



Leigh Creek Energy

Air Quality Monitoring Plan

ISG Demonstration Plant



Leigh Creek Operations Pty Ltd

ACN: 107 531 822

PO Box 12 Rundle Mall

Adelaide SA 5000

Phone: 08 8132 9100

Fax: 08 8231 7574

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Prepared by	Michelle Waters Environmental Approvals and Compliance Manager Johan Meline Pacific Environment

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Leigh Creek Energy acknowledge the Adnyamathanha people, the traditional owners of the land on which our operations occur and pay our respects to their Elders past and present.

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1 Introduction

1.1 Leigh Creek Energy Project

Leigh Creek Energy Ltd (LCK) is the owner and proposed operator of the Leigh Creek Energy Project, located at Leigh Creek in South Australia, 550 km north of Adelaide. The project is located within Petroleum Exploration Licence 650 (PEL650), which overlies the Leigh Creek Coalfield, where the development of traditional extraction methods for existing resources are considered unviable.

LCK plans to produce energy from coal using a process known as in situ gasification (ISG). The ISG process converts coal from its solid state into a gaseous form, resulting in the generation of synthesis gas (syngas) containing methane, hydrogen and other valuable components. The syngas can be either used to produce electricity directly or further refined into a variety of products including synthetic methane and ammonia.

As the initial stage of the project, a small-scale ISG demonstration plant is proposed to be constructed to obtain information to inform the design for a possible commercial facility. The demonstration plant will involve establishment of a single gasifier chamber and above-ground infrastructure to produce syngas for a short period (approximately 2-3 months), so that the syngas composition and performance of the process can be confirmed. Environmental and geotechnical data will also be collected during operation of the demonstration plant to support any commercial plant approvals process. Syngas produced by the demonstration plant will be combusted following analysis.

1.2 Scope of Document

This Air Quality Monitoring Plan (AQMP) has been prepared for the operation of the demonstration stage of the Leigh Creek Energy Project and should be read in conjunction with the Environmental Impact Report (EIR) and the Statement of Environmental Objectives (SEO).

1.3 Relevant Reports, Guidelines and Standards

This AQMP has been prepared based on information provided within the following documents:

- Leigh Creek Energy (2017). Environmental Impact Report, ISG Demonstration Plant;
- Leigh Creek Energy (2017). Statement of Environmental Objectives, ISG Demonstration Plant;
- Pacific Environment (2017). Air Quality Impact Assessment, Leigh Creek Energy ISG Demonstration Plant; and
- Pacific Environment (2017a). Leigh Creek Coalfield and Copley Township Background Field Odour Observations – Preliminary Assessment.

The Air Quality Impact Assessment included dispersion modelling of standard operations for the demonstration plant with emissions from the syngas thermal oxidiser and onsite generators and compressors; as well as emissions from non-routine operations such as purging and venting.

This AQMP has developed in general accordance with the *Environment Protection (Air Quality) Policy 2016* (Air EPP).

1.4 Terminology and Definitions

The following terms are used within this document in relation to the demonstration plant operation.

Table 1: Terms and Definitions

Term	Definition
DEM-ERD	Department for Energy and Mining-Energy Resources Division
EIR	Environmental Impact Report
Flaring	The burning of unwanted gas through a pipe (called a flare).
PEL650	Petroleum Exploration Licence 650 comprising the tenement for the Leigh Creek Energy Project.
SEO	Statement of Environmental Objectives
STEMS	Incident reporting programme/software
Syngas	Synthesis gas. The product of gasification, composed mainly of carbon dioxide, hydrogen, carbon monoxide, methane, nitrogen, steam and gaseous hydrocarbons.
Thermal oxidiser	A process unit for air pollution control to remove hazardous gases from industrial air streams by destroying them using high temperature.
Venting	The release of gas, usually through a vertical pipe called a vent or vent stack.

2 Demonstration Site Details

2.1 Description of Demonstration Plant Site

The demonstration plant site is located in a relatively flat area between waste rock stockpiles on the southern side of the main mine access road, within the Leigh Creek Coalfield. It is significantly disturbed and a substantial proportion of the site has been previously graded. Haul roads, old road alignments, excavations, stockpiles and other disturbances are prevalent across the site. At the demonstration plant site, stockpiling of mine spoil has occurred extensively adjacent to the site.

Aerial photographs indicate that the site is located west of the original path (before mine development) of the Leigh Creek floodplain.

2.2 Demonstration Plant Infrastructure

The demonstration plant facilities will include both subsurface and surface infrastructure.

Subsurface infrastructure will include the inlet and outlet wells, a number of monitoring wells and a gasifier observation well. Inlet, outlet, observation and monitoring wells will all contain instrumentation to monitor temperature and/or pressure.

At the surface, the majority of the infrastructure will be installed adjacent to the inlet and the outlet wells, which will be approximately 300 to 350 m apart at the surface. A combination of wired and wireless instrumentation equipment will be installed to communicate between the two sites and the control room.

At the inlet well, equipment will include:

- the inlet wellhead
- piping and valves
- flow control and metering equipment
- diesel-powered compressors to inject air into the well
- pumps for water injection
- tanks for water storage prior to injection
- diesel generator(s)
- diesel storage tank(s) for compressor and generator
- electrical and control equipment
- control room
- site office and amenities
- vehicle parking
- truck off-loading area
- equipment storage and maintenance facilities.

At the outlet well, equipment will include:

- the outlet and observation wellheads
- piping, valves and pressure safety valves
- flow metering and pressure control equipment
- gas analysis and sampling equipment
- gas clean-up equipment
- condensate storage vessel and transfer pumps
- tanks for storage of outlet condensate and water
- thermal oxidiser
- cold vent
- nitrogen storage vessels (for inert blanketing of vessels and purging of pipelines)

- diesel generator(s)
- diesel storage tank(s)
- LPG cylinders
- truck off-loading and loading area
- pumps for water injection
- tanks for water storage prior to injection
- electrical and control equipment
- vehicle parking.

The demonstration plant surface facilities will utilise standard oil and gas and petrochemical components. Many of these will be pre-assembled and skid-mounted to facilitate installation at the site and later removal.

3 Air Quality Monitoring Plan

3.1 Purpose and Objectives

The specific environmental objectives for the operation of the demonstration plant, as detailed in the SEO and relevant to air quality, are:

- Ensure that reasonable practical measures are implemented in the design and operation of the ISG demonstration plant to minimise emissions.
- Regular air quality measurements are undertaken to indicate levels are below relevant health-based air quality criteria at sensitive receptors.
- Stakeholder complaints regarding air quality or odour are documented and reasonable steps taken to address them can be demonstrated.

In practical terms, the purpose of the AQMP is to provide details for the monitoring planned for the project and record the performance for the operation of the demonstration plant.

To assist with meeting the environmental objectives for the demonstration project, background air quality has already been undertaken and two automatic weather stations have been installed on PEL650.

3.2 Existing Air Quality

Air quality in the broader region is typical of a remote rural environment and influenced by a range of activities including dust from stock and vehicle movements or high winds, and vehicle and equipment exhaust fumes. Air quality in the vicinity of the Leigh Creek Coalfield is also influenced by:

- dust generation from spoil dumps and mining / rehabilitation activities; and
- particulates, vapour and combustion emissions from spontaneous combustion of mine spoil dumps. The pits are surrounded by mine spoil dumps which are known to spontaneously combust releasing particulates and sulphurous and phenolic odours.

The closest residences are at Copley which is located approximately 8.5 km south of the demonstration plant site and approximately 1 km south of the southern boundary of PEL 650. The occurrence of odours at Copley (e.g. the smell of rotten eggs) has been informally raised by several stakeholders in mid to late 2016 (before any activities with the potential to release odour had been undertaken by LCK).

A preliminary background odour assessment was undertaken in June 2017 (Pacific Environment 2017a). This detected odour from the coalfield (a smoky character consistent with fugitive emissions from spontaneous combustion) at a distance of approximately 5 km. Odour was also recorded in Copley from the caravan park wastewater irrigation area. Winds were not blowing towards Copley at the time of the site visit for field odour observations, which meant that there was no opportunity to observe odour from the coalfield at Copley. However, it is understood that odour from the coalfield is occasionally present in Copley and that coalfield odour has been observed as far south as Leigh Creek.

The air quality baseline assessment undertaken as part of the EIR and SEO showed that:

- For the standard operations, with normal gas flows for the thermal oxidiser for destruction of the syngas, compliance with the *Environment Protection (Air Quality) Policy 2016* (Air EPP) assessment criteria is demonstrated at surrounding sensitive receptors with no exceedances predicted outside of the PEL 650 boundary;

- Non-routine high and low flow venting operations are unlikely to occur, and very unlikely to co-occur with worst dispersion conditions. However, should venting take place in poor dispersion conditions in wind directions towards sensitive receptors odour from the venting at receptors can occur; and
- While higher concentrations of odour are predicted at peak impacts Air EPP health based air quality assessment criteria are not predicted to be exceeded for the non-routine venting events.

More detailed results of the preliminary background odour assessment are available and discussed in Appendix D of the EIR document.

3.3 Odour Management and Monitoring Plan

Based on the information collected and modelled in air quality baseline assessment the following monitoring will be undertaken for the operation of the demonstration plant:

- Field odour observations: field odour observations targeting near-field and far-field potential odours from the demonstration plant and monitoring programme;
- Thermal oxidiser emissions monitoring;
- Exposure: health and safety monitoring around the demonstration plant area targeting CO, H₂S, SO₂ and NO₂;
- Ambient: combination of field odour observations and hand held ambient air quality readings targeting near-field and far-field CO, H₂S, SO₂ and NO₂ to demonstrate decline in concentrations with distance from the demonstration plant area in downwind directions; and
- Meteorological: two on-site automatic weather stations (AWS), a 2m AWS recording wind speed and wind direction, and a 10m AWS recording wind speed, wind direction, solar radiation, humidity, rainfall and temperature.
- Stakeholder management: All odour complaints will be investigated promptly and appropriate remedial action will be taken if the complaint is validated.

3.3.1 Field Odour Observations

The proposed field odour observations methodology is a modified version of the “German Standard VDI 3490” (1993) method for odour surveys. The method standardises the odour logging approach by the adoption of a standard scale for describing odour intensity, as detailed in the German Standard VDI 3882, which relates to odour measurement. This method was selected as it enables the evaluation of odour over time rather than single point in time with discrete observations.

The German Standard describe a procedure for logging odour in the field which involves noting the odour intensity based on a scale of 0 to 6 (as shown in Table 2) every 10 seconds over a 10-minute period for a number of locations. In addition to making intensity observations, the observer also notes the character of the odour/odours observed, if that can be determined. Generally, the observations are focussed on the targeted odour/odours. If other relevant odours or background odours are present in significant intensities this is also noted and recorded as appropriate.

Locations for the field odour observations are selected to cover downwind locations at various distances from the targeted odour source/sources as well as upwind locations for reference of background odour. The locations for observations will be selected considering operation conditions and weather conditions (dispersion conditions and wind direction) at the time of the observations.

The following areas will be monitored for odour:

- the demonstration plant area;
- the PEL 650 boundary;
- areas downwind of the plant with access beyond the site boundary; and

- nearest receptors (if down wind and site access).

In addition to recording odour intensity observations, wind conditions (i.e. wind direction and wind speed) from the site weather stations will also be presented as part of the field odour observation results.

Table 2: Odour Intensity

Perceived Odour Strength	Intensity Level Rating	Interpretation
Extremely Strong	6	In normal circumstances, this should be very rare in a field situation. For an offensive type of odour, the reaction would be to immediately mitigate against further exposure until the exposure level is reduced. The odour cannot be tolerated.
Very Strong	5	The odour character is clearly recognisable. For an offensive type of odour, exposure to this level is considered unpleasant/undesirable to the point that action to mitigate against further exposure is considered or taken.
Strong	4	The odour character is clearly recognisable. For an offensive type of odour, exposure to this level would be considered unpleasant/undesirable.
Distinct	3	The odour character is clearly recognisable. Note that this must still apply even if in a different context or situation - for example, not knowing or expecting what type of odour may be present. The odour is tolerable – even for an offensive odour.
Weak	2	A detectable weak odour stronger than very weak and less strong than distinct.
Very Weak	1	Odour only just detectable.
Not Perceptible	0	No odour detected.

Sources:

- Pitt, D. (2014). Field odour assessments for estimating odour concentrations. *Air Quality and Climate Change*, 48(1), 24-32.
- VDI. (1993). Determination of odorants in ambient air by field inspections intensity VDI3940. Dusseldorf: Kommission Reinhaltung der Luft im VDI und DIN.

3.3.2 Thermal Oxidiser Emissions Monitoring

As part of the regular air quality measurements LCK will sample and assess gas emissions from the top of the thermal oxidiser to assess the efficiency of the oxidiser and to better understand the composition of gas emissions. The results from this sampling will further refine the methodology of the air quality monitoring plan for the ISG demonstration plant and potential future phases of the project.

3.3.3 WHS Exposure Monitoring

Portable multi gas monitors¹ are to be used for the monitoring around the plant area with sensors for carbon monoxide (CO), sulphur dioxide (SO₂), hydrogen sulphide (H₂S) and nitrogen dioxide (NO₂). The results are to be evaluated against the Australian occupational exposure standards for short term (STEL 15 minutes) and daily (TWA 8 hour) averages exposure as presented in the Performance Criteria section below.

¹ MX6 iBrid or similar. Detection limits typically in the parts per million (ppm) range with the lower detection limits such as: 1.0 ppm for CO and 0.1 ppm SO₂, H₂S and NO₂.

Monitoring locations primarily to target work areas at the demonstration plant. Depending on conditions and access downwind locations at radiuses of 10 m at 50 m from emission sources could be targeted².

The monitoring will include:

- one upwind location; and
- two downwind locations each for the plant inlet and outlet ends.

The monitoring should be performed for fixed downwind locations for worst case monitoring³. To cover diurnal variations monitoring should be performed over a 24-hour period in three 8-hour sections (day time, evening and overnight or as suitable considering shift times worked).

3.3.4 Ambient Monitoring

A combination of field odour observations and WHS exposure monitoring will be applied to assess far-field (or ambient) air quality conditions in downwind directions. The primary principle of this approach is to document and demonstrate the decline in impacts with distance in the downwind direction from the demonstration plant site to the PEL650 boundary and beyond. Monitoring and observation locations will be selected as to track any plume centre lines⁴. Receptor locations will also be considered, when in downwind wind directions.

3.3.5 Meteorological Monitoring

Two on site automatic weather stations (AWS) were installed by LCK on PEL650 in 2017, including a 2m AWS mast at the demonstration plant and a 10m AWS mast at high point on the southern end of the PEL. These AWS record the following data in five-minute intervals:

- 2m AWS: wind speed and wind direction; and
- 10m AWS: wind speed, wind direction, solar radiation, humidity, rainfall and temperature.

Wind data for the monitoring events is to be reviewed in parallel to the air quality monitoring data and field odour observations.

3.3.6 Stakeholder Management

Air quality measurements will be undertaken to indicate levels are below relevant health-based air quality criteria at sensitive receptors (i.e. Copley and Leigh Creek towns). But should any complaints be received from community stakeholders specific to issues around odour will be managed through the LCK *Enquiries and Complaints Handling Procedure (2018)* and documented in our safety incident management software (STEMS). Section 6, Complaints Specific to Air Quality, of the procedure indicates the following will occur:

1. Review of wind direction for the time of the complaint.
2. The Environmental/Site Manager or other nominated and appropriately trained person will travel to the complainant's location (if known) to inspect the air quality situation.
3. If there is reason to believe that another source is behind the complaint the manager will drive around the local area in an attempt to identify other possible sources.

² Monitoring locations need to consider wind directions and safe access non-activity locations.

³ To be evaluated. It is noted that WHS monitoring is typically not performed for fixed locations. Monitors are usually carried by representative workers to capture typical exposure levels.

⁴ Beyond the PEL650 boundary land access issues may restrict coverage.

4. The results of any inspections will be recorded in the Complaints Register.

Note that complaints will be cross checked against any activities on site (e.g. venting during an abnormal/emergency event).

Air Quality fact sheet have also been prepared and will be available on the LCK website. Hard copies will also be available to the public at Copley and Leigh Creek. LCK will also develop a community newsletter that will enable LCK to communicate with the local communities in addition to ongoing open days in Leigh Creek and Copley.

3.4 Frequency of Monitoring

Air quality monitoring and field odour observations will be undertaken monthly for the operation of the demonstration plant, as per the proposed following schedule:

- one month prior initiation;
- during start up and initiation;
- monthly intervals during operation;
- at closure; and
- one month post decommissioning.

The air quality monitoring for each event will cover a 24-hour period in three 8-hour sections with field odour observations included in sessions covering the same period.

3.5 Performance Criteria

Table 3: Safe Work Australia Exposure Standards Monitoring Performance Criteria

Pollutant	Time Weighted Average (TWA)		Short Term Exposure Limit (STEL)	
	Averaging Period	Exposure Standard	Averaging Period	Exposure Standard
CO	8 hours	30 ppm, 34 mg/m ³	NA	NA
H ₂ S	8 hours	10 ppm, 14 mg/m ³	15 minutes	15 ppm, 21 mg/m ³
SO ₂	8 hours	2 ppm, 5.2 mg/m ³	15 minutes	5 ppm, 13 mg/m ³
NO ₂	8 hours	3 ppm, 5.6 mg/m ³	15 minutes	5 ppm, 9.4 mg/m ³

Sources:

- Safe Work Australia. (2014). Search Exposure Standards. Retrieved from Hazardous Chemical Information System (HCIS): <http://hcis.safeworkaustralia.gov.au/ExposureStandards>

3.6 Reporting

External reporting (e.g. incidents, annual reports) will be carried out in accordance with Petroleum and Geothermal Energy Act 2000 requirements and the SEO.

Notification will be provided to DEM-ERD where relevant for the following non-routine operational matters:

- thermal oxidiser off-line for unscheduled extended period
- cold vent on-line for unscheduled extended period
- reasonable complaints from directly affected stakeholders.

4 References

Leigh Creek Energy (2017). Environmental Impact Report, ISG Demonstration Plant.

Leigh Creek Energy (2017). Statement of Environmental Objectives, ISG Demonstration Plant.

Pacific Environment (2017). Air Quality Impact Assessment Leigh Creek Energy ISG Demonstration Plant. Pacific Environment Pty Ltd, Adelaide.

Pacific Environment (2017a). Leigh Creek Coalfield and Copley Township Background Field Odour Observations – Preliminary Assessment. Report to JBS&G, August 2017.

Appendix A: Figures

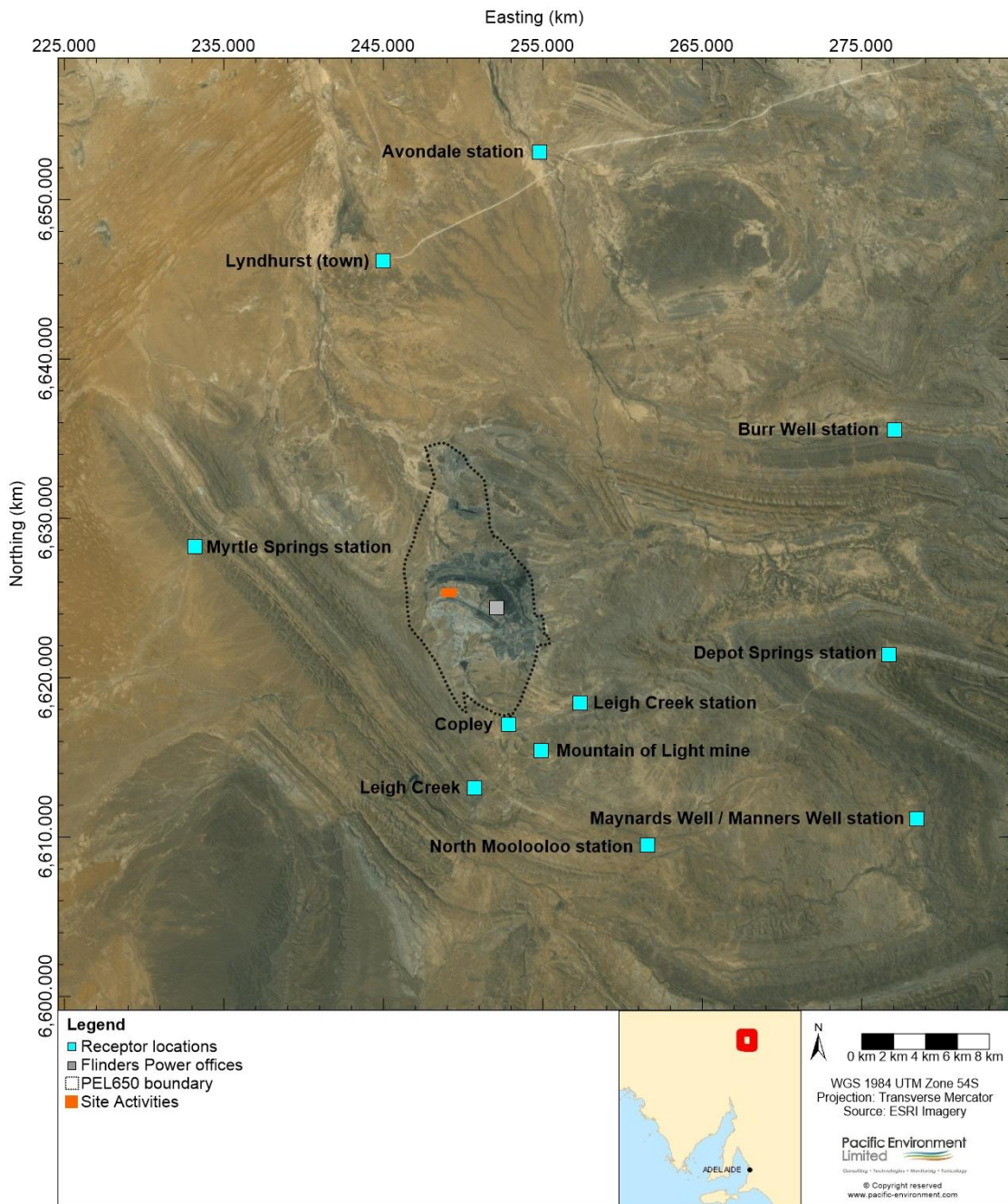


Figure A.1: Site location and PEL650 with surrounding townships and receptor locations

Appendix B: Summary of Government Agency Consultation Submissions and Responses

#	AQMP Reference	Issue Raised in Submission	LCK Response
1	pg. 8	<p>Section 3.1 outlines the purpose and Objectives of the monitoring plan, however nowhere within the plan does it outline the specific SEO assessment criteria that must be met to ensure compliance with the Objectives of the SEO.</p> <p>Relevant criteria should be documented with relevant information stated on how the monitoring plan will demonstrate compliance with those criteria.</p>	Noted. The change has been reflected in the AQMP.
2	pg. 8	Section 3.2 outlines the occurrence of odours at Copley (rotten egg gas) being informally raised by the several stakeholders in mid to late 2016. Has there been any further stakeholder concerns regarding odour raised since 2016?	No, there have been no further complaints from residents at Copley.
3	pg. 8	Section 3.2 outlines that a preliminary background odour assessment was undertaken in June 2017 (Pacific Environment 2017), please provide a copy of this assessment. It is also suggested that it be made clear that more detailed results of this assessment are available and discussed in Appendix D of the EIR document.	<p>An electronic copy of the report was submitted to DEM-ERD.</p> <p>The revised AQPM has a statement that reads <i>more detailed results of this assessment are available and discussed in Appendix D of the EIR document.</i></p>
4	pg. 8	<p>Section 3.2 outlines that a background odour assessment was carried out in June 2017, however at the time winds were blowing away from Copley township. Has LCK undertaken any further baseline odour assessments?</p> <p>It is noted that air quality monitoring and field observations will be undertaken 1 month prior to operation of the demonstration plant. DEM-ERD suggest that this baseline assessment is undertaken when winds are blowing towards Copley.</p>	<p>LCK has not undertaken any further baseline odour assessments since June 2017.</p> <p>We have two on site automatic weather stations that record among other parameters wind speed and wind direction. Monitoring of the wind direction over that last 30 days has shown that winds have generally been blowing away from Copley.</p>

#	AQMP Reference	Issue Raised in Submission	LCK Response
5	pg. 8 and 9 of the AQPM and Appendix D of the EIR	<p>Section 3.2 and Appendix D of the EIR outlines that during non-routine cold venting that coincides with worst case dispersion conditions, odours may be present at receptors (Copley). How do LCK intend to manage odour complaints, and how do LCK intend to verify their validity?</p> <p>DEM-ERD request LCK develop an odour management plan to ensure odours complaints received by nearby receptors can be adequately documented (registered) and reasonably verified/addressed in line with the criteria under Objective 10 of the SEO.</p> <p>This management plan should also better document how LCK intend to liaise with the local community regarding operations, including the provision of fact sheets as outlined within the guide to how section of Objective 10 of the SEO.</p>	<p>LCK has an <i>Enquiries and Complaints Handling Procedure (2018)</i> that details the process for recording, managing and responding to enquiries and complaints from stakeholders. <i>Section 6, Complaints Specific to Air Quality</i>, of the procedure indicates the following will occur:</p> <ul style="list-style-type: none"> • Review of wind direction for the time of the complaint. • The Environmental/Site Manager or other nominated and appropriately trained person will travel to the complainant's location (if known) to inspect the air quality situation. • If there is reason to believe that another source is behind the complaint the manager will drive around the local area in an attempt to identify other possible sources. • The results of any inspections will be recorded in the Complaints Register. <p>Note that complaints will be cross checked against any activities on site (e.g. venting during an abnormal/emergency event).</p> <p>Noted. Rather than writing a separate odour management plan section 3.3 has been revised to read Odour Management and Monitoring Plan developed in line with the criteria under Objective 10 of the SEO. Any complaints received will be managed through the <i>Enquiries and Complaints Handling Procedure (2018)</i> and documented in our safety incident management software (STEMS).</p> <p>An Air Quality fact sheet has been prepared and will be available on the LCK website. Hard copies will also be available to the public at Copley and Leigh Creek.</p>

#	AQMP Reference	Issue Raised in Submission	LCK Response
		It is expected that community liaison is proactive and not reactive and should be undertaken prior to any approved gasification processes.	Development of a community “newsletter” / “news” will enable LCK to communicate with the local community, in addition to ongoing open days in Leigh Creek and Copley.
6	pg. 9	Section 3.3 – It is suggested that this section makes mention that LCK will be assessing and sampling gas emissions from the top of the thermal oxidiser to assess the efficiency of the oxidiser and to better understand the composition of gas emissions. The results from this sampling will further refine the methodology of the air quality monitoring plan for the demonstration plant and/or potential future phases of the project.	Noted. This has been reflected in the revised AQMP.
7	pg. 12	Under section 3.6, it is requested that further details are provided on data and events to be reported to DEM-ERD in line with section 3.2 of the SEO, in particular: <ul style="list-style-type: none"> • Thermal oxidiser offline for unscheduled extended period • Cold vent online for unscheduled extended period • Reasonable complaints from directly affected stakeholders 	Noted. This has been reflected in the AQMP.