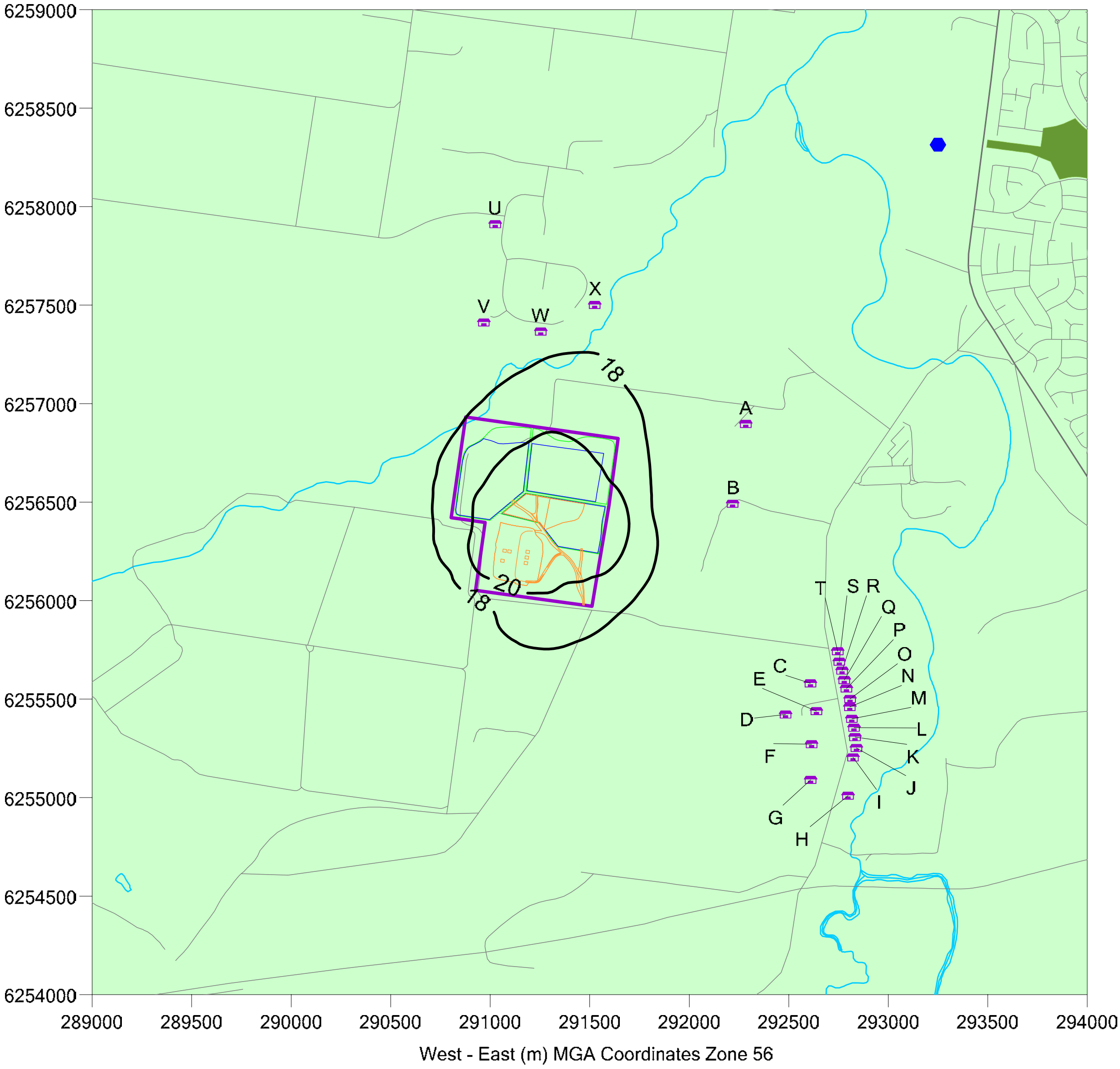

Figure 48: Scenario 4 - Predicted annual average PM_{10} concentrations (µg/m^3) due to emissions from the Project including background

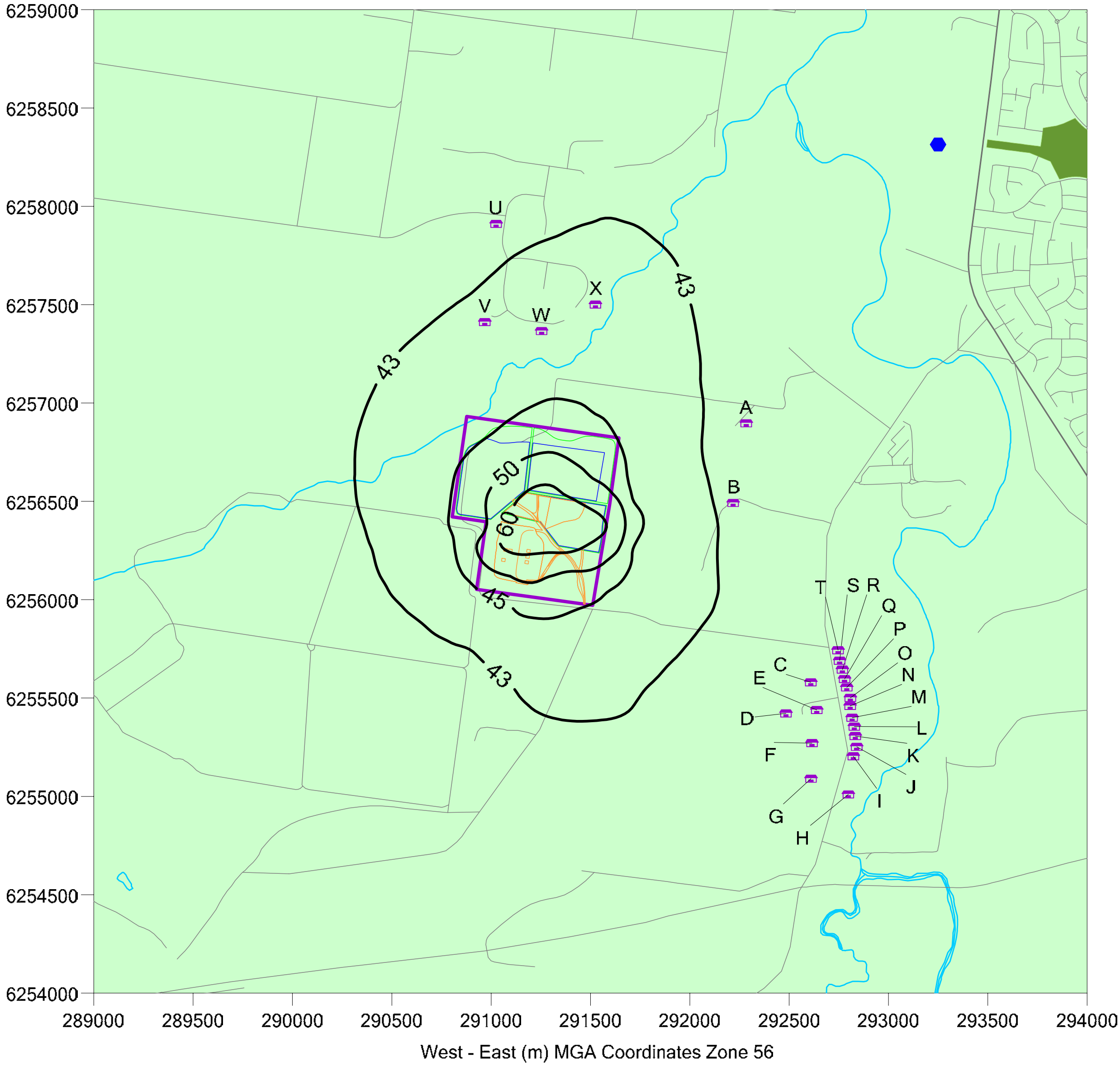

Figure 49: Scenario 4 - Predicted TSP concentrations (µg/m^3) due to emissions from the Project including background

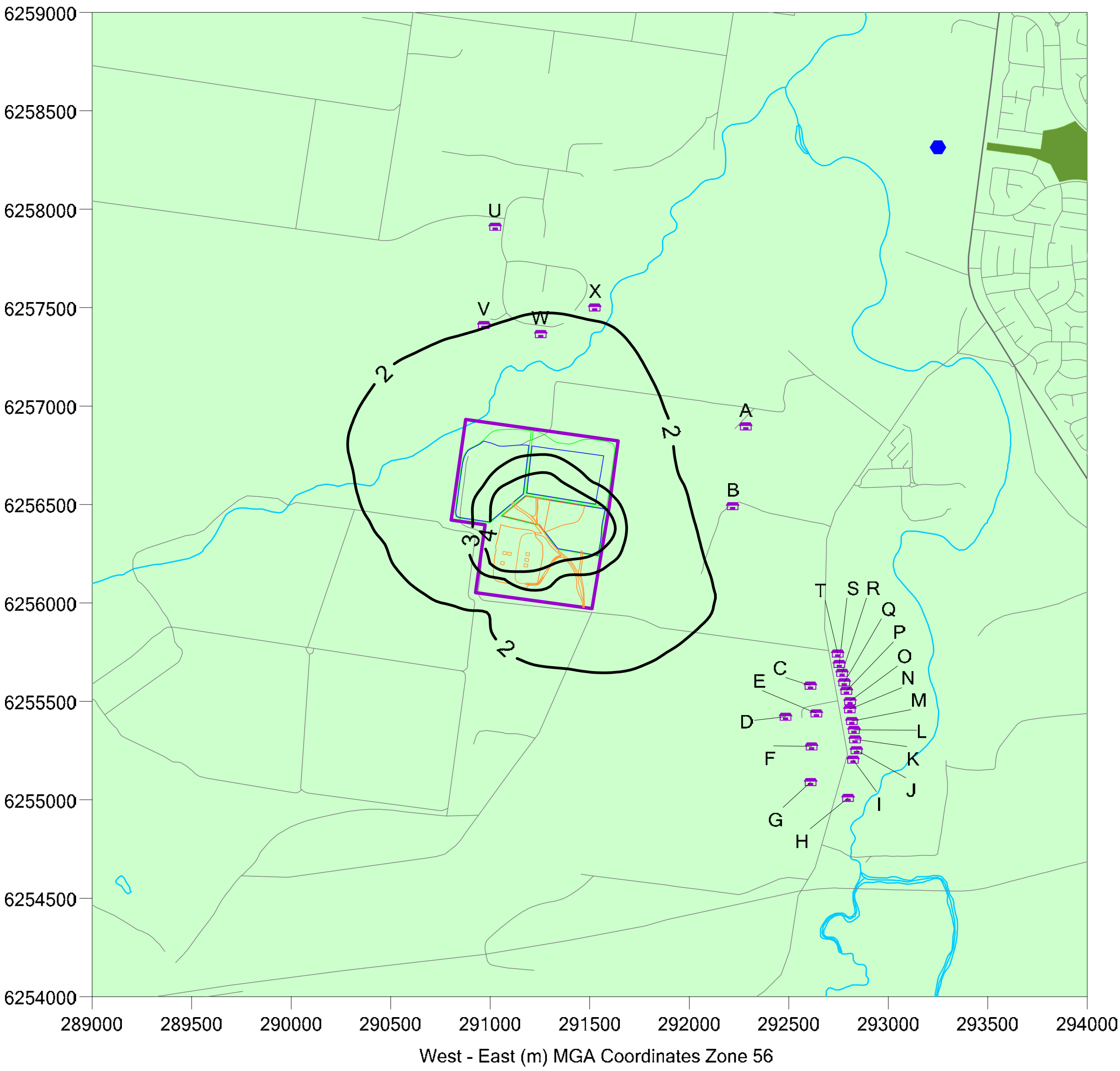

Figure 50: Scenario 4 - Predicted dust deposition levels (g/m^2/month) due to emissions from the Project including background

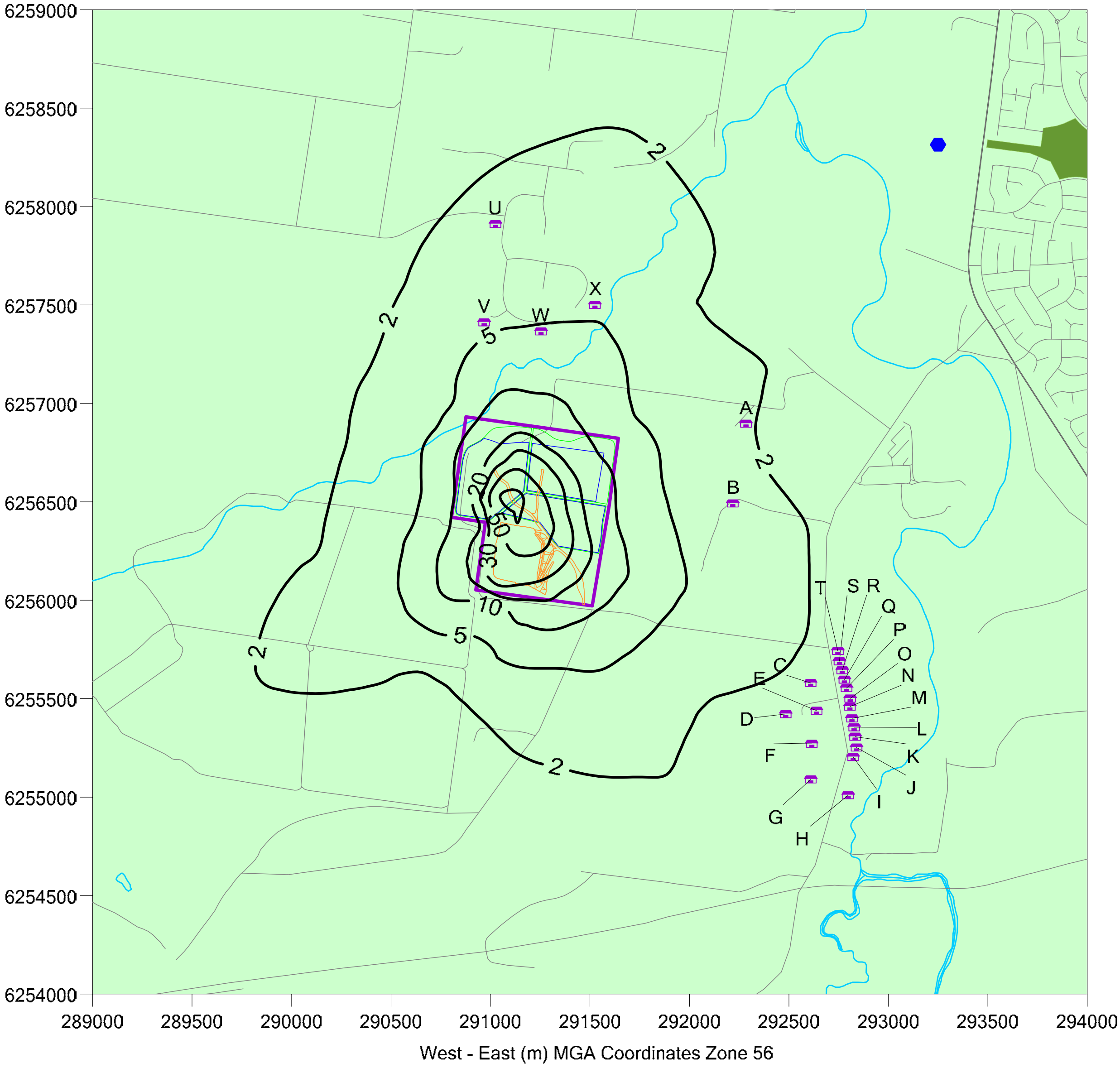

Figure 51: Scenario 5 - Predicted 24-hour average PM_{10} concentrations ($\mu g/m^3$) due to emissions from the Project

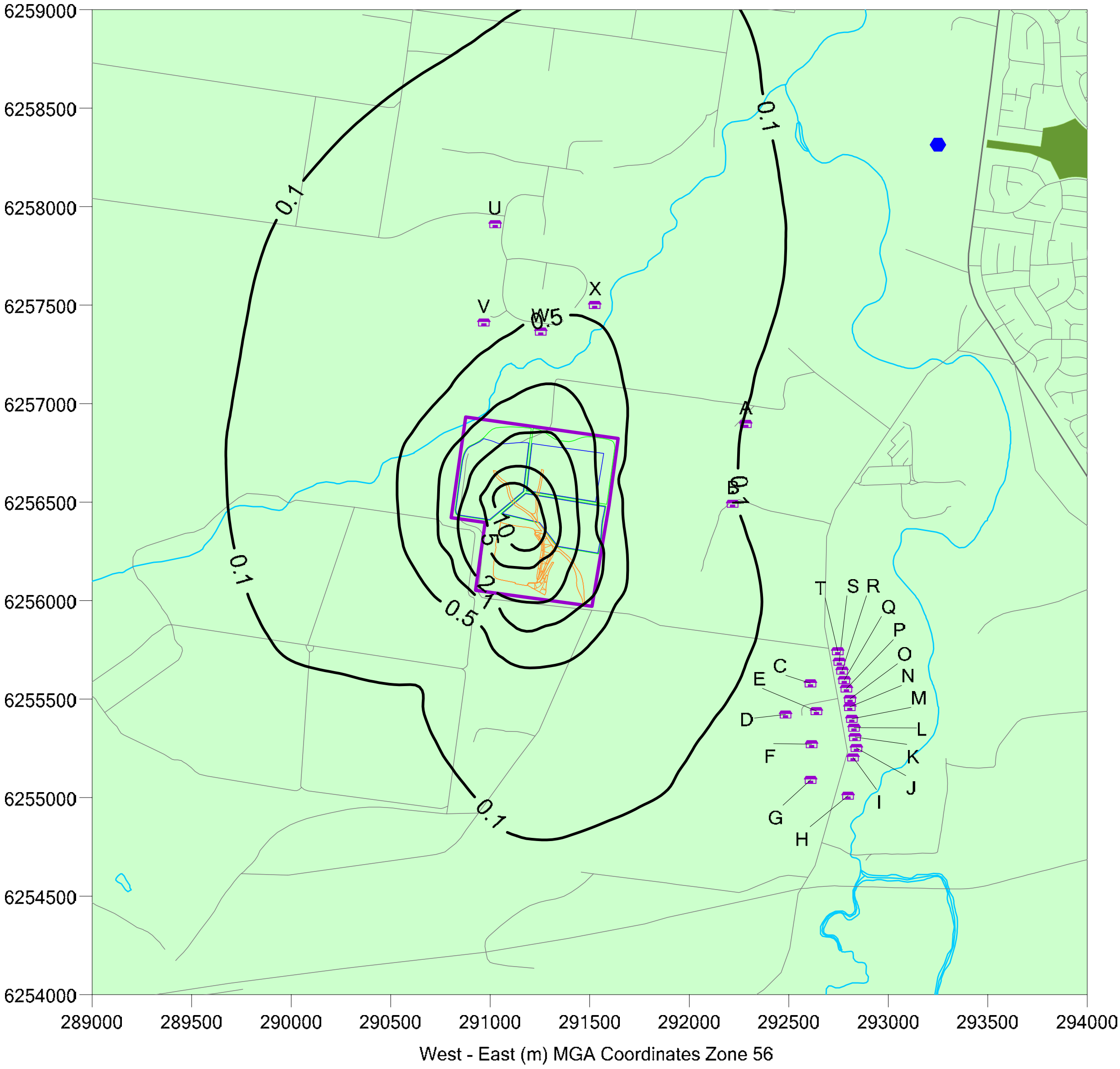

Figure 52: Scenario 5 - Predicted annual average PM_{10} concentrations (µg/m^3) due to emissions from the Project

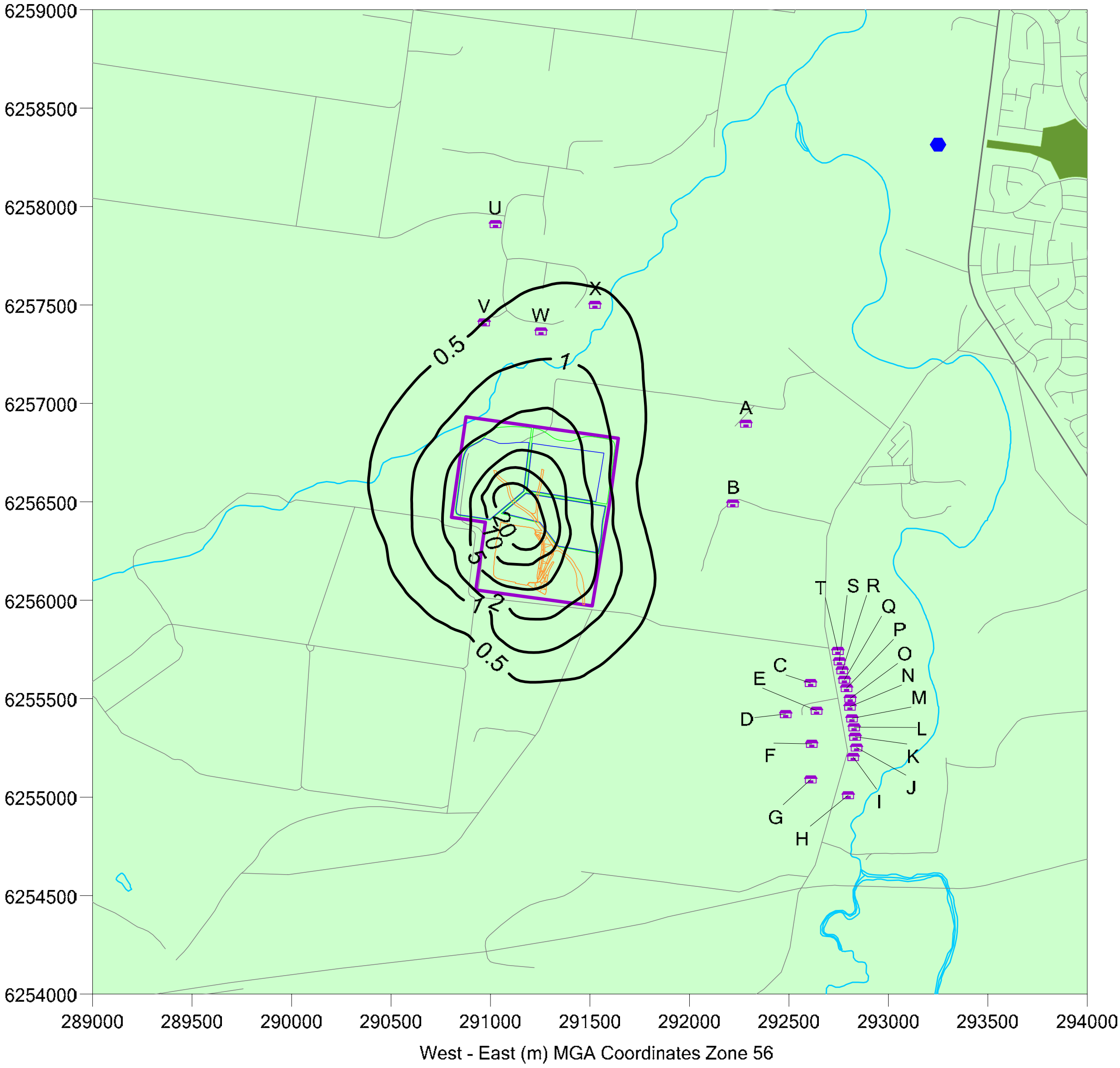

Figure 53: Scenario 5 - Predicted TSP concentrations (µg/m³) due to emissions from the Project

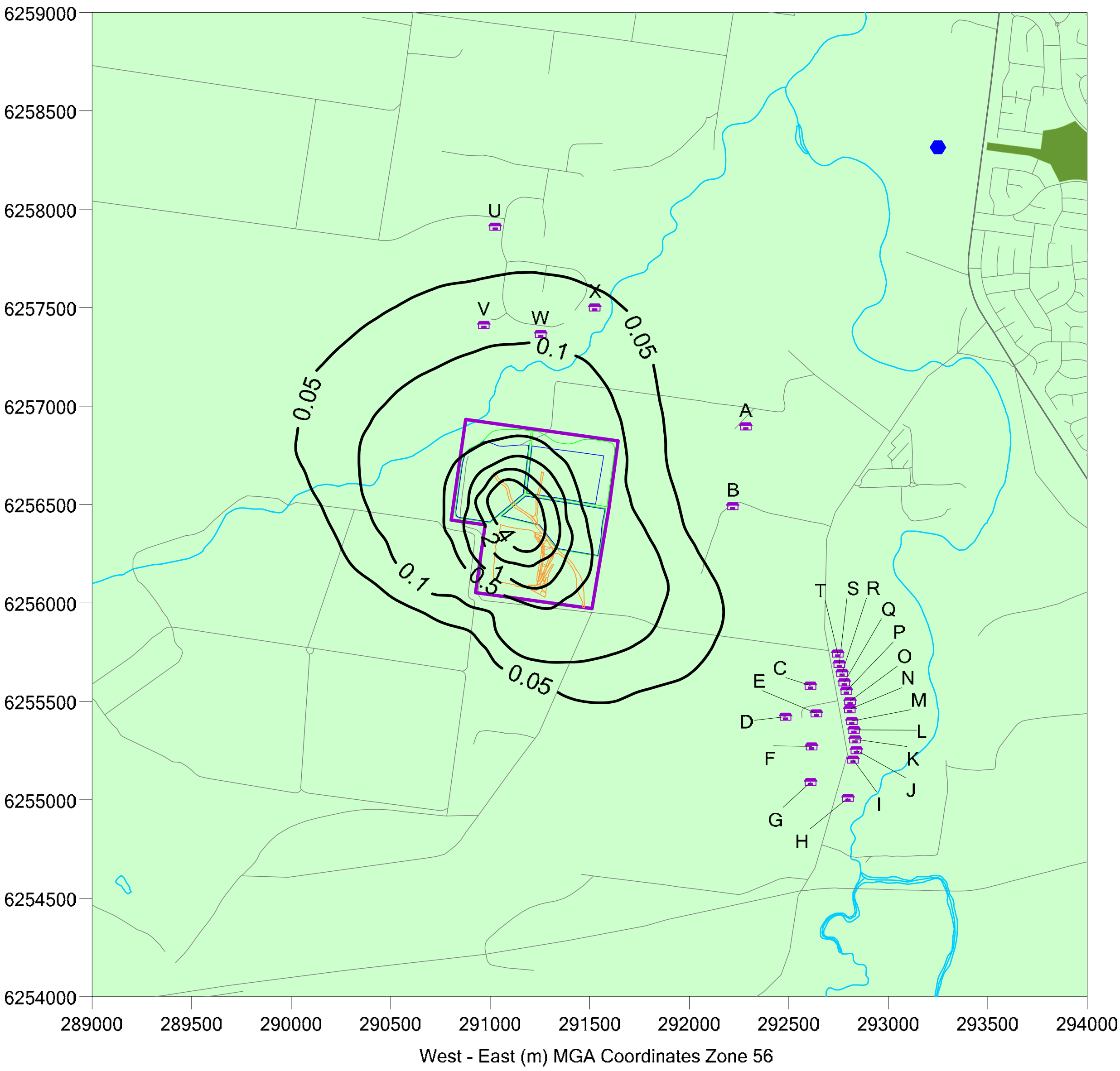

Figure 54: Scenario 5 - Predicted dust deposition levels (g/m^2/month) due to emissions from the Project

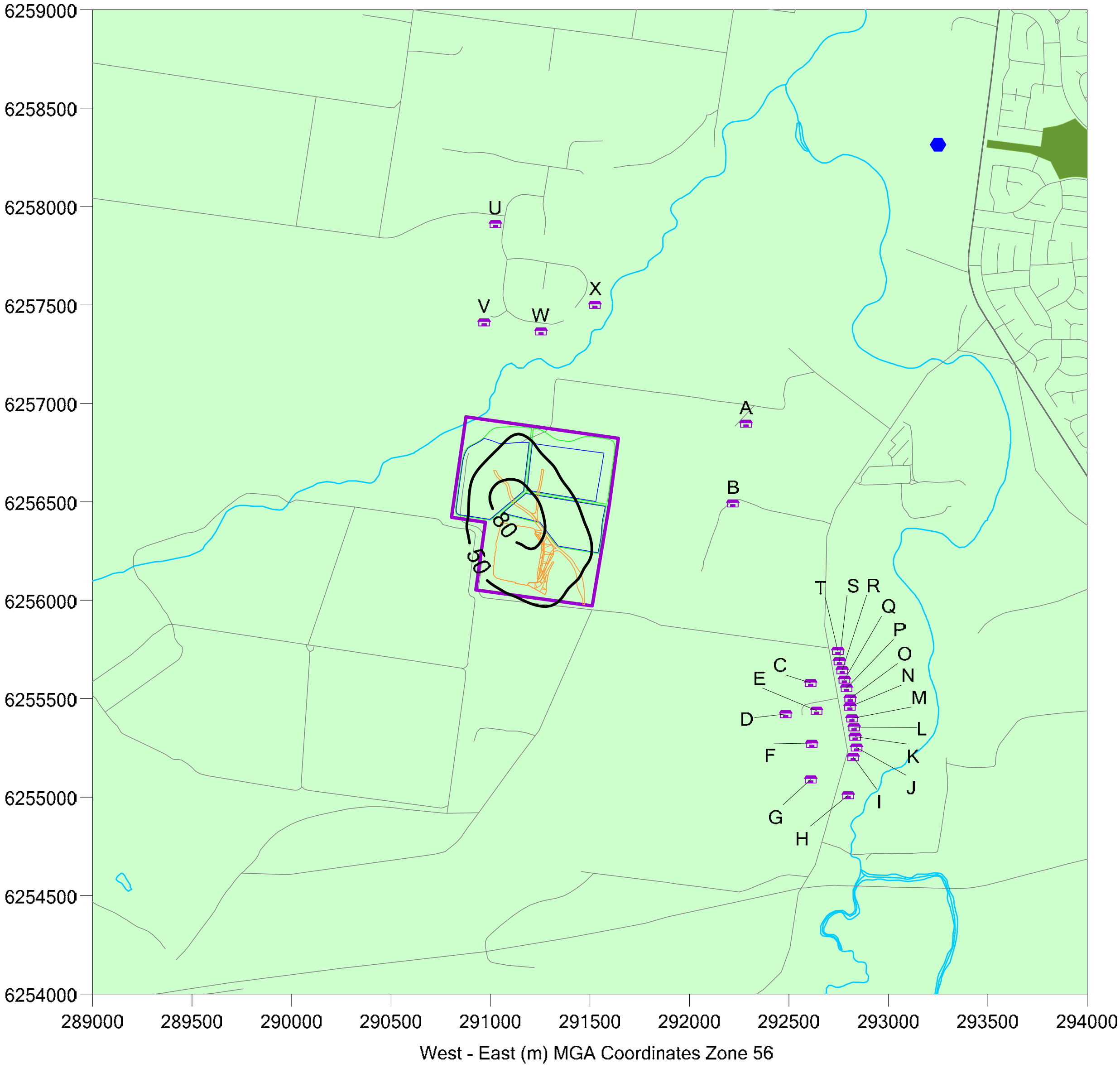

Figure 55: Scenario 5 - Predicted 24-hour average PM_{10} concentrations ($\mu g/m^3$) due to emissions from the Project including background

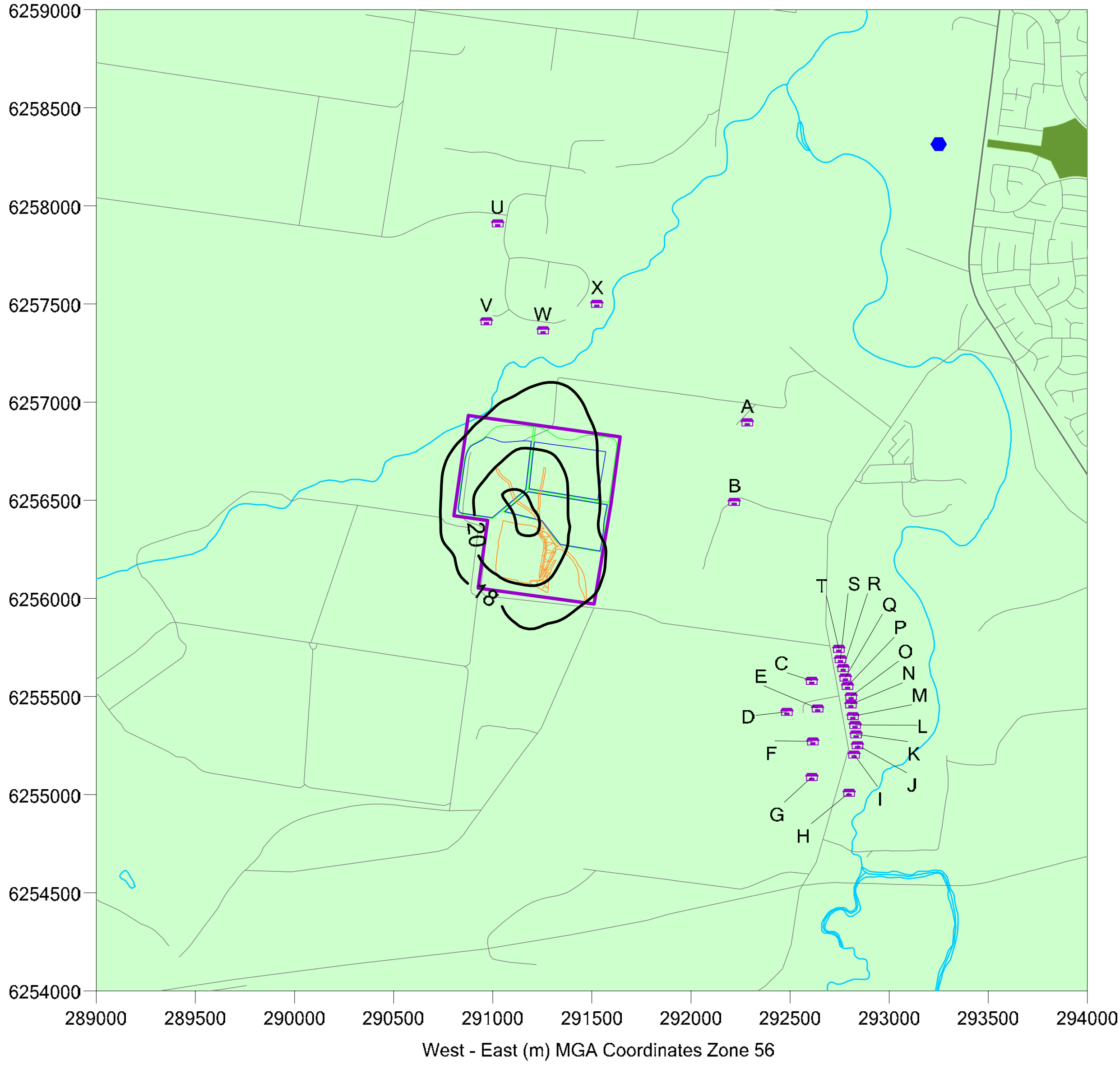

Figure 56: Scenario 5 - Predicted annual average PM_{10} concentrations (μg/m^3) due to emissions from the Project including background

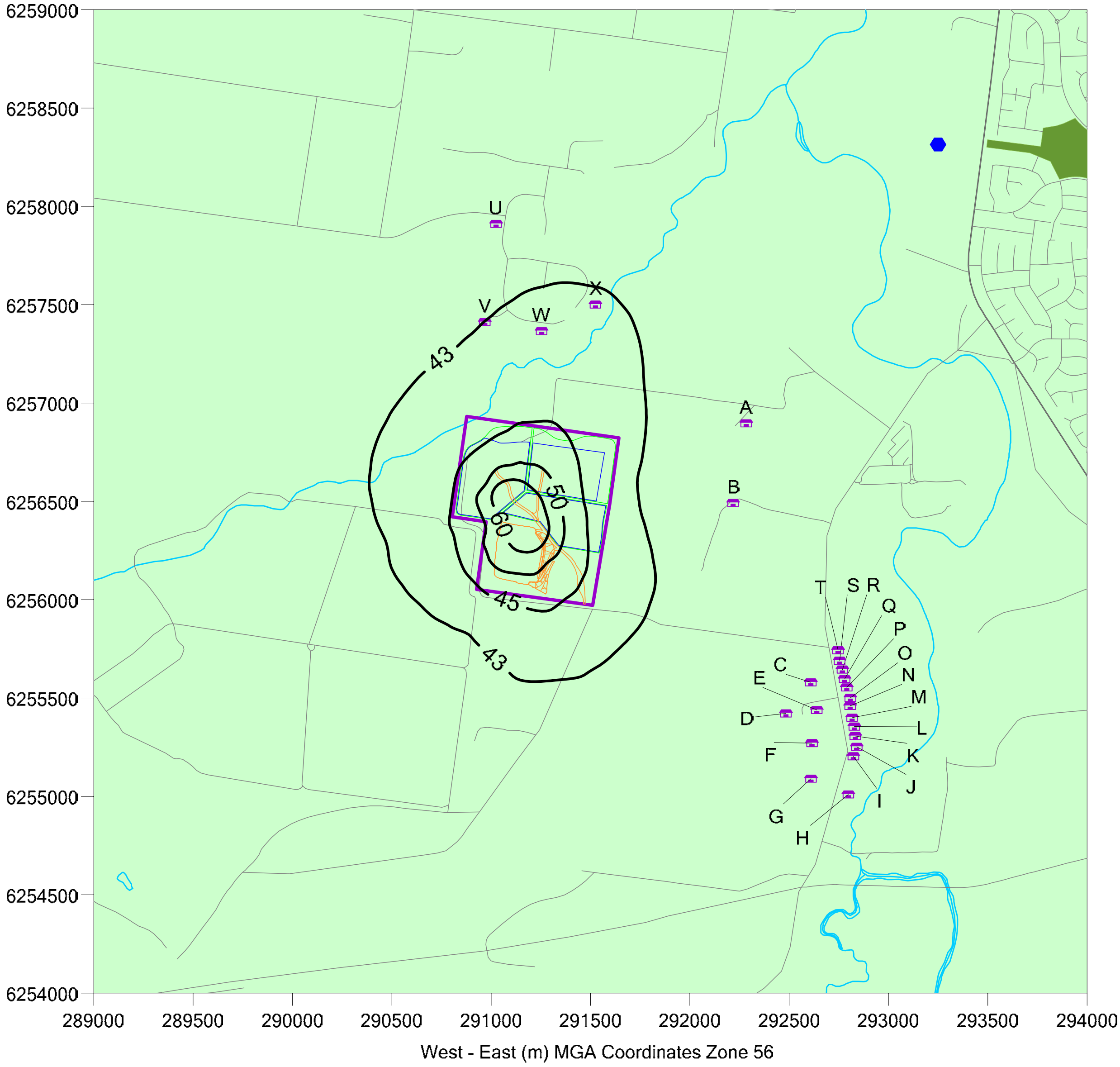

Figure 57: Scenario 5 - Predicted TSP concentrations (µg/m^3) due to emissions from the Project including background

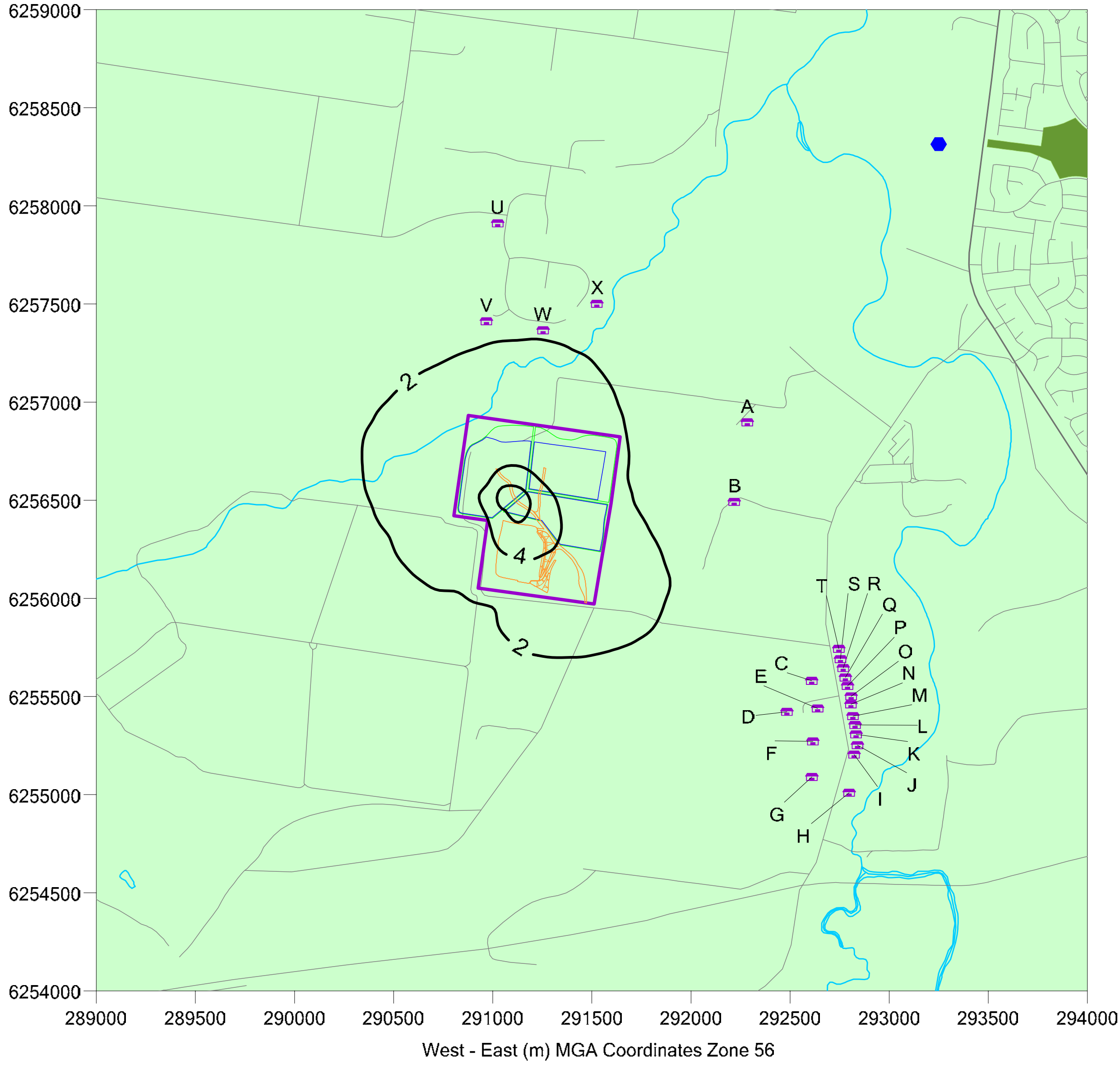

Figure 58: Scenario 5 - Predicted dust deposition levels (g/m^2/month) due to emissions from the Project including background

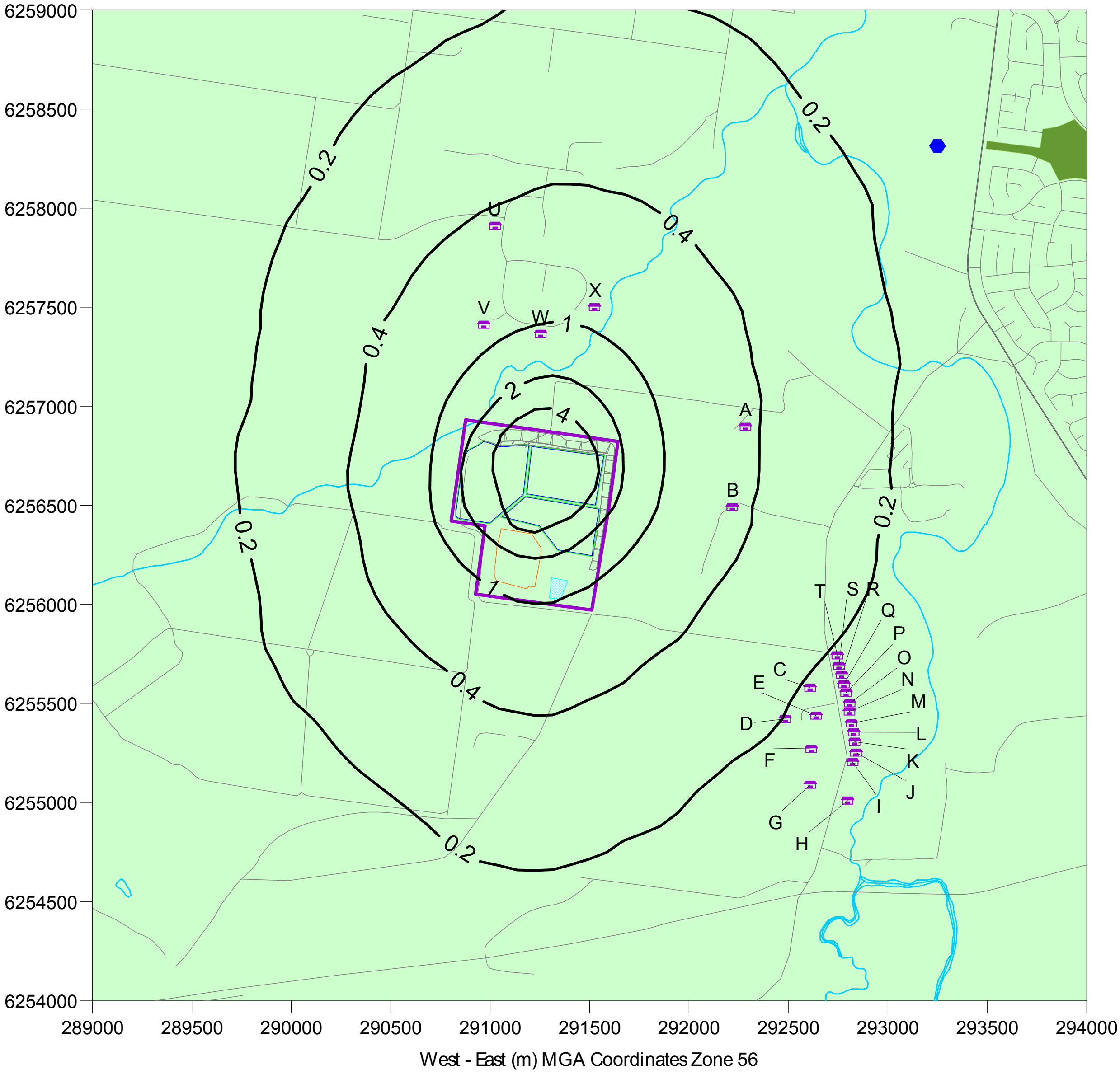

Figure 59: 99th predicted odour concentrations for the Project