Appendix D

Air Quality Impact Assessment

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AECOM

St Marys Waste Management Facility Expansion Project
Worth Recycling Pty Ltd
23 April 2013

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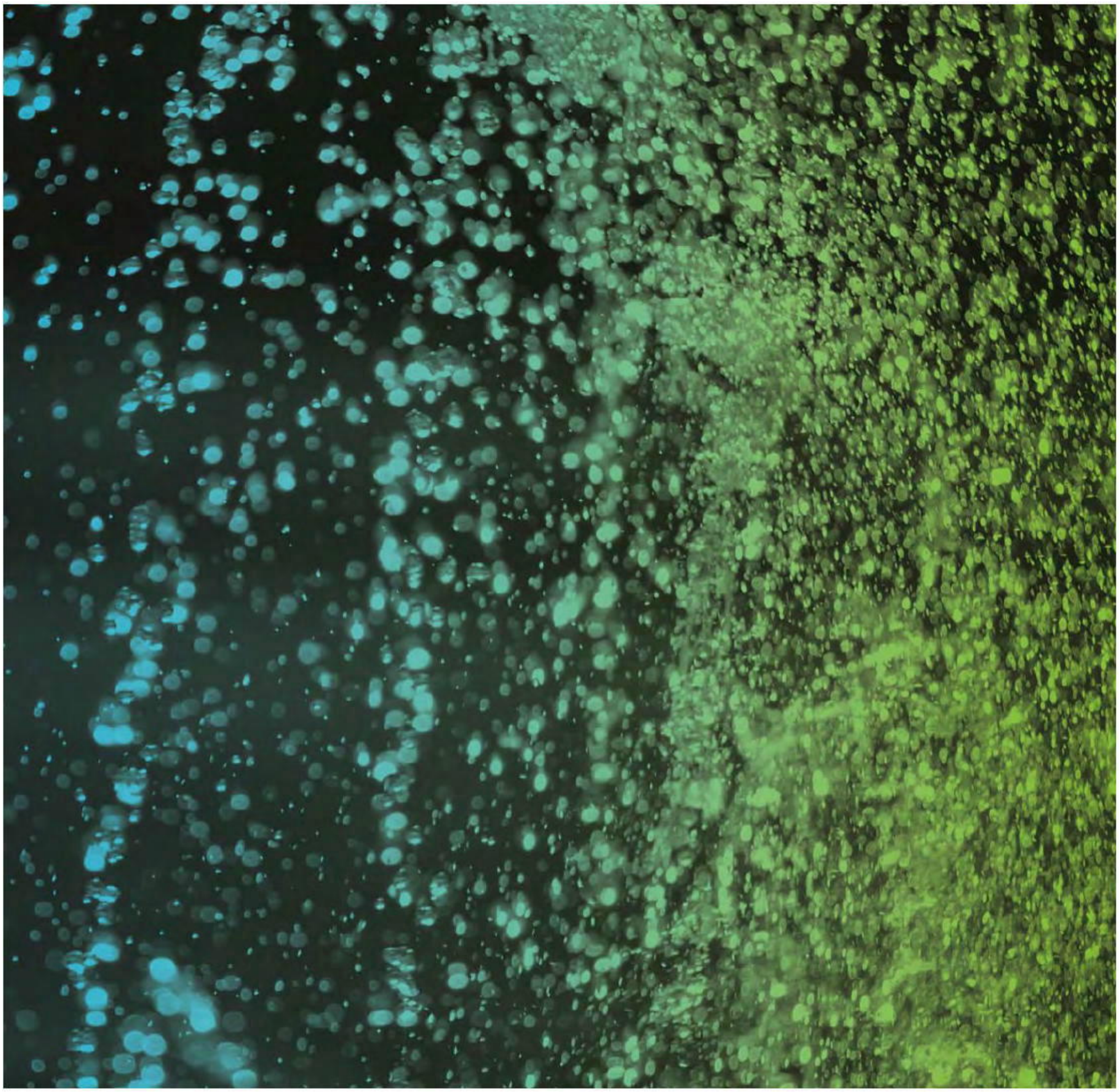

Air Quality Impact Assessment

St Marys Waste Management Facility Expansion Project

Prepared for

Worth Recycling Pty Ltd

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23 April 2013

60283208

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Quality Information

Document Air Quality Impact Assessment

Ref 60283208

Date 23 April 2013

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Reviewed by David Rollings

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	05/04/13	Draft report	Caitlin Bennett Principal Environmental Planner	
B	23/04/13	Final report	Caitlin Bennett Principal Environmental Planner	

Table of Contents

Executive Summary

Worth is seeking to relocate the solid waste operations currently undertaken at its South Windsor facility to St Marys, where around 77,100 tonnes of contaminated soils, restricted soils, greases, oil filters, drill muds, stormwater and canal dredging materials will be processed and treated per year in addition to Acid Sulphate Soils. The proposed development would include modifications to existing buildings and facilities to support the treatment of the l waste streams. The existing facility includes two warehouses (Area 1 and Area 2, 3 and 4) where with some modification, potential odour and dust generating waste would be processed and stored.

Worth engaged AECOM Australia Pty Ltd (AECOM) to undertake and Environmental Impact Statement of the proposed project to support a development application. This air quality impact assessment (AQIA) was prepared to inform the EIS regarding the potential effects of the project on local air quality. The purpose of this report was to address the air quality impacts of the project with regards to offsite odour and dust impacts in accordance with the Director General's Requirements. As advised by the EPA in January the assessment of potential odour impacts from the site were the key focus of the air quality impact assessment.

Odour

The CALPUFF dispersion modelling was used to predict ground-level odour concentrations in the vicinity of the Recycling Facility for the proposed operations. The dispersion model predictions were compared to relevant air quality guidelines to assess the effect of the emissions on existing air quality. The assessment was based on a conventional approach following the procedures outlined in the NSW Environment Protection Authority's (EPA) *Approved Methods for the Modelling and Assessment of Pollutants in NSW* (DEC 2005) and a complex odour criteria of 3 odour units (99^{th} percentile) was adopted for the assessment based on the absence of nearby residential receivers and site location within an industrial precinct. The dispersion modelling took account of local meteorology and terrain information and used odour monitoring to predict the odour impacts for proposed operating conditions of the proposed waste management facility expansion project.

Odour emission sources were modelled as area sources contained within two partially enclosed warehouses on the site. The dispersion model does not account for the enclosed nature of each source within warehouses which would largely contain odour emissions onsite; thus the reported results are likely to over predict offsite odour impacts. Results of the modelling indicate that the OU concentration at nearby sensitive receptor locations falls below the 1-hour 3 OU (99^{th} percentile) EPA criterion, however the maximum 1-hour (99th percentile) 3 OU criterion contour slightly extends outside the northern site boundary for the proposed expansion scenario.

Given the partially enclosed nature of the odour emission sources and predicted concentrations at nearby sensitive receptors the modelling suggests that the proposed operations as modelled are unlikely to cause any adverse odour impacts beyond the site boundary. As such no mitigation measures would be required. In the event however that frequent increase in odours at adjoining industrial premises is observed however, Worth may consider the introduction of odour controls.

Assessment of odour impacts at the St Marys site has been limited to the odour emission sources currently present under standard operating conditions at Worth's South Windsor Waste Management site. The South Windsor site at the time of testing was not treating refinery sludge onsite which would be considered an additional odour source to be held with the available waste holding sites within the existing warehouse. Conservatively currently present waste streams at the South Windsor site have been assumed to occupy all pit and bunker waste holding sites at the St Marys site.

Dust

This report provided a qualitative assessment of potential dust impacts associated with the proposed expansion of the St Marys Waste Management Facility.

During construction there is the potential for particulate matter emissions to be generated during earthmoving activities from the excavation and construction of pits for waste storage, construction of a catch drain, cleared groundcover and topsoil and stockpiling of spoil and construction materials. Potential dust impacts during operational activities onsite would largely arise from the tracking of dirt onto hardstand areas and subsequent disturbance by heavy and/or light vehicle movements within the site. Potential dust impacts from proposed operations were not considered a key issue due to the high moisture content of waste materials handled onsite and the majority of the treatment operations at the site undertaken undercover in partially enclosed areas.

Provided suitable mitigation measures are introduced during project construction and operation, no impacts on local air quality due to dust emissions during the operational phase are anticipated.

1.0 Introduction

Worth Recycling Pty Ltd (herein Worth) owns a waste management facility at St Marys (the St Marys facility), 43 kilometres from the Sydney CBD and approximately 7.5 kilometres from Penrith town centre. The facility currently has approval to accept up to 30,000 tonnes of acid sulphate soils (ASS) per year.

Worth is seeking to relocate the solid waste operations currently undertaken at its South Windsor facility to St Marys, where around 77,100 tonnes of contaminated soils, restricted soils, greases, oil filters, drill muds, stormwater and canal dredging materials will be processed and treated per year in addition to ASS. The proposed development would include modifications to existing buildings and facilities to support the treatment of the additional waste streams.

Worth engaged AECOM Australia Pty Ltd (AECOM) to undertake and Environmental Impact Statement (EIS) of the proposed project to support a development application. This air quality impact assessment (AQIA) was prepared to inform the EIS regarding the potential effects of the project on local air quality.

1.1 Scope of Works

The purpose of this assessment is to address the Director General's Requirements (DGRs) for the project issued by the NSW Department of Planning and Infrastructure (DoPI) on 12 February 2013 with regards to assessment of air quality impacts from the project. The DGRs state that air quality, including odour and dust, were to be considered in accordance with relevant EPA guidelines, and the assessment must consider any potential impacts on nearby private receptors.

The DGRs were issued without comment from the NSW Office of Environment and Heritage (OEH) and the Environmental Protection Authority (EPA). Supplementary to the DGRs AECOM attended a meeting with the OEH on the 30 January 2013. It was advised at the meeting that potential odour impacts from the site should be the key focus of the air quality impact assessment. Potential dust impacts were not considered a key issue due to the high moisture content of waste materials handled onsite.

Based on the requirements of the DGRs and the outcomes of the meeting held with the EPA a quantitative assessment of odour impacts and qualitative assessment of dust impacts have been undertaken in this report. The quantitative odour assessment was based on the computer dispersion model, CALPUFF, to predict ground-level odour levels in the vicinity of the Recycling Facility for the proposed operations. The dispersion model predictions were compared to relevant air quality guidelines to assess the effect of the emissions on existing air quality. The assessment was based on a conventional approach following the procedures outlined in the NSW Environment Protection Authority's (EPA) *Approved Methods for the Modelling and Assessment of Pollutants in NSW* (DEC 2005).

In summary, this report provides information on the following:

- Description of the proposed activities at the St Marys Facility relevant to the air quality assessment;
- Identification of relevant air quality goals;
- Description of existing local meteorological and climatic conditions and existing air quality;
- Description of the odour sampling and calculation methods used to estimate complex odour emissions from the site;
- Quantitative impact assessment of the odour impact of the proposed development on local and regional ambient air quality;
- Qualitative impact assessment of dust emissions of the proposed development on local and regional air quality; and
- Description of proposed mitigation and management measures to minimise the generation of air emissions.

2.0 Project Description

2.1 Overview

Section 2.0 provides a description of the project site and a summary of existing approvals and proposed operations at the St Marys Facility. A detailed description of the project is presented in Section 4 of the EIS.

2.2 Site Location

The St Marys Waste Management Facility is located at 42-46 Charles Street within the Dunheved industrial precinct within the Penrith Local Government Area. The site covers an area of approximately 1.5 hectares and its location is shown in **Figure 1**. **Figure 2** shows the proposed site layout of the St Marys Waste Management Facility including the existing two warehouses (Area 1 and Area 2, 3 and 4) where potentially odorous waste onsite would largely be processed and stored.

Several residential areas are located within two kilometres of the industrial precinct, including Ropes Crossing, North St. Marys, St Marys, Werrington and Werrington County. Adjacent to the industrial estate are the Dunheved Golf Course (west of Links Road) and the St Marys Leagues Stadium (east of Forrester Road). The site is not visible from residential areas.

Neighbouring premises within the industrial estate include:

- Linfox (transport and logistics);
- ARC (steel industry);
- Jasco (stationery products);
- Corinthian Doors (timber door manufacturer);
- R & G Fencing (metal fencing manufacturing);
- Australian Waste Oil Refineries (oil recycling services);
- Jaybro Civil and Safety Products (safety and environmental products); and
- Ronstin (paint manufacturers and wholesalers).

2.3 Existing and Approved Operations

The existing St Marys Facility was purchased by Worth Recycling in mid-2012, and was previously operated as a materials recycling facility. On 21 August 2012, Worth submitted a development application (DA12/0780) for the change of use of the site from a materials recycling facility to a waste management facility for Acid Sulphate Soils (ASS). Development consent was granted on 30 October 2012 by Penrith City Council. Construction is underway to enable the commencement of ASS treatment following the issue of the final occupation certificate. ASS treatment is expected to commence at the site during 2013.

While waste management procedures for ASS are currently non-operational at the St Marys Facility; ASS is expected to be delivered to the site via 25 tonne capacity trucks and deposited and treated within an existing enclosed warehouse (Area 1), with a small amount of treatment undertaken in semi-enclosed bunkers adjacent to the warehouse. ASS would be treated over a period three to five days with lime in treatment pits and then collected by a licenced contractor and disposed of at a licenced solid waste facility.

During periods of peak activity, the site will store up to 1,000 tonnes of treated material and 600 tonnes of material awaiting treatment.

The site currently has approval to operate between 6 am to 6 pm Monday to Friday, and 8 am to 2 pm on Saturdays.

Figure 1 Location Map Showing Subject Site within Dunheved Industrial Precinct and Sensitive Receivers

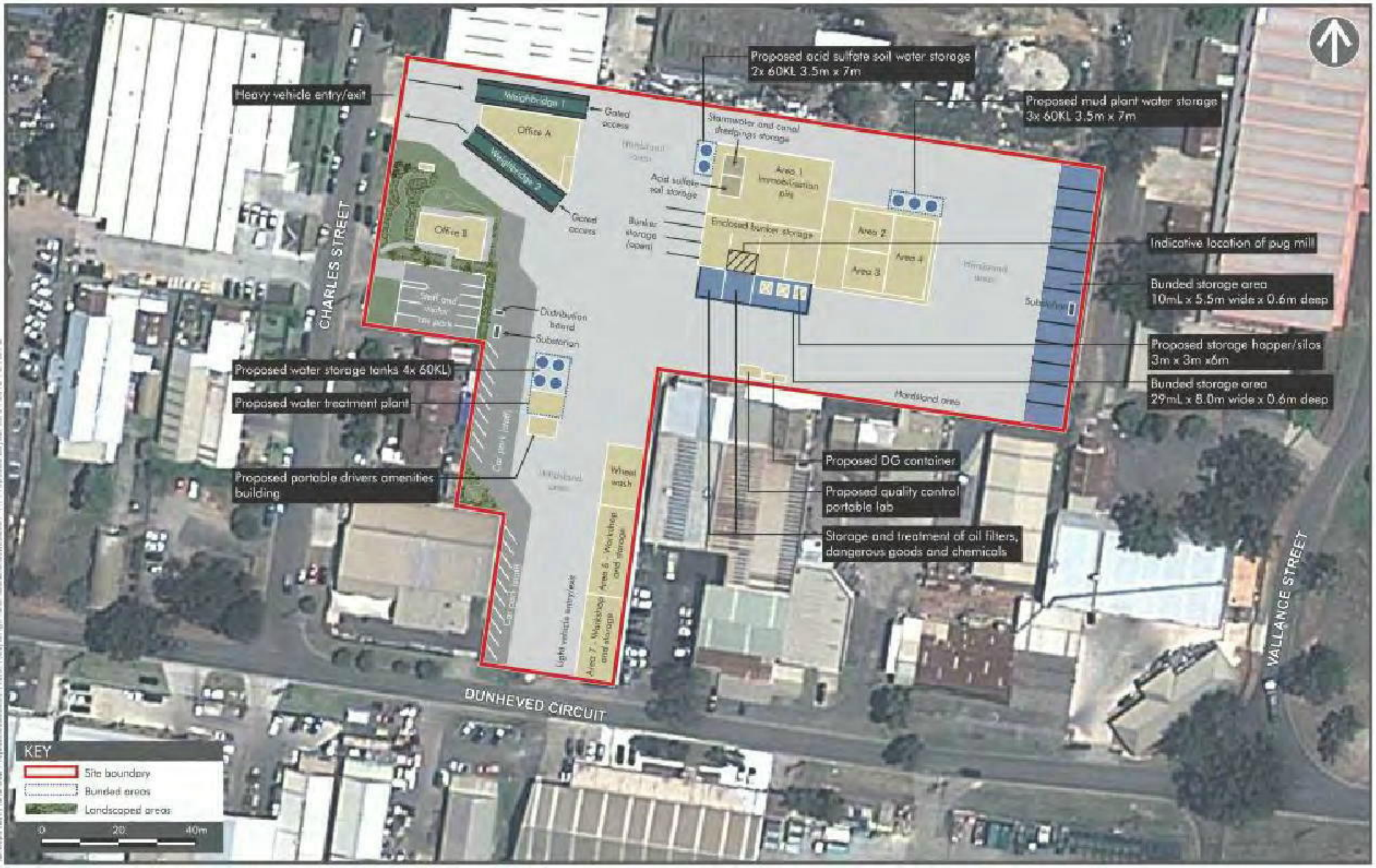

Figure 2 Proposed Site Layout

2.4 Proposed Operations

2.4.1 Operational Activities

Worth is proposing to expand its current operations at St Marys to enable the relocation of its solid waste operations from the South Windsor Facility to the Site at St Marys, and to cater for future growth in addition to treatment of ASS. The proposed development would enable the non-thermal treatment and processing of an additional 77,400 tonnes per annum to that currently received at the South Windsor Facility, comprising various waste streams as detailed in **Table 1**.

The proposed development would continue to operate primarily between the currently approved operational hours between 6 am to 6 pm Monday to Friday, and 8 am to 2 pm on Saturdays. However, to provide flexibility to Worth to respond to major peak periods, it is proposed that 24 hours operations would be undertaken to process waste streams and to receive project deliveries or deliveries from regional areas/interstate.

Table 1 **Proposed waste streams (including treatment method and annual capacity)**

Waste Stream	Treatment Method	Annual Capacity (tpa)
Drill muds	Chemical/centrifugal	47,000
Restricted soils	Segregation/immobilisation	2,400
Hazardous soils	Immobilisation	12,000
Stormwater and canal dredgings	Settling/segregation/immobilisation	6,000
Greases (and drum storage)	Immobilisation	1,000
Oil Filters	Crushing/segregating	1,500
Refinery Sludges	Immobilisation	4,800
Packaged Waste	Sorting/segregation/immobilisation	300
Construction / demolition waste	Sorting/segregation	2,400

Table 2 provides a brief description of the treatment methods applied to the waste streams listed in **Table 1**. A more detailed description of the proposed waste stream treatment process is provided in Section 4 of the EIS.

Other proposed supporting operations at the St Marys Facility would include:

- Grease and oil filter drum crushing and storage;
- Operation of a water treatment plant to treat liquids removed from drill muds, stormwater and canal dredgings prior to discharge to the sewer;
- Operation of a portable laboratory to support the testing of waste prior to and following treatment; and
- Establishment of a Workshop and storage shed (Area 6 and Area 7) for chemical storage and general maintenance activities.

Table 2 Waste Stream Treatment Process

Waste(s)	Treatment Process
Restricted and hazardous soils, greases and refinery sludge.	Restricted soils, hazardous soils, greases, refinery sludges would undergo immobilisation using a chemical fixation and solidification processes. Waste would be delivered to the site in a solid or slurry form and stored in bunkers. Waste would be tested and placed in immobilisation pits within Area 1 by a modified excavator or large loader. The waste stream would then be transferred using a front end loader or excavator to the pug mill. At this point, reagents would be added to immobilise the contaminant contained within the soil or sludge. Once the mixing is completed treated waste would be transferred by conveyor to a bunker located within Area 1 for curing. The time taken to cure would depend on the original contaminant, and can range from 12 hours to seven days. Treated waste is the tested and classified in accordance with EPA guidelines and stored in an external bunker prior to offsite removal.
Drill muds	Drill muds onsite would arrive via tanker and would be discharged into two pits (with an area 8 x 8m each) in Area 3 after passing through a large grill to remove rocks and other large material. Drill muds are then transferred to the mud separator (hydro cyclones and shaker screens), where the majority of the liquid of the drill mud would be removed. The liquid removed from this process would then be dosed with flocculants and coagulants and would then be processed through a decanter to remove any remaining solids. The water component would then be transferred to the water treatment plant at the site or transported off site for treatment. The solid component would then be transferred to Area 4 for storage using a front end loader before being transferred to external sites for beneficial reuse.
Stormwater and canal dredgings	Stormwater and canal dredgings would be treated at the Site using settling, segregating in Area 2 and, if needed, immobilisation methods within Area 1. Stormwater and canal dredgings would be received by tanker and would pass through a grate to remove any large contaminants. Following the settlement of the soil, refuse would be skimmed off the top of the water surface for collection and disposal off site. The water component would then be pumped out of the pit for treatment at the proposed water treatment plant. The soil component would be removed from the pit using an excavator and placed in a storage bunker then tested to confirm if the soil component requires immobilisation treatment. Soil not requiring treatment it would be classified and disposed of at landfill.
Oil filters	Oil filters would be crushed onsite using a hydraulic press within the enclosed external storage area located immediately south of the Area 1 building. Crushed filters would be stored in a skip bin and taken off site for recycling.
Construction and demolition waste	Construction and demolition waste, such as building rubble, timber, glass, bricks and similar materials would be accepted at the Site for sorting and segregating of waste and recyclable materials. Sorting and segregation would occur within Area 1, with waste separated by its classification or recovery potential. Waste and any materials identified for recovery or recycling would be stored within external bunkers located along the eastern boundary of the Site.
Packaged waste	Packaged waste (such as paints, household chemicals, silicone or aerosols), received at the Site would be bulked (or grouped) for classification and disposal offsite, or alternatively, immobilised where required. This would be undertaken within the enclosed external storage area south of the Area 1 building.

2.4.2 Operational Traffic

External traffic operations would include approximately eight heavy vehicles movements per hour during peak periods. Movements to and from the Site would include heavy vehicles associated with the removal of treated waste and any movements associated with support services provided at South Windsor (namely waste water treatment). To manage traffic movements, heavy vehicles arriving to the Site would travel to the Site via Forrester Road, Links Road, Dunheved Circuit and Charles Street. Heavy vehicles exiting the Site would travel via Charles Street, Links Road and Forrester Road. Heavy vehicles delivering waste to the Site would enter via Weighbridge 1 and exit via the gated Weighbridge 2. Staff and courier deliveries would enter and exit the Site via the entrance at Dunheved Circuit.

Internal operational movements would include the use of mobile equipment including forklifts a front end loader, excavator and street sweeper.

2.4.3 Construction Activities

The proposed Development would involve limited construction activity, given the existing facilities and structures on the Site. Construction activities are anticipated to be limited to the following activities:

- Augmentation of Area 1 including:
  - Construction bunding and drainage for bunkers
  - Removal of the existing back wall and part of the eastern wall;
  - Bunding and enclosure of external bays located along the southern side of Area 1
  - Roofing of other external bunkers; and
  - Installation of three hoppers along the southern side of Area 1.
- Augmentation of Area 2, 3 and 4 including:
  - Excavation and construction of two pits in Area 4;
  - Construction of catch drain along southern extent of Area 2;
  - Installation of plant equipment; and
  - Installation of three tanks.
- Construction of external bunkers on the western boundary;
- Construction of a water treatment plant; and
- Provision for a dangerous goods store to the south of Area 1.

The above construction activities would require the use of the plant and equipment including crane(s), hydraulic hammer, angle grinders, excavators, cranes, hand tools, concrete pumps and delivery trucks.

2.5 Potential Emission Sources

2.5.1 Odour

During operation, treatment and storage of waste products would largely be undertaken in partially enclosed areas (namely Area 1, 2, 3 and 4) limiting potential odour impacts offsite including surrounding industrial properties.

Waste streams which have the potential to generate odorous emissions would include:

- Soils (including those classified as hazardous, restricted and general waste and ASS);
- Refinery sludge;
- Grease Oil;
- Drill muds,
- Stormwater and canal dredgings; and
- Oil filters.

The type and quality of the above waste streams on site are likely to vary at any given time (maximum annual quantities are presented in **Table 1**), which would alter odour impacts onsite at any given time. Some odour emissions are also anticipated to be temporary in nature. For example oil filters (as currently treated at the South Windsor site) pose only a short term odour impact, with oil filters which are crushed following transportation to the site, stored within a skip bin and taken off site for recycling. Also ASS, which has the potential to emit hydrogen sulphide, would only cause temporary odour impacts, prior to being neutralised. Furthermore the type of odour would be largely dependent on the nature of the contaminants contained in the waste materials received. Based on the odour sampling undertaken at the South Windsor site (refer to **Section 5.3.4**) the largest contributing waste stream to odour emissions onsite would be grease oil solids and liquids.

Given the intermittent nature of odour sources onsite this odour impacts assessment has been limited to odour generating waste streams present during a typical operational day at the South Windsor site during the sampling period in March 2013. This is discussed in detail under sampling methodology in **Section 5.3.4**.

There are no potential sources of odour anticipated during the construction phase.

2.5.2 Dust

The principal air pollutant likely to be associated with construction of the proposed expansion project would be dust generated through excavation activities for the drainage systems and treatment pits, and potentially dust generated by vehicles tracking mud onto adjoining streets when exiting the site. During operation potential sources of dust emissions would largely arise though tracking of dirt onto the hardstand areas and subsequent disturbance by heavy and/or light vehicle movements within the site. Potential dust generating impacts during construction and operation are discussed in detail in **Section 6.2.1** and **Section 6.2.2** respectively.

3.0 Assessment Criteria

The main pollutants of interest for a waste processing facility, such as that proposed for St Marys, are odour and dust (particulates). These are discussed below.

3.1 Odour Assessment Criteria

The perception of odour is based on an individual's response to chemical exposure. The odour threshold is the theoretical minimum concentration of a chemical that produces an olfactory response, which, in practice, is used to indicate whether an odour is detectable; the odour threshold defines 1 odour unit (1 OU) for each chemical. The threshold relates to odour detection and does not consider the recognition of an odour's character.

The EPA's impact assessment criteria for complex mixtures of odours (DEC, 2005) were designed to take into account the ranges of individual sensitivity to odours based on a statistical approach based on the size of the surrounding population. As population density increases, the proportion of sensitive individuals is also likely to increase; as such, areas with larger populations require more stringent criteria. The criteria are shown in **Table 3**.

Table 3 EPA Impact Assessment Criteria – Complex Odours

Population	Criteria (OU)*
Urban ($\geq$ ~2000) and/or schools and hospitals	2
~ 500	3
~ 125	4
~ 30	5
~ 10	6
Single residence ($\leq$ ~2)	7
*99th percentile nose response time	

The St Marys site is located within an industrial park, surrounded by a number of industry types including steel, paint, timber, fencing, paint and stationary manufacture and waste recycling services. The nearest residential sensitive receivers are largely located east of Forrester Road approximately 865m south east of the site. Due to the limited proximity of urban residential land use surrounding the site an odour assessment criterion of 3OU has been adopted for this assessment to satisfy the EPA's concerns regarding odour impacts to industrial properties adjacent to the property boundary.

3.2 Air Quality Criteria

Of particular relevance to the proposed activities are criteria for particulate matter. The pollutants assessed were:

- Particulate matter with equivalent aerodynamic diameter ≤10 microns (PM_{10});
- Particulate matter with equivalent aerodynamic diameter ≤ 2.5 microns ($PM_{2.5}$);
- Total suspended particulates (TSP); and
- Deposited dust;

Table 4 summarises the NSW EPA's impact assessment criteria for the pollutants included in the assessment. In general, these criteria relate to the total burden of air pollutants in the air and not just the air pollutants from project-specific sources. Therefore, some consideration of background levels needs to be made when using these criteria to assess impacts. A discussion of background levels in the study area is provided in Section **4.3**.

Table 4 NSW EPA Air Quality Impact Assessment Criteria (DEC 2005)

Pollutant	Averaging Period	Criteria
Particulate matter (PM_{10})	Maximum 24-hour average	50 μg/m^3
	Annual average	30 μg/m^3
Particulate matter ($PM_{2.5}$)*	Maximum 24-hour average	25 μg/m^3
	Annual average	8 μg/m^3
Total suspended particulate (TSP)	Annual average	90 μg/m^3
μg/m^3 = micrograms per cubic metre *NEPM Advisory reporting standards only		

The NSW EPA's criteria for TSP and deposited dust were set to protect against nuisance impacts, while the PM_{10} criteria were set to protect against adverse health effects. There is an increasing body of evidence to suggest that criteria for finer particulate matter (for example, $PM_{2.5}$) may be more important for protecting against adverse health impacts; at this stage, however, the NSW EPA has not set criteria for $PM_{2.5}$ that are applied on a project-specific basis, and the criteria specified above represent the NEPM advisory reporting standards.

3.3 Potential Health Impacts and Environmental Effects

3.3.1 Odour

Health Impacts

The perception of odour is highly individual and varies between individuals based on their sensitivity, the acuteness of their sense of smell, and their prior history with different odours. Odour characteristics also affect people's perception of it; some odours are pleasant, while others are offensive. Offensive odours can adversely affect people's quality of life, and exposure can result in stress and other physical symptoms.

3.3.2 Dust

Health Impacts

Particles within the PM_{10} and $PM_{2.5}$ fractions generally enter the body via inhalation. In the lungs particles can have a direct physical effect and/or be absorbed into the blood. TSP may also may be deposited in the mouth, throat or nose and can be ingested. Airborne particulate matter can be generated by vehicles from direct emissions from the burning of fuels (especially diesel powered vehicles) and from wear of tyres or vehicle-generated air turbulence on roadways. Particles may also be generated from earthworks, wind erosion, and construction activities.

The factors that may influence the health effects of exposure to particles include:

- The chemical composition and physical properties of the particles.
- The mass concentration of the airborne particles.
- The size of the particles (smaller particles may be associated with more adverse effects due to increased likelihood of deep inhalation into the lungs).
- The duration of exposure (acute and long term).

Recent epidemiological research suggests that there is no threshold at which health effects do not occur. The health effects include irritation of mucous membranes, toxic effects by absorption of the toxic material into the blood and increased respiratory symptoms, aggravation of asthma and premature death.

Environmental Impacts

PM_{10} particles are easily entrained into the air by wind or disturbances. Airborne particulate matter may also react with other substances in the atmosphere, reduce visibility, increase the possibility of precipitation, fog and clouds and reduce solar radiation. Additionally, particulate matter may cause similar respiratory impacts in animals as to humans.

4.0 Existing Environment

This section provides a description of the dispersion meteorology, local climatic conditions and existing air pollutant levels in the St Marys area.

4.1 Dispersion Meteorology

Meteorology in the area surrounding the Site is affected by several factors such as terrain and land use. Wind speed and direction are largely affected by topography at the small scale, while factors such as synoptic scale winds affect wind speed and direction on the larger scale.

On a relatively small scale, local winds are largely affected by the topography. At larger scales, winds are affected by synoptic scale winds, which are modified by convective processes in the daytime and also by a complex pattern of regional drainage flows, caused by sloping terrain that can develop overnight. In the modelling undertaken for this study, it is not necessary to document the complex mechanisms that affect air movements in the area; it is simply necessary to ensure that these air movements are incorporated into the dispersion modelling.

In the absence of suitable local meteorological data, the CSIRO *The Air Pollution Model* (TAPM) and the CALMET meteorological processors were used to simulate the complex metrological patterns that exist within the study area, accounting for the effects of local topography and changes in land surface characteristics. Local wind speed and wind direction data from the EPA air quality and meteorological monitoring station (approximately 6km south of the site) (EPA 2013a) was assimilated into the TAPM model to nudge the predicted metrological surface data towards the recorded observations. A description of both TAPM and CALMET in dispersion modelling is included in **Section 5.2**.

Wind speed and direction are important variables in dispersion modelling, as they dictate the direction and distance air pollutant plumes travel. Annual and seasonal wind roses for 2011 generated from the CALMET data are presented in **Figure 3**. For comparison, the wind roses from the EPA monitoring station are presented in **Appendix A**. Additional analysis of the meteorological data used for this assessment is also presented in **Appendix A**.

It can be seen from **Figure 3** that, on an annual basis, the dominant wind direction is from the south, away from the nearest residential sensitive receivers located to the southeast of the site. A similar trend is also observed during each season. The average wind speed from the CALMET data was found to be 1.9 m/s, which represents a light wind speed. Seasonally, the average wind speed is similar for all seasons with the exception of summer which are slightly higher at 2.1 m/s.

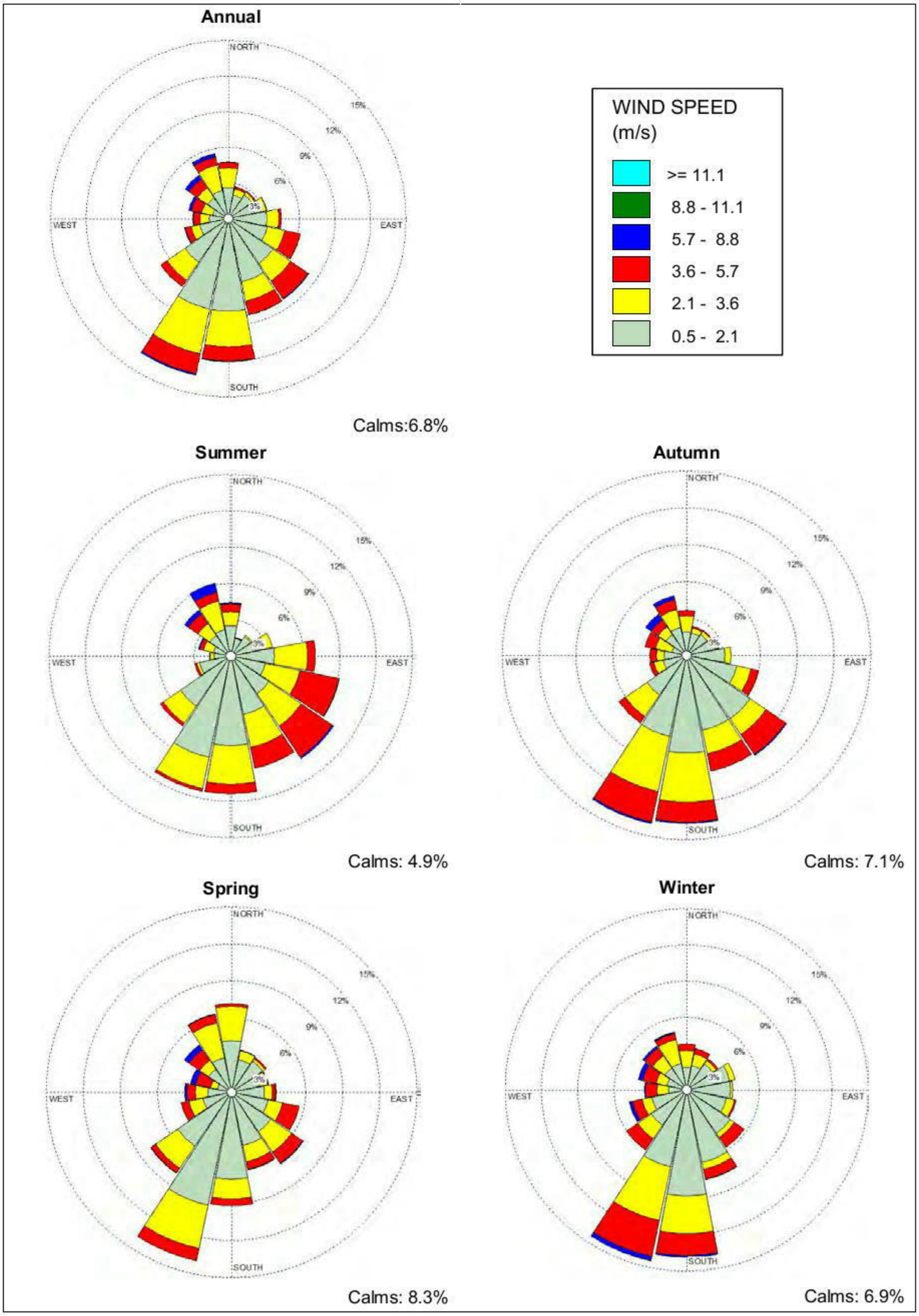

Figure 3 Annual and Seasonal Wind Rose for St Marys for 2011 generated by CALMET.

4.2 Local Climatic Conditions

The Bureau of Meteorology (BOM) operates a network of meteorological monitoring stations around the country. The closest station to the site is located at Penrith lakes, approximately 9 kilometres northwest of the facility. A summary of the long-term data recorded at this station between 1995 and 2012 is shown in **Table 5**.The data provide an indication of the regional climate of the area.

Table 5 Climate Summary, BOM Monitoring Station at Penrith, 1995 to2012

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Maximum temperature (°C)													
Mean maximum temperature	31	30	27	24	21	18	18	20	23	25	27	29	24
Highest temperature	46	45	41	34	28	26	27	30	36	39	43	42	46
Lowest maximum temperature	20	18	18	16	13	12	11	12	14	15	14	17	11
Minimum temperature (°C)													
Mean minimum temperature	18	19	17	13	9	7	6	6	9	12	15	17	12
Lowest temperature	11	12	8	4	2	-1	-1	-1	3	5	8	10	-1
Highest minimum temperature	24	26	23	20	18	15	13	14	18	21	23	25	26
Rainfall (mm)													
Mean rainfall	88	134	72	41	43	50	32	28	33	57	82	56	714
Highest rainfall	195	275	186	94	150	226	82	161	94	256	206	96	1013
Lowest rainfall	19	15	18	2	4	3	6	0	4	5	13	26	501
Highest daily rainfall	102	139	48	44	63	68	47	61	57	55	62	42	139
Mean number of days of rain	11	12	12	10	12	15	12	9	8	10	12	11	133
Average 9 am conditions													
Temperature (°C)	22	22	20	18	14	11	10	12	16	19	20	21	17
Relative humidity (%)	73	79	80	76	81	85	83	72	64	60	68	69	74
Wind speed (km/h)	9	9	8	8	7	8	7	9	11	11	10	9	9
Average 3 pm conditions													
Temperature (°C)	29	28	26	23	20	17	17	19	22	24	25	28	23
Relative humidity (%)	47	53	52	49	52	55	50	41	40	41	46	45	48
Wind speed (km/h)	16	14	14	13	12	13	14	17	18	18	17	16	15

As shown in **Table 5**, the warmest temperatures occur during the summer months, with the highest average maximum temperature (31 °C) occurring in January. July is the coldest month, with a recorded average minimum temperature of 6 °C. February is the wettest month, with an average rainfall of 134 millimetres, while the winter months, particularly August, are typically the driest. Humidity follows a diurnal cycle, with higher humidity in the morning compared to the afternoon. Wind speeds are higher in the afternoon compared to the morning, with the highest average wind speeds occurring in September (18 kilometres/hour).

4.3 Existing Air Quality

4.3.1 Odour

No existing odour complaint data for the site was available; however, the local air quality in the vicinity of the Site is expected to be typical of that experienced in any industrialised area. Of particular note are other manufacturing and waste businesses such as Nepean Rubber and Plastics, paint manufacturing, and waste storage located within the industrial estate and the St Marys sewage treatment plant located approximately 865m to the north of the site.

4.3.2 Dust

The EPA operates a number of air quality monitoring stations in northwest Sydney. The closest monitoring station sites to the proposed development are located at St Marys (6km south of the site). This station records hourly PM_{10} concentrations using a Tapered Element Oscillating Microbalance (TEOM). The maximum 24-hour concentration measured at St Marys in 2012 (the most recent year for which data are available) was 34 $\mu g/m^3$ which is below the EPA 24-hour maximum criterion of 50 $\mu g/m^3$ (EPA 2013b). The annual average PM_{10} concentration recorded at 14 $\mu g/m^3$ for 2012 which is just under half the EPA annual average criterion of 30 $\mu g/m^3$ (EPA 2013b).

No measurements of local $PM_{2.5}$ and TSP ambient air quality concentrations were available. In the absence of existing annual TSP concentration data, the annual PM_{10} concentration can be assumed to 40% of the annual TSP concentration; this is a conservative approach as data reported by the NSW Minerals Council (2000). This equates to an annual TSP concentration of 35 $\mu g/m^3$, which is below the NSW EPA criterion of 90 $\mu g/m^3$.

5.0 Assessment Methodology

5.1 Overview

Based on the requirements of the DGRs and the outcomes of the meeting held with the EPA on 30 January 2013 a quantitative assessment of odour impacts and qualitative assessment of dust impacts have been undertaken. The quantitative odour assessment was based on the computer dispersion model, CALPUFF and the modelling methodology for the odour assessment is described in **Section 5.0** with results of the assessment discussed in **Section 6.1**. A qualitative assessment of dust impacts associated with both construction and operation of the Proposal are presented in **Section 6.2**.

5.2 Dispersion Model

Assessment of odour impacts for the project utilised the TAPM, and CALMET meteorological processor and the CALPUFF dispersion model. A brief description of each model is provided below.

TAPM predicts three-dimensional meteorology, including terrain-induced circulations. TAPM is a PC-based interface that is connected to databases of terrain, vegetation and soil type, leaf area index, sea-surface temperature, and synoptic-scale meteorological analyses for various regions around the world. TAPM was used to predict local surface and upper air meteorological information required by the CALMET meteorological processor. Local wind speed and wind direction data from the EPA St Marys air quality and meteorological station was assimilated into the TAPM model to nudge the predicted metrological surface data towards the recorded observations.

CALMET is a meteorological model that develops hourly wind and temperature fields on a three-dimensional gridded modelling domain. Associated two-dimensional fields such as mixing height, surface characteristics and dispersion properties are also included in the file produced by CALMET. CALMET produces a meteorological file that is used within the CALPUFF model to predict the movement of air pollution.

CALPUFF is a non steady-state, three-dimensional Gaussian puff model developed for the US Environmental Protection Agency (USEPA) for use in situations where basic Gaussian plume models are not effective. These situations include areas where stagnation conditions occur, which are characterised by calm or very low wind speeds with variable wind direction. The CALPUFF modelling system (and associated CALMET program) has the ability to model spatially varying winds and turbulence fields that are important in complex terrain, long range transport and near calm conditions. As such, CALPUFF was selected as the appropriate dispersion model for this assessment.

A summary of the data and parameters used as part of the meteorological component of this study and the input parameters used in the CALPUFF dispersion modelling is shown in **Table 6**. A copy of the CALPUFF input files can be provided upon request.

Table 6 Summary of Meteorological and CALPUFF Input Parameters

Parameter	Input
TAPM (v4.0.4)	
Number of grids (Spacing)	5 (30 km, 10 km, 3 km, 1 km and 0.3km)
Number of grid points	30 x 30 x 25
Year of analysis	2011
Centre of analysis	-33°44.5', 150°46.0'
Meteorological data assimilation	Wind speed and wind direction data for 2011 from the NSW EPA St Marys air quality and meteorological monitoring station (MGA 56 (m) 293170, 6258083).
CALMET (v6.42)	
Meteorological grid domain	1 km x 1 km
Meteorological grid resolution	25 m
Surface meteorological stations	No on-site surface meteorological stations. Surface data, nudged with St Marys wind speed and wind direction data were generated using TAPM.
Upper air meteorological station	No upper air stations. The 3-dimensional meteorological output from TAPM was used as the initial guess wind-field for CALMET.
Terrain and land use data	Terrain data were generated from the NASA Shuttle Radar Topography data set. Land use data was determined from local satellite imagery
Simulation Length	8760 hours (365 days)
CALPUFF (v6.42)	
Modeling domain	0.5 km x 0.5 km
Modeling grid resolution	25 m
Number of sensitive receptors	8
Dispersion algorithm	PG (Rural, ISC curves) & MP Coeff. (urban)
Hours modeled	8760 hours (365 days)
Meteorological data period	1 January 2011 – 31 December 2011

CALPUFF requires information on local metrology, terrain effects, source characteristics and emission rates to determine the dispersion of air pollutants. A description of these inputs are provided in **Section 5.3**

5.3 Model Inputs

5.3.1 Modelling Scenarios

One modelling scenario for the purpose of assessing complex odour emissions from the proposed Project has been modelled for this assessment. All odour emissions were assumed to occur 24 hours per day as a conservative estimate.

5.3.2 Meteorology

The modelling was performed using information provided by the CALMET model (described in Section **4.1** and **Appendix A**). A summary of the data and parameters used as part of the meteorological component of this study is presented in Section **5.2**.

5.3.3 Terrain, Land Use and Sensitive Receptors

Terrain data were captured from NASA's Shuttle Radar Topography Mission (SRTM), which produces terrain information for the entire globe. For Australia, terrain data are available at approximately 90 m resolution (3-arc seconds). The terrain surrounding the facility is relatively flat displaying elevations between 19 and 39 metres. Ground level pollutant emissions were predicted over an area of 1km by 1km with gridded receptors located at 25m spacings.

Land use categories input into the CALMET model are assigned in accordance with the U.S Geological Survey Land Use and Land Classification System. Land use has data has been determined from local satellite imagery. **Figure 4** provides a visual representation of the land use data used in the meteorological modelling.

The site is located within an industrial estate and is surrounded by a number of industry types including steel, paint, timber, fencing, paint and stationary manufacture and waste recycling services. The nearest residential sensitive receivers are largely located east of Forrester Road approximately 865m south east of the site and are unlikely to be affected by odour emissions from the site. As such the focus of this assessment is made on the potential impacts to properties adjacent to the site boundary within the estate.

The locations of adjacent industrial buildings identified as sensitive receptors in this assessment are presented in **Table 7** and are also shown in **Figure 1**. Due to the limited residential sensitive receptors within close proximity to the facility, sensitive receptors included in this assessment have been limited to industries located along the site boundary.

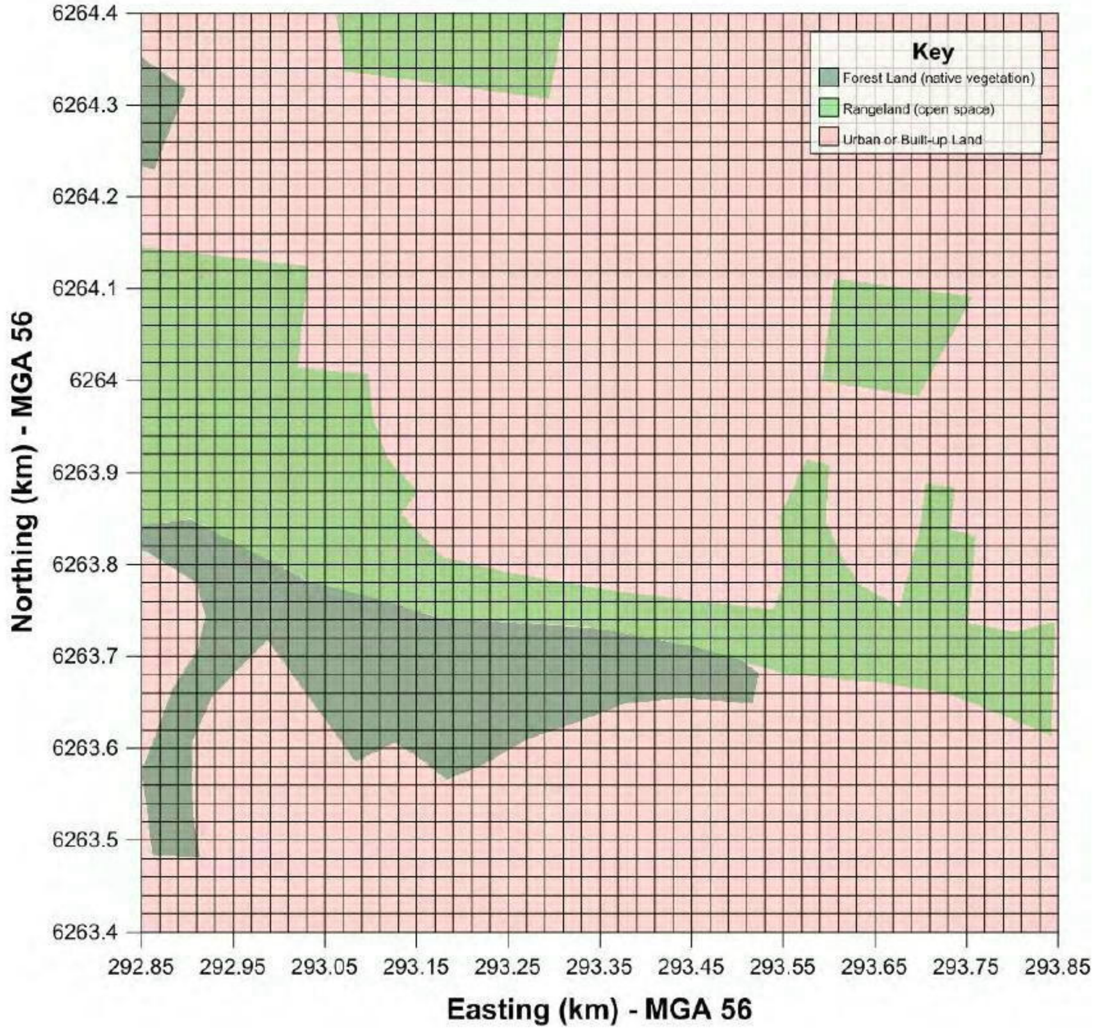

Figure 4 Land Use Categories

Table 7 Location of Sensitive Receptors

ID	MGA 55 Coordinates (m)		Base Elevation (m)
	Easting	Northing	
1	293355	6264011	29
2	293440	6264003	29
3	293549	6263957	29
4	293478	6263873	28
5	293417	6263881	28
6	293334	6263904	29
7	293269	6263978	28
8	293264	6263912	28

5.3.4 Emissions Rates

Odour Sampling

Odour emission monitoring was conducted by AECOM at the Worth Recycling South Windsor site located on the Cornet of Blackman Crescent and Fairy Road during March 2013. Odour emissions at the South Windsor site would be representative of the odour emissions from solid and liquid wastes to be stored at the St Marys site. Monitoring was conducted at 6 locations, which were chosen in order to encompass the potential odour sources at the St Marys facility, and to provide data which would assist in the preparation of this assessment. Odour source locations, the number of locations per source (i.e. the number of different physical locations on the same type of source) and the total number of samples taken are provided in **Table 8**. The number of locations and samples were chosen based on the homogeneity of the sources and the likely odour impact the sources may have.

Waste streams are intermittent on site and at the time of sampling of restricted soils, oil filters were present on site for odour sampling. It also should be noted that the South Windsor site does not store or treat ASS onsite and no longer stores and treats refinery sludge and as such no odour sampling has been undertaken for these sources. As discussed in in the Odour Emissions Inventory section of this report sampled waste streams have been assumed to occupy all storage pits and bunkers within the existing warehouses. Of these sources the largest contributor of odour emissions was found to be from grease oils (refer to **Table 10**).

Table 8 Sample Locations and Number of Samples Collected

Source	Number of Locations	Number of Samples
Stormwater Pit	1	2
Drill Muds	2	3
General Soil	2	2
Hazardous Soils	1	2
Grease Oil Pit (solids)	1	2
Grease Oil Pit (liquids)	1	1

The odour samples were collected in accordance with Australian Standard (AS) 4323.4; 2009 and AS 4323.3; 2001. AS 4323.4; 2009 specifies a method for the determination of atmospheric contaminant emission rates from area sources using a flux chamber (EPA Approved Method OM-8). The monitoring consisted of the collection of two samples per source location as recommended in AS 4323.3; 2001. One equipment blank and one duplicate sample was collected per sampling day for quality assurance and control purposes.

The odour samples were analysed by a NATA-certified olfactometry laboratory in accordance with AS 4323.3; 2001. The standard specifies a method for the measurement of odour concentration using dynamic olfactometry with a panel of human assessors. A copy of the odour sampling results is included in **Appendix B**

Odour Emissions Inventory

As discussed above, receipt of various waste streams at the facility would be variable from day to day and assessment of odour impacts from the site have been based on available waste stream samples taken during the sampling period in March 2013 from the South Windsor site. Waste streams in Area 1 ultimately include soils (hazardous, restricted and general), grease and refinery sludge and contain a number of storage areas including an immobilisation pit and four bunkers. Based on the available sample data waste the following source locations have been assigned as described in **Table 9**. **Table 9** also shows the source location of drill mud and stormwater and canal dredging waste streams.

For the purpose of this assessment all modelled waste streams have been assumed to be contained within the existing warehouses (Area 1, Area 2 and Area 3). All treated waste stored within the proposed western boundary bunkers on site and within Area 4 for the case of cake (treated waste from drill muds) is assumed to have negligible odour emissions and has been excluded from the assessment.

The odour emission data and total source areas assumed in the dispersion model for the proposed operations are shown in **Table 10**. For the purpose of comparing model results with the odour assessment criterion, the emission rates in **Table 10** were multiplied by peak to mean ratios. The peak to mean ratios for the near-field were applied for the purpose of this assessment. All sources have been modelled as area sources; peak to mean factors for area sources have numerical values of 2.5 for unstable and neutral atmospheric conditions and 2.3 for stable conditions.

It should be noted that area sources within Area 1 would be semi enclosed (with building openings on the eastern and western side of the warehouse) and area sources within Area 2 and 3 would also be largely enclosed within the existing warehouses. Modelling of area sources does not account for the enclosed nature of the proposed sources within the warehouses which would largely contain odour emissions onsite. Thus modelled odour concentrations are likely to over predict offsite odour impacts and therefore the results of this modelling are considered to be conservative.

Furthermore, all odour emissions were assumed to occur 24 hours per day as a conservative estimate.

Table 9 Location of Odour Sources

Area		Source
Area 1	Pit	Hazardous soils
	Bunker 1	Hazardous soils
	Bunker 2	General soils
	Bunker 3	Grease (solids)
	Bunker 4	Grease (liquids)
Area 2	Pit	Stormwater and Canal dredgings
Area 3	Pits (x2)	Drill Muds

Table 10 Surface and Total Odour Emission Rates from Area Sources

Source	CALPUFF ID(s)	Odour Concentration (OU/m^3)	Area (m^2)	SOER	SOER (A, B, C & D)	SOER (E & F)	TOER (A, B, C & D)	TOER (E & F)
Stormwater Pit	Area2	216.0	90	0.132	2.5	2.3	30	27
Drill Muds	Area3	158.7	128	0.096	2.5	2.3	31	28
General Soil	Area1C	554.0	75	0.333	2.5	2.3	62	57
Hazardous Soils	Area1A Area1B	876.0	100	0.530	2.5	2.3	133	122
Grease Oil Pit (solids)	Area1D	5459.0	75	3.350	2.5	2.3	628	578
Grease Oil Pit (liquids)	Area1E	2424.0	75	1.488	2.5	2.3	279	257

SOER = Surface Odour Emission Rate (OU.m/s). SOER was calculated using the average OU concentration of monitoring results conducted during March 2013.
TOER = Total Odour Emission Rate (OU.m^3/s)

Assumptions:

1) All area sources are contained within the site warehouse of 8m in height. The initial sigma z for each source is assumed to be equal to the building height.
2) Pitt area for the storm water and dredgings odour source has been estimated at approximately 80 per cent of Area 2.
3) Source area for drill muds is based on two pits located in Area 3 of 64m^2 each.

6.0 Impact Assessment

6.1 Odour Impacts

Results of the odour modelling are shown in **Figure 5** and **Table 11.** The following points should be noted when reviewing the results:

- Modelling of area sources does not account for the enclosed nature of each source within warehouses which would largely contain odour emissions onsite. Thus modelled odour concentrations are likely to over predict offsite odour impacts.
- The model scenario assumes the facility is operating with average odour emissions for each individual source obtained from sample data collected during March 2013 at the South Windsor Waste Management Facility.

Results of the modelling indicate that the maximum 1-hour (99th percentile) 3 OU criterion contour extends outside the site boundary for the proposed expansion scenario. A contour plot for the predicted maximum 1-hour (99th percentile) odour concentration for the proposed scenario is presented in **Figure 5**. The plume is orientated in a northerly direction, dictated by the dominant southerly winds as described in Section **4.1**.

Table 11 shows the model predictions at the nearest sensitive receptors (nearby industrial buildings). It can be seen that all sensitive receptor locations are predicted to experience odour levels below the 3 OU criterion for the proposed facility based on the locations provided in **Table 7**. The model predictions show that sensitive receivers to the north would experience the highest odour concentrations with a concentration of 1.6 and 2.6 OU (99th percentile) predicted at sensitive receptors 1 and 2 respectively.

Given the partially enclosed nature of the odour emission sources and predicted concentrations at nearby sensitive receptors the modelling suggests that the proposed operations are unlikely to cause adverse odour impacts beyond the site boundary.

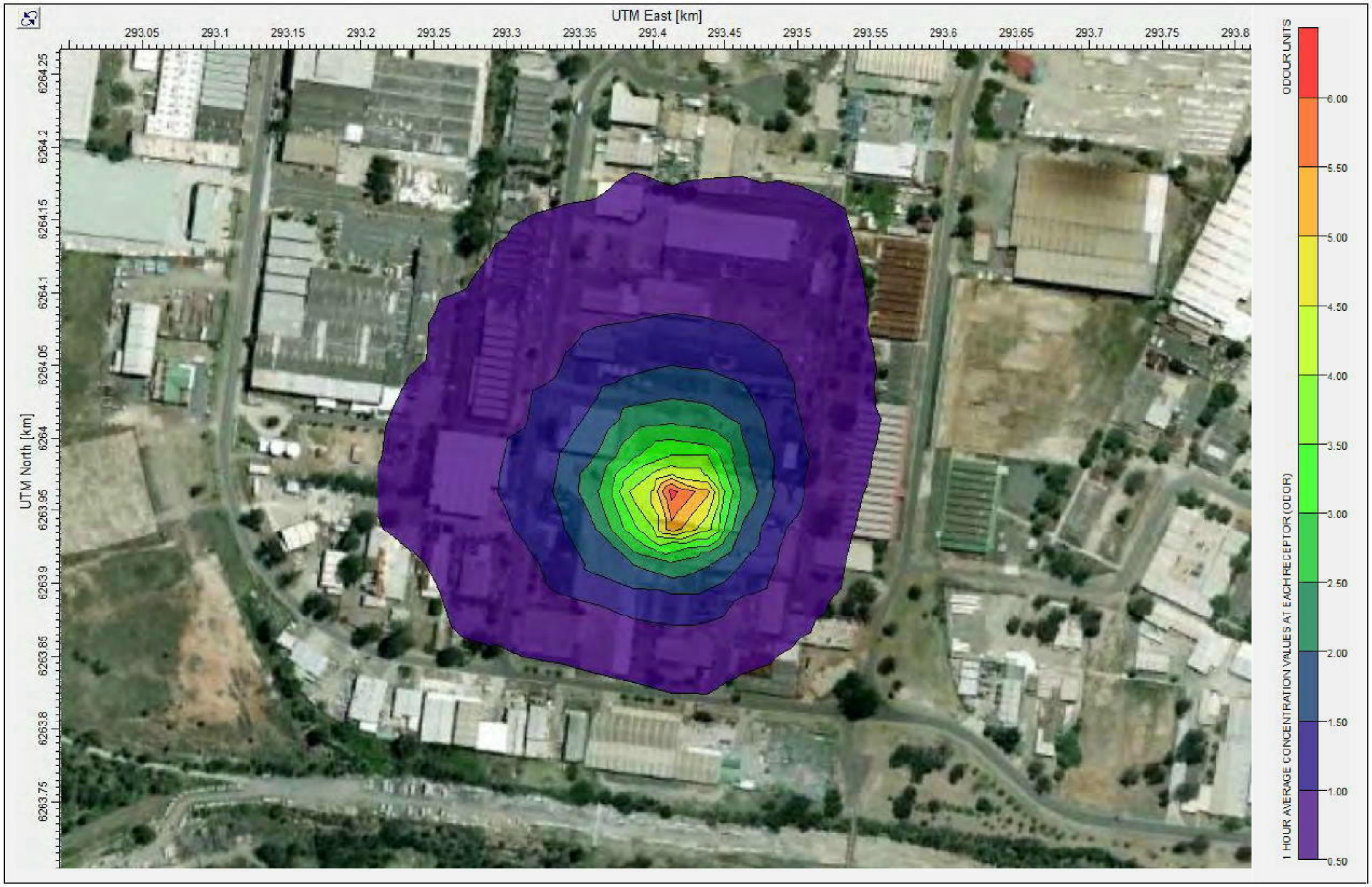

Figure 5 **Predicted Odour Concentrations (99th percentile) at St Marys Facility (OU)**

Table 11 Predicted Maximum 1-Hour Ground Level Odour Concentrations (99[th] percentile)

Sensitive Receptor	Maximum 1-hour Odour Concentration (99[th] Percentile) (OU)
1	1.6
2	2.6
3	0.5
4	0.7
5	1.2
6	1.1
7	0.6
8	0.8
Criterion	**3.0**

6.2 Dust Impacts

This section of the report provides a qualitative assessment of dust impacts associated with the construction and operation of the proposed St Marys Waste Management expansion project.

6.2.1 Construction Impacts

During construction there is the potential for particulate matter emissions to be generated during earthworks, required for the project. Fugitive dust sources present during construction of the Proposal would include earthmoving activities from the excavation and construction of pits for waste storage, construction of a catch drain, cleared groundcover and topsoil and stockpiling of spoil and construction materials.

Dust emissions from soil piles would depend on a number of factors including the moisture content and soil texture. Particulate matter emissions from general construction activities depend on site characteristics, the moisture content of the disturbed soil and the particular type of activities being carried out.

The impact of fugitive dust sources are generally related to the quantity and drift potential of the dust particles. Larger particles generally settle near the source, whereas finer particles (PM_{10} particles) can be dispersed over greater distances from the source. The closest residential receivers lie approximately 865m south east of the site and thus dust impacts from construction are unlikely to affect nearby residences. However, there is potential for construction dust from the proposed Development to impact the local air quality of the Dunheved industrial precinct. The site would continue to, manage dust generated onsite during the construction phase by standard dust mitigation techniques; use of the existing on-site sweeper and truck wash facility onsite to minimise the spread of construction dust generated.

6.2.2 Operational Impacts

Potential dust impacts during operational activities onsite would largely arise from the tracking of dirt onto hardstand areas and subsequent disturbance by heavy and/or light vehicle movements within the site. Waste streams onsite including drill muds and soil would be maintained with some level of moisture, minimising potential dust impacts. Waste streams would also be stored within the warehouses or within external bunkers south of Area 1 and along the western boundary. The external bunkers would be provided with canvas roofing mounted on a retractable frame to mitigate against potential dust impacts. The existing truck wash near Area 6 will continue to be used to remove dust and dirt from vehicles prior to their leaving the site.

7.0 Recommended Air Quality Management and Mitigation

7.1 Odour

Taking into account both the relatively enclosed nature of the odour emission sources and the modelling results presented in **Section 6.1** suggest that the proposed expansion of the St Marys Facility, operating under typical conditions would not have a significant impact beyond the immediate location of the odour sources. As such no mitigation measures would be required.

In the event however that frequent increase in odours at adjoining industrial premises is observed, Worth may consider the introduction of odour controls, which due to the variable nature of the site feedstock, would need to be selected on a case by case basis.

Assessment of odour impacts at the St Marys site has been limited to the odour emission sources currently present under standard operating conditions at Worth's South Windsor Waste Management site. The South Windsor site at the time of testing was not treating refinery sludge onsite which would be considered an additional odour source to be held with the available waste holding sites within the existing warehouse. Conservatively currently present waste streams at the South Windsor site have been assumed to occupy all pit and bunker waste holding sites at the St Marys site.

7.2 Dust

Appropriate dust management measures would be implemented throughout the duration of the construction activities including:

- Continued use of the site street sweeper during construction activities;
- Watering of exposed soils when necessary;
- Water sprays for dust generating excavation activities;
- Covering of trucks removing spoil; and
- Dust producing activities should be avoided or minimised, wherever practical, during wind conditions.

Potential dust impacts from proposed operations were not considered a key issue due to the high moisture content of waste materials handled onsite and the majority of the treatment operations at the site undertaken undercover in partially enclosed areas. The site does, and would continue to, mitigate dust by using a street sweeper during operation to minimise the spread of construction dust generated. Other proposed operation mitigation measures include:

- Ensure soils maintain a high moisture content pre and post treatment to minimise dust impacts and water exposed soils where necessary;
- Dust producing activities undertaken outside the warehouse should be avoided or minimise, wherever practical, during wind conditions.

8.0 Conclusion

This report assessed the air quality impacts associated with proposed expansion of waste management operations at the St Marys Waste Management Facility. The purpose of this report was to address the air quality impacts of the project with regards to offsite odour and dust impacts in accordance with the DGRs. As advised by the EPA in January the assessment of potential odour impacts from the site were the key focus of the air quality impact assessment.

8.1 Odour

The CALPUFF dispersion modelling was used to predict off-site odour concentrations due to waste processing and treatment activities associated with the facility. The dispersion modelling took account of local meteorology and terrain information and used odour monitoring f to predict the odour impacts for proposed operating conditions of the proposed waste management facility expansion project. Dispersion modelling was undertaken in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC, 2005)* and pollutant concentrations were assessed against the NSW EPA criteria outlined in the Approved Methods.

Odour emission sources have been modelled as area sources contained within two partially enclosed warehouses on the site. The dispersion model does not account for the enclosed nature of each source within warehouses which would largely contain odour emissions onsite; thus the reported results are likely to over predict offsite odour impacts. Results of the modelling indicate that the OU concentration at nearby sensitive receptor locations falls below the 1-hour 3 OU (99^{th} percentile) EPA criterion, however the maximum 1-hour (99th percentile) 3 OU criterion contour slightly extends outside the northern site boundary for the proposed expansion scenario.

Given the partially enclosed nature of the odour emission sources and predicted concentrations at nearby sensitive receptors the modelling suggests that the proposed operations are unlikely to cause adverse odour impacts beyond the site boundary. As such no mitigation measures would be required.

Assessment of odour impacts at the St Marys site has been limited to the odour emission sources currently present under standard operating conditions at Worth's South Windsor Waste Management site. The South Windsor site at the time of testing was not treating refinery sludge onsite which would be considered an additional odour source to be held with the available waste holding sites within the existing warehouse. Conservatively currently present waste streams at the South Windsor site have been assumed to occupy all pit and bunker waste holding sites at the St Marys site.

8.2 Dust

This report provided a qualitative assessment of potential dust impacts associated with the proposed expansion of the St Marys Waste Management Facility.

During construction there is the potential for particulate matter emissions to be generated during earthmoving activities from the excavation and construction of pits for waste storage, construction of a catch drain, cleared groundcover and topsoil and stockpiling of spoil and construction materials. Potential impacts would be limited to surrounding industrial properties as no residential properties lie within close proximity to the site.

Potential dust impacts during operational activities onsite would largely arise from the tracking of dirt onto hardstand areas and subsequent disturbance by heavy and/or light vehicle movements within the site. Potential dust impacts from proposed operations were not considered a key issue due to the high moisture content of waste materials handled onsite and the majority of the treatment operations at the site undertaken undercover in partially enclosed areas.

Provided suitable mitigation measures described in this report are implemented during project construction and operation, no impacts on local air quality due to dust emissions during the operational phase are anticipated.

9.0 References

BoM (2012) *Climate Statistics for Australia Locations: Monthly climate statistics for St Marys*, Australian Government Bureau of Meteorology. http://www.bom.gov.au

DEC (2005) *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales*. Department of Environment and Conservation: Sydney, Australia

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