MELBOURNE METRO EES INQUIRY

PROPOSED MELBOURNE METRO DOMAIN STATION ASSESSMENT OF AIR QUALITY ISSUES

Prepared for Owners Corporation 348427V of 400 St Kilda Road, Melbourne ("The Botanica")

12 August 2016

Environmental Science Associates
18 Goldsmith Crescent, Castlemaine 3450

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1. INTRODUCTION

Environmental Science Associates (ESA) has been instructed by Planning & Property Partners Pty Ltd, acting for Owners Corporation 348427V of 400 St Kilda Road, Melbourne (The "Botanica") to prepare an independent assessment of air quality issues associated with the construction and operation of Melbourne Metro's proposed Domain Station. Fig 1 shows the location of the Botanica site, which is located immediately to the south of the proposed Domain station, on the corner of St Kilda Road and Bowen Crescent.

Figure 6-9 Precinct 7 – Domain station (Concept Design)

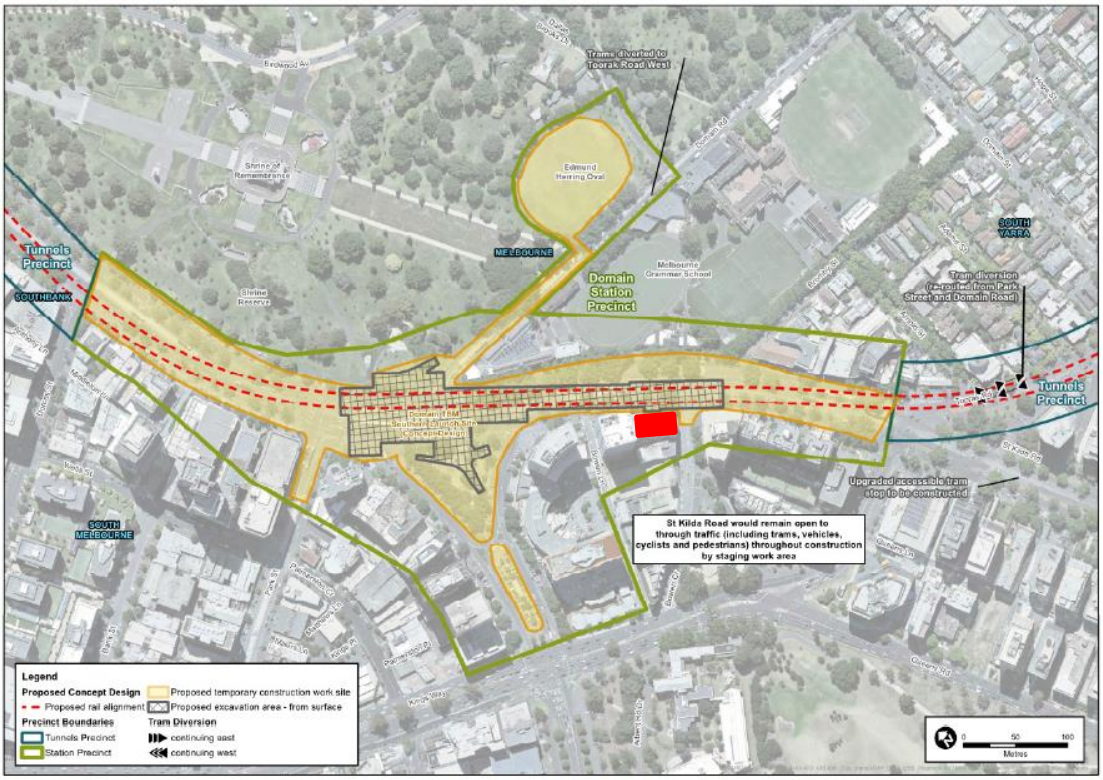

Fig 1. Domain Station precinct (based on Figure 6-9 of the EES) showing extent of construction activities and the Botanica site (in red)

The Botanica comprises some 58 apartments and two commercial properties (known as 398 and 402 St Kilda Road, respectively). On 5 July 2016, Planning & Property Partners Pty Ltd lodged a submission with the Melbourne Metro Rail EES Inquiry, on behalf of the Botanica's Owners Corporation (OC). The submission raised a number of issues, including concerns about air emissions in the vicinity of the Domain Station during the proposed 48 month construction period and subsequent operation of the Melbourne Metro.

The Botanica apartments will be particularly sensitive to an increase in local dust levels, because I understand that all of the apartments facing St Kilda Road and Bowen Crescent (and most of the others) have doors opening onto balconies, openable windows and most have individual "split" air conditioning systems (the only way to introduce fresh air into the apartments is by opening external doors and/or windows).

Sections 2, 3 and 4 of my report outline relevant information contained in the Environmental Effects Statement (EES) prepared by the Melbourne Metro Rail Authority (MMRA). Section 5 summarises the findings, conclusions and recommendations of my assessment.

As detailed in Attachment 1, the report has been prepared in accordance with Planning Panels Victoria's guide to expert evidence.

2. GEOLOGICAL AND HYDROGEOLOGICAL CONDITIONS

The geological and hydrogeological conditions encountered by the tunnelling and excavation works associated with the Domain Station will have a significant bearing on the characteristics of the spoil which is generated and air emissions associated with these works. Spoil generated by tunnel boring machines (TBMs) operating between the proposed CBD South station and the eastern portal in South Yarra (a distance of over 3 km) will be brought to the surface at the Domain station work site (an alternative arrangement could involve extracting some of this TBM spoil from a location in the NE corner of Fawkner Park).

Section 5.1.1 of the EES' Groundwater Impact Assessment notes that*"The Melbourne formation is expected to be encountered in the tunnels and stations for the majority of the alignment, from - - - the south of the Yarra River to the eastern portal. Hydraulic conductivity is very variable in this unit"*.

Table C-0-2 (from Appendix C of Technical Appendix O Groundwater) summarises the main geological and hydrogeological units and their characteristics, and describes the (Silurian) Melbourne Formation as:

- Comprising interbedded siltstone and sandstone, folded, fractured and variably weathered;
- Unconfined to semi-confined fractured rock aquifer; and
- Occurring in all precincts and sectors.

Attachment 2 reproduces three figures from Technical Appendix O, which depict longitudinal sections along the Melbourne Metro alignment between CBD South and the eastern portal. Aspects of relevance to my air quality assessment are summarised below.

2.1 Tunnels between CBD South and Domain Stations

Figure 7-8 indicates that these tunnels will be bored predominantly through the Melbourne Formation. The "Concept Design" tunnels will be above the watertable in the vicinity of the CityLink tunnels (which result in a drawdown of the watertable). In contrast, the "Alternative Design Option" alignment, which passes under the CityLink tunnels, is below the watertable.

2.2 Tunnels between Domain Station and Eastern Portal

Figure 7-10 indicates that these tunnels will be bored entirely through the Melbourne Formation and below the watertable.

2.3 Area in Vicinity of Domain Station

Figure 7-10 indicates that the (unsaturated) Brighton Group overlies the Melbourne Formation in the vicinity of Domain Station and that the (approximately 19 m deep) excavation for the station will penetrate about 10 m into the Melbourne Formation. There is a significant drawdown of the water table in this location (as a result of infiltration of groundwater into the South Yarra Main Sewer), which suggests that the majority of the Melbourne Formation to be excavated to form the "station box" will be above the water table.

As discussed later, excavation work at Domain Station, which is largely above the water table, can be expected to generate relatively dry spoil, while a similar situation can be expected to prevail where the TBM is operating above the water table. The air quality assessment in the EES indicates that the TBM spoil will typically have a moisture content of 4%.

3. POTENTIAL CONSTRUCTION METHODS

Section 6.6 of the EES describes potential construction methods which form part of the Concept Design of the Melbourne Metro project. However, as noted in Section 6.1 of the EES, contractors tendering for the project may offer alternatives to designs and/or configurations described in the EES, while further refinements may emerge as the detailed design is developed and stakeholder requirements are addressed.

My assessment is based on the Concept Design and construction methods described in the EES, which are outlined below for the Domain precinct and tunnelling. However, uncertainties remain about some important aspects of the construction techniques to be applied (and may not be clarified until the contractor has been appointed and Construction Environmental Management Plans (CEMPs) are developed and approved by MMRA and the Environment Protection Authority (EPA).

3.1 Domain Station Precinct

Section 6.5.7 of the EES outlines the main construction activities proposed at the Domain Station precinct (which are expected to extend over a period of about 48 months) as follows:

- Preliminary works associated with relocation and protection of utilities, removal and storage of the South African Soldiers Memorial, removal of trees (for subsequent replacement), road and tram removal/relocation works, and construction of diaphragm walls to form the sides of the underground station "box";

- Excavation and construction of the ("cut and cover") station, using a combination of the "top-down" and "bottom-up" techniques described in Section 6.6.6 of the EES;
- Launching the TBMs used to drive the tunnels between the CBD South Station and the eastern portal (an alternative option could involve launching TBMs at both the Domain precinct and a site in the NE corner of Fawkner Park);
- Establishing construction work sites in the Domain precinct on each side of St Kilda Road, including Edmund Herring Oval, the Albert Road Reserve and within the St Kilda Road footprint (refer to Figure 1);
- Transfer of TBM spoil along a haul road to construction stockpiles on the Edmund Herring Oval;
- Loading spoil from temporary stockpiles into trucks for off-site reuse/disposal; and
- Restoration of St Kilda Road, tram tracks, parklands and monument.

3.2 Tunnelling Methodology

The tunnels will be constructed by tunnel boring machines (TBMs), which typically consist of a rotating circular "cutter head", a thrust system and trailing support mechanisms. Excavated material ("spoil") is conveyed from behind the cutter head the to the rear of the TBM by an auger and belt conveyor system, for transfer to the construction stockpiles by trucks.

The EES includes little information on the configuration and operation of the TBMs, beyond:

- The assumption in Table 5-6 that TBMs will be closed face and pressurised types and that the concrete tunnel lining will be installed progressively behind them to create tanked (sealed tunnels); and
- Section 7.1.1 of Technical Appendix O notes that*:"The TBM would maintain a pressure at its face (to counter water pressure) that prevents groundwater inflow"*.

3.3 Spoil Management

Information in the EES relating to spoil management focuses on its classification and potential reuse/disposal options, but does not clarify how the spoil generated by the TBMs will be conveyed to the construction stockpiles (or in what form).

Table 7-1 in Section 7.1.1 of Technical Appendix Q of the EES states that: *"Tunnelling activities would produce a waste stream of wet rock cuttings (spoil) and/or a slurry. This material would require separation into solids and wastewater prior to disposal*". However, this is inconsistent with a number of other sections of the EES – in particular:

- Section 20.7.4 (Contaminated Land and Spoil Management) of the EES notes that "*Potential environmental impacts* [of construction stockpiles] *could manifest themselves as pollution, runoff, odours and <u>dust</u>* [my emphasis]";

- The emission rate estimates for the Domain Precinct, as set out in footnote (1) to Table 4-11 of Technical Appendix H assume that the spoil will have [minimal] moisture content of 4%;
- Section 4.2.4 of Technical Appendix H (Air Quality) notes that *"The main pathways for dust emissions from the proposed construction activities are spoil handling and transfer - - ";* and
- I have not come across any other reference to de-watering TBM spoil/slurry in the EES.

3.4 Tunnel Ventilation during Construction

Section 12.1 of Chapter 12 (Air Quality) notes that temporary systems will be required to ventilate underground work areas, and that the exhaust systems will need to be equipped with suitable filtration systems to control dust emissions to atmosphere. As the nature and locations of these systems will not be defined until the "delivery phase" of the Melbourne Metro project, they have not been considered further in the EES.

4. DOMAIN PRECINCT AIR EMISSIONS

The EES's assessment of potential air quality impacts is set out in Chapter 12 and Technical Appendix H. This section summarises key findings of the EES which relate to air quality impacts of the Melbourne Metro project in the Domain Precinct.

The Executive Summary of Technical Appendix H notes that the air quality assessment focuses on potential impacts during the construction phase, because air emissions during routine operation of the Melbourne Metro (involving only electric trains) will be negligible in comparison.

4.1 Relevant Air Contaminates

Section 3.2 of Technical Appendix H notes that *"the main risk for ambient air quality and amenity from construction activities is dust. The potential for contaminated dusts and odour from excavated material to cause air quality impacts is of lesser concern*".

4.2 Air Quality Criteria

Airborne dust particles are classified in terms of particle size into:

- PM_{10} (particles less than 10 microns in size);
- $PM_{2.5}$ (particles less than 2.5 microns in size); and
- total suspended particulates (TSP) which includes larger suspended particles.

The criteria for airborne dust adopted by the EES are set out in Table 3-5 of Technical Appendix H, as follows:

Contaminant	Averaging period	Maximum concentration
PM_{10}	24 hour	50 µg/m^3
$PM_{2.5}$	24 hour	25 µg/m^3
	annual	8 µg/m^3

The criterion adopted for dustfall is a dust deposition rate of 4 g/m^2.month (no more than 2 g/m^2.month above background), based on the guideline in EPA Publication 1191[1] (which is not, however, strictly applicable to the Melbourne Metro project).

4.3 Modelling of Particulates

The conduct of air quality modelling to predict the concentrations of contaminants in the vicinity of specific emission sources generally involves the following steps:

- Defining significant emission sources in terms of location, physical characteristics and estimated emission rates of relevant contaminants;
- Preparing/selecting an appropriate meteorological file;
- Selecting an appropriate mathematical model, defining modelling domains (areas) and adjusting model settings to reflect site specific factors;
- Running the model to generate predicted contaminant concentrations, frequency of exceedences of designated concentrations, and deposition rates (as appropriate) over a defined receptor grid (and at discrete receptors where appropriate);
- Plotting the predictions as isopleths (concentration "contours") over a basemap; and
- Interpreting the predictions by reference to relevant air quality criteria and other appropriate factors.

The following section summarises the dispersion modelling described in Technical Appendix H in relation to the Domain Precinct.

4.3.1 Dust Sources and Emission Rate Estimates

Section 4.2.4 of Technical Appendix H notes that the main potential dust sources are spoil handling and transfer, wheel-generated dust and wind erosion from exposed surfaces, while it is assumed that truck movements are on unsealed surfaces and that the majority of the construction work sites are exposed to wind erosion.

The dust emission rates were estimated for the various sources based on the National Pollution Inventory (NPI) Emission Estimate Technique Manual for Mining, after allowing for the implementation of dust control measures.

Table 4-9 of Technical Appendix H sets out the emission rate estimates for the Domain Precinct (reproduced below) – emission rate estimates for the alternative design option (involving works at both the Domain and Fawkner Park precincts) are shown in Table 4-11 of Technical Appendix H.

[1] EPA (December 2007). Protocol for environmental management – mining and extractive industries.

Table 4-9 Summary of emissions estimates for Domain precinct – peak scenario

Proposed activity	Proposed controls	Emission rate (kg/yr)		
		TSP	PM_{10}	$PM_{2.5}$
Proposed construction work site activities				
Loading and unloading spoil to construction stockpiles[1]	Windbreak 30% Water sprays 50%	661	313	47
Wheel generated dust on unsealed surfaces[2]	Level 2 watering 75%	33,349	9,855	1,000
Wind erosion from exposed area[3]	Windbreak 30% Water sprays 50%	4,292	2,146	322
Total		38,303	12,314	1,370

[1] Assumes 4% moisture and double handling of materials i.e. unloading to stockpile and loading to truck.
[2] Based on worst case peak truck trips and 0.6 km round trip on unsealed road.
[3] Assumes 70 per cent of the 5 ha Domain construction work site is exposed to wind erosion.

Table 4-10 Summary of emissions estimates for Domain precinct – annual scenario

Proposed activity	Proposed controls	Emission rate (kg/yr)		
		TSP	PM_{10}	$PM_{2.5}$
Proposed construction work site activities				
Loading and unloading spoil to construction stockpiles[1]	Windbreak 30% Water sprays 50%	466	220	33
Wheel generated dust on unsealed surfaces[2]	Level 2 watering 75%	23,284	6,881	699
Wind erosion from exposed area[3]	Windbreak 30% Water sprays 50%	4,292	2,146	322
Total		28,042	9,247	1,054

[1] Assumes 4 per cent moisture and double handling of materials i.e. unloading to stockpile and loading to truck.
[2] Based on worst case annual truck trips and 0.6 km round trip on unsealed road.
[3] Assumes 70 per cent of the 5 ha Domain construction work site is exposed to wind erosion.

4.3.2 Meteorological File

The meterological file used for modelling was developed from meteorological surface data collected between 2010 and 2014 at Essendon airport and upper air profiles in accordance with EPA procedures.

4.3.3 Modelling Methodology and Scenarios

EPA's regulatory plume dispersion Model AERMOD was used to predict the ground level concentrations (GLCs) of PM_{10} and $PM_{2.5}$ and dust deposition rates, with all dust sources (including area sources such as wind erosion from exposed surfaces) being treated as volume sources. This is necessary because AERMOD has proved to be unreliable when processing area sources (such as dust suspended by wind erosion).

4.3.4 Model Predictions

The AERMOD predictions for the Domain Precinct (including Fawkner Park) are presented in Figures 13-1 to 13-8 in Technical Appendix H. Based on the plots, there were no predicted exceedences of the adopted PM_{10}, $PM_{2.5}$ or dust deposition criteria (assuming implementation of the dust control measures listed in Table 4-11).

4.3.5 Limitations

Section 4.7 of Technical Appendix H lists limitations applicable to the EES air quality assessment, which are summarised below:

- The modelling does not include particulate emissions from ventilation systems which will be required (but are yet to be defined) to maintain a safe work environment for underground construction personnel;
- Detailed construction layouts were not finalised at the time of the air quality assessment; and
- The air quality assessment may require updating if the Concept Design and alternative design options are modified.

4.4 Dust Mitigation Measures

In addition to the proposed dust mitigation measures listed in Table 4-11 (above) Section 12.17 of Chapter 12 of the EES also suggests that haul roads may be sealed "where possible", and wind erosion minimised by *"enclosure with sheds if practicable"*.

4.5 Risk Assessment

Table 12-2 of Chapter 12 notes that the residual air quality risk rating (ie. after implementing the proposed dust control measures) is "medium" in the Domain Precinct.

4.6 Peer Review

A peer review of the EES's air quality assessment was undertaken by Mr Damon Roddis of Pacific Environment, and is reproduced as Appendix C to Technical Appendix H.

The peer review's overall conclusion is that "*The modelling - - - demonstrates that with appropriate mitigation, activities at the - - construction work sites can be managed within SEPP* [State Environment Protection Policy] *criteria"*. However, the body of the peer review makes two important points in Section 4:

- A reference to a note (in the P5.1 AQ assessment document provided to the peer reviewer): *"The detailed construction layout has not yet been completed and the location and distribution of various emission sources has been based on the high-level project description and assumed locations only*"; and
- "*In view of the above, it is acknowledged that at this stage in the project design it is difficult to reliably quantify dust emissions from construction activities. Further, due to the variability of the weather it is impossible to predict what the weather conditions would be when specific construction activities are undertaken*".

5. FINDINGS OF MY ASSESSMENT

This section summarises the findings of my assessment of the air quality section of the EES as it relates to the Domain Precinct. For ease of reference, it is structured under headings similar to those in Section 4 (above).

In my opinion, little weight should be given to the air quality modelling predictions presented in Chapter 12 the EES, particularly in relation to the Botanica and other nearby apartment buildings. As discussed below, my opinion is based on a number of factors including :

- The lack of transparency of the AERMOD modelling process (the model configuration file(s) are not provided);
- Potential RCS emissions were apparently not considered;
- Dust emissions from the excavation and construction of Domain Station were apparently not considered;
- Dust emissions from ventilation of the underground works were not considered;
- "Worst case" scenarios were not modelled for sensitive receptors (such as the Botanica) which is located immediately adjacent to the Domain Station construction site;
- The air quality risk assessment is based on interpreting plots of particulate and dustfall isopleths, rather than on more precise predictions at discrete receptors representing nearby sensitive locations (such as the Botanica).

I agree that it is appropriate that the air quality assessment in the EES focuses on potential air quality impacts during the construction phase, rather than the operational phase. I also consider that odours are unlikely to be an issue, as I understand that reduced sulphur compounds in the Coode Island Silts are present in the form of (non-volatile) metal sulphides.

5.1 Relevant Air Contaminates

The EES air quality assessment appropriately includes particulates, represented by PM_{10}, $PM_{2.5}$ and total suspended particulates (as dust deposition).

However, it does not consider that significant quantities of respirable crystalline silica particles less than 2.5 microns in size (RCS) may be generated by the TBMs and station excavation works (which largely will be constructed within the Melbourne Formation). This geological formation comprises interbedded siltstone and sandstone (refer to Section 2 and Attachment 2 of my report).

The extract of Safe Work Australia's publication on crystalline silica (reproduced in Attachment 3), notes on pages 2 and 3 that:

- sandstone has an average crystalline silica (quartz) content of 67%;
- examples of work activities involving crystalline silica which require special attention (from an OHS standpoint) when assessing exposure to RCS include excavation, earth moving and drilling plant operations (all of which are relevant to the proposed underground operations).

Schedule A of the EPA's State Environment Protection Policy (Air Quality Management) classifies respirable crystalline silica particles smaller than 2.5 microns as a Class 3 Indicator, on the basis that it is listed by the International Agency for Research on Cancer (IARC) as a Group 1 carcinogen. Clause 20(1) of SEPP(AQM) requires that *"Generators of emissions of Class 3 indicators must reduce those emissions to the maximum extent achievable"* – this would require much more stringent dust control than those proposed by the EES.

The potential for generation of RCS during construction activity within the Melbourne Formation will be influenced by a number of factors including: the nature of TBM and underground excavation operations; the extent of sandstone strata present; its degree of weathering; and its in-situ moisture content (however, Chapter 12 of the EES notes that the typical moisture content of TBM spoil will be 4%, which means that the spoil will be potentially "dusty").

5.2 Air Quality Criteria

Schedule A of SEPP(AQM) specifies a (very stringent) design criteria for RCS of 0.00033 mg/m^3 (3-minute average).

5.3 Modelling of Particulates

This section sets out my comments on the dispersion modelling presented in Chapter 12 and Technical Appendix H of the EES.

In my experience, dispersion model configuration files and detailed model outputs are almost invariably supplied to provide a high degree of transparency to model predictions. Configuration files specify all the model settings (including receptor grid spacings), along with specific details of the location, size and emission rate (time varying if relevant) applicable to all sources. The failure to provide the configuration files within the EES is not only unusual, but means that other parties (including myself) are unable to assess how much confidence should be placed on the model predictions, and in particular, whether appropriate "worst case" scenarios have been modelled.

5.3.1 Dust sources and Emission Rate Estimates

The emission rate estimates for the Domain Precinct are summarised in Section 4.2.4.2 of Appendix H for: loading and unloading spoil (moisture content 4%) to construction stockpiles; wheel generated dust on unsealed surfaces; and wind erosion from exposed areas (based on 70% of the 5 ha Domain construction work site). As noted earlier, these estimates are based on the NPI Emission Estimate Technique Manual for Mining, after allowing for the implementation of dust control measures. While this represents the most appropriate emission estimation technique, actual "real world" emission rates can vary widely from the theoretical estimates, for a range of site-specific factors.

In the absence of the AERMOD configuration file(s) it is not possible to provide specific comments on dust sources and emission rate estimates input to the model; however, I make the following points:

- The model does not take account of particulate emissions in air exhausted by the (as yet unspecified) mechanical ventilation systems serving the underground construction operations (this is acknowledged in the EES);
- Particulate emissions from the "cut and cover" excavation and construction of the Domain Station have not been included in the modelling, despite the fact that some of these operations will take place literally on the door step of the Botanica;
- The assumed number and size of the construction spoil stockpiles have not been specified;
- Information has not been provided on relevant factors including the proportion of silt present in the spoil or the relationship between wind speed and rates of wind erosion; and
- Emissions of RCS have apparently not been considered.

5.3.2 Meteorological File

Use of meteorological data for Essendon Airport in preparing the (AERMET) file used for modelling should not have any substantial bearing on the model predictions.

5.3.3 Modelling Scenarios

My comments focus on the "Domain only TBM launch option" as this will result in higher dust emissions in the Domain precinct than the alternative "Domain and Fawkner Park TBM launch option". The only scenario modelled for the former option is described as the "peak scenario", based on the emission sources and estimates described in Table 4-11 of Technical Appendix H.

I consider that the modelling exercise should definitely have also included "worst case" scenario(s) for nearby sensitive locations. In the case of the Botanica, such a scenario would include particulate emissions associated with the potentially most dusty phase of the "cut and cover' construction work immediately adjacent to the Botanica.

5.3.4 Model Predictions

As noted above, presentation of the model predictions only as plots of particulate concentration (and dustfall) isopleths is inadequate where sensitive locations (such as the Botanica) are situated in close proximity to the proposed construction activities. The isopleths are generated by the plotting software from AERMOD's predicted values at each grid point, while the spacing of the grid points is specified by the modeller. The wider the grid spacing, the less accurate the plotted isopleths will be, and the more likely that isopleths will fail to identify potential "hot spots" (in the absence of the configuration files, it is not possible to determine the grid spacing specified by the modeller).

Figure 12-7 in Chapter 12 of the EES illustrates this point. Despite the fact that wheel-generated dust on haul road between the Domain Station and Edmund Herring Oval is estimated to generate 73% of the $PM_{2.5}$ emissions (Table 4-9 of Technical Appendix H) the plots do not reflect this.

5.4 Dust Mitigation Measures and Monitoring

My experience with the assessment and management of dust at numerous extractive industry, mine and landfill sites is that dispersion modelling is a useful tool to identify the relative contributions of individual sources to particulate concentrations at sensitive locations and evaluate the benefits of various dust management strategies. However, model predictions are generally less reliable when it comes to predicting off-site particulate concentrations and dust deposition rates.

I believe that the most effective dust management programmes in situations such as this, where sensitive uses are located in close proximity to dust sources, is to focus on:

- Using modelling to identify the main dust sources which are likely to impact on sensitive land uses;
- Identifying appropriate dust mitigation measures - if RCS is a shown to be a potentially significant issue, control to the "maximum extent achievable" will be required by SEPP (AQM);
- Requiring all site personnel to immediately advise the site manager if excessive dust emissions are observed;
- Routinely reviewing weather model predictions to identify potentially adverse weather conditions at least two days in advance, so that dust controls can be pro-actively implemented and/or upgraded where appropriate (I understand that "Weatherzone" can provide specific advance warning of such conditions);
- Pro-actively suspending particular site activities during periods of adverse weather conditions;
- Installing suspended particulate monitors (for PM_{10} and/or $PM_{2.5}$) at sensitive locations - these should be set up to:
    - Transmit "real time" warnings to the site manager in the event that particulate concentrations reach a level which suggests that 24-hour average concentrations may be exceeded;
    - Store records in a data base which can be accessed to determine compliance with air quality criteria, and provide a basis for modifying the dust control measures where appropriate; and
    - The installation of dust deposition gauges before work commences can provide a useful indication of "background" deposition rates and the contribution of construction activities to dust deposition; however, these gauges are normally sampled on a monthly basis.

I note that sealing haul roads to reduce dust emissions is not necessarily as effective as well-watering unsealed haul roads during hot, windy conditions, because water (applied for dust control) evaporates much more quickly from bitumen pavements under such conditions – frequent street-sweeping is required to counter this, as trucks conveying spoil from the TBMs and Domain station excavations are likely to continually deposit material on the haul roads.

An effective truck wash (incorporating water sprays) will be required to prevent material from the worksite being deposited on public roads by trucks transporting spoil away from the construction site (unless they are confined to clean, sealed paved areas). Deposition of material on public roads will need to be regularly removed by a street sweeper to avoid creating additional dust sources (which are likely to be close to sensitive uses).

The contractor(s) which will undertake works within the Domain precinct should be required to prepare a comprehensive Dust Management Plan including the above points (as part of an overall Construction Environmental Management Plan), along with any other measures (such as sealing haul roads and/or enclosing the construction spoil stockpiles within a building) which may be recommended by the Inquiry.

5.5 Risk Assessment

I do not consider that the dispersion modelling described in Chapter 12 of the EES provides an adequate basis for defining a residual air quality risk rating for the Domain precinct, and in particular for nearby residents such as those in the Botanica.

5.6 Peer Review

I am surprised that the peer review did not comment on deficiencies in the air quality assessment which are identified in Section 5-3 (above).

However, I note, and agree with, the following points made by the peer review:

- It acknowledges (in Section 4) that: "*at this stage in the project design it is difficult to reliably quantify dust emissions from construction activities*";
- (section 5) – *"It is considered that the value of the dispersion modelling is principally to identify risks and to recommend appropriate mitigation measures during construction";*
- (section 8) – mitigation techniques including "- - - *ongoing construction dust monitoring at key sensitive receptor locations*."

6. CONCLUSIONS AND RECOMMENDATIONS

1. The Botanica apartments will be particularly sensitive to increases in local dust levels, because: they are located in close proximity to the Domain station worksite; the construction period is projected to extend for 48 months; and the only way to introduce fresh air into the apartments is by opening external doors and/or windows.

2. The dispersion modelling described in Chapter 12 of the EES does not provide an adequate basis for defining a residual air quality risk rating of medium for the Domain precinct, and in particular for nearby residents such as those in the Botanica.

3. It will be most important to establish whether respirable crystalline silica (RCS) will be an issue associated with managing spoil generated by the TBMs, excavation works, and ventilation systems serving underground construction areas – if so, RCS should be modelled to assess compliance with the SEPP(AQM) criterion, and dust control measures for relevant sources within the Domain precinct will need to comply with the "maximum extent achievable" requirements of SEPP(AQM).

4. I recommend that further dispersion modelling is conducted to include estimated particulate emissions from the excavation of the Domain Station, a realistic "worst case" scenario for residents at the Botanica, estimated RCS emissions if appropriate, and discrete receptors defined at sensitive locations including the Botanica and Melbourne Grammar school – the configuration files for all model runs should be provided, along with the model predictions and plots.

5. I recommend that a Community Liaison Committee be established, to include representatives of the Botanica Owners Corporation and other relevant parties, to meet regularly with technical representatives of MMRA, following the completion of the EES Inquiry process, and continue until completion of construction works within the Domain precinct. The liaison committee should review the results of particulate monitoring, consider any concerns raised by members of the community, and assess the adequacy of dust management measures, and other issues affecting local amenity.

I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.

(Dr) J T Bellair FVPELA FEIANZ

12 August 2016

Attachment 1. Content of Report – PPV Guide to Expert Evidence

1. Name and Address

John Terence Bellair
Environmental Science Associates
18 Goldsmith Crescent, Castlemaine Vic 3450

2. Qualifications and Experience

Refer to curriculum vitae (Attachment 4)

3. Areas of Expertise

I have worked as an environmental science consultant since 1973. Over this period I have played a key role in numerous assignments related to water and air quality management, pollution control, disposal of municipal and industrial wastes, environmental impact assessment, environmental audits, salinity control and the development of environmental policies. These projects have been carried out in all States and Territories of Australia, and in the USA, New Zealand, Thailand, Fiji and Kiribati.

4. Expertise to Prepare Report

Since serving as Project Manager of the consultant team which prepared the Victorian EPA's original SEPP (Air Quality) between 1979 and 1981, I have been involved in numerous air quality and odour investigations covering a very wide range of municipal and industrial sources.

5. Instructions which Defined Scope of Report

I received written instructions from Planning & Property Partners Pty Ltd on 8 August 2016 which requested that I essentially:

- review the brief supplied to me (comprising the Melbourne Metro EES);
- consider and formulate my own opinions with respect to the appropriateness of the relevant documentation in respect of air emissions and odour; and
- prepare a report which sets out my conclusions and the basis upon which they have been formulated.

6. Facts, Matters and Assumptions Relied Upon

- The brief provided by Planning & Property Partners Pty Ltd;
- Information on ventilation arrangements at the Botanica;
- Safe Work Australia's publication on RCS;
- SEPP (AQM);
- My familiarity with the Domain station precinct; and
- My experience in numerous air quality assessments involving the assessment and management of dust emissions.

7. Documents taken into Account
Refer to (6) above.

8. Identity of Persons Undertaking Work
The undersigned (Terry Bellair).

9. Summary of Opinions
Refer to Sections 5 and 6 of my report.

10. Provisional Opinions
My opinions are not provisional except where specifically qualified.

11. Limitations of Expertise and any Incomplete or Inaccurate Aspects
I consider that the subject matter of my report falls within my area of expertise and that issues dealt with are adequately addressed for purposes of this hearing.

J T Bellair
August 2016

Attachment 2. Geological and Hydrogeological Conditions

Figures 7-8, 7-10 and 13-1 reproduced from Technical Appendix O of the EES

Figure 7-8 shows the hydrogeological conditions this section of the Tunnels precinct is expected to encounter. More detail about these hydrogeological units is included in Appendix C of this report.

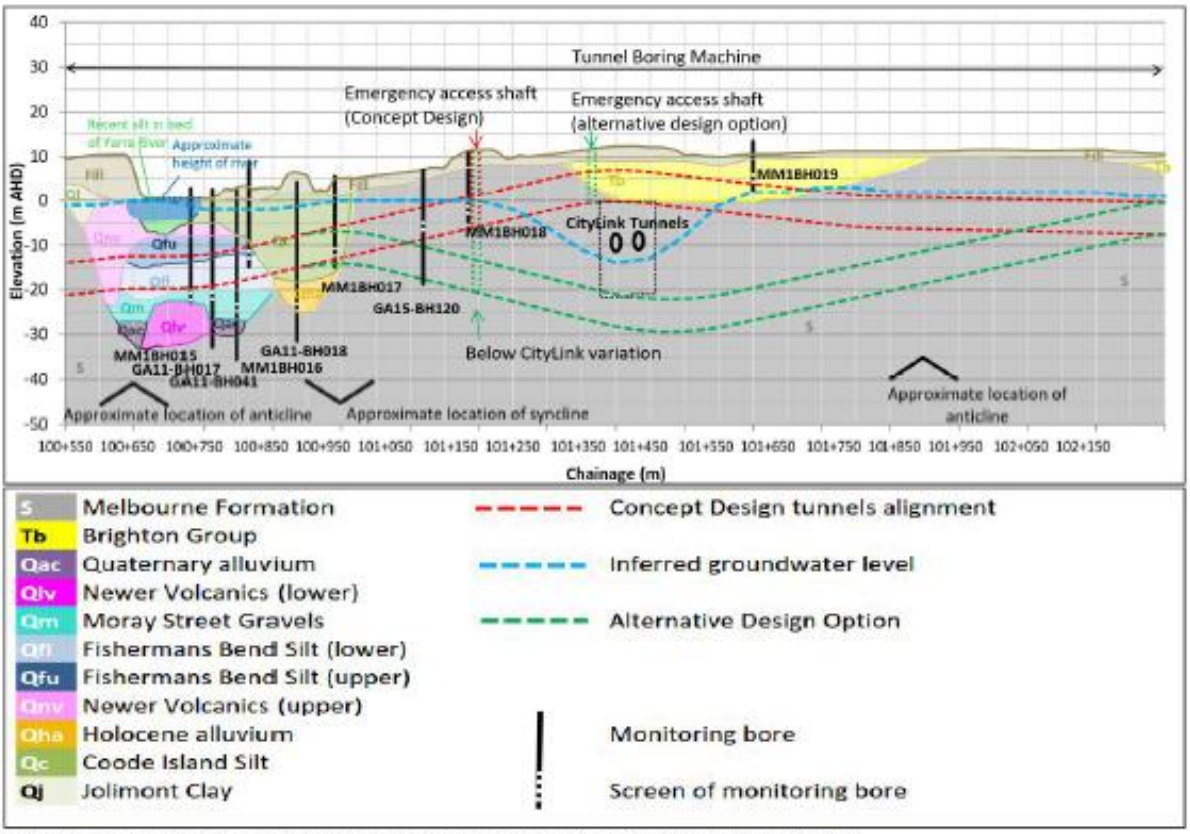

Figure 7-8: Conceptual site model for the tunnels area between CBD South and Domain stations

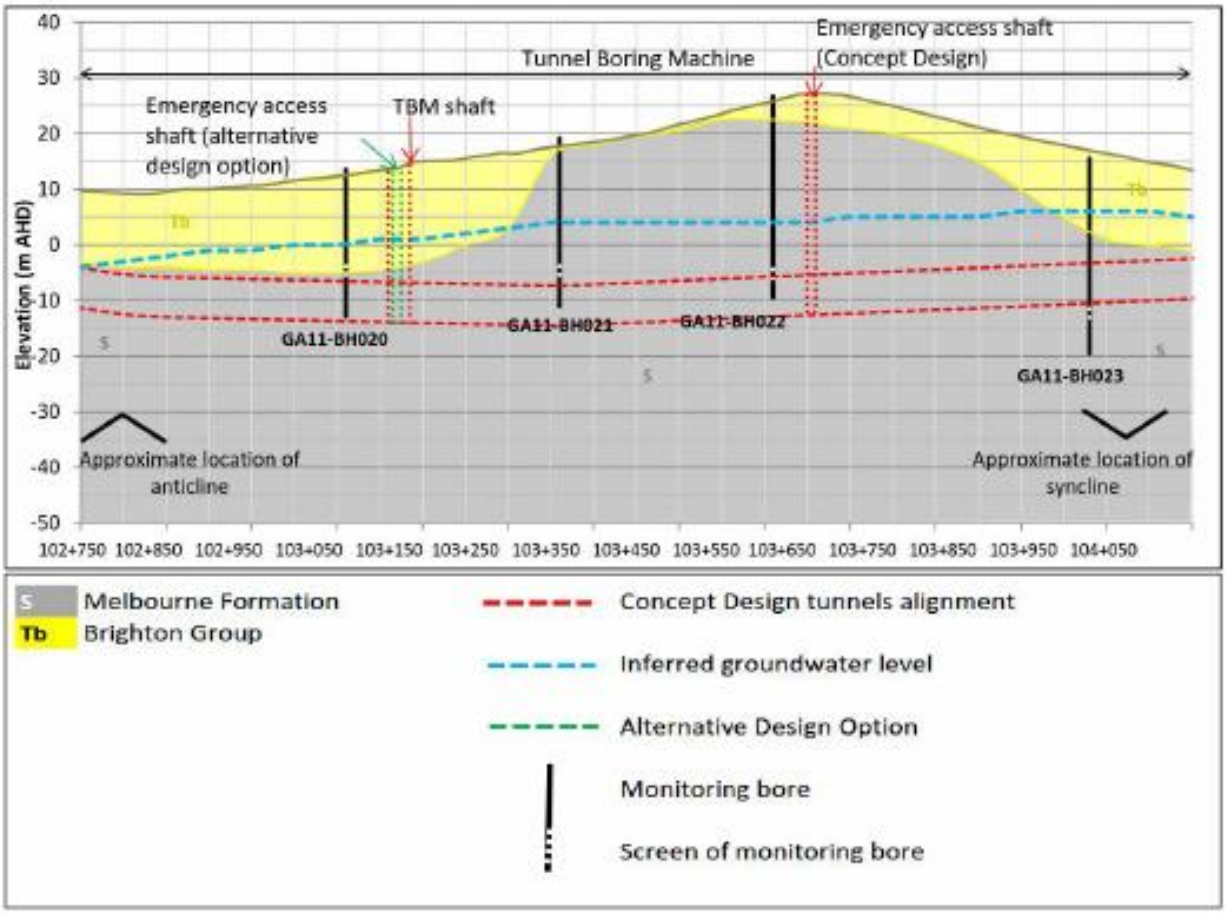

Figure 7-10: Conceptual site model for the tunnels area between Domain station and the eastern portal

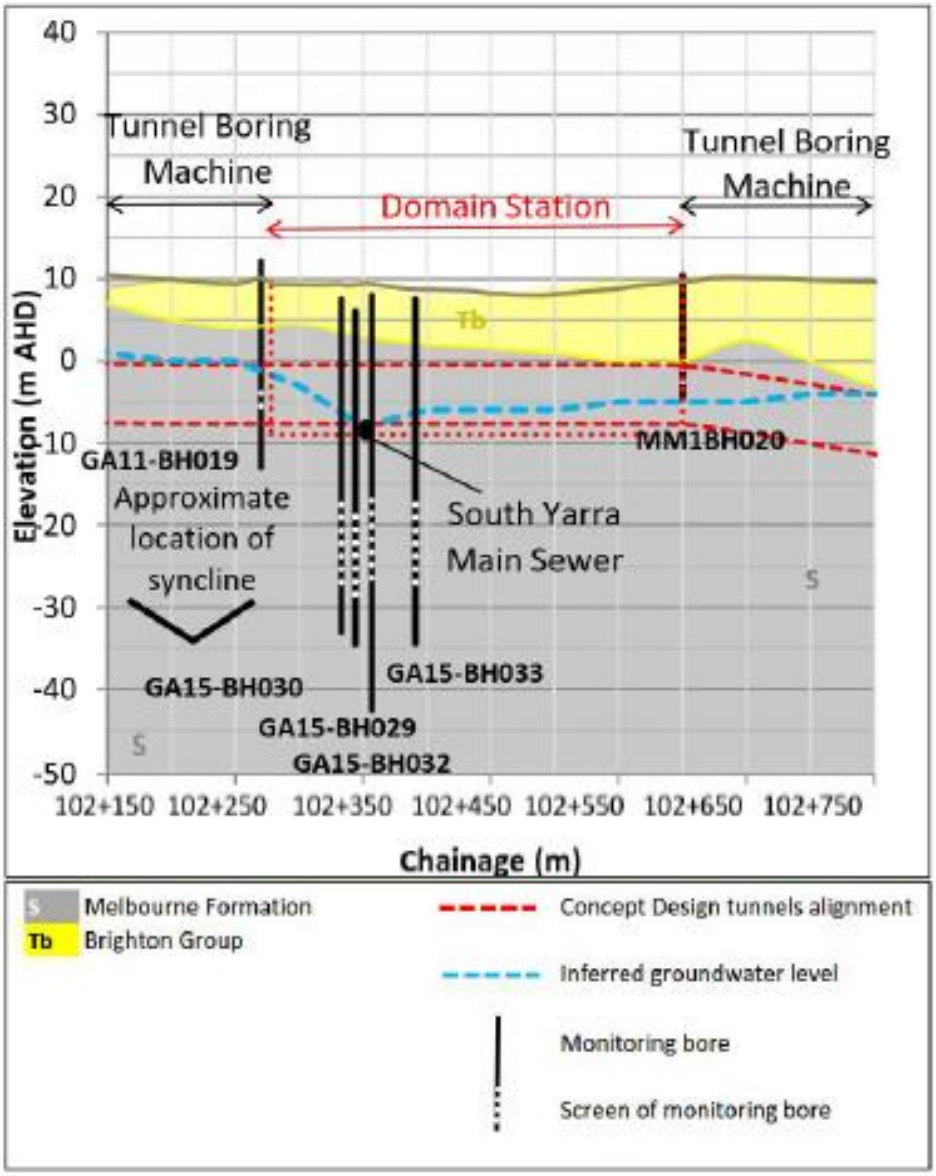

Figure 13-1: Conceptual site model for the Domain station precinct

Attachment 3. Safe Work Australia Crystalline Silica

Extract of Safe Work Australia's publication on crystalline silica.

CRYSTALLINE SILICA

BASELINE HEALTH MONITORING BEFORE STARTING WORK IN A CRYSTALLINE SILICA PROCESS

1. Collection of demographic data

2. Work history

3. Medical history

Administration of a standardised respiratory questionnaire. Two examples are the international Union Against Tuberculosis' *Bronchial Symptoms Questionnaire 1986* [1] **or** the Medical Research Council's *Questionnaire on Respiratory Symptoms 1986* [2].

4. Physical examination

A physical examination will be conducted with emphasis on the respiratory system.

5. Investigation

The following tests will be used to test the worker's baseline exposure:

- standardised respiratory function tests* to be performed. The tests are FEV_1[2], FVC[3] and FEV_1/FVC[4]. The norms for predictive values should be stated.
- chest X-ray, full size PA view. Report to be recorded according to current International Labour Organisation classification.

Note: In order to reduce radiation exposure the frequency of chest X-ray should be minimised. There is potential for excessive X-rays with a workforce that changes employers frequently. Protocols have been reviewed recently by the United Kingdom HSE, see http://www.hse.gov.uk/research/rrpdf/rr827.pdf, and there is a general consensus for annual assessment with respiratory questionnaire and lung function tests to look for lung function changes over time.

DURING EXPOSURE TO A CRYSTALLINE SILICA PROCESS

6. Monitoring exposure to crystalline silica

A medical examination should be conducted annually and will include:

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* Spirometry equipment should be calibrated regularly according to a standard protocol.

[2] Forced expiratory volume in one second

[3] Forced vital capacity

[4] Tiffeneau index

- work history
- medical history
- physical examination
- lung function investigation consisting of standardised respiratory function tests and, if required, a chest X-ray.

The Michigan State University have developed the following protocol [3]:

1. **Chest X-ray**. Every 5-10 years in first 20 years of work unless the air levels are above the exposure standard. In order to reduce radiation exposure, the frequency of chest X-rays should be minimised. (Note: be aware of the potential for excessive X-rays where the worker has worked for multiple employers, particularly in the construction industry). An abnormal X-ray or 20-years exposure or more warrants X-rays on a more frequent basis.
2. **Pulmonary function tests.** Performed as a baseline and annually. Individuals with progressive decreases in pulmonary function beyond that normally associated with age [4,5] should be closely followed up about the aetiology of the pulmonary function decrement.

The Australian Institute of Occupational Hygienists (AIOH) [6] recommends "where there is a continued likelihood of 50 per cent of the exposure standard being exceeded, exposure monitoring and health surveillance should apply. To overcome limitations in analytical sensitivity, full shift monitoring and the use of a NATA (National Association of Testing Authorities) registered laboratory is recommended."

AT TERMINATION OF WORK IN A CRYSTALLINE SILICA PROCESS

7. Final medical examination

A final medical examination will be conducted and will include:

- medical history
- physical examination
- investigation.

SUPPLEMENTARY INFORMATION ON CRYSTALLINE SILICA

8. Work activities that may represent a high risk exposure

Silica is silicon dioxide, a naturally occurring widely abundant mineral that forms the major component of most rocks and soils. There are non-crystalline and crystalline forms of silicon dioxide. Crystalline silica is also known as free silica. Crystalline silica dust particles which are small enough to penetrate deep into the lung are termed respirable. Respirable crystalline silica may cause lung damage. The non-crystalline form of silica does not cause this kind of lung damage.

The main form of crystalline silica is quartz. Granite contains 25 per cent to 40 per cent quartz, shales average 22 per cent and sandstones average 67 per cent quartz. Quartz is the major component of sand in locations like stream beds, beaches and

deserts. Other polymorphs of silicon dioxide, like cristobalite and tridymite are less common. Crystalline silica is found in varying proportions in aggregates, mortar, concrete and stone.

Examples of work activities involving crystalline silica which require special attention when assessing exposure include:

- excavation, earth moving and drilling plant operations
- clay and stone processing machine operations
- paving and surfacing
- mining and mineral ore treating processes
- construction labouring activities
- brick, concrete or stone cutting, especially using dry methods
- abrasive blasting—blasting agent must not contain >1 per cent crystalline silica
- foundry casting.

POTENTIAL HEALTH EFFECTS FOLLOWING EXPOSURE TO CRYSTALLINE SILICA

9. Route of entry into the body

The primary route of crystalline silica entry into the body is through inhalation.

10. Target organ/effect

Lungs – silicosis, International Agency for Research on Cancer (IARC) Group 1 Carcinogen for lung cancer, chronic obstructive pulmonary disease.
Kidneys – epidemiologic data emerging that silica causes renal disease.

Airborne crystalline silica can bio-accumulate in the lungs and cause disease of the respiratory system.

Large bio-accumulated loads of crystalline silica in the lung substance (or lung parenchyma) can cause a build up of connective tissue, which is termed silicosis, a specific form of pneumoconiosis. Silicosis is an irreversible and progressive condition. Early silicosis may have no untoward effects. However, severe forms can result in poor gas exchange, difficulty in breathing and death. Evidence suggests crystalline silica interacts with other respiratory hazards, like tobacco smoke, to cause airway diseases.

Silicosis virtually always requires prolonged exposure to substantial airborne quantities of respirable crystalline free silica. Four clinical patterns of diffuse lung disease may be seen with silicosis: simple nodular silicosis, progressive massive fibrosis, accelerated silicosis, and acute silicosis or silicoproteinosis.

The AIOH supports the workplace exposure standard of 0.1 mg/m^3 for respirable crystalline silica.

However, a “no observable adverse effects level” (NOAEL) cannot be demonstrated. Risks to health are occurring at levels previously thought to be acceptable.

Attachment 4. Curriculum Vitae of Dr Terry Bellair

CEE CONSULTANTS PTY LTD

FIRST FLOOR · 90 BRIDGE ROAD · PO BOX 201 · RICHMOND · VIC 3121 · TEL 03 9429 4644 · FAX 03 9428 0021

J Terry Bellair – Environmental Science Consultant

Qualifications:

B Agr Sc (Melb) 1961
Ph D Biochemistry (Melb) 1966

Fellowships:

Fellow, Environment Institute of Australia and New Zealand
Fellow, Victorian Planning and Environmental Law Association

Professional Experience:

since 1984	Director, CEE Consultants
since 1984	Principal, Environmental Science Associates
1973-1983	Principal Scientist, Caldwell Connell Engineers
1969-1972	Senior Research Fellow, Medical Research Centre, Melbourne
1967-1969	Assistant Professor, University of North Carolina Medical School
1966-1967	Post-Doctoral Fellow (biochemistry) University of North Carolina

During his environmental consulting career, spanning over 40 years, Dr Bellair has played key roles in numerous assignments related to water and air quality management, pollution control, disposal of municipal and industrial wastes, environmental impact assessment, environmental audits, salinity management and the development of environmental policies. These projects have been carried out in all States and Territories of Australia, and in the USA, New Zealand, Thailand, Fiji and Kiribati.

Dr Bellair was a founding committee/board member of both the Victorian Chapter of the Environment Institute of Australia and the Victorian Planning and Environmental Law Association. He has been appointed by the Victorian Government to conduct over 30 hearings into controversial environmental and planning issues. He has served on the Victorian Mineral Water Advisory Committee and on the board of the North Central Catchment Management Authority. He elected to not renew his Victorian EPA accreditation as an Environmental Auditor (Industrial Facilities) in 2003.

He has been retained as an expert witness in over 350 tribunal, panel and court proceedings, mainly in Victoria, but also in NSW, Queensland, South Australia and Tasmania. He has first-hand experience in land and livestock management through the rehabilitation of a 25 ha property on the upper Loddon River at Glenlyon, and is an experienced pilot (in both gliders and powered aircraft).

Examples of projects in which Dr Bellair has played either the principal or key supporting roles are summarised under the following headings: (1) air quality management; (2) water quality management; (3) environmental impact assessment and resource management; (4) municipal and industrial waste disposal; (5) salinity management; (6) mining and quarrying; and (7) environmental audits and due diligence investigations.

Air Quality Management (including odour and dust)

- Project Manager for preparation of the original State Environment Protection Policy (the Air Environment) for the Victorian EPA This was the first air quality management policy to come into effect in Australia (in 1981).
- Retained by the Tasmanian Environment Protection Policy Review Panel in 2002 to assist in the Panel's review of the Draft Environment Protection Policy (Air Quality).
- Conduct of an environmental audit of the Coode Island bulk chemical storage facility for the Victorian EPA (focussing on air emissions).
- Conduct of an audit of emissions to atmosphere from the proposed Kingstream Steel Plant at Geraldton for the West Australian EPA.
- Modelling emissions from 12 diesel generator sets on Barrow Island (to be used during construction of the Gorgon gas plant).
- Conduct of an audit of odour management at a broiler farm in the Adelaide Hills for the South Australian EPA.
- Statutory audit (odour emissions) for a tannery in Hobart.
- Preparation of over 25 EPA Works Approval and Licence amendment applications for a wide range of industrial facilities.
- Investigation and evaluation of control options for atmospheric emissions (including odours and dust) from a wide variety of sources including power stations, paper pulp mills, refineries, petrochemical plants, food processing plants, abattoirs, by-products plants, piggeries, feedlots, poultry farms, cement plants, dye works, printing works, brick works, ferrous and non-ferrous foundries, scrap metal recyclers, wastewater treatment and disposal facilities, landfills, medical waste incinerators, composting operations, mineral sands separation plants, construction and demolition waste recycling facilities, and a range of chemical plants.

Organisations for which Dr Bellair has carried out air quality work include the following:

Chemical, Petrochemical and Waste Treatment Plants – Petroleum Refineries Australia Pty Ltd, Altona Petrochemical Complex, BP Australia Limited, Smorgan Consolidated Industries, Monsanto Australia Limited, Dow Chemical, Taubmans, Nufarm Chemicals, Cablemakers, Worth Environmental, Active Environmental, Kemrez Chemicals, A C Hatrick Chemicals, Megachem, ICI Australia, Dunlop Foam Products Group, Trident Technologies, Victorian Chemical Company, Hoechst Australia, Harpers Liquid Waste, Jennings Liquid Waste, Albright & Wilson, Visy Industries, Rhodia PMC, Nuplex.

Other Industries – Carlton & United Breweries, Geelong Wool Combing Ltd, Boral Insulwool, Boral Bricks, Australian Cement Limited, CSR Readymix, David Mitchell Limited, Mulwala Explosives Factory, Australian Newsprint Mills, Tennyson Textiles, Synthetic Dyeworks Industries, Toyota Motor Corporation, Colin Martyn Packaging, Bendigo Mining NL, Wimmera Industrial Minerals, Perseverance Mining NL, Heathcote Gold Project, Nonferral, Gatic (Australia) Pty Ltd, Pacific BBA, Delphi Automotive Systems, Cheetham Salt, Iluka Resources, Bonlac, Delta Demolitions, Alex Fraser Recycling, Visy Industrial Packaging, VisyPak, Murray Goulburn Co-operative, City Circle Demolitions, Dual Gas Pty Ltd, Greenchip Recycling, Orica.

Abattoirs and By-products Plants etc – S P Holman & Sons, Thomas Borthwick & Sons, RJ Gilbertson Pty Ltd, J H Ralph and Sons, Peerless Holdings, G & K O'Connor Pty Ltd, Mackay By-Products, Aspen By-Products, Bears Lagoon Piggery, United Meat Products, Australian Tallow Producers, Tallowmaster, ICM Farm Products, Tabro Meat, Castricum Brothers, Baybrick Pty Ltd, Master Renderers, Goulburn and Ballarat saleyards, various broiler farm operators (and objectors), Victorian Chicken Meat Council, Liberty Meats, Hazeldenes Chicken Farms, Blue Ribbon Products, several cattle and sheep feed lots.

Government Authorities – Victorian, West Australian, South Australian, and Tasmanian EPAs, Urban and Regional Land Corporation, Victorian Solar Energy Council, VicRoads, Port of Geelong Authority, Sydney Water Board, Port of Darwin Authority, NT Works Department, NT Electricity, numerous municipal councils and water authorities in Victoria and Tasmania, Engineering and Water Supply Department (SA), Metropolitan Water Board (Perth), Northern Territory Electricity Commission, Hydro Electric Commission (Tasmania).

Water Quality Management

- Management of effluent re-use study of seven wastewater treatment plants for the Lower Murray Region Water Authority.
- Preparation of a detailed assessment of the effects of river regulation on "in stream" uses of NSW rivers and development of strategies to enhance these uses, for the Department of Water Resources.
- Assessment of the environmental water requirements of the Barmah and Millewa forest ecosystems and development of an appropriate water management strategy, for the Murray Darling Basin Commission.
- Planning and assessment of biological investigations of proposed ocean outfalls at North Head, Bondi, Malabar, Geelong, Wellington, Suva, Port Lincoln and Darwin.
- Specialist consultant engaged in the development of water quality management strategies for the Songkhla Lakes Basin in Southern Thailand.
- Conduct of a detailed analysis of water quality data for all river basins in Victoria, for the Department of Water Resources.

- Assessment of the effects of proposed pulp mill effluent on aquatic environments in Victoria and Tasmania.
- Investigation of the environmental and public health implications of three wastewater outfalls on Tarawa Atoll, Republic of Kiribati.
- Detailed investigations of the rate of bacterial die-off in receiving waters, and its implications for public health and the design of treatment and disposal systems (field studies conducted in Sydney, Port Lincoln, Geelong, Mooloola, Wellington and Suva).
- Investigation of the effects of land use and wastewater disposal on water quality in the Murrumbidgee, Wimmera, Georges and Shoalhaven rivers.
- Development of effluent treatment, storage and irrigation systems for tourist developments at Dinner Plain, Hanging Rock, Mt Macedon, Marysville, Mt Dandenong and Howqua.
- Assessment of water quality aspects of proposed marina and lake developments at Noosa and Moreton Bay (QLD), Patterson Lakes, Martha Cove, St Kilda, Werribee and Meetung.

Environmental Impact Assessment and Resource Management

- Responsible for the preparation of environmental impact assessments (EIAs) since 1975 for a wide range of proposals including power stations, major ports, wastewater treatment and disposal systems, landfills, wind farms, freeways, ocean outfalls, marina developments, industrial plants and forestry, mining, extractive industry and mineral processing projects.
- Served as Project Manager in preparation of EIA reports including: Illawarra Wastewater Strategy ($100 million sewerage project); Channel Island (coal fired) Power Station, Channel Island (gas turbine) Power Station, Darwin; Georges River wastewater treatment and disposal systems, NSW; East Arm Port development in Darwin, and a regional landfill at Port Latta, Northern Tasmania, Wonthaggi and Bald Hills Wind Farms, Lonsdale Golf Club Development Project.
- Provided major contributions to EIA reports including: Mulwala explosives factory; Wimmera Industrial Minerals mineral sand project; proposed Tasmanian coal-fired power station; ANM Albury pulp mill upgrading; Central Deborah gold mining project, Bendigo; Hampshire wood chip mill, Tasmania; Heathcote gold project, Victoria; Perseverance gold mine, Nagambie; Ferntree Gully quarry extension; Eastern and Southeastern freeways and Western By-Pass Road, Cranbourne By-pass, Hobart sewerage upgrade.
- Chaired Independent Panel which assessed the original Toora wind farm proposal by the (then) Victorian State Electricity Commission.
- Prepared EESs for two wind farm proposals in South Gippsland at Wonthaggi (10.5 MW) and Bald Hills (105 MW).
- Prepared environmental assessments and environmental management plans for numerous proposals in Victoria which were not required to undergo formal EIA assessment, but were reviewed through the Works Approval and Planning Permit processes – presented expert evidence in appeals relating to many of these.

- Preparation of a report for the Commissioner for the Environment on appropriate methods for monitoring the environmental impacts of past and present agricultural activities in Victoria, and assessing the sustainability of current farming practices.

Municipal and Industrial Waste Management

- Conduct of an industrial waste generation survey of Tasmania for the Department of Environment and Planning.
- Two surveys of industrial waste generation rates and disposal practices in Victoria for the EPA.
- Development of environmental control strategies for existing and proposed municipal landfill operations at South Clayton, Spring Valley, Broadmeadows, Preston, Colac, and in the Shires of Eltham, Diamond Valley, Colac, Flinders, Morwell, Alexandra and Upper Yarra (including assessment and control of odour emissions, pathogens, litter, dust, leachate, and birds).
- Preparation of environmental control strategies for management of odours, dust, litter, vermin and birds for existing and proposed commercial landfills at South Clayton (Pioneer, Allied Sands), Wollert (Pioneer) and Niddrie (Whelan the Wrecker and Quadry Investments), Badgerys Creek (NSW), Colac (CSR), and Burnie (Tas).
- Environmental review of proposed prescribed waste landfill and composting facilities at Werribee (CSR/Envirogreen).
- Investigations of odour emission rates from existing municipal, commercial and prescribed waste landfills and conduct of plume dispersion modelling to identify landfill gas management systems and operational measures necessary to avoid off-site odour problems (at seven sites).
- Preparation of a solid waste management strategy for the City of Devonport, including conduct of a waste generation survey and site selection investigations for a new regional landfill.
- Preparation of Development and Environmental Management Plans for two regional landfills in Northern Tasmania (at Port Latta and Dulverton), to serve the municipalities of Devonport, Circular Head and Wynyard in Tasmania.
- Review of the design, operation and potential environmental impacts associated with existing and proposed refuse transfer and material recycling facilities at Rosebud, Camberwell, Brunswick, Broadmeadows, Clayton, Niddrie, Morwell, Sunshine, Geelong, Devonport, Wynyard and Circular Head.

Salinity Management

- Chairman of the Loddon Murray Forum (2000-2003) which has overall responsibility for the preparation of the "2nd generation" Land and Water Management Plan for the Loddon Murray region of Victoria.
- Responsible for environmental aspects of the development of the original Shepparton and Kerang Lakes Area Salinity Management Plans.
- Environmental assessment of the proposal by Cheetham Salt to increase salt production at its Lake Tyrrell operation to one million tonnes per year.

- Specialist consultant advising the Victorian Parliamentary Salinity Committee on the environmental implications of a range of salinity control options for Northern Victoria.
- Preparation of an assessment of the environmental implications of salinity management options in Victoria, and research and investigation needs, for the Ministry for Planning and Environment.
- Investigation of die-back of river red gums adjacent to a major evaporation basin near Loxton, South Australia, and development of an environmental rehabilitation strategy for the basin.
- Investigation of the feasibility of harvesting salt from the proposed Mineral Reserve Basin evaporation ponds and the environmental implications of the scheme for Lake Tuchewop.
- Review of the environmental implications of rice growing for the Australian Ricegrowers Association.
- Portfolio responsibility for management of floodplains and irrigation salinity as a board member of the North Central Catchment Management Authority.

Mining and Quarrying

- Chaired Independent Panel appointed by the Victorian Government to hear submissions on the Environment Effects Statement for Valdora Mineral NL's Ballarat East open cut gold mine proposal (one million ounces per annum) - this was the first project to be assessed following the 1993 amendments to the Mineral resources Development Act 1990.
- Independent review of potential air quality implications of Iluka Resources' proposed mineral separation plant near Hamilton.
- Preparation of technical submission on the Draft National Environment Protection Measure for PM_{10} (respirable dust) for the Extractive Industry Council.
- Investigation of potential environmental effects and control measures in connection with the Central Deborah gold mining project, including mine operation and dewatering, gold recovery plant and tailings disposal, for (the original) Bendigo Mining NL.
- Conduct of dustfall and meteorological investigations at a number of hard-rock quarries and sand mining operations, and associated crushing, lime and cement plants (for a number of clients including Rio Tinto, Pioneer, Boral, CSR, Australian Cement, David Mitchell Ltd, Barro Group, Lang Lang Holdings).
- Investigation of potential environmental effects and control measures related to development of the WIM 150 mineral sands deposit at Drung South.
- Investigation of environmental issues and development of environmental control and monitoring programs for Perseverance Mining NL's open cut gold mine and heap-leach treatment process at Nagambie.
- Provision of specialist environmental advice in relation to existing or proposed gold mining operations at Bendigo, Eaglehawk, Gaffneys Creek, Heathcote, Chewton, Tarnagulla and Moliagul.

- Environmental investigations of existing and proposed hard rock quarrying operations at Ferntree Gully, Lysterfield, Montrose, Tynong North, Kilmore and Neerim North, and sand mining operations at Lang Lang, Grantville and Bacchus Marsh.
- Environmental investigations at a number of concrete recycling facilities.

Environmental Audits and Due Diligence Investigations

- Conduct of numerous internal environmental assessments of industrial and public facilities over the past 25 years (commencing well before the development of formal environmental audit processes).
- Conduct of an environmental audit of the Coode Island bulk chemical storage facility for the Victorian EPA.
- Conduct of an audit of emissions to atmosphere from the proposed Kingstream Steel Plant at Geraldton for the West Australian EPA.
- Conduct of an audit of odour management at a broiler farm in the Adelaide Hills for the South Australian EPA.
- Statutory environmental audit of a major paint manufacturing operation in Victoria.
- Statutory audit for a tannery in Hobart.
- Environmental audits of 12 of the Sydney Water Board's wastewater treatment plants (including North Head and Bondi).
- Environmental audits of 18 waste paper recycling and paper mill operations throughout Australia.
- Environmental audit of a major non-ferrous metal recycling operation.
- Periodic audits of the air quality monitoring programme designed to assess the impact of vehicle emissions discharged from the Burnley tunnel vent stack.
- Due diligence environmental investigations of over 50 industrial sites for potential purchasers and lenders.