

**WESTFIELD
EASTGARDENS**

20/02/2019

QUANTIFIED RISK ASSESSMENT



WESTFIELDS EASTGARDENS

QUANTIFIED RISK ASSESSMENT

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1. INTRODUCTION AND SCOPE OF REPORT

1.1 Background

Scentre Group operate, manage and co-own the Westfield Eastgardens Shopping Centre with co-owners Terrace Tower Group. Westfield Eastgardens Shopping Centre (the site) is located at 152 Bunnerong Road, Eastgardens, NSW 2036.

Scentre Group seeks to initiate the preparation of an amendment to the Botany Bay Local Environmental Plan 2013 (BBLEP) as it applies to the Site. In order to do so Bayside Council (the “Council”) need to prepare a Planning Proposal to amend the planning controls at the Site in accordance with Section 3.33 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

Proposed Development Vision

The ‘Vision’ for the Westfield Eastgardens redevelopment is to create a mixed use town centre through introducing new land use such as commercial office, and extending the depth of the retail offer into new categories including casual dining, restaurants, entertainment, gym, beauty and wellness, and additional services such as childcare and medical. The existing bus interchange will be upgraded through additional capacity and an improved customer experience. The proposed scheme responds to the evolving needs and behaviours of the community, and will assist in the creation of jobs and strengthening the economic role of the centre.

Proposed LEP Amendment

To Facilitate this vision, it is intended to amend the BBLEP 2013 as follows:

- Floor Space Ratio: Introduce a new maximum allowable floor space ratio (FSR) of 1.85:1
- Height of Buildings: Introduce a new maximum allowable building height of Part 34m / Part 40m / Part 70m.

Scentre Group had originally proposed to redevelop the site to increase the floor area (GFA) from 95,500 sqm to 155,500 sqm, with associated increases in patronage. They are now proposing increasing the GFA from 99,400 sqm to 171,700 sqm. The current land use zoning of Commercial Core remains unchanged.

The revised scheme for the site seeks to introduce an increase in floor space at the centre by approximately 72,300 sqm of Gross Floor Area (GFA) of which approximately 37,500 sqm (GFA) would be for retail purposes and 34,800 sqm (GFA) would be for a new commercial building. An increase in car parking will also be provided at the site to support the expanded centre.

	GFA	
	Previous Sysstra report	Feb 2019 re-submission
Existing	95,500 sqm	99,400 sqm
Incremental Retail	+60,000 sqm	+37,500 sqm
Incremental Office	-	+34,800 sqm
Sub-total incremental	+60,000 sqm	+72,300 sqm
Total GFA on completion	155,500 sqm	171,700 sqm
Land size	92,900 sqm	92,900 sqm
FSR	1.67x (1.70x rounded)	1.85x

Table 1 Planned Floor Area Increases

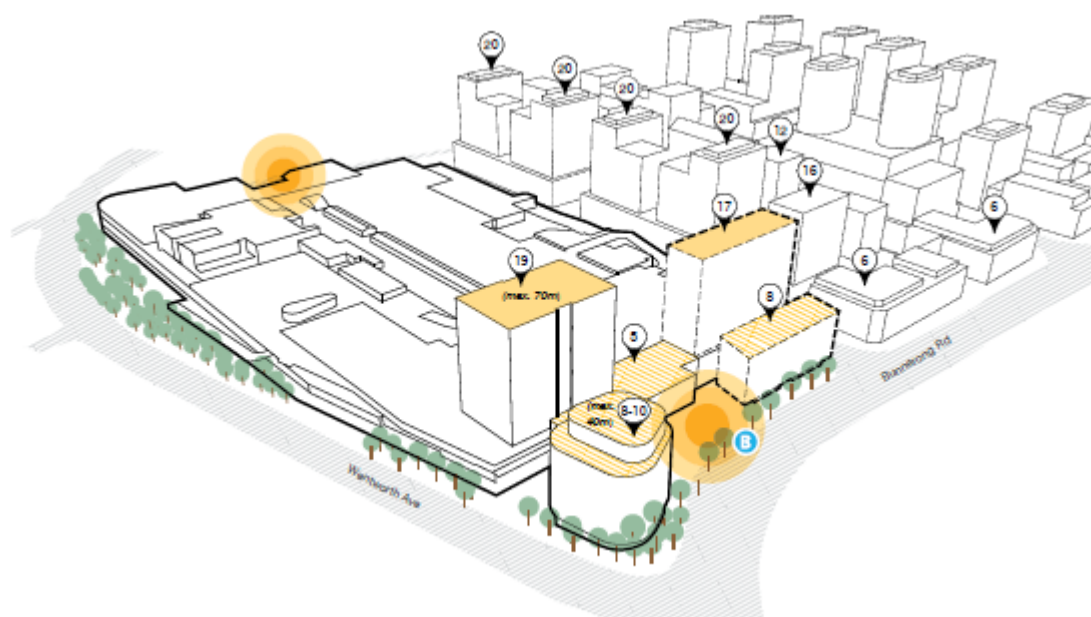


Figure 1: Westfield Eastgardens – Proposed masterplan concept

Dangerous Goods Risks

The Eastgardens site is exposed to risk from the Dangerous Goods route running along Denison St, Wentworth St and Bunnerong Road. These risks have been analysed by the initial report by Systra Scott Lister.

The area of Port Botany is undergoing substantial change, with many industries in decline or ceasing operations. This offers opportunities for re-development but can identify conflicts with incumbent industries and port operators desire to remain unconstrained by further residential or commercial development.

The suitability of sensitive developments such as residential in proximity to major industrial hazards such as the Botany Industrial Precinct (BIP) and Port Botany is determined by planning authorities such as Bayside Council and the DPE. Such authorities follow policy of the State Environmental Planning Policy (SEPP) which refers to risk based criteria for the suitability of sensitive developments near major hazards (expressed in documents such as HIPAP 4).

A review of the re-development plans has been performed by council which included the original Systra Scott Lister report on risks to the development from Dangerous Goods traffic coming from Denison St. Council engaged Arriscar Pty Ltd to perform the review. Arriscar are very familiar with the Dangerous Goods model developed by Systra Scott Lister as they have previously performed work with the model under contract from Systra Scott Lister. Additionally in 2016, Arriscar undertook a review of land use safety planning controls due to the proximity of the Botany Industrial Park (BIP) and the transport of Dangerous Goods (DGs) along Denison Street, for Bayside Council. This review drew heavily on the Systra Scott Lister assessments for Bunnings and other developments around Denison St.

In their review Arriscar has raised a number of recommendations to the original report for the Eastgardens re-development. These mainly regard documentation of assumptions, the presentation of results with regard to DPE risk criteria and contributors to fatality risks at the Eastgardens site.

The report makes a number of recommendations, which are reproduced below:

1. Refer to the Department of Planning for an interpretation of 'incremental risk' in societal risk assessment for new developments near major hazard facilities. This will assist in risk criteria compliance with HIPAP No.4.
2. The risk assessment must be updated to account for an increase in building height up to 70m, taking into account the building wake effects in the dispersion calculations. The report must also provide consequence results of incidents at the corner of Wentworth Avenue and Denison Street. Currently Ref.2 does not have consequence calculation results.
3. The existing cumulative F-N curve must be compared with an updated F-N curve including the population from the proposed future development at East Gardens to assess the impact of incremental risk. If the overall F-N curve including the proposed development exceeds the upper limit, the development clearly exceeds acceptable land use safety for the location.

4. The Planning Safety Report must be updated to address (a) risk contributors to the incremental risk and rank them (b) assumed population distribution of the 1640 persons (c) whether the risk was assessed for persons inside and outside the building, and at different levels in the building, and (d) how the risk mitigation in design suggested in Ref.1 have been addressed in the incremental risk assessment.
5. If the updated F-N curve for the area still falls within the ALARP and the incremental risk is deemed marginal, the development cannot be precluded.
6. The emergency response plan for the Westfield East Gardens complex must include response to a dangerous goods transport accident near the intersection of Denison Street and Wentworth Avenue.
7. There must be a public address system in the East Gardens Complex to notify shoppers of the actions to take in the event of a dangerous goods transport accident that may affect the car park on Wentworth Avenue.

Recommendation 5 is just a restatement of the HIPAP 4 and HIPAP 10 criteria. Recommendations 6 and 7 are sensible emergency management provisions that can be integrated in the centre's future emergency management plans. As such recommendations 5, 6 and 7 are not discussed further.

Scentre Group has asked Systra Scott Lister to update the original report to reflect the updated re-development scheme and to address the applicable comments from the Arriscar report. This study addresses those two requests.

1.2 Scope

The scope of this report is to use models available to Systra Scott Lister on risks presented by the BIP and DG transport on Wentworth Avenue and how they impact on the proposed redevelopment on the site. This involves the following tasks;

- Update the societal risk model with the new concept for the development,
- Add the risk increment to the cumulative societal risk for all populations in the study area. Compare the resulting FN curve with the upper limit of the DPE societal risk criteria,
- Present societal risk contributors to the incremental risk of the development,
- Document the assumed population distribution of the additional populations on site (was previously 1,640),
- Document how populations were located on different levels of the building and if they were indoors or outdoors,
- Document how the risk mitigation in design suggested in the original study have been addressed in the incremental risk assessment
- Update the report conclusions.

1.3 Assumptions and Limitations

The concept scheme and design drawings relied upon by SSL have been supplied by Scentre Group. This data is presented in Appendix A – Master Plan. Calculations of expected populations and where they are located are presented in Appendix B.

The following parameters apply to the assessment:-

1. Generally the assessment follows a Level 3 Risk methodology laid done in the NSW DP&E Multi-Level Risk Assessment (Ref 1)
2. Risk Inputs are taken from the SHERPA 2012 BIP QRA study (Ref 2), and models developed by Scott Lister for Dangerous Goods transport along Denison St.
3. The Risk review does not consider natural hazards, or chronic health risk issues, and only covers acute risks as a result of an industrial incident (e.g. tank release at the BIP) as defined in item 2 above.

2. OVERVIEW OF THE SITE MASTERPLAN

The redevelopment of the Eastgardens site will lift the GFA from 99,400 sqm to 171,700 sqm and will realise an average population increase from around 3,200 to around 5,800 when fully developed. (See Appendix B for details).

2.1 Site Location, Zoning and Surrounding Land Uses

The Westfield Eastgardens site sits within the B3 Commercial Core (coloured light blue) under the *Botany Bay Local Environmental Plan 2013* (Botany LEP).

This area lies outside of the Pert SEPP zone IN1 - General Industrial under SEPP (3 Ports) 2013 (coloured Purple) as shown in Figure 2. (Taken from Local Environmental Plan Land Zoning Map LZN 005 9th October 2015 (current version)).

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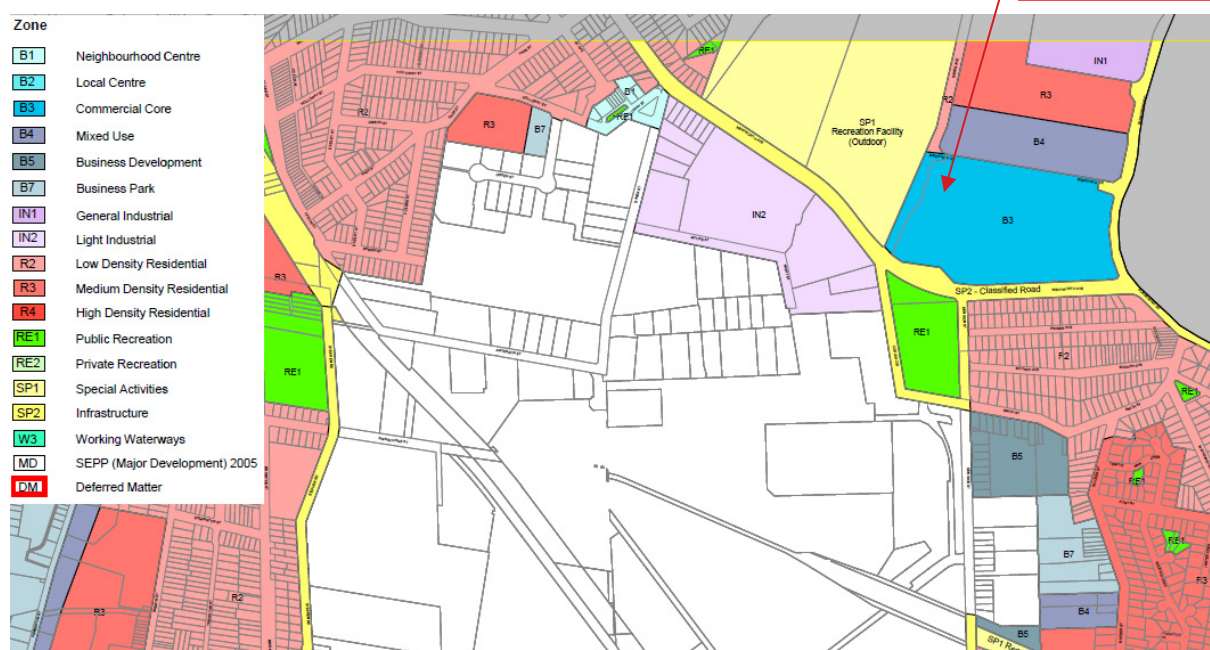


Figure 2 Zoning Map

The site is situated along Wentworth Ave, adjacent to the Hensley Athletic Field to the South, and Bonnie Doon Golf Club and Much Park to the West

3. PROPOSAL DESCRIPTION

Scentre Group propose a mix of commercial and retail development as summarised Table 2, with an existing average population of around 3,200 persons, that will increase to around 5,800 persons when fully developed. The concept scheme proposes new retail within the existing footprint of the Level 2 car park, a new vertical fresh food, casual dining and restaurant precinct on the Western edge of the site, and two new commercial buildings on the Bunnerong Road edge, above a redeveloped bus interchange and new public plaza.

It should be noted that for the existing retail areas it is not the same 3,200 people each hour, and neither is it the same 3,200 each day. A shopping centre has a complete spread of visitation, from weekly shoppers to those who only attend for one-off Christmas shopping. This stands in contrast to say a residential area, where it is largely the same group of people day to day. Hence considerations of individual risk should take into account this low exposure per person.

Area	GFA (m2)	Population assumption
Existing	99,400	3,200
Incremental Retail	37,500	1,207
Incremental office	34,800	1,373
Total on completion	171,700	5,780 (say 5,800 rounded)

Table 2 Site Development Areas and Estimated Populations

Further details on how these have been determined are provided in Appendix B.

4. RISK ASSESSMENT FRAMEWORK

4.1 NSW Risk Criteria for Hazardous Industries

To keep communities and hazardous industry sufficiently separated the NSW Department of Planning & Environment (NSW DP&E) has developed planning controls based on an assessment of hazards and risks. The NSW DP&E has formulated and implemented risk assessment and land use safety planning processes that account for both the technical and the broader locational safety aspects of potentially hazardous industry. These processes are implemented as part of the environmental impact assessment procedures under the Environmental Planning and Assessment Act 1979 and include the following planning guidelines;

- State Environmental Planning Policy (SEPP) 33 - provides an approach to determine whether industries are to be considered hazardous or offensive , and the level of information required to be submitted to planning authorities to allow a suitable determination to accept or reject the proposal
- HIPAP Series of documents (1 through 10) – In particular HIPAP 4 sets out the Individual and Societal risk criteria relevant to hazardous industries and surrounding land uses.
- Multilevel risk assessment – sets out the appropriate level of detail for a risk assessment study

4.2 Individual Risk

HIPAP 4 sets out the Individual and Societal risk criteria relevant to hazardous industries and surrounding land uses. 'Individual fatality risk' is the risk of death to a person at a particular point if they were to remain there for a year. Table 2 indicates a range of various risks to which people are exposed as the result of various activities.

Consideration of such risks led the department to conclude that if a risk from a potentially hazardous installation is below most risks being experienced by the community, then that risk may be tolerated. This is consistent with the basis of criteria setting used in HIPAP 4 (ref 4), as well as those adopted by most authorities nationally and internationally.

The department has adopted a fatality risk level of one in a million per year (1×10^{-6} per year) as the limit for risk acceptability for residential area exposure. This risk criteria has been adopted by the department when assessing the safety implications of industrial development proposals and when advising on land use proposals in the vicinity of a hazardous industry.

Experience with implementation indicates that the criteria is practical and appropriate, and as such should be maintained. It is necessary, however, to account for variations in the duration of exposure to that risk at any particular point by any one individual. It is also necessary to account for variations in people's vulnerability to the hazard and their ability to take evasive action when exposed to the hazard.

The one in a million criterion assumes that residents will be at their place of residence and exposed to the risk 24 hours a day and continuously day after day for the whole year. In practice this is not the case and this criterion is therefore conservative.

People in hospitals, children at school or old-aged people are more vulnerable to hazards and less able to take evasive action, if need be, relative to the average residential population. A lower risk than the one in a million criterion (applicable for residential areas) may be more appropriate for such cases. On the other hand, land uses such as commercial and open space do not involve continuous occupancy by the same people. The individual's occupancy of these areas is on an intermittent basis and the people present are generally mobile. As such, a higher level of risk (relative to the permanent housing occupancy exposure) may be tolerated. A higher level of risk still is generally considered acceptable in industrial areas.

Accordingly, the following risk assessment criteria are used by the NSW DP&E and planning authorities for the assessment of the safety of location of a proposed development of a potentially hazardous nature, or the land use planning in the vicinity of existing hazardous installations (such as the BIP) :

- (a) Hospitals, schools, child-care facilities and old age housing development should not be exposed to individual fatality risk levels in excess of half in one million per year (0.5×10^{-6} per year).
- (b) Residential developments and places of continuous occupancy, such as hotels and tourist resorts, should not be exposed to individual fatality risk levels in excess of one in a million per year (1×10^{-6} per year).
- (c) Commercial developments, including offices, retail centres, warehouses with showrooms, restaurants and entertainment centres, should not be exposed to individual fatality risk levels in excess of five in a million per year (5×10^{-6} per year).
- (d) Sporting complexes and active open space areas should not be exposed to individual fatality risk levels in excess of ten in a million per year (10×10^{-6} per year).
- (e) individual fatality risk levels for industrial sites at levels of 50 in a million per year (50×10^{-6} per year) should, as a target, be contained within the boundaries of the site where applicable.

Table 3 summarises the preceding criteria for the various categories of land use.

Land Use	Suggested Criteria
	(risk in a million per year)
Hospitals, school, child-care facilities, old age housing	0.5
Residential, hotels, motels, tourist resorts	1
Commercial developments including retail centres, offices and entertainment centres	5
Sporting complexes and active open space	10
Industrial	50

Table 3 Individual Risk Criteria

4.3 Injury & Irritation Criteria

Relying entirely upon fatality risk criteria may not account for the following factors:

- Society is concerned about risk of injury as well as risk of death.
- Fatality risk levels may not entirely reflect variations in people's vulnerability to risk.

Some people may be affected at a lower level of hazard exposure than others. It is therefore appropriate that risk criteria also be set in terms of injury, i.e. in terms of levels of effects that may cause injury to people but will not necessarily cause fatality.

The suggested injury risk criteria from HIPAP 10 of the NSW DP&E are:

- Incident heat flux radiation at residential and sensitive use areas should not exceed 4.7 kW/m² at a frequency of more than 50 chances in a million per year.
- Incident explosion overpressure at residential and sensitive use areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year.
- Toxic concentrations in residential and sensitive use areas should not exceed a level which would be seriously injurious to sensitive members of the community following a relatively short period of exposure at a maximum frequency of 10 in a million per year.
- Toxic concentrations in residential and sensitive use areas should not cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community over a maximum frequency of 50 in a million per year.

4.4 Societal Risk

Developing criteria on tolerability of risks for hazards giving rise to societal concerns is difficult. Hazards giving rise to such concerns often involve a wide range of events with a range of possible outcomes. The summing or integration of such risks, or their mutual comparison, may call for the attribution of weighting factors for which, at present, no generally agreed values exist as, for example, the death of a child as opposed to an elderly person, dying from a dreaded cause, e.g., cancer, or the fear of affecting future generations in an irreversible way.

Nevertheless, the Department has provisionally adopted indicative criteria as shown in Figure 3 for addressing societal concerns arising when there is a risk of multiple fatalities occurring in one event. These were developed through the use of so-called FN-curves (obtained by plotting the frequency at which such events might kill N or more people, against N). The technique provides a useful means of comparing the impact profiles of man-made accidents with the equivalent profiles for natural disasters with which society has to live. The suggested criteria take into account the fact that society is particularly intolerant of accidents, which though infrequent, have a potential to create multiple fatalities. The indicative societal risk criteria reflect these regions as three societal risk bands: negligible, ALARP and intolerable.

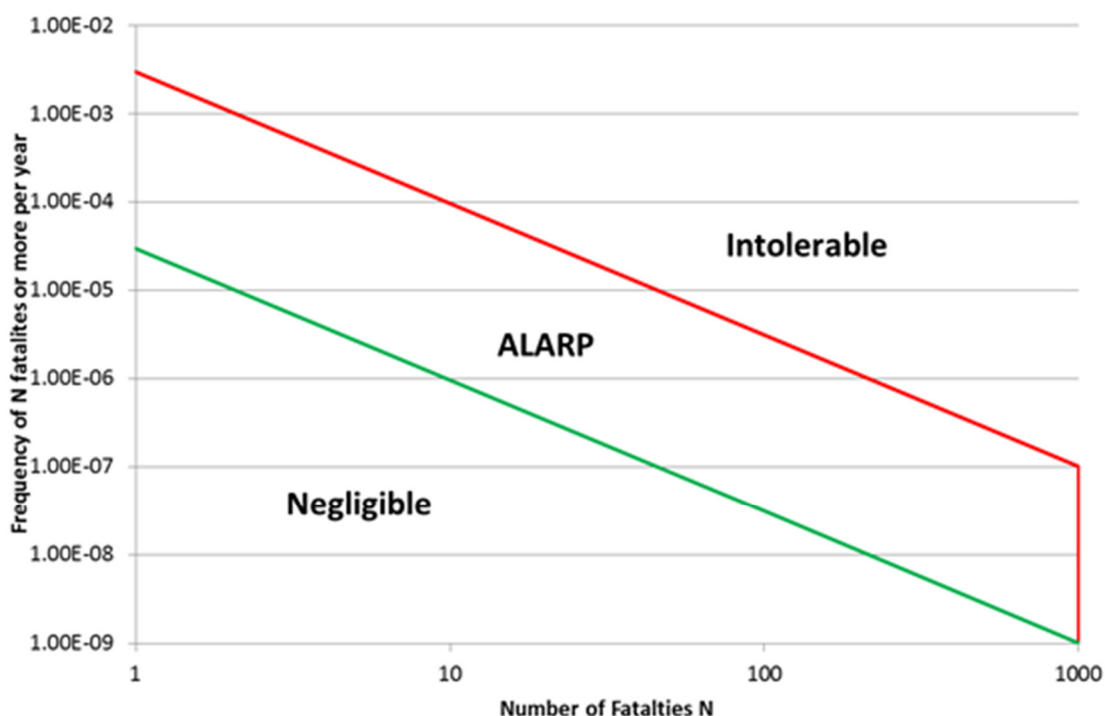


Figure 3 DPE Interim Societal Risk Criteria

Below the negligible line, provided other individual criteria are met, societal risk is not considered significant. Above the intolerable level, an activity is considered undesirable, even if individual risk criteria are met. Within the ALARP region, the emphasis is on reducing risks as far as possible towards the negligible line. Provided other quantitative and qualitative criteria of HIPAP 4 are met, the risks from the activity would be considered tolerable in the ALARP region.

4.5 Risk Criteria for Development in the Vicinity of Potentially Hazardous Facilities

4.5.1 Individual risk

The suggested risk assessment criteria outlined in section 4 apply when assessing the land use safety implications of industrial development of a potentially hazardous nature. There are also similar criteria for land use planning and development in the vicinity of existing potentially hazardous facilities.

While existing industry should ideally meet the same residential and sensitive land use criteria as new proposals, it is recognised that this may not be possible in practice. The following principles apply to residential and sensitive use development in the vicinity of existing industry:

- the half in a million per year individual fatality risk level is an appropriate criterion above which no intensification of sensitive use development should take place;
- the one in a million per year individual fatality risk level is an appropriate criterion above which no intensification of residential development should take place;
- residential intensification may be appropriate where mitigating measures can be implemented to reduce risk exposure to less than the one in a million per year individual fatality risk level, provided the pre-mitigation residual risk levels are below the 10 in a million per year individual fatality risk level; and
- no residential intensification should take place where pre-mitigation residual risk levels are in excess of the 10 in a million per year individual fatality risk level.

The injury and irritation individual risk criteria from Section 4 also apply for developments in vicinity of existing industrial hazards.

4.5.2 Societal Risk

In accordance with HIPAP 4, when there is a significant intensification of population around an existing hazardous facility the incremental societal risk must be assessed.

HIPAP 4 suggests that for a new development in proximity to a major hazard that

“... where a development proposal involves a significant intensification of population in the vicinity of such a facility, the change in societal risk needs to be taken into account, even if individual risk criteria are met.

Examples of such situations would include medium to high density residential development (although this would not normally be considered to be appropriate in such a location), sporting facilities where large numbers of spectators are likely to be present and shopping complexes.

In such instances, the incremental societal risk should be compared against the indicative criteria of Figure 3. Provided the incremental societal risk lies within the negligible region, development should not be precluded. If incremental risks lie within the ALARP region, options should be considered to relocate people away from the affected areas. If, after taking this step, there is still a significant portion of the societal risk plot within the ALARP region, the proposed development should only be approved if benefits clearly outweigh the risks."

This suggested criteria is ambiguous on whether the incremental societal risk is for the development on its own, or the total societal risk with the additional population.

4.6 Botany Industrial Park (BIP) Risk Assessment

The Botany Industrial Park (BIP) is a large integrated petrochemical and chemical manufacturing complex located at Matraville, NSW (formerly ICI Australia). Multiple companies own and operate plants at the site. Facilities include Chloralkali, operated by Orica, an Olefines plant and plastics manufacturing plants operated by Qenos, and a Surfactants Facility operated by Huntsman. Utilities and other services support these plants. There are also a number of remediation processes occurring at the site to clean up land portions known to be contaminated. However, The Botany Industrial Park (BIP) is undergoing substantial change, with many industries in decline or ceasing operations as chemical manufacturing moves offshore.

The BIP has a residential area immediately to the east along Denison St, and in all other directions adjoins industrial or commercial land uses. A cumulative Quantitative Risk Assessment (QRA) drawing on detailed design information and the results from previous risk studies has been prepared at the request of the NSW DP&E by SHERPA Engineering (Ref 6) for the operating facilities at the BIP. This study currently forms the land use safety study used to make decisions on the suitability of development proposals in the area.

The QRA focused on the effects of potential major accident scenarios and atypical events with the potential to have impacts outside the BIP site boundary. It does not cover long-term or chronic impacts or continuous small emissions. These are addressed via other mechanisms such as environmental protection licences, site remediation action plans and occupational health and safety management regulations.

SHERPA used TNO Riskcurves version 7.0 a to generate the individual fatality risk, injury and irritation risk, property damage risks and societal risk results as required by the condition of consent.

In broad terms, risk was estimated quantitatively by:

- identifying hazardous incident / release scenarios.
- estimating the physical consequences, i.e. the extent of fire, explosion or toxic release, and the associated impact on people for the defined release scenarios due to heat radiation from fire events, explosion overpressure or acute toxic exposure.
- combining the consequence and impact results with incident frequency information, plant grid information and population data to determine risk.

For this QRA, the results of the risk calculations have been presented in four forms:

- **Individual Fatality Risk:** the likelihood of fatality to notional individuals at locations around the site, as a result of the defined fire / explosion and toxic gas release scenarios. This is shown as contours on a map of the area. The units for individual risk are probability (of fatality) per million per year. By convention it is assumed that people are located outdoors, are always present and take no evasive action if an incident occurs. The results are presented cumulatively for all fire/explosion and toxic gas impacts in Figure 4.1

- **Injury and Irritation Risk:** is the likelihood of injury or irritation to individuals at locations around the site as a result of the same scenarios used to calculate individual fatality risk. As for individual risk, evasive action is not allowed for. Results are presented as contours and are shown separately for fire/explosion injury at 50×10^{-6} per year (Figure 4.2 & 4.3), and toxic injury and irritation impacts, as there are different criteria for flammable and toxic gas exposures.

- **Escalation / Property Damage:** is the likelihood of property damage occurring to surrounding facilities as a result of exceeding threshold levels of heat radiation or overpressure. Results are presented as risk contours.

- **Societal Risk:** takes into account the number of people exposed to risk. Whereas individual risk is concerned with the risk of fatality to a (notional) person at a particular location (person 'most at risk'), societal risk considers the likelihood of actual fatalities among people exposed to the hazard and allows mitigating effects such as probability of presence, whether they are located inside or outside etc., to be accounted for, hence requires population data as an input. Societal Risk results are presented in Figure 4.6.

5. BIP RISK ASSESSMENT FINDINGS

The concept risk assessment results are presented in this section for the Eastgardens Redevelopment.

5.1 BIP Individual Risk

The individual risk contours arising from the BIP development to the south of the Eastgardens site are presented as Figure 4.

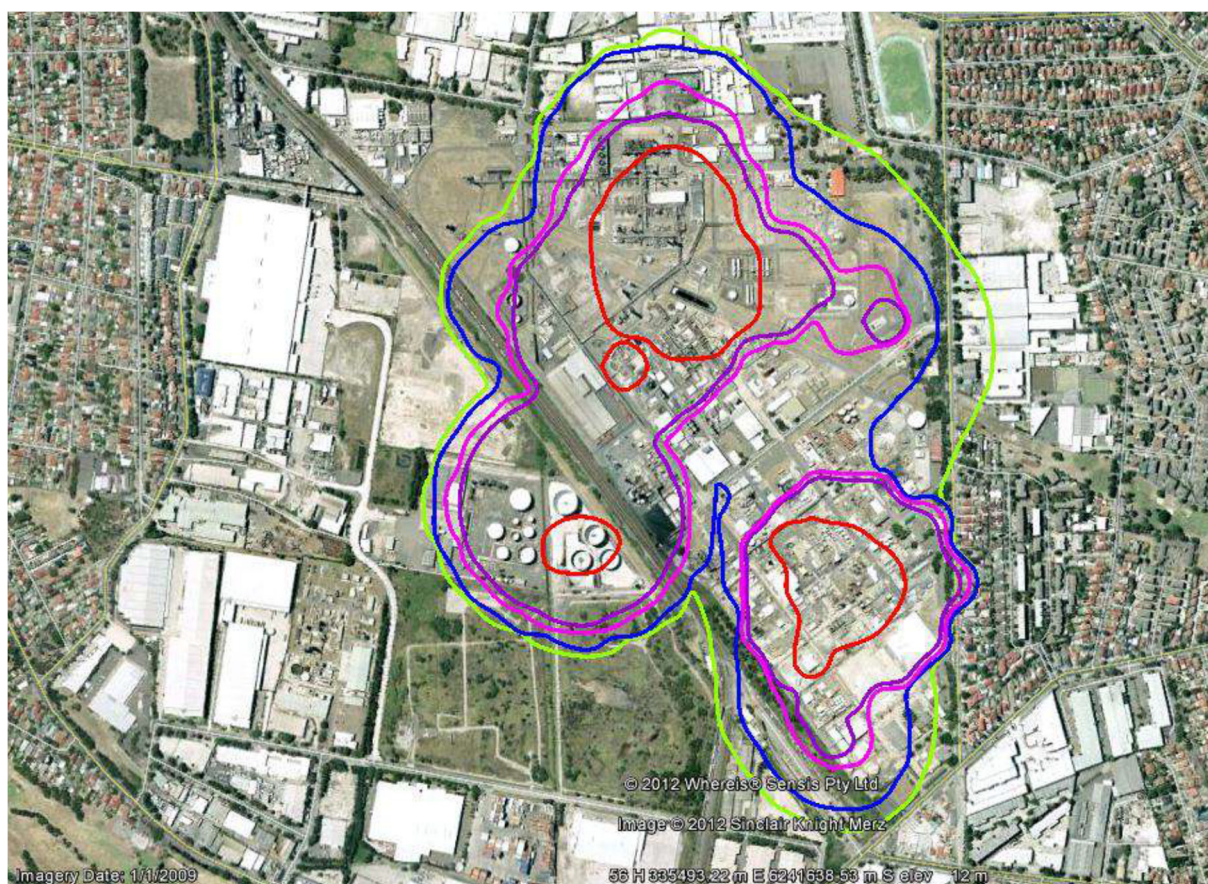


Figure 4 BIP Individual Fatality Risk 2012

The results show that the subject site is exposed to risks below 0.5 in a million per year (as the site is outside the green line, site not shown in the image). Therefore there are no individual risk concerns from the BIP that would prevent development on the site, including more sensitive land uses such as medical or residential development.

The individual risk of injury from 4.7kW/m² of radiation is shown in Figure 5. Risk levels of greater than 50 chances in a million do not reach the Eastgardens site.

LEGEND:

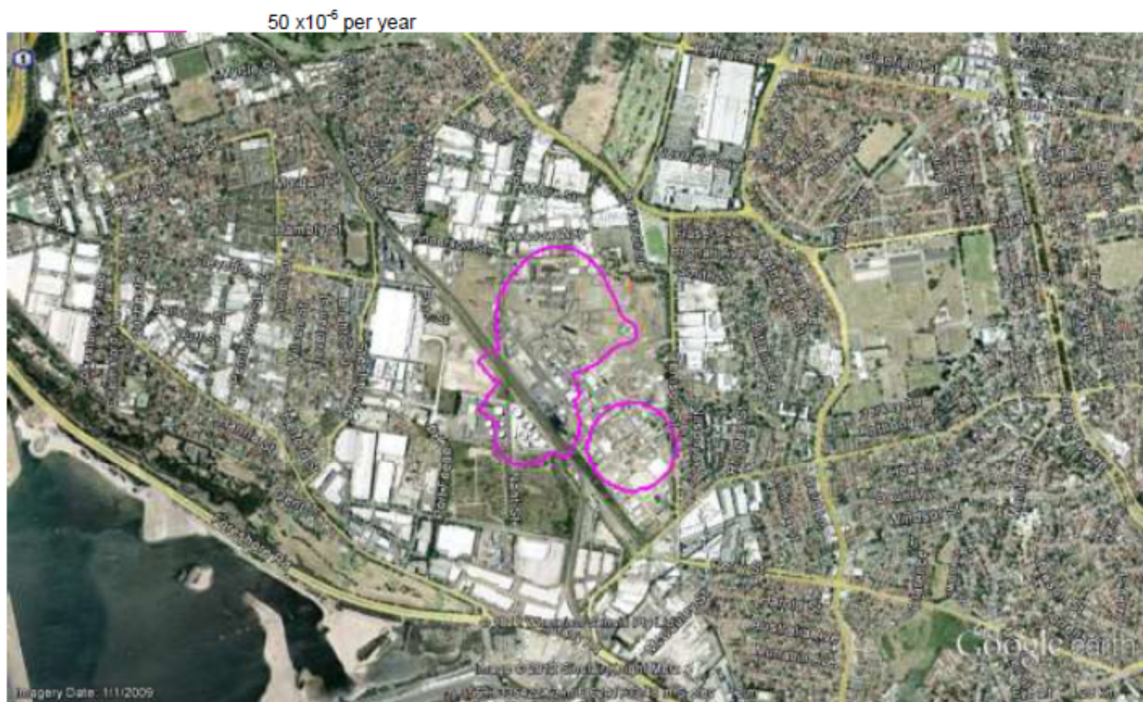


Figure 5 INJURY RISK – HEAT RADIATION 4.7KW/M2 at 50 chances in a million per year BIP 2012

The individual risk of injury from overpressure of 7kPa is shown in Figure 6. Risk levels of greater than 50 chances in a million do not reach the Eastgardens site.

LEGEND:



Figure 6 INJURY RISK – OVERPRESSURE 7KPA at 50 chances in a million per year BIP 2012

The individual risk of injury from toxics is shown in Figure 7. Risk levels of greater than 50 chances in a million do not reach the Eastgardens site.

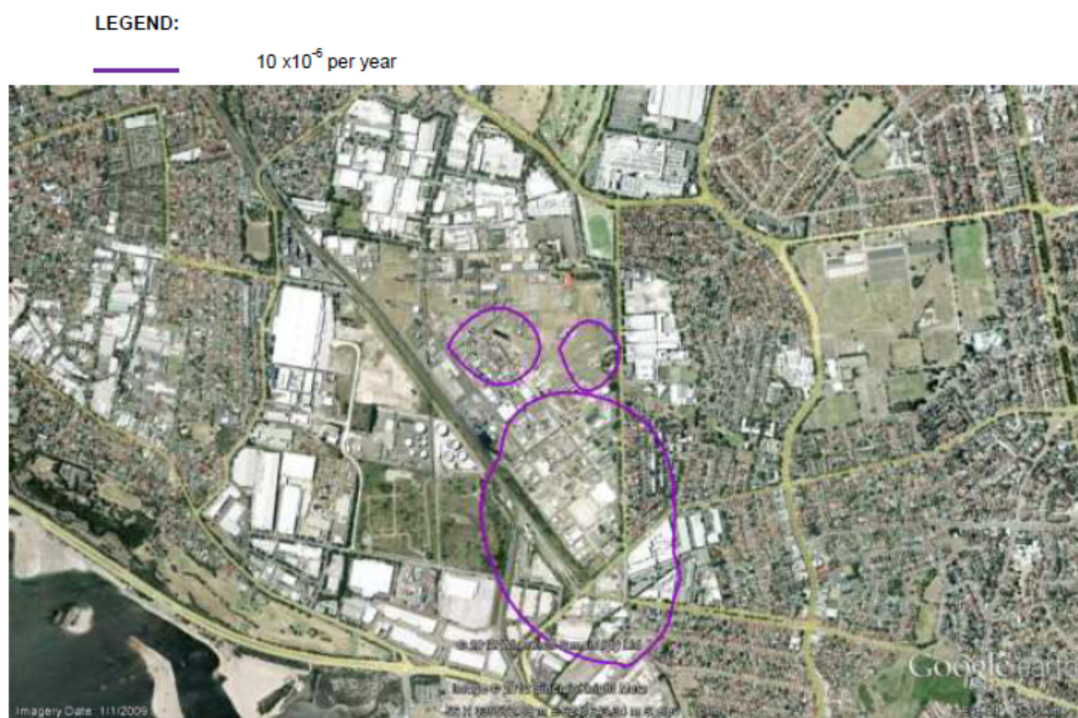


Figure 7 INJURY RISK – TOXIC GAS (ERPG3) 50 chances in a million per year BIP 2012

The individual risk of irritation from toxics is shown in Figure 8. Risk levels of greater than 50 chances in a million do not reach the Eastgardens site.



Figure 8 IRRITATION RISK – TOXIC GAS (ERPG2) at 50 million chances per year BIP 2012

5.2 BIP Societal Risk

The 2012 societal risk result for the BIP on all surrounding populations is presented as Figure 9. The result shows the FN curve is towards the middle of the ALARP zone. This means that there is some “risk budget” available for an increase of populations around the BIP.

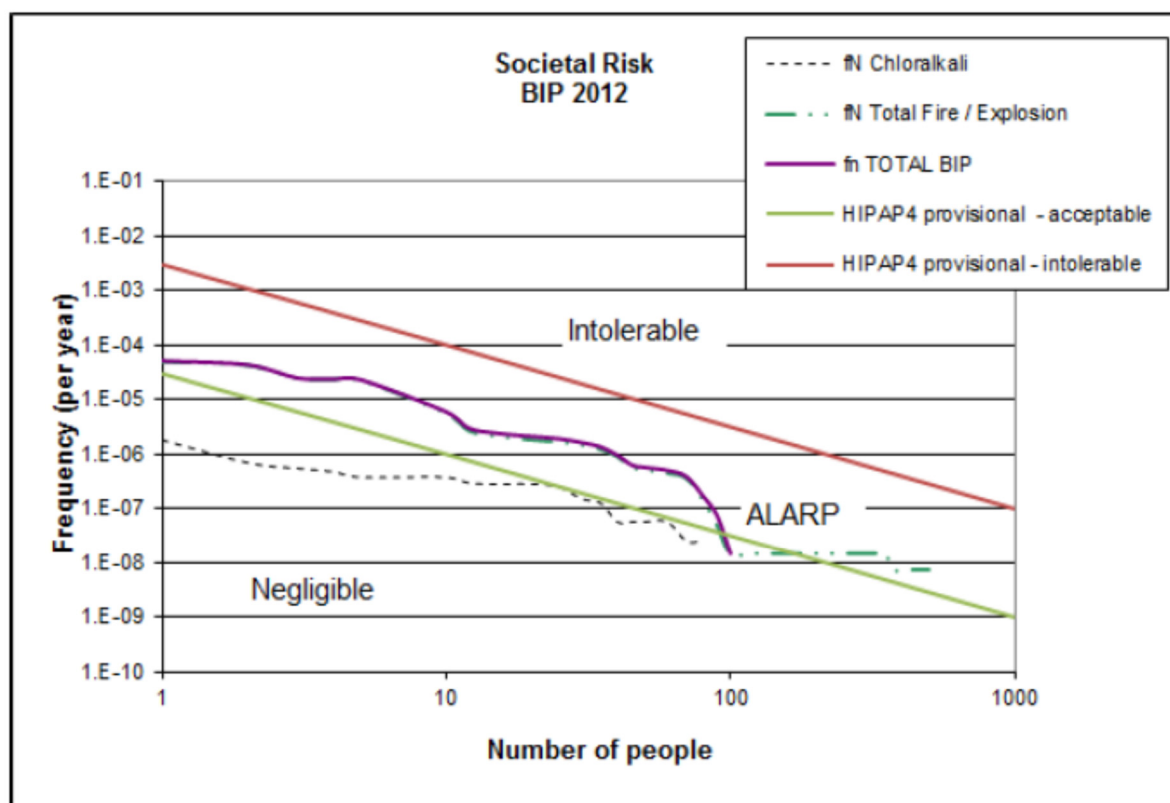


Figure 9 Societal Risk BIP 2012

To determine the increment in societal risk for the expanded Eastgardens development access to the Sherpa risk model is required. Systra Scott Lister does not have such access. Regardless, considering how Eastgardens is a long distance from the BIP, and how the site is also very distant from the individual risk contours of fatality, injury and irritation, we do not expect the societal risk to increase markedly as a consequence of the proposed development.

For BIP risks it has become common practice to calculate the “Scaled Risk Integral” (SRI) as described in HIPAP 10, but since values of individual risk at the site are not available from the BIP QRA results (contours fall well short of the site) this calculation cannot be performed either. Because the individual risk contours of the lowest level of interest of 0.5 in a million fall well short of the facility, the SRI would be small. An example is provide below to demonstrate this.

Area (ha)	n (number of people)	T (portion of time)	c (Land use category)	IFR (Individual Fatality Risk)	P = (N+N ²)/2	SRI (Scaled Risk Integral)
7.36	3000	0.33	1	0.005	4501500.0	1009

This calculation shows individual risks would need to be greater than 5×10^{-9} before the SRI nears the criteria value of 1100. Looking at our own models the 5×10^{-6} contour drops to 5×10^{-9} in 200m which if the same drop off is experienced for BIP risks, the level of individual risk will be $<5 \times 10^{-9}$ at Westfield Eastgardens.

6. DANGEROUS GOODS TRANSPORT RISK STUDY

The Dangerous Goods Transport QRA, Denison St, Hillsdale was finalised by Systra Scott Lister in 2015 on the request of the NSW Department of Planning and Environment and Botany Bay Council (now Bayside Council) to assist in the assessment of a development application for a new Bunnings Warehouse store at Denison Street, Hillsdale. This report calculated the individual and societal risk results for dangerous goods truck movements along Denison Street.

In broad terms, risk was estimated quantitatively by:

- identifying hazardous incident / release scenarios as a results of dangerous goods truck accidents
- estimating the physical consequences, i.e. the extent of fire, explosion or toxic release, and the associated impact on people for the defined release scenarios due to heat radiation from fire events, explosion overpressure or acute toxic exposure.
- combining the consequence and impact results with truck accident frequency information, and population data to determine risk.

Consistent with the 2015 Denison St study, the risk acceptability criteria used for this study are those detailed in the DPE's Hazardous Industry Planning Advisory Paper No.4, Risk Criteria for Land Use Safety Planning [HIPAP4 - Ref 003]. The DP&E does not have any formal published criteria for transport risk but for the 2015 Denison St report, the HIPAP4 criteria for fixed installations was accepted by the Department as providing a reasonable basis to inform planning decisions. (Note: This infers a risk/ km basis for societal risk for transport movements).

For this Dangerous Goods QRA, the results of the risk calculations have been presented as individual and societal risk.

Individual Risk - the likelihood of fatality to notional individuals at locations alongside Denison Street, as a result of the defined fire / explosion and toxic gas release scenarios. This is shown as contours on a map of the area. The units for individual risk are probability (of fatality) per million per year. By convention it is assumed that people are located outdoors, are always present and take no evasive action if an incident occurs. The results are presented cumulatively for all fire/explosion and toxic gas impacts in Figure 10.

Societal Risk - takes into account the number of people exposed to risk. Whereas individual risk is concerned with the risk of fatality to a (notional) person at a particular location (person 'most at risk'), societal risk considers the likelihood of actual fatalities among people exposed to the hazard and allows mitigating effects such as probability of presence, whether they are located inside or outside etc., to be accounted for, hence requires population data as an input.

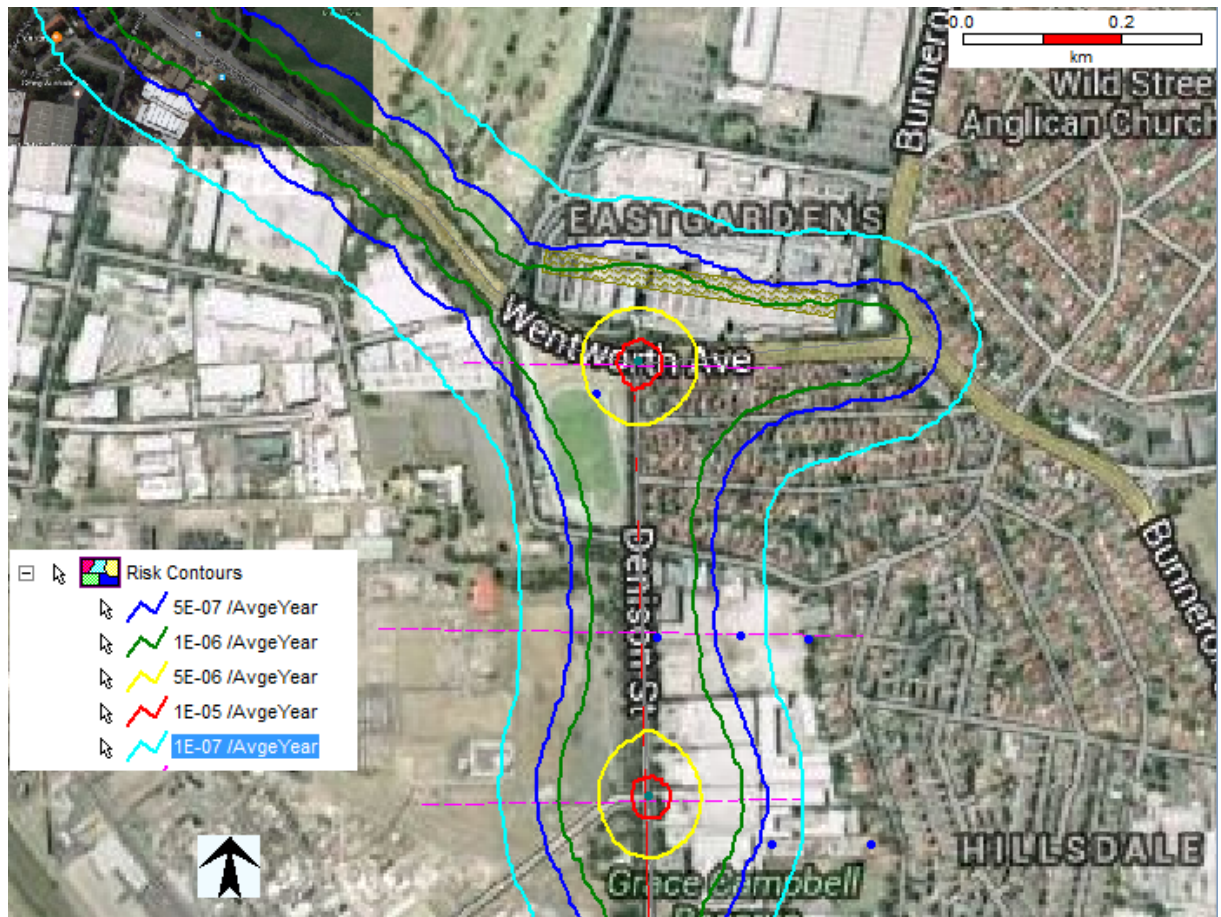


Figure 10 Individual Risk Results for Dangerous Goods Transport on Denison Street & Wentworth Ave

The Dangerous Goods routes have been extended east and west along Wentworth Ave. The working assumption is an even split of traffic east and west.

Note that the individual risk shown in Figure 11 has a small excursion of the 5 in a million contour (yellow line) into the existing parking area of the Eastgardens development, opposite the intersection between Denison St and Wentworth Ave. As this is part of the proposed development area, risk mitigations can be incorporated into the design to ensure an acceptable level of individual risk is achieved. Possible mitigations are discussed in Section 7.

Previous studies for dangerous goods on Denison St have modelled DG traffic running from Wentworth St to Beauchamp Rd, the original area of focus for the Dangerous Goods Transport study. For this assessment a 1km section of road has been shifted north up along Wentworth St so that the hazard is opposite the area of interest. This produces a difference societal risk curve to that presented in previous studies.

6.1.1 Incremental Societal Risk from Dangerous Goods

The incremental societal risk from Dangerous Goods has been assessed, in accordance with HIPAP 4 and 10. This has been done by calculating the societal risk FN curve for the population of the new development with an increased population of around 2,600 additional persons during the day and 10% estimated during the night.

HIPAP 4 suggests that for a new development in proximity to a major hazard that

“... where a development proposal involves a significant intensification of population in the vicinity of such a facility, the change in societal risk needs to be taken into account, even if individual risk criteria are met.

Examples of such situations would include medium to high density residential development (although this would not normally be considered to be appropriate in such a location), sporting facilities where large numbers of spectators are likely to be present and shopping complexes.

In such instances, the incremental societal risk should be compared against the indicative criteria of Figure 3. Provided the incremental societal risk lies within the negligible region, development should not be precluded. If incremental risks lie within the ALARP region, options should be considered to relocate people away from the affected areas. If, after taking this step, there is still a significant portion of the societal risk plot within the ALARP region, the proposed development should only be approved if benefits clearly outweigh the risks.”

This suggested criteria is ambiguous on whether the incremental societal risk is for the development on its own, or the total societal risk with the additional population. We have assumed it is the total societal risk with all populations in the area, plus the additional developments population (the additional Westfield Eastgardens proposal plus other recent developments that have been added to our model).

The incremental risk result is presented as Figure 11, where the total societal risk for all surrounding areas plus the expanded Westfield Eastgardens is presented. It shows the total societal risk result does not exceed the upper criteria line, but does exceed the maximum fatality limit of 1000 people.

Possible protective measures to reduce the risk to populations in the expanded area of Westfield Eastgardens are:

1. The Level 2 conversion of the existing parking areas into retail can be sealed with solid walls to the south, and east and west corners. The internal area will be pressurised from roof mounted HVAC units and have auto sliding doors at entry points to the internal retail mall. Such arrangements are expected to protect occupants from the effects of toxic gases arising from accidents on Denison St or Wentworth Ave.

2. That the new Level 2 retail area built into the existing car park will be oriented such that back-of-house and storage functions are towards the southern façade wall, with the bulk of customers and staff to the North of the façade wall.
3. Construction of new retail areas will have solid steel reinforced concrete walls to the Southern building façade facing Wentworth Avenue. Such walls are to have no glazing and no ventilation ports. Walls will be fire rated to withstand LPG fire radiation of 37kW/m² for 15 minutes. Solid steel reinforced concrete walls on the southern sides of the expanded retail areas are recommended to protect customers from the impacts of flash fires, jet fires and fireballs

It is noted that the previous version of this report suggested the ground level carpark could be walled-in to the south, east and west to prevent the accumulation of flammable gases in the area. Current modelling does not use the 3D explosion module in Safeti v8 and assumes strong explosions for all vapour cloud explosions. Therefore given an acceptable incremental societal risk result has been achieved with these conservative assumptions, such a mitigation should not be necessary.

The incremental risk result presented as Figure 11 does not include the effect of the mitigations recommended above. With the building protected from flashfires, explosions and fireballs from accidental releases of pressure liquefied flammable gases, it is expected that the maximum fatality levels will drop to the toxics curve and therefore avoid of the breach of the maximum number of fatalities.

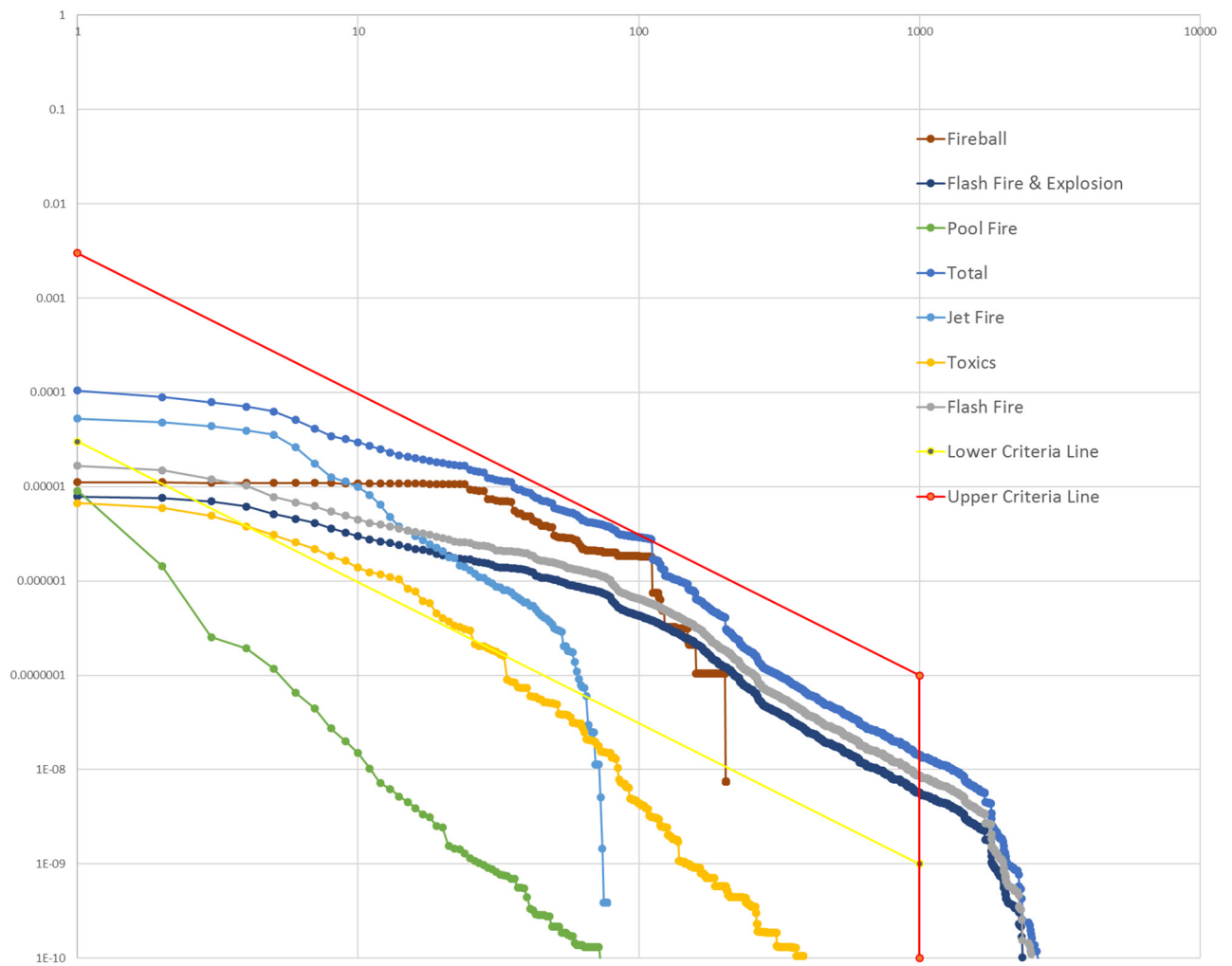


Figure 11 Societal Risk from DGs on Denison St and Wentworth Avenue

7. CONCLUSIONS

Scentre Group are proposing a redevelopment of the Westfield Eastgardens site at Wentworth Avenue in Banksmeadow and have engaged Systra Scott Lister to undertake a quantified risk assessment of the proposed redevelopment scheme.

The risk review uses QRA models available to Systra Scott Lister for DGs transport, and included the Botany Industrial Park (BIP) Risk assessment undertaken by SHERPA Engineering.

Risks from the BIP do not appear to exceed the DPEs criteria for development in the vicinity of hazardous installations, although without access to the BIP QRA model the acceptability of the increment in societal risk cannot be confirmed.

Individual risk from Dangerous Goods has a small excursion of the 5 in a million contour into the existing parking area of the subject site, opposite the intersection between Denison St and Wentworth Ave. This area forms part of the redevelopment proposal and through design engineering appropriate mitigations be can included to reduce this risk to an acceptable level.

In order to meet the incremental societal risk criteria for dangerous goods, it is recommended that the development meets a number of design requirements. These are as follows:

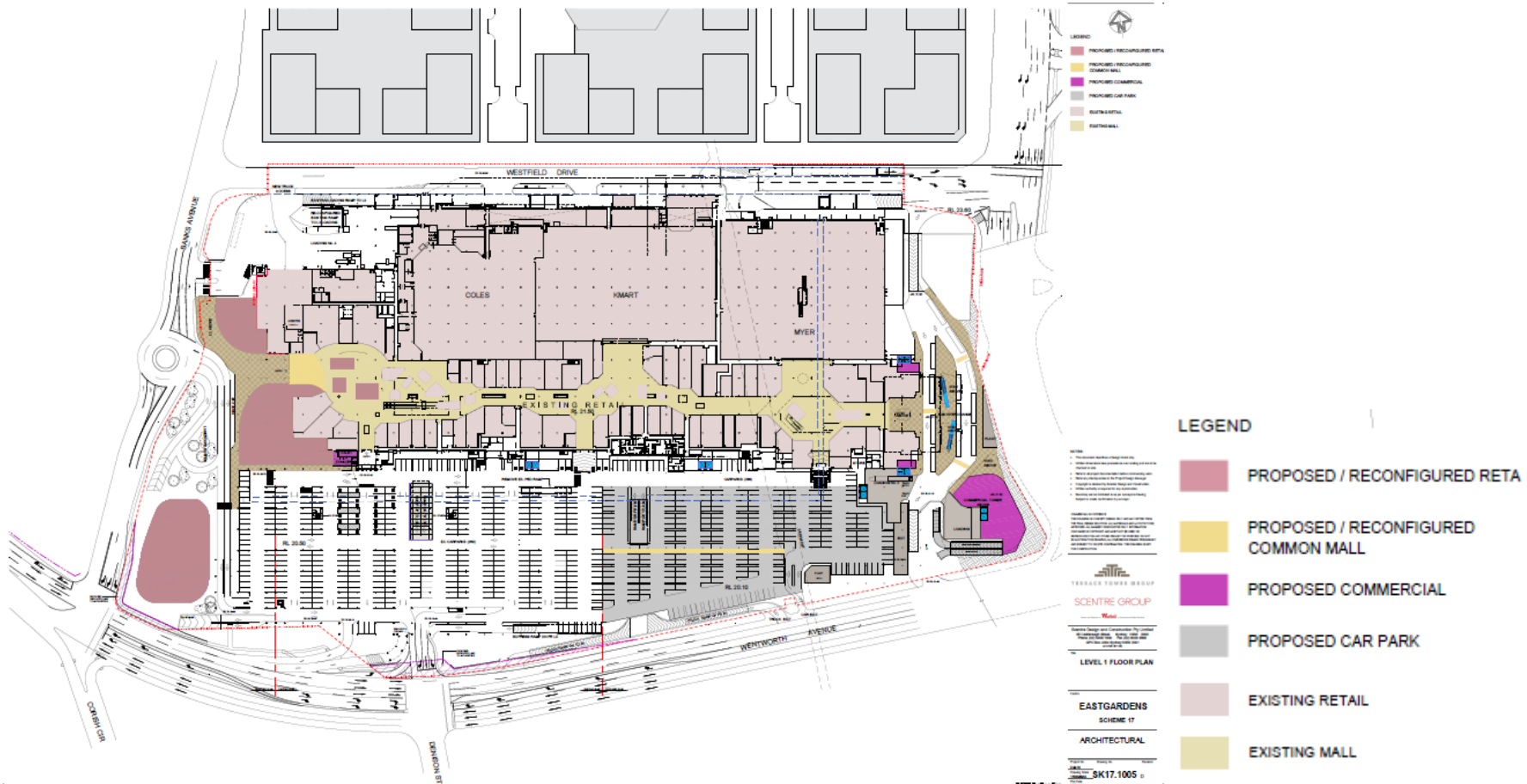
1. The Level 2 conversion of the existing parking areas into retail can be sealed with solid walls to the south, and east and west corners. The internal area will be pressurised from roof mounted HVAC units and have auto sliding doors at entry points to the internal retail mall. Such arrangements are expected to protect occupants from the effects of toxic gases arising from accidents on Denison St or Wentworth Ave.
2. That the new Level 2 retail area built into the existing car park will be oriented such that back-of-house and storage functions are towards the southern façade wall, with the bulk of customers and staff to the North of the façade wall.
3. Construction of new retail areas will have solid steel reinforced concrete walls to the Southern building façade facing Wentworth Avenue. Such walls are to have no glazing and no ventilation ports. Walls will be fire rated to withstand LPG fire radiation of 37kW/m² for 15 minutes. Solid steel reinforced concrete walls on the southern sides of the expanded retail areas are recommended to protect customers from the impacts of flash fires, jet fires and fireballs

8. REFERENCES

1. Hazardous Industry Planning Advisory Paper No.6 – Guidelines for Hazard Analysis, Department of Planning, NSW, 2011.
2. State Environmental Planning Policy No.33 – Hazardous and Offensive Development Application Guidelines (2011), “Applying SEPP 33”, Department of Planning NSW.
3. Multi-Level Risk Assessment, Department of Infrastructure, Planning and Natural Resources – May 2011.
4. Hazardous Industry Planning Advisory paper No.4, “Risk Criteria for Land Use Safety Planning”, NSW Department of Infrastructure, Planning and Natural Resources (2011)
5. Botany Industrial Park– QRA, SHERPA Engineering - 2012
6. Dangerous Goods Transport Study – Denison Street, Botany, Scott Lister (2015) (to support planning approval for the Bunnings site at Denison St)

APPENDIX A - CLIENT INPUT DATA – CONCEPT SCHEME

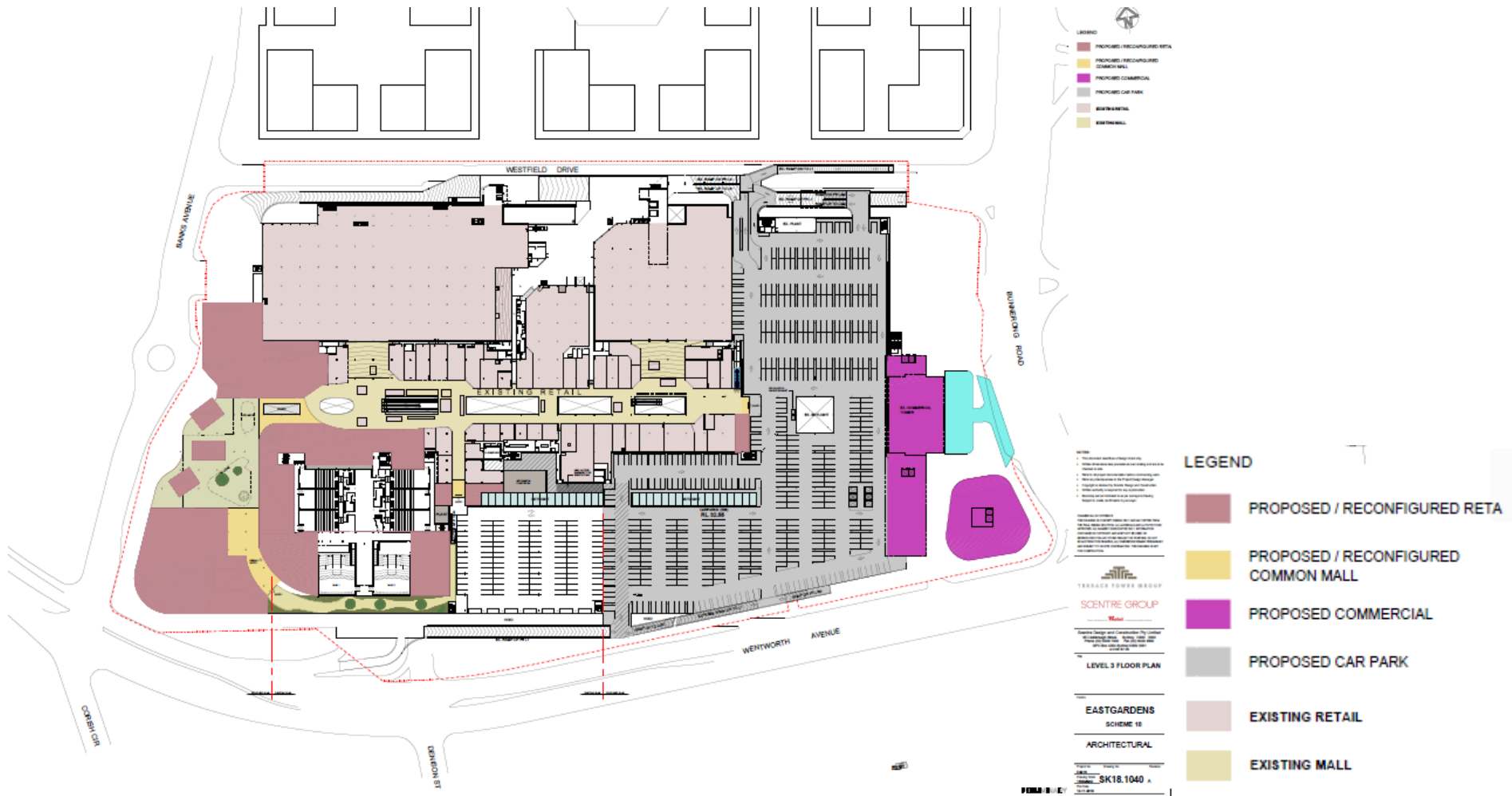
Westfields Eastgardens	
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Ground Level



First Level



Second Level

APPENDIX B - CLIENT INPUT DATA – POPULATION DATA

Retail populations are estimated using Westfield Eastgardens total actual visits for 2018.

Office populations are estimated using the worker density estimates included in the Colliers Economic Impact Assessment.

Annual visits		11,454,000	Based on door counters at entries, 2018			Assumed average visit time: 1 hours		
Weeks per year		52				Casual car park dwell time for Feb 2019 is 64.8mins		
Visits per week		220,269						
						Straight-line		
<u>Distribution of an average week</u>			Trading hours	Add 15% for after hours	Total hours	People per hour	GFA Sqm	Person per GFA sqm
Monday	0.13	27,681	8.5	1.3	9.8	2,832	99,400	0.028
Tuesday	0.13	27,956	8.5	1.3	9.8	2,860	99,400	0.029
Wednesday	0.13	27,966	8.5	1.3	9.8	2,861	99,400	0.029
Thursday	0.16	35,666	12.0	1.8	13.8	2,585	99,400	0.026
Friday	0.15	32,254	8.5	1.3	9.8	3,300	99,400	0.033
Saturday	0.17	37,211	8.0	1.2	9.2	4,045	99,400	0.041
Sunday	0.14	31,535	7.0	1.1	8.1	3,917	99,400	0.039
Total	1.00				Average:	3,200		0.032
Existing centre:						Retail development proposal:		
Lettable area		84,400				Additional retail area (GFA): 37,500		
Common mall		15,000				Additional retail population: 1,207		
Total GFA		99,400						
Commercial population calculations:								
Proposed incremental GFA			34,800					
Efficiency factor			88%					
Proposed incremental GLA			30,500					
Assumed worker density per sqm of GLA			1 worker per 20-25sqm of GLA					
Low worker estimate			1,220					
High worker estimate			1,525					
Mid worker estimate			1,373					
Worker density per sqm of GFA			0.039					
Commercial GFA located <10m above ground level			3,248	Assumed to be GFA for basement, Level 1 and Level 2				
Worker population located <10m above ground level			128					

Based on an existing floor area of 99,400m² and an average 1 hour visit per customer, this produces an average density of 0.032 people per square meter and an average daytime population of 3,200 people. For an additional 37,500m² of retail this introduces an additional 1,207 people.

For commercial office areas a density of 22.5sqm of GLA per person is assumed. Which for 34,800sqm of commercial GFA this produces 30,500sqm of gross lettable space and 1,373 people during the day. Given the vertical arrangement of the office buildings, and the fact that two buildings site above the retail podium, only 128 of this population are expected to be less than 10m above ground level.

The location of populations is shown with the following figure. The risk model used, Safeti v8, cannot distinguish vertical separation of populations. Hence all populations are modelled as being on the same level, including the full 1,373 office population.

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APPENDIX C – RESPONSE TO RECOMMENDATIONS

ARRISCAR recommendations from Planning Risk Assessment Review S17/75 Planning Proposal by Scentre Group for Westfield East Gardens For Bayside Council 2 July 2018 Doc. No.: J-000315-BC-01 Revision: 1.

Recommendation 1

Refer to the Department of Planning for an interpretation of ‘incremental risk’ in societal risk assessment for new developments near major hazard facilities. This will assist in risk criteria compliance with HIPAP No.4.

Response:

Incremental societal risk is described in HIPAP 4 and HIPAP 10 . HIPAP 4 suggests that for a new development in proximity to a major hazard that:

“... where a development proposal involves a significant intensification of population in the vicinity of such a facility, the change in societal risk needs to be taken into account, even if individual risk criteria are met.

Examples of such situations would include medium to high density residential development (although this would not normally be considered to be appropriate in such a location), sporting facilities where large numbers of spectators are likely to be present, and shopping complexes.

In such instances, the incremental societal risk should be compared against the indicative criteria of Figure 3. Provided the incremental societal risk lies within the negligible region, development should not be precluded. If incremental risks lie within the ALARP region, options should be considered to relocate people away from the affected areas. If, after taking this step, there is still a significant portion of the societal risk plot within the ALARP region, the proposed development should only be approved if benefits clearly outweigh the risks.”

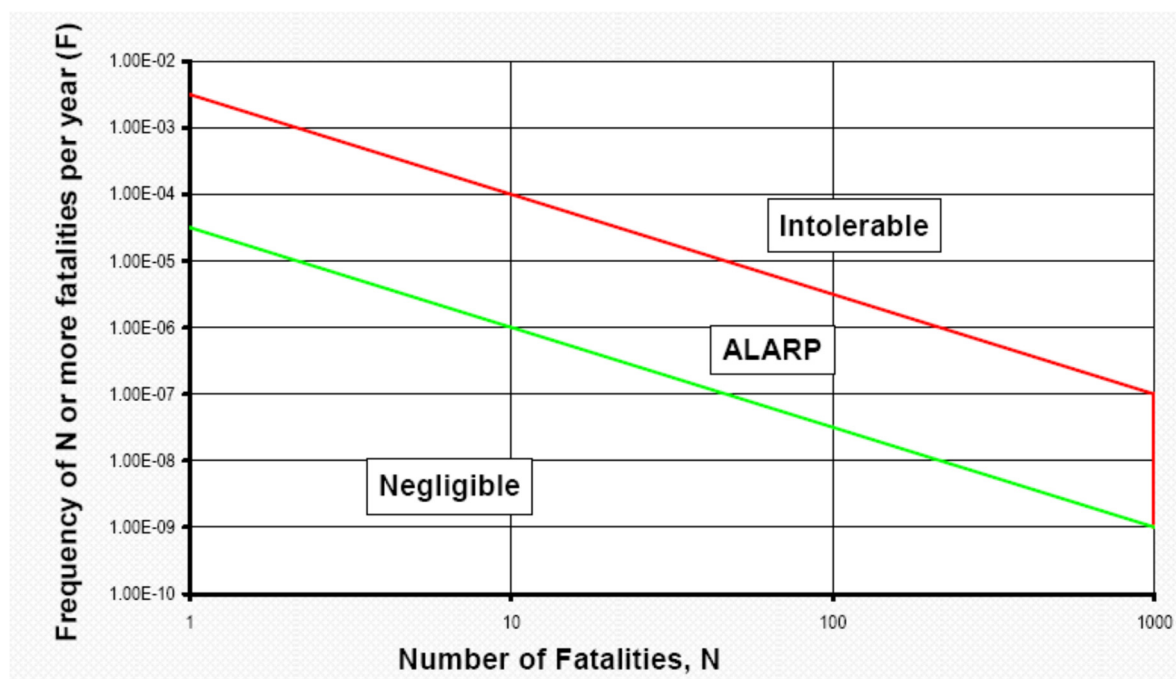


Figure 3 Indicative Societal Risk Criteria for risks from fixed installations

This description of the societal risk increment is ambiguous. It can be interpreted either as:

- (a) the societal risk from the population of the new development alone in proximity of a major hazard is assessed against the criteria.

Equally it can be assessed as

- (b) being the incremental risk of the developments population on top of the existing populations in the area, assessed against the criteria.

Following interpretation (a), an increment of societal risk that falls below negligible line would make a very small difference to the total societal risk if the total were to be positioned in the upper ALARP region, as the criteria lines are two orders of magnitude apart.

Following interpretation (b) If the total societal risk is in the ALARP area, then:

...options should be considered to relocate people away from the affected areas [HIPAP No. 10 Section 5.5.4]. If, after taking this step, there is still a significant portion of the societal risk plot within the 'Tolerable if ALARP' region, the proposed development should only be approved if benefits clearly outweigh the risks [HIPAP No. 10 Section 5.5.4].

This means once the overall populations in the area put the societal risk into the ALARP zone, any further development may be rejected if the benefits clearly don't outweigh the risks. This judgement of benefits and risks is subjective and ambiguous as well and does not provide clear guidance to developers.

In addition for dangerous goods risks in the ALARP zone, it is also incumbent on the transporter of dangerous goods to reduce risks as low as reasonably practicable. Hence those transporting dangerous goods (following the chain of responsibility) should be exploring if safer options that are reasonable and practicable are available, and adopting them if so. This may involve alternative routes.

To address this ambiguity, both interpretations of the societal risk increment have been considered. The risk of the new development on top of all existing populations being assessed against the criteria has been chosen the proposed interpretation (ie interpretation (b) above). This is considered to be the more conservative interpretation of the policy.

Further to this, Systra Scott Lister have tried to engage with the representative from the Department of Planning and Environment who is responsible for assessments in this region, however they do not wish to engage until after the proposal is referred to them during the post Gateway consultation phase.

The methodology applied in this report is consistent with other submissions we have made, where both the total populations plus the additional has been considered as well as the new population on its own. Such submissions have been assessed and approved by DPE, and therefore it is considered appropriate for the purposes of this report.

Recommendation 2

The risk assessment must be updated to account for an increase in building height up to 70m, taking into account the building wake effects in the dispersion calculations. The report must also provide consequence results of incidents at the corner of Wentworth Avenue and Denison Street. Currently Ref.2 does not have consequence calculation results.

Response:

Such modelling capabilities are only just becoming available. For example DNV GL's Phast v8 made the following release statement in October 2018:

Update on addition of 3D Visualization to Phast

The work to include 3D visualization capability to Phast is well advanced. A development version showcased at the Phast/Safeti user conference in London in early October was well received by users.

Key features include:

- Ability to import 3D geometry
- Ability to build your own geometry (currently limited to a few object types)
- View dispersion results in 3D
- View heat flux/radiation shielding results in 3D

Development is ongoing with a view to releasing it in a future version of Phast. Current emphasis is on optimization, improving the feature set and robustness testing.

As such capabilities mature, such modelling can be performed.

It is our view that the hazards most likely to reach the proposed commercial buildings are dense gas releases which stay at lower levels due to the density of gas vs air. Hence the fact that the office buildings are generally raised above the retail podium (apart from the corner building) significantly reduces the potential impact for this commercial office worker population set. It is estimated that only 128 persons would be accommodated below 10m above ground level in the commercial development.

Some representative consequence modelling results are provided with the following figures.

Figure 1. LPG tanker rupture – Flash Fire Envelope – all wind directions

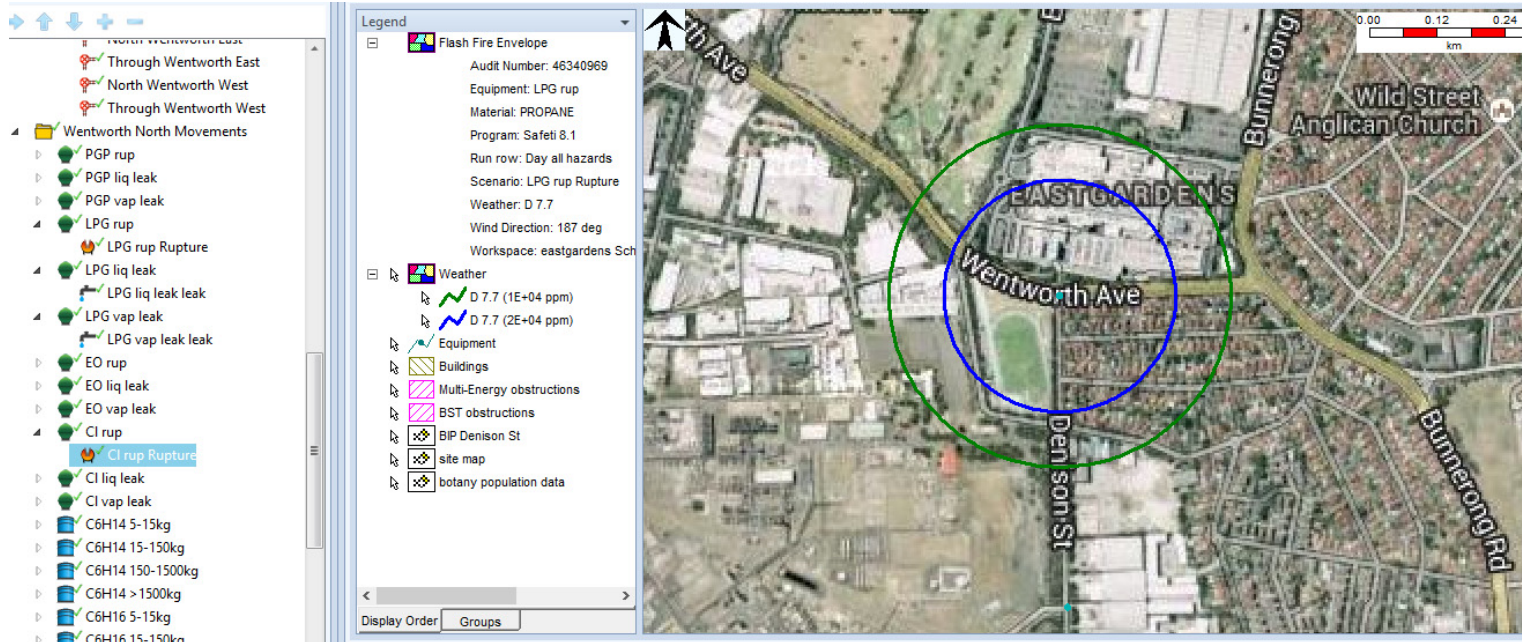


Figure 2. LPG Road Tkr Rupture – Max cloud footprint – wind from the south

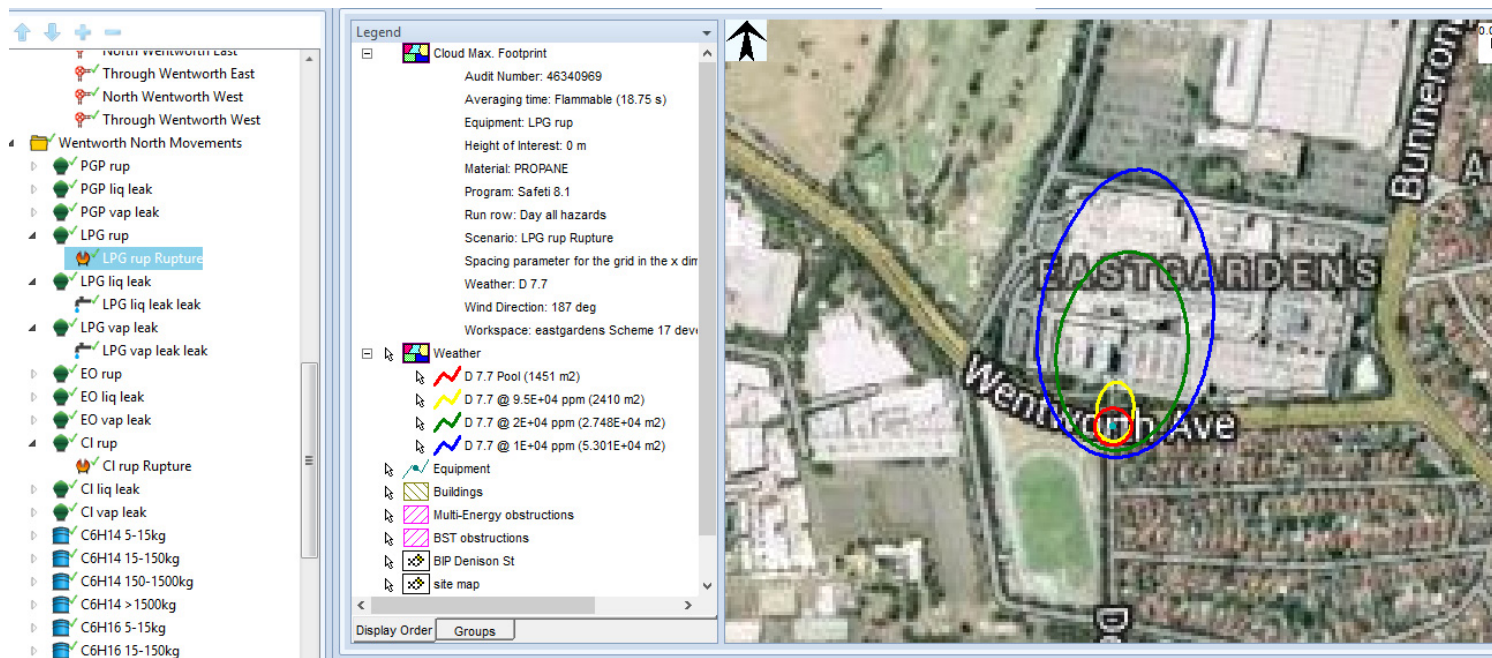


Figure 3. LPG – large leak – Flash fire envelope

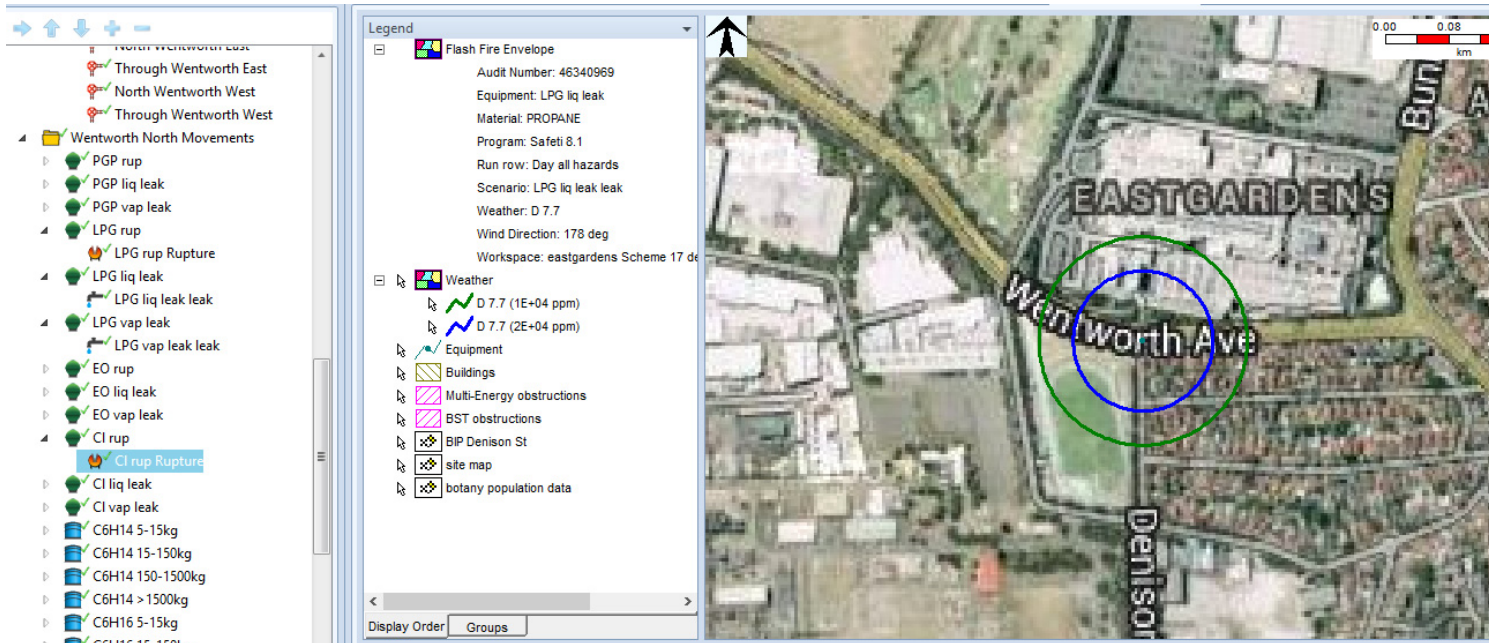


Figure 4. LPG – large leak – Flash fire cloud shape – wind from the south

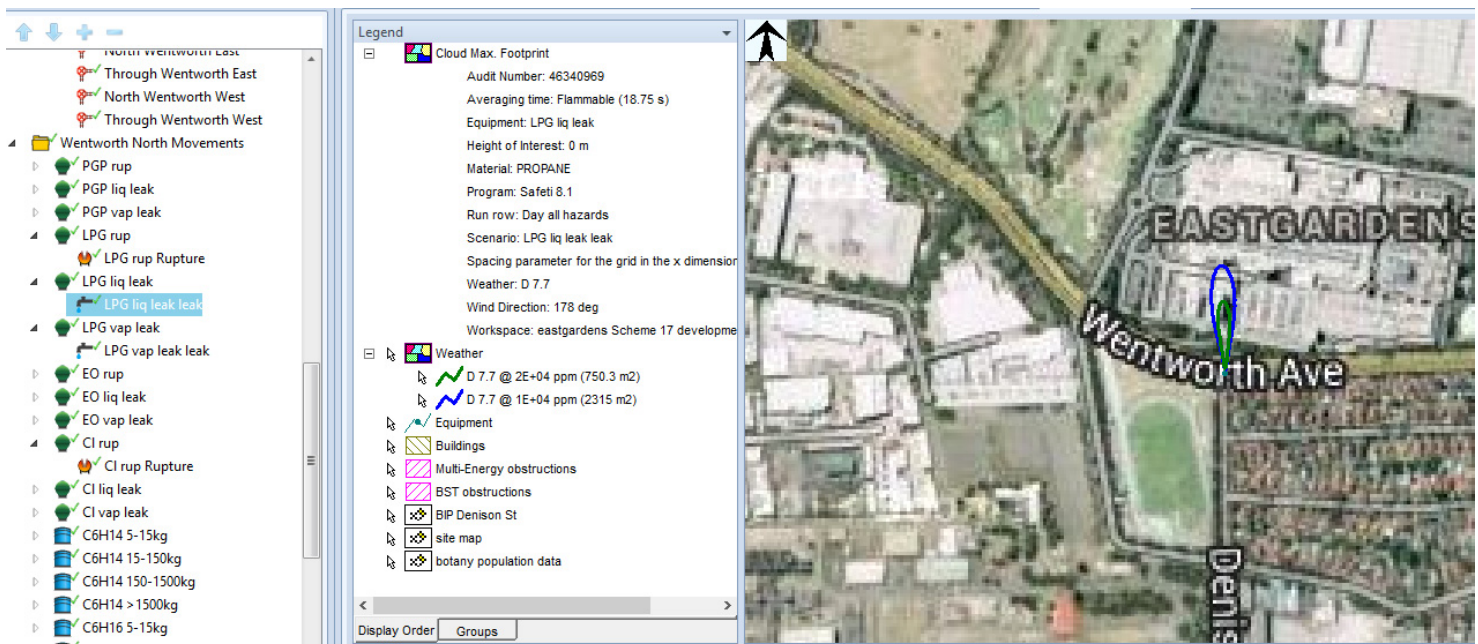


Figure 5. Chlorine Tkr – Rupture – Toxic indoor fatality envelope

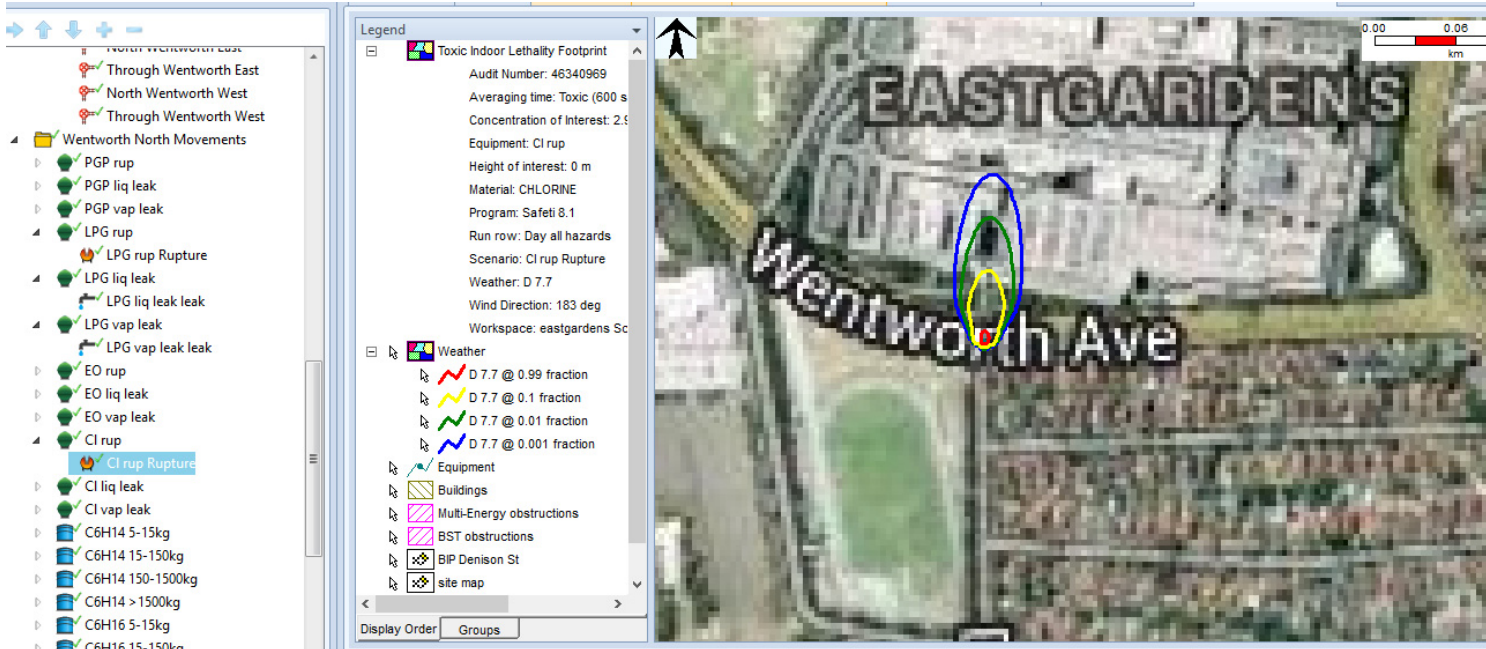


Figure 6. Chlorine Tkr – Rupture – Toxic outdoor fatality envelope

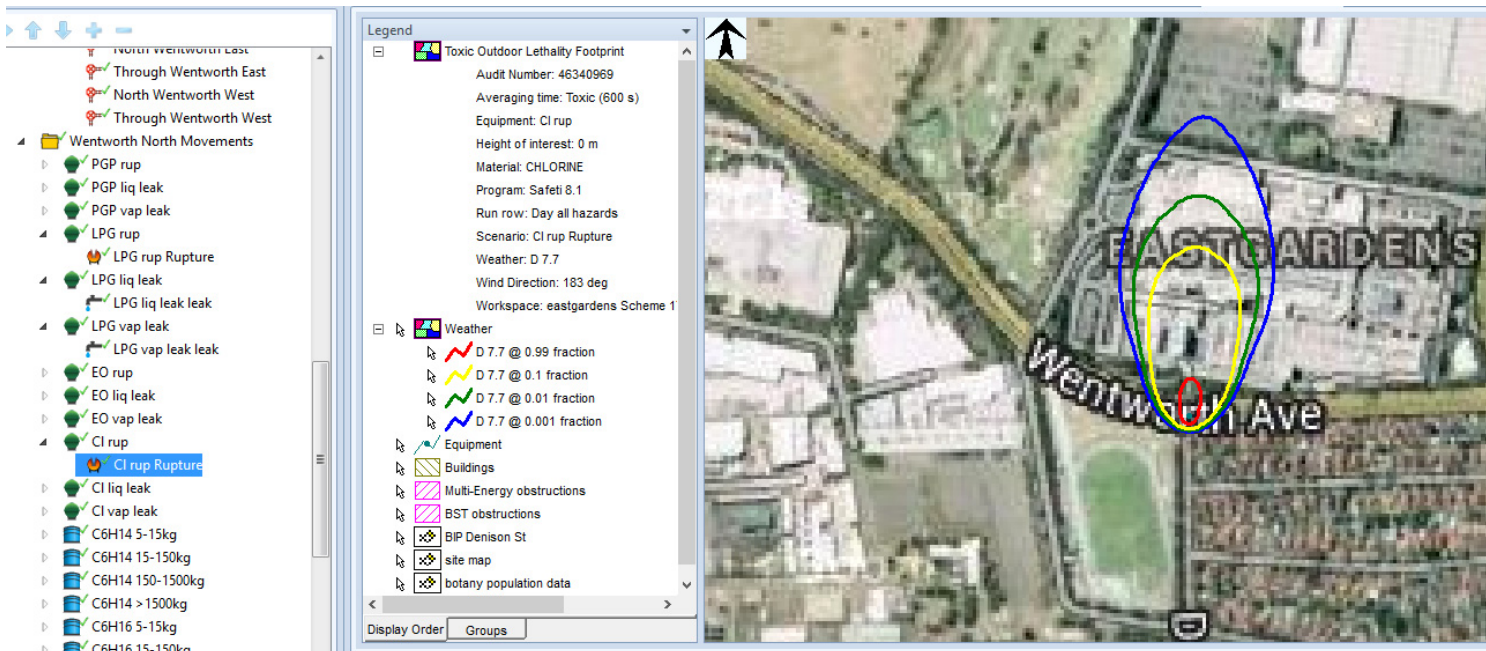
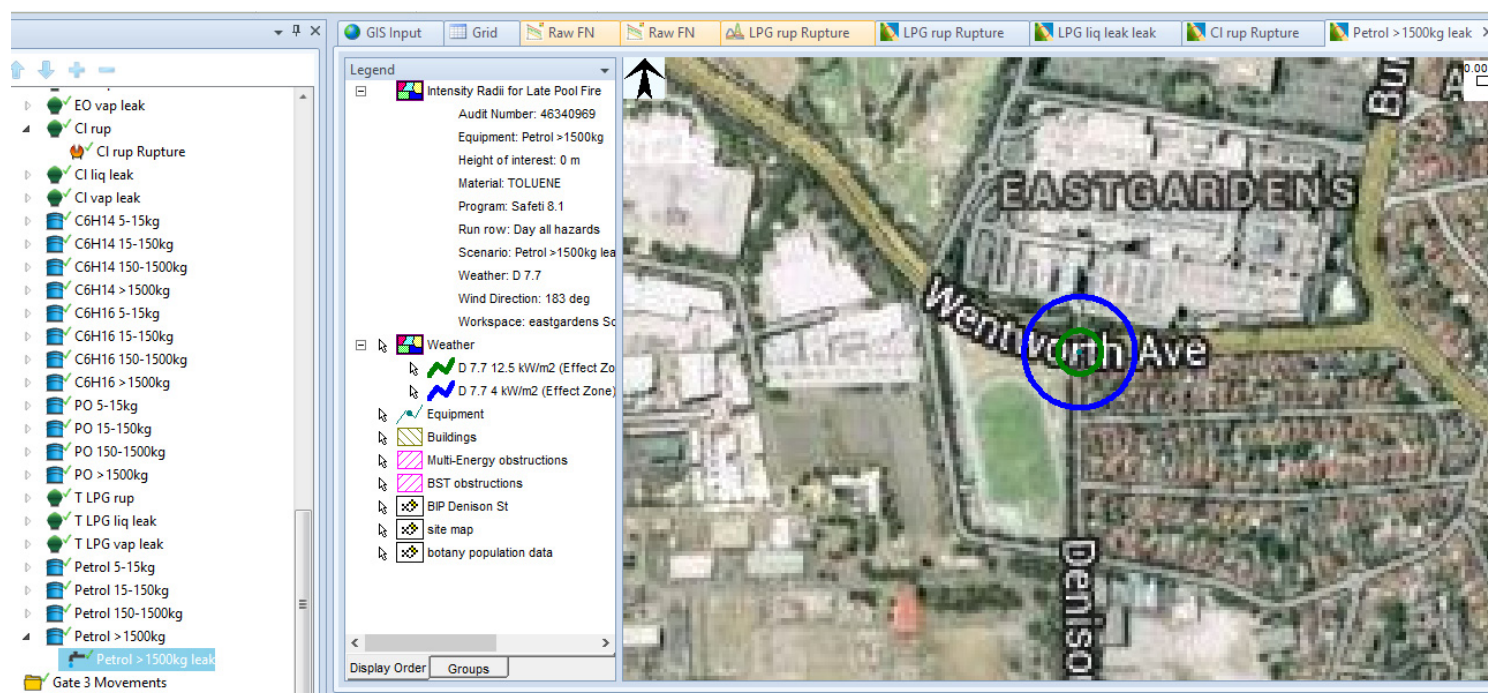


Figure 7. Petrol Tanker – Large release – 1500kg – pool fire



Recommendation 3

The existing cumulative F-N curve must be compared with an updated F-N curve including the population from the proposed future development at East Gardens to assess the impact of incremental risk. If the overall F-N curve including the proposed development exceeds the upper limit, the development clearly exceeds acceptable land use safety for the location.

Response:

This has been compared in Figure 11 of the main report, the proposed development does not exceed the upper limit.

Recommendation 4

The Planning Safety Report must be updated to address

- risk contributors to the incremental risk and rank them*
- assumed population distribution of the 1640 persons*
- whether the risk was assessed for persons inside and outside the building, and at different levels in the building, and*

(d) *how the risk mitigation in design suggested in Ref.1 have been addressed in the incremental risk assessment.*

Response:

- (a) risk contributors to societal risk are shown in Figure 11 of the main report.
- (b) Diagrams showing the assumed distribution of populations have been provided in Appendix B.
- (c) Diagrams showing the assumed distribution of populations have been provided in Appendix B. These indicate if persons are outside or inside.
- (d) Mitigations are suggested, but the modelling does not include them. Hence the presented risk results overstate the risk.