IN THE MATTER OF the Resource Management Act (1991)

AND

IN THE MATTER OF an application by Tasman Bay Asphalt Ltd to discharge contaminants to air from an asphalt plant at 272 Bartlett Road.

STATEMENT OF EVIDENCE

JOHN GRAHAM ISELI

1.0 INTRODUCTION AND SCOPE OF EVIDENCE

1.1 My full name is John Graham Iseli. I hold a Master of Science degree from the University of Canterbury. During the past 28 years I have worked on a range of resource management matters in New Zealand as an Air Quality Scientist, Consents Planner and Hearings Commissioner. This work has required me to provide air quality advice to councils, central government and industries and to prepare numerous decisions on consent applications to discharge contaminants to air.

1.2 I have been an Air Quality Scientist with Specialist Environmental Services Limited (SES) for the past 23 years. During this time, I have reviewed discharge to air applications and assessed the environmental effects of emissions to air from a wide range of industrial and commercial facilities throughout New Zealand. As part of this work I have presented evidence at numerous resource consent hearings, including at the Environment Court. I have prepared assessments of effects (as part of consent applications) for a variety of activities that discharge contaminants into air, including several asphalt plants. I have also been engaged by Regional Councils to undertake technical reviews of several consent applications to discharge contaminants to air from asphalt plants at various locations throughout New Zealand.

1.3 My work has included significant technical input to various Regional Air Plans. I am regularly employed by several councils in New Zealand to review air discharge permit applications and provide technical advice on air quality matters.

1.4 I have sat as a commissioner on more than 70 consent hearings over the past 20 years, primarily involving applications to discharge contaminants to air. In 2015 I acted as commissioner on a consent application for an asphalt plant located in an industrial zone in Christchurch.

1.4 I have read the Environment Court consolidated Practice Note 2014 on expert witnesses and I confirm that I have complied with it in preparation of my evidence and will do so in any oral evidence. My evidence has been prepared in accordance with the principles of the Practice Note.

1.6 I have been engaged by Mr McFadden of Duncan Cotterill on behalf of five submitters (Boysenberries NZ Limited, MG Group Holdings Limited, Blackbyre Horticulture Limited, JS Ewers Limited and Eden Road Fruit Limited) to review the assessment of effects of the discharge to air from the proposed asphalt plant at 272 Bartlett Road. My evidence will address:

- The applicant's assessment of effects of the proposed discharge;
- Dust effects;
- Odour effects;
- Appropriate siting and consideration of alternatives;
- Comments on the Section 42A report;
- Comments on the evidence of Mr Bender;
- Conditions of consent, if granted;
- Concluding remarks.

1.7 Due to time constraints I have not yet had opportunity to visit the proposed site, but I intend to do so before presenting my evidence. I am familiar with the wider area and have reviewed aerial imagery of the proposed site and the local area.

2.0 The Applicant's Assessment of Effects

2.1 An assessment of the effects of discharges to air from the proposed asphalt plant was prepared by Mr Chris Bender of PDP. The assessment has focussed on dispersion modelling using CALPUFF to demonstrate that contaminant concentrations are within guidelines for protection of human health. This is commonly used methodology to assess potential health effects associated with discharges from asphalt plant emission stacks. It does not assess dust or odour effects associated with asphalt plants.

2.2 The dispersion modelling predicts concentrations of primary contaminants discharged from the stack that are within health-based guidelines at neighbouring residences. That is not surprising given the minimum separation to existing dwellings (approximately 600-700m), the degree of particulate matter control proposed (bag filtration) and the choice of diesel as fuel.

2.3 The modelling predicts maximum ground level concentrations (GLCs) of fine particulate matter (PM) at the site boundary that indicate a substantial contribution to background concentrations. Maximum predicted PM_{10} and $PM_{2.5}$ GLCs are 15µg/m^3 (24-hr average) and 10 µg/m^3 (24-hr average) respectively. Cumulative 24-hour peak off-site PM_{10} GLCs are predicted to be 39 µg/m^3 (the NES is 50 µg/m^3), while cumulative peak off-site $PM_{2.5}$ GLCs are assessed as 23µg/m^3, approaching the proposed NES of 25 µg/m^3 (24-hr average) and exceeding the recently updated WHO guideline of 15 µg/m^3 (24-hr average). It is unclear to me if this assessment includes condensable PM, or only filterable PM. Condensable $PM_{2.5}$ is expected to be a significant component of asphalt plant emissions.

2.4 The relatively high PM concentrations predicted at the site boundary are a function of the low emission stack (7.8m above ground level) and the close proximity of the proposed plant to the site boundary. If the commissioners decide to grant consent, I recommend a taller stack and increase separation from the boundary. The primary reasons for this are to control odour and dust effects, but it would also reduce fine PM concentrations experienced by persons (including horticultural workers) in the immediate vicinity of the plant.

2.5 The modelling does not predict ground level concentrations of individual volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs), such as benzo(a)pyrene, which is common practice for such assessments. However, given the separation to neighbouring dwellings, my experience is that predicted concentrations of these contaminants at locations where people are likely to be exposed for extended periods will be low relative to guidelines. Nevertheless, I note that VOCs from various sources at the asphalt plant will contribute to odour effects that have not been assessed in the application. I also note that workers will be present at times in the horticultural areas adjacent to the proposed site.

2.6 In my opinion the assessment submitted with the application does not adequately assess odour and dust effects. These are key issues for the submitters, particularly given that sensitive crops (such as boysenberries) are grown in rural areas immediately adjacent to the proposed asphalt plant site and workers will be present in these areas at times.

3.0 Dust Effects

3.1 Dust is a primary concern for the submitters. The evidence of Mr Sutton describes dust effects experienced in relation to the operation of the existing crusher site and truck movements on unsealed surfaces.

3.2 I consider that dust effects have not been meaningfully assessed in the AEE, given the sensitivity of crops grown in the immediate vicinity of the proposed asphalt plant.

3.3 Primary sources of dust from the site would include truck movements on unsealed surfaces, crusher dust/sand storage and aggregate stockpiles. Truck movements are expected to be the most significant source of dust, particularly if good practice controls are not employed. Cumulative effects will occur with windblown dust from the riverbed, the substantial unsealed areas adjacent to the proposed site, and also with emissions from the mobile crusher operating nearby. These cumulative effects have not been appropriately taken into account in the assessment.

3.4 In my opinion the proposed dust control measures have not been sufficiently detailed in the application. Sealing of primary vehicle use areas and the site entrance would be appropriate in this case and should be shown accurately on a plan that forms part of any consent conditions. Maximum vehicle speeds on site should be specified. Water application methodology and treatment of any unsealed surfaces should also be specified. Measures to prevent tracking of mud and generation of dust by trucks at the site entrance should be detailed. I consider that these various dust control measures should be included in a comprehensive dust management plan for the site, to be certified as part of conditions if the commissioners decide to grant consent.

3.5 A primary issue for the horticultural producers in the surrounding area is the potential increase to dust effects on crops that could be caused by emissions from the site and by vehicles movements at the site entrance and on Bartlett Road. Excessive dust in the finer fractions has the potential to adversely affect vegetation by interfering with plant photosynthesis, promoting weed or disease incidence and interfering with the efficacy of pesticide and fertiliser applications. The application has not attempted to assess such impacts on crops.

3.6 I do not have specific expertise relating to the effects of dust on commercial crops. Those effects would be best considered by someone with horticultural expertise. However, I note that the literature indicates that potential effects of dust on crops include:

- Potential for reduction in photosynthetic activity (and potential consequential loss of production) if dust is deposited on leaves or rain covers at levels which block the amount of light needed for photosynthesis;
- Deposits of dust on vegetation or fruit combining with moisture from rain or sprays, leading to potential fungal/mould damage to fruit;
- Inhibition of insects which control pests, enabling pests to flourish;
- Inhibiting spray effectiveness for control of pests; and
- Downgrading of fruit value due to contamination around the time of harvest, particularly at fruit washing and packing stages.

3.7 The horticultural crops grown adjacent to the proposed site include high value soft fruits such as boysenberries that are expected to be sensitive to dust and odour contamination. The boysenberry crops shown on the plan in the evidence of Mr Sutton are immediately downwind of the proposed site during the prevalent west to south-westerly winds. In the absence of a comprehensive dust assessment and expert advice from a horticulturist, I recommend that a precautionary approach should be taken. That approach would involve imposition of best practice dust controls and monitoring in combination with a setback distance from sensitive crops, as discussed later in my evidence.

4.0 Odour Effects

4.1 Odour associated with VOCs discharged from asphalt plants has potential to cause significant effects at neighbouring properties, particularly where sensitive receptors are located in close proximity to the discharge. This is a primary reason, along with dust impacts, why setback distances are recommended for asphalt plants.

4.2 The AEE does not include an assessment of odour effects. Such an assessment would typically include analysis of FIDOL (frequency, intensity, duration, offensiveness and location) factors in light of the sensitivity of the receiving environment, comparison to effects experienced at other asphalt plants, reference to recommended setback distances from sensitive receptors in guidance documents, and controls proposed to minimise odour emissions.

4.3 The normal operation of asphalt plants generates odour from various sources, in addition to the emission stack. Storage and transfer of hot asphalt to the trucks is a significant odour source. Odour is also discharged from the heated bitumen tank vents. Poor maintenance or operation can result in black smoke and odour from the drum burner. While the discharge of odour from the stack can be modelled, bearing in mind variability of emissions, this does not account for fugitive sources which are significant.

4.4 My experience is that odour can be an issue within 100-200m of asphalt plants, particularly if they are located close to dwellings, urban areas or other sensitive activities (such as horticultural crops in this case). The proposed separation distance to rural dwellings (600m+) is such that odour is not likely to be a significant issue at existing residences if appropriate controls are in place.

4.5 In 2001 I prepared an assessment and expert evidence for Fulton Hogan Limited in relation to a hot mix asphalt plant in Hamilton where neighbouring residents had experienced odour issues. A copy of my evidence presented at the council hearing of the application is attached. At that time the nearest residential properties were located approximately 200m west of the emission stack and one first floor dwelling was located in a commercial building 120m to the southwest. Discharges from the 10m high (above ground level) asphalt plant stack and fugitive VOC emissions had caused numerous odour complaints prior to 2001. This was despite the modelling predictions that concentrations of individual VOCs would be less than 10% of health-based guidelines at dwellings.

4.6 I recognise that the Fulton Hogan Hamilton application was heard 20 years ago, but it nevertheless provides relevant information relating to potential odour impacts from asphalt plants. The technology employed in asphalt production has not changed substantially since that time. The measured odour emission rate from the stack was variable, ranging from 10,000 OU/s (odour units per second) to 35,000 OU/s. Screening modelling predicted peak odour GLCs of more than 1 OU/m^3 (1-hr average) for a distance of approximately 300m from the 10m high stack. I recommended increasing the stack height to 18m to reduce downwash effects and the predicted peak odour GLCs reduced to less than 0.5 OU/m^3 at all locations. Note that this screening modelling did not include fugitive odour sources.

4.7 Various mitigation measures were implemented at the Hamilton plant to reduce odour impacts at neighbouring residences. These measures included:

- Increasing the proposed stack height to 18m above ground level (ultimately increased to 20m);
- Fitting carbon filters on the heated bitumen tank vents;
- Ducting fumes from the top of the asphalt bins to the drum mixer;
- Fitting mist curtains around the truck load-out area; and
- Using odour neutralising sprays.

4.8 Bearing in mind the sensitivity of horticultural cropping areas adjacent to the site, including potential tainting issues, I consider that such odour mitigation measures would be appropriate if the commissioners determine to grant consent. In addition, I recommend that the asphalt plant should be setback at least 200m from sensitive horticultural crops such as boysenberries. These crops would be affected during the prevailing west to south-westerly winds.

4.9 The application has not assessed tainting effects on fruit crops as a result of VOC discharges from the asphalt plant. Whilst I have no expertise in relation to crop tainting, I am aware that this has been raised as a concern in other cases where odour discharges occur close to horticultural areas. In the absence of expert evidence on this matter, I consider that a precautionary approach is appropriate.

5.0 Appropriate Siting and Consideration of Alternatives

5.1 I recognise that I am not providing evidence in relation to planning matters. However, I note that given my evidence regarding potential adverse effects on sensitive horticultural areas immediately adjacent to the proposed site, consideration of alternative methods of discharge (including stack height) and locations would typically be undertaken for an application of this type. That is because my assessment, based on the information provided in the application and the sensitivity of adjacent land uses, indicates that adverse effects of odour and dust may be significant for the proposed site.

5.2 In my experience asphalt plants are typically located in industrial areas or in rural sites that are well removed from sensitive neighbouring land uses. I am not aware of an asphalt plant located immediately adjacent to sensitive horticultural crops such as boysenberries. However, I note that I am not familiar with all asphalt plants in New Zealand and it is possible that there may be examples of relevance. If so, it would have been helpful to cite such examples as part of the assessment submitted with the application.

5.3 There are no official guidance documents published in New Zealand that recommended setback distances for asphalt plants from sensitive activities. However, several Australian EPAs (Environment Protection Authorities) recommend setback or evaluation distances for hot mix asphalt plants. The Victoria EPA[1] and the South Australia EPA[2] recommend separation distances to sensitive receptors of 500m, based on odour and dust effects.

5.4 The EPA guidance describes sensitive receptors as dwellings and other locations where people are expected to be present for extended periods. In this case the

[1] EPA Victoria, 2013. Recommended Separation Distances for Industrial Residual Air Emissions. March 2013.
[2] EPA South Australia, 2016. Evaluation Distances for Effective Air Quality and Noise Management. August 2016.

horticultural crops adjacent to the proposed site are also sensitive and require consideration. That is because of the potential for tainting and damage to crops and the presence of horticultural workers on occasion.

5.5 I recognise that the recommended EPA separation distances are not strict limits and lesser distances than 500m may be acceptable based on site specific assessment and application of additional mitigation. Provided that additional dust and odour mitigation is applied, as discussed in my evidence, I consider that a precautionary approach would require a setback of at least 200m from sensitive horticultural crops to minimise the risk of crop damage. Given that such a separation distance does not appear to be feasible for the proposed location, it is my opinion that alternative sites should be considered.

6.0 Comments on the Section 42A Report

6.1 Mr Leif Pigott has provided comment on air quality matters in the s42A report. He is generally in agreement with the dispersion modelling assessment of the applicant in terms of potential health effects. He has not commented on the applicant's prediction that cumulative $PM_{2.5}$ GLCs of up to 23µg/m³ (24-hr average) at the site boundary approach the proposed NES of 25 µg/m³ (24-hr average) and exceed the recently revised WHO guideline of 15 µg/m³ (24-hr average). However, Mr Pigott does note that the stack height is "low for a source of this nature".

6.2 Mr Pigott states that the modelled discharge rates will be approximately 2.6 times the actual maximum, being about 50 tonnes/hr production because of transport issues. The applicant has sought consent based on 130 tonnes/hr production for 10 hours per day. I consider that the assessment should be based on that rate of production. If a lesser rate will occur in practice, that should be imposed as a condition of consent.

6.3 Mr Pigott provides some brief comments regarding odour and dust effects. He has not directly commented on the lack of any detailed odour or dust assessment in the application or recognised the sensitivity of adjacent horticultural crops. Mr Pigott stated that "subject to good practice the risk of a significant odour discharge is not considered to be high". The evidence for this conclusion is not clear to me.

6.4 Dust is recognised as a potential issue by Mr Pigott. He notes that the applicant has proposed to include dust management in the Environmental Management Plan for the site. I do not consider that this constitutes a proper assessment of dust effects, particularly given the sensitivity of adjacent crops. In my opinion detailed dust control measures should be described in the application and specific mitigation should be required by conditions of consent, if granted.

6.5 With regards to effects on horticulture, Mr Pigott states that "no effects from the plant discharge are predicted on the horticulture crops in the area." I am not aware of any evidential basis for this statement. Given the sensitivity of crops grown immediately adjacent to the site I consider that expert opinion is required from a horticultural specialist.

7.0 Comments on the Evidence of Mr Bender

7.1 At para 9.4 Mr Bender comments on the measurement of condensable PM. I note that emission testing for condensable PM is becoming more common in NZ as awareness increases and I can recall at least one other asphalt plant where testing of condensable PM is required by condition.

7.2 The assessment was based on 20mg/Nm^3 PM emission concentration and I consider that this value should have included condensable PM. As I noted earlier, cumulative 24-hour peak off-site PM_{10} GLCs are predicted to be 39 µg/m^3 (the NES is 50 µg/m^3), while cumulative peak off-site $PM_{2.5}$ GLCs are assessed as 23µg/m^3, approaching the proposed NES of 25 µg/m^3 (24-hr average) and exceeding the recently updated WHO guideline of 15 µg/m^3 (24-hr average). Given this, and the presence of horticultural workers for extended periods at times immediately beyond the site boundary, I do not support increasing the total PM_{10} emission rate by 50% as suggested by Mr Bender at para 9.7.

7.3 At para 9.9 Mr Bender suggests removing the minimum stack efflux velocity. This is a key factor contributing to dispersion of the discharge, particularly given the low stack height proposed. In my opinion a substantially taller stack and an efflux velocity minimum would be appropriate, if consent is granted for the asphalt plant at this site.

7.4 Mr Bender's Attachment A includes a number of comments relating to matters raised by submitters. With respect to comments on the low stack height, I note that this will contribute to high odour concentrations with potential to taint crops and cause nuisance to horticultural workers immediately adjacent to the site. I also note that this low stack height results in relatively high PM_{10} and $PM_{2.5}$ at the site boundary.

7.5 The indicative odour modelling undertaken by Mr Bender appears to be based on stack emissions alone. Fugitive odour sources at asphalt plants make a significant contribution to odour emissions. Consequently, modelling of stack emissions alone is expected to substantially underestimate GLCs, particularly near the site boundary.

7.6 Mr Bender has assessed the neighbouring rural land as having low sensitivity to odour. However, given the presence of crops that may be susceptible to tainting and the presence of horticultural workers for extended periods, I would classify the sensitivity as at least "moderate" in terms of the odour modelling guidelines. I note that predicted odour concentrations for the stack source alone beyond the site boundary exceed the 5OU/m^3 (1-hr average, 99.5th percentile) odour guideline for moderate sensitivity activities.

7.9 Mr Bender's assessment of effects on crops does not address the key issue, that being potential taint of sensitive crops caused by odour emissions from the plant. The brief discussion of fugitive dust effects also does not consider effects of dust on sensitive horticultural crops, despite the presence of such crops immediately adjacent to the proposed site.

8.0 Conditions of Consent, If Granted

8.1 Draft conditions of consent for the discharge to air have been suggested by Mr Pigott. The conditions appropriately require annual monitoring of both condensable and filterable PM emissions. I consider that these conditions are generally appropriate in relation to a plant located in a low sensitivity environment but require several additions to control potential adverse effects to sensitive horticultural crops such as boysenberries and the workers who tend those crops.

8.2 If the commissioners determine to grant consent, additional matters to be covered by conditions include:

- A specified minimum setback from sensitive horticultural crops. As discussed in my evidence, ideally this setback would be at least 200m to reduce the risk of crop damage and tainting. That does not appear to be feasible at this site, indicating that further consideration should be given to alternatives.
- Best practice odour controls, similar to those employed at the Fulton Hogan Hamilton plant that I have discussed in my evidence.
- An increased minimum stack height to reduce odour downwash effects associated with the stack discharge.
- A maximum speed limit of no more than 15kph for vehicles on site.
- Requiring certification of the Air Quality Management Plan by the Council. The proposed wording in that regard is somewhat unclear.
- The plan showing the areas of the site to be sealed (Plan CRC151364B) is not attached to the recommended conditions. This plan should clearly show sealing of the site entrance and all areas subject to vehicle movements.

9.0 Concluding Remarks

9.1 The proposed asphalt plant is sited in a rural location. The separation from dwellings is expected to be sufficient to prevent significant adverse effects at these locations. However, the plant would be immediately adjacent to sensitive horticultural crops (including boysenberries) and the impact on these crops and horticultural workers has not been adequately assessed.

9.2 There is potential for odour and dust emissions to cause crop damage and tainting effects. Additional mitigation should be applied as a precautionary approach and further analysis should be provided by a horticultural expert. I recommend a setback of at least 200m from sensitive horticultural crops.

9.3 Given the size limitations of the site and the sensitivity of neighbouring land uses, further consideration of alternatives would be appropriate. Asphalt plants are typically located in industrial zones where the inability to internalise effects is less problematic.

John G Iseli

16th December 2021

Attachment: Fulton Hogan Waikato Evidence

IN THE MATTER OF the Resource Management Act 1991

AND

IN THE MATTER OF an application for resource consent by Fulton Hogan Limited to discharge contaminants into air from a hot mix asphalt plant and associated activities

STATEMENT OF EVIDENCE OF JOHN ISELI

Experience and Qualifications

1. My full name is John Graham Iseli. I have been engaged by Fulton Hogan Limited to assess the effects on the environment of discharges to air from an asphalt plant at Higgins Road, Hamilton.

2. I have a Master of Science degree (first class honours) from the University of Canterbury. During the past 8 years I have worked with resource management issues in New Zealand as an air quality scientist, consents officer and planner. I have been a principal consultant with Specialist Environmental Services Limited in Christchurch since 1999.

3. As an air quality consultant I have prepared impact assessments for a wide range of activities and presented evidence at numerous resource consent hearings. Recent work has included significant technical input to Regional Air Plans and to the Ministry for the Environment's Good Practice Guide for Assessing and Managing the Environmental Effects of Dust Emissions. I am regularly employed by several councils in New Zealand to audit air discharge permit applications. In Canterbury I have been appointed as a commissioner to hear and determine resource consent applications. I am a member of the Clean Air Society of Australia and New Zealand (CASANZ), the primary air quality association for professionals in Australasia.

Contaminant Emissions

General

4. The various processes occurring at the asphalt plant have been described in the evidence of Mr Waters and Mr Slaughter. These processes and the general operation of the site will result in discharges to air of the following contaminants:

(a) Particulate matter from the storage and handling of materials, vehicle movements and general yard processes, and from the asphalt plant stack after passage through a bag filter;

(b) Products of combustion (primarily oxides of carbon and nitrogen) from operation of a 5.86MW liquid petroleum gas (LPG) burner to heat the drum mixer;

(c) Volatile organic compounds (VOCs), including polycyclic aromatic hydrocarbons (PAHs), primarily from the asphalt plant stack, filling of asphalt bins, load-out of asphalt to trucks and storage of bitumen in heated tanks; and

(d) Odour resulting from a combination of VOCs discharged from the plant.

Particulate Matter

5. Fine particulate matter is discharged from the drum mixer stack after passage through a bag filter unit. Because of the high efficiency of the bag filter, the large majority of particles discharged from the stack are expected to have a diameter of less than 10 microns (PM_{10}). The existing discharge permit for the site requires that the concentration of particulate matter in the stack discharge is less than $50mg/m^3$, adjusted to standard conditions. Stack testing in July 2000 indicated that particulate emissions are well within this limit, with an average concentration of $10mg/m^3$, adjusted to standard conditions.

6. Larger particles are discharged from the yard area as fugitive dust, generated from vehicle movements, storage and handling of aggregate and wind action on exposed surfaces. These particles generally have a diameter of more than 20 microns and are classified as "nuisance dust". Because such particles are normally too large to be inhaled deep into the lungs, they are not associated with adverse effects on human health.

Combustion Products

7. Heat is provided to the drum mixer by combustion of LPG in a 5.86MW burner. The combustion products discharged include carbon oxides and nitrogen oxides, with trace quantities of particulate matter, sulphur oxides and VOCs. In terms of potential adverse health effects, the contaminant of primary concern in this case is nitrogen dioxide.

8. The maximum LPG burning rate is approximately 800L/hr. Based on USEPA emission factors for industrial combustion sources, this results in the discharge of approximately 190g/hr of nitrogen dioxide. Combustion products are discharged from the stack after passage through the bag filter unit.

PAHs

9. Emissions of polycyclic aromatic hydrocarbons (PAHs) have been estimated using USEPA AP-42 emission factors for drum mix asphalt plants. Calculated emission rates for these contaminants are listed in Appendix 1. In this case accurate emission

measurement of PAHs and VOCs is difficult to achieve and very expensive. The emission factor results have been compared to the results of emission testing at the Bitumix Dunedin asphalt plant to confirm applicability to New Zealand conditions.

10. The calculated emission rates apply to operation of the plant at maximum capacity of 50 tonnes per hour. Excluding emissions from the stack (via the bag filter), the predicted rates are for uncontrolled sources. Thus the effect of odour filters and other control measures implemented by Fulton Hogan has not been taken into account. Furthermore, the emission factors are considered to be highly conservative because they are based on testing of some plants that processed recycled asphalt pavement. This practice does not occur at Fulton Hogan's Waikato plant.

11. Fulton Hogan has ceased the bulk storage of cut-back (a heated bitumen/kerosene mix) that is believed to have been a significant source of odour. This tank will be used for the storage of bitumen only. Small quantities of kerosene will be stored unheated for mixing with bitumen as required. This change is expected to have resulted in a large reduction in organic compound emissions from the site because the more volatile kerosene will no longer be stored at 160 degrees Celsius.

12. The two existing bitumen storage tanks at the site have also be replaced with a larger single horizontal tank. Therefore emission calculations are based on storage of heated bitumen in one new primary storage tank and the smaller existing tank that was previously used for cut-back storage.

13. PAH emissions have been predicted for the primary emission sources at the plant: the stack; the asphalt storage bins ('silo filling'); loading of trucks from the storage bins ('load-out'); and the two bitumen tanks. The enclosed asphalt slat-conveyor is not considered to be a significant source of emissions, but emissions from the conveyor to the bins are estimated from 'silo filling' factors.

14. Total hydrocarbon emissions and PAH emissions from the bitumen storage tanks were calculated according to AP-42 procedures for organic liquid storage tanks (USEPA, 1997), using the TANKS programme made available by the USEPA. The assumptions used in these calculations are listed in Appendix 2.

15. It should be noted that the USEPA emission factors used generally have a rating of C, D or E. This means that they are often based on a relatively small number of samples and limited information. Therefore in some cases there may be significant variation between the emission factors and actual emissions from the subject site. However, conservative assumptions have been made such that the estimates are likely to over-predict emissions from the Waikato plant. In particular, the emission factors do not account for control technology used at the plant (excluding the bag filter) and the fact that recycled asphalt is not processed. Furthermore, it should be noted that emission estimates are based on operation at maximum plant capacity or under worst-case conditions (such as filling of the bitumen tanks).

16. PAH emissions from the Bitumix Dunedin asphalt plant stack were measured by ESR in 1994. Total PAH concentrations of 2700 and 4000 μg/m³ were measured, equating to an emission rate of 11.99–17.76 g/hr. While these measured PAH emission rates are very low (quoted as being similar to a single domestic open fire burning coal), they are significantly higher than the 4.75 g/hr predicted for the Waikato plant. This is considered to be reasonable given the high efficiency of the bag filters at the Waikato plant, having average measured TSP emission concentrations of 10 mg/m³. PAH compounds are known to be absorbed onto particulate in the discharge.

VOCs

17. Key volatile organic compound (VOC) emissions from the asphalt plant have been estimated using USEPA AP-42 emission factors for drum mix asphalt plants. Useful measurements of VOC emissions from the storage tanks, silo filling and truck load-out are difficult to obtain. Reliable emission factor information is available for the stack emission source. Given the scale of the activity and the minor adverse effects predicted, it is considered that expensive emission testing is not warranted in this case.

18. Maximum predicted VOC emission rates are listed in Appendix 3. VOC emission calculations were based on the same assumptions as those described for PAHs. In this case VOC species were calculated as a percentage of total organic compounds emitted. The qualifications regarding the use of emission factors, as discussed above, also apply here. However, it should be noted that the assumptions used will result in conservative predictions.

Odour

19. Three odour samples were collected from the asphalt plant stack on 14 February 2001 by Watercare Services Limited. The samples were taken while the plant was producing asphalt at a rate of approximately 40 tonnes per hour. Each sample was extracted for a period of approximately 20 minutes. Samples were quantified using forced choice dynamic dilution olfactometry, as described in the Watercare laboratory report.

20. The odour measurement results presented by Watercare indicate significant variability in the odour emission rate from the stack. The odour emission rate (certainty) varied from 10 000 to 35 000 OU/s (corrected to 20 degrees C.), with an average of 19 000 OU/s.

Predicted Effects of the Discharges

21. Based on the nature of the discharges and observed effects from the existing asphalt plant operation, it is considered that particulate matter and combustion product emissions will not cause any significant adverse effects. Therefore my evidence will primarily focus on the effects of VOC, PAH and odour emissions from the site.

PAHs

22. Predicted PAH emission rates from the asphalt plant are low when compared to emissions measured for the Dunedin Bitumix plant or domestic fires. This is not surprising given the particulate removal efficiency of the bag filter and the relatively low plant operating temperatures.

23. It should be noted that much of the concern regarding PAH emissions from asphalt plants relates to the past practice of using coal tars as a binder, having significantly higher PAH emissions than petroleum bitumen. The quantity of PAH in tar can be a factor of 10,000 higher than bitumen (EAPA, 1994). Coal tars are not used at the Waikato plant.

24. PAHs have low vapour pressures at ambient temperatures and are generally absorbed onto particles when detected in the air. The primary source of these compounds in the environment is the incomplete combustion of organic materials, particularly under oxygen-deficient conditions. Because combustion conditions are often poor, domestic fires are regarded as a major source of PAHs in ambient air.

25. Measured emissions of selected PAHs from domestic fires and solid fuel burners (coal and wood) have been reported by Calvert (1994). Benzo(a)pyrene measurements for these sources were used to calculate emission rates of 1.2 (wood fire) – 13 (coal burner) mg/hr. These results may be compared to the predicted benzo(a)pyrene emissions for the asphalt plant of 0.25 mg/hr (stack) and 0.08 mg/hr (load-out). Benzo(a)pyrene is generally regarded as the most significant (in terms of toxicity) of the PAHs. This comparison suggests that PAH emissions from the asphalt plant complex are no more significant than emissions from a single domestic fire.

VOCs

26. The potential health effects of VOC emissions will be addressed in detail in the evidence of Dr Kelly. I would note that occupational exposure studies such as that of Riala et al (1996) indicate that ambient exposure of the general population to VOC emissions is unlikely to result in adverse health effects.

27. To support the findings of these studies that asphalt plant emissions are not expected to adversely affect the health of neighbouring residents, it is useful to predict 'worst-case' concentrations of emitted VOCs at neighbouring sensitive areas. This has been done using the AUSPLUME atmospheric dispersion model developed by the Victorian Environmental Protection Agency in Australia. This is a Gaussian plume model that is commonly used for impact assessment in Australia and New Zealand.

28. The predicted maximum ground level concentrations (GLCs) from this modelling exercise should be regarded as approximate only. It is commonly stated that simple Gaussian dispersion models can predict concentrations to within a factor of two of the actual case, at best (McKendry et al, 1996). The model does not perform well where there is significant plume downwash in the lee of tall structures or under very calm conditions (wind speeds less than 0.5m/s). However, conservative assumptions have been used to calculate both the emission rates and the model input parameters, as detailed in Appendix 4. Thus the modelling undertaken is more likely to over-predict than under-predict the effects of VOC emissions.

29. AUSPLUME has been used to predict maximum ground level concentrations (GLCs) from the existing plant operation (10m high stack) at the nearest residential properties on Higgins Road, approximately 200m west of the asphalt plant stack. This is the area where the majority of complaints concerning odour and possible health effects have originated. One elevated residence, currently occupied by Mr and Mrs Sayers, is situated on the top floor of a two storey commercial building approximately 120m to the southwest of the asphalt plant stack. Because this residence is relatively close to the source and significant downwash of the discharge from the 10m high stack will occur in this direction, accurate model predictions are unlikely to be achieved for this receptor.

30. Screening meteorological data (Metsamp) has been used to simulate the full range of meteorological conditions that may occur at the site. Thus predicted worst–case conditions may occur very rarely, if at all, at the subject site.

31. It should be noted that the model assumed that all four primary emission sources are operating at maximum capacity (50 tonnes/hr) simultaneously, including the assumption that the bitumen tanks are being filled at that time. Of course, this combination of events is unlikely. This conservative approach more than compensates for the fact that minor fugitive emissions (such as temporary emissions from the road tankers, rejects conveyor and yard area) cannot be adequately modelled. Because the major VOC sources are not 'in-line' when the wind blows towards the residential properties across Higgins Road, additive effects from multiple sources are limited.

32. Peak one-hour average GLCs have been predicted by AUSPLUME for the key VOCs emitted from the plant (Table 1). The model outputs for benzene are attached in Appendix 5. The results are compared to recent guidelines for these chemicals,

including the modelling design concentrations for hazardous air contaminants proposed by the Ministry for the Environment (2000).

Contaminant	Concentration (µg/m³) – 1-hr Average			
	GLC @ 200m (Higgins Rd)	GLC at the Plant Centre	MfE Modelling Design Concentration[1]	Other Guideline Value[2,3]
Benzene	0.1	1	22	100[2]
Ethylbenzene	0.3	8	-	4000[3]
Toluene	0.3	6	500	650[2]
Xylene	1	13	1000	350[2]
Formaldehyde	2	6	20	65[3]

1. Modelling design concentration for hazardous air pollutants recommended by the Ministry for the Environment (2000)
2. Design ground level concentrations listed by the State of Victoria, Australia (3-minute average)
3. Ontario Ministry of the Environment Ambient Air Quality Criteria 1992 (1-hr average)

Table 1. Predicted maximum ground level concentrations (1-hr average) of key VOCs emitted from the existing asphalt plant complex, compared to relevant guideline values. These results represent the situation prior to instigation of any VOC control measures or increase in stack height.

33. The model results indicate that, even under worst case conditions, peak GLCs of benzene, ethylbenzene, toluene, xylene and formaldehyde at residential areas will be much less than guidelines. The highest concentrations at residences across Higgins Road are predicted for formaldehyde at 2 µg/m3, approximately 10% of the conservative modelling design concentration recently recommended by the Ministry for the Environment. Even at the centre of the plant, in close proximity to ground level emission sources such as the truck load-out area, peak concentrations of VOCs are predicted to be well below guidelines.

34. Implementation of the proposed VOC control measures and raising the stack height will significantly reduce the concentrations predicted for the existing plant configuration. Increasing the stack to a height of 18m will prevent any significant influence of the 7m high fabric filter structure on downwash of the contaminant plume from the stack. This will markedly reduce peak concentrations of contaminants at the elevated Sayers' residence to the southwest of the plant, where the effects of the discharge from the existing 10m high stack are difficult to predict. Model results for the situation after the proposed increase in stack height are presented in Table 2.

Contaminant	Concentration (μg/m^3) – 1-hr Average		
	Peak Concentration at the Sayers' Residence[4]	**MfE Modelling Design Concentration[1]**	**Other Guideline Value[2,3]**
Benzene	0.2	22	100[2]
Ethylbenzene	0.3	-	4000[3]
Toluene	0.3	500	650[2]
Xylene	0.8	1000	350[2]
Formaldehyde	1	20	65[3]

1. Modelling design concentration for hazardous air pollutants recommended by the Ministry for the Environment (2000)
2. Design ground level concentrations listed by the State of Victoria, Australia (3-minute average)
3. Ontario Ministry of the Environment Ambient Air Quality Criteria 1992 (1-hr average)
4. Modelled for a height of 5m above ground, 120m directly downwind of the stack, asphalt bins and truck load-out area operating simultaneously and 'in-line' at maximum calculated rate.

Table 2. Predicted maximum concentrations (1-hr average) of key VOCs at the Sayers' residence after increase of the stack height to 18m, compared to relevant guideline values.

35. The modelling results indicate that emissions of organic compounds from the asphalt plant are not expected to cause adverse health effects at neighbouring properties. The predicted VOC concentrations at the Sayers' residence and at Higgins Road are low compared to background concentrations measured in urban areas. For example, the Ministry of Health (1999) reported annual average concentrations of benzene at two urban sites in Hamilton of 2μg/m3 and 3.8μg/m3. By comparison the maximum predicted benzene GLC at Higgins Road is only 0.1μg/m3 (1-hr average). Because of the intermittent nature of plant operation and varying weather conditions, annual average GLCs will be much less than this value. Measurements at various urban centres throughout New Zealand are presented in Figure 1.

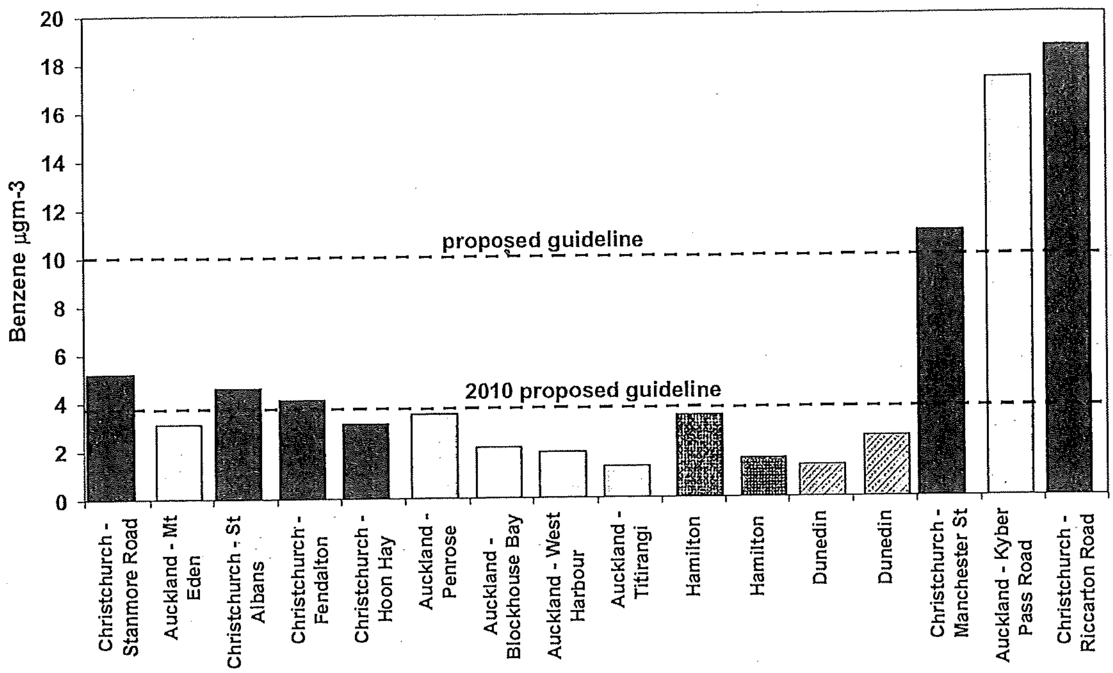

Figure 1. Annual average benzene concentrations measured in Christchurch, Auckland, Hamilton and Dunedin (from Ministry of Health, 1999).

36. Given the very low predicted VOC concentrations relative to measured concentrations in ambient air, adoption of a detailed risk assessment approach is not warranted in this case. Such an approach would require analysis of lifetime exposure to VOCs. As noted above, long-term exposure is much reduced for intermittent sources. For this small-scale discharge the only practical approach is to focus on the minimisation of emissions at source. To this end Fulton Hogan has instigated a number of innovative emission control measures, as discussed in the evidence of Mr Waters and Mr Slaughter.

37. Monitoring of air quality for VOCs at the asphalt plant boundary was undertaken by Watercare Services Limited on February 14, 2001. The results of the monitoring programme and a description of the methods used are provided in the Watercare laboratory report (Newby 2001).

38. Four ambient air samples were collected and analysed for VOCs. Samples were collected at Site 1 (southern plant boundary), Sites 2 and 3 (western plant boundary) and Site 4 further west at a residential property (30 Higgins Road). Sampling was undertaken from 0620-1057hrs at Site 1, 0630-1100hrs at Site 2, 0637-1102hrs at Site 3 and 0740-1117hrs at Site 4. Thus each sample has an averaging period of approximately 4 hours. Meteorological data recorded on-site by Fulton Hogan Ltd indicates variable easterly winds during the monitoring period. Odour complaints were registered by nearby residents during the day of sampling.

39. The only VOC detected in significant concentrations was toluene. The monitoring report (Newby 2001) explains that xylene was measured at the detection limit of the

method and that trichloroethene initially measured at Site 1 was likely to be caused by nearby cleaning of road marking equipment. In Table 3 the monitoring results are compared to recent guidelines for toluene, including the modelling design concentration recommended by the Ministry for the Environment (2000). Note that because monitoring was undertaken over a period of approximately 4 hours, one-hour average concentrations may be slightly higher than the results reported.

Monitoring Site	**Measured Concentration of Toluene ug/m³ (4-hr average)**	**MfE Recommended Modelling Design Concentration ug/m³ (1-hr average)**	**State of Victoria DGLC² ug/m³ (3-min. average)**
1	53	500	650
2	154	500	650
3	21	500	650
4	41	500	650

1. Modelling design concentration (one-hour average) for toluene recommended by the Ministry for the Environment (2000)
2. Design ground level concentration listed by the State of Victoria, Australia (3-minute average), based on odour effects.

Table 3. Measured ambient concentrations (approximately 4-hr average) of toluene near the boundary of the asphalt plant complex, compared to relevant guideline values.

40. The measured concentrations of toluene at the asphalt plant boundary and at 30 Higgins Road are well below relevant ambient air quality guidelines. At these concentrations toluene is not considered to cause any adverse effects on human health. The monitoring programme did not detect any VOCs in sufficient concentration to cause adverse health effects.

41. It is unlikely that the measured toluene originated from normal activities at the asphalt plant. USEPA emission factors for asphalt plants indicate that toluene emissions would be accompanied by similar quantities of ethylbenzene, xylene and formaldehyde. The conservative emission estimates and dispersion modelling has predicted similar peak concentrations for all four VOCs of between 6 and 13 ug/m³ (1-hr average) within the plant under worst case conditions. It is therefore expected that, if the measured toluene originated from asphalt production, other VOCs would have been detected at similar concentrations.

42. Watercare laboratory staff carrying out the sampling noticed other activities that may have contributed to the measured toluene. Staff were cleaning the top of one of the bitumen tanks and road marking equipment (including paint) was being cleaned (M Newby, pers. comm.). Both of these activities could release significant quantities of solvents such as toluene. It is also possible that emissions from a neighbouring industry were the source of toluene detected by the monitoring programme.

43. Given the low magnitude of VOC concentrations, both measured and predicted by dispersion modelling, I do not consider that any further ambient air quality monitoring is warranted in this case. The proposed increase in stack height to 18m will markedly reduce peak concentrations at the elevated Sayers' residence such that monitoring at this location is unnecessary. Having regard to these factors and the significant VOC control measures implemented by Fulton Hogan, I do not agree with Sinclair Knight Merz (SKM) that further VOC monitoring is justified.

Odour

44. As noted earlier, odour emission monitoring from the asphalt plant stack has been undertaken by Watercare Services. The odour measurement results indicate significant variability in the odour emission rate from the stack. The odour emission rate (certainty) in three samples varied from 10 000 to 35 000 OU/s (corrected to 20 degrees C.), with an average of 19 000 OU/s.

45. Atmospheric dispersion modelling may be used as a tool to predict the dispersion of odour from the stack, as has been done for VOCs. The results provide an indication of the importance of the stack discharge as a potential source of odour at neighbouring properties.

46. The AUSPLUME model has been used with screening meteorological data to predict 'worst-case' GLCs of odour at the asphalt plant property boundary, based on the existing 10m stack height. The approach taken is considered to be very conservative because peak GLCs are predicted without the usual consideration of a percentage compliance component.

47. Once again it should be noted that the results of this dispersion modelling exercise will be approximate only. In particular, the model does not perform well where there is significant plume downwash in the lee of tall structures and where the receptor is close to the source. Thus for the existing stack configuration realistic predictions of peak odour concentrations at the nearby Sayers' residence are unlikely to be achieved. However, conservative assumptions have been used when selecting the model input parameters, as detailed in Appendix 4, resulting in modelled GLCs at Higgins Road residences that are likely to over-predict the effects of the discharge.

48. Peak one-hour average odour GLCs from the 10m high stack discharge have been predicted. Model results based on the maximum measured odour emission rate are presented in Figure 2. This plot of odour concentration versus distance shows that, even under worst-case conditions using very conservative assumptions, peak odour GLCs are expected to be in the order of 2 OU/m^3 (one-hour average) beyond the nearest plant boundary. At residential properties across Higgins Road (approximately 200m from the stack), peak odour GLCs are predicted to be approximately 1.3 OU/m^3 (one-hour average).

49. It should be noted that the predictions relate only to emissions from the asphalt plant stack. Odour emissions from other sources such as the bitumen tank, truck load out and asphalt bins have not been taken into account. However, peak GLCs from these volume sources are likely to occur under different meteorological conditions than from the stack source. In any case, the results are presented to enable an assessment

of the significance of the stack emissions in contributing to potential odour nuisance beyond the property boundary.

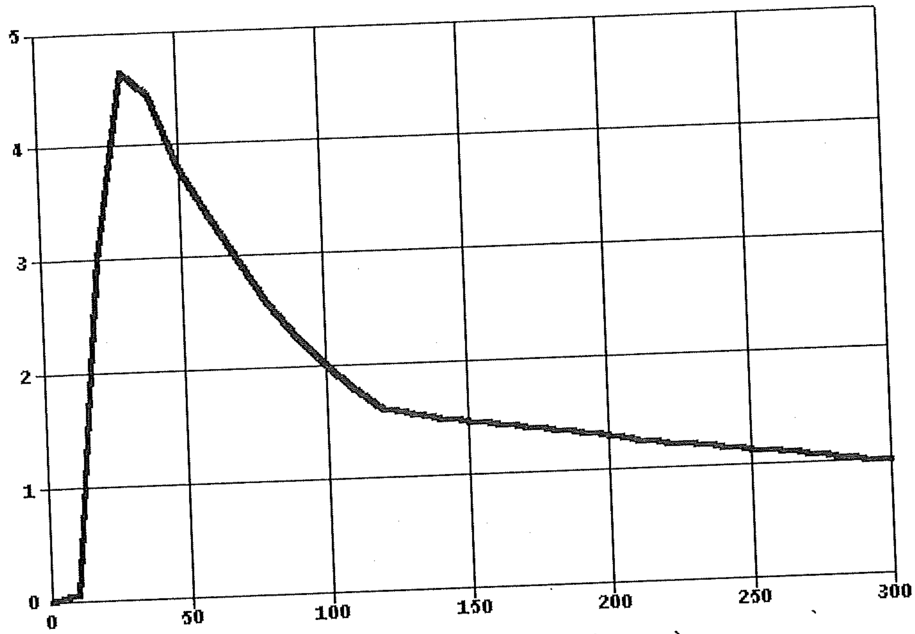

Figure 2. Plot of maximum predicted GLCs (OU/m^3, certainty, one-hour average) vs. distance from the 10m high asphalt plant stack, based on the maximum measured odour emission rate.

50. There is considerable debate at present regarding the selection of modelling guidelines to determine acceptable odour as part of resource consent applications. In a report prepared for the Auckland Regional Council, Freeman et al (2000) discuss the selection of odour modelling guidelines in detail, including options to vary the concentration and percentile compliance components according to the sensitivity of the receiving environment.

51. The Proposed Waikato Regional Air Plan contains guidelines for odour assessment that have been subject to submissions and considerable debate among air quality professionals. The plan recommends a guideline as follows:

"One hour average concentrations of odour, as predicted by an ISC-type atmospheric dispersion model, shall be assessed against a guideline for no objectionable odour of 5 OU/m^3 divided by the appropriate peak-to-mean ratio from Table 6-4 for more than 0.1% of the time."

52. If a full year of meteorological data is not available for the site in question and screening meteorological data is used, the plan recommends that the guideline be applied without a percentile compliance component. The use of screening meteorological data (as in this application) is therefore very conservative as the

predicted maximum GLCs may occur under conditions that happen very rarely, if at all, in reality.

53. It is generally accepted that the modelling guideline recommended in the plan is stringent, particularly for existing activities. However the plan does take care to point out that the recommendation is a guide only and should not be regarded as a modelling standard. A recent revision of the Ministry for the Environment's Guide to Odour Management Under the Resource Management Act (draft of June 15, 2001) recommends different concentration and percentile compliance components, depending on the sensitivity of the receiving environment. For areas of "moderate" sensitivity a guideline concentration component is suggested that is twice that recommended in the Waikato plan. Given that the discharge is from an existing activity that is appropriately zoned, it could be argued that the sensitivity of the receiving environment is moderate in this case. However, the large number of complaints and proximity of residents would tend to indicate higher sensitivity.

54. A peak-to-mean ratio is applied to the predicted one-hour average concentrations to ensure that fluctuations in the odour concentration during an hour are taken into account. This approach recognises that human response to odour occurs within a few seconds where the concentration may be significantly higher than the hourly average. In this case the 10m high stack behaves as a wake-affected point source where the contaminant plume is subject to significant turbulence immediately down-wind of the stack. The Proposed Waikato Regional Air Plan recommends a peak-to-mean ratio of 2.5 for such a source, in general accordance with the recommendations of Katestone Scientific (1998) for wake-affected point sources and volume sources.

55. Division of the plan's recommended odour modelling guideline by a peak-to-mean ratio of 2.5 gives a guideline of 2 OU/m^3 (one-hour average). As shown in Figure 2, stack emissions are not expected to cause GLCs greater than this guideline beyond the plant boundary, even when the maximum measured emission rate is modelled. It is recognised that there is some uncertainty in the prediction. However, having regard to the conservative modelling assumptions used, the emission rate selected for modelling, and the stringent guideline applied (without consideration of percentile compliance), it is considered that the existing 10m high stack is unlikely to cause objectionable or offensive odour at residences across Higgins Road.

56. A number of complaints relating to odour from the asphalt plant site have been received by Environment Waikato and Fulton Hogan during the past year. These complaints are discussed in detail in the Officer's Report prepared by Mr Sinclair. In Section 5.4, this report notes that council staff have detected odour off-site on several occasions, but that odour assessments indicated that the level of odour is generally not intense and normally of short duration. I consider that odour impacts will be reduced significantly as a result of the mitigation measures recently implemented by Fulton Hogan and the proposed increase in stack height.

57. Increasing the stack to a height of 18m will prevent any significant influence of the 7m high fabric filter structure on downwash of the contaminant plume. This will markedly reduce odour impacts at the elevated Sayers' residence to the southwest of the plant, where the effects of the discharge from the existing 10m high stack are difficult to predict. Recent complaints have indicated that the stack may, under

certain conditions, have been a significant source of odour at this second storey dwelling. Dispersion modelling indicates a peak odour concentration at this 5m high receptor of approximately 0.5 OU/m^3 (one hour average), based on discharge from an 18m high stack. This result indicates that odour from the raised stack is unlikely to be detected at the Sayers' residence.

58. A plot of maximum predicted odour GLCs from the raised stack is presented in Figure 3. Peak predicted odour concentrations at ground level are approximately 0.5 OU/m^3 (one hour average). Based on this conservative prediction, I consider that the discharge from the raised stack is unlikely to be a significant source of odóur at any neighbouring properties.

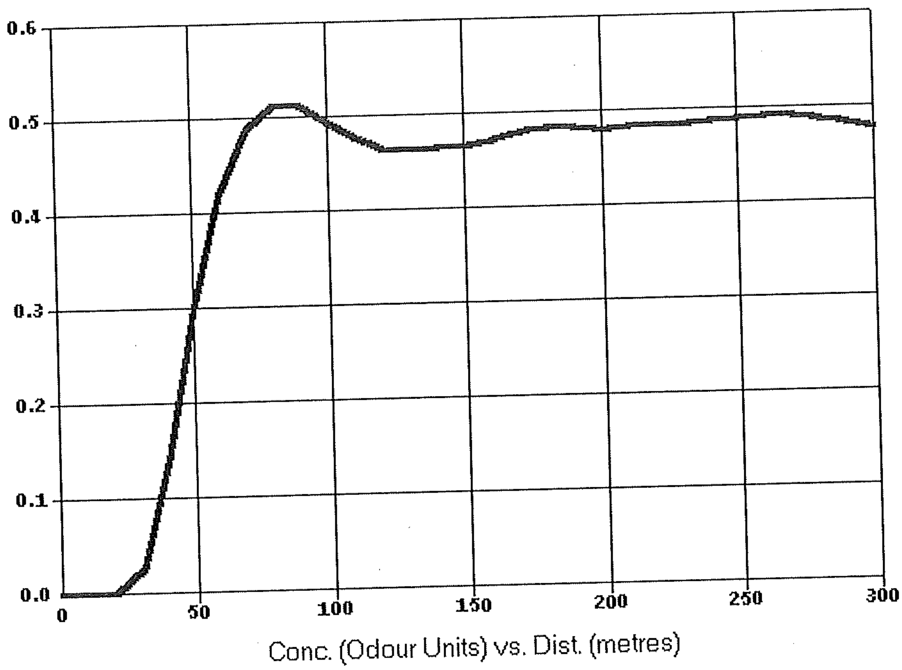

Figure 3. Plot of maximum predicted GLCs (OU/m^3, certainty, one-hour average) vs. distance from the raised 18m high asphalt plant stack, based on the maximum measured odour emission rate.

59. Fulton Hogan have implemented significant mitigation measures to reduce odour emissions from other areas of the plant, including:
    a) installation of carbon filters on the bitumen tank vents;
    b) fitting curtains and ducting fumes from the top of the asphalt bins to the drum mixer;
    c) operating a mist curtain around the truck load-out area, including odour neutralising sprays.

60. Anecdotal evidence and response from some complainants in recent months indicates that these measures have resulted in a significant reduction in odour impacts from these sources. The degree of odour control is certainly superior to that employed by other asphalt plants in New Zealand. It is considered that further expensive odour control measures, such as enclosure of the truck load-out area, is neither necessary nor

justifiable.

Particulate Matter

61. Recent testing has indicated that particulate emissions from the bag filter are well below the existing consent limit of 50mg/m^3. I concur with the conclusion of SKM that the contribution of PM_{10} from the stack to winter background concentrations will be very small. Fulton Hogan will continue to monitor the pressure drop across the filter bags to detect any bag failure, should it occur.

62. Fulton Hogan have established a good record of dust control at the asphalt plant site. Few complaints have been received by Environment Waikato concerning dust from this source, and submitters have not identified dust emissions as a primary concern. Housekeeping procedures are in place to minimise fugitive dust emissions. A water cart is present on the site to dampen dusty surfaces when there is potential for discharge during dry and windy conditions.

63. Monitoring of deposited dust is currently undertaken by Fulton Hogan at five deposit gauges located around the site. Unfortunately meaningful results from recent monitoring are not available at this time. However, given the dust control measures in place at the site and the lack of significant complaints concerning dust nuisance, it is expected that the rate of dust deposition beyond the site boundary will be well within 4g/m^2/30 days, above background concentration.

64. The Ministry for the Environment has prepared a draft Good Practice Guide for Assessing and Managing the Environmental Effects of Dust Emissions. This draft document recommends a trigger level for deposited dust of 4g/m^2/30 days, above background concentration. However, it is noted that the acceptable dust deposition rate will vary according to the sensitivity of the receiving environment and the type of dust. An appendix to the draft guide notes that dissolved material is of no interest in assessing nuisance effects from typical dust sources, and thus the recommended dust deposition criterion would only be applied to insoluble matter in this case.

65. Submissions have been received regarding the recommended deposited dust trigger level in the guide, and in particular the interpretation of insoluble dust. I am currently revising the guide for the Ministry to take into account the comments that have been received. However a final document has not yet been completed and the fact remains that appropriate trigger levels will vary for each site according to the nature of the discharge and the sensitivity of the receiving environment.

66. I am concerned that in this case the trigger level recommended by SKM of 2g/m^2/30 days insoluble dust, above background concentration, is overly stringent. This value is half the level recommended in the draft Good Practice Guide and that has been applied to numerous sites of this type throughout New Zealand in recent years. There are significant difficulties in distinguishing between background concentrations and deposition caused by the discharge, and the monitoring method is relatively crude. Such a tight limit may be appropriate in some cases, such as coal dust deposition in a sensitive area, but I do not consider it to be appropriate in this case. A trigger level in the order of 4g/m^{2}30 days insoluble dust, above background concentration, is

appropriate for this site, coupled with requirements to operate according to a dust management plan such that there is no objectionable or offensive dust nuisance.

Combustion Products

67. I concur with the comments of SKM that the discharge of combustion products from burning of LPG in the drum mixer is unlikely to cause adverse effects. Emission rates of nitrogen dioxide, carbon monoxide and particulate matter from a well operated burner of this scale, discharged via an 18m high stack, are very small such that GLCs of these contaminants are not predicted to make a significant contribution to background concentrations.

Comments on Recommended Conditions in the Officer's Report

Condition 2

68. This condition lists activities that may be undertaken at the site, including *"The storage of bitumen in fixed or mobile tanks so long as the vents from these tanks are passed through a filtration system prior to discharge to the atmosphere"*. It is submitted that the words *"or mobile"* should be deleted from this condition. At times it will be necessary for mobile bitumen tankers to be temporarily present on the site, and it is neither reasonable nor practical to require filtration of these discharges.

Condition 11

69. This condition requires ambient monitoring of benzene, xylene and toluene at two locations (including the Sayers' residence) downwind of the plant on a monthly basis. Given that VOCs discharged from the plant are not predicted to cause adverse health effects at neighbouring properties, monitoring of this type is not considered to be necessary or justifiable. Predicted concentrations of VOCs are well below typical background levels, and will have been further reduced in recent months by the mitigation measures implemented by Fulton Hogan. The proposed increase in stack height will significantly reduce VOC concentrations at the Sayers' residence. It is submitted that such a monitoring programme of this type would serve little purpose at significant expense.

70. The condition states that monitoring may cease if three successive samples show concentrations that are less than 5μg/m^3. It is likely that background concentrations of toluene and xylene will often be above this value, and at times benzene background concentrations could also exceed this value. Thus the condition, as worded, effectively requires monthly monitoring for the duration of the consent.

71. It is considered that the trigger level for such a condition should be related to benzene only and be at least 10μg/m^3 (24-hour average). This is a conservative value given that the air quality guideline recommended by the Ministry for the Environment (2000) is 10μg/m^3 (annual average) prior to 2010 and that the proposed modelling design concentration for benzene is 22μg/m^3 (1-hour average).

72. However, I reiterate that the condition is not considered to be necessary in this case.

Condition 12

73. This condition requires annual odour monitoring of the stack using dynamic dilution olfactometry. It has been demonstrated that, following increase of the stack to a height of 18m, odour emissions from the stack at even twice the maximum measured rate are unlikely to be detected at neighbouring properties. It is therefore submitted that any further odour monitoring of the stack is unnecessary. Given that Fulton Hogan intends to raise the stack at significant expense, such costly ongoing monitoring is not considered to be a reasonable requirement.

Condition 17

74. Condition 17 requires the consent holder to undertake further investigations if insoluble dust measurements exceed $2g/m^2/30$ days above background concentration. For the reasons stated earlier it is considered that the trigger level should be $4g/m^2/30$ days, in accordance with common practice for similar cases in New Zealand. In any case it is submitted that such a condition has limited value as there can be significant difficulty in determining background concentration. Ultimately Environment Waikato would be able to rely on Condition 1 (no objectionable dust beyond the boundary) and the recommended review clause if dust nuisance is detected by the monitoring programme or complaints.

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Appendix 1. Calculated Maximum Emission Rates of PAHs

Contaminant	Source Emissions (g/hr)				
	Stack	Silo Filling[3]	Load-Out[3]	Primary Bitumen Tank[4]	2nd Bitumen Tank[4]
Acenaphthene	0.035	0.026	0.0093	0.020	0.011
Acenaphthylene	0.215	0.00078	0.00010	0.00060	0.00033
Anthracene	0.0055	0.0073	0.0025	0.0056	0.0031
Benzo(a)anthracene	0.0053	0.0031	0.00068	0.0024	0.0013
Benzo(b)flouranthene	0.0025	ND[2]	0.00027	ND[2]	ND[2]
Benzo(k)flouranthene	0.001	ND[2]	0.000079	ND[2]	ND[2]
Benzo(g,h,i)perylene	0.001	ND[2]	0.000068	ND[2]	ND[2]
Benzo(a)pyrene	0.00025	ND[2]	0.000082	ND[2]	ND[2]
Benzo(e)pyrene	0.0028	0.00053	0.00028	0.00041	0.00022
Chrysene	0.0045	0.012	0.0037	0.0091	0.0049
Dibenz(a,h)anthracene	NA[1]	ND[2]	0.000013	ND[2]	ND[2]
Flouranthene	0.015	0.0084	0.0018	0.0065	0.0035
Fluorene	0.095	0.057	0.027	0.044	0.024
Indeno(1,2,3-cd)pyrene	0.00018	ND[2]	0.000017	ND[2]	ND[2]
2-Methylnaphthalene	1.850	0.295	0.085	0.228	0.124
Naphthalene	2.250	0.102	0.045	0.079	0.043
Perylene	0.00022	0.0017	0.00078	0.0013	0.0007
Phenanthrene	0.19	0.101	0.029	0.078	0.042
Pyrene	0.014	0.025	0.0054	0.019	0.011
Total PAHs	**4.750**	**0.638**	**0.212**	**0.493[4]**	**0.269[4]**

1. Not available
2. Measurement below the detection limit for this compound.
3. Based on an asphalt temperature of 320 degrees F and default asphalt volatility of – 0.5
4. Total hydrocarbon emissions as working losses from the bitumen tank were calculated as discussed below. Based on 40 tank turnovers per year in the primary tank, it has been assumed that emissions occur within 40 one-hour periods per year as a result of tank filling. Emissions for the secondary tank are based on 18 turnovers per year. This is a very conservative approach that does not average emissions as evaporative losses throughout the year, but recognises that the most significant emissions will occur during tank filling.

Appendix 2. Assumptions Used in Bitumen Tank Emission Calculations

Total hydrocarbon emissions from the bitumen storage tanks were calculated according to AP42 procedures for organic liquid storage tanks (USEPA, 1997), using the TANKS programme made available by the USEPA. Because the tanks will be electrically heated to a constant temperature, breathing losses are insignificant and the programme only calculates working losses as a function of product turnover.

Input parameters used to calculate emissions from the bitumen tanks are as follows:

Tank Dimensions –
New Primary Tank: Horizontal cylinder, 5m long, 3.6m diameter (50 tonne)
Secondary Tank (previously cut-back): Vertical, 5m high, 2.6m diameter (25 tonne)

Temperature – 160 degrees C constant (320 degrees F)

Bitumen Throughput –
Primary tank: 2000m^3/yr
Secondary tank: 450m^3/yr (based on current usage data)

Turnovers per Year – 40 primary tank, 18 secondary tank

Vapour Pressure – 0.0046 psia, calculated from Antoine's Equations using the constants specified by AP-42 (11.1-10) for an average asphalt binder

Vapour Molecular Weight – 346 atomic mass units, as given by AP42 (11.1-11)

PAH emissions from the bitumen tanks were calculated from the speciation profiles provided by AP42 for this purpose (Table 11.1-15). Organic PM emissions (required for these calculations) were determined as a ratio to the Total Organic Compound (TOC) emissions calculated by the TANKS programme. This was based on the organic PM/TOC ratio for silo filling (2.07%) determined from the equations in Table 11.1-14.

Appendix 3. Calculated Maximum Emission Rates of Key VOCs

Contaminant	Source Emissions (g/hr)				
	Stack	Silo Filling[1]	Load Out[1]	Primary Bitumen Tank[2]	2nd Bitumen Tank[2]
Benzene	12.75	0.086	0.048	0.066	0.036
Ethylbenzene	6.00	0.103	0.256	0.079	0.043
Toluene	3.75	0.167	0.192	0.129	0.071
Xylene	5.00	0.694	0.448	0.535	0.292
Formaldehyde	62.50	1.863	0.081	1.437	0.785
Total Organic Compounds	1100	270	91.5	208	114

1. Based on an asphalt temperature of 320 degrees F and default asphalt volatility of -0.5
2. Total hydrocarbon emissions as working losses from the bitumen tank were calculated as discussed above. Based on 40 tank turnovers per year in the primary tank, it has been assumed that emissions occur within 40 one-hour periods per year as a result of tank filling. Emissions for the secondary tank are based on 18 turnovers per year. This is a very conservative approach that does not average emissions as evaporative losses throughout the year, but recognises that the most significant emissions will occur during tank filling.

Appendix 4. Assumptions Used for Dispersion Modelling

(a) VOC Modelling for Higgins Road Receptors

Parameter	Selected Value	Explanation
Stack Height (m)	9.8	As specified in the AEE
Stack Emission Velocity (m/s)	14	From FH 2000 stack test report (appended to AEE)
Stack Internal Exit Diameter (m)	0.6	From FH 2000 stack test report (appended to AEE)
Stack Temperature (degrees C)	130	From FH 2000 stack test report (appended to AEE)
Volume Source Release Height	10.2m asphalt bins 3.5m #1 btmn tank 5m #2 bitmn tank 1m truck load-out	Approximate centre of the plume at the point of release. Vertical and horizontal spread approximated according to Ausplume guidance.
Surface Roughness Height (m)	0.8	Conservative value for a predominantly industrial area.
Meteorological Data Used	Metsamp	Screening data containing a full range of possible conditions.
Building Downwash	None	No significant tall structures (>4m high) affect dispersion from the stack when the wind blows towards Higgins Rd.

(b) Odour Modelling from the Stack

Parameter	Selected Value	Explanation
Odour Emission Rate	Maximum value	The maximum measured value (20 min. sample) is likely to overestimate emissions for a full hour.
Stack Height (m)	9.8 (18m proposed)	As specified in the AEE
Stack Emission Velocity (m/s)	18	From emission test report (Newby 2001)
Stack Internal Exit Diameter (m)	0.6	From FH 2000 stack test report (appended to AEE)
Stack Temperature (degrees C)	130	From emission test report (Newby 2001)
Dispersion Coefficient	Urban	Conservative at this site where urban development is not intensive.
Surface Roughness Height (m)	0.8	Conservative value for a predominantly industrial area.
Meteorological Data Used	Metsamp	Screening data containing a full range of possible conditions.
Building Downwash	Yes	Takes into account the affect of the 7m high bag filter structure adjacent to the stack.

Appendix 5. AUSPLUME Output Files for VOC and Odour Modelling

Ausplume version 4.0

Fulton Hogan Waikato Benzene (10m Stack, Higgins Rd Receptors)

Concentration or deposition Concentration
Emission rate units grams/second
Concentration units micrograms/cub.metre
Units conversion factor 1.00E+06
Background concentration 0.00E+00
Terrain effects None
Smooth stability class changes? No
Other stability class adjustments ("urban modes") None
Ignore building wake effects? No
Decay coefficient (unless defined in met. file) 0.000
Anemometer height 10 m
Averaging time for sigma-theta values 60 min.
Roughness height at the wind vane site 0.300 m

DISPERSION CURVES
Horizontal dispersion curves for sources <100m high Sigma-theta
Vertical dispersion curves for sources <100m high Pasquill-Gifford
Horizontal dispersion curves for sources >100m high Briggs Rural
Vertical dispersion curves for sources >100m high Briggs Rural
Enhance horizontal plume spreads for buoyancy? Yes
Enhance vertical plume spreads for buoyancy? Yes
Adjust horizontal P-G formulae for roughness height? Yes
Adjust vertical P-G formulae for roughness height? Yes
Roughness height 0.800m
Adjustment for wind directional shear None

PLUME RISE OPTIONS
Gradual plume rise? Yes
Stack-tip downwash included? Yes
Building downwash algorithm: Schulman-Scire
Entrainment coeff. for neutral & stable lapse rates 0.60,0.60
Partial penetration of elevated inversions? No
Disregard temp. gradients in the hourly met. file? No

and in the absence of boundary-layer potential temperature gradients
given by the hourly met. file, a value from the following table
(in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Category boundaries (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS
"Irwin Urban" values (unless defined in met. file)

AVERAGING TIMES
1 hour

Fulton Hogan Waikato Benzene (10m Stack, Higgins Rd GLCs)

SOURCE CHARACTERISTICS

Stack Source: Stack

X(m)	Y(m)	Ground Elev.	Stack Height	Diam.	Temp.	Speed
0	0	0m	10m	0.60m	130C	14.0m/s

No building wake effects.
(Constant) emission rate = 3.50E-03 grams/second
No gravitational settling or scavenging.

Volume Source: BTank1

X(m)	Y(m)	Ground ht.	Source ht.	Hor. spread	Vert. spread
0	-10	0m	4m	1m	1m

(Constant) emission rate = 2.00E-05 grams/second
No gravitational settling or scavenging.

Volume Source: Load

X(m) Y(m) Ground ht. Source ht. Hor. spread Vert. spread

-15	-15	0m	1m	1m	1m

(Constant) emission rate = 1.00E-05 grams/second
No gravitational settling or scavenging.

Volume Source: Bins

X(m)	Y(m)	Ground ht.	Source ht.	Hor. spread	Vert. spread
-15	-15	0m	10m	1m	1m

(Constant) emission rate = 2.00E-05 grams/second
No gravitational settling or scavenging.

Volume Source: BTank2

X(m)	Y(m)	Ground ht.	Source ht.	Hor. spread	Vert. spread
0	-90	0m	5m	1m	1m

(Constant) emission rate = 1.00E-05 grams/second
No gravitational settling or scavenging.

Fulton Hogan Waikato Benzene (10m Stack, Higgins Rd GLCs)

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
0.m 20.m 40.m 60.m 80.m 100.m 120.m
140.m 160.m 180.m 200.m 220.m 240.m 260.m
280.m 300.m

and these y-values (or northings):
-15.m -10.m -5.m 0.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	Elevn	Height	No.	X	Y	Elevn	Height
1	200	0	0.0	0.0	4	200	-15	0.0	0.0
2	200	-5	0.0	0.0	5	180	-90	0.0	0.0
3	200	-10	0.0	0.0					

Meteorological data file information:

"METSAMP" test meteorological file

---

1 HIGHEST RECORDINGS FOR EACH RECEPTOR (in micrograms/cub.metre)
AVERAGING TIME = 1 HOUR

X (km):	0.000	0.020
Y (km)		
0.000	6.44E-02 07,01/01/00	1.68E-01 20,01/01/00
-0.005	1.01E-01 20,01/01/00	3.17E-01 20,01/01/00
-0.010	3.62E-01 11,02/01/00	4.72E-01 11,02/01/00
-0.015	1.11E+00 19,02/01/00	5.00E-01 19,02/01/00

X (km):	0.040	0.060
Y (km)		
0.000	1.98E-01 11,02/01/00	2.05E-01 19,02/01/00
-0.005	3.25E-01 19,02/01/00	3.08E-01 19,02/01/00
-0.010	4.59E-01 19,02/01/00	3.69E-01 19,02/01/00
-0.015	4.32E-01 19,02/01/00	3.52E-01 19,02/01/00

X (km):	0.080	0.100
Y (km)		
0.000	2.01E-01 19,02/01/00	1.83E-01 19,02/01/00
-0.005	2.59E-01 19,02/01/00	2.18E-01 19,02/01/00
-0.010	2.90E-01 19,02/01/00	2.36E-01 19,02/01/00
-0.015	2.82E-01 19,02/01/00	2.31E-01 19,02/01/00

X (km):	0.120	0.140
Y (km)		
0.000	1.63E-01 19,02/01/00	1.46E-01 19,02/01/00
-0.005	1.86E-01 19,02/01/00	1.61E-01 19,02/01/00
-0.010	1.97E-01 19,02/01/00	1.69E-01 19,02/01/00
-0.015	1.94E-01 19,02/01/00	1.67E-01 19,02/01/00

X (km): 0.160 0.180

Y (km)		
0.000	1.31E-01 19,02/01/00	1.19E-01 19,02/01/00
-0.005	1.42E-01 19,02/01/00	1.27E-01 19,02/01/00
-0.010	1.47E-01 19,02/01/00	1.30E-01 19,02/01/00
-0.015	1.46E-01 19,02/01/00	1.30E-01 19,02/01/00

X (km):	0.200	0.220
Y (km)		
0.000	1.09E-01 19,02/01/00	1.01E-01 19,02/01/00
-0.005	1.15E-01 19,02/01/00	1.05E-01 19,02/01/00
-0.010	1.17E-01 19,02/01/00	1.07E-01 19,02/01/00
-0.015	1.17E-01 19,02/01/00	1.07E-01 19,02/01/00

X (km):	0.240	0.260
Y (km)		
0.000	9.84E-02 01,02/01/00	9.56E-02 01,02/01/00
-0.005	9.81E-02 01,02/01/00	9.54E-02 01,02/01/00
-0.010	9.89E-02 19,02/01/00	9.47E-02 01,02/01/00
-0.015	9.87E-02 19,02/01/00	9.36E-02 01,02/01/00

X (km):	0.280	0.300
Y (km)		
0.000	9.22E-02 01,02/01/00	9.04E-02 24,01/01/00
-0.005	9.20E-02 01,02/01/00	9.02E-02 24,01/01/00
-0.010	9.14E-02 01,02/01/00	8.98E-02 24,01/01/00
-0.015	9.05E-02 01,02/01/00	8.89E-02 24,01/01/00

At the discrete receptors:

1: 1.09E-01 @Hr19,02/01/00 2: 1.15E-01 @Hr19,02/01/00
3: 1.17E-01 @Hr19,02/01/00 4: 1.17E-01 @Hr19,02/01/00
5: 5.78E-02 @Hr10,01/01/00

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1 SECOND-HIGHEST RECORDINGS FOR EACH RECEPTOR (in micrograms/cub.metre)
AVERAGING TIME = 1 HOUR

At the discrete receptors:

1: 1.03E-01 @Hr16,11/01/00 2: 1.03E-01 @Hr16,11/01/00
3: 1.01E-01 @Hr16,11/01/00 4: 9.94E-02 @Hr16,11/01/00
5: 5.78E-02 @Hr12,10/01/00

---

1 Peak values for the 100 worst cases (in micrograms/cub.metre)
Averaging time = 1 hour

Rank	Value	Time Recorded hour date	Coordinates (* denotes polar)
1	1.11E+00	19,02/01/00	(0, -15)
2	6.73E-01	11,02/01/00	(0, -15)
3	5.55E-01	20,02/01/00	(0, -15)
4	4.66E-01	20,01/01/00	(0, -15)
5	4.66E-01	20,03/01/00	(0, -15)
6	4.66E-01	06,05/01/00	(0, -15)
7	4.66E-01	16,06/01/00	(0, -15)
8	4.66E-01	02,08/01/00	(0, -15)
9	4.66E-01	12,09/01/00	(0, -15)
10	4.66E-01	22,10/01/00	(0, -15)
11	3.70E-01	21,02/01/00	(0, -15)
12	3.37E-01	12,02/01/00	(0, -15)
13	2.78E-01	22,02/01/00	(0, -15)
14	2.33E-01	21,01/01/00	(0, -15)
15	2.33E-01	21,03/01/00	(0, -15)
16	2.33E-01	07,05/01/00	(0, -15)
17	2.33E-01	17,06/01/00	(0, -15)
18	2.33E-01	03,08/01/00	(0, -15)
19	2.33E-01	13,09/01/00	(0, -15)
20	2.33E-01	23,10/01/00	(0, -15)
21	2.24E-01	13,02/01/00	(0, -15)
22	2.22E-01	23,02/01/00	(0, -15)
23	1.85E-01	24,02/01/00	(0, -15)
24	1.76E-01	07,01/01/00	(20, -10)
25	1.76E-01	07,03/01/00	(20, -10)
26	1.76E-01	17,04/01/00	(20, -10)
27	1.76E-01	03,06/01/00	(20, -10)
28	1.76E-01	13,07/01/00	(20, -10)
29	1.76E-01	23,08/01/00	(20, -10)
30	1.76E-01	09,10/01/00	(20, -10)

Ausplume version 4.0

Fulton Hogan Waikato Benzene (18m Stack, Sayers' Residence Receptor)

Concentration or deposition Concentration
Emission rate units grams/second
Concentration units micrograms/cub.metre
Units conversion factor 1.00E+06
Background concentration 0.00E+00
Terrain effects None
Smooth stability class changes? No
Other stability class adjustments ("urban modes") None
Ignore building wake effects? No
Decay coefficient (unless defined in met. file) 0.000
Anemometer height 10 m
Averaging time for sigma-theta values 60 min.
Roughness height at the wind vane site 0.300 m

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high Sigma-theta
Vertical dispersion curves for sources <100m high Pasquill-Gifford
Horizontal dispersion curves for sources >100m high Briggs Rural
Vertical dispersion curves for sources >100m high Briggs Rural
Enhance horizontal plume spreads for buoyancy? Yes
Enhance vertical plume spreads for buoyancy? Yes
Adjust horizontal P-G formulae for roughness height? Yes
Adjust vertical P-G formulae for roughness height? Yes
Roughness height 0.800m
Adjustment for wind directional shear None

PLUME RISE OPTIONS

Gradual plume rise? Yes
Stack-tip downwash included? Yes
Building downwash algorithm: Schulman-Scire
Entrainment coeff. for neutral & stable lapse rates 0.60,0.60
Partial penetration of elevated inversions? No
Disregard temp. gradients in the hourly met. file? No

and in the absence of boundary-layer potential temperature gradients given by the hourly met. file, a value from the following table (in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Category boundaries (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS
"Irwin Urban" values (unless defined in met. file)

AVERAGING TIMES
1 hour

Fulton Hogan Waikato Benzene (18m Stack, Sayers' Residence)

SOURCE CHARACTERISTICS

Stack Source: Stack

X(m)	Y(m)	Ground Elev.	Stack Height	Diam.	Temp.	Speed
0	0	0m	18m	0.60m	130C	14.0m/s

No building wake effects.
(Constant) emission rate = 3.50E-03 grams/second
No gravitational settling or scavenging.

Volume Source: BTank1

X(m)	Y(m)	Ground ht.	Source ht.	Hor. spread	Vert. spread
-10	-5	0m	4m	1m	1m

(Constant) emission rate = 2.00E-05 grams/second
No gravitational settling or scavenging.

Volume Source: Load

X(m)	Y(m)	Ground ht.	Source ht.	Hor. spread	Vert. spread
-20	0	0m	1m	1m	1m

(Constant) emission rate = 1.00E-05 grams/second
No gravitational settling or scavenging.

Volume Source: Bins

X(m)	Y(m)	Ground ht.	Source ht.	Hor. spread	Vert. spread
-20	0	0m	10m	1m	1m

(Constant) emission rate = 2.00E-05 grams/second
No gravitational settling or scavenging.

Volume Source: BTank2

X(m)	Y(m)	Ground ht.	Source ht.	Hor. spread	Vert. spread
-100	-30	0m	5m	1m	1m

(Constant) emission rate = 1.00E-05 grams/second
No gravitational settling or scavenging.

Fulton Hogan Waikato Benzene (18m Stack, Sayers' Residence)

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
120.m

and these y-values (or northings):
0.m

at a height above ground level of 5.0 metres

Meteorological data file information:

"METSAMP" test meteorological file

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1 Peak values for the 100 worst cases (in micrograms/cub.metre)
Averaging time = 1 hour

Rank	Value	Time Recorded hour date	Coordinates (* denotes polar)
1	1.63E-01	19,02/01/00	(120, 0)
2	1.01E-01	11,02/01/00	(120, 0)
3	8.14E-02	20,02/01/00	(120, 0)
4	6.55E-02	20,03/01/00	(120, 0)
5	6.55E-02	06,05/01/00	(120, 0)

6	6.55E-02	16,06/01/00	(120,	0)
7	6.55E-02	02,08/01/00	(120,	0)
8	6.55E-02	12,09/01/00	(120,	0)
9	6.55E-02	22,10/01/00	(120,	0)
10	6.37E-02	20,01/01/00	(120,	0)

Ausplume version 4.0

Fulton Hogan Waikato 18m High Stack Odour Emissions

Concentration or deposition Concentration
Emission rate units OUV/second
Concentration units Odour Units
Units conversion factor 1.00E+00
Background concentration 0.00E+00
Terrain effects None
Smooth stability class changes? No
Other stability class adjustments ("urban modes") None
Ignore building wake effects? No
Decay coefficient (unless defined in met. file) 0.000
Anemometer height 10 m
Averaging time for sigma-theta values 60 min.
Roughness height at the wind vane site 0.300 m

DISPERSION CURVES
Horizontal dispersion curves for sources <100m high Sigma-theta
Vertical dispersion curves for sources <100m high Pasquill-Gifford
Horizontal dispersion curves for sources >100m high Briggs Rural
Vertical dispersion curves for sources >100m high Briggs Rural
Enhance horizontal plume spreads for buoyancy? Yes
Enhance vertical plume spreads for buoyancy? Yes
Adjust horizontal P-G formulae for roughness height? Yes
Adjust vertical P-G formulae for roughness height? Yes
Roughness height 0.800m
Adjustment for wind directional shear None

PLUME RISE OPTIONS
Gradual plume rise? Yes
Stack-tip downwash included? Yes
Building downwash algorithm: Schulman-Scire
Entrainment coeff. for neutral & stable lapse rates 0.60,0.60
Partial penetration of elevated inversions? No
Disregard temp. gradients in the hourly met. file? No

and in the absence of boundary-layer potential temperature gradients given by the hourly met. file, a value from the following table (in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Category boundaries (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS
"Irwin Urban" values (unless defined in met. file)

AVERAGING TIMES
1 hour

Fulton Hogan Waikato 18m High Stack Odour Emissions

SOURCE CHARACTERISTICS

Stack Source: Stack

X(m)	Y(m)	Ground Elev.	Stack Height	Diam.	Temp.	Speed
0	0	0m	18m	0.60m	130C	18.0m/s

Effective building dimensions (in metres)

Wind dir.	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°
Width	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Height	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0

Wind dir.	130°	140°	150°	160°	170°	180°	190°	200°	210°	220°	230°	240°
Width	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Height	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0

Wind dir.	250°	260°	270°	280°	290°	300°	310°	320°	330°	340°	350°	360°
Width	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Height	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0

(Constant) emission rate = 3.50E+04 OUV/second
No gravitational settling or scavenging.

Fulton Hogan Waikato 18m High Stack Odour Emissions

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):

0.m	10.m	20.m	30.m	40.m	50.m	60.m
70.m	80.m	90.m	100.m	110.m	120.m	130.m
140.m	150.m	160.m	170.m	180.m	190.m	200.m
210.m	220.m	230.m	240.m	250.m	260.m	270.m
280.m	290.m	300.m				

and these y-values (or northings):
0.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	Elevn	Height	No.	X	Y	Elevn	Height
1	120	0	0.0	5.0					

Meteorological data file information:

"METSAMP" test meteorological file

At the discrete receptors:

1: 4.77E-01 @Hr12,01/01/00

SECOND-HIGHEST RECORDINGS FOR EACH RECEPTOR (in Odour Units)
AVERAGING TIME = 1 HOUR

At the discrete receptors:

1: 4.77E-01 @Hr14,10/01/00

1 Peak values for the 100 worst cases (in Odour Units)
Averaging time = 1 hour

Rank	Value	Time Recorded hour date	Coordinates (* denotes polar)
1	5.12E-01	06,01/01/00	(80, 0)
2	5.12E-01	06,03/01/00	(80, 0)
3	5.12E-01	16,04/01/00	(80, 0)
4	5.12E-01	02,06/01/00	(80, 0)
5	5.12E-01	12,07/01/00	(80, 0)
6	5.12E-01	22,08/01/00	(80, 0)
7	5.12E-01	08,10/01/00	(80, 0)
8	4.96E-01	13,01/01/00	(90, 0)
9	4.96E-01	13,03/01/00	(90, 0)
10	4.96E-01	23,04/01/00	(90, 0)
11	4.96E-01	09,06/01/00	(90, 0)
12	4.96E-01	19,07/01/00	(90, 0)
13	4.96E-01	05,09/01/00	(90, 0)
14	4.96E-01	15,10/01/00	(90, 0)
15	4.91E-01	02,01/01/00	(260, 0)
16	4.88E-01	05,01/01/00	(90, 0)
17	4.88E-01	05,03/01/00	(90, 0)
18	4.88E-01	15,04/01/00	(90, 0)
19	4.88E-01	01,06/01/00	(90, 0)
20	4.88E-01	11,07/01/00	(90, 0)