Report

Odour Impact Assessment - Marmong Point Retirement Village

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1. INTRODUCTION

Advitech Pty Limited (Advitech) was engaged by Empowered Living Support Services Ltd (ELSS) to undertake an odour impact assessment of potential odours from nearby Hunter Water Corporation (HWC) sewerage pumping station Marmong Point 2. The sewerage pumping station is located close (approximately 25 metres) to the proposed Marmong Point Retirement Village (MPRV) open storage space area, and there is concern that odour from sewage may negatively impact on future residents and site amenity.

It should be noted that this report was prepared by Advitech for ELSS ("the customer") in accordance with the scope of work and specific requirements agreed between Advitech and the customer. This report was prepared with background information, terms of reference and assumptions agreed with the customer. The report is not intended for use by any other individual or organisation and as such, Advitech will not accept liability for use of the information contained in this report, other than that which was intended at the time of writing.

2. BACKGROUND AND OBJECTIVES

HWC own and operate a sewerage pumping station in the north-western portion of the proposed MPRV. The Lake Macquarie City Council (LMCC) has requested that ELSS provide an assessment of odour from the sewerage pumping station to determine what affect this will have for future residents at the retirement village.

3. REFERENCES

The following references were used in this study:

- Supplied sewerage system data and personal conversations with HWC;
- Personal conversations with Odour Control Systems Pty Ltd;

- Metropolitan Melbourne Board of Works (*'Hydrogen Sulphide Control Manual - Septicity, Corrosion and Odour Control in Sewerage Systems'. Technical Standing Committee on Hydrogen Sulphide Corrosion in Sewerage Works. Vol. 1 and 2 1989*. MMBW, Melbourne); and
- Coombes, P *(Integrated Water Cycle Modelling - Probabilistic Urban Rainwater and Wastewater Reuse Simulator, 2004)*.

4. MARMONG POINT RETIREMENT VILLAGE

4.1 General Description

The proposed MPRV site is located at No. 135A Marmong Street, Marmong Point, in the Lake Macquarie Local Government Area, and is identified as Lot 1 in DP 377679 and Lot 784 in DP 533494.

The proposed development comprises of a retirement village incorporating 48 buildings containing 94 independent living units and associated community buildings and facilities, landscaping and access roads.

The size of the MPRV site is 33 hectares with proposed building development occupying approximately five and a half hectares. It comprises a large, pentagonal shaped parcel of land, connected to Marmong Street by a small rectangular shaped lot in the site's south-east (Lot 784).

Figure 1 shows the planned development and location of sewerage pumping station.

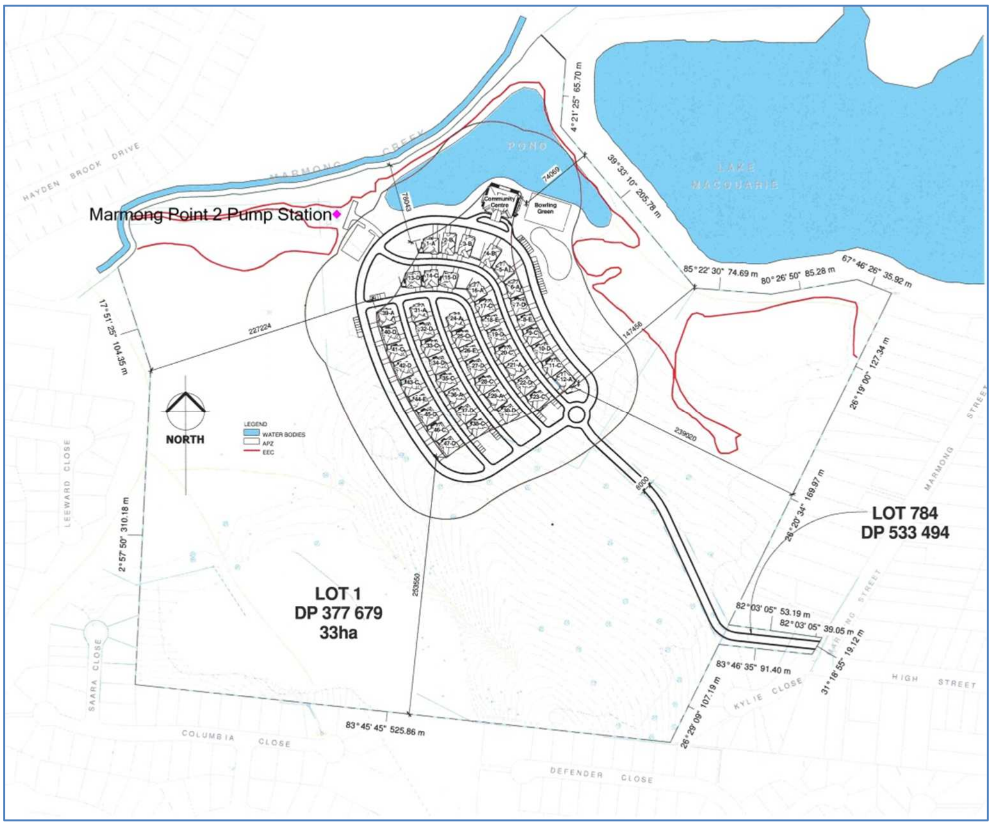

Figure 1: MPRV Site Plan

5. ODOUR ASSESSMENT

5.1 Source of Odour

Based on supplied information from HWC, Marmong Point 2 pumping station is expected to have a low odour generation potential under normal operating conditions. In April 2011, HWC contractors, Odour Control Systems (OCS), installed a chemical dosing system to reduce hydrogen sulphide generation (i.e. odour) in the Marmong Point sewerage system. The chemical dosing system is close to the Marmong Point 2 pumping station and its operation has significantly reduced the odour generation potential at the Marmong Point 2 pumping station.

Odour generated within the sewerage pumping station is predominately due to biological activity within the wastewater. Depending upon the characteristics of the influent wastewater and the sewage residence time within the pump station wet well, biological anaerobic reactions may occur. Anaerobic activity by bacteria is predominately responsible for odour generation. The physicochemical characteristics of the influent sewage, the sewerage reticulation design and diurnal flows will impact more significantly on odour evolution potential. The most significant precursors to odour generation are:

1. the degree of septicity within the influent sewage (this is a function of the sewage residence time as well as the design of the sewerage network);
2. the pH of the sewage;
3. the temperature of the sewage; and
4. the degree of sewage turbulence within the sewerage system and the entry into the Marmong Point 2 pump station.

5.2 Level 1 Screening Assessment

The methodology used in this report follows procedures outlined by the New South Wales (NSW) Office of Environment and Heritage (OEH) for Level One odour assessment studies. The OEH publication *Assessment and management of odour from stationary sources in NSW November 2006* uses simple calculations to generate a predicted separation distance that can be applied over a range of situations for the distance between the sewerage pumping station and the proposed retirement village.

5.3 Air Dispersion Analysis

The NSW OEH publication *Assessment and management of odours from stationary sources in NSW* DEC, 2006, specify impact assessment criteria. The relevant sections from this publication are reproduced below in **Table 1** which presents the ground level concentration (GLC) criteria for odour expressed as odour units (OU).

The air dispersion modelling review was undertaken using AUSPLUME software program using an externally prepared meteorological dataset for Newcastle for the year 2003.

Table 1: OEH Impact Assessment Criteria

Pollutant	OEH Design Criteria	Units	Averaging Time
Odour	2-7[a]	OU	1 hour

a - Source: NSW Department of Environment, Climate Change and Water, Approved Methods for the Modelling and Assessment of Air Pollutants, 2005 (Table 7.5). The range 2-7 OU represent population-dependant odour performance criteria. Odours below 2 OU are not considered offensive (DECCW, 2005).

For odour, the 100th percentile, one-second average GLC was calculated using the AUSPLUME gaussian plume dispersion model. The OEH design criteria applied in this study is 2 OU.

To arrive at a one-second averaging time, appropriate peak-to-mean factors have been applied to hourly average odour concentrations. Peak-to-mean factors estimate the effects of plume meandering and concentration fluctuations perceived by the human nose. Based on HWC data regarding sewerage pump station inlet flowrates and dimensions for stack height and diameter; stack air emissions will be wake affected for all meteorological conditions. A peak-to-mean factor of 2.3 for a wake affected stack has been adopted, for all atmospheric stability classes (A-D).

The odour assessment assumes that if the AUSPLUME adjusted one-hour ground level odour concentration is higher than the regulatory standard, a potential odour problem is apparent.

6. SPECIFIC ODOUR EMISSION RATE

A specific odour emission rate for odours emanating from the Marmong Point 2 pumping station was calculated using procedures developed by the Metropolitan Melbourne Board of Works (*'Hydrogen Sulphide Control Manual - Septicity, Corrosion and Odour Control in Sewerage Systems'. Technical Standing Committee on Hydrogen Sulphide Corrosion in Sewerage Works. Vol. 1 and 2 1989.* MMBW, Melbourne). This assessment assumes that the qualified odour potential arising from the Marmong Point 2 pumping station is characterised by hydrogen sulphide (H_2S).

For purposes of the Level One odour assessment, concentrations of gaseous H_2S are estimated from influent sewage flows and translated into an equivalent OU. A direct relation exists between the gaseous H_2S concentration and the OU. The relation is:

$$1\ OU = 1\ ppm\ H_2S \times \left(\frac{1000}{1.4}\right). \qquad (1.)$$

Appendix I describes the methodology to arrive at an odour concentration within the Marmong Point 2 pumping station.

6.1 Estimate of Exchange Air Flows from Sewerage Pumping Station

The exchange of air between the Marmong Point 2 pumping station and the environment is dependent upon whether the wet well within the pumping station is filling or emptying. When the wet well is filling, air (potentially foul) is educted out into the environment through the stack. When the tank is emptying, fresh air is inducted into the wet well allowing it to mix with gaseous H_2S.

According to HWC, the Marmong Point 2 pumping station receives an average dry weather flow of 1.56 ML/day. A diurnal water usage cycle for Newcastle developed by Dr. Peter Coombes *(Integrated Water Cycle Modelling - Probabilistic Urban Rainwater and Wastewater Reuse Simulator, 2004)* was employed to construct the diurnal sewage inflow pattern for the sewerage pumping station. **Figure 2** illustrates the instantaneous 6-minute influent sewage flows into the Marmong Point 2 pumping station.

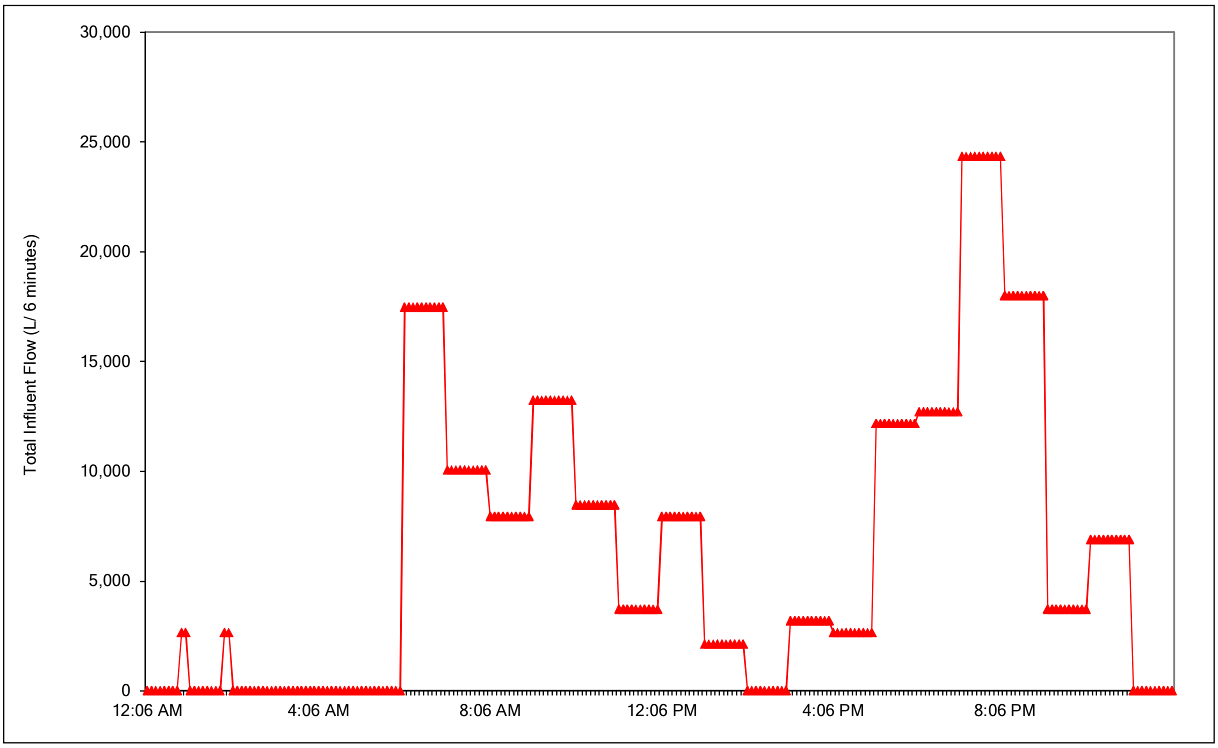

Figure 2 - Instantaneous Sewage Flow into Marmong Point 2 Pumping Station

Two peak inflow events occur during any diurnal period. The first (morning peak) begins at 6 am and the second (evening peak) begins at 3 pm. Estimation of worst-case educt airflows during peak sewage inflow periods assumes that the pump station wet well is at a minimum level before the two peak inflow events. The values listed in **Table 2** are the estimated educt air flows from the sewerage pumping station during peak and averaged inflow events.

Table 2: Peak and Averaged Educt Flows from Pump Station Stack

Description	Educt Air Flow (Nm^3/s)
Morning Peak	$4.49E^{-02}$
Evening Peak	$6.26E^{-02}$
Daily Average	$1.67E^{-02}$

Note: Educt flowrate at zero degrees Celsius and 1 atmosphere.

7. RESULTS

Potential odour impacts from the Marmong Point 2 pumping station rely on calculation procedures to determine equivalent odour concentrations. An odour concentration value of 276 OU has been applied to determine surrounding land odour impacts. The applied odour value is likely conservative given that the recently installed chemical dosing system by OCS should inactivate a significant proportion of the precursor sewage compounds responsible for odour generation. Furthermore, the HWC has advised Advitech that chemical dosing rates are expected to progressively increase over the coming months to further manage dissolved sulphide concentrations entering the Toronto wastewater treatment plant.

7.1 Level 1 Screening Assessment

Tables 3 and **4** outline the results of the Level One odour assessment for Marmong Point 2 pumping station.

Table 3: Worst-case emission data

Description	Value	Units
Predicted Odour Concentration[1]	276	OU
Morning Peak Stack Educt Flow	4.49E^{-02}	Nm^3/s
Evening Peak Stack Educt Flow	6.26E^{-02}	Nm^3/s
Daily Average Stack Educt Flow	1.67E^{-02}	Nm^3/s
Stack height	9.0	m

[1]- Predicted odour concentration based upon 10th- percentile equilibrium H_2S gaseous concentration with sewage having dissolved sulphide concentration of 0.055 mg/L within the Marmong Point 2 wet well (refer to **Section 6** and **Appendix I**).

Table 4: Results of Level One Odour Screening Assessment

Description	Morning Peak	Evening Peak	Daily Average
Zone potentially affected by offensive odour from sewerage pumping station[1] (m)	13	15	7

1- Based upon Level One NSW OEH level one odour screening assessment guidelines. Odour guideline criteria 2 OU.

7.2 Dispersion Model of Predicted Odours

Figure 3 illustrates the predicted one-second 100th percentile GLC for odour. The dispersion analysis suggests odour concentrations are well below the maximum GLC criteria of 2 ODU for urban localities. The maximum predicted odour is 0.17 OU.

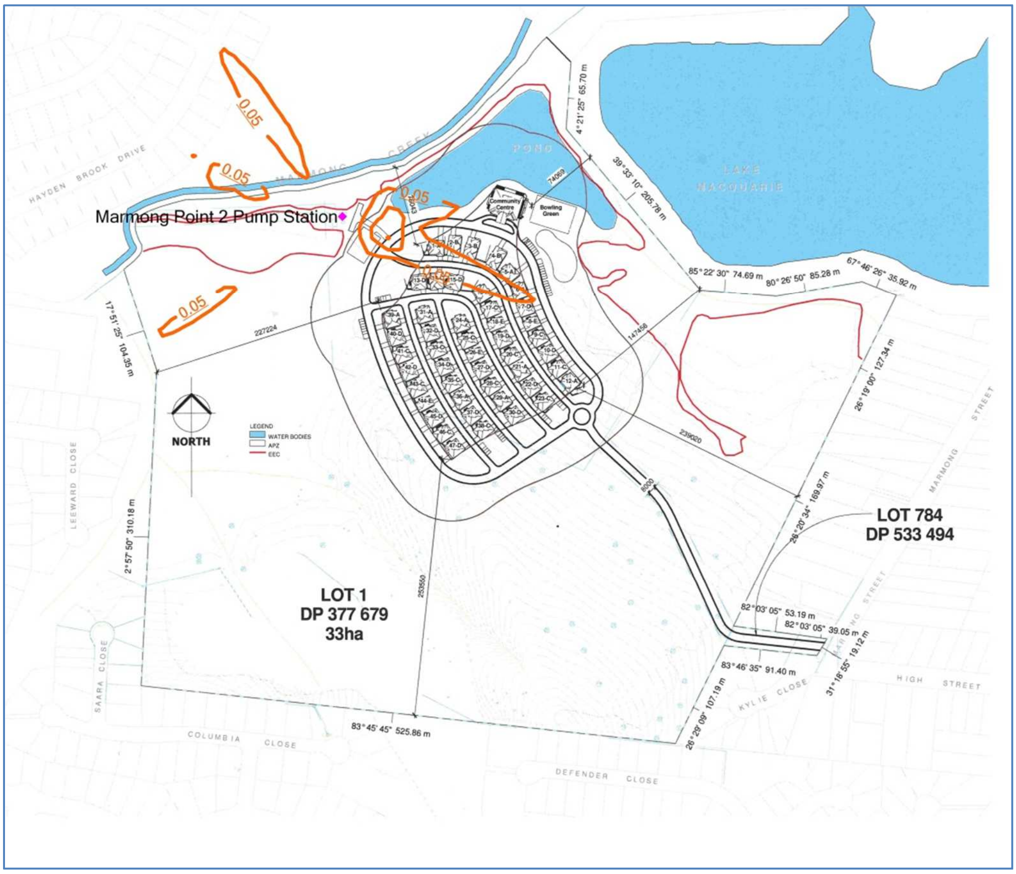

Figure 3 – GLC for Odour (OU) One-second Averaging Period 100th Percentile

8. CONCLUSIONS AND RECOMMENDATIONS

The results of the Level One odour assessment and air dispersion analysis indicate that potential odours from the Marmong Point 2 pumping station are unlikely to result in odour nuisance at any MPRV dwellings. The closest building to the Marmong Point 2 pumping station is the proposed open storage area. The storage area is located approximately 25 metres from the pumping station. Level One odour assessment suggests land within a radius of 15 metres from the pump station stack may likely be impacted by sewage odours above guideline criteria of 2 OU. Additional air dispersion analysis using AUSPLUME predicts odour GLC to be well under the NSW OEH 2 OU guideline.

HWC has recently installed a chemical dosing system that will significantly control odour generation at the Marmong Point 2 pumping station. The chemical dosing system has undergone commissioning and performance testing with significant reductions in dissolved sulphides reported and maintained. HWC is currently in the process of increasing chemical dosing rates to achieve its performance objectives at the nearby Toronto wastewater treatment plant. The increased dosing rates will further lower the odour generation potential at the Marmong Point 2 pumping station and ensure that nuisance odour on surrounding land areas is unlikely.

Endorsements

Function	Signature	Name and Title	Date
Written By		Carl Fung Senior Consultant - Environmental Engineering	29-10-2012
Checked By		Carl Fung Senior Consultant - Environmental Engineering	29-10-2012
Authorised for Release By		Steven Smith Managing Director	29-10-2012

Appendix I

Hydrogen Sulphide Generation in Sewers

In brief, sulphate (SO_4^{2-}) in the wastewater is reduced anaerobically to sulphide (S_2^-) by bacteria. S_2^- is a precursor to soluble H_2S and the relationship between them is dependent upon the water pH and ionic dissociation constant. Virtually all S_2^- is in the form of HS^- for waters that have a pH lower than 8. The HS^- ion, in turn, is in equilibrium with soluble H_2S given by:

$$H_2S \Leftrightarrow HS^- + H^+, \quad (1.)$$

and

$$[H_2S]_{aq} = \frac{[HS^-]\,[H^+]}{1.12x10^{-7}}, \quad (2.)$$

where $[H_2S]_{aq}$ is the aqueous concentration of H_2S in (gmole/L), $[HS^-]$ is the aqueous concentration of HS^- in (gmole/L) and $[H^+]$ is the aqueous concentration of H^+ in (gmole/L). A value of H^+ is determined by knowing the pH of the water defined as:

$$pH = -\log[H^+]. \quad (3.)$$

S_2^- concentrations in sewage reticulation systems vary depending upon the characteristics of the drainage catchment. According to HWC monitoring and testing the average soluble sulphide (assumed S_2^-) concentration at the Marmong Point 2 pump station between 2006 to 2009 is 0.11 mg/L.

The installation of an iron salt chemical dosing system will significantly reduce S_2^- within the Marmong Point 2 pump station wet well. Post commissioning testing within the Marmong Point 2 pump station wet well (February 2012) indicates soluble sulphide concentrations between 0.03 and 0.09 mg/L (average 0.06 mg/L). This suggests that the iron salt chemical dosing system is achieving approximately a 50% reduction. It should be noted that HWC is currently embarking on progressive stepwise increases in iron salt dosing in order to achieve certain catchment key performance criteria. At the time of writing this report, HWC had incrementally increased its dosing rate twice since February 2012 measurements. As such, it is expected that soluble sulphide concentrations within the Marmong Point 2 pump station wet well will further reduce and therefore lower the odour generation potential at this location and the immediate sewerage catchment.

This study assumes a reduction of 50% based upon the 2006 to 2009 average value of 0.11 mg/L. Based on previous discussions this reduction is considered conservative.

The *Hydrogen Sulphide Control Manual* (MMBW, 1989) describes the steady-state equilibrium between the aqueous H_2S concentration and the gaseous H_2S concentration as:

$$K = \frac{|H_2S|_{aq}}{|H_2S|_g} = 0.0009T_w^{\ 2} - 0.1007T_w + 4.3737, \quad (4.)$$

where K is the partition coefficient between the aqueous H_2S (mg/L) and the gaseous H_2S (mg/L). The gaseous H_2S concentration in mgH_2S/L_{air} is similarly converted into ppm:

$$1ppm = \frac{1mgH_2S}{L_{air}} \times \frac{22.415L_{H_2S}}{gmoleH_2S} \times \frac{1gH_2S}{1000mgH_2S} \times \frac{1gmoleH_2S}{34.06gH_2S} \times 1x10^6. \quad (5.)$$

Equation 1 in **Section 6** can be applied to produce a corresponding value of OU. According to the *Hydrogen Sulphide Control Manual* (MMBW, 1989) the actual gaseous H_2S concentration is much lower than the steady-state equilibrium concentration calculated from Equations 4 and 5. The suggested 10th percentile value is used to arrive at an operating condition.