D5

Appendix D5

South West Rocks STP

BUFFER ZONE ODOUR IMPACT ASSESSMENT

- Final
- 11 July 2008

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Sinclair Knight Merz
ABN 37 001 024 095
100 Christie Street
PO Box 164
St Leonards NSW
Australia 1590
Tel: +61 2 9928 2100
Fax: +61 2 9928 2500
Web: www.skmconsulting.com

Contents

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1. Introduction

1.1 Background

Kempsey Shire Council (Council) operates the South West Rocks Sewerage Treatment Plant (STP) at South West Rocks. Council is making an application to the Department of Planning (DoP) to rezone the land surrounding the STP to enable development within the existing STP buffer zone.

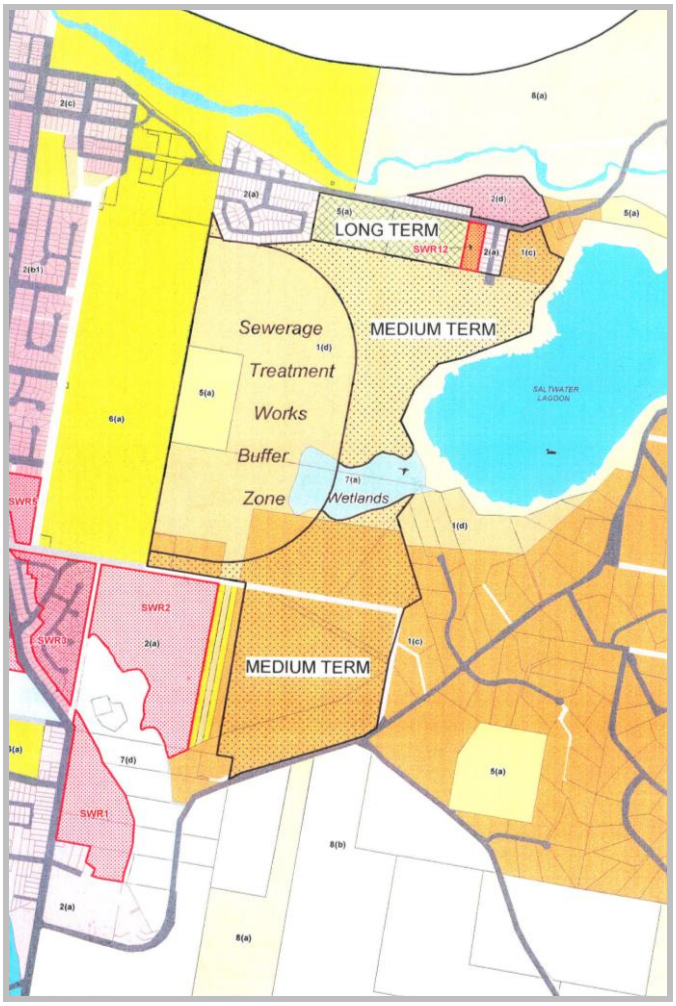
The NSW Department of Planning issued a circular in 1989 that recommended minimum buffer zones of 400 m around STPs (DUAP, 1989), but allows for individual evaluation of zone sizing based on local conditions. In order to assist local councils to conduct these individual assessments, the Water Directorate developed complementary guidelines to assess the risks associated with permitting developments within the buffer zones (Water Directorate, 2006). Application of the Water Directorate guidelines represents a preliminary assessment, which should be followed up by further investigation if the proposed development is found to be potentially compatible with the requirements of an STP buffer zone.

SKM conducted an initial odour modelling assessment in 2005 which found that the buffer zone land was potentially usable (SKM, 2005). This finding was supported by an independent assessment conducted by HLA-Envirosciences (HLA, 2007). Both assessments indicated the need for further work to justify the use of the buffer land for development.

Council commissioned SKM to assess the size of the buffer zone required around the STP for the existing and proposed future expansion of the STP. This report summarises the buffer zone assessment conducted by SKM, and reports on further investigations by SKM to assess whether the proposed future expansion of the plant is likely to result in significant odour impacts to any receptors within the existing buffer zone area. Odour measurements were taken from sources within the existing STP and used in dispersion modelling performed using the AUSPLUME v 6.0 model, together with data obtained from Sydney Water Corporation's (SWCs) odour database. Modelling was performed in accordance with guidelines developed by the NSW Department of Environment and Climate Change (DECC) (DEC, 2005; 2006).

1.2 STP Site Location

The STP is located on Belle O'Connor Street in South West Rocks in the Kempsey Local Government Area. The area outside the existing buffer zone comprises low density residential development to the north, a golf course to the west, and undeveloped areas to the east and south. South West Rocks contains minor areas of commercial and industrial development, national parks and reserves located on relatively flat coastal and riverine plains. The study area is shown on **Figure 1-1**, indicated as the Sewerage Treatment Works Buffer Zone.

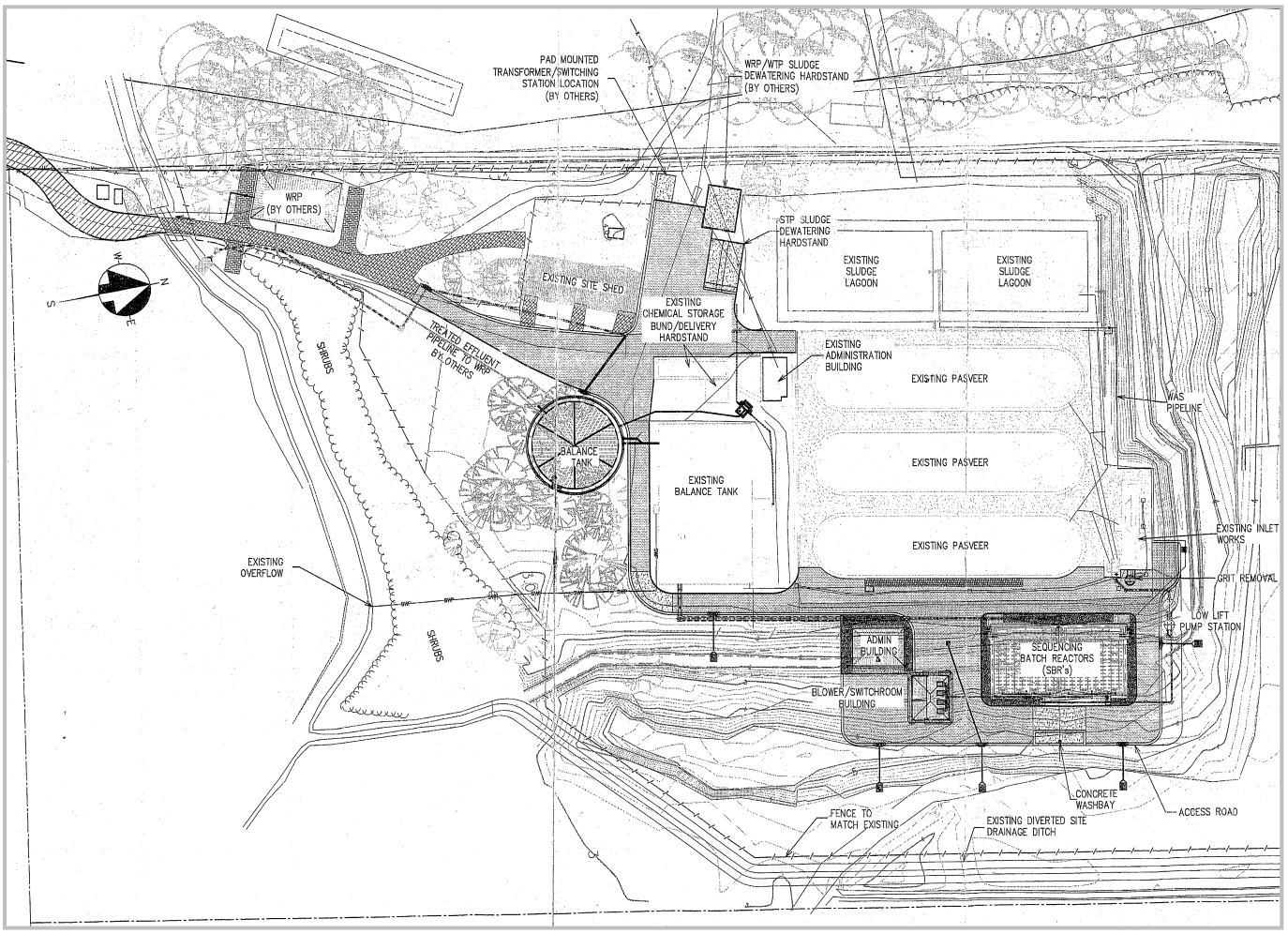


- **Figure 1-1 - Study Area**

1.3 Existing and Proposed STP Layouts

The STP is a secondary wastewater treatment plant consisting of inlet works, Pasveer Channels that serve as activated sludge reactors, sludge lagoons and holding ponds. The existing nominal capacity of the STP is 6,000 EP.

Council intends to upgrade the plant by installing 2x Sequential Batch Reactors (SBRs) that will increase the capacity of the STP to 12,000 EP. This proposed capacity is designed to accommodate future increases in the local population (the ultimate equivalent population) and the influx of tourists to the area that occurs in the summer months. The layout of the existing STP (including the proposed SBR) is shown in **Figure 1-2**.



- **Figure 1-2 - STP Layout**

1.4 Consultation

In preparing this assessment, the following organisations have been consulted:

- Kempsey Shire Council;
- Macleay Water;
- DoP /DECC; and
- Sydney Water Corporation (SWC) – for access and permission to their odour database.

2. STP Buffer Zone Use Planning Guidelines

The Department of Urban Affairs and Planning (now the Department of Planning) issued a circular to Councils outlining general policy guidelines for buffer areas surrounding STPs (DUAP, 1989). The guidelines state that buffer zones should, ideally, be at least 400 m wide, but that the actual size may vary to suit the local conditions. The widest buffer areas should be established in the direction of the most likely air flows.

A complementary set of guidelines (the Guidelines) were issued to local Councils by the Water Directorate (2006) that provide additional guidance in determining alternate buffer zone sizes based on local conditions. The Guidelines provide a structured approach for assessing and determining appropriate land uses within the 400 m buffer zone based on a risk-assessment methodology.

It is important to note that the Guidelines do not supersede the Government circular, nor do they replace the DECC guidelines relating to odour and air quality management and assessment practices (DEC 2005, 2006). Rather, they provide a methodology for preliminary assessment of land use suitability within STP buffer zones. Where buffer zone land is considered to be 'likely' or 'potentially' usable following the application of the methodology outlined in the Guidelines, additional work is required to support any modifications to the buffer zone, such as through odour dispersion modelling.

The Guidelines indicate that off-site impacts of STPs can occur in any of the following areas:

- Odour, depending on the offensiveness of the odour, the duration and frequency of exposure, and the tolerance and expectations of the receptor;
- Aerosols, generated from unit processes involving open agitation or aeration of the wastewater;
- Noise and vibration, depending on time of exposure, offensiveness, frequency and level;
- Soil and groundwater contamination by chemicals or raw/partially treated sewage;
- Visual impact, depending on surrounding land uses and perceived beauty of the area; and
- Lighting, which can affect the sleep cycles of people in nearby residential areas.

A preliminary application of the Guidelines to the South West Rocks STP based on odour emissions are summarised below.

2.1 Risk Analysis

The following assessments have been made:

1) Determination of the Impact Sensitivity Value – The sensitivity of each land use was quantified on a scale of 1 to 5, where 1 represented negligible sensitivity and 5 indicated extreme sensitivity. The Guidelines assign the highest odour sensitivity (4-5) to residential land use. For South-West Rocks STP, the proposed land use is residential, with a golf course and park land also in the area. A value of 4 was, therefore, assumed for this assessment.
2) Determination of the Impact Potential Value – The likelihood of off-site impacts was quantified on a scale of 1 (lowest impact potential) to 5 (highest impact potential). The Guidelines provide different values for different processes and sizes of STP. The Impact Potential for South West Rocks STP was determined by averaging the impact potential for the five main STP processes [4 for the sludge lagoons and clarifier (biological); 4 for the Pasveer channels (aerobic); and 5 for the inlet works and mobile belt press (mechanical)] to provide an Impact Potential of 4.4.
3) Determination of the Overall Mitigation Factor Value – The effectiveness of odour mitigation measures were assigned a mitigation factor between 0 (total elimination of risk) and 1(no reduction in impact). Mitigation measures include measures such as process design, chemical addition, maintenance and operating procedures, scrubbers and chemical sprays. For the South West Rocks STP, SKM allocated the following mitigation factors: 0.5 for the sludge lagoons and Pasveer channels; 0.1 for the clarifier and inlet works; and 0.9 for the mobile belt press. The Guidelines indicate that the overall mitigation factor should be determined by multiplying the different mitigation factors together. For this assessment, however, it was assumed that multiplication of the mitigation factors was only appropriate where the mitigation measures were applied to a single process. As the mitigation measures at the South West Rocks STP apply to different processes, the overall mitigation factor was determined by averaging the individual mitigation factors, resulting in a value of 0.42.
4) Determination of the Altered Impact Potential Value - The Altered Impact Potential (1.8) was calculated by multiplying the Impact Potential (4.4) by the Overall Mitigation Factor (0.42).
5) Plotting of results on the Risk Matrix – the Impact Sensitivity (4) and Altered Impact Potential (rounded up) values were then plotted on the Risk Matrix provided by the Guidelines as shown in **Table 2-1** .

- **Table 2-1: Risk Matrix**

		Altered Impact Potential				
		1	2	3	4	5
Impact Sensitivity	1					
	2					
	3					
	4		SWR STP			
	5					

	400m buffer likely to be useable – further work recommended to justify this
	400m buffer potentially usable – additional work required to justify its use
	400m buffer unlikely to be usable

As shown in the above table, the South West Rocks buffer zone was found to be potentially usable, with additional work required to justify its use.

3. Summary of Previous Assessments

As indicated in **Section 2**, the development of land within the South West Rocks buffer zone may be feasible if further assessment can demonstrate that such development will not be significantly affected by odour from the STP.

A number of studies have investigated odour emissions from the STP, including:

- Peter A. Jelliffe, Environmental Engineering and Planning Consultants (Jelliffe): Buffer Zone Assessment South West Rocks STP For the Proposed Subdivision Development South West Rocks (January, 1997);
- Holmes Air Sciences (HAS): Air Quality Assessment – Establishment of a Suitable Buffer Zone for South West Rocks STP (May, 1998);
- Sinclair Knight Merz (SKM): South West Rocks STP – Odour and Noise Assessment (June, 2004);
- Sinclair Knight Merz (SKM): South West Rocks STP – Odour and Noise Assessment (November 2005); and
- HLA-Envirosciences (HLA): Odour and Noise Impact Assessment – South West Rocks Sewage Treatment Plant (May, 2007).

While the above reports also considered noise impacts, only odour is considered in this assessment. Furthermore, the Jelliffe (1997) and Holmes Air Sciences (1998) assessments were based on odour criteria that have since been superseded, and are not discussed further.

Details of the SKM and HLA assessments are summarised in **Table 3-1**. None of the assessments measured odour emissions from the existing plant; the SKM reports used odour emissions derived from existing data from other STPs under normal STP operating conditions. All three assessments used 2 OU/m^3 as the criterion for acceptable odour concentration. The maximum size of buffer zone (extent of odour impacts) found to be required under these assessments was 250 m.

Table 3-1: Summary of Previous Assessments

Assessment	Meteorology	Existing Sources*	Future Sources	Extent of Odour Impacts
SKM, 2004	Coffs Harbour met station data and TAPM, Jan – Dec 2002	▪ Inlet works ▪ 3 x Pasveer channels ▪ 2 x sludge lagoons ▪ Mobile belt press	▪ Pasveer channel ▪ 2 x sludge lagoons ▪ 2 x clarifiers	250 m
SKM, 2005	TAPM data for July – Sep 2005, nudged with observational data from the on-site weather station	As above	As above	150 m
HLA, 2007	TAPM, Jan – Dec 2006	▪ Inlet works ▪ 3 x Pasveer channels ▪ 2 x sludge lagoons ▪ Mobile belt press	▪ 2 x sequential batch reactors (one anoxic, one aerobic) ▪ 2 x balance ponds	150 m
* NB: HLA report modelled only the future scenario; existing sources used in previous studies are provided here for comparative purposes.				

4. Buffer Zone Odour Impact Assessment

4.1 Odour Criteria

The DECC regulates air quality in NSW, and has set odour criteria objectives for odour-producing activities such as STPs that are intended to minimise the adverse effects of odours on sensitive receptors. Under the Protection of the Environment Operations Act (1997), the South West Rocks STP is not permitted to emit any offensive odour beyond the premises (buffer zone) boundary. An offensive odour is defined as one:

> *that, by reason of its strength, nature, duration, character, or quality, or the time at which it is emitted, or any other circumstances:*
>
> *(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or*
>
> *(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted.*

Odour perception is very subjective and differs between individuals. The DECC assessment criteria were designed to take into account the range of odour sensitivities within a community, and are based on population density as shown in **Table 4-1**.

Table 4-1 Recommended Odour Performance Criteria (complex mixtures of odorous air pollutants)

Size of Affected Community	Odour Performance Criteria # (OU)
Urban (Population ≥ ~ 2000)	2.0
Population ~ 500	3.0
Population ~ 125	4.0
Population ~ 30	5.0
Population ~ 10	6.0
Single Residence (≤ ~2)	7.0

nose-response time average, 99th percentile

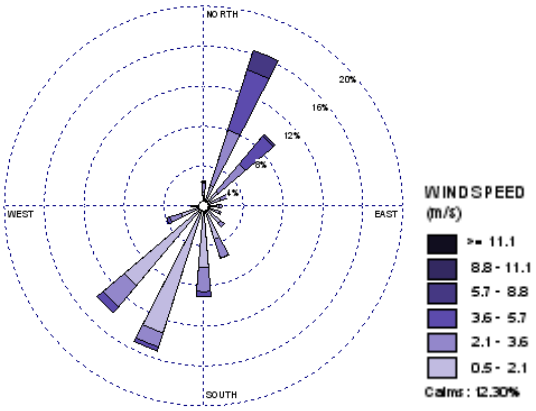
The urban odour performance criterion of 2 OU is typically used for odour impact assessments in residential areas, and was adopted for this assessment.

4.2 Existing Air Quality

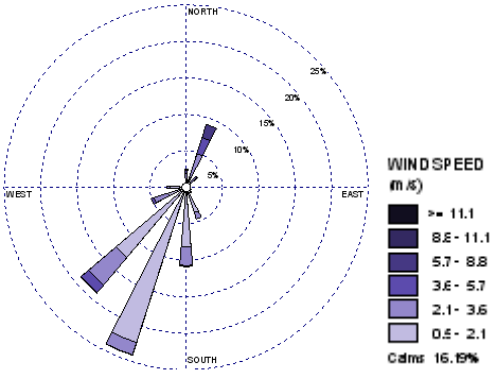
There are few sources of air pollution in the South West Rocks area. There are no major industries in the general vicinity of the site, and the STP is the primary potential source of odour in the area.

4.3 Dispersion Meteorology

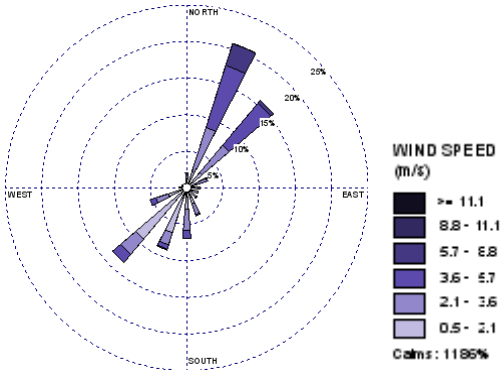
Data collected from the on-site meteorological station are summarised in **Figure 4-1**.



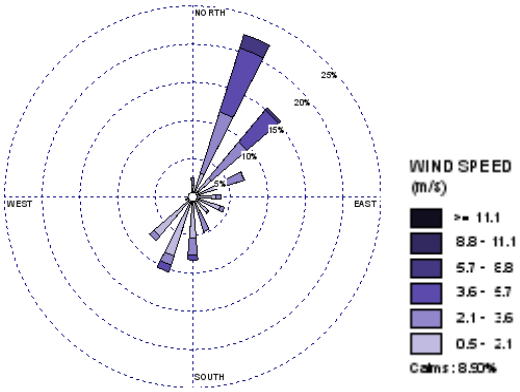
Annual Wind Rose: July 2005 – June 2006



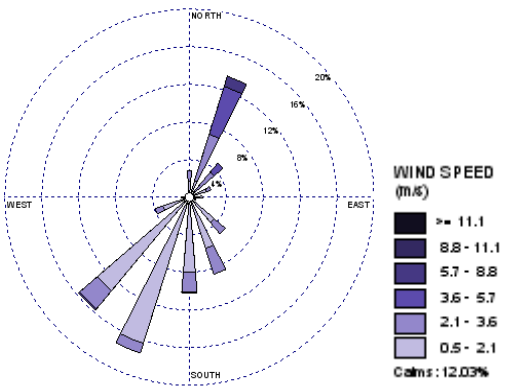
Winter (June – August)



Spring (September – November)



Summer (December – February)

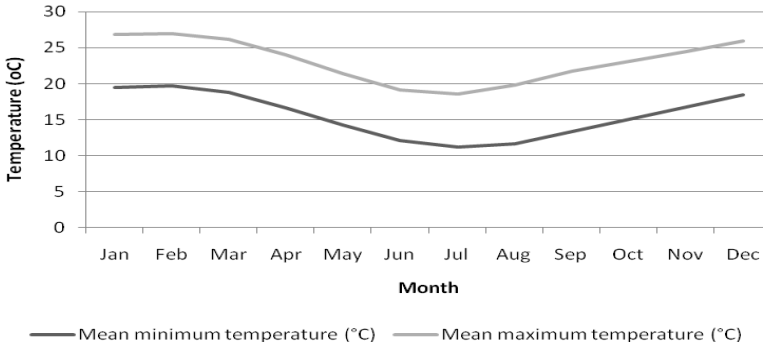


Autumn (March – May)

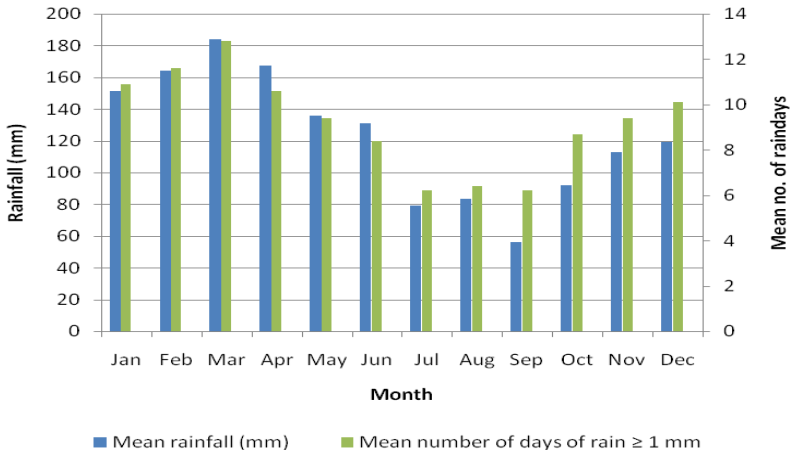
Figure 4-1: Wind Roses: July 2005 – June 2006 (blowing from)

Winds at the site predominantly blow along the northeast-southeast axis throughout the year, with faster winds blowing from the northeast. Winds in spring and autumn blow both ways; winds in winter blow predominantly from the southwest, reversing in summer to blow mainly from the northeast. More calm periods occur in winter than the other months. The least number of calm periods were measured in summer, which also had the highest wind speeds.

The closest weather station operated by the Bureau of Meteorology is located at Smoky Cape Lighthouse. Climate averages from this weather station (http://www.bom.gov.au; accessed 5 June 2008) are considered to be indicative of conditions at the STP. Temperature and rainfall data from this weather station are shown in **Figures 4-2** and **4-3**. Average minimum temperatures range from around 19 ^{o}C in summer to 11 ^{o}C in winter, while average maximum temperatures vary from approximately 27 ^{o}C (summer) to 18 ^{o}C (winter). The most rain falls between January and April, with March having the highest average rainfall and number of rain days.



- **Figure 4-2: Temperature Variation at South West Rocks, 1939 - 2008**



- **Figure 4-3: Rainfall at South West Rocks, 1939 – 2008**

4.4 Assessment Methodology including Odour Emissions Data

The DECC guidelines (2005, 2006) provide for a range of levels of assessment. The most accurate assessments are performed using site-specific input data, and are referred to as Level 2 assessments when they pertain to air pollutants (DEC, 2005) or Level 3 assessments when referring to odours (DEC, 2006). Site-specific assessments require reporting of the nose response time (1 second) 99th percentile of dispersion model predictions. Model predictions were compared to the DECC criterion for complex odours (2 OU).

4.4.1 Dispersion Model

The AUSPLUME v6.0 model was used to predict odour concentrations within the South West Rocks STP buffer zone. AUSPLUME was developed by the Victorian EPA, and is the preferred model for conducting site-specific odour impact assessments in Australia (DEC, 2006).

Inputs required by the AUPLUME model include:

- Emission sources;
- Emission rates;
- Topographical data;
- Locations of sensitive receptors; and
- Meteorological conditions.

4.4.2 Odour Sources

The odour sources investigated in this assessment were the:

- Inlet works (IW);
- Pasveer channels (PS1, PS2 and PS3);
- Sludge lagoons (SL1 and SL2);
- Mobile belt press (MBP); and
- 2 x Sequential batch reactors (SBRs).

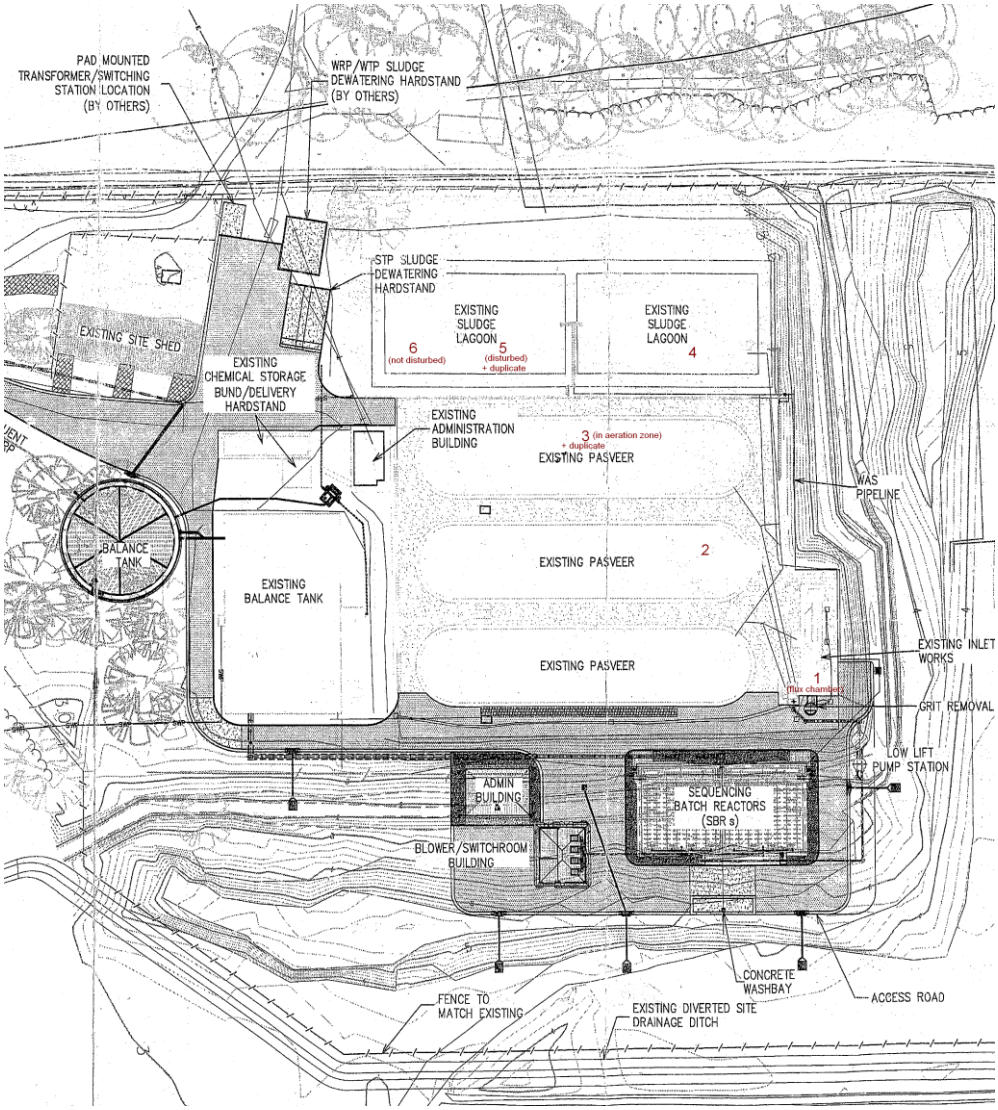
4.4.3 Odour Sampling

Odour sampling was conducted by Stephenson Environmental Management Australia on 22 May 2008. Sampling was conducted at the following locations (refer to **Figure 4-4**):

- Inlet works;
- Pasveer channel 2;

- Pasveer channel 3 (in aeration zone, plus a duplicate);
- Sludge lagoon – south (SL1) [one sample taken in undisturbed conditions, and two samples (one duplicate) taken under disturbed conditions]; and
- Sludge lagoon – north (SL2).

Samples were collected in accordance with AS4323.3 using an equilibrium flux hood, and analysed by Odour Research Laboratories Australia, a NATA-accredited laboratory. The full odour report is provided in **Appendix A**.



- **Figure 4-4: Odour Sampling Locations**

4.4.4 Sydney Water Corporation Odour Database

The Sydney Water Corporation (SWC) Odour Database contains details of over 1200 odour samples measured at various STPs around NSW, primarily those operated by SWC. A summary of the data relating to processes used at South West Rocks is provided in **Table 4-2**.

- **Table 4-2: Odour Measurement Summary – SWC Odour Database (STPs of all sizes)**

Season	Average Odour Detection Concentrations (OU)									
	Inlet works		Pasveer channel		Reactor*- aerobic		Reactor* - anoxic		Sludge lagoon	
	Av.	No.	Av.	No.	Av.	No.	Av.	No.	Av.	No.
Summer	16005	12	61	10	278	3	1317	14	909	22
Autumn	8927	14	0	0	582	18	1399	15	2284	16
Winter	2429	4	0	0	605	6	2615	2	519	3
Spring	1250	2	0	0	278	7	2878	12	0	0
Overall	10289	32	61	10	497	34	1842	43	1417	41
* Taken to be indicative of SBRs										

Of the processes shown in **Table 4-2**, only the inlet works and sludge lagoons show a clear trend in odour strength with season. The highest odour concentrations for the inlet works were measured in summer, while the highest odour concentrations for the sludge lagoons were measured in autumn. While the number of samples within some of the categories is small, there does not appear to be sufficient evidence within these data to suggest that the worst-case odours for each process will occur in summer, particularly for the sludge lagoons, which are the dominant odour source at the South West Rocks STP.

4.4.5 Modelling Scenarios

Three main scenarios were investigated in this assessment:

- Measured emission levels;
- SWC average emission levels across all seasons; and
- SWC worst-case emission levels by season.

Given the odour emissions measured at South West Rocks STP were significantly lower than the average and worst-case SWC database emissions it is considered reasonable to assume that at most the average emission scenario is representative of the worst-case conditions that are actually likely to occur at the South West Rocks STP. This aside the worst-case scenario is included for comparative purposes.

4.4.6 Emission Rates

The odour emission rates for this assessment were derived from the results of the odour sampling and from the SWC odour database. As no samples were taken of the MBP, and as the odour database did not contain representative samples of this type of equipment (the measured concentrations of the closest indicative plant were at least 50% lower than the value used in previous assessments), the odour concentration used in previous assessments for this plant (SKM, 2004 & 2005; HLA, 2007) was again used. The highest seasonal averages for the aerobic and anoxic reactors in the SWC odour database were averaged [i.e. (605 + 2878)/2] and used as the odour concentration of the SBRs, as this plant is likely to alternate between aerobic and anoxic conditions. Emissions from the SBR were assumed to be the same for each scenario.

The emissions inventories used in the dispersion modelling are shown in the tables below: **Table** 4-3 shows data used for the measured scenarios; **Table 4-5** shows the data used for the average case scenarios (existing and proposed plant); and **Table 4-4** shows the data used for the worst-case emissions scenarios (existing and proposed plant).

- **Table 4-3: Scenario 1 Emissions Inventory – Measured Emissions**

Odour Source	Odour Concentration (OU)	Sampling speed (m/s)	Source Odour Emission Rate ($OU.m^3/m^2.s$)	Area (m^2)	Odour Emission Rates* ($OU.m^3/m^2.s$)	
					Convective Atmosphere (A-D)	Stable Atmosphere (E&F)
IW	279	0.00064	0.17856	27	0.4	0.4
PS1	60	0.00064	0.0384	864	0.1	0.1
PS2	60	0.00064	0.0384	864	0.1	0.1
PS3	60	0.00064	0.0384	864	0.1	0.1
SL1	305	0.00064	0.195	684	0.5	0.4
SL2	529	0.00064	0.339	684	0.8	0.8
MBP	2000	-	0.684	21	1.7	1.6
SBR[#]	1741	0.000385	0.669776	396	1.7	1.5

* Including peak to mean ratios (2.5 for convective conditions and 2.3 for stable conditions)

[#] SBR included in future scenario only

The odour concentration assigned to each of the three Pasveer channels was the highest value sampled at the South West Rocks STP. The two highest odour concentrations measured at the South West Rocks STP sludge lagoons were used, with the highest value assigned to the northern sludge lagoon (SL2), which is located closest to the existing residential areas.

- **Table 4-4: Scenario 2 Emissions Inventory – Average Emissions^**

Odour Source	Odour Concentration (OU)	Assumed Sampling speed (m/s)	Source Odour Emission Rate ($OU.m^3/m^2.s$)	Area (m^2)	Odour Emission Rates* ($OU.m^3/m^2.s$)	
					Convective Atmosphere (A-D)	Stable Atmosphere (E&F)
IW	10289	0.00038	3.957	27	9.9	9.1
PS1	61	0.00038	0.024	864	0.1	0.1
PS2	61	0.00038	0.024	864	0.1	0.1
PS3	61	0.00038	0.024	864	0.1	0.1
SL1	1417	0.00038	0.545	684	1.4	1.3
SL2	1417	0.00038	0.545	684	1.4	1.3
MBP	2000	-	0.684	21	1.7	1.6
SBR#	1741	0.00038	0.670	396	1.7	1.5

^ emissions taken from Sydney Water Corporation Odour Database

* Including peak to mean ratios (2.5 for convective conditions and 2.3 for stable conditions)

SBR included in future scenario only

The overall average emissions shown in **Table 4-2** were used for in the average emission scenario with the exception of the SBR and the MBP. The highest seasonal average values from **Table 4-2** were used in the worst-case emission scenario, again with the exception of the SBR and MBP.

- **Table 4-5: Scenario 3 Emissions Inventory – Worst-Case Emissions^**

Odour Source	Odour Concentration (OU)	Assumed Sampling speed (m/s)	Source Odour Emission Rate ($OU.m^3/m^2.s$)	Area (m^2)	Odour Emission Rates* ($OU.m^3/m^2.s$)	
					Convective Atmosphere (A-D)	Stable Atmosphere (E&F)
IW	16005	0.00038	6.156	27	15.4	14.2
PS1	61	0.00038	0.024	864	0.1	0.1
PS2	61	0.00038	0.024	864	0.1	0.1
PS3	61	0.00038	0.024	864	0.1	0.1
SL1	2284	0.00038	0.878	684	2.2	2.0
SL2	2284	0.00038	0.878	684	2.2	2.0
MBP	2000	-	0.684	21	1.7	1.6
SBR#	1741	0.00038	0.670	396	1.7	1.5

^ emissions taken from Sydney Water Corporation Odour Database

* Including peak to mean ratios (2.5 for convective conditions and 2.3 for stable conditions)

SBR included in future scenario only

The South West Rocks STP incorporates biological treatment systems that rely on microbes to break down sewage. Increased influent levels can change sewage properties such as biological oxygen demand (BOD) and levels of potentially odour-producing compounds in an STP. Microbial populations, however, should self-regulate according to the available food levels when the STP is operated appropriately, leading to relatively stable odour emissions from a facility.

The primary variables affecting odour emissions from an STP are the type of microbes used in the system, the quality of the inputs (levels of BOD and nitrogenous and sulphurous compounds), the time difference between sewage generation and treatment, and maintenance procedures. Extended time delays between generation and treatment, and poor maintenance of sludge lagoons can result in the sewage or sludge becoming septic. These variables were assumed to be approximately the same for each phase of the development; as such, emissions from each source were assumed to be the same for the existing and future cases of each scenario investigated. The only difference between the existing and proposed cases within each scenario was, therefore, the addition of the SBR for the proposed case.

4.4.7 Sensitive Receptors

The term sensitive receptors refers to all nearby receptors that may potentially be affected by odour emissions, both now and in the future. As this assessment was limited to the existing buffer zone, which currently contains no sensitive receptors, no specific receptor locations were incorporated into the model. Rather, odour concentrations were predicted at each point in the modelling domain grid.

4.4.8 Terrain

Due to the nature of the STP site, building wake effects were not considered in this assessment. The terrain within the buffer zone was digitised and incorporated into the AUSPLUME model.

4.4.9 Meteorological Data

Data for July 2005 – June 2006 were obtained from the on-site meteorological station by Connell Wagner. The data were formatted for use in the AUSPLUME model. Wind roses prepared from the data are presented in **Figure 4-1**; quality assurance checks of the data are provided in **Appendix B**.

4.5 Odour Impact Assessment

The results of odour modelling are shown in **Figures 4.4 – 4.6**. In these figures, the black dashed line indicates the existing 400 m buffer zone, the white dashed line represents an arbitrary 200 m from the STP boundary, and the purple line represents the 2 OU/m^3 odour criterion level for the 99^{th} percentile odour concentration predictions.

The following points should be noted when reviewing the figures:

- The measured scenario uses worst-case data measured on-site during autumn for the inlet works, Pasveer channels and sludge lagoons;
- A sequential batch reactor is included in the proposed case odour sources, which is the only difference between the existing and proposed cases for each scenario;
- The average scenario considered the plant operating with average odour emissions for the inlet works and sludge lagoons obtained from the Sydney Water Corporation odour database;
- The worst-case scenario used the worst-case seasonal average odour emissions from the odour database for the inlet works and sludge lagoons;
- All scenarios assume the operation of a mobile belt press with a worst-case odour concentration of 2000 OU.

Existing Proposed

- **Figure 4-5 Scenario 1 Measured STP Odours – Existing vs Proposed Plant**

Existing Proposed

- Figure 4-6 Scenario 2 Average STP Odours – Existing vs Proposed Plant

Existing Proposed

- Figure 4-7 Scenario 3 Worst-case STP Odours – Existing vs Proposed Plant

As shown in **Figures 4-4** to **4-6**, odour concentrations from the existing and proposed plant are at acceptable levels at approximate distances of 100m for Scenario 1, 180 m for Scenario 2 and 220 m for Scenario 3 from the STP.

It is reminded that:

- Scenario 1 relates to odour impacts as measured at the existing plant in Autumn 2008 and anticipated worst-case emissions from the future SBRs and MBP;
- Scenario 2 relates to odour impacts assuming STP odour emission levels are equivalent to the average of SWC odour database emissions for like sources plus anticipated worst-case emissions from the future SBRs and MBP; and
- Scenario 3 relates to odour impacts assuming STP odour emission levels are equivalent to the seasonal worst-case averages of SWC odour database emissions for like sources plus anticipated worst-case emissions from the future SBRs and MBP.

4.6 Discussion of Results

4.6.1 Previous Assessments

Previous dispersion modelling assessments performed for the South West Rocks STP indicated that odour impacts were likely to be limited to within 150 m to 250 m of the STP.

While these assessments did not use meteorological data or measured emissions from the STP site the results are generally consistent with this more detailed assessment.

4.6.2 Steps Taken to Present a Worst-Case Assessment

The current assessment used 12 months' of meteorological data recorded from the on-site automatic weather station, and investigated the dispersion of odours at concentrations measured at the South West Rocks STP site. This assessment predicted odour concentrations from the STP to be below the guideline criterion at a distance of 100 to 220 m from the STP site, depending on the assumptions used in the modelling.

The odour sampling was performed in autumn, which the DECC does not consider represents worst-case odour emission conditions. This issue was addressed in three ways:

- Firstly, conservative values were used in the measured emissions assessment. The highest measured odour concentrations for each plant, and a very conservative estimate of emissions from the MBP (which was not sampled), were modelled.
- Secondly, odour measurements from the SWC odour database were analysed for seasonal trends. While the data indicated that odour emissions from inlet works were highest during summer, this association was not seen for other types of plant that are operating at the South West Rocks STP site. In fact, emissions from sludge lagoons, which are the dominant odour

sources at the South West Rocks site (based on measured odour concentration and area), were highest in the autumn months. Additionally, assessment of the wind patterns measured by the on-site meteorological station indicate that the fewest number of calm periods and the highest wind speeds occur in summer at the site, suggesting that weather conditions during summer are not likely to result in the highest odour impacts.

- Finally, two additional modelling scenarios were investigated, where the average and worst-case seasonal averages from the SWC odour database were used in the dispersion modelling. In the absence of any odour emissions data collected during summer periods the use of the average emissions data was considered to be representative of the highest odour concentrations possibly likely to emanate from the South West Rocks STP, i.e. the most feasible worst-case scenario for the site. As shown in **Figure 4-5**, the predicted odour concentrations resulting from this level of odour emission resulted in odour concentrations below the guideline criterion at the 200 m boundary from the STP, i.e approximately 180 m. The worst-case data were included for comparative purposes only and, as shown in **Figure 4-6**, the predicted odour concentrations from this extreme level of odour emission were found to go slightly beyond this 200 m boundary.

4.6.3 Consideration of Peak Flow Conditions

One issue raised by Macleay Water and the DECC in regards to assessing odours at this time is that odour impacts at South West Rocks STP increase significantly at Xmas when the weather is hot and the plant is overloaded from the influx of tourists for the Holiday Season.

The issue this raises is that without having sampled odours at the treatment plant over Xmas or obtaining data from a similarly located plant under peak load conditions how can it be ascertained what the impact at South West Rocks STP would be during the Xmas peak load. It is acknowledged that the sampling at South West Rocks STP during autumn 2008 was under average loading and that in a review of the SWC odour database it was not possible to determine odour emissions for different treatment plant loadings.

As such it is not possible to determine from the results of this assessment how representative the results would be of past Xmas peak load conditions. What can be said, however, is that there is a significant increase in odour emissions from the 2008 measured data to the worst-case emissions assumed in the modelling.

Having considered the above analysis, South West Rocks STP is about to be upgraded to include 2 x SBRs it is understood that the purpose of the upgrade is to cater from an increase in population including peak Xmas tourist season. As such in the future it is assumed that the existing pasveer plant and SBRs will be able to be operated at design capacities throughout the year, so while strong

odours associated with Xmas peak loading may have occurred in the past, with the additional SBR plant, it is considered reasonable that this should not be an issue in the future.

In going forward what will continue to be relevant for Xmas related odours will be potentially stronger inlet works odour emissions associated with warmer ambient temperatures. Such conditions have been assessed in detail in this assessment.

4.6.4 Best Estimate of Buffer Zone Requirements

The results of this odour study demonstrate that the buffer zone requirements for South West Rocks STP when upgraded and without any odour control measures range from between 100 m to 220 m depending on odour emissions assumed for the plant.

As discussed these results are consistent with previous studies which identified buffer zones ranging between 150 m and 250 m. Aside from this study the two other most recent investigations, SKM, 2005 and HLA, 2007 both recommended buffer zones of 150 m.

To accurately determine the extent of the odour impact and therefore buffer zones requires certainty over STP odour emission rates. Odour emission rates are best determined from on-site measurements at the actual plant under investigation. Such measurements were collected at South West Rocks STP during Autumn 2008, and the results of odour modelling using this measured data, as well as high odour emissions assumed for SBRs and the MBP is that a 100 m buffer zone is required for the upgraded STP.

It is acknowledged that odour sampling during autumn might not capture maximum odour emissions from STPs, with summer commonly regarded as providing conditions more conducive for maximum odour generation. As such as well as determining a buffer zone distance based on measured odour emissions this assessment also determines buffer zone requirements using average and worst-case odour emissions from a large database of odour emission measurements sourced from SWC. As discussed this data when applied to South West rocks STP provides for buffer zones of between 180 m and 220 m.

In an attempt to forecast what the odour generation at South West Rocks STP would be during hot summer conditions and assuming the peak load conditions that have occurred in the past will not be an issue in the future (refer to **Section 4.6.3**), analysis of the SWC odour database suggest that only the inlet works might be considered more odorous in summer than in say autumn. There is no evidence within SWC odour database to suggest that the sludge lagoons which are the dominant source of odour at the plant should be any more odorous in summer than in autumn.

Sensitivity modelling has shown that the odour model has a low sensitivity to inlet works inputs, that is given the comparatively small size of the inlet works, whether high or low odour emission

concentrations are assumed for this source has little bearing on the results. That is even in the event that summer odour sampling showed very high inlet works odours, eg. similar to worst-case SWC data, this alone would not have the effect of extending the 100 m buffer zone determined for existing (Autumn 2008) odour emissions to anymore than 150 m. As stated there is no reason to assume sources other than the inlet works would increase during summer, however, summer odour sampling would be required to confirm this.

As such 150 m is considered a reasonable estimate of the buffer zone requirement for South West Rocks STP, both now and in the future following the proposed plant upgrade, and without the need for any odour controls.

4.6.5 Opportunities for Odour Control if Needed

There is no suggestion in this report that any odour controls are needed at South West Rocks STP even for buffer distances of the order of 150 m. However, should any further assessment work, eg. summer odour measurements show that odour control at the plant are required to meet a certain buffer distances then such works could be implement to reduce odour impacts.

This report shows that the inlet works and sludge lagoons have the highest odour emissions per unit area, with the sludge lagoons being dominant based on their very large size compared to the inlet works.

As such any odour control investigation at South West Rocks STP would most likely target the sludge lagoons..

One method of odour control often used at STPs is to cover the sources of odour and extract foul air to some treatment facility eg. biofilter, chemical scrubber, carbon filters. This works well for sources such as inlet works where the air volumes being treated are low and there is typically no need for regular access of the process unit being treated. Generally covers do not work well for sources such as sludge lagoons, as they need to be accessed for emptying etc. Typically odour controls for sludge lagoons involve removing the lagoons and replacing them with some other form of sludge management eg. dewatering plants such as belt presses and centrifuges. Such solutions have been commonly applied to STPs with odour emission problems. They do, however, have operational implications for STPS and would needed to be investigated in close consultation with the plant operator, in this case Macleay Water.

Sensitivity modelling undertaken where the sludge lagoons are removed from the model, on the assumption that that they could be replaced by a centrifuge or belt press and noting that a mobile belt press (MBF) is included in the models shows that total site odour impacts could be maintained within 100 m of the STP.

5. Conclusion

5.1 Conclusions

A site-specific assessment of odour emissions from the South West Rocks STP for the existing and proposed future upgrade of the plant was conducted.

Meteorological data and odour emissions from the site were used in dispersion modelling and compared to the results of modelling using worst-case emissions data from the SWC odour database, which contains odour measurements from a variety of STPs around NSW. These scenarios were considered to adequately reflect the worst possible levels of odour emissions from the STP.

Odour concentrations were found to be below the DECC guideline criterion of 2 OU/m^3 at a distance of 100 m to 220 m from the plant, with distances varying depending on the assumptions made with regards to odour emission rates. **A best estimate of the buffer zone based on available information is 150 m. This buffer is considered to be reasonable both now and in the future following the proposed plant upgrade, and without the need for any odour controls. This assessment also provides site-specific evidence for the potential development of some areas of land within the existing South West Rocks STP buffer zone.**

None of the scenarios considered the addition of any mitigation measures to reduce odour emissions; as such, potential odour concentrations may be reduced if required. Sensitivity modelling undertaken where the sludge lagoons are removed from the model, on the assumption that that they could be replaced by a centrifuge or belt press and noting that a mobile belt press (MBF) is included in the models, shows that total site odour impacts could be maintained within 100 m of the STP.

References

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

DEC. (2006). Technical Notes: Assessment and Management of Odour from Stationary Sources in NSW. Department of Environment and Conservation: Sydney.

DUAP. (1989). Guidelines for buffer areas around sewage treatment (water pollution control) plants, Circular No. E3 (formerly DEP 148). Department of Urban Affair and Planning: Sydney.

Water Directorate. (2006). STP Buffer Zone Land Use Planning Guidelines.

Appendix A Odour Measurement Report

Appendix B Meteorological Data – Quality Check

Stability Class by Time of Day – South West Rocks STP Meteorological Station

Time of Day	Stability Class						
	A	B	C	D	E	F	Total
1				71	61	216	348
2				67	59	222	348
3				60	61	227	348
4				59	65	224	348
5				47	63	238	348
6				42	59	247	348
7	40	17	11	43	51	186	348
8	134	48	45	38	15	68	348
9	187	70	44	47			348
10	180	74	43	51			348
11	156	84	51	57			348
12	175	60	52	61			348
13	177	53	48	70			348
14	182	48	51	67			348
15	190	46	42	70			348
16	186	44	47	71			348
17	182	44	45	77			348
18	163	49	53	83			348
19	114	31	38	96	9	60	348
20	32	10	9	104	43	150	348
21				102	48	198	348
22				92	58	198	348
23				79	56	213	348
24				75	59	214	348
Total	2098	678	579	1629	707	2661	8352

Stability Class by Wind Speed – South West Rocks STP Meteorological Station

Wind Speed	Stability Class						
	A	B	C	D	E	F	Total
0.5	220	17	1	8	41	1065	1352
1	341	38	24	33	178	857	1471
1.5	488	65	27	27	173	401	1181
2	478	94	72	47	142	218	1051
2.5	381	101	103	111	72	96	864
3	190	114	103	206	25	24	662
3.5		177	87	210	12		486
4		72	54	224	21		371
4.5			52	210	21		283
5			36	183	22		241
6			20	221			241
7				126			126
8				21			21
9				2			2

Sinclair Knight Merz
710 Hunter Street
Newcastle West NSW 2302 Australia
Postal Address
PO Box 2147 Dangar NSW 2309 Australia

Tel: +61 2 4979 2600
Fax: +61 2 4979 2666
Web: www.skmconsulting.com

Keiley Hunter
Kempsey Shire Council
PO Box 78
West Kempsey NSW 2440

16January 2009

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EN02478

Dear Keiley,

ADDENDUM - SOUTH WEST ROCKS STP ODOUR ASSESSMENT

Sinclair Knight Merz (SKM) prepared a Buffer Zone Odour Impact Assessment for the South West Rocks Sewage Treatment Plant (STP) for Kempsey Shire Council (Council) in July 2008 (SKM, 2008)[1]. The purpose of this assessment was to inform a rezoning application to Kempsey Council and the Department of Planning by assessing the required size of buffer zone for the existing and proposed expansion of the STP. Following the receipt of comments on that assessment from the Department of Environment and Climate Change (DECC) and Macleay Water, Council commissioned SKM to conduct additional modelling using odour measurements taken during the STP's peak operating period (summer) and revised plant upgrade details. The details and results of the additional work are reported below.

1. Odour Sampling

Sampling of the STP was undertaken by Stephenson Environmental Management Australia on 5 January 2009 in accordance with the DECC guidelines[2].

The sampling described in **Table 1** was performed to obtain odour concentrations from the existing plant that are representative of peak load conditions; samples are described in **Table 1**. The sampling locations were the same as those sampled in July 2008; a site plan is shown in **Figure 1** for reference. Samples were collected in accordance with AS4323.3 using an equilibrium flux hood, and analysed by Odour Research Laboratories Australia, a NATA-accredited laboratory. The odour sampling speed reported in the odour report was the same as that assumed for SKM (2008).

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[1] SKM. (2008). South West Rocks STP Buffer Zone Odour Impact Assessment

[2] DEC. (2005). Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales, Department of Environment and Conservation.

- **Table 1: Odour Sampling Results**

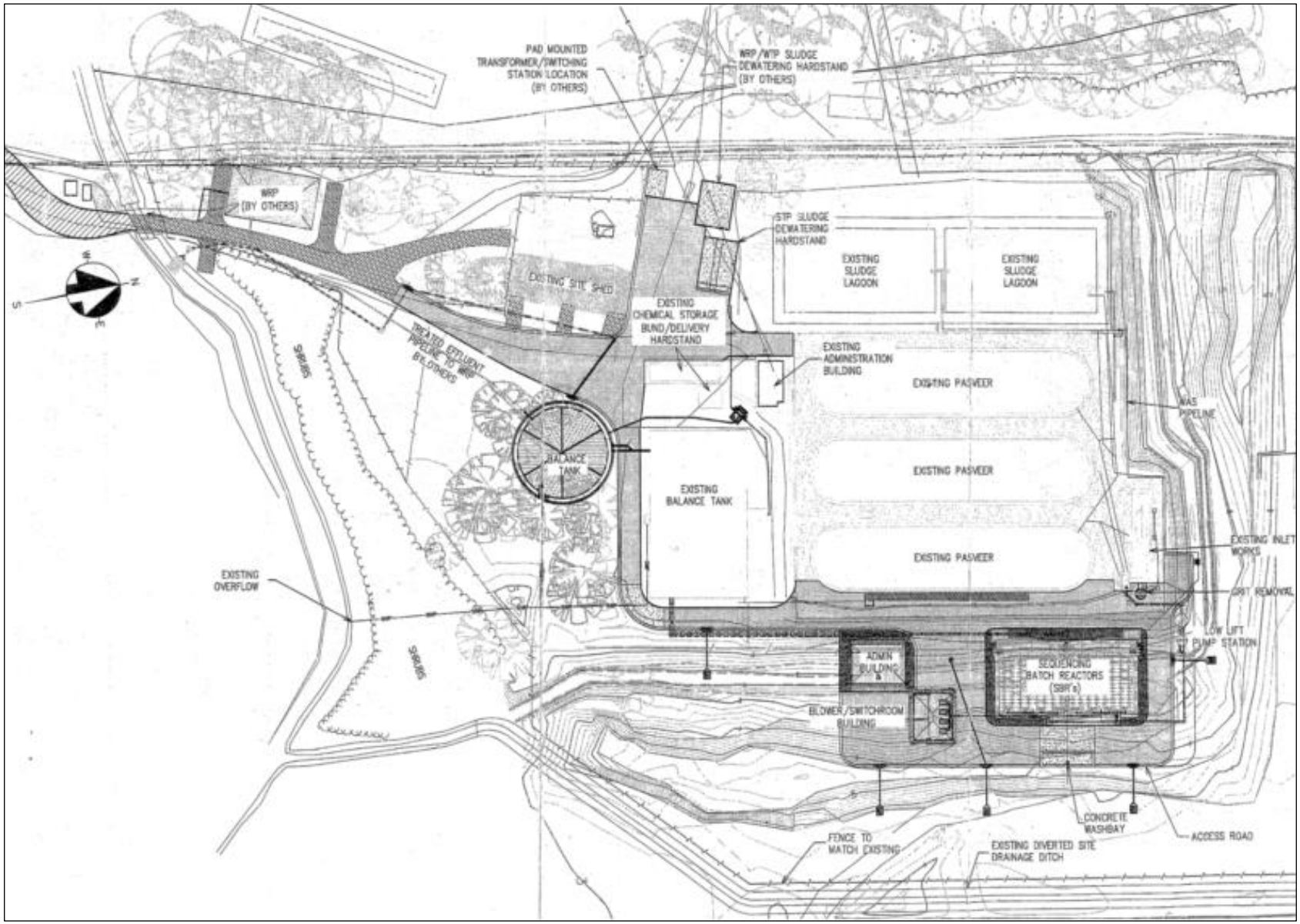
Sample	Sample Time (hours)	Odour Concentration (OU)	Source Odour Emission Rate ($OU.m^3/m^2.s$)	H_2S (ppmv)
Inlet works	0845 – 0910	941	0.605	2
Pasveer 1 – aeration	0658 – 0709	25	0.016	0
Pasveer 1 – settling	0759 – 0809	23	0.015	0
Pasveer 2 - aeration	0902 – 0912	35	0.022	0
Sludge Lagoon 1 (south) – south end, liquid phase	0902 – 0912	77	0.049	0
Sludge Lagoon 2 (north) – north end, undisturbed	0950 – 0959	1106	0.711	2
Sludge Lagoon 2 (north) – south end, disturbed	1001 – 1010	385	0.247	1
Sludge Lagoon 2 (north) – south end, undisturbed	1032 – 1042	385	0.247	0

Due to the high load on the plant, the condition of the north sludge lagoon was essentially the same in the undisturbed and disturbed states. As such, the two samples taken from the south end are essentially replicate samples, and were considered as one sample to provide a conservative estimate of odour emissions from the north sludge lagoon.

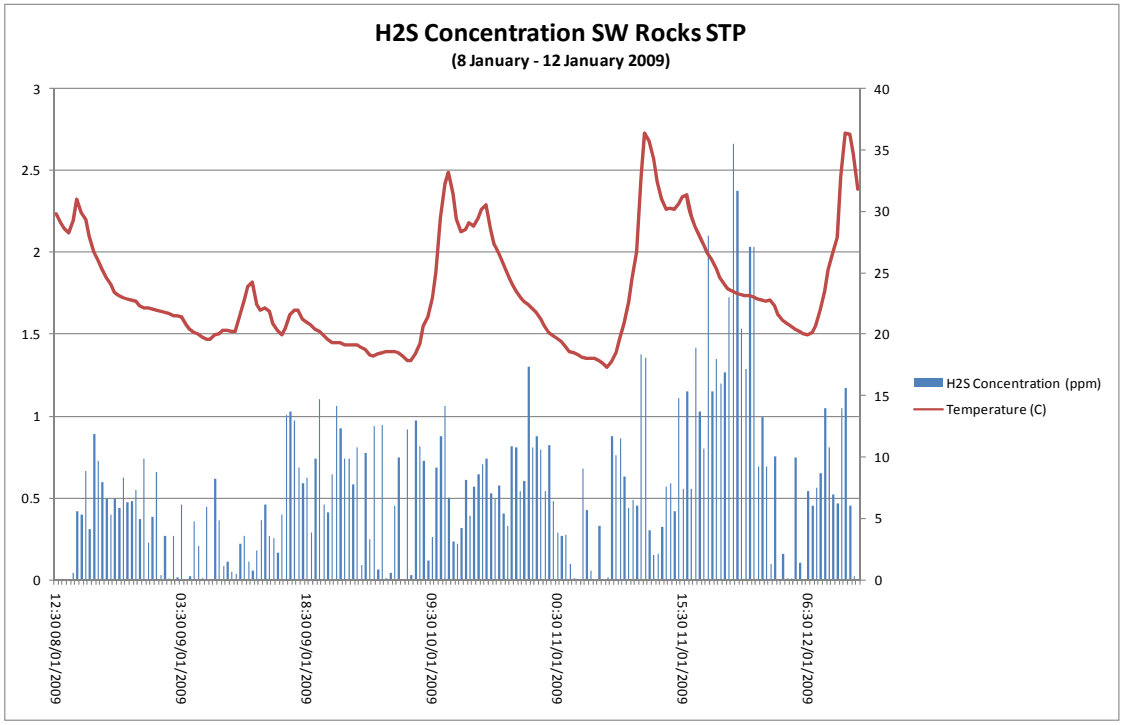
In addition to the olfactometry odour sampling, continuous H_2S measurements were made in the inlet works to the STP between 8 and 12 January 2009 to capture peak H_2S load over the weekend peak following the odour sampling on 5 January 2009. The purpose of the monitoring was to determine H_2S levels at time of maximum odour generation within the inlet works which was noticeably variable during the 5 January 2009 odour sampling, and may also vary between AM and PM peak loads to the plant.

The results of these H_2S measurements are shown in **Figure 2**. It can be seen from the results of sampling that peak 30-minute average H_2S concentrations are of the order of 2 – 2.5 ppm, which corresponds well with the 2 ppm H_2S measurement of the inlet works olfactometry odour sample measured on 5 January 2009. This provides a reasonable basis for the assumption that the inlet works odour sample was collected during a period of maximum odour generation during the peak flow period on 5 January 2009.

- **Figure 1: Site Map**



- **Figure 2 Inlet Works H_2S Measurements 8 – 12 January 2009**



2. Modelling Methodology

The assessment was undertaken in accordance with the DECC guidelines[3]. Dispersion modelling was conducted using the AUSPLUME v 6 Gaussian plume model.

2.1 Odour Criterion

As per SKM (2008), the DECC's odour criterion[4] of 2 OU (nose-response time average, 99th percentile) for an urban area (population ≥ ~ 2000) was used for this assessment.

[3] DEC. (2006). Technical Notes: Assessment and Management of Odour from Stationary Sources in NSW, Department of Environment and Conservation.

[4] DEC. (2005). Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, Department of Environment and Conservation.

2.2 Modelling Scenarios

Three scenarios were investigated using dispersion modelling:

- Scenario 1: Measured peak load odour levels (including two MBPs), January 2009; and
- Scenario 2: Worst case measured odour levels for each odour source, (May 2008 and Jan 2009 odour sampling) including two MBPs (i.e. the worst odour level measured at sludge lagoon 1 was used for sludge lagoon 1).

All scenarios incorporated odours from the Sequential Batch Reactors (SBRs) proposed to be installed to upgrade the plant and the Mobile Belt Press (MBP). As such, this assessment is analogous to the proposed plant upgrade scenarios assessed in SKM (2008). Emissions from SKM (2008) were used for this assessment for the SBRs and the MBP (which was not operating at the time of the odour sampling). For each scenario, an additional MBP was included in the assessment to account for the full complement of potential odour sources following the plant upgrade, that is to account for sludge dewatering from both the sewage and water recycling plants. Emissions from both MBPs were assumed to be the same, and therefore a worst-case for the water recycling plant sludge where there would be minimal organic matter.

2.3 Emissions Inventory

The data used in the dispersion modelling for each of the Scenarios are shown in **Tables 2 – 3**. The peak to mean ratios (2.5 for convective conditions and 2.3 for stable conditions), which convert 1 hour results to 1 second averages, are included in Odour Emissions Rates reported in the following tables.

- **Table 2: Emissions Inventory – Scenario 1**

Odour Source	Odour Conc (OU)	Source Odour Emission Rate ($OU.m^3/m^2.s$)	Area (m^2)	Odour Emission Rates ($OU.m^3/m^2.s$)	
				Convective Atmosphere (A-D)	Stable Atmosphere (E & F)
Inlet works	941	0.605	27	1.5	1.4
Pasveer 1	30 ^	0.019	864	0.05	0.04
Pasveer 2	30 ^	0.019	864	0.05	0.04
Pasveer 3	23 #	0.015	864	0.04	0.03
Sludge Lagoon 1 (south)	77	0.050	684	0.1	0.1
Sludge Lagoon 2 (north)	746	0.479	684	1.2	1.1
Mobile Belt Press 1	2000	0.684	21	1.7	1.6
Mobile Belt Press 2	2000	0.684	21	1.7	1.6
Sequential Batch Reactor	1741	0.670	396	1.7	1.5
^ Average of the two aeration Pasveer sample results from Table 1 (i.e. 35 and 25) # The Pasveer settlement sample result from Table 1					

- **Table 3: Emissions Inventory – Scenario 2**

Odour Source	Odour Conc (OU)	Source Odour Emission Rate ($OU.m^3/m^2.s$)	Area (m^2)	Odour Emission Rates ($OU.m^3/m^2.s$)	
				Convective Atmosphere (A-D)	Stable Atmosphere (E & F)
Inlet works	941	0.605	27	1.5	1.4
Pasveer 1	61	0.039	864	0.1	0.09
Pasveer 2	61	0.039	864	0.1	0.09
Pasveer 3	61	0.039	864	0.1	0.1
Sludge Lagoon 1 (south)	529	0.340	684	0.9	0.8
Sludge Lagoon 2 (north)	1106	0.711	684	1.8	1.6
Mobile Belt Press 1	2000	0.684	21	1.7	1.6
Mobile Belt Press 2	2000	0.684	21	1.7	1.6
Sequential Batch Reactor	1741	0.670	396	1.7	1.5

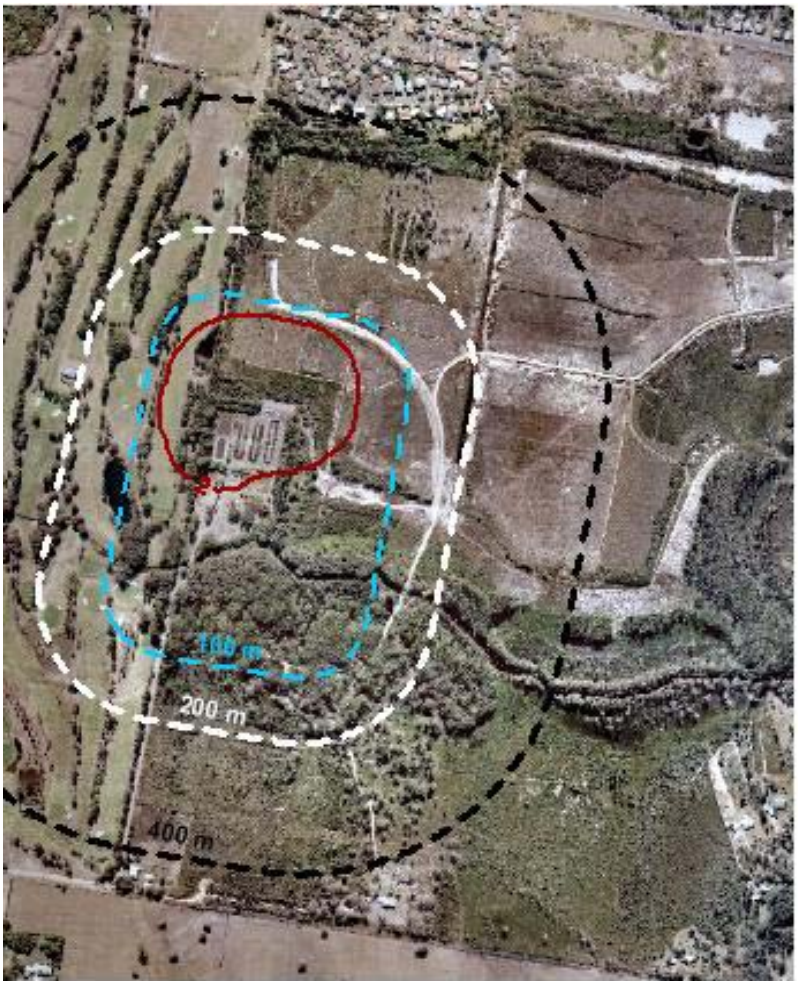
2.4 Meteorology

Meteorological data recorded from the on automatic weather station on site for July 2005 – June 2006 on site were used in the dispersion modelling. The data were the same as that used for the previous report (SKM, 2008).

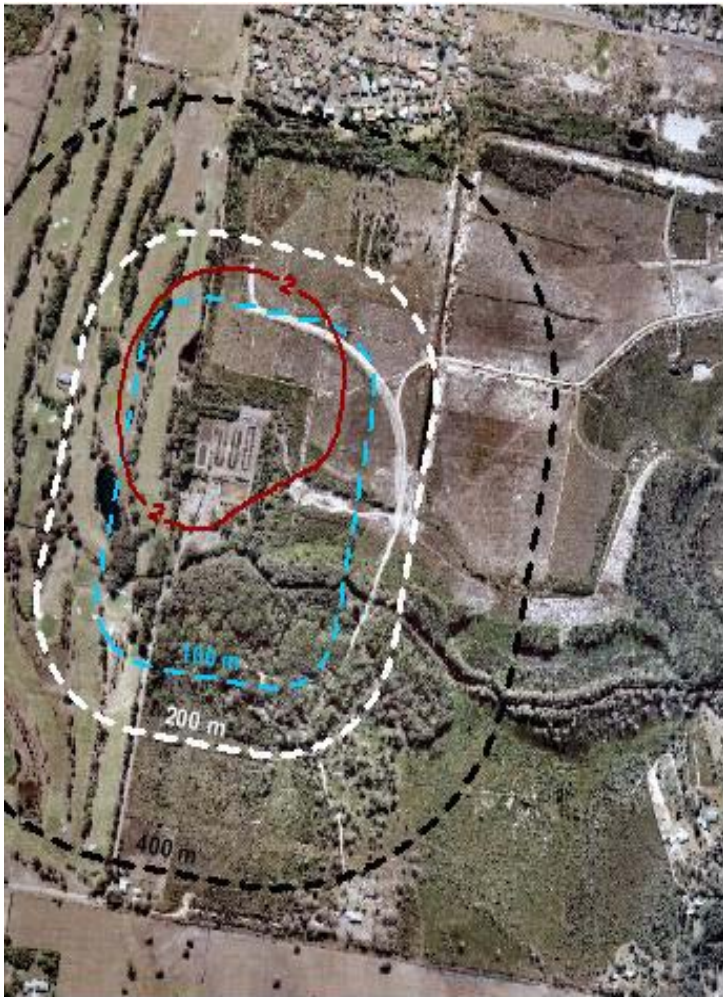
3. Modelling Results

The results of the dispersion modelling are shown in **Figure 3** and **Figure 4**, which displays the 2 OU criterion for each Scenario. The results of the January 2009 odour assessment are consistent with Scenario 1 and Scenario 2 from the May 2008 assessment.

- **Figure 3: Scenario 1 Dispersion Modelling (2 OU, 1 sec, 99th percentile)**



- **Figure 4: Scenario 2 Dispersion Modelling (2 OU, 1 sec, 99th percentile)**



4. Conclusion

In interpreting the results of the January 2009 odour modelling, any residential rezoning of the land surrounding the STP should not occur within the 2 OU "red" contour shown in **Figure 4**.

The results from this assessment indicate that under measured peak load conditions (January 2009 actual measurements as requested by Macleay Water and DECC) odour concentrations are limited to acceptable levels within a distance of approximately 100m from the STP property boundary (which is well below the previously recommended 150m buffer).

As such, this odour assessment which utilises peak load measurements (taken in January 2009), together with a sensitivity analysis combining worst-case data from both May 2008 and January 2009, supports the findings of the previous SKM (2008) recommendation that a buffer zone of 150m from the STP property boundary is adequate to manage odour impacts from the South West Rocks STP to acceptable levels.

Yours sincerely

Matt Davies
Senior Associate
Practice Leader – Air Quality