Bayside Council
Serving Our Community

8 March 2017

Our ref: 09/177-04

Ms Sally Munk
Acting Director – Industry Assessments
Department of Planning & Environment
GPO Box 39
SYDNEY NSW 2001

Attention: Ms Pamela Morales

Dear Ms Munk,

Exhibition – Vopak Bulk Liquids Storage Facility, Port Botany (MP 06_0089 MOD 2)

I refer to your letter dated 11 January 2017 inviting submissions on the Environmental Assessment for the Vopak Bulk Liquids Storage Facility at 1-9 and 20 Friendship Road, Port Botany (MP 06_0089 MOD 2). Thank you for the opportunity to comment on the application.

It is understood that the modification involves increasing the capacity at Vopak's bulk liquid terminal from the existing approved product throughput of 3,950,000 m3 (3,950 ML) per year to 7,800,000 m3 (7,800 ML) per year and the following works:

- Construction of a new access road and driveway;
- Construction of four new road tanker bays, driver amenities building and extension to existing warehouse;
- Upgrade to the vapour recovery unit; and
- Installation of additional transfer pumps and pipelines and associated infrastructure.

Council officers have reviewed the application and provide the following comments:

Risk

Denison Street, Hillsdale has been identified as a Dangerous Goods Route. The former City of Botany Bay Council engaged a consultant, Arriscar Pty Limited (Arriscar), to undertake the *Denison Street Land Use Safety Study Review of Planning Controls* to examine the risk along Denison Street due to the transport of dangerous goods and the proximity to the Botany Industrial Park (BIP). The report found that changes are required to Council's planning controls to incorporate risk-related controls and make informed land use safety decisions for existing and future developments in the area. At its meeting on 7 September 2016, the former City of Botany Bay Council resolved to make the report public. A copy of the Study is available on Council's website at http://www.botanybay.nsw.gov.au/Planning-Business/Risk.

Given the application involves the transport of dangerous goods along Denison Street, Hillsdale, Bayside Council engaged Arriscar to review the Environmental Assessment (EA) submitted by Vopak for the subject application.

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A copy of Arriscar's report is attached to this letter but in summary, Arriscar conclude:

- For Vopak Site B, consequence distances for tank overflows and risk contours corresponding to criteria in HIPAP No. 4 do not extend to Bayside Council precincts.

- The EA clearly addresses two of the requirements in Section 7.2.4 of the *Denison Street Land Use Safety Study Review of Planning Controls*. It is unclear if the QRA of Dangerous Goods Transport presented in Appendix F has considered the cumulative impact of Dangerous Goods Transport and risk arising from nearby fixed facilities, as recommended in the *Denison Street Land Use Safety Study Review of Planning Controls*.

- The QRA of Dangerous Goods Movements on Denison Street (Appendix F) of the EA does not provide the consequence result detail required by HIPAP No. 6 *Hazard Analysis* to provide a full appreciation of the consequences of hazardous events and thereby demonstrate claims about limited impact. As such, the accuracy and conclusions of Appendix F cannot be verified.

Accordingly, Arriscar recommends that the proponent confirm if the cumulative effect of both fixed installations and Dangerous Goods Transport was considered in Appendix F and provide the information if it has been omitted. This will enable Council to review its own planning scheme near Denison Street based upon the total risk in the area.

Traffic

Council's traffic engineer believes that the net development traffic (a maximum of 5 light vehicles and 14 heavy vehicle trips per hour (or 10 light vehicles and 196 heavy vehicle trips per day)) will be dissipated by the time it reaches Council's local roads in Banksmeadow.

However, the main traffic impact will be on Port Botany roads and Roads and Maritime Services (RMS) roads i.e. Botany Road, Foreshore Road and Wentworth Avenue, especially at the major signalised intersections. There is ongoing consultation between Council and the RMS regarding potential traffic issues for traffic accessing Council's industrial area in Banksmeadow to Botany Road and Foreshore Road during peak hours.

Nevertheless, Council's main concerns is in regards to the transport of dangerous goods along roads in close proximity to residential and sensitive land uses, in particular Denison Street.

Environmental

There is an Environmental Protection Authority (EPA) environmental protection license (EPL) for the site that has a daily stormwater discharge requirement and the site has a stormwater management system collecting water from non-bunded areas that is routed to a Final Interceptor Pit for testing prior to disposal. However, given the proximity of the proposed new road, following the western and northern sides of the property to the bay, Council requests that the new road be connected to the existing stormwater management system for the site and that any variation to the EPL (as referenced in the EA) in regards to stormwater discharge, not reduce the water quality requirements of the water discharged to the bay.

Environmental Health

Should the application be approved despite Council's concerns, the following conditions are recommended:

Air Emissions

- The use of the premises must not give rise to air impurities in contravention of the *Protection of the Environment Operations (POEO) Act 1997*. Waste gases released from the premises must not cause a public nuisance nor be hazardous or harmful to human health or the environment.

- No offensive odour from any trade, industry or process must be detected outside the premises by an authorised Council officer as defined in the *POEO Act 1997.*

Odour Standards - National Pollutant Inventory Guide (Version 6.1 Sep 2015)

Noise Emissions

- Noise from construction activities associated with the development must comply with the NSW EPA's Environmental Noise Manual – Chapter 171 and the *POEO Act 1997*.

- The operation of all plant and equipment must not give rise to an equivalent continuous (LAeq) sound pressure level at any point on any residential property greater than 5dB(A) above the existing background LA90 level (in the absence of the noise under consideration).

- The operation of all plant and equipment when assessed on any residential property must not give rise to a sound pressure level that exceeds LAeq 50dB(A) day time and LAeq 40 dB(A) night time.

- The operation of all plant and equipment when assessed on any neighbouring commercial/industrial premises must not give rise to a sound pressure level that exceeds LAeq 65dB(A) day time/night time.

- For assessment purposes, the above LAeq sound levels must be assessed over a period of 10-15 minutes and adjusted in accordance with EPA guidelines for tonality, frequency weighting, impulsive characteristics, fluctuations and temporal content where necessary.

Air Standards	DECCW Interim Construction Noise Guidelines; and NSW EPA Industrial Noise Policy requirements

Should you have any queries concerning this matter, please contact Stephanie Lum, Senior Strategic Planner, on 9366 3564.

Yours faithfully

Zoran Sarin
ACTING MANAGER STRATEGIC PLANNING

Attachment:

Review of MP 06_0089 MOD 2 – Vopak Site B Capacity Increase (Arriscar Pty Ltd)

Review of MP 06_0089 MOD 2

Vopak Site B Capacity Increase

For Bayside Council (East)

27 February 2017

Doc. No.: J-000237-01

Revision: 1

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A	15 Feb 2017	JL	First draft for client review.	PS	PS
0	20 Feb 2017	JL	Incorporating client comments	PS	PS
1	23 Feb 2017	JL	Correct minor typographical errors.	PS	PS

Summary

Bayside Council (Bayside) has requested Arriscar Pty Limited (Arriscar) to review parts of an Environmental Assessment (EA) submitted by Vopak Terminals Sydney Pty Ltd (Vopak). The EA is in support of an application to modify project approval 06_0089 to increase capacity at Vopak's bulk liquid terminal at 1 – 9 and 20 Friendship Road, Port Botany.

The current modification request is to increase capacity from the existing approved product throughput of 3,950,000 m^3 (3,950 ML) per year to 7,800,000 m^3 (7,800 ML) per year.

Conclusions

For Vopak Site B, consequence distances for tank overflows do not extend to Bayside Council precincts, and risk contours corresponding to criteria in HIPAP No. 4 do not extend to Bayside Council precincts.

The EA clearly addresses two of the requirements in Section 7.2.4 of the Review of Planning Controls: Denison St, Hillside [1]. It is unclear if the QRA of Dangerous Goods Transport presented in Appendix F has considered the cumulative impact of DG Transport and risk arising from nearby fixed facilities, as recommended in Review of Planning Controls: Denison St, Hillside.

Appendix F of the EA does not provide the consequence result detail required by HIPAP No. 6 to provide an appreciation of the consequences of hazardous events, and thereby demonstrate claims about limited impact.

Recommendations

Bayside Council could make to following comments in a submission and request further information:

- The QRA of DG Movements on Denison Street (Appendix F) does not provide the consequence analysis detail required by HIPAP No.6 *Hazard Analysis* for a full appreciation of the consequences of hazardous events. As such, the accuracy and conclusions of the Appendix cannot be verified.
- The proponent confirms if the cumulative effect of both fixed installations and DG transport was considered in Appendix F, and provide the information if it has been omitted. This is to enable the council review its own planning scheme near Denison Street based upon total risk in the area.

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Notation

Abbreviation	Description
Arriscar	Arriscar Pty Limited
Bayside	Bayside Council
DG	Dangerous Goods
EA	Environmental Assessment
HIPAP	Hazardous Industry Planning Advisory Paper
LSPSS	Large Scale Petrol Storage Sites
m^3	Cubic metres (1,000 L)
ML	Mega Litres (1,000,000 L)
QRA	Quantitative Risk Assessment
TIA	Traffic Impact Assessment
UK HSE	United Kingdom Health and Safety Executive
Vopak	Vopak Terminals Sydney Pty Ltd

1 INTRODUCTION

Bayside Council (Bayside) has requested Arriscar Pty Limited (Arriscar) to review parts of an Environmental Assessment (EA) submitted by Vopak Terminals Sydney Pty Ltd (Vopak). The EA is in support of an application to modify project approval 06_0089 to increase capacity at Vopak's bulk liquid terminal at 1 – 9 and 20 Friendship Road, Port Botany.

2 BACKGROUND

2.1 Vopak Site B

Vopak operates terminal facilities at 1 – 9 and 20 Friendship Road, Port Botany (Site B), storing and handling bulk liquids that are flammable or combustible. Vopak has submitted for exhibition an EA for modifying project approval 06_0089. Storage capacity at the terminal was increased by project approval 06_0089, which was issued by the then Minister for Planning on 28 February 2007.

The current modification request is to increase capacity from the existing approved product throughput of 3,950,000 m^3 (3,950 ML) per year to 7,800,000 m^3 (7,800 ML) per year. The EA states the following changes are proposed to achieve the throughput increase:

- West Entry Northern Approach Roadways - requiring the need to lease an additional 2,870 m^2 of land from NSW Ports to the north and west of Site B plus the modification to the Simblist Road intersection with Friendship Road.
- Construction of three New Road Tanker Loading Bays (Bays 7, 8 & 9).
- Installation of additional transfer pumps and product supply pipelines to existing RT Pump Manifolds.
- Construction of one Road Tanker Unloading Bay for biofuels, additives and other ancillary products together with RT unloading pumps.
- Construction of a new drivers' amenities building at the Fishburn Road entrance.
- Construction of a steel framed awning (19m x 1.9m wide) on the northern side of the existing Control Room Building.
- Increasing the capacity of the Vapour Recovery Unit (VRU) by upgrading the existing VRU, replacing the existing VRU or installing a second VRU alongside the existing unit, or a combination of these.
- Debottlenecking of inlet manifolds, tank import pipelines and tank inlets, inclusive of tank-to-tank and tank recirculation piping and pump facilities as well as instrumentation for quantity and quality control to increase flowrates.
- Debottlenecking of tank outlets, tank export pipelines and transfer pumps as well as instrumentation for quantity and quality control to increase flowrates.
- Civil, structural, piping, electrical and instrumentation works for the above.
- Increase in the size of the approved warehouse (8m x 12m) near the fire pump house. The proposal is to extend the warehouse to 12m x 20m.
- Modification of several conditions of project approval (06_0089).
- Clarification of Vopak's ability to change products.

Notably, the proposed changes do not involve an increase in the storage capacity of bulk flammable or combustible liquids.

In addition to these changes, there will be an increase in Dangerous Goods (DG) truck movements from the port. The EA states "*The original Application in 2007 assumed that almost 50% of the Terminal throughput would be by pipeline export but this has not been the case in practice. The majority (approximately 70%) has been by Road Tanker export.*".

2.2 Bayside Council

Bayside is an amalgamation of the City of Botany Bay, and Rockdale City Council, established by proclamation on Friday 9 September 2016. While the site of the development is not within the Bayside boundaries, Bayside is an adjoining LGA and the proposal will increase DG movements through Bayside precincts.

The Hazardous Industry Planning Advisory Paper No. 10 – *Land Use Safety Planning* (HIPAP No. 10) states that it is important for local councils to have "policies and follow procedures for ensuring appropriate zoning and development assessment in areas that could be impacted by major accidents". To formulate an approach to implement the HIPAP No. 10 objectives, the then City of Botany Bay commissioned a review of planning controls around Denison Street, Hillsdale. The review [1] recommended development applications with the potential to affect DG traffic along Denison street, including development outside the local government area, submit a Transport Risk Assessment.

The proposal to modify project approval 06_0089 will increase DG movements along Denison Street, Hillsdale.

3 SCOPE OF WORK

The following scope of work was agreed between Bayside and Arriscar:

- Review Appendix D in the Environmental Assessment and compare the consequence distances and risk contours against consultation zones documented in the UK HSE's "Land use planning advice around large scale petrol storage sites" [2];
- Confirm the EA has addressed the issues identified in Section 7.2.4 of the "Review of Planning Controls: Denison St, Hillsdale" [1];
- Confirm the traffic data is consistent across all appendices of the EA and that accident rates used in the risk assessment are consistent with "Dangerous Goods Transport QRA, Denison Street, Hillsdale" [3] (Denison Street QRA) and addendum [4] (Denison Street QRA Addendum); and
- Check consequence modelling assumptions are consistent with "Dangerous Goods Transport QRA, Denison Street" [3] .

Specifically, the following documents from the Environmental Assessment Exhibition were retrieved from the NSW Department of Planning and Environment major projects assessment website [5]:

- Section 75W Modification MP 06_0089 - Modification 2 ENVIRONMENTAL ASSESSMENT [6] (The EA);
- Appendix C - Vopak Site B Expansion, Port Botany, Traffic Impact Assessment [7] (Appendix C);

- Appendix D - Site B Proposed Throughput Increase S75W Application for Expansion Quantitative Risk Assessment [8] (Appendix D);
- Appendix E - Site B Proposed Throughput Increase S75W Application for Expansion Dangerous Goods Road Transport Quantitative Risk Assessment [9] (Appendix E); and
- Appendix F - VOPAK Port Botany Expansion – Denison Street Transport QRA – July 2016 Update [10] (Appendix F).

4 FINDINGS

4.1 Impact of Site B on Bayside (East)

The United Kingdom Health and Safety Executive (UK HSE) has developed operational guidance for land use planning near Large Scale Petrol Storage Sites (LSPSS) [2]. The guidance defines LSPSS as "COMAH upper and lower tier sites[1] where petrol is stored in vertical, cylindrical, non-refrigerated, above ground storage tanks with side walls greater than 5 metres in height, and where the filling rate is greater than 100 cubic metres/hour (unless enclosed overflow systems are provided to take the material to a safe place)."

Vopak's site B3 is a Major Hazard Facility, stores flammable material in above ground storage tanks up to 24 m high, and the proposal seeks to increase filling rates to 1750 m^3/h. It therefore meets the definition of a LSPSS.

In the guidance provided by the UK HSE, the area surrounding LSPSS is subdivided into four zones, as shown in Figure 1. The outer zone, beyond which the UK HSE does not advise against any development, extends 400 m from the tank bund wall.

[1] COMAH upper and lower tier sites are the equivalent of Major Hazard Facilities in Australia

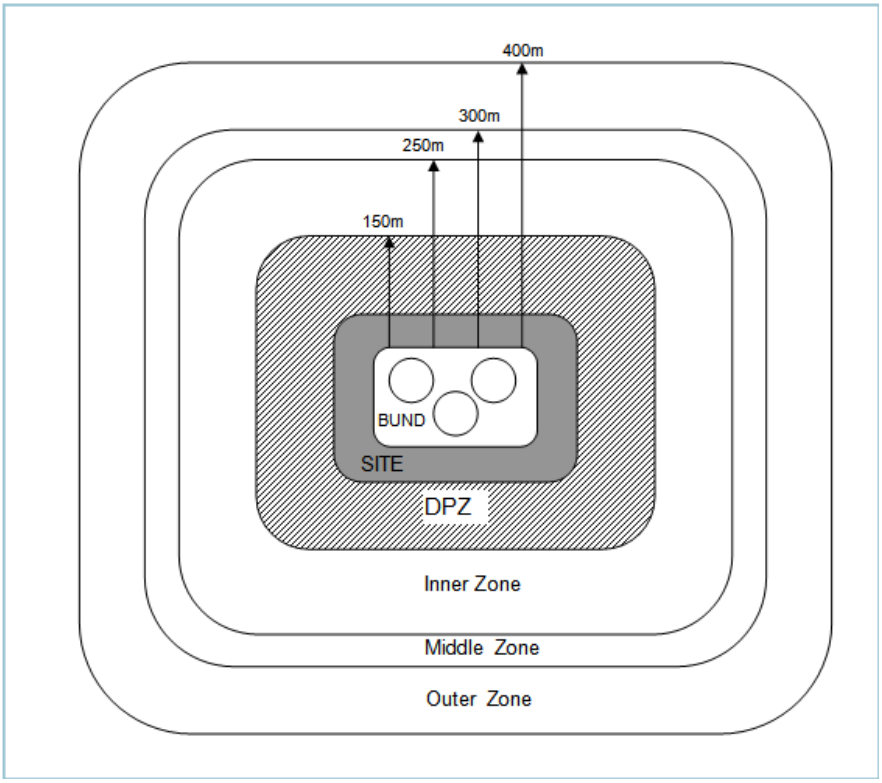

Figure 1: Zones applied in UK HSE planning guidance

The extent of gas cloud dispersion was examined in Appendix D [8] using a technique based on the UK HSE's Vapour Cloud Assessment model [11]. The results, presented in Appendix D [8], Table C.10, indicate the furthest extent of a flammable cloud is 539 m from the centre of the pool of released material.

Figure 2 shows the comparison between the dispersion results for Vopak and the UK HSE Outer Zone that would have been applied to a LSPSS in the UK. The calculated dispersion distance extends beyond the outer zone, indicating the calculation is suitably conservative. Neither the calculated vapour cloud nor the Outer Zone distance encroach the boundary of any Bayside precincts.

Arriscar used information directly from the UK HSE Contract Research Report 908 [12] and process data from Appendix D [8] to confirm the modelling of Sherpa. Calculations are provided in Appendix I of this report. While it is not clear what process temperature was used in the Sherpa modelling, at 28°C Arriscar found the flammable cloud could extend 539 m. This also confirms reasonable modelling of the gas cloud.

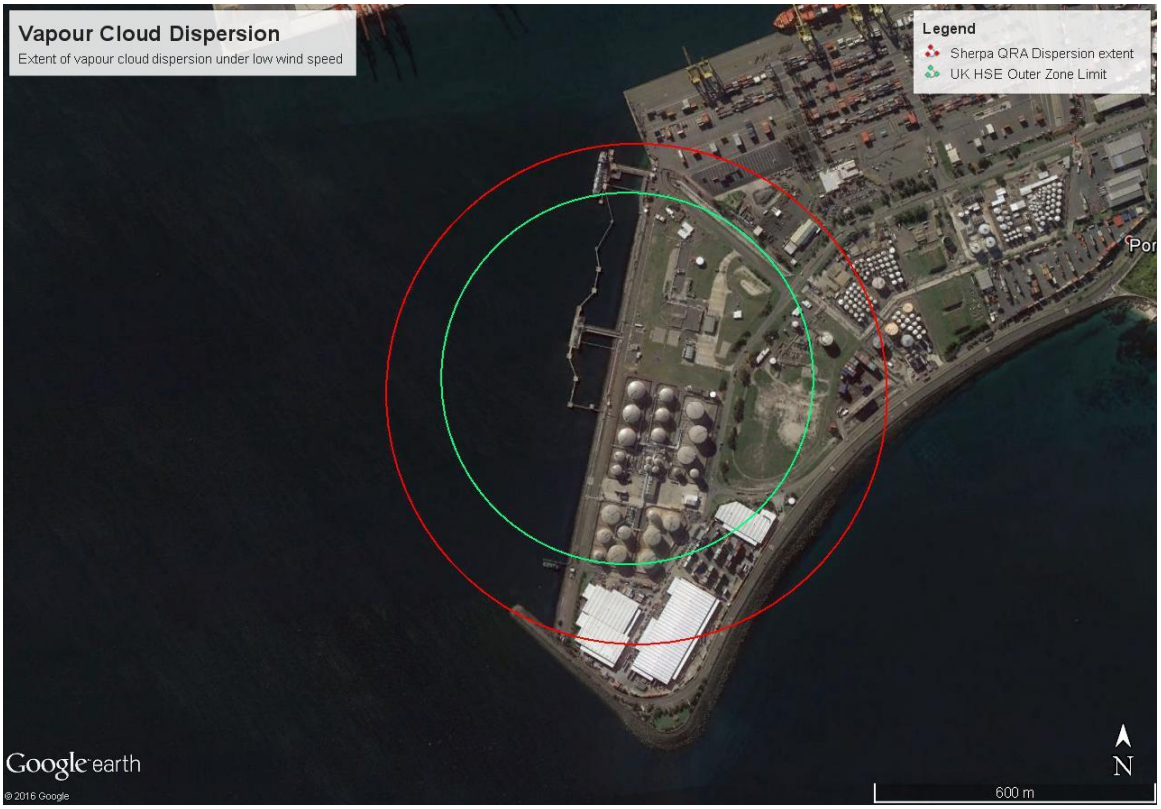

Figure 2: Comparison of QRA worst case tank overfill dispersion results and UK HSE LSPSS Outer Zone

Appendix D [8] also assessed individual risk against the criteria defined in the Hazardous Industry Planning Advisory Paper No. 4 Risk Criteria for Land Use Safety Planning [13] (HIPAP No.4). The results are shown graphically in Figure 3. None of the risk contours corresponding to the criteria in HIPAP No. 4 encroach land within Bayside Council.

Figure 3: Figure 1.2 from Vopak Site B S75W Application QRA, "Individual Risk Contour Projected Future Operation"

4.2 Issues Arising from "Review of Planning Controls: Denison St, Hillside"

The review of planning controls commissioned by the former City of Botany Bay [1] recommended in Section 7.2.4:

a) A Transport Risk Assessment report should be submitted with all future development applications with the potential to directly or indirectly affect DG traffic along Denison Street.

b) The (location-specific) individual fatality risk and societal risk criteria for fixed facilities should be used to assess the risks from the transport of DGs. Established qualitative principles should also be considered.

c) Any proposed changes to the transport of DGs the Study Area (Including new operations or modifications to existing operations), should be assessed individually and in the context of the cumulative risk presented in the most recent available risk assessments for the Study Area (Including the individual and societal from fixed facilities and transport of DGs).

The exhibition includes two documents relating to risks generated by the transport of dangerous goods, Appendix E [9] and Appendix F [10]. Appendix F specifically addresses risk along Denison Street, Hillsdale, and has evaluated the risk using both individual risk and societal risk criteria for fixed facilities in HIPAP No. 4 [13].

The individual risk at different stages, and for both all DG traffic, and limited to VOPAK traffic only is presented in [10]. The individual fatality risk results for existing movements and the 2023 case, as shown in [10] are presented in Figure 4, Figure 5 and Figure 6. The following findings may be drawn:

- The existing individual risk from all DG movements exceeds the residential individual fatality risk criterion provided in HIPAP No. 4 [13]. Individual fatality risk levels in residential areas to the south near Beauchamp Road and north near Wentworth Avenue exceed 1×10^{-6} p.a.
- In 2023, the residential land use individual risk criterion is exceeded on the same basis as above.
- Vopak traffic alone (total Vopak movements in 2023) does not exceed the criteria set out in [13]. Furthermore, as Vopak traffic forms the majority of Class 3 (Flammable Liquids) movements in Denison Street, the majority of risk must be generated by other DG Classes, namely Class 2.1 (Flammable Gases), and Class 2.3 (Toxic Gases). This is explained by the typically greater consequence distances for the latter two DG scenarios as compared to Class 3 fires.

Figure 4: Individual Fatality Risk Results for the Base Case, from all DG movements [10]

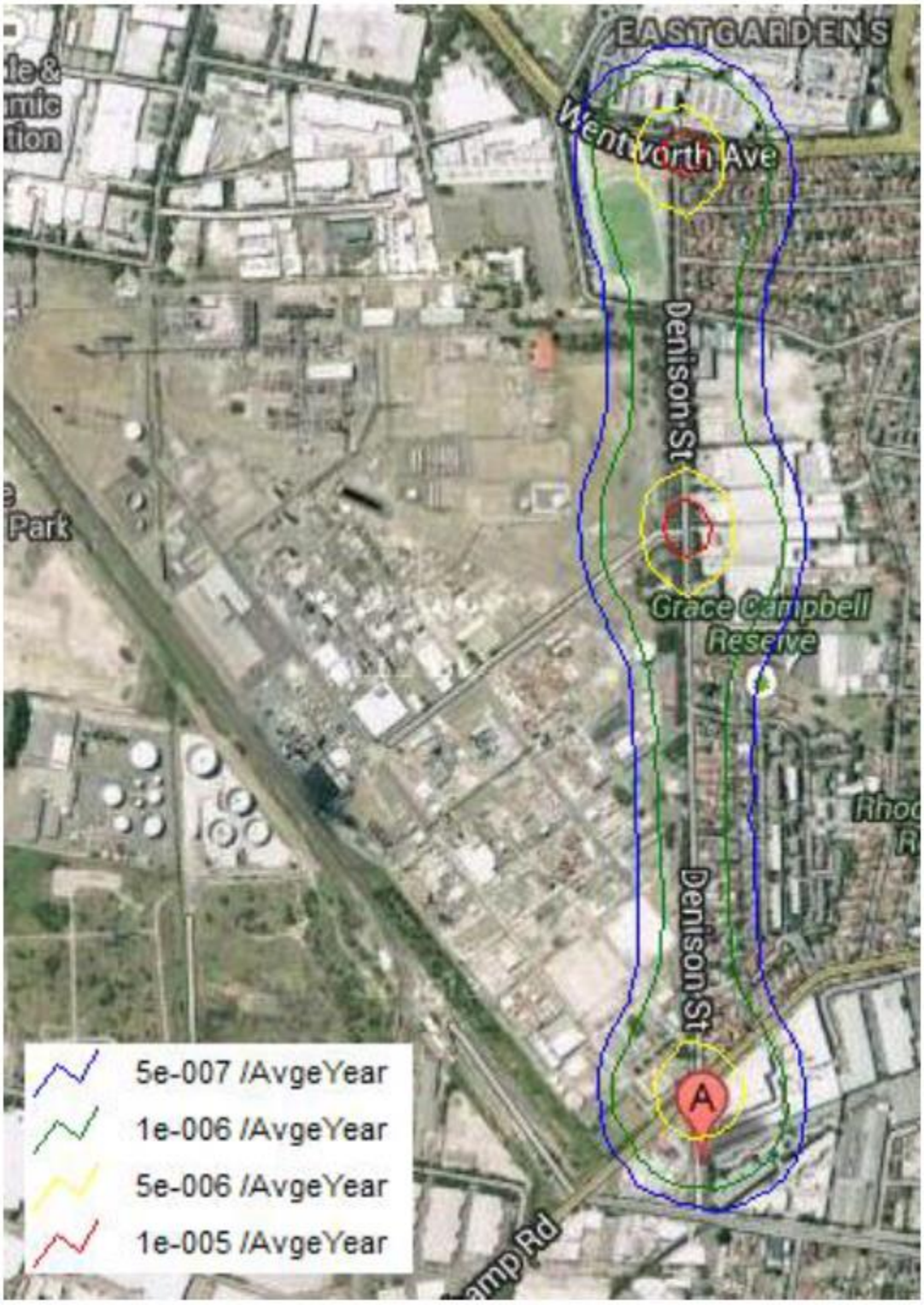

Figure 5: Individual Fatality Risk Results for the Vopak 2023 Case, from all DG movements [10]

Figure 6: Individual Fatality Risk Results for the Vopak 2023 Case, from Vopak's movements only [10]

Appendix F also examined the proposal's impact on societal risk. Societal risk is typically represented as "FN Curves", plots showing the cumulative frequency events causing N or more fatalities.

Figure 7 shows the societal risk for Vopak movements only. From this, it can be shown the scale of the Class 3 scenarios as modelled are small because the number of fatalities is limited to four or less. It should be noted however this is also a result of the calculation technique that assumes a homogenous distribution, based on population data. As per the DP&E guidelines contained in HIPAP N0. 10 [14], the societal risk is below the negligible line, and therefore societal risk is not considered significant if other individual risk criteria are met.

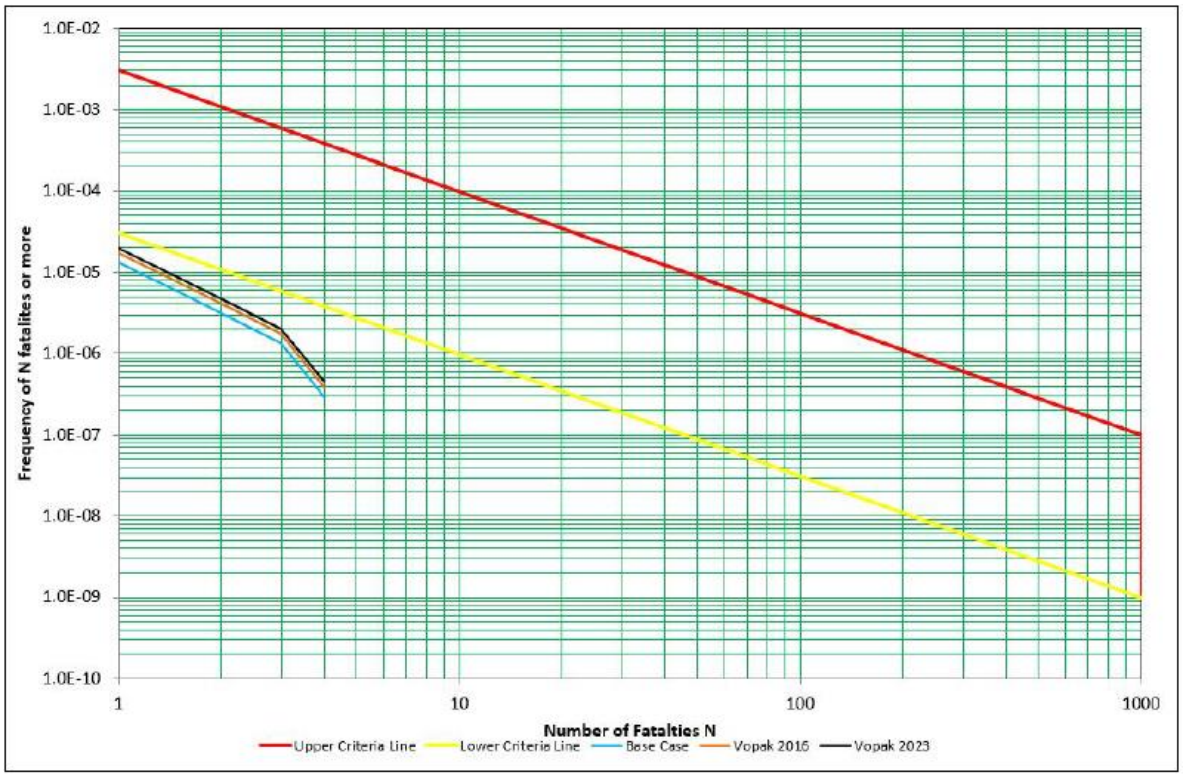

Figure 7: FN Curve for Vopak's tanker movements only [10]

Figure 8 shows societal risk for all DG movements along Denison Street, and confirms the conclusion drawn from Figure 7. Above N= 4 fatalities, the increase in societal risk due to the increase in Vopak movements is barely appreciable.

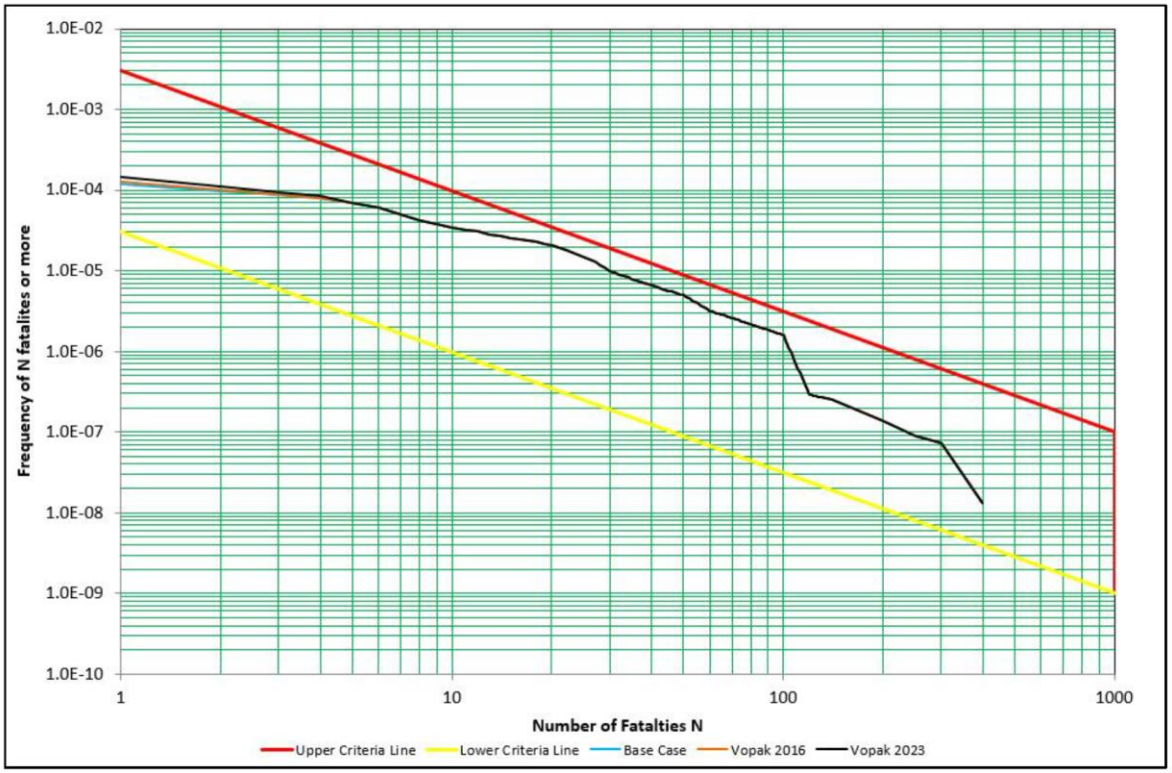

Figure 8: FN Curve for all DG movements on Denison St [10]

Table 1 lists the captions from F-N curves submitted in Appendix F [10]. From the captions of each figure, it is unclear if the contribution of risk from nearby fixed facilities such as the Botany Industrial Park (BIP) has been included in these results. As such, the EA has not addressed item 7.2.4 c) from the Review of Planning Controls [1] .

Table 1: FN curves provided in assessments on exhibition

Figure	Caption
Figure 10	FN Curve for Vopak's tanker movements only
Figure 11	FN Curve for all DG movements on Denison St
Figure 12	FN Curve for all DG movements on Denison St, including the 2015 addendum without the incremental increase in population

4.3 Traffic Data

Three documents ([7], [9], and [10]) on exhibition discuss increased traffic and DG movements related to the proposal. Appendic C [7], Table 3.3, conservatively estimates 36.3 kL per tanker, and the number of tanker loads per day increasing by 98 from 182 to 280 by 2023. Appendix C then determined this results in an additional 196 road trips per day, each load being two trips. Of these 196 trips, [7] estimates this will contribute an additional 20 vehicles per day using the Beauchamp Road / Denison Street route. This includes both full tankers leaving the site, and empty tankers

approaching the site. It follows that the study estimates ten percent of loads will depart the site and take Beauchamp Road / Denison Street.

The ten percent figure is also quoted in [9]. It further clarifies that only 70% of the loads are flammable liquids, the remainder are combustible liquids.

4.4 Consequence Modelling Assumptions

None of the assessments on exhibition relating to DG Transport provide any discussion on consequence analysis. The original Denison Street QRA [3] and the 2016 Amendment [4] are referred to in the Appendix E [9]. Both are available on the former City of Botany Bay's website. These documents refer to release scenarios, release frequencies, and atmospheric conditions used for the modelling, but no summary of consequence data.

HIPAP No. 6 [15] states "Consequence analysis results should be presented in sufficient detail to provide a good appreciation of the consequences of the hazardous incidents identified for further analysis.", and further "Information regarding inputs and relevant assumptions should also be presented in sufficient detail to allow regulatory bodies to assess and validate calculations.".

Appendix F [10] claims the increase in DG movements along Denison Street results in a marginal increase in fatality risk close to the Denison Street, and no impact for the far field. This is due to the relatively small consequence distances for Class 3 flammable liquid pool fires compared to consequence distances for LPG jet fires and flash fires, and toxic dispersion of Class 2.3 DG. Arriscar considers the conclusion reasonable, but notes that the only evidence Appendix F provides to substantiate the claim is inference from final Individual Fatality Risk contours and F-N Curves.

4.5 Other

The DG Transport QRA (Appendix E) [9] discusses risk reductions measures, and concludes that the contribution to risk from Vopak activities is relatively minor, and the only effective measures would need to include industry wide measures.

There is no discussion of alternative roots or limiting traffic, but these options are problematic:

1. Section 32 of the Ports Assets (Authorised Transactions) Act 2012 makes any planning control that limits cargo throughput for Port Botany
2. From Figure 9, Denison Street is the only heavy vehicle route northeast without travel conditions. The only other alternative is to take Foreshore Road to General Holmes Drive, Botany Road, Mill Pond Road, Botany Road and finally right into Wentworth Avenue. This adds considerable distance and is counterproductive in that it forces DG vehicles past more residential areas.
3. Any such control is difficult to monitor and enforce

Figure 9: Heavy Vehicle Routes

5 CONCLUSIONS

Consequence distances for tank overflows do not extend to Bayside Council precincts, and risk contours corresponding to criteria in HIPAP No. 4 do not extend to Bayside Council precincts.

The EA clearly addresses one of the requirements in Section 7.2.4 of the Review of Planning Controls: Denison St, Hillside [1]. It is unclear if Appendix F [10] has considered the cumulative impact of DG Transport and risk arising from nearby fixed facilities, as recommended in Review of Planning Controls: Denison St, Hillside. This is important information for Bayside Council so that the planning scheme for the area may be updated to implement NSW DP&E policy regarding land use safety planning.

As scenarios involving Class 3 DGs have a minor contribution to the total risk, it is unlikely that the recommendations from the review of planning controls [1] will need changing.

Neither of the documents on exhibition relating to DG movements [9] [10] provide the consequence result detail required by HIPAP No. 6 to provide an appreciation of the consequences of hazardous events, and thereby demonstrate claims about limited impact.

6 RECOMMENDATIONS

Bayside Council could make the following comments in a submission and request further information:

- The QRA of DG Movements on Denison Street (Appendix F) does not provide the consequence analysis detail required by HIPAP No.6 *Hazard Analysis* for a full appreciation of the consequences of hazardous events. As such, the accuracy and conclusions of the Appendix cannot be verified.
- The proponent confirms if the cumulative effect of both fixed installations and DG transport was considered in Appendix F, and provide the information if it has been omitted. This is to enable the council review its own planning scheme near Denison Street based upon total risk in the area.

7 REFERENCES

[1] Arriscar Pty Limited, “Review of Planning Controls, Denison St, Hillsdale,” 2016.

[2] United Kingdom Health and Safety Executive, “Land use planning advice around large scale petrol storage sites,” [Online]. Available: http://www.hse.gov.uk/foi/internalops/hid_circs/technical_general/spc_tech_gen_43/. [Accessed 1 February 2017].

[3] Scott-Lister, “Dangerous Goods Transport QRA, Denison Street, Hillsdale,” 2015.

[4] Scott-Lister, “Addendum To Dangerous Goods Transport QRA, Denison St, Hillsdale,” 2016.

[5] “Vopak Bulk Liquids Facility - Port Botany SIte B3, Increase Capacity (06_0089 MOD 2),” [Online]. Available:

http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=7122. [Accessed 2 February 2017].

[6] PlanCom Consulting Pty Ltd, "Section 75 W Modification MP 06_0089 - Modification 2 Environmental Assessment," 2016.

[7] Samsa Consulting Pty Ltd, "Vopak Site B Expansion, Port Botany, Traffic Impact Assessment," 2016.

[8] Sherpa Consulting Pty Ltd, "Site B Proposed Throughput Increase S75W Application for Expansion Quantitative Risk Assessment Rev 2," 2015.

[9] Sherpa Consulting Pty Ltd, "Site B Proposed Throughput Increase S75W Application for Expansion Dangerous Goods Road Transport Quantitative Risk Assessment Rev 4," 2016.

[10] Systra - ScottLister, "VOPAK Port Botany Expansion – Denison Street Transport QRA – July 2016 Update Rev 4," 2016.

[11] Fire and Blast Information Group, "Technical Note 12 – Vapour Cloud Development in Over-filling Incidents," 2013.

[12] Health and Safety Laboratory, "Vapour cloud formation: Experiments and modelling," 2012.

[13] NSW Department of Planning, Hazardous industry Planning Advisory Paper No. 4 - Risk Criteria for Land Use Safety Planning, Sydney: State of New South Wales, 2011.

[14] NSW Department of Planning, "Hazardous Industry Planning Advisory Paper No. 10 - Land Use Safety Planning," 2011.

[15] NSW Department of Planning, Hazardous Industry Planning Advisory Paper No. 6 - Hazard Analysis, Sydney, NSW: State of New South Wales, 2011.

Appendices

Appendix I Low Wind Speed Flammable Cloud Dispersion

Calculation following method described in [12].

Known inputs:	
Tank Diameter(m), $D = 37.75$ Tank Height (m), $H = 24$ Fuel Flowrate (kg/s), $F = 365$ Fuel Temperature (°C), $T_{fuel} = 28$ Ambient Air Temperature (°C), $T_{ambient} = 20$ Duration of release (s), $t = 1800$ Air density (kg/m^3), $\rho_{ambient} = 1.28$	All values apart from T_{fuel} and $\rho_{ambient}$ taken from [8], Table C.10.
Equation	Calculated value.
Rate of air entrained in cascade (kg/s) $\dot{M}_{air} = 90\left(\frac{D}{25}\right)^{0.75}\left(\frac{H}{10}\right)^{0.45}\left(\frac{F}{115}\right)^{0.25}$	242.6437
Concentration of cloud at foot of tank (% w/w) $C_{fuel} = 17\left(1.28\frac{\dot{M}_{air}}{F}\right)^{-0.42} e^{0.011(T_{fuel}-10)} e^{0.0062(T_{ambient}-10)}$	23.59464
Rate of hydrocarbon vaporised into cloud (kg/s) $\dot{M}_{vaporised} = \dot{M}_{air}\frac{C_{fuel}}{100 - C_{fuel}}$	74.93048
Rate of hydrocarbon splashed into cloud (kg/s) $\dot{M}_{splash} = 0.02F$	7.3
Total rate of addition to cloud, including air (kg/s) $\dot{M}_{cloud} = 2\left(\dot{M}_{air} + \dot{M}_{vaporised} + \dot{M}_{splash}\right)$	649.7484
Volume growth of cloud (m^3/s) $\dot{V}_{cloud} = \frac{\dot{M}_{cloud}}{\rho_{ambient}}$	507.3544
Concentration of fuel in vapour cloud (kg/m^3)	0.162077

$C_{cloud} = \frac{\dot{M}_{vaporised} + \dot{M}_{splash}}{\dot{V}_{cloud}}$	
Range after 1800s to which cloud may hinder escape (m) $R_{escape} = \sqrt{\frac{\dot{V}_{cloud} t}{2\pi}}$	381
Range after 1800s to which low level cloud may be ignited (m) $R_{ignition} = \sqrt{\frac{V_{cloud} t}{\pi}}$	539