AIR QUALITY IMPACT ASSESSMENT

Prepared for

PSP TIMBERS
OUDTSHOORN

FINAL REPORT
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1 INTRODUCTION

Messrs PSP Timbers (PSP) operates a wood preservative treatment plant in Oudtshoorn in the Western Cape. Three different wood preservative treatment operations are carried out by PSP, i.e. treatment with:

-- Creosote
-- Copper-chrome arsenate (CCA)
-- Borates

Two significant residential areas are located close the PSP's plant. One is situated approximately 120 metres to the east of the PSP property's eastern corner while the other is situated approximately 140 metres to the north of the PSP property's northern corner. Both are low income / informal settlements.

In addition to the wood preservative treatment plant PSP also wishes to install a timber drying kiln to dry wood from their sawmill. For this purpose an environmental impact assessment is in process to support PSP's application for official approval of their expansion plans.

In addition, PSP is in the process of applying for an atmospheric emission license (AEL) for both processes to the Eden District Municipality (EDM) in terms of the Air Quality Act and commissioned Messrs Lethabo Air Quality Specialists (LAQS) to assess the impact that the plant will have on the ambient air in the general vicinity of the plant.

LAQS modelled the dispersion of pollutants emitted from PSP’s operations to estimate ground-level concentrations of the pollutants and to determine the spread of odours from the wood treatment process.
This report discusses the dispersion modelling work and odour assessment in detail.

2 PROCESS DESCRIPTION

2.1 WOOD PRESERVATIVE TREATMENT

PSP preserves wooden poles by either treatment with a water-based preservative (copper chrome arsenate or borates) or by treatment with coal-tar creosote.

-- Creosote treatment: Use of coal-tar creosote
-- Copper chrome arsenate (CCA) treatment - use of a mixture of copper oxide, chromic acid and arsenic acid
-- Borates - use of a mixture of boric acid and borax (borates)

Of the three treatment processes, only emission of volatile organic compounds resulting from creosote treatment pose a potential risk to ambient air quality in the vicinity of the plant.

As a result, only the creosote treatment process is dealt with in this study.

2.1.1 Types of Creosote

The two main types in industrial production are wood-tar creosote and coal-tar creosote. The coal-tar variety, having stronger and more toxic properties, has chiefly been used as a preservative for wood, while the wood-tar variety has been used for meat preservation, wood treatment and for medicinal purposes as an expectorant, anti-septic, astringent, anaesthetic and laxative, though these have mostly been replaced by newer medicines. Coal-tar creosote had also in the past been used as an escharotic to burn malignant skin tissue and in dentistry to prevent necrosis, a practice that was ceased because of coal-tar's toxic and carcinogenic properties.
Wood-tar creosote is a combination of plant phenolics, primarily guaiacol and creosol (4-methylguaiacol), which will typically constitute 50% of the oil, followed by cresol and xylenol. The remainder consist of a combination of monophenols and polyphenols.

The two groups that occur in the greatest amounts in coal-tar creosote are the "tar acids", which consist mainly of phenols, cresols, and xylenols, including carbolic acid, and aromatic hydrocarbons, which divide into naphthalene and constituents of an anthracene nature. The quantity of each varies, based on the quality of tar and temperatures used, but generally, the tar acids won't exceed 5%, the naphthalene will make up 15 to 50%, and the anthracenes will make up 45% to 70%. The hydrocarbons are mainly aromatic and derivatives of benzene and related cyclic compounds such as naphthalene, anthracene, phenanthrene,acenaphthene, etc.

2.1.2 PSP Operations

Wood preservation is achieved by pressure or thermal impregnation of chemicals into wood to provide effective long-term resistance to attack by fungi, bacteria, insects, and marine borers. By extending the service life of timber products by five to ten times, wood preservation reduces the need for harvest of already stressed forestry resources, reduces operating costs in industries such as utilities and railroads, and ensures safe working conditions where timbers are used as support structures.

PSP generally operates their plant from 07h00 to 17h30 daily from Mondays to Saturdays. During the summer months when wood supply is higher, the operating hours may be extended to 21h00 on two days per week. On rare occasions overnight operations may occur as and when required to meet production schedules. The current total production rates of the three preservative treatment processes used by PSP are:

-- Creosote: 1 000 m³ per month
-- CCA: 1 200 m³ per month
-- Boron: 20 m³ per month
Steam required for the process is generated in a boiler that is fired with waste material generated during the timber preparation process. PSP currently burns approximately 20 m$^3$ of wood waste per day to meet its steam demands.

Regardless of the type of preservative used, a three-stage process is followed, i.e. conditioning, treating and storage.

**Conditioning:**

During conditioning the wood is dried to a moisture content of less than 25%. In PSP’s case this is achieved naturally as wood is stored on site for 4 weeks during summer and 6 to 8 weeks during winter to dry before it is ready for treatment.

**Treating:**

Dried wood is packed into a pressure vessel together with creosote. The vessel is pressurised to 4 to 8 bar pressure, depending on the volume of wood loaded into the vessel. The pressure is maintained for approximately 90 minutes.

On completion of the pressure stage the excess creosote is pumped from the pressure vessel to a holding tank after which a vacuum is drawn in the pressure vessel. The vacuum is maintained for 15 to 20 minutes after which the vacuum is released by the introduction of ambient air so that the vessel doors can be opened for removal of the treated wood. The vacuum step results in the retention of approximately 95% of the chemicals in the wood pores.

Up to the point of opening the pressure vessel the process operates in a closed loop as all liquids are pumped between the holding tank and pressure vessel and no fumes are released from the process. Some creosote vapours are released to atmosphere when the vessel is opened.
Treated wood is removed from the pressure vessel and retained in a drip area for approximately 24 to 36 hours so that excess creosote can drip from the wood. The drip area is a bunded area with concrete floors so that no creosote ends up in the soil. Due to the high retention achieved by the vacuum stage the drip quantity is low.

The drip area is located in an open-air area immediately adjacent to the treatment.

**Storage:**

Treated wood is stored on site in a finished goods yard of approximately 0.4 hectares.

### 2.1.3 Creosote Handling

Creosote is delivered to site by truck and transferred to a storage tank in the off-loading bay. This bay is designed to collect any spillage and to drain it to the drip area inside the building.

### 2.2 TIMBER DRYING OPERATIONS

Although currently in the planning stage and not operational yet, PSP wishes to install a wood drying kiln to dry wood from their sawmill on site. In the past PSP made use of a contractor in Knysna to dry the wood, but the contractor has ceased its operation. Wood is currently dried in ambient air, a process that consumes lots of space and is very slow. The following steps are envisaged for future operations:

Up to the drying stage nothing will change from current operations, i.e. wood is delivered to PSP's premises by road directly from the forests where the wood was harvested. The wood is delivered as untreated logs.

Excess branches and bark are removed from the logs prior to passing through the sawmill where the logs are sawed into planks, mainly for the manufacturing of pallets.
and fruit bins. Approximately 50% of the wood is used in this manner, the rest being unsuitable for planks and is, therefore, waste product.

The planks will subsequently be stacked on pallets and dried in a drying kiln prior to being used to manufacture pallets and fruit bins. PSP plans to dry approximately 100 m$^3$ wet wood per day, equivalent to approximately 52 tons dried wood per day, given an average specific gravity for dry pine wood of 0.52. This equates to an annual production capacity of approximately 17 900 tons per annum, based on an annual operating cycle of 344 days.

During the drying cycle the moisture content of the wood will be reduced from approximately 55% to approximately 12% by weight.

A portion of the waste product will be burned in a dedicated boiler to generate hot water that is circulated through the drying kiln. The hot water is circulated through a radiator inside the kiln prior to being returned to the boiler for reheating. Fans inside the kiln will circulate air in the cabin through the radiator, thus heating the air prior to it passing through the pallets with wet wood. Drying of the wood will, therefore, be indirect as the wet wood does not come into direct contact with the combustion gases.

A humidity sensor will automatically open vents in the drier so that saturated air can be replaced by "dry" ambient air.

PSP estimates that it will burn approximately 30 m$^3$ of wood waste per day to generate the energy necessary for the drying process. Combustion gases from the boiler will be emitted directly to atmosphere without passing through any air pollution control equipment.
3 EMISSIONS

There are two main sources of emission from the current process, i.e. volatile organic compounds (VOCs) from the creosote treatment process and emissions from the wood waste fired boiler.

Two further sources of emissions will be formed in the drying process, i.e. volatile organic compounds (VOCs) from the drying kiln and emissions from the wood waste fired boiler.

3.1 CREOSOTE PROCESS EMISSIONS

According to AP-42\(^{(1)}\) the VOC emissions consist of poly-aromatic hydrocarbons (PAHs) and a list of the 15 most prominent compounds included is given in Appendix A. Some physical properties and odour detection limits for the compounds contained in AP-42 are given as well.

AP-42 provides emission factors for each of the individual PAH compounds, as well as for total VOC emissions. According to AP-42 the total PAH content forms less than 1.5\% of the total VOC content.

3.2 WOOD-FIRED BOILERS

According to AP-42 the emission from wood-fired boilers consist of products of combustion and subsequently provides emission factors for total particulate matter, sulphur dioxide (SO\(_2\)), nitrogen oxides (NOx) and carbon monoxide (CO).

3.3 TIMBER DRYING

According to AP-42 the volatile organic compounds and particulate matter are released during timber drying operations. Emission factors for both are contained in AP-42.
3.4 EMISSION LIMITS

Limits on emissions of various pollutants from several types of industries have been set by the Department of Environmental Affairs and were published in the List of Activities resulting in atmospheric emissions and emission limits in Government Notice No. 248 (GN248) of 31 March 2010.

Both the creosote treatment plant and proposed timber drying plant are included in the List of Activities under sub-categories 3.3, "Tar production" and 9.5, "Wood drying and the production of manufactured wood products" respectively. The following emission limits have been set:

- Creosote plant: VOCs, existing plant: 250 mg/Nm$^3$
- Timber drying: Particulate matter, new plant: 150 mg/Nm$^3$
- Nitrogen oxides, new plant: 500 mg/Nm$^3$

Currently boilers are not included in the List of Activities with the result that no official emission limits for such installations exist.

4 DISPERSION MODELLING STUDY

The dispersion modelling study was carried out with EnviMan, a GIS-based emissions management software suite produced by Opsis AB in Sweden. The dispersion modelling component of the suite consists of the following four modules:

- Mapper: A map manipulation tool
- Emissioner: An extensive, relational emissions data base
- EnviMet: A meteorological data management program
- Planner: The actual dispersion model
4.1 MAPPER

Mapper is a digital map compiler. It is used to define GIS data sets and map sets to be used by all EnviMan GIS modules. It can import a variety of digital maps and structure the data in suitable forms, e.g. sheets, objects, etc.

It is the basis of the EnviMan GIS suite as it defines all co-ordinates for subsequent use by the various EnviMan modules.

4.2 EMISSIONER

Emissioner is a comprehensive, relational emissions data base that locates emission sources at fixed co-ordinates on the map compiled with Mapper. Sources are placed on the map by the user and the co-ordinates are automatically generated by Mapper.

Emissioner can handle particulate and gaseous emissions from the following sources:

-- Point sources, e.g. industrial stacks
-- Area sources, e.g. landfill sites
-- Grid sources, e.g. complete informal settlement areas
-- Line sources, e.g. motor vehicle emissions

Of these, point sources and area sources are of interest in this study (please see Section 4.5.2 below).

4.3 ENVIMET

Envimet uses meteorological data collected at ground level to calculate meteorological data sets used in dispersion modelling studies. Of primary importance are those parameters that determine scaling of the boundary air layer. These are:

-- Wind speed
These parameters are used by Envimet to calculate all of the parameters, e.g. stability of the air boundary layer, mixing heights, climate sets, etc., which are required by Planner in calculating the dispersion of pollutants from a source.

4.4 PLANNER

Planner is the dispersion module of the EnviMan suite and links with Mapper, Emissioner and Envimet to carry out dispersion modelling activities. It is designed to run simulations of air quality based on emission data created in Emissioner for the following scenarios:

-- Hypothetical weather definitions, i.e. user-supplied information about temperature, wind speed, wind direction, cloud cover, etc.

-- True weather period, i.e. using recorded data from a weather monitoring station to simulate plume dispersion hour-by-hour over a defined period

-- Statistical weather period, i.e. using a pre-calculated sample of various weather conditions that typically occur during a year. This allows the creation of annual air quality maps for comparison against national guidelines and limit values.

Of these scenarios, the statistical period is applicable to the study of plume dispersion from PSP’s plant.

Planner makes use of three different dispersion models, two of which are aimed at motor vehicle emissions. Use is made of the Aermod dispersion model for the purposes of calculating the dispersion of plumes from point, area and grid sources. Aermod is a
USEPA-approved Gaussian plume dispersion model and is capable of simulating dispersion of pollutants over a distance up to approximately 50 km from the source.

4.5 INPUT DATA

4.5.1 Mapper

A 256-colour bitmap of the area around PSP’s plant was obtained from Google Earth® and imported into Mapper as a suitable multi-layer digital map of the area was not readily available.

The map is shown in Figure 1 below. For dispersion modelling purposes the area covered by the map was divided into a 50m x 50m grid.

The emissions data base (Emitter) links with the map and places emission sources on specific locations, as defined by the user.

![Figure 1: Map covering 2.5 km x 1.6 km](image)
4.5.2 Emissioner

In estimating annual emission from PSP's current and future operation, LAQS followed a conservative approach in which emission are rather over-estimated than under-estimated. This approach implies that the dispersion modelling study is based on the full design capacity of all processes concerned, instead of current or planned production rates.

The rationale behind the approach is straight-forward. Should the results of the dispersion modelling study indicate that PSP's emissions will not result in any exceedence of official ambient air quality standards, its actual operation will definitely not do so either.

Current operations:

As is mentioned in Section 3 above, two types of sources currently exist at PSP’s plant. The boiler stack is a point source as emissions are emitted through the stack tip only. VOC emissions from the creosote treatment plant, however, are not emitted through a stack, but are fugitive emissions emitted from the open sided building, storage of treated wood, etc. These emissions are, therefore, treated as an area source.

The major source of concern associated with wood preservative plants is the emissions of odorous compounds during the creosote treatment process. In fact, total volatile organic compounds are the only controlled emissions listed in GN248 for this type of process.

Compulsory information required for area source emissions are:

-- Height of release (average of 3 metres assumed)
-- Area of emissions (outer walls building assumed to be emission borders)
-- Definition of pollutants (PAH compounds as per Appendix A)
Emission rates of pollutants (PAH compounds, as per Appendix A)

Building downwash effects have been included in the setup of the dispersion model.

As was stated in Section 3.1 above, total PAH emissions form less than 1.5% of the VOC content of emissions. However, to follow a very conservative approach LAQS saw fit to regard all of the VOC emission and consisting of PAH compounds, thus creating the worst odour spread scenario possible.

Using the current production rate of the plant, as was discussed in Section 2.1.2 above, it implies that the maximum PAH emission rate will be 0.9 tons per annum.

While not regarded as a "controlled" source, emissions from the wood-fired boiler were included in the dispersion modelling study. Compulsory information required for area source emissions are:

-- Height of stack (11 metres)
-- Internal diameter of stack (0.5 metres)
-- External diameter of stack (assumed to be 0.51 metres)
-- Flue gas temperature (assumed to be 150 °C)
-- Flue gas velocity (assumed to be 12 m/s)

Building downwash effects have been included in the setup of the dispersion model.

Based on the mass of wood waste that is being burned to meet PSP's steam demands, the annual emissions from the boiler stack were estimated to be:

-- Total particulate matter (TPM) 8.4 tpa
-- SO₂ 0.5 tpa
-- NOx 10.3 tpa
-- CO 12.6 tpa
Future operations:

As was stated in Section 2.2 above, PSP plans to install a timber drying kiln on site will result in the addition of two more sources of emissions, i.e. the drying kiln itself and its associated boiler.

As is the case with the creosote plant, the drying kiln's emissions were regarded as an area source with the following emissions, based on maximum production capacity:

- -- VOCs 12.2 tpa
- -- TPM 2.8 tpa

Emissions from the boiler were regarded as from a point source with the same stack and flue gas characteristics as the creosote plant boiler, i.e. stack height, diameter, etc. The following emissions were estimated:

- -- Total particulate matter (TPM) 12.6 tpa
- -- SO₂ 0.8 tpa
- -- NOx 15.4 tpa
- -- CO 18.9 tpa

Combined Emissions:

Once the drying kiln is in operation the following total emissions were estimated:

- -- Total particulate matter (TPM) 23.8 tpa
- -- SO₂ 1.3 tpa
- -- NOx 25.7 tpa
- -- CO 31.5 tpa
- -- PAH 0.9 tpa
- -- VOCs 12.2 tpa
Output units:
Given an input of tons per annum, the output of Planner is in units of micrograms per cubic meter ($\mu g/m^3$).

4.5.3 EnviMet

Eighteen months' meteorological data collected at three monitoring stations around Oudtshoorn was procured by LAQS. None of the datasets included all of the required parameters with the results that data was extracted from the three sets and compiled into a single and complete meteorological dataset.

4.5.4 Planner

Planner does not require any user input as it extracts data from Mapper, Emissioner and EnviMet.

5 RESULTS

The approach to the project was to determine both annual average ground-level concentrations and 99-percentile concentrations (the levels below which concentrations will occur for 99% of the time) of all of the pollutants listed in Section 4.5.2 above.

In addition, the maximum estimated ground-level concentrations were determined, as well as where these would occur. The highest annual average concentrations at the nearest two residential areas were determined as well.

All simulations were carried out for a receptor height of 2 metres above ground level and a plume dispersion period of 120 minutes. This simulation period ensured that very low winds, e.g. below 1 m/s, would carry pollutants some distance from the plant.
In addition to the various pictures, results are summarised in tabular format in Table 1 below.

5.1 CURRENT OPERATIONS

The dispersion of pollutants from PSP's current operations is shown graphically in Figures 2 to 11 below.

Figures 2 and 3 respectively show the annual average and 99-percentile ground-level concentrations for total particulate matter (TPM) emissions.

Figures 4 and 5 respectively show the annual average and 99-percentile ground-level concentrations for sulphur dioxide (SO$_2$) emissions.

Figures 6 and 7 respectively show the annual average and 99-percentile ground-level concentrations for nitrogen oxides (NOx) emissions.

Figures 8 and 9 respectively show the annual average and 99-percentile ground-level concentrations for carbon monoxide (CO) emissions.

Figures 10 and 11 respectively show the annual average and 99-percentile ground-level concentrations for poly-aromatic hydrocarbon (PAH) emissions.

5.2 PLANNED FUTURE OPERATIONS

The dispersion of pollutants from PSP's planned future operations, i.e. once the drying operation is in place, is shown graphically in Figures 12 to 21 below.

Figures 12 and 13 respectively show the annual average and 99-percentile ground-level concentrations for total particulate matter (TPM) emissions.
Figures 14 and 15 respectively show the annual average and 99-percentile ground-level concentrations for sulphur dioxide (SO$_2$) emissions.

Figures 16 and 17 respectively show the annual average and 99-percentile ground-level concentrations for nitrogen oxides (NOx) emissions.

Figures 18 and 19 respectively show the annual average and 99-percentile ground-level concentrations for carbon monoxide (CO) emissions.

Figures 20 and 21 respectively show the annual average and 99-percentile ground-level concentrations for volatile organic compound (VOC) emissions.
Figure 2: Annual Average TPM Concentrations, Current Operations
Figure 3: 99-percentile TPM Daily Averaged Concentrations, Current Operations
Figure 4: Annual Average SO₂ Concentrations, Current Operations
Figure 5: 99-percentile SO$_2$ Concentrations, Current Operations
Figure 6: Annual Average NOx Concentrations, Current Operations
Figure 7: 99-percentile NOx Concentrations, Current Operations
Figure 8: Annual Average CO Concentrations, Current Operations
Figure 9: 99-percentile CO Concentrations, Current Operations
Figure 11: 99-percentile PAH Concentrations, Current Operations
Figure 12: Annual Average TPM Concentrations, Planned Future Operations
Figure 13: 99-percentile TPM Daily Averaged Concentrations, Planned Future Operations
Figure 14: Annual Average SO\textsubscript{2} Concentrations, Planned Future Operations
Figure 15: 99-percentile SO₂ Concentrations, Planned Future Operations
Figure 16: Annual Average NOx Concentrations, Planned Future Operations
Figure 17: 99-percentile NOx Concentrations, Planned Future Operations
Figure 18: Annual Average CO Concentrations, Planned Future Operations
Figure 19: 99-percentile CO Concentrations, Planned Future Operations
Figure 20: Annual Average VOC Concentrations, Planned Future Operations
Figure 21: 99-percentile VOC Concentrations, Planned Future Operations
<table>
<thead>
<tr>
<th>Location</th>
<th>Current Operations</th>
<th>Planned Future Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max annual average</td>
<td>Max 99-percentile</td>
</tr>
<tr>
<td>Distance (m), Direction</td>
<td>50, WSW</td>
<td>50, WSW</td>
</tr>
<tr>
<td>TPM, µg/m³</td>
<td>6.5</td>
<td>81.5</td>
</tr>
<tr>
<td>SO₂, µg/m³</td>
<td>0.5</td>
<td>7</td>
</tr>
<tr>
<td>NOₓ, µg/m³</td>
<td>10.3</td>
<td>143.8</td>
</tr>
<tr>
<td>CO, µg/m³</td>
<td>12.7</td>
<td>175.9</td>
</tr>
<tr>
<td>VOCs, µg/m³</td>
<td>37.4 (on-site)</td>
<td></td>
</tr>
<tr>
<td>PAH, µg/m³</td>
<td>16.1</td>
<td>313 (on-site)</td>
</tr>
<tr>
<td>Residential Area North</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPM, µg/m³</td>
<td>0.9</td>
<td>13.8</td>
</tr>
<tr>
<td>SO₂, µg/m³</td>
<td>&lt;0.1</td>
<td>1.1</td>
</tr>
<tr>
<td>NOₓ, µg/m³</td>
<td>1.1</td>
<td>23.5</td>
</tr>
<tr>
<td>CO, µg/m³</td>
<td>1.3</td>
<td>29.7</td>
</tr>
<tr>
<td>VOCs, µg/m³</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>PAH, µg/m³</td>
<td>0.4</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>Residential Area East</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------------------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TPM, µg/m³</td>
<td>SO₂, µg/m³</td>
</tr>
<tr>
<td>0.9</td>
<td>13.8</td>
<td>0.4</td>
</tr>
<tr>
<td>&lt;0.1</td>
<td>1.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>1.1</td>
<td>23.5</td>
<td>0.5</td>
</tr>
<tr>
<td>1.3</td>
<td>29.7</td>
<td>0.6</td>
</tr>
<tr>
<td>1.3</td>
<td>15.4</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Table 1: Results Summary

As can be seen from the 1st row of data, the estimated maximum concentrations will all occur on PSP's site. While these may pose a threat to ambient air quality levels, allowable concentrations on industrial premises are substantially higher. Please see Section 7.7 below.
6 DISCUSSION

6.1 MODEL RELIABILITY

The results of any computer model are only as reliable as the quality of the input data.

6.1.1 Emissioner:

The concentrations of all pollutants included in this study were estimated from internationally published emission factors and have not been verified. A degree of uncertainty exists, therefore, in the reliability of the emissions data.

The conservative approach followed implies that the predicted results are an over-estimation of expected actual conditions, but the degree of over-estimation cannot be determined.

6.1.2 EnviMet:

The meteorological data assembled by LAQS is comprehensive and no gaps exist in the final data set. It is, therefore, complete and a reliable meteorological data set could be compiled.

The distribution of winds in the Oudtshoorn area is shown graphically in Figure 22 below.
6.1.3 Planner:

As was stated previously, the user provides no direct data input to Planner. It uses Aermod, a USEPA-approved Gaussian plume dispersion model, and there is no reason to doubt the reliability of the dispersion calculations.

It is acknowledged that the Western Cape Province’s Department of Environmental Affairs and Development Planning (DEADP) compiled a general set of map and meteorological data for use in approved dispersion models in the Western Cape Province. While the dispersion model used by LAQS (Aermod) is one of these approved methods, locally measured data is regarded as more reliable and representative than the data set compiled by DEADP.
7 IMPACT ON OVERALL AIR QUALITY

Air quality standards for some pollutants were published by the Department of Environmental Affairs (DEA) in Government Notice No. 263 on 13 March 2009 (GN 263). Of the pollutants included in this study ambient air quality standards exist for SO$_2$, NOx and CO only and these are:

<table>
<thead>
<tr>
<th></th>
<th>SO$_2$</th>
<th>NOx</th>
<th>CO (mg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual average</td>
<td>50 µg/m$^3$</td>
<td>40 µg/m$^3$</td>
<td>10 mg/m$^3$ (*)</td>
</tr>
<tr>
<td>Maximum hourly concentration</td>
<td>350 µg/m$^3$</td>
<td>200 µg/m$^3$</td>
<td>30 mg/m$^3$</td>
</tr>
</tbody>
</table>

(*) 8-hour average

South Africa currently does not have ambient air quality standards for total particulate matter (TPM), but only for PM10 particulates, a sub-set of TPM, and the values are:

<table>
<thead>
<tr>
<th></th>
<th>TPM (µg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual average</td>
<td>40 µg/m$^3$</td>
</tr>
<tr>
<td>Maximum daily concentration</td>
<td>75 µg/m$^3$</td>
</tr>
</tbody>
</table>

At the time of publication of the Air Quality Act draft AQ limits for TPM were considered and these were:

-- Annual average of 100 µg/m$^3$
-- 24-hour average of 300 µg/m$^3$

No ambient air quality standards for PAHs or VOCs exist. The former is usually associated with odours and assessed accordingly. Please see Section 7.5 below.

7.1 SULPHUR DIOXIDE

The highest annual average concentration of SO$_2$ at current production is estimated to be 0.5 µg/m$^3$ which is well below the allowable annual average standard of 40 µg/m$^3$. 
published in GN 263. This value is estimated to increase to 0.7 µg/m³ when PSP's planned expansion comes into full operation.

The maximum 99-percential concentration was shown to be 7.0 µg/m³ which is also substantially lower than the ambient air quality standard of 200 µg/m³ as published in GN 263. This value is estimated to increase to 8.1 µg/m³ when PSP's planned expansion comes into full operation. Both of these maximum values will occur on PSP's site.

The highest annual average and 99-percentile concentrations at either of the two residential areas are estimated to be less than 0.1 µg/m³ and 1.1 µg/m³ respectively and will occur at the northern residential area. These two values are estimated to increase to less than 0.1 µg/m³ and 2.0 µg/m³ respectively once drying operations commence, i.e. well below the ambient air quality standards.

7.2 NITROGEN OXIDES

The highest annual average concentration of NOx at current production is estimated to be 10.3 µg/m³ which is well below the allowable annual average standard of 50 µg/m³ published in GN 263. This value is estimated to increase to 13.6 µg/m³ when PSP's planned expansion comes into full operation.

The maximum 99-percential concentration was shown to be 144 µg/m³ which is also substantially lower than the ambient air quality standard of 350 µg/m³ as published in GN 263. This value is estimated to increase to 165 µg/m³ when PSP's planned expansion comes into full operation. Both of these maximum values will occur on PSP's site.

The highest annual average and 99-percentile concentrations at either of the two residential areas are estimated to be 1.1 µg/m³ and 23.5 µg/m³ respectively and will occur at the northern residential area. These two values are estimated to increase to be
2.1 µg/m³ and 40.3 µg/m³ respectively once drying operations commence, i.e. well below the ambient air quality standards.

### 7.3 CARBON MONOXIDE

The highest annual average concentration of CO at current production is estimated to be 12.7 µg/m³ which is well below the allowable annual average standard of 10 mg/m³ (10 000 µg/m³) published in GN 263. This value is estimated to increase to 16.6 µg/m³ when PSP's planned expansion comes into full operation.

The maximum 99-percential concentration was shown to be 176 µg/m³ which is also substantially lower than the ambient air quality standard of 30 mg/m³ (30 000 µg/m³) as published in GN 263. This value is estimated to increase to 202 µg/m³ when PSP's planned expansion comes into full operation. Both of these maximum values will occur on PSP's site.

The highest annual average and 99-percentile concentrations at either of the two residential areas are estimated to be 1.3 µg/m³ and 29.7 µg/m³ respectively and will occur at the northern residential area. These two values are estimated to increase to be 2.5 µg/m³ and 50.3 µg/m³ respectively once drying operations commence, i.e. well below the ambient air quality standards.

### 7.4 TOTAL PARTICULATE MATTER

The highest annual average concentration of TPM at current production is estimated to be 6.5 µg/m³. This value is estimated to increase to 11.1 µg/m³ when PSP's planned expansion comes into full operation.

The maximum 99-percential daily concentration was shown to be 81.5 µg/m³. This value is estimated to increase to 93.6 µg/m³ when PSP's planned expansion comes into full operation. Both of these maximum values will occur on PSP's site.
The highest annual average and 99-percentile concentrations at either of the two residential areas are 0.9 µg/m³ and 13.8 µg/m³ respectively at current production and will occur at the northern residential area. These two values are estimated to increase to 1.6 µg/m³ and 22.9 µg/m³ respectively, i.e. below the ambient air quality PM10 standards.

7.5 ODOURS

It is known that tar acids contain some very odorous compounds, e.g. cresol. However, as is discussed in Section 2.1 above, tar acids are more common in wood-tar creosote while the content of these acids in coal-tar creosote is low, the main components being naphthalene and anthracene-based compounds.

In fact, the concentration of tar acids in coal-tar creosote, and cresol in particular, is so low that the USEPA’s AP-42 discussion of wood preservative operations makes no mention of these compounds at all, nor does it provide any emission factors for those compounds. As a result LAQS can only assume that odours from tar acids do not play any role in odours generated in wood preservation processes.

The odorous emissions associated with creosote treatment originate from various poly-aromatic hydrocarbon (PAH) compounds that form part of the total volatile organic compounds emitted during the creosote process. The PAH compounds involved are listed in Appendix A as well as their odour detection limits. It can be seen that the compound with the lowest odour detection limit is naphthalene.

As can be seen from Appendix A, the odour detection limits of only 3 of the fifteen compounds associated with creosote treatment, i.e. acenaphthene, dibenzofuran and naphthalene, were obtained from one source found during an extensive literature search\(^{(2)}\). The Appendix shows that the odour thresholds of these three compounds are in the high µg/m³ range.
LAQS attempted to indicate the potential range of odours by following a conservative approach in which it was assumed that all of the VOC emissions consist of PAH compounds and that all of these have odour threshold values equal to that of naphthalene. If the conservative approach indicated that odours would only rarely be detected at the nearest residential area it would be less detectable under actual conditions, i.e. the dispersion model outcome would be an over-estimation of actual conditions.

However, the literature search could not produce a common odour threshold value for naphthalene as researchers reported a wide range of odour detection limits. The following were obtained:

- 440 µg/m$^3$ (0.084 ppm)$^{(3)}$
- 1 570 - 4 710 µg/m$^3$ (0.3-0.9 ppm)$^{(4)}$
- 50 - 3 350 µg/m$^3$ (0.0095-0.64 ppm)$^{(5)}$
- 15 µg/m$^3$ (0.003 ppm)$^{(6)}$
- 50 - 5 340 µg/m$^3$ (0.05 - 1.0 ppm)$^{(7)}$

As odours are subjective and perceived differently by different people, no clear odour detection limit can be set for the gases emitted from PSP’s operations. As was mentioned in Section 3.1 above, and shown in the various references given, odour threshold for the individual compounds in the PAH list is very hard to come by.

As can be seen from Appendix A and the values stated above, naphthalene has an odour detection limit of anywhere between 15 and 5 340 µg/m$^3$ at 25 ºC, making interpretation of potential spread of odours a complex issue. Nevertheless, from Table 1 above it can be seen that the annual average concentration on PSP's site was estimated to be 16.2 µg/m$^3$ while the maximum 99-percentile value was 313 µg/m$^3$ at a point that also falls on PSP's site. The highest 99-percentile at a residential area is estimated to be 15.4 µg/m$^3$, i.e. at the closest point of the eastern residential site.
These maximum concentrations fall within the range of naphthalene detection limits found during the literature search and implies that creosote odours will generally be detected continuously on PSP's site. It also implies that creosote odours may be detected at the nearest residential area to the east of the plant from time to time.

7.6 HEALTH ISSUES

A detailed discussion of the potential health effects associated with creosote exposure is given in Section 1.2.3 of Wikipedia’s discussion of Creosote (www.en.wikipedia.org/wiki/Creosote). The following is extracted from that discussion:

“According to the Agency for Toxic Substances and Disease Registry (ATSDR), eating food or drinking water contaminated with high levels of coal tar creosote may cause a burning in the mouth and throat, and stomach pains. ATSDR also states that brief direct contact with large amounts of coal tar creosote may result in a rash or severe irritation of the skin, chemical burns of the surfaces of the eyes, convulsions and mental confusion, kidney or liver problems, unconsciousness, and even death. Longer direct skin contact with low levels of creosote mixtures or their vapors can result in increased light sensitivity, damage to the cornea, and skin damage. Longer exposure to creosote vapors can cause irritation of the respiratory tract.

The International Agency for Research on Cancer (IARC) has determined that coal-tar creosote is probably carcinogenic to humans, based on adequate animal evidence and limited human evidence. It is instructive to note that the animal testing relied upon by IARC involved the continuous application of creosote to the shaved skin of rodents.

The United States Environmental Protection Agency has stated that coal tar creosote is a probable human carcinogen based on both human and animal studies. As such, the Federal Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit of 0.2 mg/m$^3$ of coal tar creosote (200 µg/m$^3$) in the workplace during an 8-hour day.
There is no unique exposure pathway of children to creosote. Children exposed to creosote will probably experience the same health effects seen in adults exposed to creosote. It is unknown whether children differ from adults in their susceptibility to health effects from creosote.

A 2005 mortality study of creosote workers found no evidence supporting an increased risk of cancer death, as a result of exposure to creosote. Based on the findings of the largest mortality study to date of workers employed in creosote wood treating plants, there is no evidence that employment at creosote wood-treating plants or exposure to creosote-based preservatives was associated with any significant mortality increase from either site-specific cancers or non-malignant diseases. The study consisted of 2,179 employees at eleven plants in the United States where wood was treated with creosote preservatives. Some workers began work in the 1940s to 1950s. The observation period of the study covered 1979 - 2001. The average length of employment was 12.5 years. One third of the study subjects were employed for over 15 years.

The largest health effect of creosote is deaths caused by residential fires.

From the information given above it appears that prolonged exposure to high concentrations of creosote fumes is required before any serious health effects are manifested.

The occupational health limit of 200 µg/m³ set by the USEPA is approximately 6.7 times greater than the 99-percentile value at the nearest residential area and more than 200 times greater than the annual average concentrations of PAHs at the nearest residential area, as predicted by the dispersion model and shown in Table 1 above.

From figure 1 it can be seen that the nearest residential area is located to the north-east of PSP’s plant, implying that wind from the south to south-west of the plant will carry emissions towards this area.
7.7 INDUSTRIAL SITES

The ambient air quality standards published in GN 263 do not apply within the boundaries of industrial sites, but to areas outside such sites only.

Within the boundaries of an industrial site the allowable concentration of various pollutants are controlled by occupational health and safety legislation. Generally, two levels of pollutant threshold concentrations are used. These are:

-- Threshold limit value, time-weighted average (TLV-TWA): The concentration to which the average worker can be exposed for 8 hours per day, day after day, without any adverse health effects.

-- Threshold limit value, short-term exposure limit (TLV-STEL): The concentration to which the average worker can be exposed for a period of 15 minutes without any adverse health effects.

The TWA and STEL limits for the pollutants included in this study are:

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>TLV-TWA (mg/m³)</th>
<th>TLV-STEL (mg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPM</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>SO2</td>
<td>5.2</td>
<td>13</td>
</tr>
<tr>
<td>NOx</td>
<td>56</td>
<td>9.4</td>
</tr>
<tr>
<td>CO</td>
<td>29</td>
<td>330</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>52</td>
<td>79</td>
</tr>
</tbody>
</table>

Please note that the units are in milligrams per cubic metre (mg/m³). The values above must be multiplied by a factor of 1000 to obtain equivalent concentrations in micrograms per cubic metre (µg/m³).
Therefore, while it may appear that the maximum ground-level concentrations of some of the pollutants may exceed ambient air quality standards, these are estimated to occur on PSP's site and all of those concentrations are well below the relevant occupational health and safety standards listed above.

8 AIR POLLUTION CONTROL

Given the description of PSP’s process it is evident that the two main potential current sources of emissions are the creosote plant and the wood-fired boiler. Once the drying process is put into operation, two additional sources of emissions will exist, i.e. the drying kiln and its associated wood-fired boiler.

Of these four sources two can be regarded as area sources while the other two are point sources. The nature of the two area sources are such that emissions can be regarded as fugitive emissions, i.e. do not occur via a stack to atmosphere. Currently only the emissions from the creosote process and drying kiln are subject to limits, but it is expected that small boilers will be included in the List of Activities referred to in Section 3.4 above.

There are few options for controlling fugitive emission losses from area sources. Constructing a ventilation hood to collect VOC emissions emanating from the freshly treated wood in the drip area is economically unfeasible due to the size of the hood needed for covering the drip pad. In addition, the open-sided nature of the creosote treatment building implies that a capture hood over the drip area will, in all probability, be inefficient as winds swirl in and around the building.

The effectiveness of controlling emissions by using water to cool freshly treated wood by spraying or quenching is questionable. A primary drawback to water quench systems is that the contaminant is merely transferred to water, resulting in the need for an effluent treatment system. In addition, water quench systems generate significant
amounts of waste water which include listed hazardous substances and is, therefore, not desirable.

Similarly, constructing an enclosed area in which treated wood is stored implies covering an area of approximately 2 hectares which, in turn, implies significant capital costs. Should fence-line measurements identify this source as the main contributor to odours at the nearest residential source it is suggested that consideration be given to relocating the finished product yard to a point as far from the residential area as possible, thus providing a greater opportunity to emissions to disperse to below odour detection levels.

Similarly emissions from a wood drying kiln occur via various vents in the system and are thus not controllable.

9 CONCLUSIONS

As described in Section 3 above some assumptions were necessary in order to compile an emissions database for PSP’s operations. The assumptions made were aimed at over-estimating the mass emissions of the pollutants in order to create a worst-case scenario.

The results of the dispersion modelling study show that the estimated maximum ground-level concentrations were generally low at the nearest residential area, although on-site concentrations can be high. This is, however, not unexpected, given the open-sided nature of the creosote treatment building and the low height above ground-level from which emissions occur from this plant and the proposed drying kiln.

Even though the on-site concentrations may be high, all are well below the relevant occupational health and safety requirements for industrial areas.
LAQS concludes, therefore, that the impact of PSP’s emissions on air quality in the residential areas surrounding the plant is low and that odours should not be detected at any residential area.

PSP is fortunate in the sense that its operations are located in an area where there are no other industries that emit significant quantities of the pollutants included in this study.

Should any such industry start operations in the area it is recommended that a cumulative impact assessment is carried out to determine if the combined emissions will pose a risk to human and environmental health.

10 RECOMMENDATIONS

10.1 EMISSIONS VERIFICATION

As no representative data on the various emissions from the existing plant exist, LAQS recommends that PSP commissions a suitably qualified and experienced contractor to carry out the required measurements within the next 12 months and to repeat the measurements on an annual basis. The latter will, in any event, form part of an atmospheric emissions license.

The measurements recommended are two-fold. Firstly, it is recommended that fence-line VOC concentration measurements are undertaken by means of passive sampling methods. Seasonal variations in wind direction can be used to select the most appropriate period for such measurements in order to maximise the benefit of the results obtained. It must be borne in mind that the same sampling position/s should be used for subsequent annual measurements to allow trend analysis of measured concentrations.

Secondly, the emissions from the boilers must be determined by means of in-stack isokinetic sampling methods, as required by Section 4 of GN248.
It is accepted that the proposed drying kiln will only become operational at some stage in the future. However, during the planning phases all attempts must be made to obtain design emission values from the vendors considered for the supply of the drying equipment.

The results of such a program will allow LAQS to compare it with the assumptions made and revise the outcome of the dispersion modelling study if necessary.

10.2 CONTINUOUS EMISSIONS MONITORING

LAQS is of the opinion that no continuous emission monitoring equipment will be required to monitor the various emissions addressed by this report, but that fence-line concentrations should be verified annually by an independent contractor and reported to EDM accordingly to meet regulatory requirements.

LAQS is similarly of the opinion that the boiler emissions should be verified by an independent contractor on an annual basis and that all results obtained over time are used to calculate more representative average pollutant emission values for the boiler stack.

10.3 FUTURE BOILER REQUIREMENTS

Cognisance is taken of the fact that PSP plans to install a second wood-fired boiler once drying operations commence.

It is recommended that serious consideration be given to the use of a single boiler for both purposes, rather than the planned two boilers. A single boiler will form a single emission source and, therefore, require a single point from which emissions must be verified. In addition, It will simplify operations on site and will use less fuel than two separate boilers.
10.4 AIR QUALITY MANAGEMENT PLAN

LAQS is of the opinion that a PSP management should give serious consideration to the development of a dedicated air quality management plan for their operations. The management of the plant should bear in mind that their processes are potential sources of harmful emissions and should, therefore, take all possible in-house steps to minimise emissions and possible impact on human and environmental health.

11 REFERENCES

1 Clearing House for Inventories and Emission factors (CHIEF) and published in AP-42, “Compilation of Air Pollutant Emission Factors”, USEPA.


3 http://www.epa.gov/ttn/atw/hlthef/naphthal.html


6 http://www.creosotecouncil.org/pdf/CreosoteOdor.pdf

### APPENDIX A

**PAH COMPOUNDS INCLUDED IN EMISSIONS FROM CREOSOTE PROCESSES**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Melting point, °C</th>
<th>Boiling point, °C</th>
<th>Mol mass</th>
<th>Odour detect, μg/Nm³</th>
<th>Odour detect, μg/m³, 25 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acenaphthene</td>
<td>96</td>
<td>279</td>
<td>154</td>
<td>550</td>
<td>504</td>
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<tr>
<td>Acenaphthylene</td>
<td>92</td>
<td>265</td>
<td>152</td>
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<tr>
<td>Anthracene</td>
<td>216</td>
<td>340</td>
<td>178</td>
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<td></td>
</tr>
<tr>
<td>Benzo(a)anthracene</td>
<td>197</td>
<td>300</td>
<td>278</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzo(b)fluoranthene</td>
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<td>200</td>
<td>266</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzo(k)fluoranthene</td>
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<td></td>
<td>266</td>
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<tr>
<td>Benzo(a)pyrene</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Carbazole</td>
<td>247</td>
<td>355</td>
<td>167</td>
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<td>448</td>
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<td></td>
</tr>
<tr>
<td>Dibenzofuran</td>
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<td>287</td>
<td>168</td>
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<td>776</td>
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<tr>
<td>Fluoranthene</td>
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<td>375</td>
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<td>Fluorene</td>
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<td>Phenanthrene</td>
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<tr>
<td>Pyrene</td>
<td>156</td>
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