HAZARD AND RISK ASSESSMENT

BROADMEADOW REGIONALLY SIGNIFICANT GROWTH AREA

PACKAGE H: LAND USE SAFETY

EMERGING PREFERRED SCENARIO REPORT

NSW DEPARTMENT OF PLANNING, HOUSING AND INFRASTRUCTURE

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ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
DA	Development Application
DG	Dangerous Goods
DPHI	NSW Department of Planning, Housing and Infrastructure
EbD	Enquiry by Design
EIS	Environmental Impact Statement
HIPAP	Hazardous Industry Planning Advisory Paper
IOGP	International Association of Oil & Gas Producers
MHF	Major Hazard Facilities
MLRA	Multi-Level Risk Assessment Guideline
NSW	New South Wales
PCYC	Police Citizens Youth Clubs
PHA	Preliminary Hazard Assessment
QRA	Quantitative Risk Assessment
SEPP	State Environmental Planning Policy
SMS	Safety Management Study
TAHE	Transport Asset Holding Entity
TfNSW	Transport for New South Wales

1. EXECUTIVE SUMMARY

This report details the land use safety assessment of the emerging preferred scenario for the Broadmeadow Precinct (the Precinct). The objectives of the study are:

- identification and assessment of how land use conflicts between existing and potential land uses may be managed
- consideration of synergies and relationships with adjoining areas and land uses.

Where required, existing planning controls are identified or new controls proposed to manage identified risks.

The study has been prepared to inform future planning decisions which support a Place Strategy for the precinct with up to 20,000 homes, 15,000 jobs and 45,000 people including a first-move state-led rezoning with the capacity for approximately 3,200 new dwellings.

An emerging preferred scenario for the Precinct (Figure 1.1) was developed from an Enquiry by Design (EbD) process (Preliminary EbD 3-4 May 2023 and EbD 11-12 November 2023). The first-move state-led rezoning sites are shown in Figure 1.2.

The study basis is that existing developments were assessed and associated risks are acceptable. It is also noted that school infrastructure and transport initiatives are indicative only and subject to detailed design, analysis, feasibility review, funding commitments etc. No investment decisions have been made. Furthermore, the final list, extent, details, locations of initiatives will be subject to the satisfactory resolution of the above.

Figure 1.1: Emerging preferred scenario

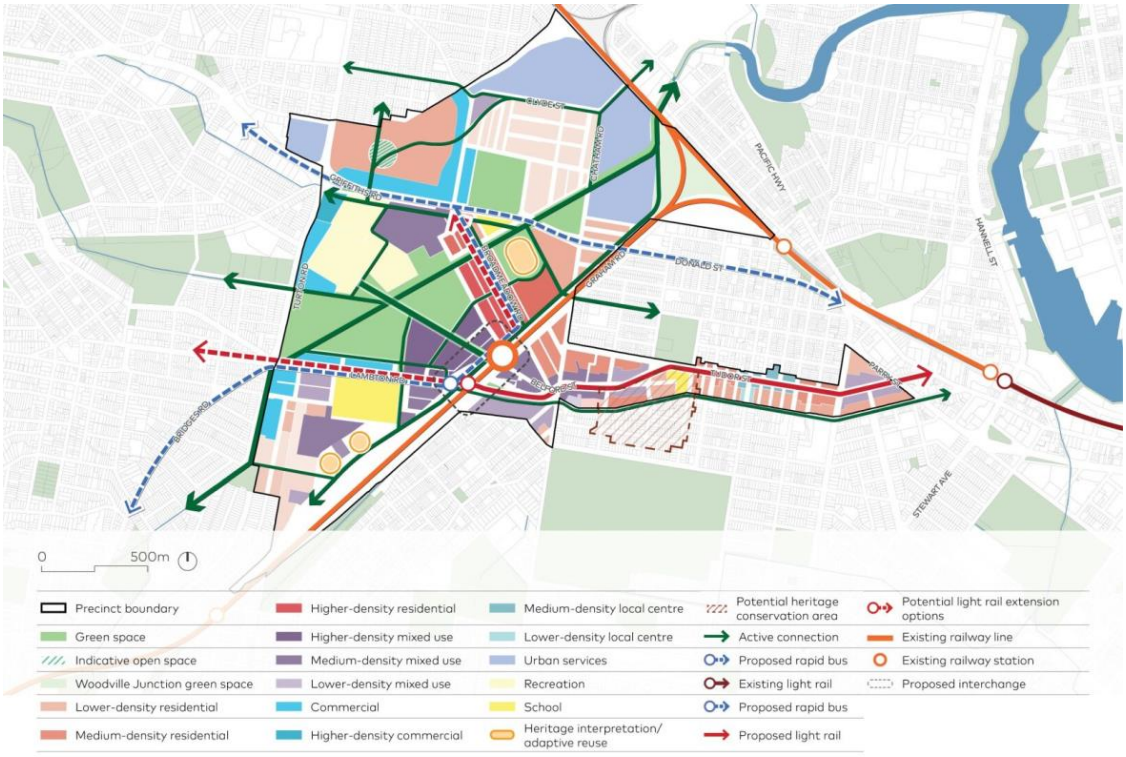


Figure 1.2:First-move state-led rezoning sites

The study follows:

- NSW Multi-Level Risk Assessment Guideline (MLRA) (Ref. [1])
- NSW Hazardous Industry Advisory Paper No. 10 – Land Use Safety Planning (HIPAP 10) (Ref. [2])
- NSW Hazardous Industry Advisory Paper No 4 – Risk Criteria for Land Use Safety Planning (HIPAP 4) (Ref. [3]).

A qualitative assessment (MLRA Level 1) of the current and potential land uses under the emerging preferred scenario identified that, with the exception of the Ampol fuel pipeline and the Jemena secondary gas main (approximate alignments shown in Figure 1.3), land use safety risks can be managed to acceptable levels subject to current and proposed additional planning controls in Table 1.1 and Table 1.2.

Figure 1.3: Ampol and Jemena pipelines

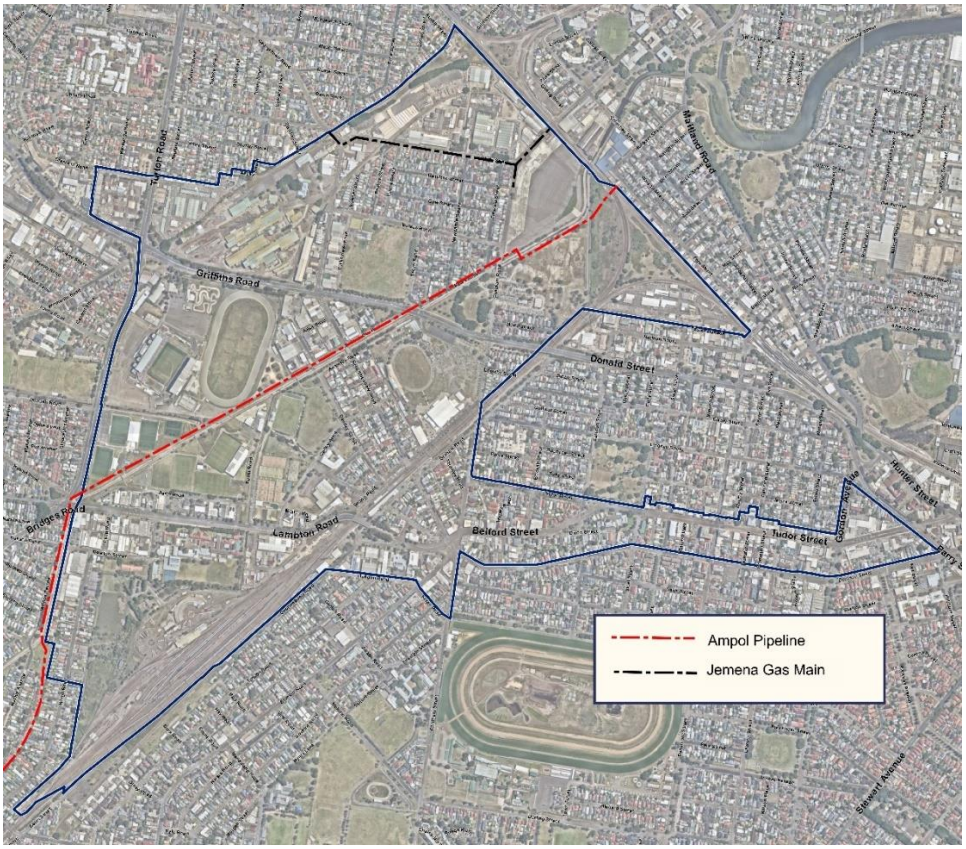


Table 1.1: Qualitative assessment current planning controls

Land use zone/ development	Current control
- Mixed use - Commercial	Apply Resilience and Hazards SEPP (Ref. [4]) screening criteria to ensure offsite risk from a development can be managed to an acceptable level.
Existing rail line	Apply derailment assessment framework including requirements for building/structure impact design as detailed in guidance from Transport for NSW (TfNSW) on Airspace and External Developments.

Table 1.2: Qualitative assessment additional proposed planning controls

Land use zone/ development	Proposed controls
- Mixed use - Commercial	Advise against development of Major Hazard Facilities[1] (MHF).
- Employment/ urban services - Local centre - School - Entertainment/ indoor recreation - Residential (all) - Open space/ recreation	Advise against development of Major Hazard Facilities (MHF).
	Advise against developments that exceed Resilience and Hazards SEPP screening criteria thresholds.
Westpac helicopter operations	Transition operation out of the precinct. In the interim undertake a risk assessment of helicopter operations impacting on any development proposed under the flight path (aligned with Styx Creek).

The qualitative review noted the following synergies and land use relationship contribute to managing risk at a strategic level:

- New or intensified residential zoned areas adjacent to the Ampol pipeline are limited to a length of approximately 300m on the north side of Styx Creek near Broadmeadow Road. Land uses adjacent to the remaining 2.7km length of the pipeline are predominately open space with some commercial and employment zones.
- Green buffers in North Hamilton will contribute to managing any residual risk from the employment/urban services zone.

Following guidance in the MLRA full quantification (Level 3) was undertaken for the Ampol and Jemena pipelines (including a fenced compound on the Ampol pipeline). The quantitative risk assessment showed:

[1] Major Hazard Facilities are defined in the NSW Work Health and Safety Regulation 2017

- risk from the Jemena secondary gas main is below the NSW land use planning safety risk criteria and no additional controls are proposed
- risk from the Ampol pipeline can be managed by applying the planning controls in Table 1.3.

Table 1.3: Quantitative assessment planning controls

Land use zone/ development	Proposed controls
Sensitive land uses	Avoid new or intensification of sensitive land uses within 39m of the Ampol pipeline and 42m from the Ampol compound.
Residential land use	Avoid new or intensification of residential land use within 26m of the Ampol pipeline and 32m from the Ampol compound.
Development within Ampol pipeline notification length (noted as 100m in DPHI pipeline data)	Apply Transport and Infrastructure SEPP (Ref. [5]) requirements for development adjacent to licensed pipelines within 100m of the pipeline. This includes consideration of the risk to the pipeline from the development.
Development adjacent to Ampol pipeline	The pipeline operator should be consulted for the following within the pipeline notification length (100m as noted in the DPHI hazards pipeline data): 1. Changes in land use zoning adjacent to the pipeline (triggers a review of the pipeline Safety Management Study (SMS)) 2. Changes to population density in current zones adjacent to the pipeline (triggers a review of the pipeline SMS) 3. Construction activities adjacent to or in the pipeline corridor (may trigger an encroachment SMS).

The land use safety study is premised on Westpac helicopter flying operations ceasing in the precinct. If staged development occurs before helicopter flying operations cease, then the risk of development under the flight path (which is aligned with Styx Creek) will need to be assessed and determined to be acceptable.

In conclusion, for the emerging preferred scenario, the assessment found that general land use safety can be managed in the Precinct by applying the current (Table 1.1) and proposed (Table 1.2) controls identified in this study.

In addition to controls around individual development, the cumulative population in the investigation area needs to be monitored against the populations used in this study to ensure the societal risk does not exceed tolerability criteria.

Managing the risk of development of the state-led first-move sites will require specific consideration of proposed controls for the Newcastle Showgrounds site covering:

- Ampol pipeline risks by applying the proposed controls in Table 1.3
- Westpac helicopter operations by assessing risks under the flight path which is aligned with Styx Creek.

The risk of development of the Basketball Site, Go Karts and Stadium Forecourt and the Locomotive Site can be managed by applying current land use planning controls.

All proposed risk treatments will apply to any staged approach of the precinct.

2. INTRODUCTION

This report details the land use safety assessment of the emerging preferred scenario for the Broadmeadow Precinct (the Precinct). It is one of a suite of technical studies prepared to inform the development of a Precinct Structure Plan and a Precinct Place Strategy.

2.1. Broadmeadow Precinct

The Precinct is identified as a 'Regionally Significant Growth Area' in the NSW Government Hunter Regional Plan 2041[2] [6], with commentary that the area provides an opportunity for sustainable growth as well as housing choice and lifestyle opportunities to retain the Hunter's position as a leading regional economy in Australia.

The Precinct is centred around Broadmeadow station and includes parts of Hamilton and Hamilton North. The Precinct currently has a range of landowners (government and private) and leased areas. It supports a wide range of uses including:

- sport, entertainment and recreation
- commercial and industrial (operational and decommissioned)
- residential and educational
- road, rail and active transport corridors.

The Broadmeadow precinct in the context of existing features is shown in Figure 2.1.

2.2. Structure Plan and Place Strategy

The City of Newcastle (the City), in partnership with the NSW Department of Planning Housing and Infrastructure (DPHI), is preparing a Structure Plan for the Precinct that will be informed by a Structure Plan.

[2] Figure 17 of the Hunter Regional Plan Hunter Regional Plan 2041 (nsw.gov.au) uses the term 'Broadmeadow' to define a regionally significant growth area that includes parts of the suburbs of Broadmeadow, Hamilton and Hamilton North. The term 'Broadmeadow Precinct' is used in the emerging preferred scenario to describe the same geographical area and is the term used in this study.

Figure 2.1: Broadmeadow precinct[3]

[3] 20230228_Broadmeadow_InvestigationArea_Aerial_A3P_RevB.pdf (amazonaws.com)

2.3. Objectives and approach

The Structure Plan will be informed by a set of technical studies. DPHI engaged Sherpa Consulting Pty Ltd (Sherpa) to execute Technical Package H – Land Use Safety.

The objective of the Land Use Safety assessment is to addresses the following:

- Identification and assessment of how land use conflicts between existing and potential land uses may be managed.
- Consideration of synergies and relationships with adjoining areas and land uses.

The objective is achieved by:

- Identifying hazards and activities in the Precinct with the potential to lead to land use safety risks.
- Completing a qualitative risk assessment.
- Where required to provide more detail, completing a quantitative risk assessment of identified risks that present an acute safety consequence.
- Assess the risk results against qualitative and quantitative criteria for strategic land use planning in NSW Hazardous Industry Advisory Paper No. 10 Land Use Planning (HIPAP 10), Ref [2], and identify appropriate planning controls.
- Provide land use safety advice to inform the Precinct planning process.

2.4. Strategic land use safety planning

Strategic level land use planning balances the threats and opportunities associated with developing land to maximise utility whilst managing land use conflicts and avoiding unnecessary sterilisation of land. To achieve this balance, strategic planning assesses a range of factors and issues including, but not limited to, threats to the natural environment, noise and air pollution.

Strategic land use **safety** planning provides the opportunity to put in place controls that eliminate or minimise land use safety conflicts though a combination of buffer zones and limits on certain types of industries, and associated activities and quantities of hazardous materials.

This study is limited to land use **safety** planning. It takes into consideration acute risks to people living or working in and around the precinct. Whilst an important input it should be noted that other factors may result in controls that are over and above any requirements identified in this study.

The study has been prepared to inform future planning decisions. The study assumes that existing developments were assessed and associated risks are acceptable.

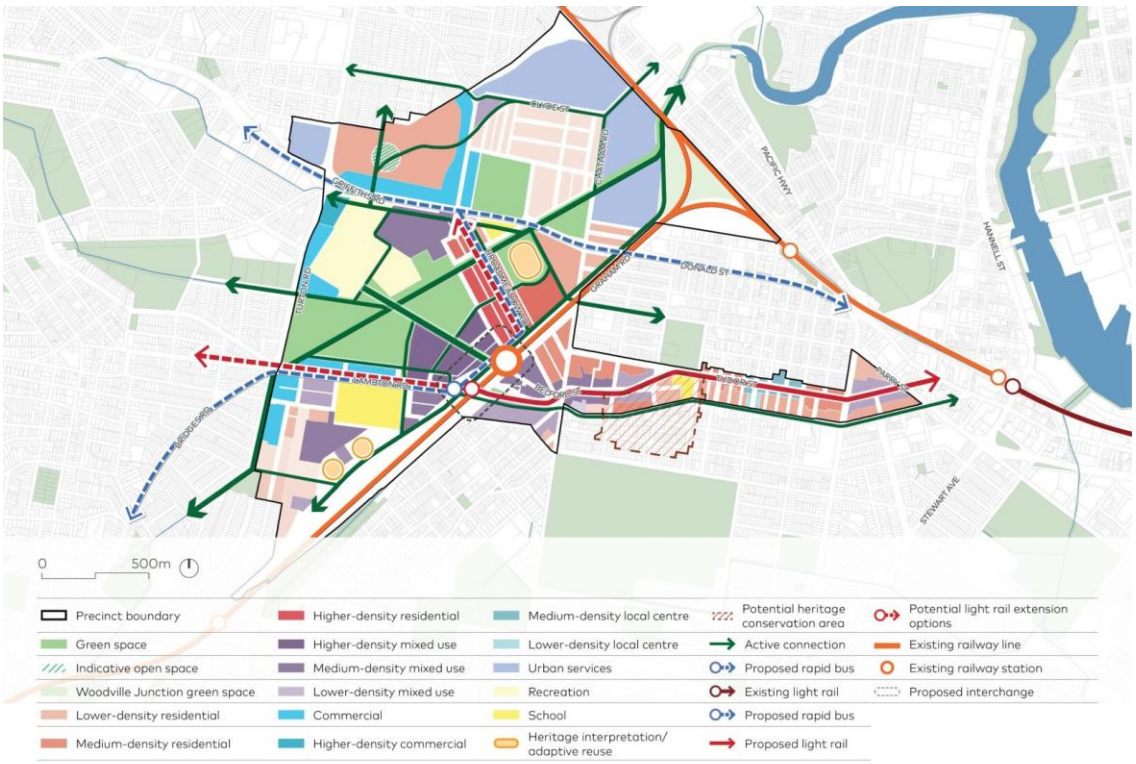
3. STUDY BASIS AND METHODOLOGY

3.1. Emerging preferred scenario

An Enquiry by Design (EbD) process was undertaken to inform the preparation of an emerging preferred scenario for the Precinct over two sessions (Preliminary EbD 3, 4 May 2023 and EbD 11, 12 November 2023). The EbD was an interactive process which proposed a vision for the Precinct and explored options which could deliver the vision.

The outputs of the EbD were used to develop the emerging preferred scenario shown in Figure 3.1. The scenario was provided to Sherpa by DPHI and is the basis for this assessment[4].

Figure 3.1: Emerging preferred scenario



Key features of the emerging preferred scenario are:

- Provision for up to 20,000 additional homes, 15,000 jobs and 45,000 people.

[4] There are minor variations between illustrative figures and the data used for analysis. Whilst the most recent data was used in analysis, figures such as Figure 3.1 which are used to provide a general overview and broader context may contain minor variations to land use boundaries and zones analysed. These variations are not material to the outcome of the study.

- Opportunity for new educational establishments in the precinct[5].
- Reconfiguration and relocation of current government land, entertainment areas and public use areas such as the Newcastle showground, basketball stadium and Police Citizens Youth Clubs (PCYC) sites, harness racing track and Locomotive Depot (Transport Asset Holding Entity (TAHE) site).
- Adaption and development of active transport, local road network and bus services, with connections into and out of the precinct.
- Opportunities to integrate future modes of mass transit through the Precinct.
- Migration of incompatible users from the precinct.

It is noted that school infrastructure and transport initiatives are indicative only and subject to detailed design, analysis, feasibility review, funding commitments etc. No investment decisions have been made. Furthermore, the final list, extent, details, locations of initiatives will be subject to the satisfactory resolution of the above.

3.2. Assessment methodology

3.2.1. Overview

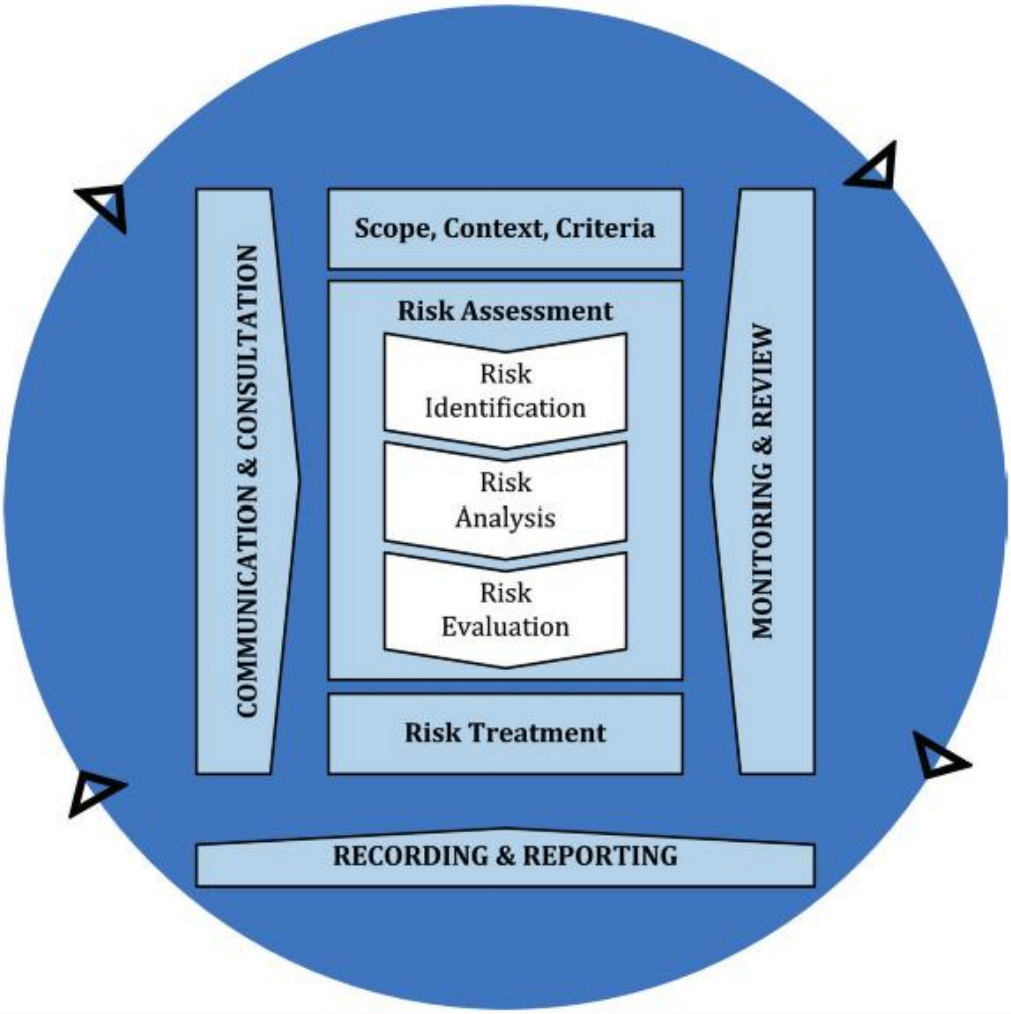
NSW land use planning follows a risk-based approach supported by guidance to manage the risk associated with developments whilst avoiding unnecessary sterilisation of land or restrictions on development. Further details can be found in HIPAP 10 with a summary of the framework in APPENDIX B.

This assessment followed the NSW framework through a process defined in Figure 4 of AS ISO 31000:2018 Risk Management – Guideline (reproduced as Figure 3.2 in this report) with the following exceptions:

- Risk acceptance and treatment is limited to proposed future land uses.
- Communication and consultation with external parties was managed by DPHI.

[5] Schools Infrastructure NSW will undertake a review of existing and planned schools within the general area to assess the preferred option to meet demands for school infrastructure generated by both existing projected demand and the needs generated by the Precinct.

Figure 3.2: AS ISO 31000:2018 Risk Management process



3.2.2. Scope and context

The scope of the study is the Precinct. The study was undertaken in the context of the Precinct and surrounds and the following NSW planning documents:

- State Environmental Planning Policy (Resilience and Hazards) 2021 (Resilience and Hazards SEPP) and supporting application guidelines (e.g. Applying SEPP 33), Ref [4, 7]
- Hazardous Industry Planning Advisory Paper (HIPAP) No. 4 – Risk Criteria for Land Use Safety Planning, Ref [3]
- HIPAP No. 6 – Hazard Analysis, Ref [8]
- HIPAP No. 10 – Land Use Safety Planning, Ref. [2]
- Assessment Guideline Multi-level Risk Assessment (MLRA), Ref [1].

3.2.3. Communication and consultation

Preliminary consultation was held with Ampol (operator of a liquid fuel pipeline) (27 June 2023), Jemena (operator of a secondary gas main) (27 June 2023) and Westpac (helicopter operations) (28 June 2023) to gain an understanding of their operations in the Broadmeadow Precinct as an input to the study. Consultation was managed by DPHI with Sherpa in attendance.

The EbDs provided the forum for extended communication and consultation with local and state government bodies and other technical consultants engaged on the project.

3.3. Criteria

NSW DPHI describes risk criteria in terms of qualitative and quantitative aspects in HIPAP No. 10, Ref. [2] and supporting guidance. Application in this study is summarised in the following sections.

3.3.1. Qualitative criteria

The general qualitative principles from HIPAP 10 are summarised as follows:

- The avoidance of all avoidable risks.
- The risk from a major hazard should be reduced wherever practicable, even where the likelihood of exposure is low.
- The effects of significant events should, wherever possible be contained within the site boundary.
- Where the risk from an existing installation is already high, further development should not pose any incremental risk.

3.3.2. Quantitative risk criteria

Quantitative criteria are described in HIPAP 10 for:

- Individual fatality risk
- Individual injury risk
- Societal risk.

Individual risk is based on 24 hour-per-day exposure with no allowance for the protection buildings may offer. The individual risk criteria are specified in Table 3.1 (fatality) and Table 3.2 (injury) for land use categories.

Societal risk provides a mechanism by which the number of people exposed, as well as protection factors, can be considered. It is used to ensure that the risk impact on the community is not excessive. The societal risk criteria are shown in Figure 3.3.

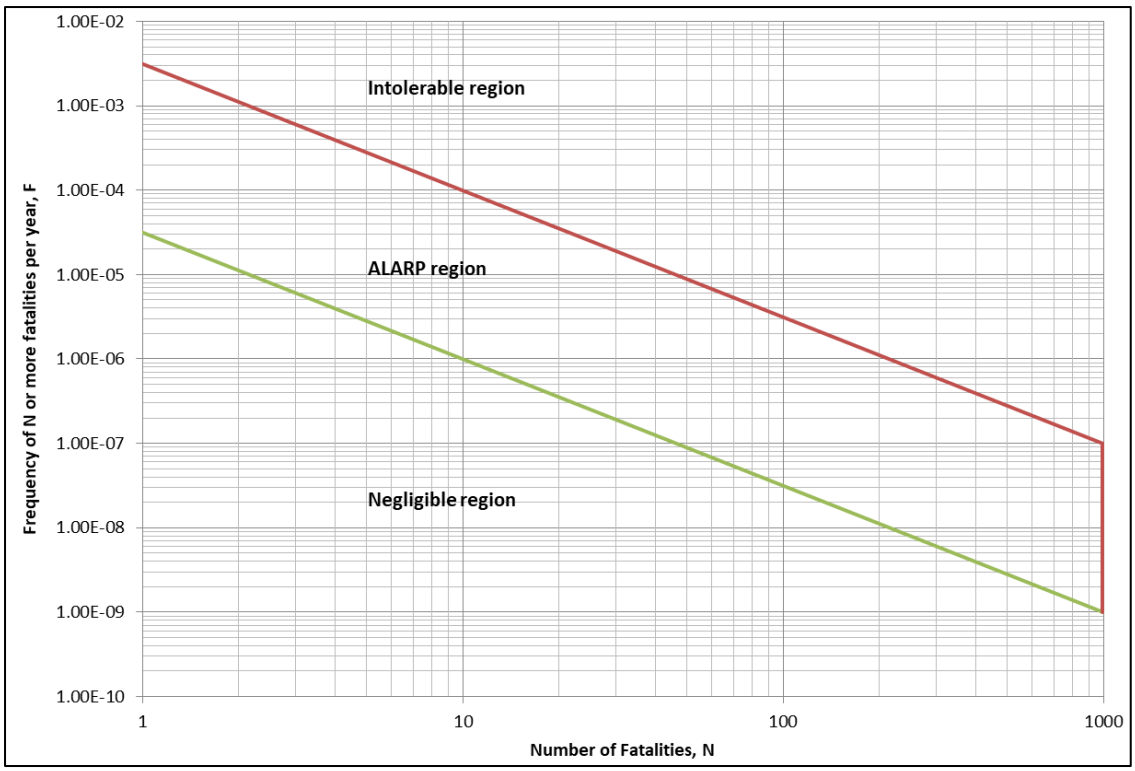
Table 3.1: Individual fatality risk criteria

Risk levels (individual fatality risk per year)	Land use	HIPAP description
0.5 x 10^{-6}	Sensitive	Hospitals, schools, child-care facilities, old age housing, correctional facilities.
1 x 10^{-6}	Residential	Residential developments and places of continuous occupancy such as hotels and tourist resorts.[6]
5 x 10^{-6}	Commercial	Commercial developments, including offices, retail centres and entertainment centres.
10 x 10^{-6}	Recreational	Sporting complexes and active open space areas.
50 x 10^{-6}	Industrial	Target for site boundary.

Table 3.2: Individual injury risk criteria

Risk levels (individual injury risk per year)[(a)]	Type
50 x 10-6	Incident heat flux radiation at residential and sensitive use areas should not exceed 4.7 kW/m^2.
Note: (a) Toxic and overpressure criteria excluded as it is not applicable to this study.	

Figure 3.3: Societal risk criteria



[6] The criteria apply at the built form of the dwelling where people may be permanently located.

3.4. Pipeline guidance

A licensed liquid hydrocarbon fuel pipeline operated by AMPOL crosses the Broadmeadow precinct and is used to transfer petrol and diesel from Sydney to a storage and distribution terminal in Wickham.

NSW DPHI issued a Draft Guideline for planning proposals near High Pressure Dangerous Goods pipelines (April 2022) (Ref. [9]). The guide includes draft setback distances (Table 3.3).

It is noted that the DPHI draft guideline applies to a licensed pipeline. The Jemena secondary main is not a licensed pipeline and as such the guideline is not applicable.

Table 3.3: DPHI Draft setback distances

Distance (m)	Description
Not required	No requirement for setback distance to residential land uses.
60	Distance to sensitive receptors in the absence of a site-specific assessment.
140	Investigation area adjacent to high pressure gasoline pipelines. Generally defined as the area where injury may occur in the event of catastrophic failure of a licensed pipeline. Future development should be assessed and monitored to manage population growth and intensification of risk.
200	Investigation area adjacent to high pressure natural gas pipelines. Generally defined as the area where injury may occur in the event of catastrophic failure of a licensed pipeline. Future development should be assessed and monitored to manage population growth and intensification of risk.

3.5. Risk assessment

Risks were identified based on a review of:

- existing potentially hazardous developments and receptors
- permissible types of development and receptors under the emerging preferred scenario land use zones.

The level of assessment followed the DPHI Assessment Guideline - Multi-level Risk Assessment (MLRA) [1].

Under the MLRA there are 3 levels of assessment:

- Level 1 (qualitative) assessment is appropriate where the potential for offsite impact can be avoided or does not present a significant offsite risk.
- Level 2 (semi-quantitative) is appropriate where a level of quantification of consequence or likelihood is required to inform decisions on the potential for offsite impact and associated risk.
- Level 3 (fully quantitative) assessment is appropriate where there is the potential for significant offsite risk with a requirement to define risk treatment including buffers.

3.6. Risk treatment

Risk treatment options were reviewed and are summarised in this report. In the context of strategic land use planning the risk treatment options relate to controls that can be managed through a planning and approval pathway.

4. QUALITATIVE ASSESSMENT

4.1. Background and inputs

A qualitative risk assessment was carried out for the emerging preferred scenario. Inputs for the assessment were gathered from the following sources:

- the EbD
  - current developments and activities that will be retained in the precinct
  - types of development that may be introduced in the future
- consultation with pipeline and helicopter operators
- the preferred emerging scenario
  - land use zones
  - population densities (educational, residential and employment).

The qualitative risk assessment was completed for the final configuration of the emerging preferred scenario - of note this assumes the Ampol fuel pipeline is operational, but Westpac helicopter flight operations have transitioned from the precinct.

4.2. Approach

The key steps in the risk assessment were:

- Identification of existing sources of risk in the emerging preferred scenario.
- Identification of land use zones with the potential to introduce new sources of risk.
- Collation of available information into a hazard identification table, including:
  - Identification of scenarios with potential for acute impact to life and health
  - Identification of controls that can be managed under a planning framework to manage risks.
- Identification of scenarios that required quantification to further inform the risk assessment.

4.3. Qualitative Risk Assessment

The output of the qualitative risk assessment is shown in Table 4.1.

Controls are classified as:

- Current – for existing planning control
- Proposed – for controls that are in addition to current controls.

Table 4.1: Qualitative risk assessment

Zone/ development	Hazardous Event	Consequence	Controls	Current /proposed	Qualitative risk criteria appropriate and met?	Further assessment required
- Mixed use - Commercial	Loss of containment or loss of control of dangerous goods stored or handled on site.	Fire, explosion or toxic release resulting in offsite injury or fatality.	Advise against development of Major Hazard Facilities (MHF).	Proposed	Avoidable risk is avoided. Criteria is met.	No
			Apply SEPP 33 screening criteria to ensure offsite risk from a development can be managed to an acceptable level.	Current	Risks are reduced and/or kept on site where practicable. If further quantification is required, it will be triggered by the SEPP screening process. Criteria met.	No
- Employment/ urban services - Local centre - School - Entertainment/ indoor recreation - Residential (all) - Open space/ recreation	Loss of containment or loss of control of dangerous goods stored or handled on site.	Fire, explosion or toxic release resulting in offsite injury or fatality.	Advise against development of Major Hazard Facilities (MHF).	Proposed	Avoidable risk is avoided. Criteria is met.	No
			Advise against developments that exceed SEPP screening thresholds.	Current	SEPP screening is intended to manage risks to an acceptable level, taking into account material, activity and distances to site boundaries. If further quantification is required, it will be triggered by the SEPP screening process. Criteria met.	No
Ampol pipeline	Loss of containment – multiple causes.	Fire/explosion with potential for fatalities.	Multiple controls including pipeline route identification, Dial Before You Dig.	Current	There is the potential for significant offsite risk with a requirement to define risk treatment including buffers. MLRA guidance requires quantification.	Yes
Jemena pipeline	Loss of containment – multiple causes.	Fire/explosion with potential for fatalities.				Yes

Zone/ development	Hazardous Event	Consequence	Controls	Current /proposed	Qualitative risk criteria appropriate and met?	Further assessment required
Westpac helicopter operations	Helicopter crash.	Fire/ explosion/ direct impact with potential for fatalities.	Transition operation out of the precinct. In the interim, conduct a risk assessment for any development under the flight path.	Proposed	Avoidable risk is avoided. Criteria is met.	No
Existing rail line	Derailment.	Building or structure collapse. Injury/fatalities.	Apply TfNSW derailment assessment framework including requirements for building/structure impact design. (Transport for NSW, “Airspace and External Developments,” T HR CI 12090 ST).	Current	Application of TfNSW standard will trigger further assessment if required to manage derailment risks.	No

4.4. Discussion

A qualitative assessment (Level 1 under the MLRA) found that land use safety risk associated with the proposed land use zones can be managed to an acceptable level in the Precinct by applying the following planning controls:

- Development of MHFs (the highest hazard permitted development in NSW) should be advised against in the Precinct.
- The risk of non-MHF developments in the mixed use, commercial and employment/urban services zones can be managed by applying the potentially hazardous development controls in the Resilience and Hazards SEPP. Developments that exceed the screening threshold will require a PHA to demonstrate risk can be managed to an acceptable level.
- Developments in all other zones in the precinct should be advised against if they exceed the potentially hazardous screening thresholds in the Resilience and Hazards SEPP.
- The risk of derailment impacting structural supports or buildings adjacent to railway lines should be managed through the application of AS 5100, Ref [10], specifically Section 11.4.2.4, which states the following.

Where supports are located between 10 m and 20 m from the centre-line of the rail track, a risk analysis shall be carried out and approved by the relevant rail authority, which shall determine the required level of protection.

- Westpac helicopter operations should be transitioned from the precinct prior to increasing building heights or intensification of population under the flight path (nominally aligned with Styx Creek).

The qualitative review found the following synergies and land use relationship that contribute to managing risk at a strategic level:

- New or intensified residential zoned areas immediately adjacent to the Ampol pipeline are limited to approximately 300m on the north side of Styx creek near Broadmeadow Road. Land uses adjacent to the remaining 2.7km of the pipeline are predominately open space with some commercial and employment zones.
- Green buffers in North Hamilton will contribute to managing any residual risk from the employment/urban services zone.

Risks from the Ampol and Jemena pipelines are carried forward to a quantitative risk assessment to determine the requirement for additional planning controls, including buffers.

5. QUANTITATIVE RISK ASSESSMENT

5.1. Background and approach

The qualitative risk assessment identified the need to quantify the risks associated with pipeline operation in the Precinct.

Two pipelines were carried forward for quantitative analysis:

- Ampol - licensed liquid fuel pipeline
- Jemena - secondary gas main.

The risk was quantified by:

- Identifying credible leak scenarios
- Assessing the magnitude of possible consequences following a leak
- Assessing the frequency of the consequence occurring
- Combining the consequence and frequency into a risk model and reporting individual and societal risk
- Assessing quantitative risk against NSW land use planning risk criteria
- Providing risk treatment options appropriate to strategic planning.

The pipeline quantitative risk assessment is detailed in the Land Use Safety Baseline report (Ref. [11]). This report summarises the key data, approach and results.

5.2. Pipeline information

5.2.1. Ampol pipeline

Ampol operates a liquid fuel pipeline in a pipeline corridor that bisects the precinct. The pipeline is used to transfer liquid fuel (e.g. gasoline and diesel) from Sydney to the Ampol fuel storage depot in Wickham. The pipeline route is marked with signs and is buried within the study area.

The Ampol pipeline is licensed under the Pipelines Act (1967) and Pipelines Regulation (2013) requiring that Ampol:

- lodges a pipeline management plan with DPHI
- monitors performance and procedures by conducting periodic independent third-party audits of their pipeline management system
- uses Australian Standard 2885 (AS 2885) as a mandatory safety standard for the design, construction, operation and maintenance of the pipeline including the requirement for a Safety Management Study.

Following a meeting with Ampol, Sherpa requested precinct-specific information. As Ampol has not provided additional data, Sherpa adopted the approach used to model

the same pipeline in the Camellia precinct (Camellia is located at the southern end of the pipeline near to its starting point). Inputs that are material to the study are presented in Table 5.1.

Table 5.1: Ampol pipeline input data

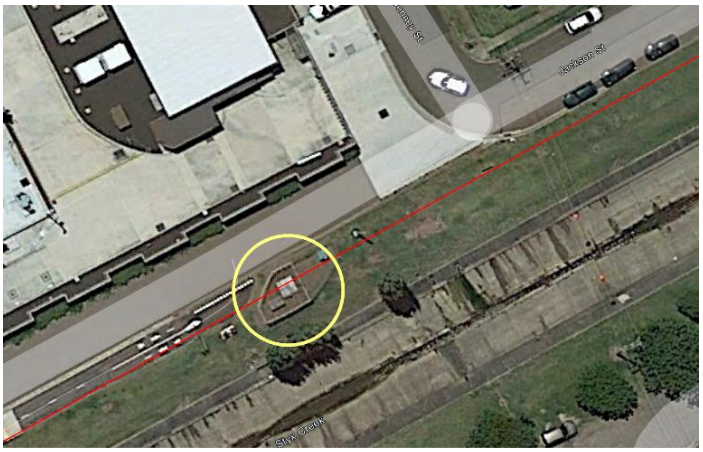
Data	Input	Commentary
Pressure	7,500kpag (Maximum Operating Pressure)	Whilst this pressure may not be reached at this location (near to the end of the pipeline) it is a conservative but appropriate basis for strategic land use safety.

As detailed in the Baseline report (Ref. [11]) no credit was taken for depth of cover, increased wall thickness, impact protection, detecting or isolation of releases.

Site inspection identified a fenced and signed compound on the Ampol pipeline located near the corner of Jackson Street and Denney Street (referred to as the Ampol compound in this report).

Figure 5.1: Fenced and signed compound

Figure 5.2: Location of compound



Whilst the pipeline leak frequency already includes standard pipeline fixtures and fittings such as mid line isolation valves, the frequency is spread along the pipeline rather than being concentrated at a location. To ensure a robust analysis, leaks and fires from the compound were assessed assuming there is a valve underground at this location. Leak frequencies from the International Association of Oil & Gas Producers (IOGP) Risk Assessment Data Directory Process Release Frequencies, Ref [12] were used as the basis of the assessment.

Adjustments were made to the frequency to reflect the pipeline having a Safety Management System (SMS), the product being in clean service and the area being in a locked and fenced compound to reduce the likelihood of third-party impacts to the valve and pipeline in the compound.

Additionally, there is a possibility that smaller releases (i.e. 20 mm hole size) would be restricted to the manhole/concrete slab and then flow into the drainage channel.

A summary of the cases modelled to assess the risk from the Ampol compound is shown in Table 5.2.

Table 5.2: Cases modelled for Ampol compound

No.	Factor applied to frequency of valve leak (all causes)	20 mm leak included in analysis
1	0.5	Yes
2	0.5	No
3	0.1	Yes
4	0.1	No

5.2.2. Jemena pipeline

Jemena operates a secondary gas main in North Hamilton, the pipeline is not licensed, and is not required to follow AS 2885. Key input data is summarised in Table 5.3.

The pipeline is buried. As detailed in the Baseline report, no credit was taken for depth of cover, increased wall thickness, impact protection, detecting or isolation of releases.

Table 5.3: Jemena pipeline input data

Data	Input	Commentary
Pressure	1050kPag (Maximum Operating Pressure)	Whilst it is unlikely that the MAOP will be reached it is a conservative but appropriate basis for strategic land use safety. It allows for changes in operating basis that do not exceed MAOP.

5.3. Consequence modelling

The consequences of loss of containment were modelled using TNO Effects v12.1.0, with the exception of fireballs, which were modelled using the appropriate equations in the TNO Yellow Book, Ref [13], with an estimated fireball mass from HSE research report 036, Ref [14].

Results were obtained for:

- Pool fire, if a liquid release forms a pool.
- Fireball, in the event of immediate ignition following a pipeline rupture.
- Jet fire, if a continuous natural gas release is ignited immediately.
- Flash fire, in the event of delayed ignition of a natural gas release.

The approach and assumptions were agreed with DPHI for the Camellia Precinct and applied to Broadmeadow.

5.4. Frequency analysis

Historical leak frequency and ignition data was used to quantify the frequency of the modelled consequences. With the exception of leaks from the Ampol compound, no leak frequency reduction factors were applied in the model to ensure a reasonable but conservative calculation of risk.

5.5. Risk analysis

Risk analysis was performed using Gexcon Riskcurves v12.0.1, which combines the consequences and frequencies of the identified hazardous scenarios. Assessment of risk results against relevant risk criteria was then conducted for:

- Individual fatality risk
- Injury risk
- Societal risk.

The results are presented in the following sections.

5.6. Individual fatality risk

The extents of the 1 x 10^{-6}/year individual fatality risk contour adjacent to the Ampol compound are shown for each of the cases described in Section 5.2.1. The distances of the 1 x 10^{-6}/year individual fatality risk contour at the Ampol compound area ranges from 27.5 to 32m compared to 26m from the general pipeline area. The highest value (32m) has been applied as a conservative but appropriate approach for strategic land use safety planning.

Table 5.4: Risk contour extents for sensitivities for Ampol compound

No.	Factor applied to frequency	20 mm included	Distance (m) 1 x 10^{-6}/year individual fatality risk contour from pipeline (near Ampol compound)
1	0.5	Yes	32
2	0.5	No	30.5
3	0.1	Yes	28
4	0.1	No	27.5

The individual fatality risk contours for the Ampol and Jemena pipelines are shown in Figure 5.3. It is noted that:

- The Jemena pipeline risk levels are below the risk criteria and hence are not shown in the figure.
- A section of the Ampol pipeline runs adjacent to the southwest boundary of the precinct. The pipeline outside the precinct was included to assess potential impact inside the precinct.
- A release from the Ampol pipeline compound has a higher fire frequency than the remainder of the pipeline, so the contours extend slightly further in this location but do not increase the risk at the proposed higher density residential area.
- The HIPAP land use planning risk criteria do not directly translate to land use planning zones. Table 5.5 shows examples of the relationships adopted in this study to allow assessment against the HIPAP criteria.

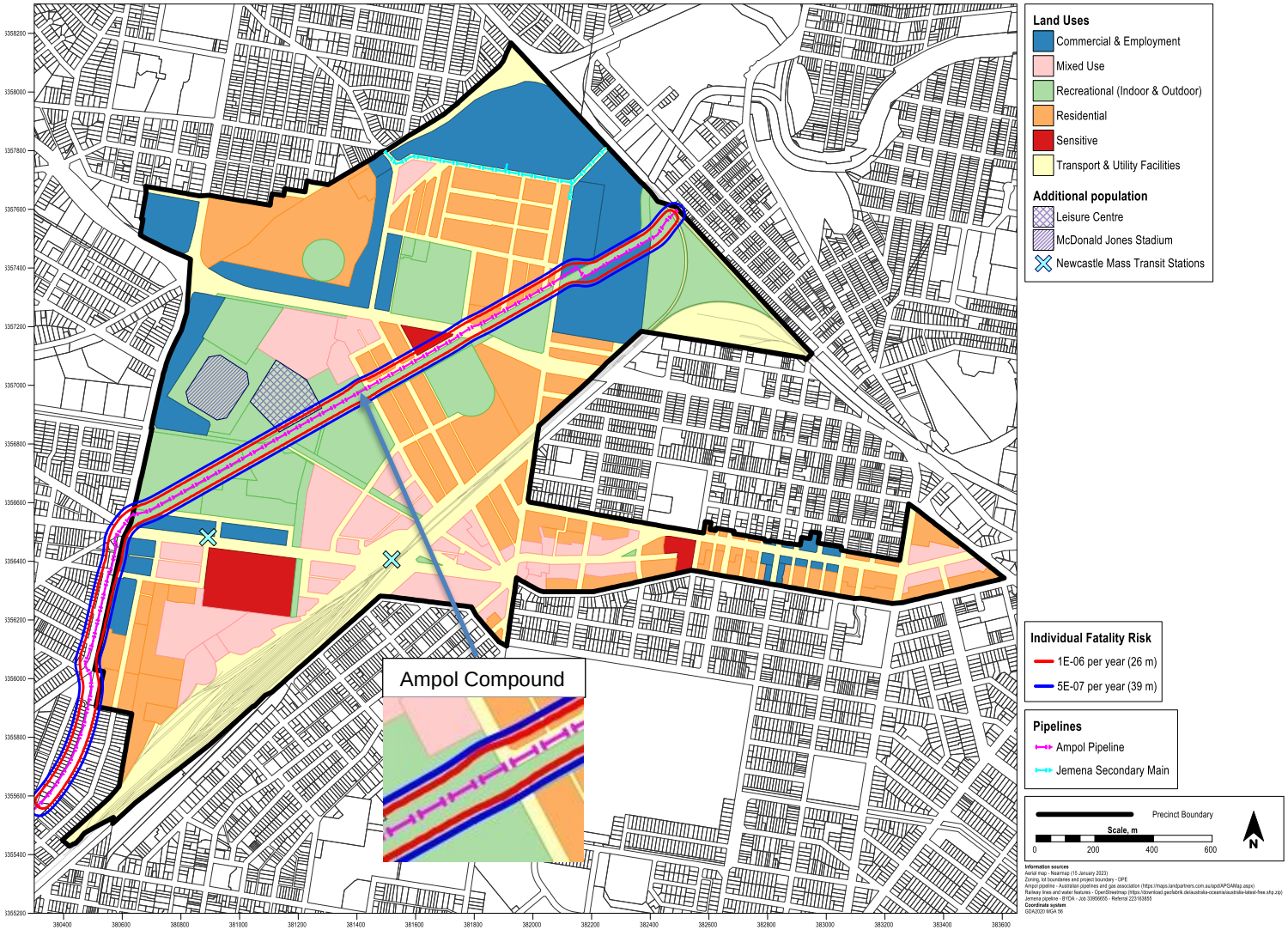
Table 5.5: HIPAP land use categorisation

HIPAP land use	Figure 5.3 legend	Figure 5.3 colour	LEP Zones
Commercial	Commercial and Employment		Employment Zones (E1/2/3))
Mixed Use Note 1	Mixed Use		Mixed Use (MU)
Recreational	Recreational (indoor and outdoor)		Recreational (RE) Conservation (C)
Residential	Residential		Residential (R)
Sensitive	Sensitive		Permitted under a range of land uses
Transport Note 2	Transport and utility facilities		Special Purpose (SP2)
Note 1: Mixed use and transport are not defined in HIPAP Note 2: There are no industrial zones (equivalent to E4/E5) identified on Figure 1.1.			

5.7. Individual injury risk

Individual injury risk from pipelines in the Precinct is below the criterion of 50 x 10^{-6}/year, and therefore meets the HIPAP 10 individual injury risk criteria.

Figure 5.3: Individual fatality risk contours



The results are assessed against the HIPAP land use planning criteria in Table 5.6.

Table 5.6: Evaluation of individual fatality risk

Individual fatality risk levels (per year)	Land use	Compliance with criteria?	Comments
0.5×10^{-6}	Sensitive	No – see comments	Contour extends approximately 39m from the pipeline and impacts on the existing North Hamilton public school. Additionally, the contour extends 42m from the Ampol compound but only into areas proposed for recreational use or transport infrastructure.
1×10^{-6}	Residential	No – see comments	The contour extends 26m from the Ampol pipeline into existing and proposed residential zoned areas. The contour extends 32m from the pipeline near the Ampol compound but only into areas proposed for recreational or transport infrastructure.
5×10^{-6}	Commercial	Yes	No contour generated. Criteria are met.
10×10^{-6}	Recreational	Yes	No contour generated. Criteria are met.
50×10^{-6}	Industrial	Yes	No contour generated. Criteria are met.

5.8. Societal risk

Societal risk takes account of population including the distribution of population between day, night, residential and employment.

The population used to calculate societal risk was based on land areas and yields provided by DPHI linked to shape files which represent physical areas in the precinct.

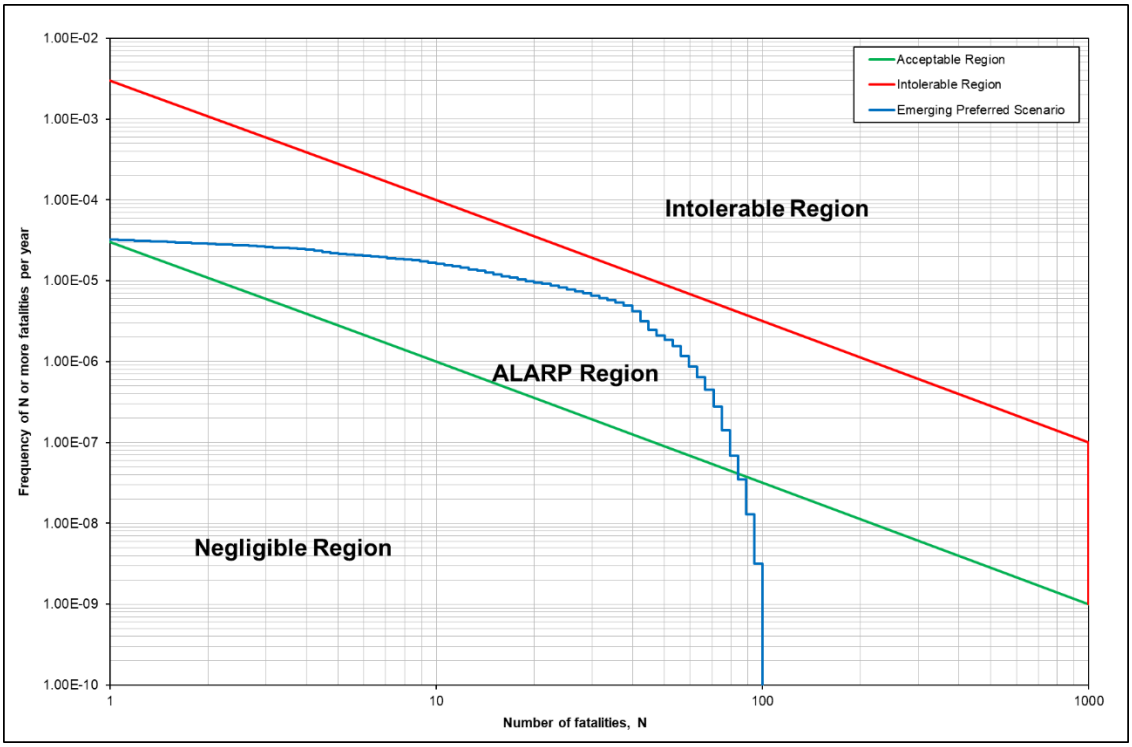
The model evenly distributes assigned populations within the defined area, with allowance made for day and night changes and indoor/outdoor to account for population. The key assumptions are detailed in APPENDIX C.

When calculating societal risk for a linear hazard such as a pipeline it is necessary to define a length of interest. Whilst there is no guidance in NSW it is conventional to consider 1km lengths of pipeline. To account for uncertainty in how residential populations may be distributed and to capture large but infrequent population (e.g. events at the stadium) the FN curve in this study represents the full pipeline length in the precinct and area to the southwest that boarders the precinct. This is approximately 3km of pipeline and results in an overestimation of societal risk compared to a standard 1km model.

The risk model does not account for any buffer between populations and the pipeline. If a population shape file is located adjacent to or overlapping the pipeline, then populations are assumed to be in that location.

The results in Figure 5.4, show the societal risk is in the ALARP region. This is likely to be a conservative assessment as the model includes events that occur over 3km (rather than the standard assumption of 1km) and there is no allowance for a buffer to populated areas.

Figure 5.4: Societal risk F-N curve



5.9. DPHI Draft Pipeline setback distance guidance

The results of the assessment are compared to the draft DPHI planning guidance in Table 5.7.

As previously noted, the results of the assessment are intended for strategic future land use planning. The results are not intended to be applied retrospectively to approved developments.

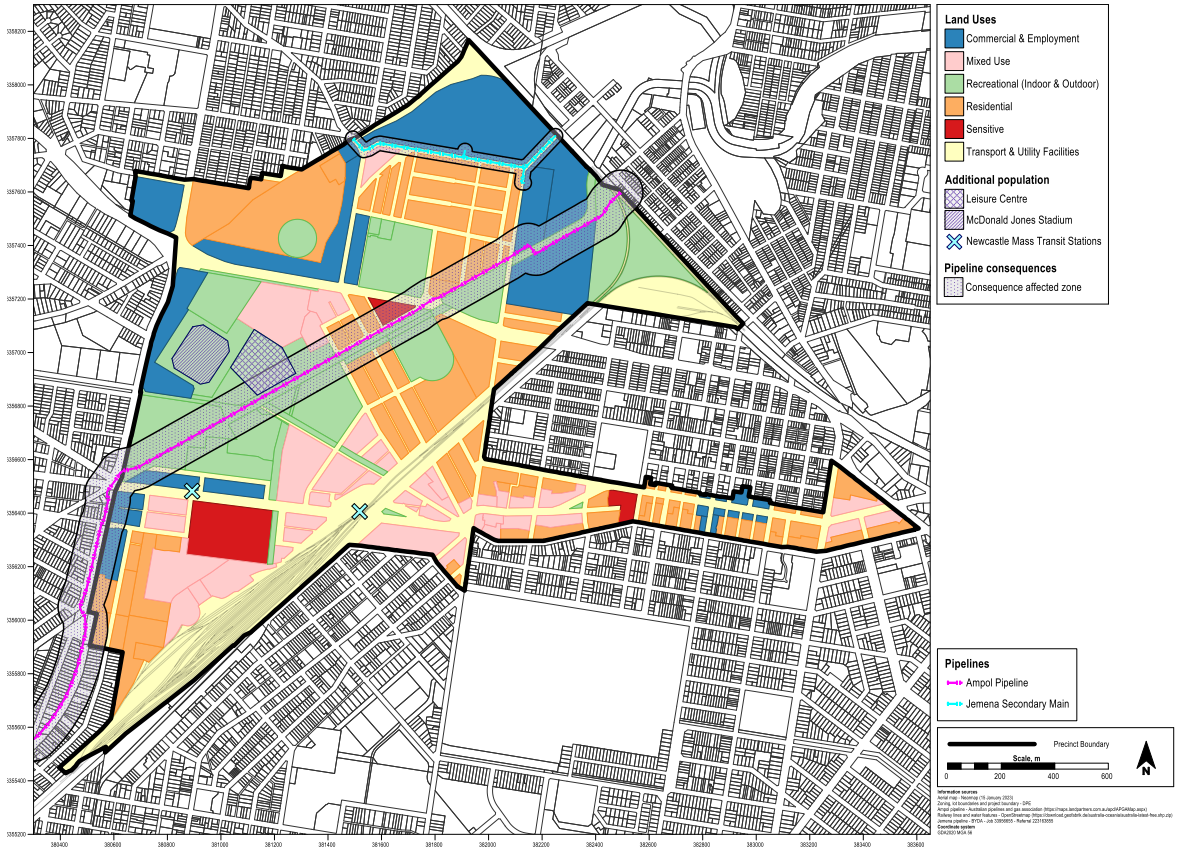
Table 5.7: Risk results compared to DPHI guidance

Distance (m)	Description	Comparison
60	Distance to sensitive receptors in the absence of a site-specific assessment.	The quantitative risk assessment recommends buffers of 39m from the pipeline and 42m from the Ampol compound based on a site-specific assessment. The buffers are proposed as a planning control.
140	Investigation area adjacent to pipelines. Generally defined as the area where injury may occur in the event of catastrophic failure	The distance to the 4.7kW/m^2 contour (injury due to heat radiation) for the Ampol pipeline is shown in Figure 5.5. The area extends approximately 100m from the pipeline.

Distance (m)	Description	Comparison
	of a licensed pipeline. Future development should be assessed and monitored to manage population growth and intensification of risk.	The notification zone for the Ampol pipeline is indicated as 100m in the DPHI licensed pipeline data set. From a strategic land use perspective: • the draft DPHI consultation zone (140m) is proposed as a planning control for consultation with DPHI hazards team • the pipeline measurement length is proposed as a consultation zone with Ampol.
Not specified	The guidance does not specify any requirement for a buffer from a licensed pipeline to residential development.	The risk assessment calculates a 26m buffer from the pipeline (and a 32m buffer from the Ampol compound) to residential areas. This distance is measured from the pipeline and does not take account of the pipeline corridor. As the precinct is proposing 'higher density residential' zones adjacent to the pipeline it is considered appropriate for strategic land use planning to provide a buffer of 26m from the pipeline (and a 32m buffer from Ampol compound) to the built form of dwellings[7] to avoid future land use conflict.

[7] The buffer is required to the building line of a dwelling. Appropriate uses in buffers include: roads, paths, gardens and parking.

Figure 5.5: Consequence zone



6. RISK TREATMENT

6.1. Current and proposed planning controls

The qualitative assessment (MLRA Level 1) of the current and potential land uses under the emerging preferred scenario identified that, with the exception of the Ampol fuel pipeline and the Jemena secondary gas main, land use safety risks could be managed to acceptable levels subject to current (Table 6.1) and proposed (Table 6.2 and Table 6.3) additional planning controls.

Table 6.1: Current planning controls

Land use zone/ development	Current control
- Mixed use - Commercial	Apply Resilience and Hazards SEPP (Ref. [4]) screening criteria to ensure offsite risk from a development can be managed to an acceptable level.
Existing rail line	Apply TfNSW derailment assessment framework including requirements for building/structure impact design (Transport for NSW, "Airspace and External Developments," T HR CI 12090 ST).

Table 6.2: Proposed planning controls

Land use zone/ development	Proposed controls
- Mixed use - Commercial	Advise against development of Major Hazard Facilities[8] (MHF).
- Employment/ urban services - Local centre - School - Entertainment/ indoor recreation - Residential (all) - Open space/ recreation	Advise against development of Major Hazard Facilities (MHF).
	Advise against developments that exceed Resilience and Hazards SEPP screening criteria thresholds.
Westpac helicopter operations	Transition operations out of the precinct. In the interim undertake a risk assessment of helicopter operations impacting on any development proposed under the flight path (aligned with Styx Creek).

The qualitative review noted the following synergies and land use relationship that contributes to managing risk at a strategic level:

- New or intensified residential zoned areas immediately adjacent to the Ampol pipeline are limited to approximately 300m on the north side of Styx Creek near Broadmeadow Road. Land uses adjacent to the remaining 2.7km of the pipeline are predominately open space with some commercial and employment zones.
- Green buffers in North Hamilton will contribute to managing any residual risk from the employment/urban services zone.

[8] Major Hazard Facilities are defined in the NSW Work Health and Safety Regulation 2017

Following the guidance in the MLRA, full risk quantification (Level 3) was undertaken for the Ampol and Jemena pipelines. The quantitative risk assessment showed:

- risk from the Jemena secondary gas main is below the NSW land use planning risk criteria
- risk from the Ampol pipeline can be managed by applying the planning controls in Table 6.3.

Table 6.3: Quantitative assessment proposed planning controls

Land use zone/ development	Proposed controls
Sensitive land uses	Avoid new or intensification of sensitive land uses within 39m of the Ampol pipeline and 42m from the Ampol compound.
Residential land use	Avoid new or intensification of residential land use within 26m of the Ampol pipeline and 32m from the Ampol compound.
Development within Ampol pipeline notification zone / consequence zone (100m)	Apply Transport and Infrastructure SEPP requirements for development adjacent to licensed pipelines. This includes consideration of the risk to the pipeline from the development.
Development adjacent to Ampol pipeline	The pipeline operator should be consulted for the following: 1. Changes in land use zoning adjacent to the pipeline (triggers a review of the pipeline SMS). 2. Changes to population density in current zones adjacent to the pipeline (triggers a review of the pipeline SMS). 3. Construction activities adjacent to or in the pipeline corridor (may trigger an encroachment SMS).

The results of the quantitative risk assessment were compared with the Draft DPHI guidelines for development near to high pressure dangerous goods pipelines (Ref. [9]) as summarised in Table 6.4.

Table 6.4: Risk results compared to DRAFT DPHI guidance

Distance (m)	Description	Comparison
60	Distance to sensitive receptors in the absence of a site-specific assessment.	The quantitative risk assessment recommends a 39m buffer based on a site-specific assessment from the pipeline and 42m from the compound. The 39m and 42m buffers are proposed as a planning control.
140	Investigation area adjacent to pipelines. Generally defined as the area where injury may occur in the event of catastrophic failure of a licensed pipeline. Future development should be assessed and monitored to manage population growth and intensification of risk.	The distance to the 4.7kW/m^2 contour (injury due to heat radiation) for the Ampol pipeline is shown in Figure 5.5. The area extends approximately 100m from the pipeline. The notification zone for the Ampol pipeline is indicated as 100m in the DPHI licensed pipeline data set. From a strategic land use perspective: • the draft DPHI consultation zone (140m) is proposed as a planning control for consultation with DPHI hazards team.

Distance (m)	Description	Comparison
		• the pipeline measurement length is proposed as a consultation zone with Ampol.
Not specified	The guidance does not specify any requirement for a buffer from a licensed pipeline to residential development.	The risk assessment calculates a 26m buffer from the pipeline (and a 32m buffer from the pipeline near the Ampol compound) to residential areas. This distance is measured from the pipeline and does not take account of the pipeline corridor. As the precinct is proposing 'higher density residential' zones adjacent to the pipeline it is considered appropriate for strategic land use planning to provide a buffer of 26m from the pipeline (and a 32m buffer from the pipeline near the Ampol compound) to the built form of dwellings [9] to avoid future land use conflict.

The land use safety study is premised on Westpac helicopter flying operations ceasing in the precinct. If staged development occurs before helicopter flying operations cease, then the risk of development under the flight path (which is aligned with Styx Creek) will need to be assessed and determined if acceptable.

In conclusion, for the emerging preferred scenario, the assessment found that general land use safety can be managed in the Precinct by applying the current (Table 6.1) and proposed (Table 6.2) controls identified in this study.

In addition to controls around individual development, the cumulative population in the investigation area needs to be monitored against the populations used in this study to ensure the societal risk does not exceed tolerability criteria.

6.2. State led first move sites

Managing the risk of development of the state-led first-move sites will require specific consideration of proposed controls for the Newcastle Showgrounds site covering:

- Ampol pipeline risks by applying the proposed controls in Table 6.3
- Westpac helicopter operations by assessing risks under the flight path which is aligned with Styx Creek.

The risk of development of the Basketball Site, GO Karts and Stadium Forecourt and the Locomotive Site can be managed by applying current land use planning controls.

6.3. Staged development

The proposed controls will apply to all stages of any proposed development of the precinct.

[9] The buffer is required to the building line of a dwelling. Appropriate uses in buffers include: roads, paths, gardens and parking.

APPENDIX A. LIMITATIONS

The limitations in Table A.1 apply to the study.

Table A.1: Limitations

Item	Issue	Remarks
1	Level of assessment	With the exception of the pipelines, the study is a qualitative assessment of potential land use conflicts associated with proposed zoning. It is not a substitute for individual assessment of specific developments.
2	Potentially offensive developments	The study assessed land use safety considerations only. The study excludes potentially offensive (under the Resilience SEPP) and environmental considerations.
3	Dangerous Goods (DG) Transport Route Selection	The study has not assessed transport (road, rail or pipeline) of dangerous goods to and from the precinct.
4	Existing potential land use conflicts	Existing developments are assumed to have been subject to planning controls including consideration of land use safety risks. The offsite risk from existing developments is assumed to be acceptable and no commentary in this report is intended to question existing planning decisions.
5	Discrepancies between representations of the emerging preferred scenarios	There are minor discrepancies in zones between versions of the emerging preferred scenarios. The analysis in this study is based on the shape files issued on 22 November 2023. The discrepancies are not material to the results.

APPENDIX B. LAND USE PLANNING FRAMEWORK

B1. Resilience SEPP and PHA

The Resilience and Hazards SEPP (Ref. [4]) provides a mechanism to determine if a development is potentially hazardous. Below defined thresholds of DGs and subject to other general considerations, developments may be determined to be not potentially hazardous and can be developed with no specific land use safety consideration.

If a development is determined to be potentially hazardous, there is a requirement to undertake a PHA to determine if the risk associated with the development can be managed to an acceptable level. If the risk cannot be managed to an acceptable level at the PHA stage, the development is hazardous and cannot proceed.

HIPAP 6 (Ref. [8]) details the requirements of a PHA and HIPAP 4 (Ref. [3]) details the criteria to determine if the risk associated with a development is managed to an acceptable level.

B2. HIPAP 10 Land Use Safety Planning

B2.1. General

HIPAP 10 (Ref. [2]) describes land use safety planning as a mechanism for dealing with actual or potential conflicts between sources of risk, such as potentially hazardous industrial developments and surrounding land uses. HIPAP 10 focuses on the impacts of industrial hazards, in particular 'those arising from loss of containment of hazardous materials leading to fires, explosions and toxic releases'.

This strategic land use safety consideration study focuses on avoiding impacts to existing and proposed land uses and the compatibility of nearby land uses, in the context of acute safety impacts to people.

This is supported by four general principles:

- the avoidance of avoidable risks
- the risk from a major hazard should be reduced wherever practicable, even where the likelihood of exposure is low
- the effects of significant events should, wherever possible, be contained within the development site boundary; and
- where the risk from an existing installation is already high, further development should not pose incremental risk.

B2.2. Strategic land use planning criteria

HIPAP 10 provides guidance on integrating land use safety considerations into a strategic plan and land use safety performance objectives. Table B.1 summarises how

the HIPAP 10 factors are taken into consideration in this study and summarises how the factors are used to determine land use safety conflicts and separation distances.

The HIPAP 10 performance objective 'protect residential amenity and health', was used to frame the assessment of impact at residential and sensitive land uses. In the context of risk to people, amenity is concerned with nuisance type issues such as noise and odour. Amenity is not assessed in this study and 'health' is taken to mean safety due to acute effects of incidents from potentially hazardous facilities.

Table B.1: HIPAP 10 strategic land use planning factors

Factor	HIPAP 10 consideration	Use in study
Permissibility of land use	Determine which types of development are permissible in an area.	The study assesses the implications of locating types of proposed development in the precinct.
Avoid environmentally sensitive areas	Lists examples of environmentally sensitive areas which includes areas close to sensitive land uses such as schools, nursing homes and hospitals.	The study assesses the potential impact to sensitive land uses, For this study it is primarily related to educational establishments.
Compatibility with land uses	Provision of buffer zones including the identification of beneficial land uses which can form a buffer between potentially hazardous industries and sensitive land uses such as residential areas.	The study assesses the need for and extent of buffer zones including beneficial use of land in buffer zones.
Initial site investigation	The purpose of the initial site investigation is to provide an early indication of the suitability of a proposed site.	Given the generic nature of possible developments and the lack of any formal development applications, the site level assessment was limited to likely compliance with risk criteria.

B2.3. Consequence criteria

The consequences (acute impact) of incidents from potentially hazardous facilities were assessed against the criteria in Table B.2. Where quantitative data was available the results were used to inform the assessment.

Table B.2: Consequence criteria

Impact	Qualitative criteria	Quantitative criteria
Heat radiation	Heat radiation reaches target	Incident heat flux radiation: • at a residential and sensitive use areas does not exceed 4.7 kW/m^2 (injury) • at neighbouring hazardous installation does not exceed 23 kW/m^2 (escalation potential).

Impact	Qualitative criteria	Quantitative criteria
Explosion overpressure	Explosion overpressure of concern reaches target	Incident explosion overpressure at a residential and sensitive use areas should not exceed 7 kPa (significant effect to people and property damage). Incident explosion overpressure at 21 kPa at industrial facility to cause escalation.
Toxic exposure	Emergency response guideline distances met	Toxic concentrations in residential and sensitive areas should not exceed a level which would be seriously injurious to sensitive members of the community following a relatively short period of exposure [Emergency Response Planning Guide (ERPG 2) or 1% fatality level].

B2.4. Individual and societal risk criteria

Individual and societal risk criteria are presented in HIPAP 10.

The individual and societal risk criteria were applied to the Ampol and Jemena pipelines.

B2.5. Uncertainty

A key aspect of this assessment is the uncertainty in the nature, scale, number and location of future developments that may be permitted in a land use zone.

The above criteria were used to frame a discussion of the types and locations of development in the precinct. The assessment adopted a precautionary approach when assessing the potential outcomes of hazardous incidents.

The report is not a substitute for application of the Resilience SEPP in the development approval process. However, it does provide guidance on areas where potentially hazardous facilities will have the least impact on sensitive receptors and hence the best potential for approval under the Resilience SEPP framework.

APPENDIX C. POPULATION ASSUMPTIONS

The population and job projections were converted into population densities per hectare for input into the risk model. The population for the three areas zoned for schools were divided as shown in Table C.1.

Table C.1: School population allocation

Location	Student/teacher population
Hamilton North Public School	178
Hunter School of Performing Arts & allowing for some future growth equivalent to a new school	1,281
Hamilton Public School	188
Total	**1,647**

C1. Population by day/night

Population assumptions were agreed in consultation with DPHI for the Camellia Precinct Land Use Safety Study, Ref [15], as shown in Table C.2. These modified assumptions were carried forward for the Broadmeadow Precinct.

Table C.2: Population distribution by day/night

HIPAP land use	Population		Jobs	
	Day	Night	Day	Night
Sensitive	1	0	1	0
Residential	0.2	1	1	0
Commercial	1	0	0.9	0.1
Recreational	1	0	1	0
Industrial	1	0.2	1	0
Mixed Use[(a)]				
90% residential	0.28	0.90	0.99	0.01
85% residential	0.32	0.85	0.99	0.02
80% residential	0.36	0.80	0.98	0.02
70% residential	0.44	0.70	0.97	0.03
66% residential	0.46	0.66	0.96	0.03
20% residential	0.84	0.20	0.92	0.08

Notes:

(a) Population distributions between day and night for land zoned 'Mixed Use' are calculated based on the proportion of residential and commercial populations in each area.

C2. Population by indoor/outdoor

The population assumed to be indoors and outdoors during the day and night are summarised in Table C.3, based on:

- TNO Purple Book

- DPHI guidance from Camellia redevelopment, Ref [15].

Table C.3: Population distribution by indoor/outdoor

Factor	Indoor population	Outdoor population	Comments
Day	0.90	0.10	DPHI guidance from Camellia
Night	0.99	0.01	TNO Purple Book

C3. Transient populations

Transient populations were added to the risk model for McDonald Jones Stadium, Leisure Centre and future mass transit nodes. The populations used in the risk model are summarised in Table C.4.

Table C.4: Transient populations

Location	HIPAP land use	Population	Time in use (days/year)[(a)]	Basis
McDonald Jones Stadium	Recreational	60,000[(b)]	13	Assumed maximum seating capacity, used for 6 hrs per week (2 x 3 hr events).
Leisure Centre	Recreational	129	182.5	Assumed 200 people per weekend and 100 people per weekday, on average (129 people per day). Open from 0600-1800 each day.
Mass transit nodes	Commercial	500[(b)]	8.7	Assumed 500 people per day, split evenly between morning and evening peak hour.

Notes:
(a) Time in use is divided equally between daytime and night-time at McDonald Jones Stadium and the mass transit nodes. The Leisure Centre is assumed to only be in use during the day.
(b) Population is divided evenly between day and night.

APPENDIX D. REFERENCES

[1] NSW Department of Planning, Housing and Infrastructure, “Assessment Guidline, Multi Level Risk Assessment,” 2011.

[2] NSW Department of Planning, Housing and Infrastructure, “HIPAP No. 10 - Land Use Safety Planning,” 2011.

[3] NSW Department of Planning, Housing and Infrastructure, “Hazardous Industry Planning Advisory Paper No. 4 - Risk Criteria for Land Use Safety Planning,” 2011.

[4] NSW Government, “State Environmental Planning Policy (Resilience and Hazards) 2021,” 2022.

[5] NSW Government, State Environmental Planning Policy (Transport and Infrasctructure), 2021.

[6] NSW Government, Hunter Regional Plan 2041, December 2022.

[7] NSW Department of Planning, Housing and Infrastructure, “Hazardous and Offensive Development Application Guidelines: Applying SEPP 33,” 2011.

[8] NSW Department of Planning, Housing and Infrastructure, “HIPAP No. 6 - Guidelines for Hazard Analysis,” 2011.

[9] NSW Department of Planning, Housing and Infrastructure, Draft Guideline for planning proposals near High Pressure Dangerous Goods pipelines, 2022.

[10] Standards Australia, “Bridge Design - Design Loads,” AS 5100.2:2017, Version 1.0, 2017.

[11] Sherpa Consulting Pty Ltd, Broadmeadow Precinct Package H - Land Use Safety Baseline Study, 2023.

[12] International Association of Oil & Gas Producers, “Risk Assessment Data Directory: Process Release Frequencies,” IOGP 434-01, 2019.

[13] TNO, Yellow Book: Methods for Calculation of Physical Effects due to the releases of hazardous materials (liquids and gases), 3rd ed., 2005.

[14] UK HSE, “Research Report 036: Report on a second study of pipeline accidents using the Health and Safety Executive’s risk assessment programs MISHAP and PIPERS Section 2.1 The Fireball.,” 2002.

[15] Sherpa Consulting Pty Ltd, “Camellia Precinct Land Use Safety Study,” 20920-RP-001, Jan 2018.