IN THE MATTER OF
The Hazelwood Mine Fire Inquiry

STATEMENT OF PAUL TORRE

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I, Paul Torre, of 200 Victoria Street, Carlton, Victoria, Team Leader of Analysis and Predictions, Environment Protection Authority, can say as follows:

Question One: Briefly outline your qualifications and experience, and describe your role at the EPA:

1. My full name is Paul Torre. I am the Team Leader of Analysis and Predictions in the Monitoring and Assessment Unit at the Environment Protection Authority (**EPA**) of 200 Victoria Street, Carlton, Victoria. I hold the position of Principal Expert (Air Quality).

2. I commenced employment with the Environment Protection Authority in 1985 and my role is in environmental assessment, specialising in air quality. I manage a group of scientists and technicians who undertake a number of such assessments.

3. I hold a PhD (Applied Science-Air pollution), Grad Dip (Analytical Chemistry) and BSc (Chemistry).

4. I am also an authorised Emergency Response Officer and am regularly asked to assist in incidents involving discharges to air that might affect public health and safety.

5. This Statement has been prepared pursuant to the request made by Counsel assisting the Hazelwood Mine Fire Board of Inquiry by letter of 1 May 2014 (**the Letter**). A copy of this letter is in [VGSO.0003.001.0015].

Question Two: Identify the relevant standard applied by the EPA in relation to the ambient air quality for:

6. The relevant air quality standard or assessment criteria used by EPA in assessing the ambient air quality monitoring for the pollutants labelled (1) to (7) in the Letter are listed in Table 1 below. These are the air quality objectives specified in the State Environment Protection Policy (Ambient Air Quality) (**SEPP(AAQ)**) which adopts the national air quality

standards specified in the National Environment Protection Measure (Ambient Air Quality). SEPP (AAQ) is in [EPA.0001.006.0469] and [EPA.0001.006.0485].

7. The relevant air quality guideline or assessment criteria for the pollutants labelled (8) to (9) in the Letter are listed in Table 2 and 3 respectively below. The national or state relevant standard or air quality guideline was used where available. In the absence of national or state guidelines international air guidelines were adopted based on advice from the Department of Health's (**DH**) Environmental Health Branch.

Table 1: Air Quality Standards used for air monitoring results for pollutants

Pollutant	**Averaging period**	**Assessment Criteria**	**Standard**
Carbon monoxide	8 hours	9.00 ppm	SEPP(AAQ)
Sulfur dioxide	1 hour 1 day Yearly	0.20 ppm 0.08 ppm 0.02 ppm	SEPP(AAQ)
Nitrogen dioxide	1 hour	0.12 ppm	SEPP(AAQ)
Particles as PM_{10}	24 hours	50 $\mu g/m^3$	SEPP(AAQ)
Particles as $PM_{2.5}$	24 hours	25 $\mu g/m^{3}$*	SEPP(AAQ)
	Yearly	8 $\mu g/m^{3}$*	SEPP(AAQ)
Ozone	1 hour 4 hours 8 hours	0.10 ppm 0.08 ppm 0.05 ppm	SEPP(AAQ)
Lead	Yearly	0.50 $\mu g/m^3$	SEPP(AAQ)
Visibility reducing particles	1 hour	20 km	SEEP(AAQ)

* $PM_{2.5}$ has an advisory reporting level rather than a promulgated or government sanctioned air quality objective.

Table 2: Air Quality Standards used for air monitoring results for pollutants

Pollutant	**Averaging period**	**Assessment Criteria**	**Standard**
Benzene	24 hours Yearly	9 ppb 3 ppb	ADSTR NEPM(Air Toxics)
1,3-Butadiene	24 hours	145 ppb	ATSDR
Propene	24 hours	232 ppb	ATSDR
Chloromethane (methyl chloride)	24 hours	155 ppb	ATSDR
Acetone	24 hours	497 ppb	ATSDR
Ethanol	24 hours	10084 ppb	ATSDR
Carbon disulfide	24 hours	106 ppb	ATSDR
2-Butanone (MEK)	24 hours	339 ppb	ATSDR
Hexane	24 hours	284 ppb	ATSDR
Heptane	24 hours	2684 ppb	ATSDR
Toluene	24 hours Yearly	1000 ppb 531 ppb 100 ppb	NEPM(Air Toxics) ATSDR NEPM(Air Toxics)
Ethylbenzene	24 hours	230 ppb	ATSDR

Naphthalene	24 hours	4.3 ppb	ATSDR
Formaldehyde	24 hours	40 ppb	NEPM(Air Toxics)
Benzo(α)pyrene	Yearly	0.03μg/m3	NEPM(Air Toxics)

Table 3: Air Quality Standards used for air monitoring results for pollutants

Pollutant	Averaging period	Assessment Criteria	Assessment Criteria
Aluminium (Al)	24 hours	38 ~~ppb~~ μg/m3	TQEC
Antimony (Sb)	24 hours	9.6 ~~ppb~~	TQEC
Arsenic (As)	24 hours Yearly	1.3 ~~ppb~~ 0.003 μg/m^3	TQEC PEM
Barium (Ba)	24 hours	9.6 ~~ppb~~	TQEC
Beryllium (Be)	24 hours	0.04 ~~ppb~~	TQEC
Bismuth (Bi)	24 hours	95 ~~ppb~~	TQEC
Boron (B)	24 hours	95 ~~ppb~~	TQEC
Cadmium (Cd)	24 hours	0.2 ~~ppb~~	TQEC
Calcium (Ca)	24 hours	95 ~~ppb~~	TQEC
Cerium	24 hours	95 ~~ppb~~	TQEC
Chromium	24 hours	0.8 ~~ppb~~	TQEC
Cobalt (Co)	24 hours	0.4 ~~ppb~~	TQEC
Copper (Cu)	24 hours	19 ~~ppb~~	TQEC
Gallium (Ga)	24 hours	38 ~~ppb~~	TQEC
Gold (Au)	24 hours	47 ~~ppb~~	TQEC
Iron (Fe)	24 hours	95 ~~ppb~~	TQEC
Lanthanum (La)	24 hours	95 ~~ppb~~	TQEC
Lead (Pb)	24 hours	9.6 ~~ppb~~	TQEC
Lithium (Li)	24 hours	19 ~~ppb~~	TQEC
Mangnesium	24 hours	95 ~~ppb~~	TQEC
Manganese (Mn)	24 hours	3.8 ~~ppb~~	TQEC
Mercury (Hg)	24 hours	0.5~~ppb~~	TQEC
Molybdenum (Mo)	24 hours	57 ~~ppb~~	TQEC
Nickel (Ni)	24 hours	1.1 ~~ppb~~	TQEC
Phosphorus (P)	24 hours	1.9 ~~ppb~~	TQEC
Potassium (K)	24 hours	38 ~~ppb~~	TQEC
Respirable crystalline silica	Yearly	3 μg/m$^{3\#}$	PEM
Rubidium (Ru)	24 hours	47~~ppb~~	TQEC
Selenium (Se)	24 hours	3.8 ~~ppb~~	TQEC
Silver (Ag)	24 hours	0.2 ~~ppb~~	TQEC
Sodium (Na)	24 hours	19 ~~ppb~~	TQEC
Strontium (Sr)	24 hours	38 ~~ppb~~	TQEC

Pollutant	Averaging period	Assessment Criteria	Assessment Criteria
Sulphur (S)	24 hours	95 ppb	TQEC
Tellurium (Te)	24 hours	1.9 ppb	TQEC
Thallium (Tl)	24 hours	1.9 ppb	TQEC
Thorium (Th)	24 hours	n/a	TQEC
Tin (Sn)	24 hours	38 ppb	TQEC
Titanium (Ti)	24 hours	95 ppb	TQEC
Tungsten (W)	24 hours	19 ppb	TQEC
Uranium (U)	24 hours	1.0 ppb	TQEC
Vanadium (V)	24 hours	1.0 ppb	TQEC
Yttrium (Y)	24 hours	19 ppb	TQEC
Zinc (Zn)	24 hours	38 ppb	TQEC
Zirconium (Z)	24 hours	95 ppb	TQEC

ATSDR = United States Agency for Toxic Substances and Disease Registry

TCEQ = US Texas Commission on Environmental Quality

PEM = Air quality assessment criteria from the Protocol of Environmental Management (PEM) Mining and Extractive Industries

Question 3: In relation to the standard applied for each of these substances, explain the scientific basis for the standard, with particular reference to the known effects, both short and long term, of exposure to the substance on human health and wellbeing.

8. The SEPP (AAQ) has specified a list of Class 1 indicators or pollutants that are widespread air pollutants to monitor and manage because of their potential impacts on human health and the environment. Each of these Class 1 pollutants has air quality objectives that are designed to generally protect against the harmful impacts of these pollutants. Research studies on air pollution and health impacts indicate different groups of people are sensitive to different types of air pollution. Further studies are being undertaken to better understand the impacts of specific air pollutants on human health.

9. Small airborne particles such as PM_{10} and $PM_{2.5}$ are widespread and the pollutant that tends to exceed the air quality objectives in Victoria. These particles are most likely to affect people with asthma, lung disease and cardiovascular (heart) disease and other sensitive members of the community such as children and older adults. Research is showing these particles can aggravate asthma and even result in premature death in some people with heart or lung disease at low concentrations below the air quality standards. At very high concentrations healthy adults may experience some temporary symptoms, such as sore eyes, throat or irritated nose, a dry or productive cough, tightness in the chest and shortness of breath.

10. Although $PM_{2.5}$ is currently an advisory reporting level rather than a promulgated or government sanctioned air quality objective it is a pollutant of high concern because research is indicating $PM_{2.5}$ particles is more closely associated with adverse health compared to the slightly larger PM_{10} particles. The smaller $PM_{2.5}$ particles can penetrate deeper in the lung and into the blood stream. The adverse health effects of $PM_{2.5}$ will be integral in the current review of the air policy and associated standards underway.

11. Inhaling high levels of carbon monoxide have been reported to cause headache, nausea, vomiting, dizziness, blurred vision, confusion, chest pain, weakness, heart failure, difficulty breathing, and can cause miscarriage during pregnancy. Breathing lower levels of carbon monoxide during pregnancy can lead to slower than normal mental development of the child. Prolonged exposure to carbon monoxide at lower levels can cause tissue damage and people suffering from cardiovascular or lung diseases are more vulnerable to the toxic effects of carbon monoxide.

12. Sulfur dioxide is an irritant gas that impacts the throat and lungs. Its effect on health is increased by the presence of airborne particles. Prolonged exposure to sulfur dioxide can lead to increases in respiratory illnesses like chronic bronchitis. Those most at risk of developing problems that are exposed to sulfur dioxide are people with asthma or similar conditions.

13. Nitrogen dioxide is known to affect the throat and the lungs. In levels encountered in polluted air, people with respiratory problems, particularly infants, children and the elderly, may be affected. People with asthma are often sensitive to nitrogen dioxide.

14. Ozone is very reactive, affecting the linings of the throat and lungs, restricting the air passages and making breathing difficult. It also increases the risk of respiratory infections. Ozone is of greater concern for the elderly and those with existing lung disease.

Question Four: Outline the current state of knowledge in relation to the short and long term effects on human health and wellbeing of exposure to fine particles as PM2.5 at the levels recorded in and around Morwell between 9 February and 27 March 2014. Identify any key studies.

15. EPA would defer health matters to the Department of Health as the lead agency for such matters in Victoria. As air quality guidelines and standards are health-based, EPA air quality scientists try to keep abreast of the key issues work closely, collaboratively and share knowledge with the DH experts.

16. A very good recent example of this is the development of the bushfire response protocol used during the Hazelwood incident. This has been used a number of times over the last 6-7 years, and is a result of extensive input from all parties.

17. The fact that exposure to smoke has some health effects is unquestioned, it is remarkably difficult to define is exactly what these effects are. To give a broad indication of the nature of this problem, consider the range of variables that need to be taken into account:-

    17.1 What is the concentration? How thick is the smoke? Just noticeable to obscuring your hand in front of your face.

    17.2 How long does the exposure last? Few minutes (in a garden small fires), to years (the case of the disastrous London smog event of 1952 where about 4000 deaths were attributable to the event)

    17.3 Where does it occur? In the middle of town with many people, or out in the hills with no one around?

17.4 What is in it? Just some fine particles, or is it full of toxic ash and hazardous chemicals?

17.5 Who is being exposed? Healthy and fit young adults, or children and people with asthma?

17.6 Is there anything else there? Smoke plus heavy vehicles emissions is likely worse than smoke alone.

18. Each of these factors is highly variable, and the challenge is to determine just where the Hazelwood fire smoke lies in this complex spectrum.

19. A further complication is that there have been a great deal of studies on long-term exposure (months to years) to particles and air pollution (chronic effects), but very few on shorter term exposures (days or weeks). For instance most people in their lives will have been exposed to dense smoke for very short periods – for example lighting a barbeque, walking behind a smoky bus, setting off fireworks, driving though bushfire smoke, etc. These do not seem to have severe long-term consequences on healthy people. Sensitive people may be affected by any smoke exposure.

20. A key issue with the Hazelwood incident is that whilst it was not long-term or chronic, which would be months to years, neither was it short-term and transitory. It lasted around 5-6 weeks and this is an exposure period for where there is limited epidemiological evidence available. That is the long-term (annual) health assessment criteria were not really ideal, and neither were the short-term (hours). There is very little in between. The DH (or CHO) faced a major dilemma as to how to make an appropriate assessment.

21. I am not qualified to fully discuss the state of epidemiological evidence in relation to smoke and air pollution effects. However I can provide comment on the basis of two recent comprehensive reports. The first is from Europe and is a major review of the state of knowledge by a panel of experts to the World Health Organisation (*Review of evidence on health aspects of air pollution – REVIHAAP Project Technical Report. WHO. 2012*). The report discusses the implications of a number of very recent studies on short-term particle effects buts gives no defined guidance on how these might be used in a case such as Morwell. The second significant report is an Australian Senate review (*The Senate: Impacts on health of air quality in Australia,* 2013). This report directly addresses issues relevant for Victoria, including bushfire effects and the high use of coal. It contains a series of recommendations around increased and more focused particle monitoring, mitigation measures and Australia-specific studies. EPA scientists are very much part of the process in recommending and developing these measures, and the EPA Victoria will be one on the country's leaders in implementing them. Again unfortunately there is little guidance on how to deal with situations such as at Morwell.

22. All of this discussion does serve to highlight a particular feature of the Hazelwood incident – it was very uncommon, both in its size and in its duration and it will be very challenging to make a valid public health risk assessment.

Question 5: Identify any gap in the scientific understanding of the effects on human health and wellbeing of exposure to fine particles as $PM_{2.5}$ at the levels recorded in and around Morwell between 9 February and 27 March 2014 over that duration?

23. The discussion in the previous section has shown that there are significant gaps in the scientific understanding of the effects exposure to fine particles such as $PM_{2.5}$ at the levels recorded in and around Morwell as result of the mine fire on public health. DH is better placed to cover these in detail, but EPA has a very strong interest in this since EPA undertakes to report the effects to the public.

24. The EPA's web site has standards and guideline levels for particles on 24-hours and annual periods. These are clear and widely used throughout the world. The values, for $PM_{2.5}$ and PM_{10} are based on a large body of incontrovertible evidence to estimate the public health burden. However the same is not true for exposures to particles over the time scale of weeks – as occurred at Morwell. Health experts would almost unanimously agree there are health effects but are likely to disagree over what that effect is, and what level should be set to mitigate it.

25. This question of effects of the fires is nevertheless highly relevant, and the EPA is pleased to support the DH in their long term health study. In working to this end, EPA has already defined plans to assess air quality in the Latrobe Valley for the next 12 months to gather information to help improve knowledge of these effects.

Question 6: What is "fly ash"? Is exposure to and ingestion or inhalation of fly ash hazardous to human health?

26. Fly ash is a fine grey powder that is generally produced in electricity generation plants during the combustion of coal to produce electricity. Fly ash is generally classified as a hazardous substance when the material is handled for occupational purposes by Material Safety Data Sheets (MSDS). Fly ash is classified as harmful because it can cause irritation to eyes, respiratory system and skin. The presence of small particles less than 10 micrometers (μm) can penetrate the lungs and is capable of producing the health effects associated with these small particles. Fly ash also contains some crystalline silica that is equal or less than PM_{10} which can be harmful when inhaled.

Question 7: Can the ash from the fires at the Mine that fell in and around Morwell during February and March 2014 be characterised as fly ash? If not, why not?

27. The deposition of coal mine fire ash that was in sufficient quantities for sampling and analysis was found close to the mine. These locations were in Wallace Street, Club Astoria Morwell, Morwell Football Club and the German Club. A sample of fly ash from the Hazelwood Power Station was also collected and analysed with the other ash samples. Ash samples collected in Morwell cannot be characterized as fly ash based on the analysis results. The deposited ash samples contained significantly higher organic carbon material ranging from 17%, 21% compared to 6% in the fly ash. The lower carbon content in fly ash is due to the coal burning in the power generation process at a constant high temperature. This is in contrast to the varying temperatures that can occur in uncontrolled fires. The overall range of particle size in all of the Morwell samples is very similar but significantly different to the fly ash sample. The fly ash sample comprised of 27% of particles less than 10μm in size unlike the Morwell samples that consisted of 6 % of particles less than 10μm in size.

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PAUL TORRE