EAQ Consulting

UPDATED MODELLING PREDICTIONS OF ODOUR IMPACTS

C-WISE: ORGANIC COMPOSTING FACILITY (NAMBEELUP, WESTERN AUSTRALIA)

C-Wise: Organic Composting Facility (Nambeelup, Western Australia)

Prepared for: C-Wise

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EAQ Consulting

Environment | Air Quality
Environmental & Air Quality Consulting Pty Ltd

PO Box 897
JOONDALUP DC
WA 6919
+61 (8) 6108 3760
+61 (0) 449 915 043
www.eaqconsulting.au
jhurley@eaqconsulting.com.au

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John Hurley	Principal Air Quality Consultant	EAQ23024-C-Wise+TheoreticalOdourModelling_Report_20230908

Signature

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1 Introduction

1.1 Preamble

These works were undertaken to update a previous 2019 odour modelling assessment for the purposes of informing C-Wise of their potential odour footprint based on current odour emitting operations. The use of theoretical odour units to further understand the estimated odour footprint has been undertaken to inform the works and allow a more in-depth interpretation of the estimated odour footprint. The works have not been undertaken to satisfy regulatory compliance objectives.

1.2 Background

Environmental & Air Quality Consulting Pty Ltd (EAQ) was engaged by C-Wise (CW) to undertake a predictive modelling assessment (the Assessment) of odour emissions from CW's Nambeelup operations.

The intent of the Assessment was to understand the potential for the estimated odour footprint to have a negative impact on nearby sensitive receptors.

The Assessment plotted ground level odour concentrations (strength), using input odour emission rates, from three discrete composting process areas, being the Mobile Aeration Floor area (MAF), Dam 22 and the Raw Materials mixing area.

The input odour emission rates (OER) were back-calculated by applying a range of OER's to each of the three discrete composting process areas, and comparing the plotted ground level odour concentrations to theoretically derived odour concentrations.

Determining the theoretical odour concentrations was done by using the odour threshold value for surrogate odorants of Hydrogen sulphide (H_2S) and Methyl mercaptan.

These surrogates are currently being measured at multiple static locations throughout the CW site using electrochemical monitors. The surrogates are measured in chemical concentration values of parts per million (ppm).

The odour threshold data for the surrogate odorants was applied to the chemical emissions data collected for these surrogates. In this way the measured chemical concentration of these odorants in ambient air can be converted to a theoretical odour concentration using each odorants threshold odour value.

The derived odour concentrations provide a theoretical conversion from the measured chemical concentration data to an odour concentration at those static monitoring locations.

The odour concentrations are considered theoretical as the odour threshold data is based on pure compounds assessed in a laboratory. Since the ambient chemical concentrations monitored are part of an overall odour matrix (multiple chemical odorant species), the threshold data varies based on the laboratory methods used to derive them.

EAQ utilised the lowest odour detection threshold data found within peer reviewed public domain sources for H_2S.

NOTE: It was determined that the Methyl mercaptan data was considerably larger in concentration than the H_2S and therefore Methyl mercaptan was omitted for the purposes of deriving odour emission rates.

The Assessment utilised the Aermod dispersion model to project ground level odour impacts based on assumed odour emission rates for each of the discrete composting process areas.

The dispersion model converts these input emission rates into downwind, ground level odour concentrations and plots the ground level odour concentrations in odour units ($ou.m^3$). Local representative meteorology was developed to use in the dispersion modelling.

The objective in 2019 was to model multiple odour emission rates for each of the discrete composting process areas that would then be plotted as ground level odour units. Those plotted odour concentrations are then compared to the derived theoretical odour concentrations at those static measurement locations. Where the plots compare to those theoretical odour concentrations, the input odour emission rates therefore represent the mass odour emissions from those discrete composting process areas that would be required to produce concentrations as measured at the static monitoring locations.

1.3 Updated Monitoring Data

Static monitoring data collected by CW for the 2022-23 period was sorted and analysed by EAQ. The data was then extracted for the average and maximum average values (excluding zeros). Peak maximums were ignored as they markedly skewed the predicted odour footprint.

The updated derived theoretical odour units were compared to the values from 2019 and subsequent factors were derived that represent an increase/decrease in the odour emission rates.

For the purposes of updating the 2019 model, the meteorological year used in 2019 was applied herein to enable a like-for-like comparison of the predicted odour footprint.

As was done in the 2019 assessment, the discrete odour sources assessed were the MAF, Dam 22 and the Raw Materials Bund.

2 C-Wise Previous and Updated Emissions

2.1 Chemical Concentration Static Monitoring Data

The average and maximum data (parts per million) and corresponding sampling locations, together with the updated data are listed in the table below.

Table 2-1: Average & Maximum H_2S Chemical Concentrations

Location	Average	Maximum	Average	Maximum	Average Factor	Maximum Factor
	2019		Updated (2023)			
MAF H_2S	0.004	0.135	0.085	1.922	**x 21**	**x 14**
Dam 22 H_2S	0.139	0.480	0.488	0.679	**x 4**	**x 1.4**

2.2 Derived Theoretical Odour Concentrations

For the purposes of this Assessment, EAQ used the lowest odour detection threshold (ODT) for H_2S found within the public domain literature. Using the lowest ODTs ensures that the derived theoretical odour units are the highest i.e. conservative.

To derive a theoretical odour concentration from measured chemical data, the concentration of those compounds measured, in this case H_2S, is divided by the ODT where the result is the theoretical odour concentration.

The lowest ODT value for H_2S was 0.000457 ppm. The derived theoretical odour concentrations are tabled below. An example calculation for Average Derived MAF H_2S is 0.004 / 0.000457 = 8.75 ou.m^3.

Table 2-2: Derived Theoretical Odour Concentrations

Concentration	2019 MAF H_2S	2023 MAF H_2S	2019 Dam 22 H_2S	2023 Dam 22 H_2S
Average (ppm)	0.004	0.085	0.139	0.488
Maximum (ppm)	0.135	1.922	0.480	0.679
Average Derived ou.m^3	**8.75**	**186**	**304**	**1,068**
Maximum derived ou.m^3	**295**	**4,206**	**1050**	**1,486**

2.3 Updated Odour Emission Rates

The updated values have had the multiplicate factors applied listed above in **Table 2-1**. The 2019 and updated 2023 odour emission rates are tabled below.

Table 2-3: Odour Emission Rate Modelling Inputs

Source	2019 Average Odour Emission Rate	2019 Maximum Odour Emission Rate	2023 Average Odour Emission Rate	2023 Maximum Odour Emission Rate
MAF	10,000	100,000	**212,500**	1,423,704
DAM 22	35,000	150,000	**122,878**	212,188
RAW	4,000	15,000	**85,000**	213,556

The AERMOD dispersion model was run using the final 2023 Average Odour Emission Rate inputs in **Table 2-3**.

3 Odour Dispersion AERMOD Modelling Results

The 99.5th percentile was modelled in accordance with the current regulatory guidelines for dispersion modelling of odours.

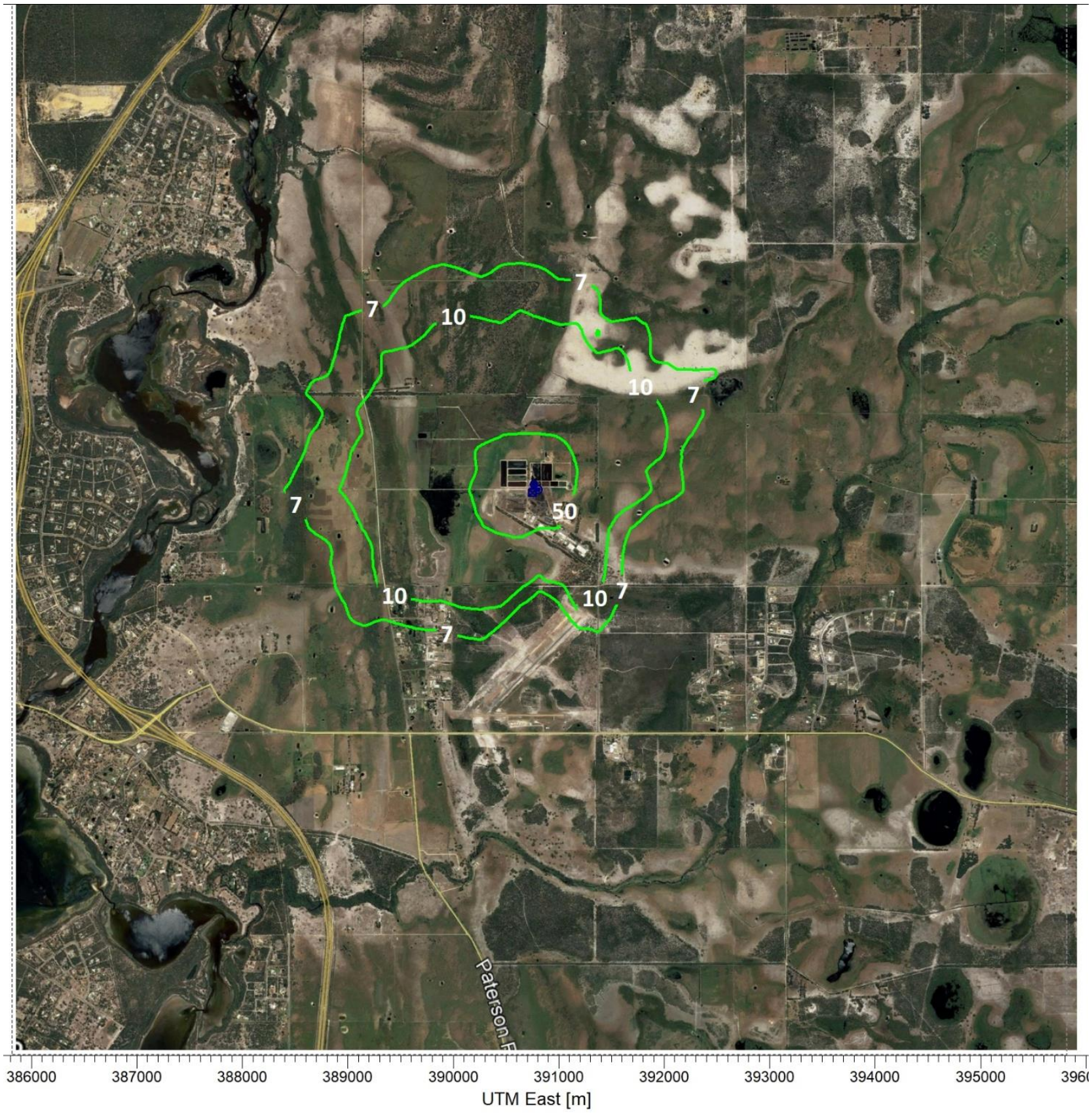
Ground level odour isopleths (plots/contours) are presented as incremental isopleths to show the odour impacts downwind of each discrete composting process area.

Importantly these discrete sources are modelled independent of one another to inform CW of their individual potential for offsite odour impacts.

The theoretical odour concentrations used in deriving mass odour emission rates from the discrete odour sources were based on the odour detection thresholds of the surrogate odorant H_2S.

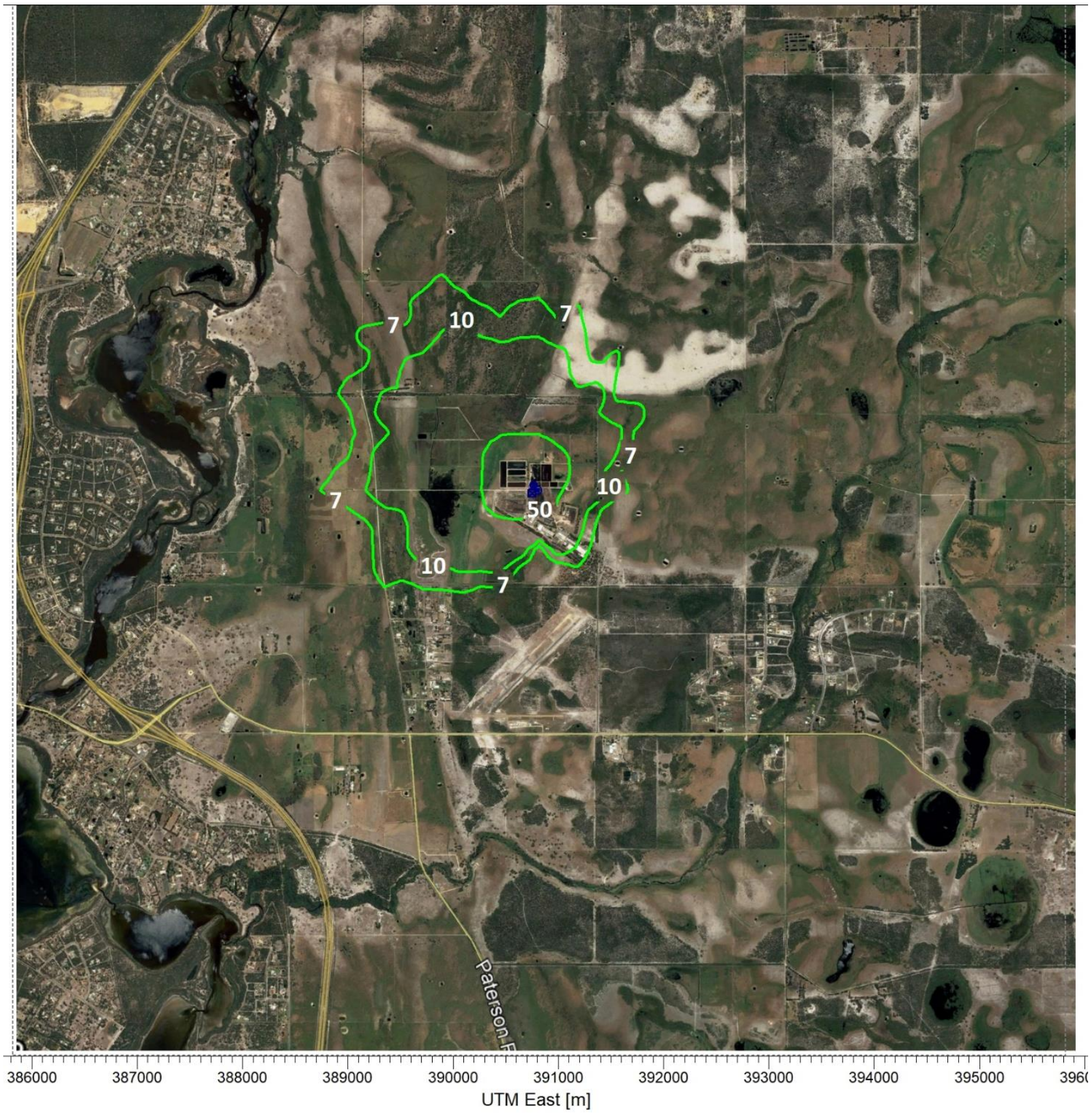
The modelling projections have uncertainty based on typical model limitations (refer Section 4), however; the projections for average impacts illustrated in **Figures 3-1, 3-2** and **3-3** are in EAQ's view a good representation of normal operations' emission impacts from those discrete odour sources. When considering model limitations, these impacts can vary within a factor of 2.

In considering standard modelling conventions where odour impacts are cumulative, the cumulative impacts from the MAF, Dam 22 and Raw Materials Bund are illustrated in **Figure 3-4** which shows a very large odour impact when combining the MAF, Dam 22 and Raw Materials Bund odour sources.



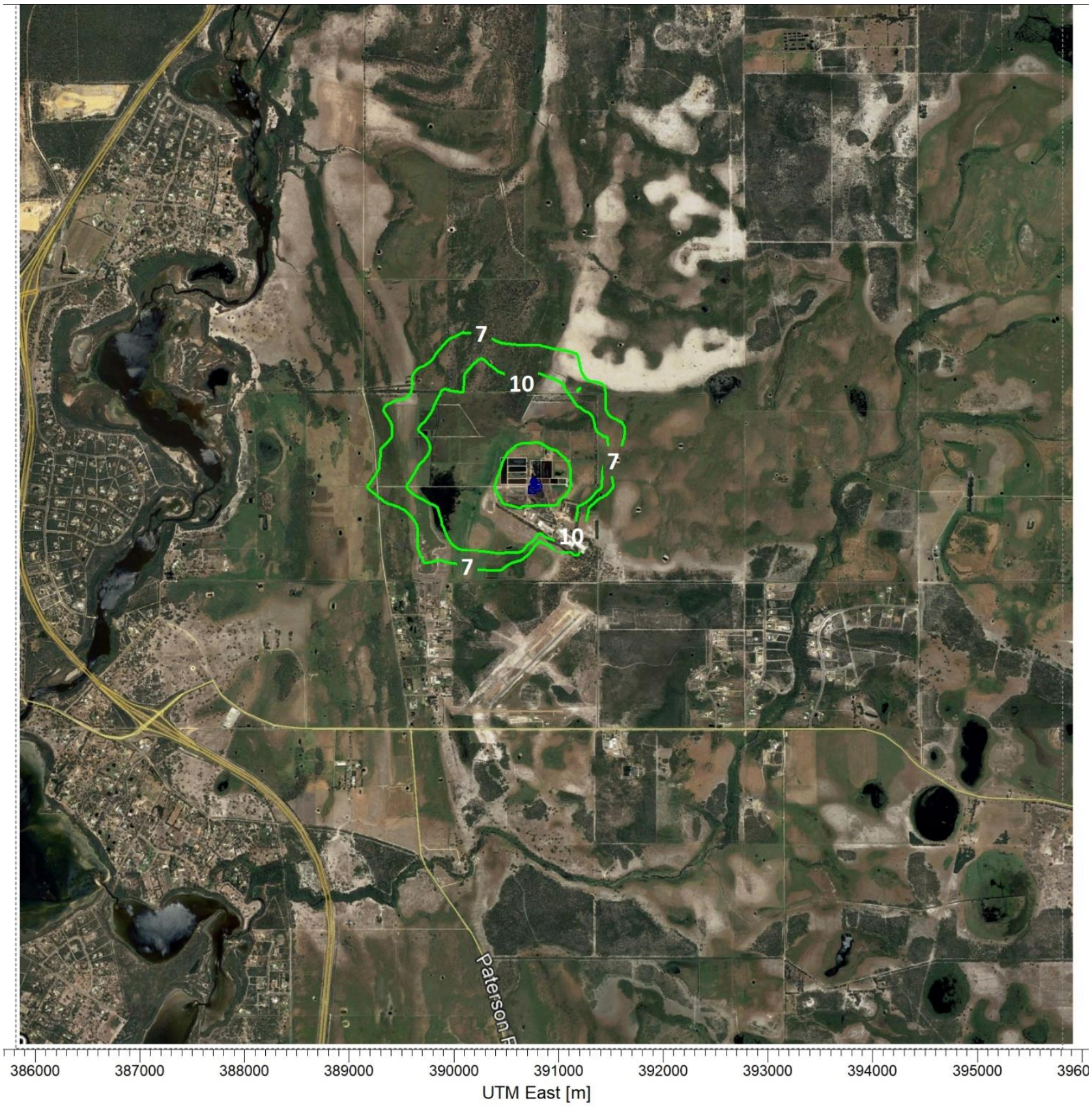
Meteorological Data & Assessment Criterion:		
• File: CSIRO TAPM Model 2019	• Modelling Hours Assessed: 44	• Averaging Time: 1-hr
• Meteorological Hours: 8,760	• Coordinates: UTM	• Assessment Percentiles: 99.5th

Figure 3-1: AVERAGE Model Projections from MAF (ou.m^3)



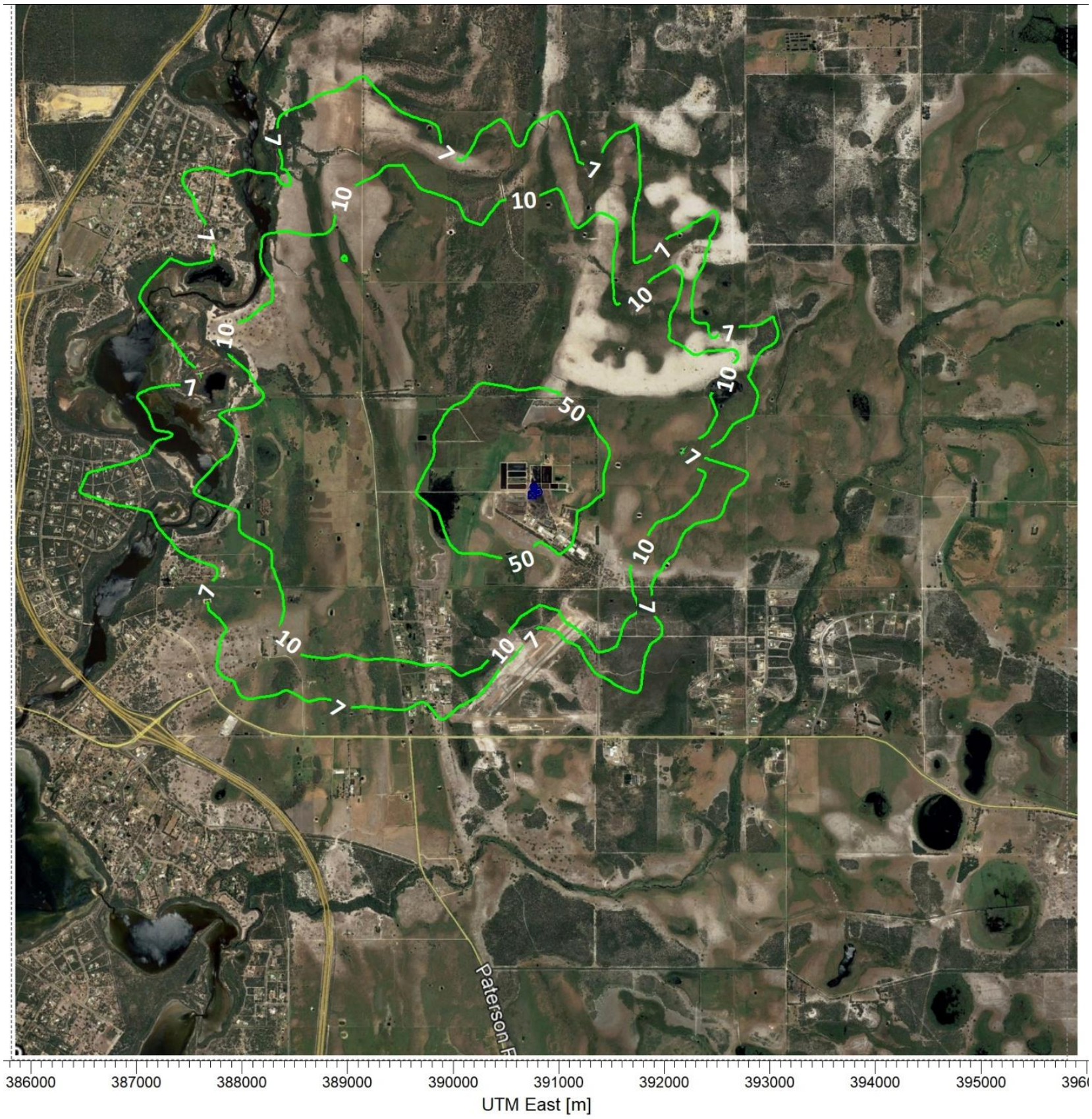
Meteorological Data & Assessment Criterion:		
• File: CSIRO TAPM Model 2019	• Modelling Hours Assessed: 44	• Averaging Time: 1-hr
• Meteorological Hours: 8,760	• Coordinates: UTM	• Assessment Percentiles: 99.5th

Figure 3-2: AVERAGE Model Projections from Dam 22 (ou.m^3)



EAQ Consulting	Meteorological Data & Assessment Criterion:
	• File: CSIRO TAPM Model 2019 • Modelling Hours Assessed: 44 • Averaging Time: 1-hr • Meteorological Hours: 8,760 • Coordinates: UTM • Assessment Percentiles: 99.5th

Figure 3-3: AVERAGE Model Projections from Raw Materials Bund (ou.m^3)



EAQ Consulting	Meteorological Data & Assessment Criterion:
	• File: CSIRO TAPM Model 2019 • Modelling Hours Assessed: 44 • Averaging Time: 1-hr • Meteorological Hours: 8,760 • Coordinates: UTM • Assessment Percentiles: 99.5th

Figure 3-4: <u>AVERAGE</u> CUMULATIVE Model Projections (ou.m^3)

4 Limitations of Dispersion Modelling Assessment

By definition, air quality models can only approximate atmospheric processes. Many assumptions and simplifications are required to describe real phenomena in mathematical equations. Model uncertainties can result from:

- Simplifications and accuracy limitations related to source data;
- Extrapolation of meteorological data from selected locations to a larger region; and
- Simplifications to model physics to replicate the random nature of atmospheric dispersion processes.

Models are reasonable and reliable in estimating the maximum concentrations occurring on an average basis. That is, the maximum concentration that may occur at a given time somewhere within the model domain, as opposed to the exact concentration at a point at a given time will usually be within the ±10% to ±40% range (US EPA, 2003).

Typically, a model is viewed as replicating dispersion processes if it can predict within a factor of two, and if it can replicate the temporal and meteorological variations associated with monitoring data. Model predictions at a specific site and for a specific hour, however, may correlate poorly with the associated observations due to the above-indicated uncertainties. For example, an uncertainty of 5° to 10° in the measured wind direction can result in concentration errors of 20% to 70% for an individual event (US EPA, 2003).

EAQ Consulting

MODELLING PREDICTIONS OF ODOUR IMPACTS USING ODOUR THRESHOLD RELATIONSHIPS

C-WISE: ORGANIC COMPOSTING FACILITY (NAMBEELUP, WESTERN AUSTRALIA)

C-Wise: Organic Composting Facility (Nambeelup, Western Australia)

Prepared for: C-Wise

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EAQ Consulting

Environment | Air Quality

Environmental & Air Quality Consulting Pty Ltd
PO Box 897
JOONDALUP DC
WA 6919
+61 (8) 6108 3760
+61 (0) 449 915 043
www.eaqconsulting.com.au
jhurley@eaqconsulting.com.au

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John Hurley	Principal Air Quality Consultant	EAQ20015-C-Wise+TheoreticalOdourModelling_Report_20200526

Signature

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1 Background

Environmental & Air Quality Consulting Pty Ltd (EAQ) was engaged by C-Wise (CW) to undertake a predictive modelling assessment (the Assessment) of the potential for odours from discrete CW operations to impact offsite sensitive receptors.

The Assessment plotted ground level odour strengths, using input odour emission rates, from three discrete composting process areas, being the Mobile Aeration Floor area (MAF), Dam 22 and the Raw Materials mixing area.

The input odour emission rates (OER) were back-calculated by applying a range of OER's to each of the three discrete composting process areas, and comparing the plotted ground level odour concentrations to theoretically derived odour concentrations.

Determining the theoretical odour concentrations was done by using the odour threshold value for surrogate odorants of Hydrogen sulphide (H_2S) and Methyl mercaptan.

These surrogates are currently being measured at multiple static locations throughout the CW site using electrochemical monitors. The surrogates are measured in chemical concentration values of parts per million (ppm).

The odour threshold data for the surrogate odorants was applied to the chemical emissions data collected for these surrogate odorants. In this way the measured chemical concentration of these odorants in ambient air can be converted to a theoretical odour concentration using each odorants threshold odour value.

The derived odour concentrations provide a theoretical conversion from the measured chemical concentration data to an odour concentration at those static monitoring locations.

The odour concentrations are considered theoretical as the odour threshold data is based on pure compounds assessed in a laboratory. Since the ambient chemical concentrations monitored are part of an overall odour matrix (multiple chemical odorant species), the threshold data varies based on the laboratory methods used to derive them. EAQ utilised the lowest odour detection threshold data found within peer reviewed public domain sources for each of the surrogate odorants.

The Assessment utilised the Aermod dispersion model to project ground level odour impacts based on assumed odour emission rates for each of the discrete composting process areas.

The dispersion model converts these input emission rates into downwind, ground level odour concentrations and plots the ground level odour concentrations in odour units ($ou.m^3$). Local representative meteorology was developed to use in the dispersion modelling.

The objective was to model multiple odour emission rates for each of the discrete composting process areas that would then be plotted as ground level odour units. Those plotted odour concentrations are then compared to the theoretical odour concentrations at those static measurement locations. Where the plots compare to those theoretical odour concentrations, the input odour emission rates therefore

represent the mass odour emissions from those discrete composting process areas that would be required to produce odour impacts comparable to the static monitoring locations.

The scope of works for the Assessment was as follows:

- Run a TAPM Prognostic Meteorological (met) Model for the C-Wise Site to develop a 2019 met dataset;
- Determine theoretical odour thresholds for the analytes of H_2S and Methyl mercaptan to subsequently determine useful odour concentrations for these analytes based on;
    - Measured onsite data for both analytes.
- Using the theoretical odour data derived from the analytes back calculate a source odour emission rate for these analytes and model using AERMOD;
    - The model will be run to project those ground level concentrations that reflect the onsite chemical monitors;
- The model will then be run for odour impacts using the theoretical odour unit relationship to project downwind odour impacts as a maximum impact.

2 C-Wise Discrete Odour Sources

The discrete odour sources assessed are the MAF, Dam 22 and the Raw Materials Bund.

The MAF, according to aerial photos, is approximately 6,000 m^2 in area, although this allows for the total surface area where MAF composting is undertaken rather than just the aerated compost piles themselves.

Dam 22 is approximately 2,000 m^2 in surface area. This represents the Dam being filled to peak volume.

The Raw Materials Bund is the process area where organic wastes, to include liquid wastes, are introduced to shredded green wastes and mixed ready for composting. The Raw Materials Bund process area, to include overflow and spillage/seepage, is approximately 850 m^2.

Any overestimation of the total surface area for these discrete composting process areas allows for overflow of the process and/or surface leachates from those processes.

Other odour sources within the CW site are liquor ponds (primary, secondary and evaporation), organic wastes stockpiles, raw/shredded green wastes, and secondary composting stockpiles before/after screening and final compost stockpiles.

The overall total composting area, encompassing all composts and raw materials but excluding the liquor ponds, is approximately 72,000 m^2, with the coverage across that total area at an estimated 50%, or 36,000 m^2 where piles of compost, compost overflow and leachate are present.

Within that estimated 36,000 m^2 of odour emitting product (raw, compost, leachate runoff) the compost piles are volumes of odour emissions rather than flat area sources. In this case many of the odour emissions are elevated where the compost piles emit odours from the top portions of these piles, and centred within the piles, based on temperature profiles within the compost piles.

2.1 Historic Odour Emissions Data

Odour concentration data has been collected previously from the CW site in 2013. The data derived OERs for those primary odour sources collected in 2013.

Currently the odour sources at the CW site are similar to those in 2013, although the MAF area has expanded since 2013. Based on the 2013 data the Dams presented the highest OERs based on the measured odour data and total surface areas of each odour emitting source, whilst the Raw Materials area presented the highest specific odour emission rate per square metre.

For the purposes of this Assessment the 2013 data that best represents the MAF Area compost, Dam 22 and Raw Materials area have been adopted as the starting OERs for the dispersion modelling.

Table 2-1 lists those OERs collected from the 2013 sampling program.

Table 2-1: Historic Odour Emission Rates

2019 Process Sample	2013 Process	2013 Average Odour Concentration ($ou.m^3$)	2013 Specific Odour Emission Rate ($ou.m^3/m^2/s$)	2013 Total Odour Emission Rate ($ou.m^3/m^2/s$)
Raw Materials Bund (850 m^2)	Organic Pond Stack (400 m^2)	3,170	88,275	35,310
MAF Area (6,000 m^2)	Mushroom Compost / Piggery Sludge Compost / Quicken Stage '0' (5,500 m^2)	453	12,715	23,704
Dam 22	Dam 22	2,670	73,650	136,179

The 2013 Total Odour Emission Rates represent the starting point for the OER inputs into the dispersion modelling.

EAQ modelled these OERs in **Table 2-1** and reviewed the extent of the ground level odour impacts projected in the dispersion model. EAQ then reviewed the modelling projections and subsequently increased/decreased the OERs to produce ground level odour concentrations that compared well to the theoretically derived odour concentrations at those static measurement locations.

2.2 Chemical Concentration Static Monitoring Data

The CW data for H_2S and Methyl mercaptan collected at static sampling locations in and around these discrete odour sources provides a chemical concentration for these surrogate odorants in ppm.

The data provided by CW logged these odorant concentrations in 10-minute sampling intervals from July 2018 to October 2019.

EAQ combined the data from multiple monitoring spreadsheets and derived the average and maximum ppm values for both surrogate odorants of H_2S and Methyl mercaptan.

The average and maximum data and corresponding sampling locations are presented in **Table 2-2**.

Table 2-2: Average & Maximum Chemical Concentrations for Surrogate Odorants

Concentration (ppm)	**MAF** H_2S - ppm	**MAF** Methyl Mercaptan (CH_4S) - ppm	**Dam 22** H_2S - ppm
Average	0.004	0.217	0.139
Maximum	0.135	0.386	0.480

2.3 Derived Theoretical Odour Concentrations

Theoretical odour concentrations can be derived from measured chemical concentrations. The odour detection threshold (ODT) values for specific odour compounds refer to the lowest concentration of any specific chemical or mixture at which it can be ascertained that an odour is present, i.e. the level that produces the first sensation of odour.

This varies not only between different people, but also from day to day for the same individual, depending on factors such as time of day, state of health, whether they are distracted or focused on the odour, whether they are awake or asleep, the presence of interfering odours, the influence of hormones (e.g. ovulation), pregnancy and migraines. Also, the odour sensation threshold usually increases (i.e. the odour sensitivity decreases) with increasing age [1].

The ODT is the concentration where that person can just detect that an odour is present. For populations, the ODT refers to the concentration where 50% of the population can detect an odour is present (under controlled conditions).

Experiments have been carried out to determine values for odour thresholds where the reported results are statistical values based on the average of when the odour becomes detectable to 50% of a panel of trained assessors (population based).

For any chemical compound or mixture the point where odour becomes detectable point, the odour detection threshold, is assigned an odour concentration of 1 ou.m^3. Odour concentrations are then expressed in multiples of this value.

For single odorous chemical compounds (pure compounds) this odour detection threshold can also be expressed in conventional concentration terms (ppm and mg/m^3, or ppb and µg/m^3).

The ODT values for single compounds reported in the literature can show wide differences based on the methods used to determine these threshold values.

For the purposes of this Assessment, EAQ used the lowest ODT's for H_2S and Methyl mercaptan found within the public domain literature. Using the lowest ODTs ensures that the derived theoretical odour units are the highest i.e. conservative.

To derive a theoretical odour concentration from measured chemical data, the concentration of those compounds measured, in this case H_2S and Methyl mercaptan, is divided by the ODT where the result is the theoretical odour concentration.

The lowest ODT values for the surrogate odorants were:

- H_2S 0.000457 ppm
- Methyl mercaptan 0.000174 ppm

[1] Review of odour character and thresholds. Science Report: SC030170/SR2. Environment Agency March 2007. ISBN: 978-1-84432-719-5

Table 2-3 lists those derived theoretical odour concentrations.

Table 2-3: Derived Theoretical Odour Concentrations

Concentration	MAF **H_2S** - ppm	MAF **Methyl Mercaptan** (CH_4S) - ppm	Dam 22 **H_2S** - ppm
Average (ppm)	0.004	0.217	0.139
Maximum (ppm)	0.135	0.386	0.480
Average Derived ou.m^3	**8.75**	**1247**	**304**
Maximum derived ou.m^3	**295**	**2218**	**1050**

An example calculation for Average Derived MAF H_2S is 0.004 / 0.000457 = 8.75 ou.m^3.

The derived odour concentrations for Methyl mercaptan are considerably higher than the H_2S derived odour concentrations. For this Assessment the H_2S derived odour concentrations were used to compare the dispersion modelling plots to those static measured locations of H_2S concentrations given the order of magnitude difference in the maximum derived odour concentration values for Methyl mercaptan compared to H_2S.

Notwithstanding, the measured concentration values for H_2S and Methyl mercaptan, converted to theoretical odour units, represents a considerably large concentration of these surrogate odorants at those static measurement locations. On this basis the potential for large offsite odour impacts are expected.

3 Aermod Dispersion Modelling

The air emissions dispersion modelling impact assessment was carried out using the Gaussian Aermod Modelling System (Version 9.9.0). The methods for undertaking Aermod assessments are in accordance with the Environmental Protection Authority Victoria (VIC EPA) publication documents 1550 and 1551.

Although this assessment has been undertaken for a site in Western Australia, the VIC EPA guidance is relevant in so much as the modelling setup and execution, where the Aermod system is the accepted plume model that supersedes Ausplume according to the VIC EPA as it contains (among others) advanced algorithms accounting for impacts that cause a plume to act in a non-Gaussian manner and more readily reflects emissions impacts affected by terrain within the modelling domain.

The VIC EPA requires that all proponents, new or existing, undertake a site-specific assessment in accordance with *Schedule C* of the *State Environment Protection Policy - Air Quality Management* (SEPP (AQM)) which sets out the minimum requirements for modelling emissions to air and includes specification of the model, Aermod.

The following VIC EPA requirements were covered by EAQ as part of the Assessment works:

- Proponents must use the currently approved version of the regulatory model Aermod, except where the proponent can demonstrate to the satisfaction of the Authority that an alternative model is appropriate, with;
    - A domain size (centered on the emission sources) of up to 10 km for flat terrain, and up to 5 km for elevated terrain;
    - A grid spacing resolution chosen so that the maximum concentration is not significantly underestimated, and not greater than 50m; and
    - Only the use of the Rural mode is approved by EPA Victoria at this stage.
- EAQ constructed a single year of meteorological data for the 2019 year, using the TAPM (v 4.0.4) prognostic model, with;
    - Outer Grid Resolution of 30 km with nesting grids 10 km, 3 km, 1 km and 0.3 km (note that nesting to an inner grid of resolution of 1 km is regarded as appropriate for flat country regions);
    - 41 by 41 horizontal grid points, centered at the location of the required data point;
    - 25 vertical levels;
    - 9-Second terrain height database;
    - TAPM default databases for land use and sea surface temperature (provided with TAPM software). Note that the default vegetation and soil type data may be modified if more representative site-specific data for the locality are available; and
    - Synoptic analysis data for the recommended year.
- TAPM outputs for the 1km grid (flat region radius within 10kms of Facility) were:
        - 10m wind speed (WSPD);

- 10m wind direction (WDIR);
- Screen level Temperature (TEMPSCR);
- Screen level Relative Humidity (RHUM);
- Net Radiation (NETR); and
- Daytime Mixing height (ZMIX) – only to be used when there are no upper air station/s in the region of interest.

The Aermod modelling methodology was based in full upon the EPA Publication 1551 [2].

For this study, the air contaminant was odour, and ground level odour concentrations ($ou.m^3$) were projected.

3.1 AERSURFACE Processing

Aersurface was run with a data tile imported to depict land use. A single surface sector was assessed to represent a Pasture/Hay land use with a small percentage of sectors representing Open water land use over the annual period.

The single sector for Albedo, Bowen Ratio and Surface Roughness' were 0.18, 0.5 and 0.082 respectively.

3.2 Prognostic Derived Meteorology (2019)

The TAPM (2019) derived meteorological dataset is presented in **Figure 3-1** and exhibits preference to south, south-easterly winds across the locale (154^0 resultant vector).

The nearest Bureau of Meteorology (BoM) Automatic Weather Station (AWS) to the CW site is the Mandurah BoM AWS. Mandurah is a coastal AWS and exhibits similar characteristic to the TAPM 2019 derived dataset, albeit there are less north easterly winds and stronger wind velocities from the north west. The resultant vector for the Mandurah AWS is 173^0 which is closer to a southerly than the TAPM 2019 derived dataset. The comparable wind speed and frequency characteristics between the TAPM 2019 and Mandurah AWS suggest that the TAPM model setup is highly representative of the CW site.

[2] https://www.epa.vic.gov.au/~/media/Publications/1551.pdf

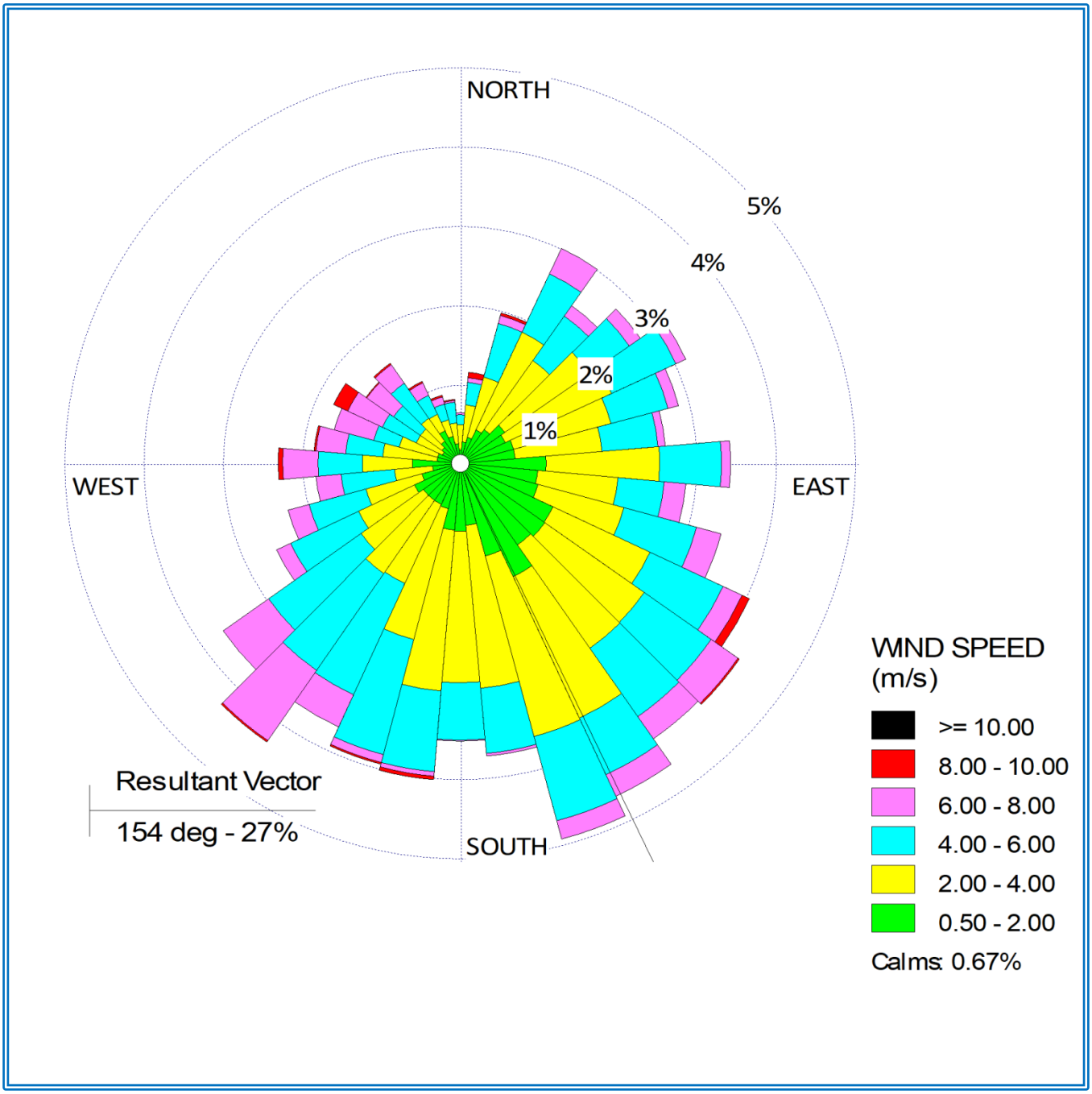


Figure 3-1: TAPM Prognostic derived 2019 meteorological dataset

3.3 Final Modelling Inputs

The dispersion model was run using the final inputs in **Table 3-1**. The final OERs used were modelled and projections of ground level odour concentration (ou.m^3) were plotted. The final OERs in Table 3-1 represent the closet source odour emission rates that give comparable ground level concentrations to those static measurement locations for H_2S.

Table 3-1: Discrete Composting Process Areas' Modelling Inputs

Source	Base Elevation (m)	Release Height (m)	SigmaY (m)	SigmaZ (m)	Length X (m)	Average Odour Emission Rate ($ou.m^3/s$)	Maximum Odour Emission Rate ($ou.m^3/s$)	Source Centre Coordinate (X_m)	Source Centre Coordinate (Y_m)
MAF	16.9	4	16.9605	0.93023	72.93	10,000	100,000	390752.30	6404713.09
DAM 22	19.75	0.5	11.6442	0.23256	50.07	35,000	150,000	390762.64	6404787.65
RAW	25.53	0.5	6.83488	0.23256	29.39	4,000	15,000	390805.63	6404739.22

4 Odour Dispersion Aermod Modelling Results

The Aermod dispersion modelling assessment of the CW site, based on derived theoretical odour concentrations using the relationship between measured concentrations (ppm) of H_2S and Methyl mercaptan and subsequent odour threshold values, has shown that maximum ground level odour impacts from discrete composting process areas are of a high magnitude. Average ground level odour impacts are of a lower impact magnitude.

The 99.5th percentile was modelled in accordance with the current regulatory guidelines for dispersion modelling of odours.

Ground level odour isopleths (plots/contours) are presented as incremental isopleths to show the odour impacts downwind of each discrete composting process area.

Importantly these discrete sources are modelled independent of one another to inform CW of their individual potential for offsite odour impacts.

The theoretical odour concentrations used in deriving mass odour emission rates from the discrete odour sources were based on the odour detection thresholds of the surrogate odorant H_2S. Methyl mercaptan was not referred to when back calculating the odour emission rates given the high variability between Methyl mercaptan and H_2S.

The odour detection threshold does not require identification or recognition of the stimulus. In other words, for example: “I can smell an odour, but I can’t identify where it would be coming from, or recognise the odour character with certainty”.

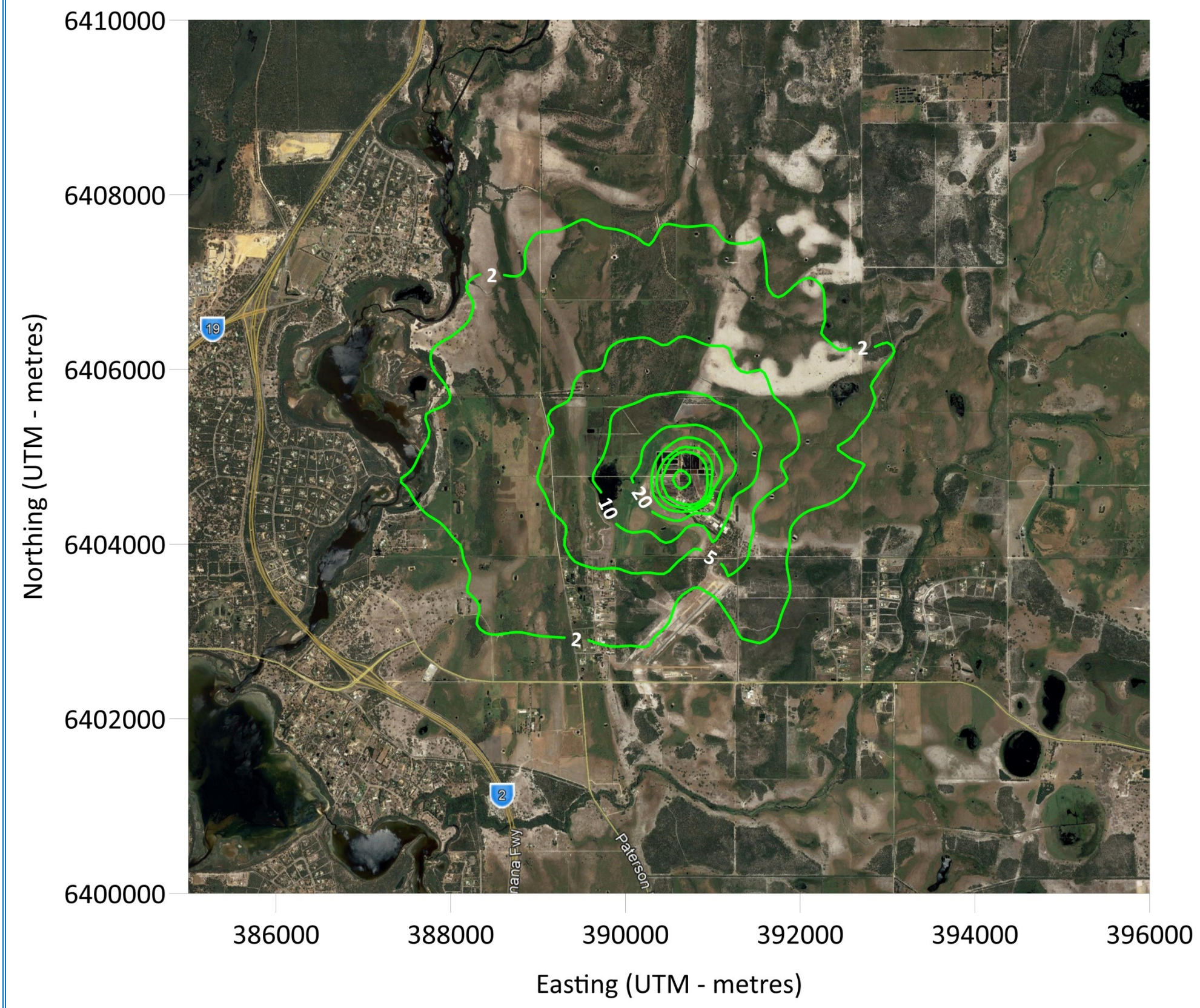
The modelling projections have uncertainty based on typical model limitations (refer Section 5), however; the projections for maximum impacts illustrated in **Figures 4-1, 4-2** and **4-3** are in EAQ’s view a good representation of peak emission impacts from those discrete odour sources.

The maximum impacts projected assume that at any one time during the annual period a maximum odour emission release will produce a ground level impact comparable to these projections. When considering model limitations, these impacts can vary within a factor of 2.

Average odour impacts projected and illustrated in **Figures 4-4, 4-5** and **4-6** are representative of those times where general odour emissions are released (i.e. no peak losses). Again, these average impacts can be within a factor of 2 at any one time and may therefore be higher than projected herein.

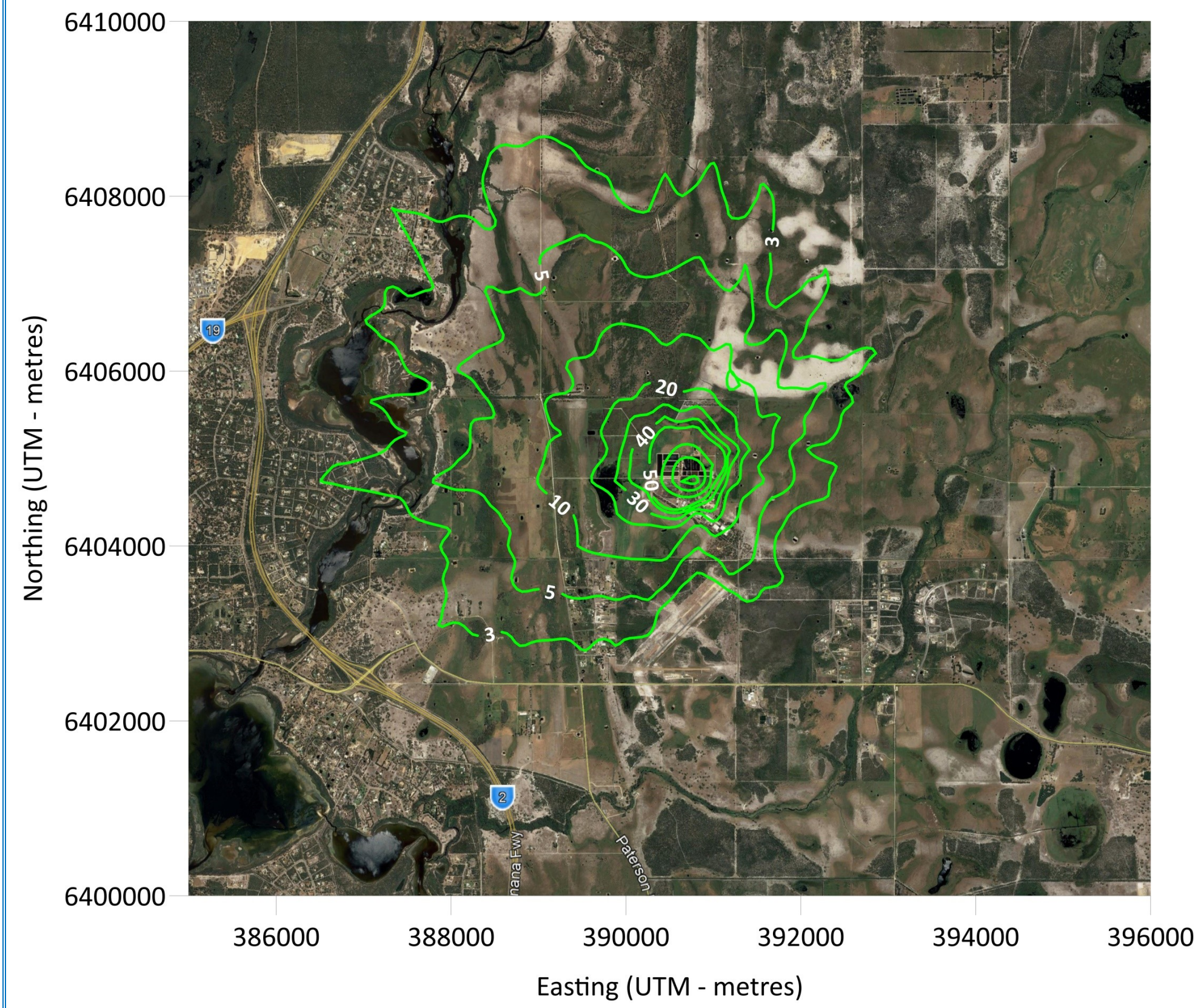
In considering standard modelling conventions where odour impacts are cumulative, the cumulative impacts from the MAF, Dam 22 and Raw Materials Bund are illustrated in **Figure 4-7** which shows a very large odour impact when combining the MAF, Dam 22 and Raw Materials Bund odour sources.

In EAQ’s opinion, the cumulative impacts are likely to represent peak (maximum) impacts from the entire CW site at any one time during a peak odour emissions scenario.



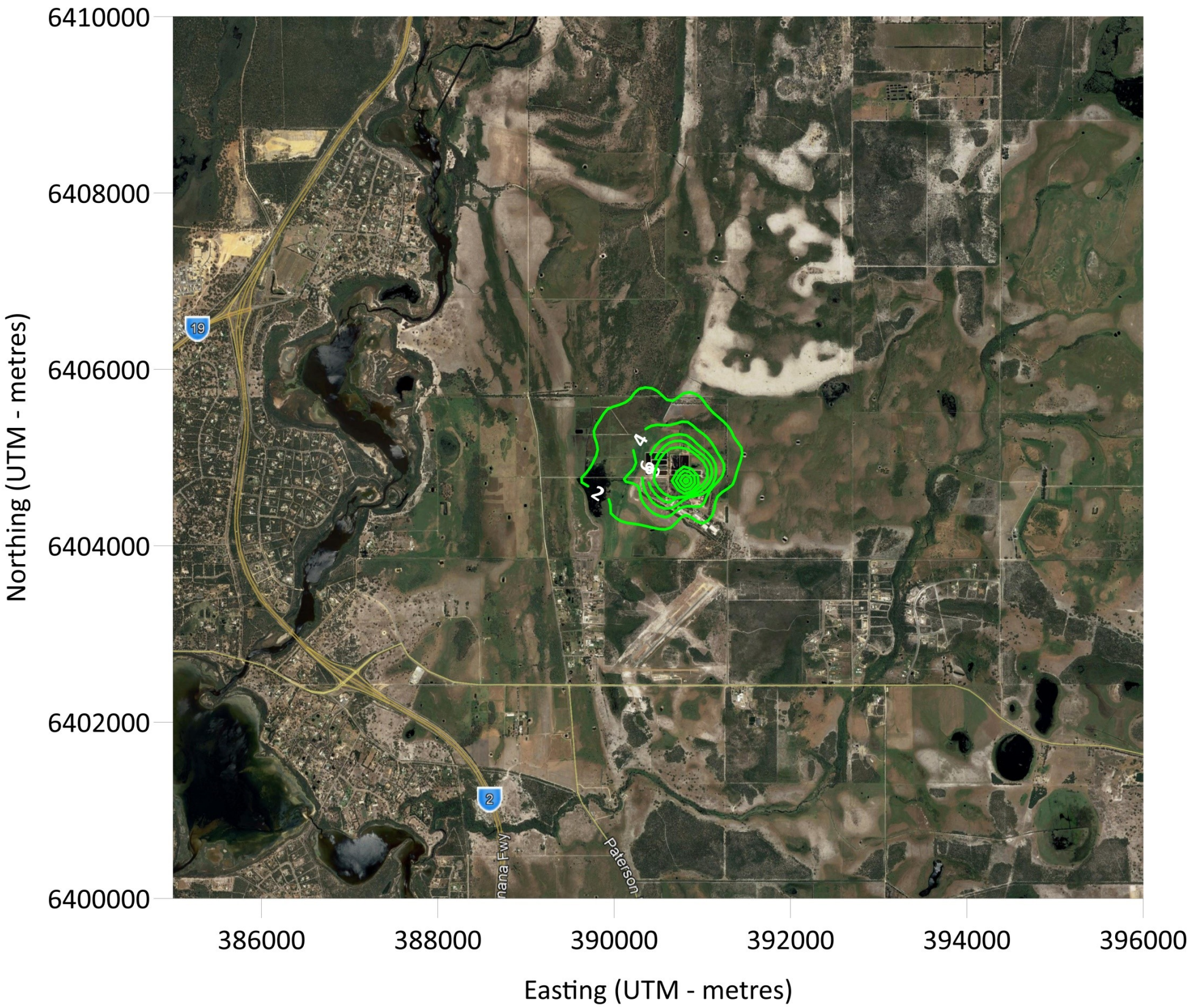
Meteorological Data & Assessment Criterion:		
• File: CSIRO TAPM Model 2019	• Modelling Hours Assessed: 44	• Averaging Time: 1-hr
• Meteorological Hours: 8,760	• Coordinates: UTM	• Assessment Percentiles: 99.5th

Figure 4-1: <u>Maximum</u> Model Projections from MAF (ou.m^3)



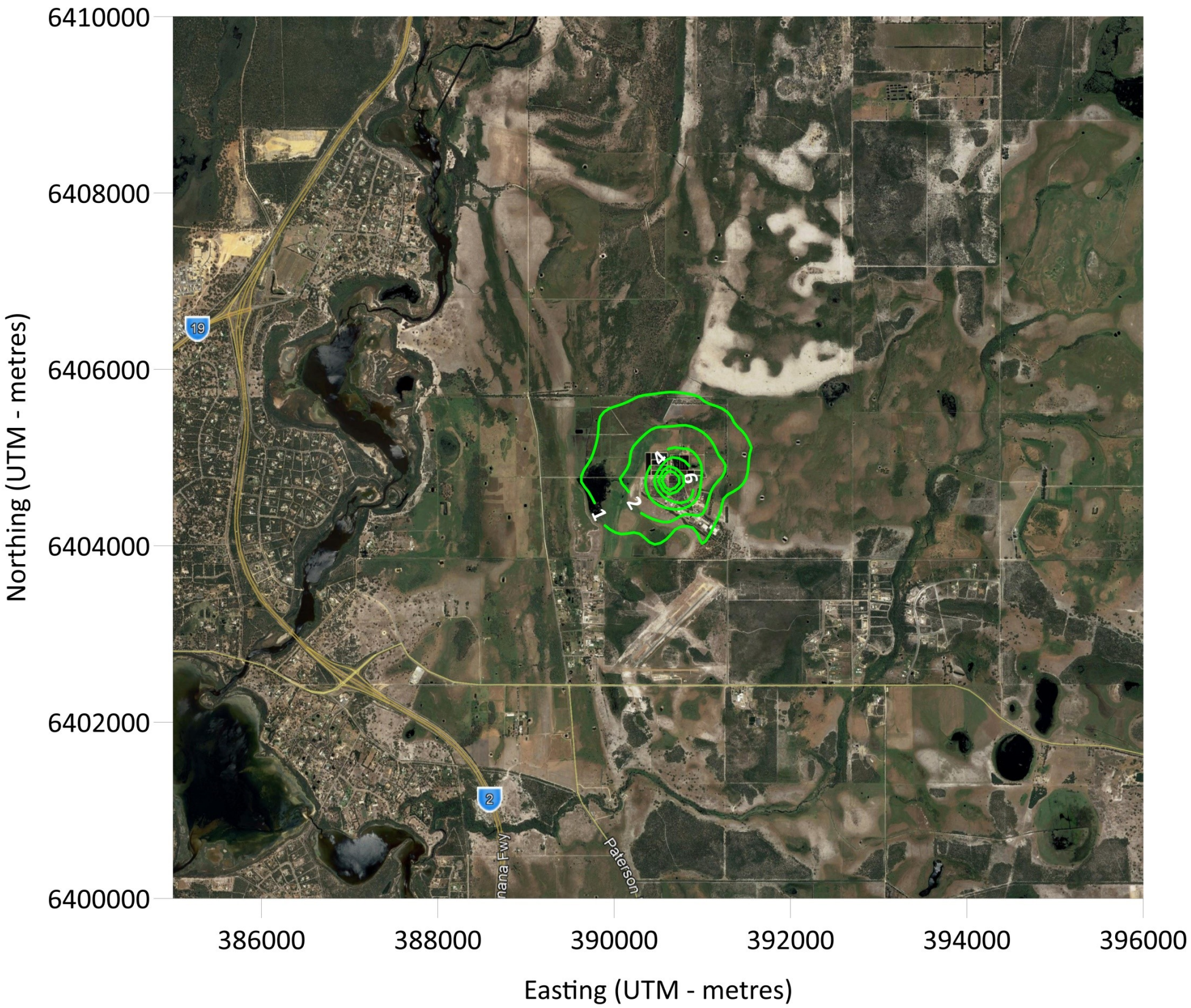
EAQ Consulting	Meteorological Data & Assessment Criterion:
	• File: CSIRO TAPM Model 2019 • Modelling Hours Assessed: 44 • Averaging Time: 1-hr • Meteorological Hours: 8,760 • Coordinates: UTM • Assessment Percentiles: 99.5th

Figure 4-2: <u>Maximum</u> Model Projections from Dam 22 (ou.m^3)



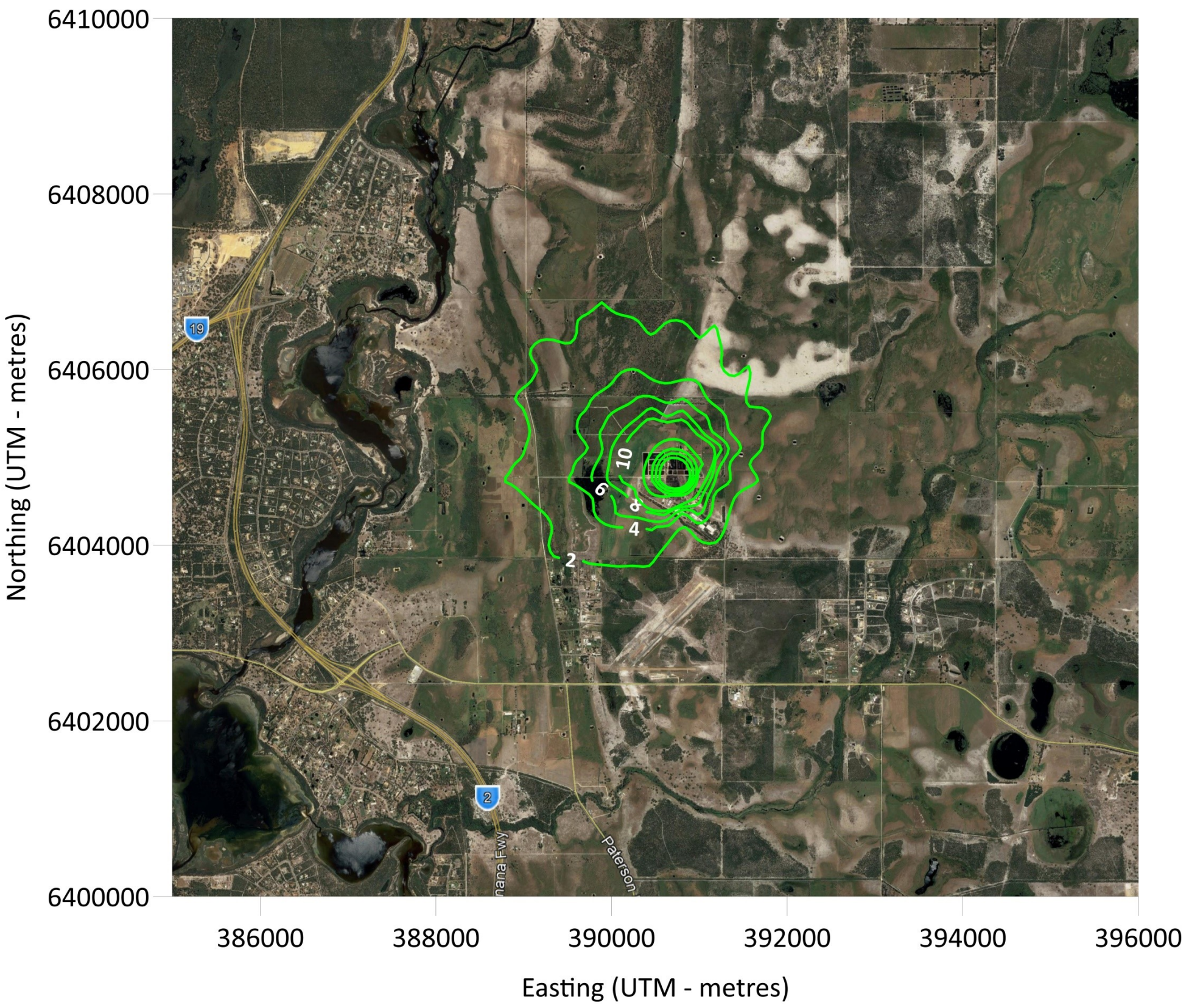
	Meteorological Data & Assessment Criterion:
	• File: CSIRO TAPM Model 2019 • Modelling Hours Assessed: 44 • Averaging Time: 1-hr • Meteorological Hours: 8,760 • Coordinates: UTM • Assessment Percentiles: 99.5th

Figure 4-3: <u>Maximum</u> Model Projections from Raw Materials Bund (ou.m^3)



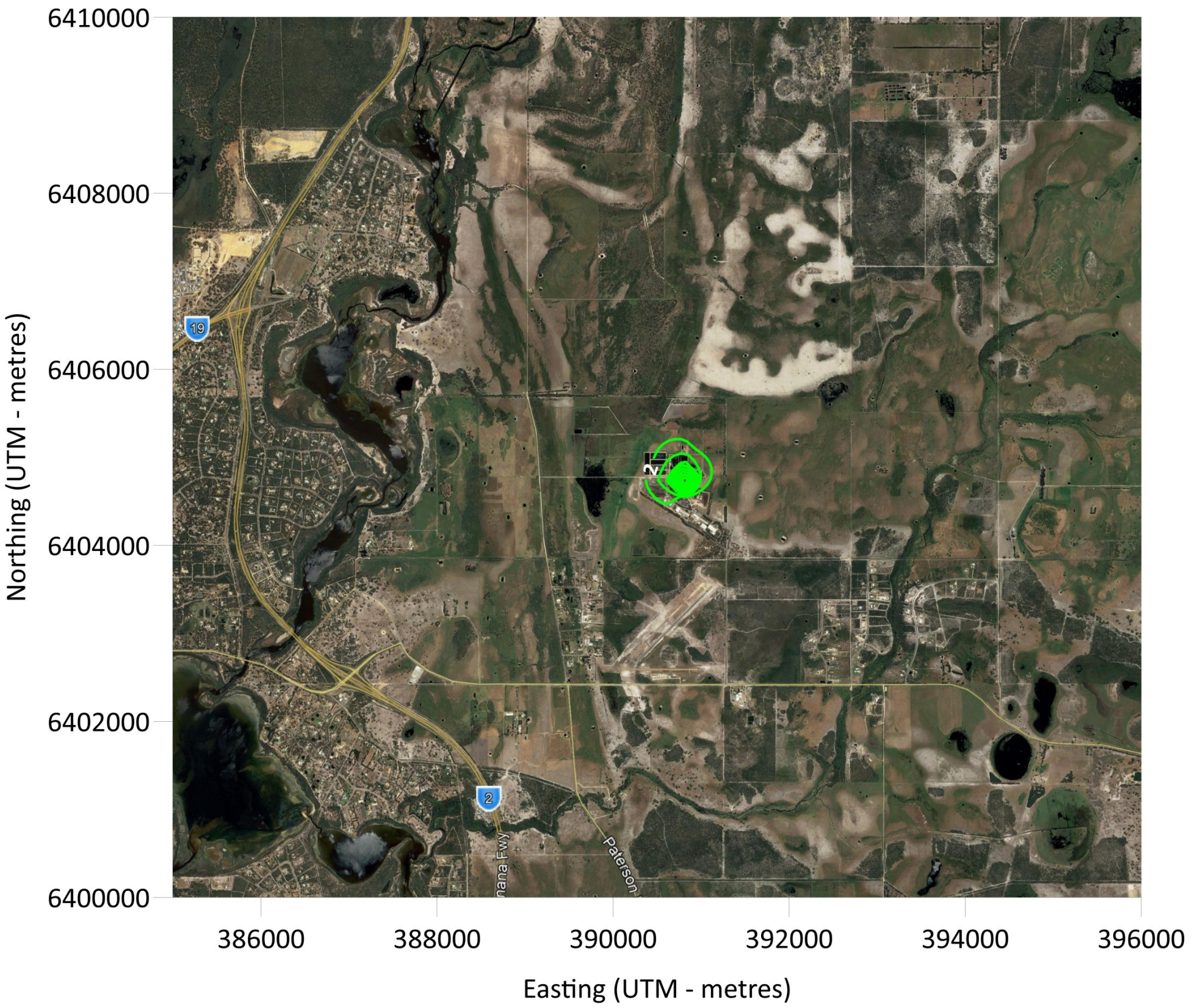
	Meteorological Data & Assessment Criterion:
	• File: CSIRO TAPM Model 2019 • Modelling Hours Assessed: 44 • Averaging Time: 1-hr • Meteorological Hours: 8,760 • Coordinates: UTM • Assessment Percentiles: 99.5th

Figure 4-4: AVERAGE Model Projections from MAF (ou.m^3)



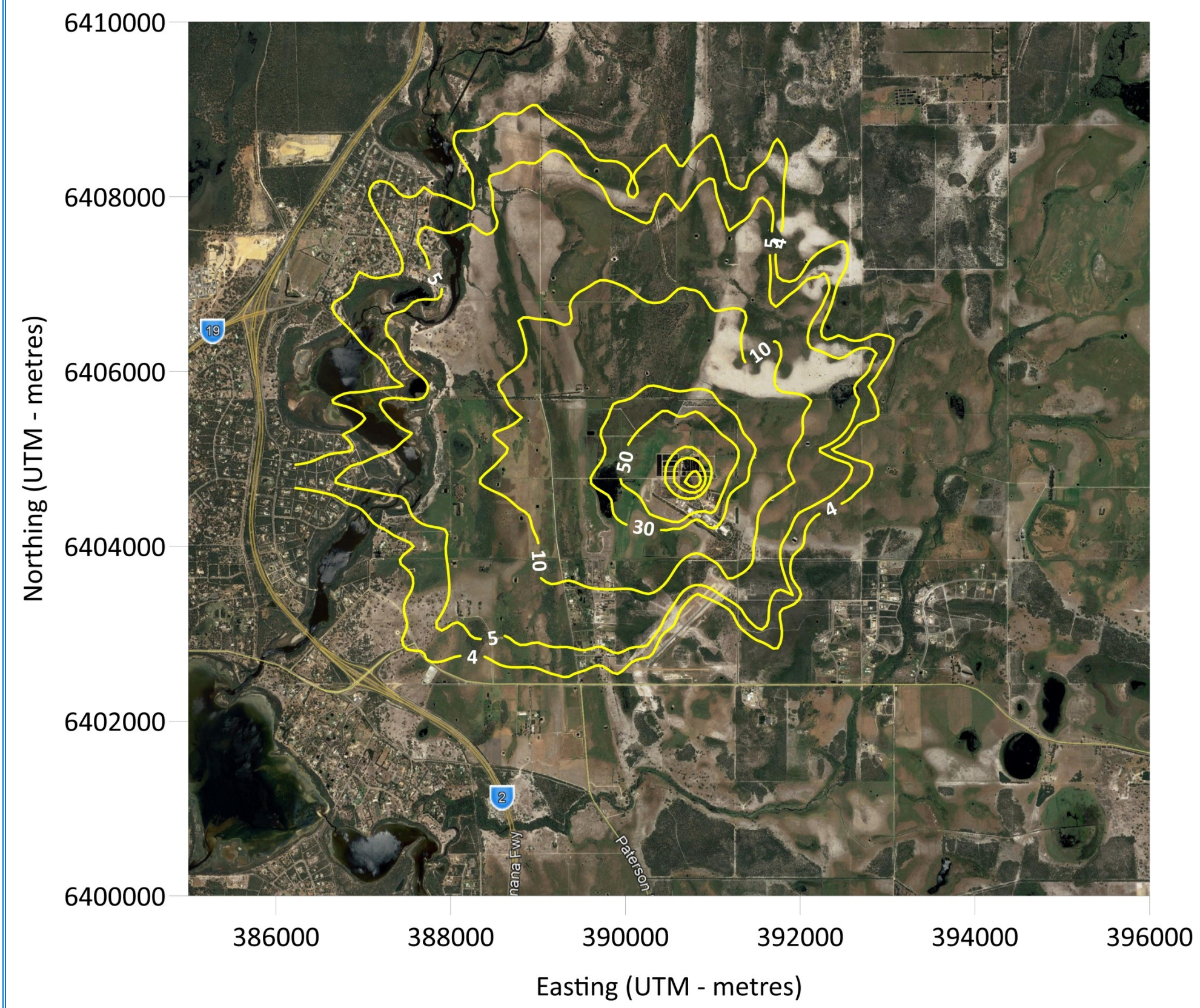
EAQ Consulting	Meteorological Data & Assessment Criterion:
	• File: CSIRO TAPM Model 2019 • Modelling Hours Assessed: 44 • Averaging Time: 1-hr • Meteorological Hours: 8,760 • Coordinates: UTM • Assessment Percentiles: 99.5th

Figure 4-5: AVERAGE Model Projections from Dam 22 (ou.m^3)



EAQ Consulting	Meteorological Data & Assessment Criterion:
	• File: CSIRO TAPM Model 2019 • Modelling Hours Assessed: 44 • Averaging Time: 1-hr • Meteorological Hours: 8,760 • Coordinates: UTM • Assessment Percentiles: 99.5th

Figure 4-6: AVERAGE Model Projections from Raw Materials Bund (ou.m^3)



EAQ Consulting	Meteorological Data & Assessment Criterion:
	• File: CSIRO TAPM Model 2019 • Modelling Hours Assessed: 44 • Averaging Time: 1-hr • Meteorological Hours: 8,760 • Coordinates: UTM • Assessment Percentiles: 99.5th

Figure 4-7: <u>Maximum</u> CUMULATIVE Model Projections (ou.m^3)

5 Limitations of Dispersion Modelling Assessment

By definition, air quality models can only approximate atmospheric processes. Many assumptions and simplifications are required to describe real phenomena in mathematical equations. Model uncertainties can result from:

- Simplifications and accuracy limitations related to source data;
- Extrapolation of meteorological data from selected locations to a larger region; and
- Simplifications to model physics to replicate the random nature of atmospheric dispersion processes.

Models are reasonable and reliable in estimating the maximum concentrations occurring on an average basis. That is, the maximum concentration that may occur at a given time somewhere within the model domain, as opposed to the exact concentration at a point at a given time will usually be within the ±10% to ±40% range (US EPA, 2003).

Typically, a model is viewed as replicating dispersion processes if it can predict within a factor of two, and if it can replicate the temporal and meteorological variations associated with monitoring data. Model predictions at a specific site and for a specific hour, however, may correlate poorly with the associated observations due to the above-indicated uncertainties. For example, an uncertainty of 5° to 10° in the measured wind direction can result in concentration errors of 20% to 70% for an individual event (US EPA, 2003).

The odour emissions data assessed in this Assessment were taken from a 2013 sampling program at the CW site. The mass odour emissions used were then varied (increased/decreased) to project ground level odour concentrations (isopleths) that compared well to the static locations measuring H_2S and Methyl mercaptan.

The modelling projections for maximum volume source odour impacts show large ground level odour impacts for each of the discrete odour emission sources (MAF, Dam 22 and Raw Materials Bund). This was expected from uncontrolled odour sources where continuous odour emission losses occur.