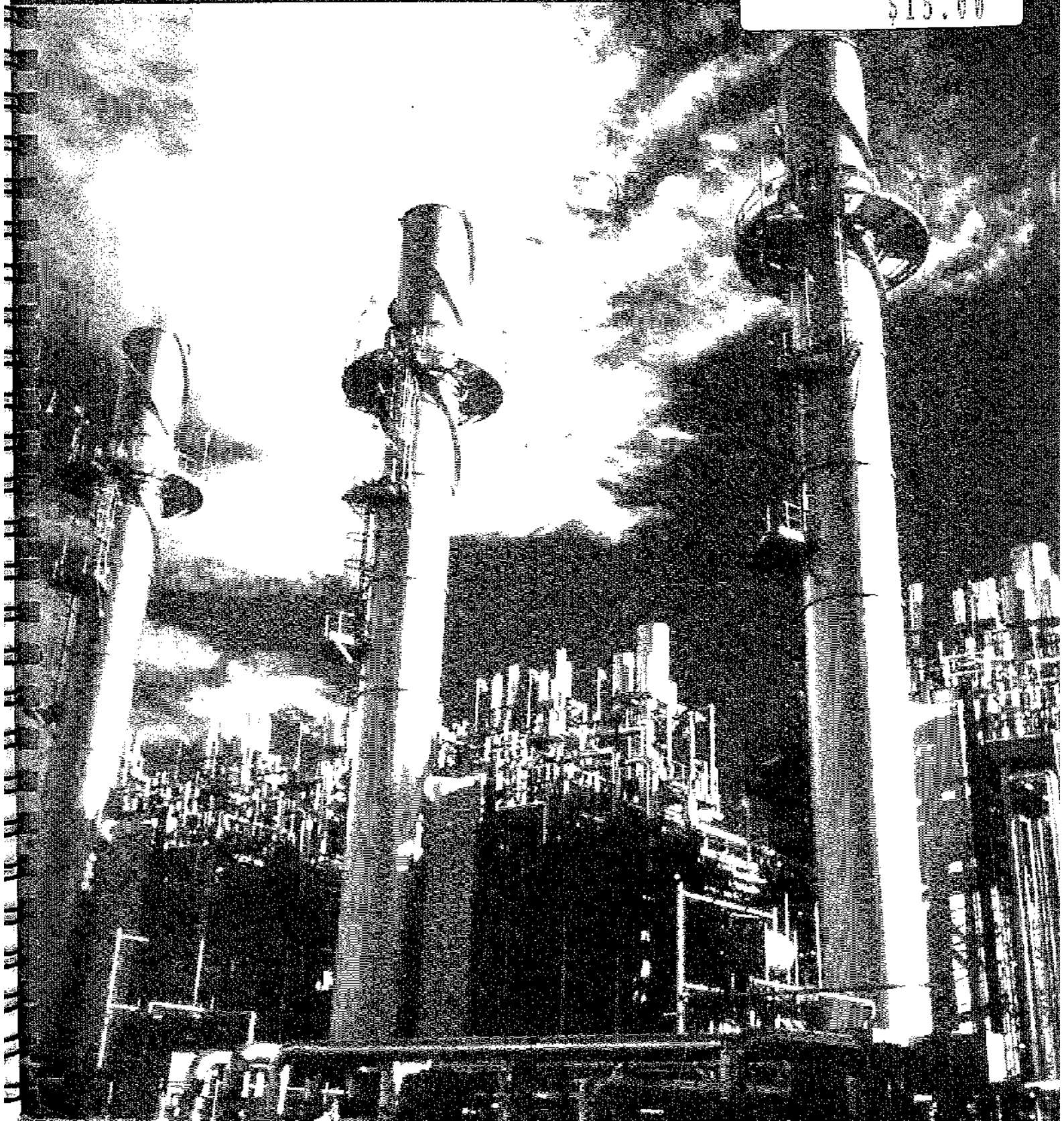
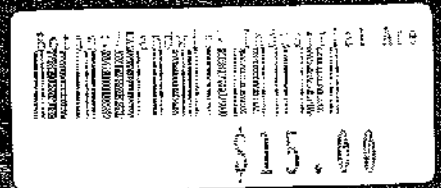


Botany/Randwick Industrial Area

Botany/Randwick Industrial Area Land Use Safety Study
Overview Report

Department of **Urban Affairs and Planning**



Botany/Randwick Industrial Area

Botany/Randwick Industrial Area Land Use Safety Study
Overview Report

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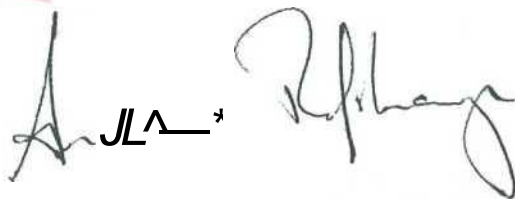
Foreword

The Botany/Randwick industrial complex is an area of regional, state and national significance. The area is an important manufacturing centre encompassing a number of activities involving hazardous materials. The use and storage of these materials has led to increasing community concerns over safety in the vicinity of the industrial activities in the Botany/Randwick area.

A comprehensive cumulative risk assessment of the Botany/Randwick industrial area was completed in 1985. Since then, industrial rationalisation and technological advances have seen the nature and scale of the industrial complex change considerably. In addition, community perception of industrial risk impacts has continued to evolve and risk assessment techniques have further developed. In view of these changes, the Department of Urban Affairs and Planning (DUAP) has undertaken the Botany/Randwick Land Use Safety Study summarised in this report. The study aims to update the 1985 study and formulate a land use safety strategy for the industrial area and surrounding land uses.

The study approach utilises techniques of hazard analysis and multi-level risk assessment pioneered by DUAR. Land use and technical controls have been used to develop a strategic framework to assist decision-making in the industrial area and land uses in Botany/Randwick. This is particularly important in the context of current initiatives to improve the control of Major Hazard Facilities in NSW.

The NSW Government is committed to ensuring the highest level of community safety and participation. I commend this strategic study as a tool for improved

A handwritten signature in black ink, appearing to read 'Andrew Refshauge'. To the left of the signature, there is a red curved line and the letters 'JL' followed by a small superscripted '3'.

Andrew Refshauge
Deputy Premier
Minister for Urban Affairs and Planning
Minister for Housing
Minister for Aboriginal Affairs

planning decision-making for the benefit of the community and industry of NSW,

Executive summary

Background

The Botany/Randwick industrial area is an important manufacturing area of regional, state and national significance. The area includes the Botany Industrial Park complex (formerly the Orica site), together with a number of activities involving hazardous materials, including chemical manufacture, and the storage and distribution of bulk and packed petroleum and chemical products. Figure 4 and Figure 5, respectively, show an aerial view of the Botany/Randwick area and a land use map of the industrial complex and surroundings. The study area boundary is shown in Figure 1.

These activities have the potential to impact on public safety and the environment. It is therefore important that the community, Government and industry understand the risk associated with the various activities in the Botany/Randwick industrial area so as to integrate development opportunities with sound land use safety and the protection of the community and the environment.

In 1985, the then Department of Environment and Planning published a comprehensive risk assessment study for the Botany/Randwick industrial complex and Port Botany. The study estimated the cumulative risk levels and associated land use safety implications for the region around the industrial area. The strategy established as the result of that study involved extensive and specialised risk assessment procedures. Developments in the area have proceeded on the basis of complying with the strategic recommendations of that study, including strict and comprehensive requirements for quantified risk assessment and on-going safety management.

The Port Botany component of the 1985 study was updated and published separately by the Department in 1996. This study aims to achieve a similar update of the Botany/Randwick industrial area component of the 1985 study.

The Botany/Randwick Industrial Land Use Safety Study

This study has been undertaken by the Department of Urban Affairs and Planning with the main objectives of:

- updating the 1985 cumulative risk study for the Botany/Randwick industrial area, taking into account approved developments implemented since the publication of that earlier study and the assessment regime that has been applied to them
- developing updated cumulative risk data, so as to provide a framework for efficient assessment and decision-making for future developments
- formulating a strategic land use safety framework for future developments in the Botany/Randwick industrial area and surrounding land uses.

Two cases were investigated as part of the study, aiming to identify cumulative risk impact levels from the industrial area under current conditions (pre-2001) and a predicted future case (2001), taking into account known approved developments. The two cases specifically covered:

- the existing case (pre-2001) including the Orica mercury cell chlorine plant and chlorine liquefaction facilities with bulk chlorine storage
- * the future case (2001) in which the existing Orica chlorine plant has been replaced with membrane production facilities and liquefaction and bulk storage of chlorine has ceased.

Data used in this investigation were collected through review of hazards studies undertaken for many of the industrial sites in the area, and through liaison with industry representatives. A review of facilities in the Botany/Randwick area allowed the identification of those sites representing significant risks with the potential to affect surrounding land uses.

-v

The study adopted up-to-date quantified risk assessment techniques using internationally recognised modelling tools. More than 5000 events were modelled for this study with quantification of cumulative risk according to multi-level risk assessment techniques. Quantitative Risk Assessment (QRA) of the industrial facilities identified as significant contributors to cumulative risk levels allowed the development of strategic recommendations for the Botany/Randwick industrial area and surrounding land uses.

Key outcomes

Existing case (pre-2001)

The study indicates that significant improvement in cumulative risk levels in the Botany/Randwick area has occurred since the last land use safety study in 1985. This improvement can be generally attributed to advances in technology, the decommissioning of some facilities in the area and effective planning controls implemented in the area as a result of the 1985 study. In response to the 1985 study, a number of installations have also carried out on-going upgrades to equipment and safety management systems.

Although there has been significant improvement, there are still areas around the industrial complex in which the Department recommends that no residential intensification take place. These areas are indicated in Figure 1. It was found that risk levels in these areas were higher than desirable to allow further residential intensification to take place.

Analysis of the risk assessment results also indicates that the major contributors to the risk levels in the 'no residential intensification' areas are the activities of the Orica mercury cell chlorine plant. Development consent has been granted for this plant to be decommissioned and replaced with an inherently safer facility, with no capacity for chlorine liquefaction or bulk chlorine storage. The new plant is expected to be commissioned in 2001.

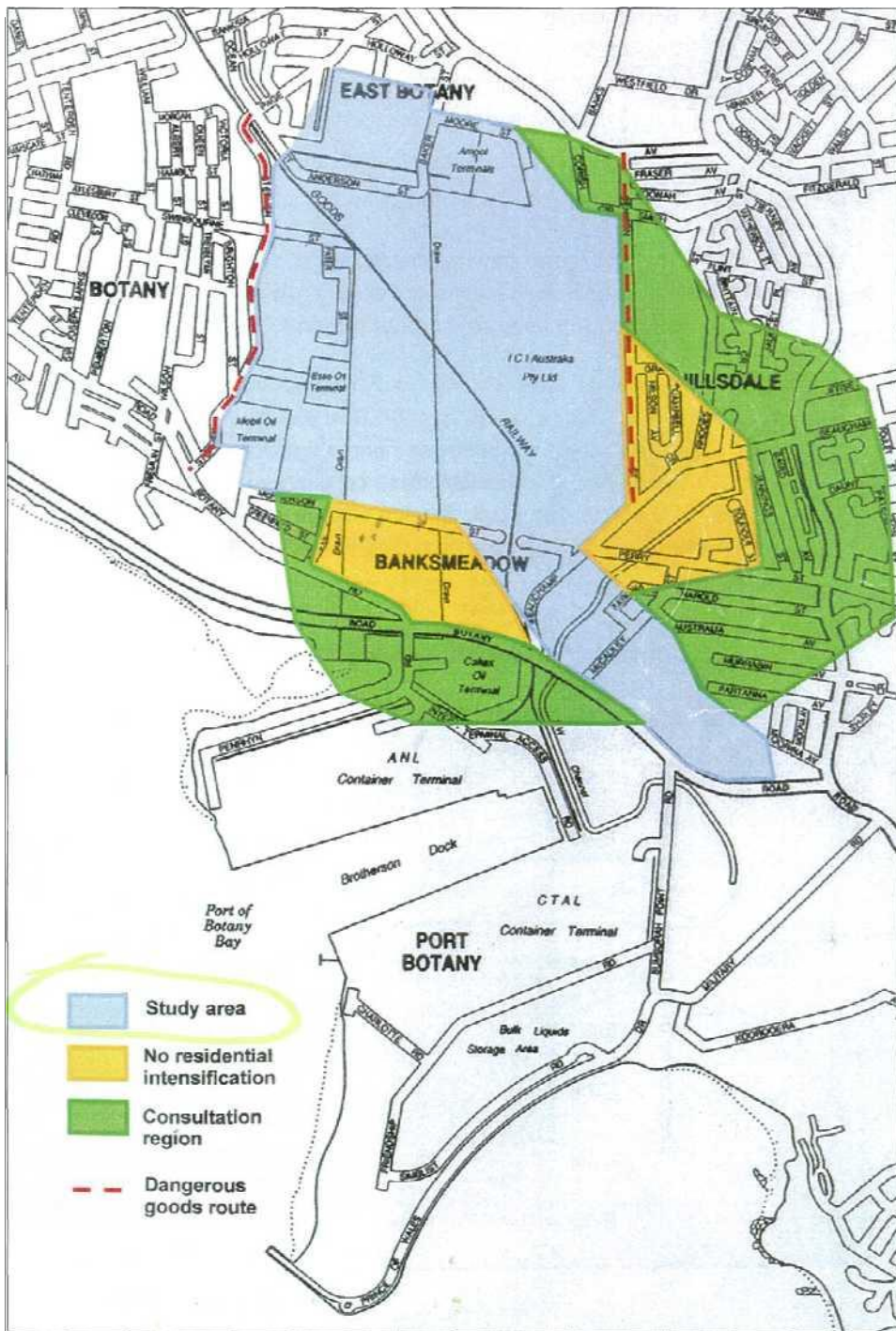
In addition to regions in which the Department recommends no further residential intensification, Figure 1 shows areas indicated as 'consultation regions'. Within these areas, results of this study indicate that, although fatality risk levels are not prohibitive to further residential intensification, there is a minor residual potential for injury or irritation to the public. This risk, although low, is sufficient to warrant the Department being consulted regarding any proposed development in this area.

if* -

For unshaded areas (as indicated by Figure 1), there are no risk-related restrictions recommended and proposed developments should undergo standard mem-based assessment on environmental impact and other non-risk related grounds.

It should be noted that risk impacts from Port Botany, Sydney Airport, or dangerous goods traffic around the industrial area are not included in the scope of this study. Stephen Road and Denison Street were identified as being significant routes for dangerous goods transport.

Figure 1. Risk reduction and consultation regions — Existing case (pre-2001)



Future case (2001)

The predicted risk levels after the replacement of the Orica chlorine plant are a further improvement on those seen for the current case. In 2001, it is expected that the risk reduction zones indicated in Figure 1 will no longer be restrictive to residential intensification. Significant fatality risk will be contained within the boundaries of the study area. There remains, however, a region for which consultation with the Department is highly recommended, as indicated in Figure 3. Within this region there is potential for public injury or irritation from hazardous incidents in the industrial complex.

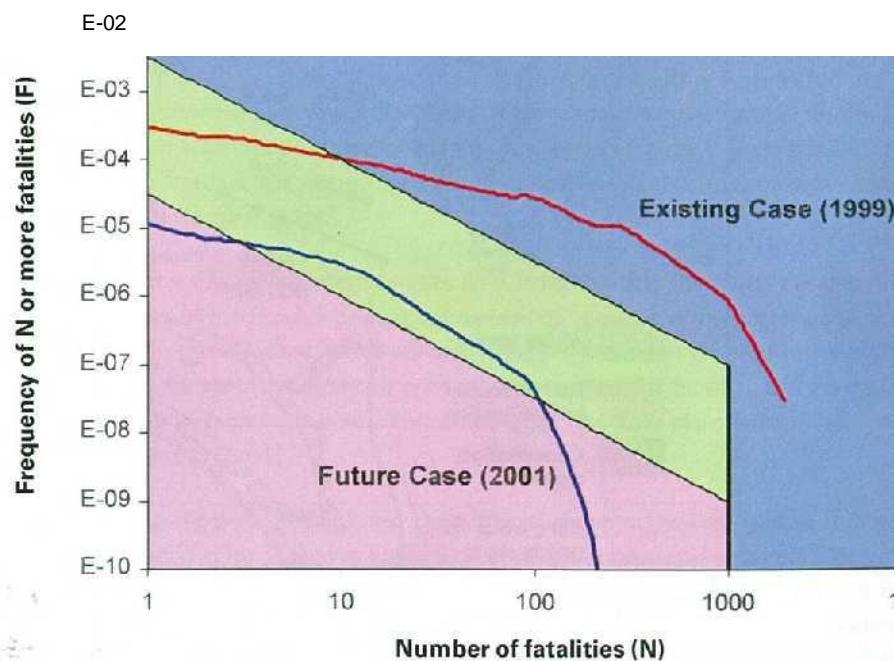
The extent of improvement between existing and predicted future cases can be clearly seen from Figure 2. Societal risk, as indicated in Figure 2, takes into account both the frequency of accidents and their severity, in terms of numbers of fatalities. The societal risk may be compared against indicative risk criteria, as used in the Port Botany study, to indicate:

- intolerable risk levels (shaded blue)
- negligible risk levels (shaded red)
- risk that is neither negligible nor intolerable (shaded green).

The risk region between negligible and intolerable is most commonly referred to as 'As Low As Reasonably Possible' (ALARP). In this case, the emphasis is placed on reducing risks as much as reasonably possible towards being negligible.

As can be seen from Figure 2, a significant reduction in societal risk is expected from the existing situation (pre-2001) to the future situation (2001). This reduction in risk is attributable to the replacement of the Orica chlorine plant. The existing plant, employing mercury cell technology, is to be replaced with a new membrane plant. Chlorine liquefaction and bulk chlorine storage on site is to cease with the replacement plant expected to be commissioned in 2001.

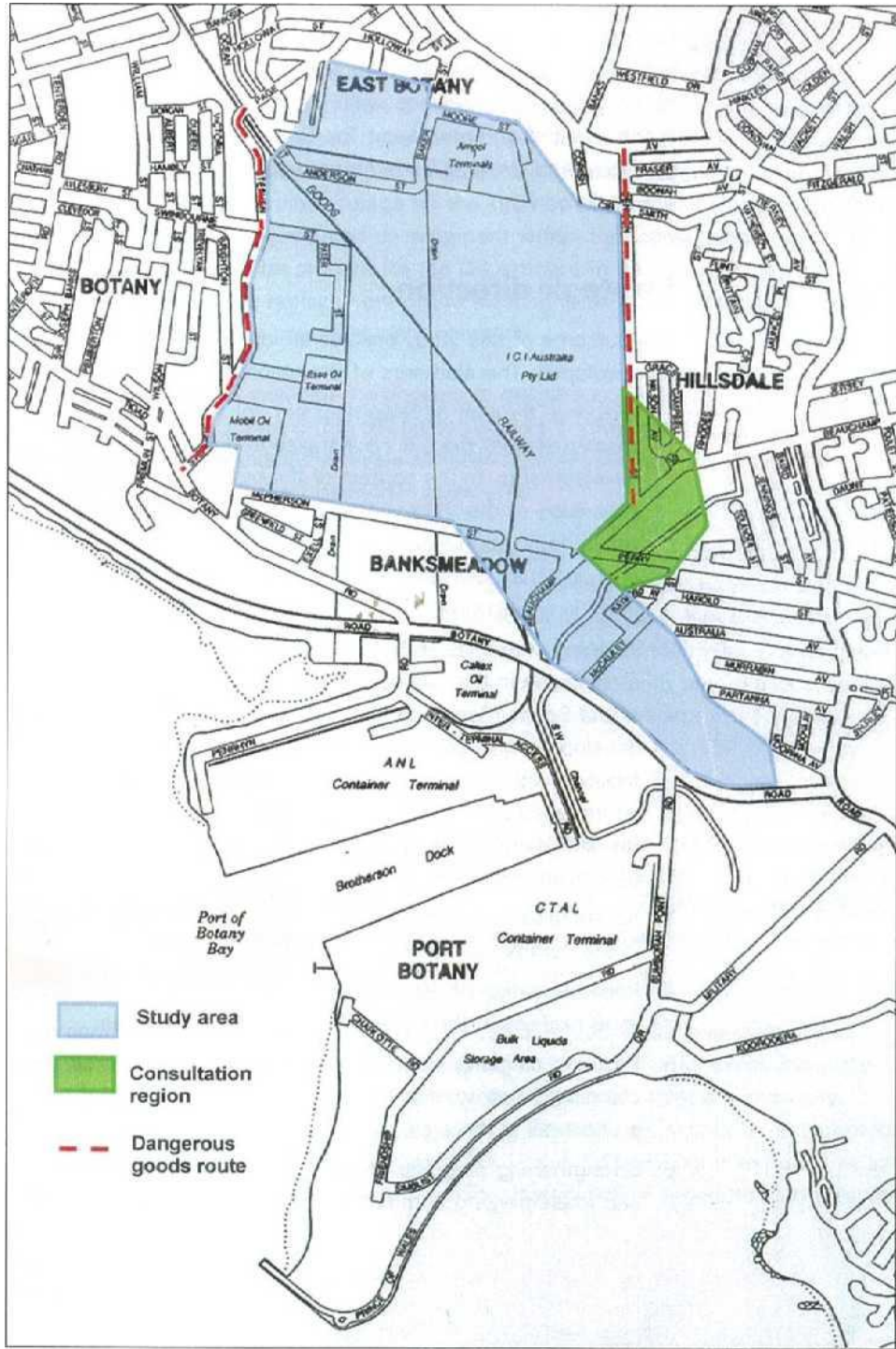
Figure 2. Botany/Randwick societal risk



if- ■

As with the existing case (pre-2001), the future case (2001) does not consider the risk impacts of dangerous goods traffic in the vicinity of the Botany/Randwick industrial complex. Major dangerous goods routes are indicated in Figure 1.

Figure 3. Consultation regions — Future case (2001)



Safety management

The study found that there was considerable variation in the scope and quality of the safety management systems for facilities within the Botany/Randwick industrial area. It was found that general improvement was required in incident/near miss reporting and follow-up procedures, with particular emphasis on determining the root cause in potentially serious cases.

Another area highlighted during this study was emergency planning within and between sites. Emergency planning was found to be adequate for on-site situations in most cases. However, there is a lack of substantial planning for incidents with the potential to affect neighbouring sites. There were no integrated emergency planning schemes between facilities within the industrial area, and no mutual aid agreements in the event of an emergency. The Department will follow up directly with site operators and relevant Government agencies to ensure appropriate updates are undertaken.

Strategic direction

The outcome of this study enables an integrated strategic land use framework to be developed. The elements of the recommended strategy are:

1. Ensuring, through development control and environmental impact assessment processes, that there is no increase in the cumulative risk from future developments. In the context of the results of this study, there should be no expansion of the 'no residential intensification' or 'Departmental consultation' zones depicted in Figure 1. Special consideration will need to be given to ensuring that, consistent with established assessment criteria and guidelines, there is no increase in risks due to interaction between various facilities.
2. Planning strategies and controls for surrounding areas should ensure that there is no increase in the number of people exposed to risk as a result of the operations of the Botany/Randwick industrial area. This involves restricting the types of development involving residential, active recreation, large commercial or sporting facilities within the 'no residential intensification' region. Similar restrictions should be imposed on the 'consultation region' of Figure 1. Societal risk implications of residential intensification in any area in the vicinity of the industrial complex should be considered when developing these strategies.
3. Issues raised under points 1 and 2 are equally applicable to the future case (2001) in the context of the shaded regions of Figure 3.
4. Implementation of risk reduction and advanced best practice risk management at all facilities in the Botany/Randwick industrial area.
5. Ensuring on-going updates and testing of emergencies and procedures and planning, adequate fire protection and prevention and coordinated emergency procedures in the area.
6. Strengthening on-going community participation, liaison and communication, and implementing community right-to-know principles and concepts.

Recommendations

Key recommendations made as a result of the findings of this study are summarised below.

Future developments within the Botany/Randwick industrial area should be subject to full risk assessment, following the seven-stage approval process. In addition, proposed developments should undergo comprehensive environmental impact assessment to conclusively demonstrate that the development will not produce off-site risks that are inappropriate for surrounding land uses.

Any future development in the vicinity of the Botany/Randwick industrial area should generally provide a buffer between the industrial area and surrounding residential zones. In assessing a proposed development, residential intensification should not be considered in the shaded region of Figure 1 until the new Orica chlorine plant is operational and bulk chlorine storage on the site has ceased. The Department should be consulted regarding proposed development within the 'consultation region' of Figure 1. It would also be prudent for the Department to be consulted regarding these regions after the replacement of the existing (pre-2001) Orica chlorine plant, at least during the early stages of plant operation.

As this study has not included the impacts of dangerous goods traffic along Stephen Road and Denison Street, or the operations of Port Botany and the Sydney Airport, it is strongly recommended that these activities be taken into account in the assessment of any development in the Botany/Randwick area.

It is recommended that all facilities investigated as part of this study review and strengthen safety management systems. These systems should be monitored by periodic independent compliance audits at intervals of not less than two years. As part of the review of safety management systems, incident/near miss reporting and follow-up procedures should be updated to be consistent with best practice. Training arrangements should be reviewed to ensure that a safety management system is supported by an employee understanding of operational hazards and emergency procedures.

Emergency procedures for facilities within the industrial area should be reviewed and updated with the aim of establishing greater consistency between the procedures at different sites. There should also be a greater level of integration between facilities in terms of regional emergency planning. An integrated emergency plan for the area should be developed and mutual aid agreements established.

The community should be adequately informed about activities, associated risks and safety management measures adopted within the Botany/Randwick industrial area. A formal mechanism needs to be established to implement a community right-to-know program. Community Consultative Committees should be established for developments, or groups of developments, in the industrial complex to act as an interface between the community and industry, particularly in regard to safety issues.

Contents

Foreword	Mi
Executive summary	v
Introduction	1
Background	1
The Botany/Randwick area	1
Planning context	2
Study description	5
Scope of the study	5
Study objectives	6
Study organisation	6
Study methodology	7
Key study outcomes	9
Preliminary screening [*]	9
Safety management audits	10
Risk assessment	11
Risk — Existing case (pre-2001)	14
Risk—Future case (2001)	14
Study implications	19
Recommendations	23
Appendix 1 — Study methodology	26
Appendix 2 — Preliminary site survey questionnaire	31
Appendix 3 ~ Typical fault and event trees	33

List of figures

1. Risk reduction and consultation regions — Existing case (pre-2001)	vii
2. Botany/Randwick societal risk	viii
3. Consultation regions — Future case (2001)	ix
4. Aerial view of Botany/Randwick area	3
5. Land use map of the Botany/Randwick industrial area and surrounds	4
6. The Multi-Level Risk Assessment approach	7
7. Societal risk contributors for non-Orica sites	13
8. Risk reduction and consultation regions — Existing case (pre-2001)	15
9. Consultation regions — Future case (2001)	16
10. Botany/Randwick societal risk	17
11. Risk analysis process	27
12. Risk screening steps	29
13. Typical event tree for a liquid leak	33
14. Fault tree — Chlorine release during start-up	34

List of tables

1. Types of facilities studied	6
2. Risk classification for non-Orica sites	9
3. Dangerous goods by site	11
4. Types of events modelled	11
5. Events with potential significant residential consequences	12
6. Selected base failure data	13
7. Facilities studied	26

1

Introduction

Background

The Botany/Randwick industrial area is a major manufacturing area of regional, state and national significance. The area includes the major Orica¹ (formerly ICI) petrochemicals complex, and a number of other activities involving the manufacture, storage and distribution of hazardous materials,

These activities have the potential to impact on public safety and the environment. Therefore, it is important that the community, Government and industry are aware of the risks associated with the various activities in the Botany/Randwick industrial area. Knowledge and understanding of the potential risks associated with operations in the area will allow integration of development opportunities and formulation of sound land use safety policies. The ultimate goal of these measures is the protection of the community and the environment.

In 1985, the then Department of Environment and Planning published a comprehensive risk assessment study for the Botany/Randwick industrial complex and Port Botany. The study estimated cumulative risk levels and associated land use safety implications in these areas. The strategy established as the result of that study involved extensive and specialised risk assessment procedures, risk mitigation and management measures, and strengthening of coordinated operational and organisational mechanisms, including emergency planning and fire protection and prevention. Developments in the areas surrounding the Botany/Randwick industrial area and Port Botany have proceeded on the basis of complying with the strategic recommendations of that study.

Since the publication of the 1985 study, there have been a number of significant changes within the industrial area. Some activities have ceased operation or been relocated and there have been significant technical improvements to a number of existing facilities. Of particular significance is a scheduled major upgrade of the Orica chlorine plant, expected to be completed by 2001. This upgrade will include a cessation of liquid chlorine manufacture and bulk chlorine storage on-site.

The Botany/Randwick area

The Botany/Randwick industrial complex and surrounding areas are primarily devoted to industrial or commercial uses. The nearest residential areas are Hillsdale, Botany, East Botany and Randwick. In some areas, residential development is within 100 metres of the industrial complex. This is particularly evident immediately to the east and the west of the industrial area, along Stephen Road and Denison Street.

¹It is noted that since the study was commenced, the Orica site has been subdivided and is now known as the Botany Industrial Park (BIP). However, since most of the work on the study was carried out in association with Orica, the Orica name has been retained for the site as a whole for the purposes of this report.

Special land uses in the vicinity of the study area include a number of schools, namely Banksmeadow Primary, Matraville Primary, Marist Brothers High and Pagewood Primary, as well as major commercial centres including Eastgardens Shopping Centre and Southport Shopping Centre. There are also various recreational land uses near to the industrial complex. These include golf courses, athletics fields and public parks. Port Botany lies to the south of the Botany/Randwick area and the Sydney Airport to the west.

Figure 4 and Figure 5, respectively, show an aerial view of the Botany/Randwick area and a land use map of the industrial complex and surroundings. The study area boundary is shown in Figure 1.

Planning context

Local planning context

The majority of the Botany/Randwick industrial complex lies within the boundaries of the Botany Local Government Area (LGA), and as such is governed by the *Botany Local Environmental Plan 1995* (LEP). Part of the region investigated in this study lies in the Randwick LGA and is covered by the *Randwick Local Environmental Plan 1998*.

The fraction of the study area within the scope of the Botany LEP is zoned 4(a) — Industrial General and is governed by the primary objective of that zoning:

...to ensure that development for industrial purposes is carried out in a manner which contributes to the economic and employment growth of the area and, in so doing, improves amenity and does not affect adversely the environment or give rise to unacceptable levels of risk in the area.

Within the Randwick LGA, the industrial complex is similarly zoned 4(a) — Industrial Zone. As a provision of the Randwick LER gazetted in 1998, proposed development in a 4(a) zone within the Randwick LGA is prohibited to include hazardous or offensive industry.

Regional planning context

In 1992, the then Department of Planning published the *Botany Bay Regional Policy Guidelines*, recognising the strategic importance of Port Botany and the Botany/Randwick industrial complex. The Guidelines make note of the community and planning concerns over levels of land use safety in the region. They recommend a balanced approach of limiting the residential population in the vicinity of the Port and industrial complex, while progressively upgrading the environmental performance of the industrial facilities.

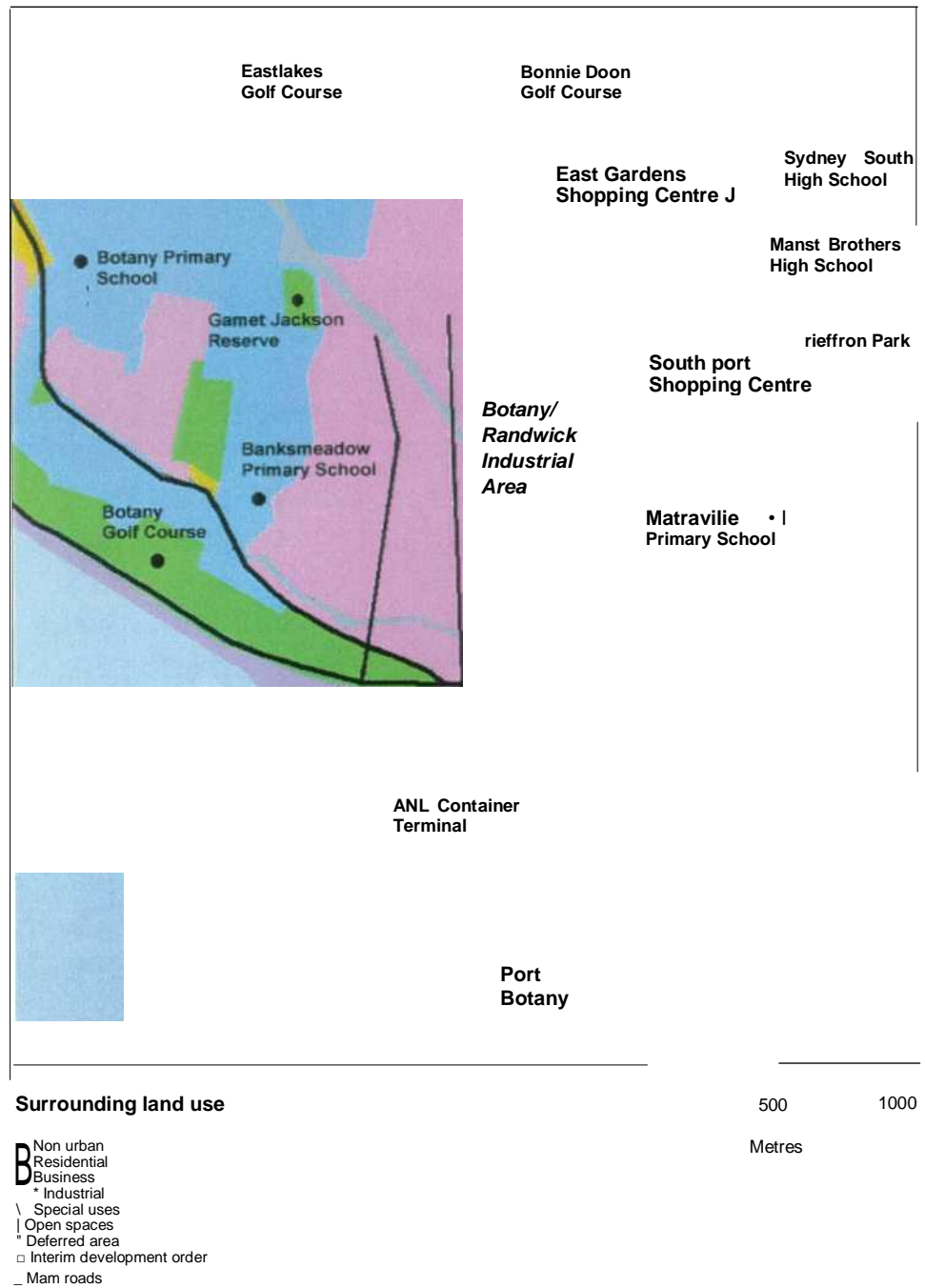
State planning context

In recognition of the state and regional importance of this area, Port Botany and the Botany/Randwick industrial complex were the subject of a direction under Section 101 of the unamended *Environmental Planning and Assessment Act 1979*, on 25 June 1991. This direction makes the Minister for Urban Affairs and Planning the consent authority for potentially hazardous and offensive developments in the Port Botany and Botany/Randwick areas. Potentially hazardous and offensive developments are defined under *State Environmental Planning Policy No. 33 — Hazardous and Offensive Development*.

Figure 4. Aerial view of Botany/Randwick area



Figure 5. Land use map of the Botany/Randwick industrial area and surrounds



Study description

Scope of the study

The current study focuses on the industrial activities within the Botany/Randwick industrial complex. In particular, focus is placed on changes in the area since the publication of the 1985 study. These changes include:

- closure of several facilities on the Orica site including the ethylene dichloride, PVC, vinyls, polypropylene and solvents plants
- closure of several facilities surrounding the Orica complex
- technical improvements and upgraded safety management systems throughout the industrial area.

The study also considers future changes to the operations within the industrial area. Two distinct cases are considered:

- current operations (pre-2001)
- future operations (2001).

The only difference between these two cases is the mode of chlorine production on the Orica site. Currently (pre-2001), a mercury cell plant is in operation and liquefied chlorine is stored in bulk stock tanks on-site. In the assessment of the 2001 case, the existing plant is assumed to have been decommissioned and a new membrane technology plant to be in operation. No liquefaction of chlorine will take place on the site in the future case. Consent was granted by the Minister for Urban Affairs and Planning on 6 November 1999 for the decommissioning of the old Orica chlorine plant and construction of the new plant. The new chlorine plant is expected to be commissioned in 2001.

The Department is not aware of any plans for significant expansion of operations of facilities within the study area beyond developments already approved. Hence no allowance for new or expanded plants has been made in risk calculations. Any future developments will be assessed on their merits and will need to be consistent with any overall policy framework developed as a result of this study.

It should be noted that the study focuses on risks from fixed facilities. Risks arising from the movement of dangerous goods by road have not been estimated. Significant movements of dangerous goods are known to take place along Denison Street and Stephen Road. The implications of this are considered in the findings and recommendations of this report.

Table 1 gives a breakdown by type of the individual facilities included in this study. It should be noted, however, that some 49 sites were considered during the initial stages of the study. Many of these sites had been decommissioned since the 1985 study, or had altered operations to no longer pose significant off-site risk. Through investigations into these plants and the process of Multi-Level Risk Assessment (MLRA), as described below, the scope of this study was narrowed to focus on eleven key facilities considered to be the major contributors to cumulative risk impacts in the Botany/Randwick area.

Study objectives

The new Botany/Randwick Land Use Safety Study has been undertaken by the Department of Urban Affairs and Planning with the main objectives of:

- updating the 1985 cumulative risk study for the Botany/Randwick industrial area, taking into account approved developments implemented since the publication of that earlier study and the assessment regime that has been applied to them
- developing a framework for efficient assessment and decision-making for future developments
- formulating a strategic land use safety framework for future developments in the Botany/Randwick industrial area and surrounding land uses
- ensuring a consistent and complementary approach to that set out in the updated Port Botany Land Use Safety Study, published by the Department in 1996.

Study organisation

The study was undertaken in liaison with industry representatives from major developments in the Botany/Randwick area. Currently accepted best-practice quantified risk assessment techniques were employed, using internationally recognised modelling tools. The key components of the study were:

- a review of the operations of facilities in the Botany/Randwick area that had the potential to pose significant off-site risks
- modelling of possible incident scenarios (more than 5000 events were modelled)
- estimation of the effect of major incidents and their likelihood of occurrence
- quantification of cumulative risk
- development of strategic recommendations based on the risk analysis.

Table 1. Types of facilities studied

Type of facility	Site studied
Bulk liquid storage	<ul style="list-style-type: none"> • BP Oil • Mobil
Liquefied gases	<ul style="list-style-type: none"> • Air Liquide • BOC Gases
Chemical manufacture	<ul style="list-style-type: none"> • Orica Chlorine and Derivatives (including chlorine liquefaction and storage for the existing case (pre-2001)) • Orica Ethylene Oxide and Derivatives • Orica Polyolefines • Nuplex Resins • Solvay Interox • Nalco
Miscellaneous	<ul style="list-style-type: none"> • Amcor

Study methodology

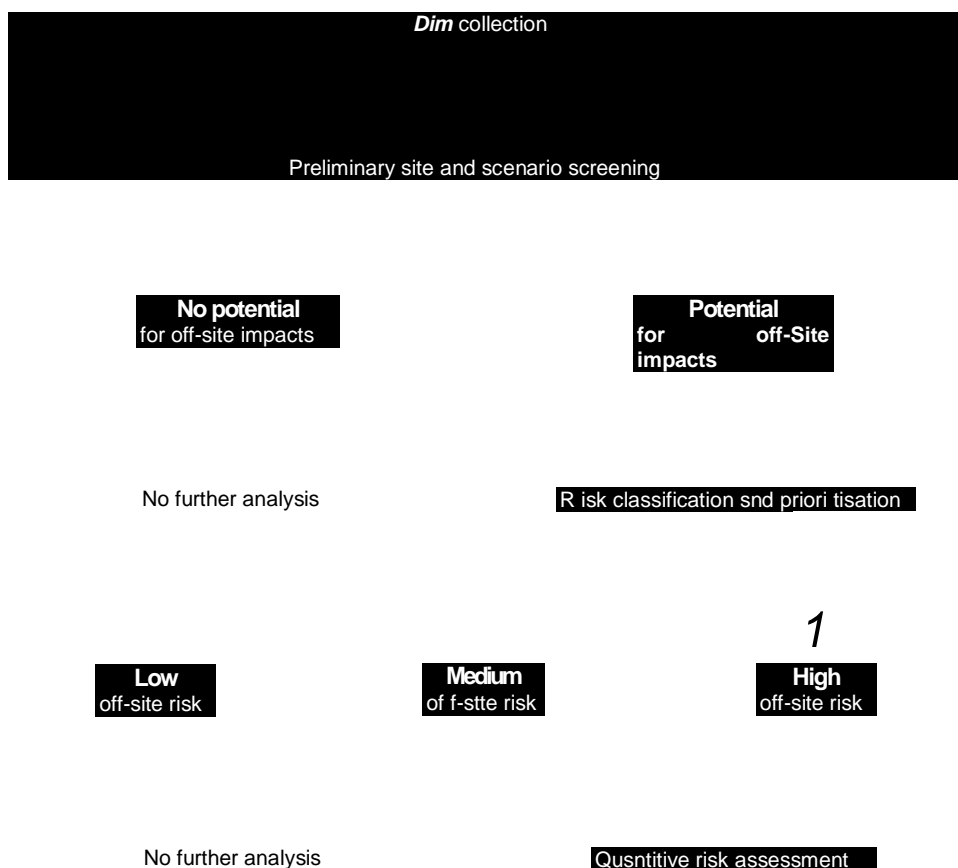
The study methodology is briefly outlined below. Appendix 1 provides more detailed information on the study process,

Screening

The Botany/Randwick Land Use Safety Study has been undertaken following the principles of MLRA. The MLRA process involves screening of possible hazards scenarios to establish those events that have potential for significant off-site impacts. This screening process allows only those events with significant off-site impacts to be incorporated into the Quantitative Risk Assessment (QRA). Through this screening process, the focus of the study was concentrated on significant hazards issues in the Botany/Randwick area. The MLRA process is illustrated below in Figure 6. The Department's publication *Multi-Level Risk Assessment* (Department of Urban Affairs and Planning, 1997) provides further information on the principles and application of MLRA.

Initial data collection for the study included a review of hazards studies undertaken for various sites within the Botany/Randwick area as part of the approval process for hazardous industry in NSW. In addition, industries were also asked to complete a questionnaire to provide site background information, details of plant operations and types and quantities of any dangerous goods utilised on site. A copy of the questionnaire is provided in Appendix 2.

Figure 6. The Multi-Level Risk Assessment approach



Risk prioritisation was based on a risk classification and prioritisation method developed by the United Nations (UN). The UN method, which is described in more detail in *Multi-Level Risk Assessment* (Department of Urban Affairs and Planning, 1997), produces a broad estimate of the risks due to major accidents from the manufacture, storage, handling and transport of dangerous goods. The dangerous goods activities are firstly classified by such factors as type, location and quantity. This information is then used to generate an approximate estimate of societal risk, which forms a basis for prioritising the further analysis. Results are expressed as annual Potential Loss of Life (PLL).

The Botany Industrial Park (Orica complex at the time of this study) has previously been recognised as the major contributor to off-site risks within the study area. As such, the Department considered it necessary to subject all plants in the Orica complex to a full Quantitative Risk Assessment (QRA). Other industrial operations in the area were subject to a preliminary evaluation using the Multi-Level Risk Assessment process to establish scenarios for which a QRA was necessary. This differentiation between the Orica complex and other industry also facilitated the future case (2001) investigation, which differed from the current case (pre-2001) only in the mode of Orica's chlorine production.

Results from the consideration of the Orica complex and other significant industrial developments were combined to indicate the cumulative risk impacts from the Botany/Randwick industrial area on surrounding land uses.

Risk assessment

The Quantitative Risk Assessment performed for sites and scenarios identified as potentially posing significant risk to off-site areas followed the guidelines presented in the Department's publication *Hazardous Industry Advisory Paper No. 6— Guidelines for Hazard Analysis*.

After screening sites and scenarios according to the principles of MLRA, the likelihood and consequences of significant scenarios were estimated to assess the resulting off-site risks. Risks were assessed on the basis of the generally accepted land use safety guidelines provided in *Hazardous Industry Planning Advisory Paper No. 4— Risk Criteria for Land Use Safety Planning*. Appendix 1 provides a more detailed explanation of the risk assessment process adopted for this study.

Format of results

The results of hazard analyses are typically depicted as risk contours around a particular study area. These contours are intended to present the likelihood of fatality at a particular distance from the study area. As these contours can often be misleading and difficult to interpret, the Department has chosen to show the results of this study in terms of areas in which further residential intensification is not recommended. In this manner, the intent and results of this study are clear, available and easily interpreted by the public, industry and authorities.

Key study outcomes

Preliminary screening

Some 49 sites were investigated during the initial stages of this study. Of these, 14 were distinct plants or areas within the Orica complex. The remaining 35 non-Orica sites were identified based on plants investigated for the 1985 study, knowledge of the Botany/Randwick area and through consultation with industry representatives. These sites were subject to preliminary screening according to Multi-Level Risk Assessment (MLRA). As a result of the screening process, eight sites were identified as having the potential to produce significant off-site risk impacts. Results of preliminary classification and prioritisation of the risk from each site using the UN method are summarised below in Table 2. Potential Loss of Life (PLL), as described in the preceding section of this report, is an initial estimate of societal risk, that is the potential for a site to cause a fatality. These approximate values are used to prioritise sites for further analysis.

It should be noted that the PLL values indicated in Table 2 are not absolute, and have been calculated for comparative purposes only. Further, calculations were made using very conservative assumptions and therefore PLL values represent a worst-case scenario.

Table 2. Risk classification for non-Orica sites

Screening Result (PLL) Site

> 6 x 10⁻⁶ per annum

> 1 x 10⁻⁵

< 1 x 10⁻⁶

Negligible

e

BP Oil

Nalco

Mobil

Nuplex Resins

Amcor

Solvay Interox

BOC Gases

Air Liquide

Safety management audits

At the commencement of this study, industrial sites in the Botany/Randwick area completed the questionnaire presented in Appendix 2. The primary purpose of this questionnaire was as a familiarisation tool to provide a better understanding of each of the sites and the potential hazards involved with each. The data provided also allowed preliminary screening of sites and specific activities.

The information obtained through these questionnaires was sufficient for general observations regarding the safety management systems for sites within the Botany/Randwick industrial complex to be made. The observations were made by comparing safety management systems between sites and against safety management best practice.

Incident reporting and investigation

All sites had a formal site safety policy with documented procedures for reporting incidents and near misses. There was, however, considerable difference between sites with regard to the quality of the reporting system and the depth to which reports are investigated.

A number of sites employed a formal review process, with ranking of the severity and potential impacts of an incident determining the extent of investigations and subsequent actions required. Generally, follow-up systems were good for most sites, although at some sites this aspect still required attention.

Emergency procedures

The primary concern relating to emergency procedures for sites in the Botany/Randwick area was the lack of integration between the sites. Although all sites had documented emergency procedures with contact numbers for neighbouring sites in the event of substantial off-site impacts, there was no common approach to emergencies in the area. There was no common framework for emergencies involving more than one site, and no mutual aid arrangements existed between sites. Communications systems and procedures between plants were reasonable, although in some cases contact details were not well maintained.

Site safety committees

Safety committees existed for all industrial facilities in the Botany/Randwick area. The size of the committee was generally dictated by the size of the facility that it served. As with emergency procedures for sites within the industrial complex, there is little coordination between safety committees for different sites.

Quality assurance

Most sites within the area are accredited under the ISO 9001 Quality Assurance system. At the time of this study, two of the sites investigated were ISO 9002 endorsed with internal and external quality audits conducted on the facilities. For all sites, a controlled document system was in place for safety manuals and procedures.

Risk assessment

The dangerous goods identified for each of the sites within the study area are given in Table 3.

Table 3. Dangerous goods by site

Site	Dangerous goods
Orica Chlorine	Flammable gas
	Flammable gas
Orica Ethylene Oxide	Flammable gas
Orica Polyolefines	Flammable gas
Air Liquide	Flammable gas
BOC Gases	Flammable liquid
Amcor	Flammable liquid
BP Oil	Combustible liquid
Mobil	Corrosive liquid
	Toxic liquid -
Nalco	Flammable liquid
	Oxidising agent
	Flammable liquid
	Flammable gas
Nuplex Resins	Toxic liquid
	Oxidising, agent
^.....
	Fla ⁴ mmable gas
Solvay Interox	Flammable liquid
	Toxic liquid
	Oxidising agent
	Corrosive liquid
	Corrosive substance
Flammable gas	

The outcomes of any major incident will be dependent on the materia l (s) involved. Table 4 summarises the most significant types of events modelled during the course of this study, and the materials class to which they are most commonly associated.

Table 4.Types of events modelled

Material class	Event
Toxic gas	Gas cloud dispersion
Flammable gas	Vapour cloud explosion
	Flash Fire
	Fireball
	Jet fire
Flammable liquid	Pool fire
	Vapour cloud explosion

Of the major types of events listed in Table 4, the most significant, in terms of their potential effects outside the Botany/Randwick industrial area, are:

- toxic gas releases from containers and drums
- fires from ruptures of major flammable liquids stores
- fires arising from LPG pipeline leaks.

Consequences

As previously described, hazards identified as a result of site questionnaires and industry consultation meetings were subjected to a screening process to eliminate those scenarios that could not produce credible off-site impacts. Over 5000 were ultimately modelled on the basis of the identified hazards.

Table 5 summarises those events with the highest potential consequences for land uses in the vicinity of the Botany/Randwick industrial complex (existing case, pre-2001). The data presented have been ranked according to severity index in order to highlight the relative magnitudes of individual events. The severity index is a relative measure of the consequence of a particular event, in terms of average potential human fatalities per event, relative to the event with the worst consequence. In this case, the worst event is the rupture of a chlorine stock tank, assigned a severity index of 100.

In interpreting the data presented in Table 5, care should be taken to differentiate between *likelihood* and *consequence*. Although the consequence of a chlorine stock tank rupture is very high relative to other feasible incidents, the likelihood of the event ever occurring is quite low. The likelihood of spontaneous failure of a stock tank through material failure or natural disaster is significantly lower than the likelihood of a chlorine drum being dropped and rupturing.

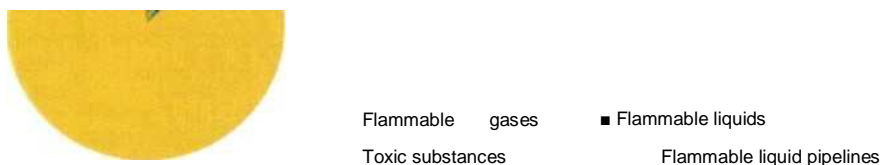
A vapour cloud explosion from an ethylene storage sphere involves the ignition of accumulated ethylene that has leaked from a 100 mm hole in a storage sphere. This event could have heat radiation effects beyond the boundary of the study area, but the likelihood is relatively low. Similarly, a propylene Boiling Liquid Expanding Vapour Explosion (BLEVE), or catastrophic failure of a propylene storage vessel, accompanied by fire, could have heat radiation effects beyond the study area; but, again, the likelihood of this incident occurring is low. Risk mitigating measures are in place to reduce the potential frequency of these events in the Botany/Randwick area.

Table 5. Events with potential significant residential consequences

Contributor	Severity index (per event)
Rupture of 20 tonne chlorine stock tank	100.00
Rupture of chlorine road tanker	48.00
Vapour cloud explosion from (100 mm)	ethylene sphere leak 0.24
BLEVE of 80.5 tonne	propylene vessel 0.06
Chlorine drum rupture	0.03

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Figure 7. Societal risk contributors for non-Orica sites



An important fact highlighted by the data in Table 5 is that major contributors to cumulative risk levels in the Botany/Randwick area are releases of toxic chlorine gas. Replacement of the Orica chlorine plant, in particular the removal of chlorine liquefaction and storage on-site, will reduce the *likelihood* of chlorine releases occurring, as well as the *consequence* of a chlorine leak, by reducing the quantity of chlorine that may be released at any one time.

Risk impacts from the release of toxic gases are primarily associated with the existing (pre-2001) mercury cell chlorine plant in the Orica complex. This can be seen from Figure 7, which depicts the contributions to societal risk for activities undertaken by non-Orica sites. It was found that the Orica complex was clearly the most significant contributor to cumulative risk levels in the Botany/Randwick area. Risk contributions from non-Orica sites, although significant in terms of the absolute magnitude of the risk (in the context of land use safety planning criteria) were relatively low compared with those impacts from Orica. The major risk impact outside of Orica is associated with pipelines between the industrial area, Port Botany and Kurnell, used to transfer flammable liquids. Major incidents involving these pipelines include pool fires and vapour cloud explosions.

Likelihood

The likelihood of credible events with significant off-site impacts was estimated using a combination of basic failure frequency and fault or event trees. Failure frequency data were rigorously checked by the Department against a number of sources to ensure the validity of the data used. Particular care was taken to ensure that the figures used were relevant to the types of facilities being studied. Selected base failure frequencies used in the study are shown in Table 6. Appendix 3 provides examples of fault and event trees.

Table 6. Selected base failure data

Incident failure	Frequency
Chlorine tank rupture	4.8 x 10 ⁻⁷ p.a
Chlorine tank leak (liquid, 25 mm)	2.04 x 10 ⁻⁵ p.a
Chlorine tank leak (gas, 25 mm)	3.63 x 10 ⁻⁵ p.a.
Chlorine drum rupture	6.5 x 10 ⁻⁶ p a
Pressure vessel leak (5 mm)	3.7 x 10 ⁻⁵ p.a.
Pressure vessel leak (100 mm)	9.7 x 10 ⁻⁴ p.a
300 mm pipeline rupture (full bore)	5.8 x 10 ⁻⁴ per metre p.a.
300 mm pipeline leak (25 mm)	8.5 x 10 ⁻⁷ per metre p.a.
Flange leak (5 mm)	3.6 x 10 ⁻⁴ p.a.

Risk — Existing case (pre-2001)

The results of the Quantitative Risk Assessment for the existing case are shown in Figure 8. The shaded regions to the south-east and south-west of the study area indicate those regions in which the Department recommends that no residential intensification should occur. This recommendation is based on the fact that the cumulative risk levels were found to be elevated above generally accepted land use safety guidelines for the land uses in those areas.

The initial assumption that the Orica complex is the major contributor to cumulative risk impacts in the area was found to be correct. Further, the risk reduction zones indicated in Figure 8 are primarily a result of the operation of the existing Orica chlorine plant, employing mercury cell technology. Generally, other plants within the Orica complex and other industrial sites in the Botany/Randwick area do not significantly influence cumulative risk levels outside the boundaries of the study area, beyond accepted land use safety criteria for land uses in these regions.

Figure 8 also shows shaded areas labelled as 'consultation regions'. Although the results of the QRA for this study did not indicate that risk levels in these regions exceeded generally accepted land use safety guidelines, the cumulative risk levels were still considered significant. Development in these areas should be assessed in the context of this report, and it is highly recommended that the Department be consulted regarding any development proposal within, or in the immediate vicinity of these areas.

A comparison of the off-site risk impacts calculated as part of this study with results of the 1985 investigation indicate a significant improvement in overall risk from the industrial complex in the past fifteen years. Areas of Botany and East Botany (to the north and north-west of the study area) that were within the risk reduction zone of the 1985 study are no longer affected by risks from fixed sites within the complex. The risk reduction zones to the south-east and south-west of the study area have also contracted since 1985. It should be noted, however, that there is significant dangerous goods traffic on Stephen Road and Denison Street, and the possible risk implications of this traffic have not been included in this study. These routes are indicated in Figure 8.

Risk - Future case (2001)

With the installation of a new chlorine plant on the Orica site, there will be no further chlorine liquefaction or permanent fixed chlorine storage on the site. There will be some transient storage of bulk tankers, cylinders and drums. As a consequence of this change, there will be a significant reduction in risk from the complex, such that **no areas outside the study boundary will be subject to a significant fatality risk.** Therefore, the restrictions shown in the shaded areas of Figure 8 will no longer apply. There is an area, indicated in Figure 9, for which the Department should continue to be consulted regarding development proposals. Within this area, there is a minor likelihood of community injury and irritation, even after the replacement of the Orica chlorine plant. Previous comments with respect to possible impacts from dangerous goods movements by road still apply.

Figure 8. Risk reduction and consultation regions – Existing case (pre-2001)

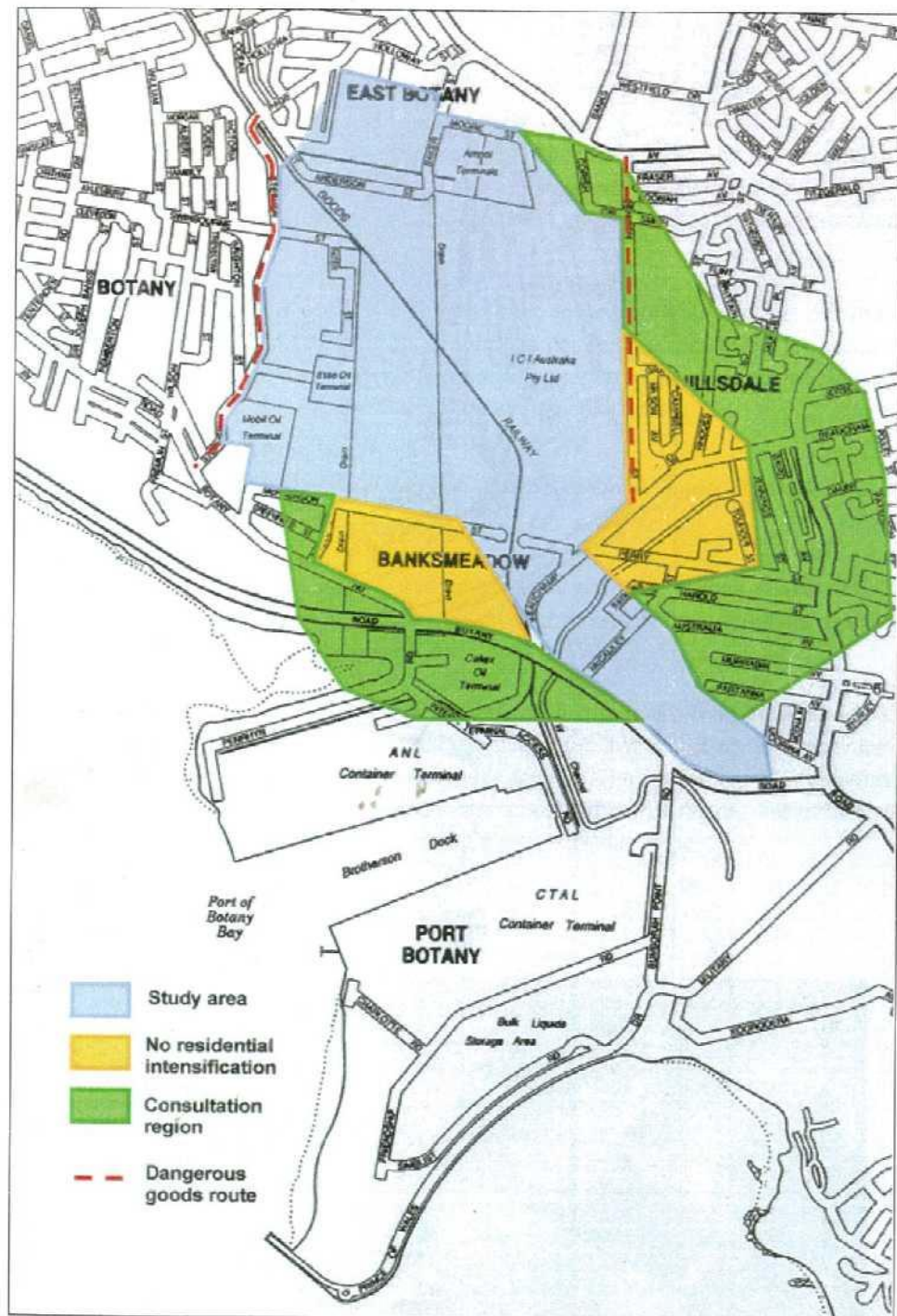
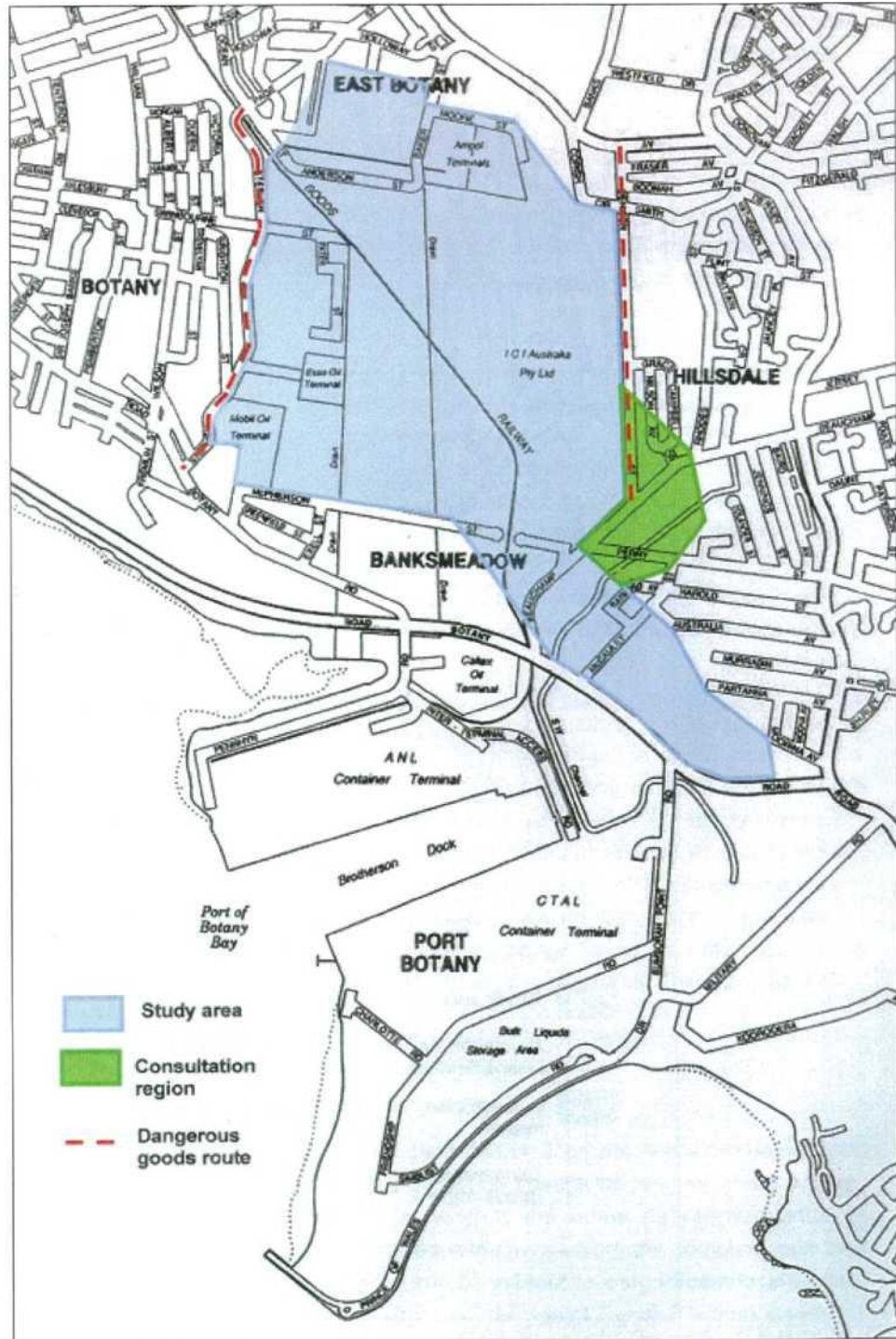


Figure 9. Consultation regions — Future case (2001)



The extent of the improvement between the existing and predicted future cases can be seen from Figure 10, which shows societal risk before and after the installation of the new chlorine facility. The results clearly show the markedly reduced impact into residential areas following the installation of the new chlorine plant-

While individual risk (as was used in the preparation of Figure 8 and Figure 9) measures the likelihood of a particular location experiencing a specified level of harm, societal risk takes into account the number of people that could be affected by the hazardous events. Societal risk is typically presented as an F-N curve (such as in Figure 10), which is a plot of cumulative frequency of accidents versus consequences, measured as fatalities.

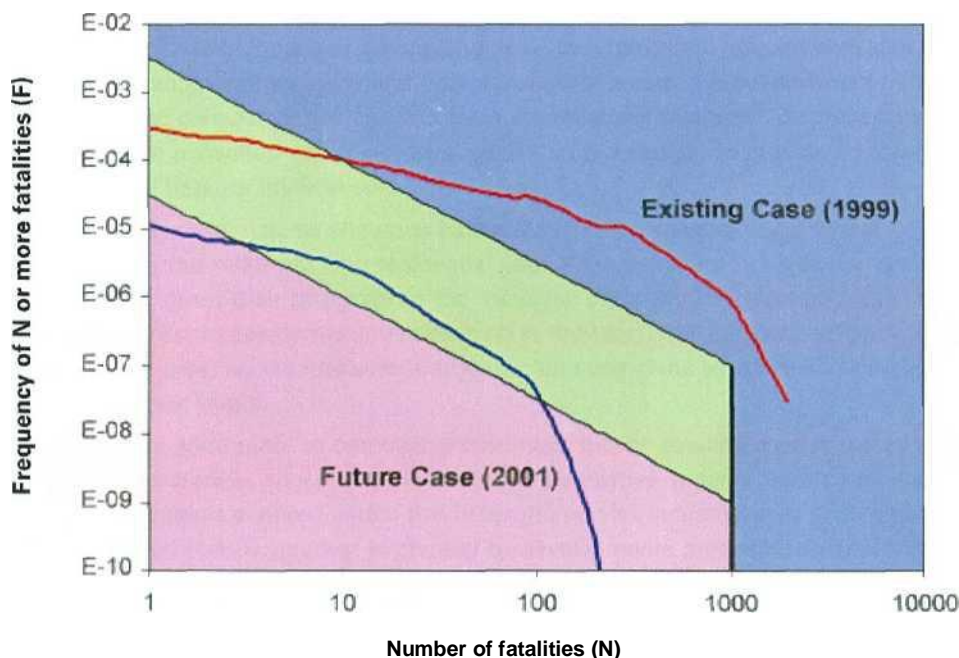
The setting of societal risk criteria is a complex task on which there is not yet common agreement. The New South Wales Government has not set specific criteria for societal risk, although an 'As Low As Reasonably Possible' approach is gaining increasing recognition. Such an approach identifies three societal risk bands:

- Negligible (shaded red in Figure 10)
- As Low As Reasonably Possible (ALARP) (shaded green in Figure 10)
- Intolerable (shaded blue in Figure 10).

The limits of each region are a composite of generally accepted criteria. It should be emphasised, however, that these criteria are illustrative only for the purposes of this study and do not represent a proposed position for NSW.

Within the negligible region, provided other individual criteria are met, societal risk is not considered significant. The intolerable region indicates that an activity is undesirable on the basis of risk, even if individual risk criteria are met. The ALARP region represents risk somewhere between negligible and intolerable. Within this region, the emphasis is on reducing risks as far as possible towards the negligible region

Figure 10. Botany/Randwick societal risk



Study implications

The key implications of the study can be summarised into four categories:

- risk from Botany/Randwick industrial area activities
- land use conflict planning and future development
- industrial safety management
- community awareness and consultation.

While some comparisons may be made between the current results and those from the 1985 study, it is noted that strict comparisons may not be valid due to the changes in calculation methods and result presentation methodologies in the period between the studies.

Risks from the Botany/Randwick industrial area activities

1. While there has clearly been a marked improvement in cumulative risk levels since the 1985 study was conducted, some areas in the vicinity of the industrial complex are still subject to a higher level of risk than that considered tolerable from new industrial facilities. These areas are shown in Figure 8 as areas in which no residential intensification should take place. Residential development in this area will need to be restricted, at least until the existing Orica chlorine plant is decommissioned and chlorine liquefaction and storage cease.
2. There is a broad region around the 'no residential intensification' zone in which cumulative risk levels are considered to be significant, but not entirely prohibitive to development. Proposed developments in this region will require consideration of the findings of this study and rigorous assessment of the development in the context of cumulative risk impacts from the industrial complex. The Department should be consulted regarding development in this region, to provide advice on industrial hazards implications.
3. Existing societal risk, as shown in Figure 10, is at an undesirably high level, reflecting the relatively high residential population densities in Matraville and Hillsdale, given their proximity to the industrial complex. This highlights the need to restrict residential intensification in the vicinity of the Botany/Randwick industrial area, and to implement strategic land use plans to avoid increases in societal risk levels.
4. The major contributor to cumulative risk levels for the existing case is the storage of toxic materials, specifically chlorine. The cumulative impacts from an increase in toxic materials stored within the Botany/Randwick industrial area should be considered before approval is granted to developments proposing such storage increases.

5. Once the new Orica chlorine plant is commissioned, the off-site risk from the industrial complex is expected to contract, so that a significant individual risk from the industrial area does not significantly encroach onto any neighbouring residential areas. Although the 'no residential intensification' zone will no longer exist, development proposals in this area should be assessed with consideration for potential residual risk levels and strategic land use planning goals.
6. For the future case (2001), societal risk has been reduced so that it is close to the negligible region. As a consequence, the need to limit residential development close to the industrial area, on the grounds of risk posed by fixed plant operations, is greatly reduced. High residential densities should still be avoided due to potential societal risk implications.
7. The assessment did not include risks from dangerous goods transportation on the roads surrounding the industrial area, nor risk from the operations at Port Botany and the Sydney Airport. The fact that a property is located outside a region in which it is recommended that there be no residential intensification does not necessarily indicate the suitability of that site for development. A merit-based assessment should still be applied.

Land use conflict planning and future development

1. Future development in the Botany/Randwick area must be assessed on the basis of strategic land use conflict planning. Land uses in the immediate vicinity of the industrial area should generally provide a buffer between industry and residential areas.
2. Residential and industrial development needs should be reconciled such that future industrial developments are only approved provided no significant off-site impacts will result from such developments.
3. The Department should be consulted regarding any proposed residential development in the vicinity of the industrial area and, in particular, any future development within or near the 'Departmental consultation' and 'no residential intensification' zones.
4. In addition to the findings of this study, the implications of any dangerous goods traffic should be taken into account when assessing future developments in the vicinity of the study area.
5. New or expanded facilities for the handling of toxic materials, particularly chlorine gas, are generally inappropriate within the Botany/Randwick area.

Safety management

1. The overall standard of safety management and safety awareness varies from site to site within the industrial area, and there is some room for improvement on a number of sites.
2. Areas in which there is a general need for improvement include:
 - quality and extent of incident and near miss reporting systems
 - follow-through of hazards issues arising from the incident and near miss reporting systems
 - consideration of the potential for emergency situations involving more than one plant in the industrial complex, and a response plan in the event of such situations
 - the purpose and integration of safety committees.
3. There is no integrated emergency plan for the Botany/Randwick industrial area, and no mutual aid agreements existing between facilities.

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Community awareness and consultation

1. There is a high degree of community concern over the level of public risk associated with the operations of the Botany/Randwick industrial area. There is a need to strengthen on-going community participation, liaison and communication associated with the implementation of community-right-to-know principles.
2. While some industrial developments in the Botany/Randwick complex have established community consultation mechanisms, there is generally a lack of interaction between industry and the public. There is a need for the establishment of more formalised Community Consultative Committees, through which industry can keep the local community informed regarding issues that may affect the public, and the community can voice any concerns it may have related to the impacts of the particular development. In some cases, it may be appropriate for a Community Consultative Committee to represent a group of related sites, rather than a single development.

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1. Future developments in the Botany/Randwick industrial area should be

Recommendations

subject to early risk assessment and comprehensive environmental impact processes to conclusively demonstrate that they will not contribute to risk impacts outside the industrial area that are inappropriate for surrounding land uses.

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1.1 There should be no significant increase in the quantities of toxic compressed or liquefied gases stored or handled within the industrial area.

1.2 Proposals to expand industrial facilities in the area should be subjected

3 to the seven-stage assessment process under the *Environmental Planning and Assessment Act 1979* and demonstrate compliance with relevant

risk criteria.

1.3 The Director-General's requirements for the preparation of an Environmental Impact Statement (EIS) should incorporate the above requirements to ensure appropriate assessment is carried out.

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1.4 Should conditions in the Botany/Randwick industrial area change to a significant degree, through facility commissioning, decommissioning, expansion or production changes, this study should be updated to reflect potentially altered cumulative risk impacts on surrounding land uses.

2. Effective land use safety planning should be implemented to allow for future development in the area, and to reconcile any potential land use planning conflicts.

2.1 Development in the vicinity of the Botany/Randwick industrial area should generally reflect land uses that provide a buffer between the industrial area and its surrounding residential areas.

2.2 Normal merit-based assessment procedures should be applied to all development applications outside those areas of Figure 8 in which it is recommended that there be no residential intensification. Where the proposed development lies within an area labelled as a consultation region in Figure 8, the Department should be contacted during the assessment process to establish the implications of risk impacts from the Botany/Randwick industrial area on the proposed development.

2.3 There should generally be no residential intensification in the designated regions in Figure 8 until the new Orica chlorine plant is operating and liquid chlorine facilities have been decommissioned.

2.4 Particular consideration should be given to the possible effect of dangerous goods traffic when assessing residential development in Stephen Road, Denison Street and any other roads carrying significant volumes of dangerous goods traffic.

- 3. A process of regular reviews and updates for site safety management systems should be undertaken.**
 - 3.1 All sites should review and strengthen their safety management system (SMS). The effectiveness of the SMS should be monitored by periodic independent compliance audits at intervals of not less than once every two years.
 - 3.2 An overall review of incident/accident recording and reporting systems should be undertaken. A consistent best practice guideline should be developed and adopted by industry in the area.
 - 3.3 All sites should review their training arrangements to ensure that personnel have an appropriate understanding of operational hazards and are fully trained in operating and emergency procedures.

- 4. Emergency plans and procedures, and fire prevention and protection systems should be kept up to date.**
 - 4.1 Emergency plans for all sites should be reviewed and updated. There should be emphasis placed on developing emergency plans that are consistent between facilities.
 - 4.2 Industrial facilities should develop greater contact with regard to emergency planning. An integrated emergency plan for the industrial area needs to be developed, and mutual aid arrangements between facilities need to be investigated in more detail.
 - 4.3 Consideration should be given to holding periodic coordinated surprise emergency field exercises to validate emergency procedures and practices.

- 5. Industrial facilities should adopt community right-to-know principles to ensure the community is adequately informed about activities, associated risks and the safety management measures adopted within the Botany/Randwick industrial area.**
 - 5.1 A formal mechanism should be established to implement a community right-to-know program through a consultative committee having representation from the industrial developments in Botany/Randwick, Councils, community groups and relevant government agencies.
 - 5.2 Priority should be given to regular dissemination to the community of information relating to safety and environmental management and performance through regular annual reporting, newsletters and public forums.
 - 5.3 Existing industrial developments should be encouraged to establish Community Consultative Committees to facilitate the dissemination of information to the public and to receive feedback from the community related to the industry's performance. Where practical. Community Consultative Committees established for similar types of industry or developments in the same general locality should be encouraged.
 - 5.4 For new industrial developments, conditions of consent should require the formation of a Community Consultative Committee for the development, or its representation on an appropriate existing Committee.

Appendices

Appendix 1 — Study methodology

The study covered industrial developments within the Botany/Randwick industrial area and the surrounding land uses. The scope of the assessment included off-site risk from existing and approved future operations, but excluded general occupational health and safety matters. Dangerous goods traffic in the vicinity of the industrial area was not within the scope of this study.

Table 7 gives a breakdown of the facilities studied and the operations performed by each.

Table 7 Facilities studied

Facility	Type of operation
Orica Limited	Produces chlorine and derivatives, ethylene oxide and derivatives, polyolefines group and utilities.
Air Liquide Australia	Cryogenic plants producing gaseous and liquid oxygen, nitrogen, hydrogen and argon.
BOC Gases	Processes, stores and distributes carbon dioxide and hydrogen.
Amcor Paper	Recycles waste paper to produce cardboard. LPG is used for forklifts and at the time of this study liquid chlorine was used for water treatment.
BP Oil	Stores and distributes refined petroleum products. Stores, packages and distributes lubricating oil. Connected to the Port Botany Bulk Liquids Berth and JUHI by pipeline.
Mobil Oil	Stores and distributes refined petroleum products. Stores, packages and distributes lubricating oil. Connected to the Port Botany Bulk Liquids Berth and JUHI by pipeline.
Nalco	Manufactures and stores specialty water treatment chemicals.
Nuplex Resins	Manufactures synthetic resins including alkyd resins, emulsion polymers, polyester resins and hard resins.
Solvay Interox	Manufactures, stores and packages hydrogen peroxide.

The sites within the study area were divided into two groups:

- the Orica complex
- other facilities in the industrial area.

Methodology for the Orica complex

For the Orica complex, the study was conducted in three stages:

- cumulative Quantitative Risk Assessment (QRA) of existing facilities
- cumulative QRA for future facilities on the site
- consideration of findings to produce technical and policy recommendations.

Based on experience with hazards issues in the Botany/Randwick area, the Department considered a full QRA was warranted for the Orica complex. Multi-Level Risk Assessment (MLRA) was employed to screen other industrial facilities in the area.

The following approach to the Orica QRA was followed for both the existing (pre-2001) and future cases (2001).

Background information related to the site was gathered from existing hazard studies and site familiarisation visits. Orica provided technical information, including flow diagrams, process and instrumentation diagrams (P&IDs), materials inventories and equipment specifications.

The Quantitative Risk Assessment procedure used for this study is fully explained in *Hazardous Industry Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis*. The procedure is conceptually depicted in Figure 11.

The Orica site was further broken down into three main production areas:

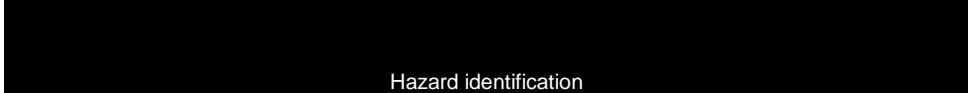
- Chlor-alkali and derivatives
- Ethylene oxide and derivatives
- Polyolefines group.

Individual QRAs were undertaken for each plant within the three production areas. The results were combined to produce cumulative risk results for each production area and the site as a whole. The methodology employed for each production area is summarised below.

Hazard identification

For each activity, the possible initiation, development and consequences of incidents, as well as any mitigating factors, were systematically considered. Hazard identification techniques included drawing on past experience, hazard and operability studies (HAZOP), fault tree analyses and event tree analyses. For this study, hazard identification was carried out using hazard identification sheets. These were completed for all plants on the site, all significant types of hazards and all classes of dangerous goods. This information was rigorously checked by Orica's consultants to ensure accuracy.

Figure 11. Risk analysis process -



Hazard identification



Calculations

Release and risk assessment calculations were performed using the SAFETI v5.22 suite of programs. SAFETI is a hazards modelling package developed by Det Norske Veritas (DNV) Technica.

Consequence calculations were carried out on each of the incidents considered during the hazard identification process. This involved estimating the effects of explosions, fires and releases of toxic materials. Analysis of the results of these calculations provided a further refinement of the hazard identification process and assisted in directing detailed analysis towards those events with significant risk potential.

Frequency estimation involved consideration of historical accident and equipment failure rate data from various sources. Historical failure rate data were checked to ensure that their sources were consistent with the operations being studied. Basic data were modified using fault and event trees to better represent the safety features characteristic of the site. Again, these data and assumptions were verified by Orica.

Risk analysis

Risk calculations were performed using a set of computer programs known as SAFETI. The programs were used to calculate the consequences of all identified failures and combine this information with the likelihood of each failure occurring to produce detailed estimates of the overall risk.

Calculations were carried out on a plant by plant basis, as well as for the Orica complex as a whole. From the QRA, the key risk contributors were identified and cumulative risk contours and societal risk results plotted.

Individual risk measures the likelihood of a particular location experiencing a specified level of risk. It is typically presented as a series of contour lines that connect points of the same level of risk. Individual risk may be compared with land use safety criteria, such as those presented in *Hazardous Industry Planning Advisory Paper (HIPAP) No. 4 — Risk Criteria for Land Use Safety Planning*.

Societal risk takes into account the number of people that could be affected by various incidents. It is typically presented as an F-N curve, which is a plot of cumulative frequency versus consequences, measured as fatalities.

Methodology for non-Orica sites

For the non-Orica sites, the study was conducted in four stages:

- collection of site data
- screening and review of information
- selective risk quantification
- consideration of findings to produce technical and policy recommendations.

Collecting site data

A number of hazard audits and risk assessment studies had been carried out for the individual sites prior to this study. These were reviewed to obtain initial information on the hazards specific to the sites, the range of incidents that could arise from these hazards and the safety management systems already in place.

Following the review of previous risk studies, detailed site questionnaires were completed by each of the sites. The questionnaires covered relevant background and technical information required for the study, including:

- site background information
- materials handled on-site and the quantities present at any one time
- details of site operation
- transportation characteristics to and from the site
- fire protection systems employed
- emergency planning procedures
- " incident history
- previous safety studies undertaken
- equipment data sheets for all major items.

The gathered information was used in a risk classification and prioritisation process developed by the United Nations. This process forms the basis of the Department's *Multi-Level Risk Assessment* guidelines.

The UN method produces a broad estimate of the magnitude of major accidents related to the manufacture, storage, handling and transport of hazardous materials. The hazardous materials are firstly classified according to class, location and quantity. This information is subsequently used to generate an estimate of societal risk. This allows prioritisation on the basis of the potential for off-site risk impacts. The procedural steps for this process are illustrated below.

Figure 12. Risk screening steps

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Sites were ranked as potentially minor, medium or major risk generators, based on their estimated risk potential, expressed as annual potential loss of life (PLL). This allowed the study team to focus on the most significant sites. Screening was applied to fixed sites only.

Following the Multi-Level Risk Assessment methodology, further quantification of risk was carried out on sites where risk screening showed that off-site risk could be significant. The Quantitative Risk Assessment undertaken was identical to that for the Orica complex.

Evaluation

The results of the QRA calculations for both the Orica complex and non-Orica industrial sites were combined to produce cumulative risk contours around the study site.

These contours were translated into the risk reduction area information presented in this report. Evaluation of cumulative risk was based on the land use safety guidelines provided in *Hazardous Industry Planning Advisory Paper No. 4 — Risk Criteria for Land Use Safety Planning*.

Appendix 2 — Preliminary site survey questionnaire

1. General site description

Please provide the following:

- 1.1 A description of the site and its operations. Please indicate when the site was first established.
- 1.2 How many people are employed on the site in total? What are the maximum and minimum number on site during operating hours, e.g. shifts, weekends?
- 1.3 Please provide diagrams (to scale if possible) covering:
 - 1.3.1 location of warehouse storage areas
 - 1.3.2 bulk storage tank locations, size, type and identification numbers
 - 1.3.3 processing or manufacturing areas, including inventories of any intermediates and waste products
 - 1.3.4 road tanker loading and unloading facilities
 - 1.3.5 pumping stations
 - 1.3.6 location of control rooms, offices, workshops
 - 1.3.7 pipeline routes (both on- and off-site) for hazardous materials
 - 1.3.8 fired heaters and boilers and other potential ignition sources
- 1.4 On one of the above diagrams, please show the location and nature of any sprinkler systems, fire walls and other major fire fighting equipment.

2. Site operations

- 2.1 Please attach a list of hazardous materials stored or held in processes in significant quantities (this includes materials defined as dangerous goods by the United Nations), including any intermediate materials. The material quantities should preferably be given in tonnes or kilograms. If only a volume is known then the density of the material should also be given.
- 2.2 Please identify which of the following activities take place on-site:
Batch processing/continuous processing/mixing and blending of materials without processing/packaging/warehousing or storage/other (please specify).
- 2.3 If the site is used for warehousing/storage, describe the nature of the warehousing/storage area. If materials are stored in drums or other packaging, please broadly describe the size, number and type of packages used.

3. Safety management

- 3.1 Is there a formal site safety policy?
- 3.2 Please describe the system for accident/near miss reporting, recording and investigation.
- 3.3 What procedures do you have for contacting nearby companies if an emergency occurs on your site? Do you participate in any mutual aid arrangements or an area emergency plan?
- 3.4 Is there a safety committee on site? How often does it meet? What is the structure of the committee?
- 3.5 Is there a quality assurance or other review program to keep process safety documentation up to date?
- 3.6 What is your procedure for managing technical and procedural change?

Appendix 3 — Typical fault and event trees

Figure 13 and Figure 14, respectively, give a typical event tree for a pipeline liquid leak and a fault tree for a chlorine release during a chlorine plant start-up. The resulting frequencies, in combination with the consequence calculations, were used in generating risk estimates. For ease of presentation, the numerical results are not shown.

Figure 13. Typical event tree for a liquid leak

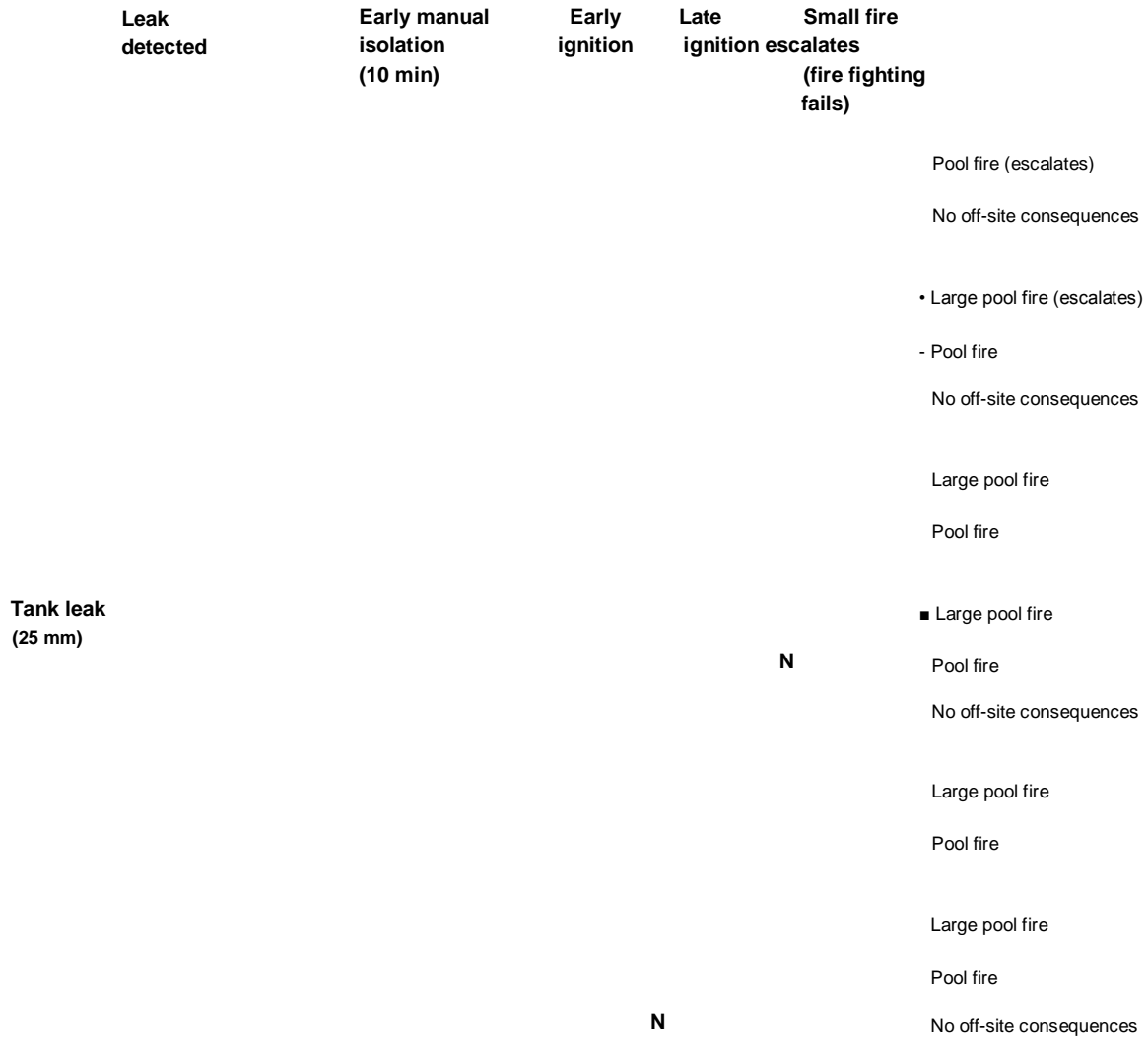


Figure 14. Fault tree — Chlorine release during start-up

Plant start-up sequence

Chlorine control valve open

Chlorine control indicator fails-

AND

Chlorine detectors fail

OR

AND

**Major chlorine
gas release**

Shut-down valve failure

Emergency isolation
valve fails

Chlorine alarm fails

OR

Operator does not
respond or is absent