

APPENDIX F

**QRA SUITABILITY REVIEW KAPUNI
WELLSITES – AECOM**

QRA Suitability Review

Kapuni Wellsites

02-Dec-2022
Doc No. 60666317-R002
Commercial-in-Confidence

QRA Suitability Review

Kapuni Wellsites

Client: Todd Energy Limited

ABN: N/A

Prepared by

AECOM New Zealand Limited

8 Mahuhu Crescent, Tāmaki Makaurau/Auckland 1010, PO Box 4241, Tāmaki Makaurau/Auckland 1140, New Zealand
T +64 9 967 9200 F +64 9 967 9201 www.aecom.com

02-Dec-2022

Job No.: 60666317

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 and ISO45001.

© AECOM New Zealand Limited (AECOM). All rights reserved.

AECOM has prepared this document for the sole use of the Client and for a specific purpose, each as expressly stated in the document. No other party should rely on this document without the prior written consent of AECOM. AECOM undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this document. This document has been prepared based on the Client's description of its requirements and AECOM's experience, having regard to assumptions that AECOM can reasonably be expected to make in accordance with sound professional principles. AECOM may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified. Subject to the above conditions, this document may be transmitted, reproduced or disseminated only in its entirety.

Quality Information

Document QRA Suitability Review
 Ref 60666317
 Date 02-Dec-2022
 Prepared by David Lockley
 Reviewed by Barry Lawrence

Revision History


Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	31-May-2022	Issued for Internal Review	Barry Lawrence Study Manager	
0	16-Jun-2022	Issued for Use	Barry Lawrence Study Manager	
0A	30-Nov-2022	Re-Issued for Internal Review	Barry Lawrence Study Manager	
1	2-Dec-2022	Re-Issued for Use	Barry Lawrence Study Manager	

Table of Contents

Executive Summary		i
1.0	Introduction	1
	1.1 Background	1
	1.2 Objectives	1
2.0	Methodology	2
	2.1 Environment Court Issue #1 – Risk Acceptability	2
	2.2 Environment Court Issue #2 – Limitations and the Precautionary Approach	2
	2.3 Environment Court Issue #3 – Review Concerns	3
	2.4 Qualifications	3
3.0	Risk Acceptability	4
	3.1 Australia, New South Wales State Government – Department of Planning, Industry & Environment	4
	3.2 United Kingdom – UK Health and Safety Executive	5
4.0	Kapuni Wellsites	6
	4.1 Facility Description Relative to Land Use Context	6
	4.2 QRA Method Review	7
	4.3 Hazard Identification	8
	4.4 Leak Frequency Identification	9
	4.5 Ignition Probability Identification	9
	4.6 Event Trees Selection (flammable events)	9
	4.7 Consequence Models Selection	9
	4.8 Climate Data Identification	9
	4.9 Vulnerability Models Selection	10
	4.10 Sensitivity Analysis	10
5.0	Conclusion	12
6.0	Standard Limitation	13
7.0	References	14

Executive Summary

South Taranaki District Council (STDC)'s current District Plan, which sets objectives, policies and rules for significant hazardous facilities, became fully operative on 22 January 2021 following an extensive stakeholder consultation period in which elements of the Plan, including the use of QRA risk contours, were challenged in the Environment Court. The Environment Court approved use of QRA risk contours in the current Plan in September 2020.

The South Taranaki district contains multiple Oil and Gas Production facilities, which contain hazards with the potential for offsite impacts. The Operators of these Oil and Gas facilities have had Quantitative Risk Assessments (QRAs) commissioned to demonstrate compliance with their legal obligations under the Health and Safety at Work Act, 2015. The Environment Court approved the use of these QRAs, specifically, risk contour plots, in the District Plan to demarcate an area in which "sensitive activity" would be exposed to an unacceptable risk. In addition, STDC uses the risk contour plots to trigger a consent requirement where any proposed changes to the Oil and Gas Production facilities extend the risk contour plots.

Taranaki Energy Watch challenged several aspects of the Proposed District Plan, in the Environment Court. With respect to use of the available QRA risk contour plots, the Environment Court directed STDC, via Court Minute, *Timeframes For Providing Fatality Risk Contours (18 September 2019)*, to verify that the risk contour plot is suitable for use in the Proposed District Plan. Specifically, the Environment Court requested the following in relation to reviewing the existing QRAs:

- *state that sensitive activities outside the risk contours will not be exposed to unacceptable risk (para [6]);*
- *take limitations into account and adopt a precautionary approach (para [8]); and*
- *be accompanied by a statement as to concerns identified by the certifier have or will be addressed by operators (para [8]).*

AECOM has reviewed the Kapuni Wellsites QRA and it is AECOM's opinion that:

- The QRA fulfills the requirements, defined by the Environment Court via Court Minute, *Timeframes For Providing Fatality Risk Contours (18 September 2019)*, to be used "as is" in the District Plan.
- The 1×10^{-6} Location Specific Risk Contours presented in the Worley QRA Report, Revision 1, June 2022 and Addendum, November 2022 that are nominated in Table 1 of this report can be used for the purposes of the District Plan.
- The 1×10^{-6} Location Specific Risk Contours presented in the Worley QRA Report, Revision 1, June 2022 and Addendum, November 2022 that are nominated in Table 1 of this report:
 - take into account the limitations of the QRA process and adopt a precautionary approach;
 - having so taken into account the limitations of the QRA process can be relied upon to represent the 1×10^{-6} fatality risk contour for the Kapuni Wellsites.

1.0 Introduction

1.1 Background

South Taranaki District Council (STDC)'s current District Plan, which sets objectives, policies and rules for significant hazardous facilities, became fully operative on 22 January 2021 following an extensive stakeholder consultation period in which elements of the Plan, including the use of QRA risk contours, were challenged in the Environment Court. The Environment Court approved use of QRA risk contours in the current Plan in September 2020.

The South Taranaki district contains multiple Oil and Gas Production facilities, which contain hazards with the potential to have offsite impacts. The Operators of these Oil and Gas facilities have had Quantitative Risk Assessments (QRAs) commissioned to demonstrate compliance with their legal obligations under the Health and Safety at Work Act, 2015. Amongst the measures reported in these QRAs is a contour plot of location-specific individual fatality risk (LSIR) for the risk level of 1×10^{-6} chance of fatality per year.

The Environment Court approved the use of these QRAs, specifically, risk contour plots, in the District Plan to demarcate an area in which "sensitive activity" would be exposed to an unacceptable risk. "Sensitive activity" is defined on page 36 in the South Taranaki District Plan (Version: 22 January 2021), hereinafter referred to as just the District Plan, as:

any of the following activities: RESIDENTIAL ACTIVITIES, VISITOR ACCOMMODATION, COMMUNITY ACTIVITIES (including Marae), OPEN SPACE, CAMPING GROUNDS/MOTOR CAMPS, EDUCATION FACILITIES, PAPA KAINGA DEVELOPMENT, HOUSING FOR THE ELDERLY, RESIDENTIAL CARE FACILITIES, CHILDCARE FACILITIES, cafés, restaurants, and hospitals. For activities in the NATIONAL GRID YARD, OPEN SPACE is excluded from the definition of SENSITIVE ACTIVITY.

Taranaki Energy Watch challenged several aspects of the Proposed District Plan, in the NZ Environment Court. With respect to use of the available QRA risk contour, the Environment Court directed STDC, via Court Minute, *Timeframes For Providing Fatality Risk Contours (18 September 2019)*, to verify that the risk contour is suitable for use in the Proposed District Plan. Specifically, the Environment Court requested the following in relation to reviewing the existing QRAs:

- *state that sensitive activities outside the risk contours will not be exposed to unacceptable risk (para [6]);*
- *take limitations into account and adopt a precautionary approach (para [8]); and*
- *be accompanied by a statement as to concerns identified by the certifier have or will be addressed by operators (para [8]).*

1.2 Objectives

AECOM has been commissioned by Todd Energy Ltd to undertake a review of the Kapuni Wellsites QRA to verify whether the location of the risk contour of interest reported in the QRA fulfills the requirements, previously defined by the Environment Court, to be used "as is" in the District Plan. The key documents reviewed are:

- Worley New Zealand Ltd, *Kapuni Wellsites – Quantitative Risk Assessment – Todd Energy Ltd, Revision 1*, June 2022
- Worley New Zealand Ltd, *Kapuni Wellsites QRA – Assumptions Register – Todd Energy, Revision 1*, June 2022
- Worley New Zealand Ltd, *Kapuni Wellsites – Quantitative Risk Assessment – Addendum – Todd Energy Ltd, Revision 0*, November 2022

2.0 Methodology

2.1 Environment Court Issue #1 – Risk Acceptability

The existing New Zealand legislation and guidance material on land use planning, specifically in relation to development of or adjacent to hazardous industry was previously reviewed to determine if any numerical risk criteria exist and to compare this with the measures reported in the existing QRA.

No explicit statement of numerical safety risk criteria for land use planning was identified; however, there is an implied criteria published by New Zealand Quality Planning, which states on its web site (<https://www.qualityplanning.org.nz/index.php/node/1149>, 28 October, 2019):

There are no standard risk criteria for hazardous substances in New Zealand but there are international criteria which are widely referenced. In particular, the New South Wales Hazardous Industry Planning Advisory Papers no. 3 (Risk Assessment) and 4 (Risk Criteria for Land Use Safety Planning) has widely been used in the New Zealand context, and can be reflected in risk any [sic] management area overlays.

This also implies that the safety culture of protection of the community in the State of New South Wales, Australia is comparable with that in New Zealand. The criteria stated in Hazardous Industry Planning Advisory Paper 4 (Risk Criteria for Land Use Safety Planning) is discussed in Section 3.1 of this Report.

It can be argued that the safety culture of protection of the community in the United Kingdom (UK) is also comparable with that in New Zealand and some useful commentary on land use planning is available from the UK Health and Safety Executive, which is the Safety Regulator in the UK. This is discussed in Section 3.2 of this Report.

2.2 Environment Court Issue #2 – Limitations and the Precautionary Approach

The Environment Court recognizes that the results from a QRA can be quite variable. The Environment Court requested that the limitations in QRAs be reviewed and whether the Precautionary Approach has been adopted by the QRA Consultant.

The Precautionary Approach is described in Part 2, Section 7 of the *Hazardous Substances and New Organisms Act 1996* as a duty on persons in control to:

... take into account the need for caution in managing adverse effects where there is scientific and technical uncertainty about those effects

Identifying a boundary around an oil and gas production facility, outside of which the risk of fatality to a person is sufficiently low, could be considered to “contain” an accidental loss of energy from the oil and gas facility. This is a common technique in land use planning for a variety of activities where the impacts of the activity cannot be fully contained within the property on which the activity takes place. Accordingly, utilising QRA to identify the location where this risk has diminished sufficiently i.e. the boundary, should consider how to respond to known uncertainties in the inputs to the QRA. It can be argued that applying the Precautionary Approach would require the boundary to be set such that significant uncertainties are contained within the boundary. This review evaluates the QRA Consultant’s approach in this context.

The following steps were undertaken to identify limitations in the QRA modelling and to evaluate whether the Precautionary Approach has been applied:

1. Confirm the QRA method used by the QRA Consultant is appropriate.
2. Breakdown the QRA calculation into its component parts.
3. Examine the inputs to the components for sources of variability as well as assumptions about them used by the QRA Consultant, with particular emphasis on the impact on the location of the risk contour of interest.
4. Qualitatively assess the degree and direction of the variability with respect to:
 - It’s effect on the location of the risk contour.

- Whether the QRA Consultant's choices are consistent with the Precautionary Approach.

Where the QRA Consultant's approach to identified limitations is consistent with the Precautionary Approach, and therefore reflected in the LSIR risk contour of interest to STDC, those limitations are not discussed in this report.

In this report, a statement that an issue may "underestimate the location of the offsite LSIR contour" is to be read as meaning that the correct location of the offsite LSIR contour may be further away from the source of the hazard than reported.

2.3 Environment Court Issue #3 – Review Concerns

It is understood that the objective of this review is to verify whether the location of the risk contour of interest reported in the QRA fulfills the requirements, previously defined by the Environment Court, to be used "as is" in the District Plan. Issues of concern are highlighted throughout the evaluation of the technical components in the following sections and considered in forming the conclusion in Section 5.0.

2.4 Qualifications

The following qualifications apply to the review documented in this Report:

1. This Report describes a "peer review" of the existing QRA by a Technical Safety practitioner, only for the purpose of assessing its suitability for use in the District Plan, but in no way constitutes certification of the existing QRA.
2. Assessment of completeness of Operations data is outside the scope of the review.
3. Assessment of correctness of plant process conditions is outside the scope of the review.
4. Assessment of correctness of transcription between data sources and calculation is outside the scope of the review.
5. Assessment of correctness of calculations is outside the scope of the review.
6. There are separate and specific regulations managing pipelines. Therefore, this review does not consider pipelines in the QRA.
7. There are separate and specific regulations managing transportation of hazardous substances. Therefore, this review does not consider transportation in the QRA.

3.0 Risk Acceptability

The LSIR level of 1×10^{-6} chance of fatality per year has been chosen to demarcate the area in which “sensitive activity” would be exposed to an unacceptable risk from the area where “sensitive activity” would not be exposed to an unacceptable risk. This criterion was agreed between the risk experts involved in the Environment Court case in South Taranaki as a suitable representation of this boundary as all Oil and Production facilities in the South Taranaki district are located in rural areas and the most likely type of sensitive activity that may seek to establish near existing facilities is a residential dwelling. This criterion forms part of the standard applied by Regulators in other jurisdictions of comparable safety culture with regards to protection of the community to that in New Zealand. Below are some extracts from published information by two such Regulators, which provide some context around the choice of LSIR, including caveats. It should be noted that, in the context of safety risk, both referenced Regulators define “sensitive activity” differently to the District Plan. This results in some of the activities listed in Section 1.11, Page 36 of the District Plan under “sensitive activity” having different LSIR levels in other jurisdictions.

3.1 Australia, New South Wales State Government – Department of Planning, Industry & Environment

Australia's New South Wales State Government Department of Planning, Industry & Environment, in its published *Hazardous Industry Planning Advisory Paper, HIPAP4*, Section 2.4.2.1-Fatality, states:

The Department has adopted a fatality risk level of one in a million per year (1×10^{-6} per year) as the limit for risk acceptability for residential area exposure. This risk criteria, which is demonstrably very low in relation to the background risk shown in Table 1, has been adopted by the Department when assessing the safety implications of industrial development proposals. It is also appropriate in considering land use proposals in the vicinity of potentially hazardous facilities.

...

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

In relation to other classes of occupants HIPAP4 also states:

People's vulnerability to the hazard and their ability to take evasive action when exposed to the hazard also need to be taken into account.

and this:

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

A higher level of risk still is generally considered acceptable in industrial areas.

The following is a copy of Table 2 from HIPAP4 indicating LSIR criteria that differ (highlighted) for some of the same “sensitive activities” listed in the District Plan:

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

3.2 United Kingdom – UK Health and Safety Executive

The UK’s Health and Safety Executive in its publication, *Reducing Risks Protecting People - HSE’s decision-making process*, states in paragraph 138 in Part 3 of the publication:

... in the case of most housing developments, for example, HSE advises against granting planning permission for any significant development where individual risk of death for the hypothetical person is more than 10 in a million per year, and does not advise against planning permission on safety grounds for developments where such individual risk is less than 1 in a million per year.

However, the UK HSE qualifies its statement as follows:

Somewhat different criteria are applied to sensitive developments where those exposed to the risk are more vulnerable, e.g. schools, hospitals or old people’s homes, or to industrial or leisure developments, reflecting the different characteristics of the hypothetical person used to assess individual risk.

4.0 Kapuni Wellsites

4.1 Facility Description Relative to Land Use Context

Kapuni is an onshore gas and condensate field located in South Taranaki, approximately 50 km south of New Plymouth. Twenty (20) Kapuni wells are located on nine (9) separate wellsites in the area surrounding the Kapuni Production Station (KPS). The production wellsite process is a simple separation of gas and liquids involving the direction of wellstream gas and liquids to a low temperature separator (LTS) unit on the wellsite. The LTS separates the gas and liquids by means of pressure reduction to cause cooling. Wellstream gas and liquids are flammable and therefore give rise to risks associated with fire and explosion, which can extend beyond the wellsite’s property boundary. The land surrounding the wellsites is generally rural, open space sparsely populated used for pastoral purposes as evident in Figure 1.

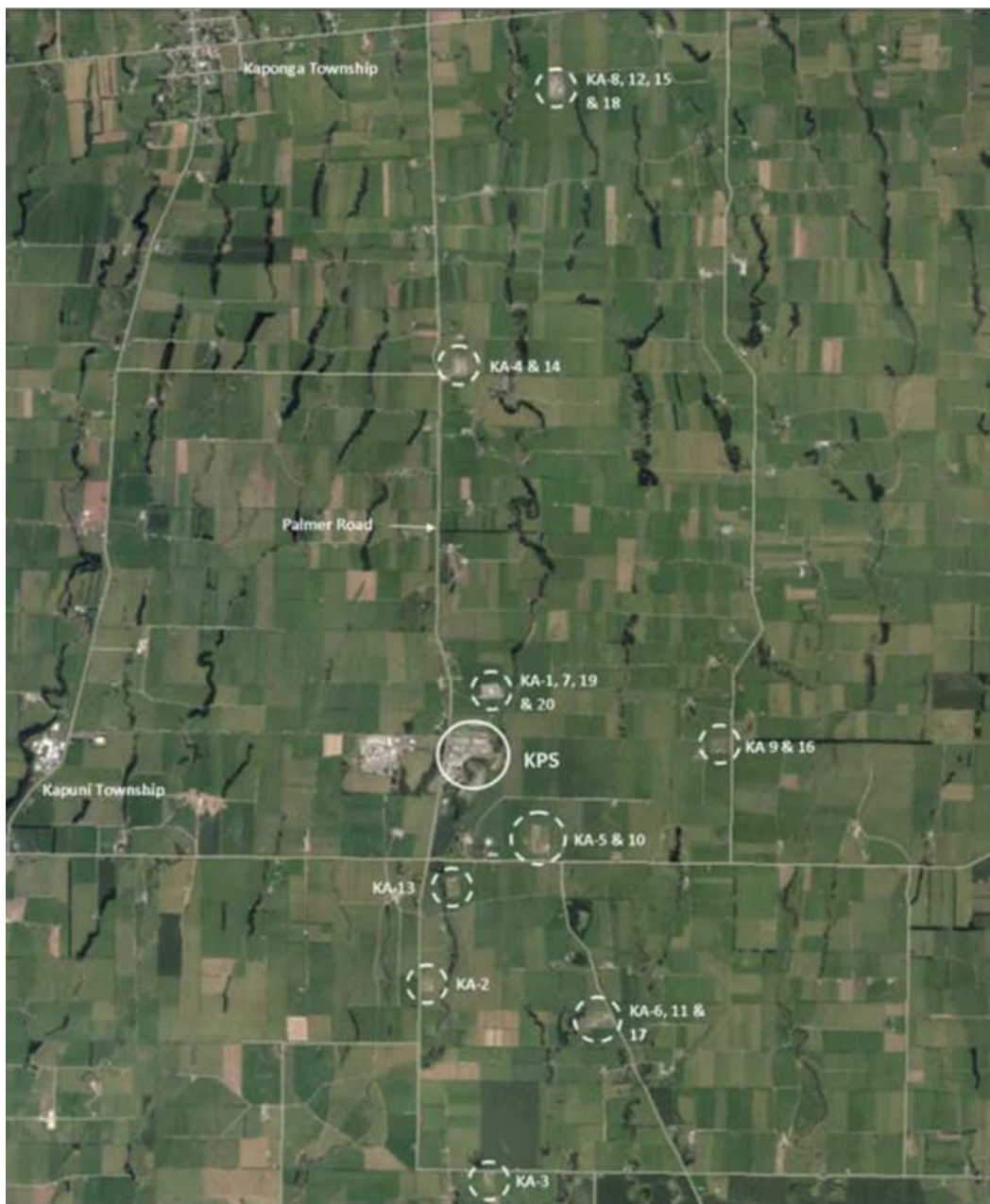


Figure 1 Kapuni Wellsites Location and Surrounding Land Use

4.2 QRA Method Review

The QRA Consultant has used a standard approach and software tool (DNV-GL's Safeti Version 8.22) to develop the QRA. The approach and software tool have proven to be acceptable to WorkSafe New Zealand and Safety and Planning Regulators elsewhere internationally. Further, the QRA software has undergone considerable validation against actual field tests, with hazardous materials typically found in oil and gas production facilities.

It is understood that this QRA was commissioned in anticipation of its use in the District Plan. Within that purpose the objective of the particular QRA is stated in the QRA Report (QRA Report Section 2.2) as being to:

- "... develop risk contours to assess land use compatibility in accordance with the NSW Hazardous Industry Planning Advisory Paper No.4 (HIPAP 4) "Risk Criteria for Land Use Planning.";

The QRA Consultant has only calculated the LSIR, which is the measure of interest for use in the District Plan.

The QRA Consultant has made various assumptions, which are relevant to the suitability of the reported offsite LSIR risk contours for use in land use planning. The specific assumptions involved are discussed in the following sections.

To aid in understanding how variations discussed in the following sections impact the risk profile and therefore LSIR risk contour location the following explanation is provided. The QRA software calculates the risk from a single event at each location in a grid overlaid on the site. A representation of the grid overlay on a hypothetical site is depicted in Figure 2.

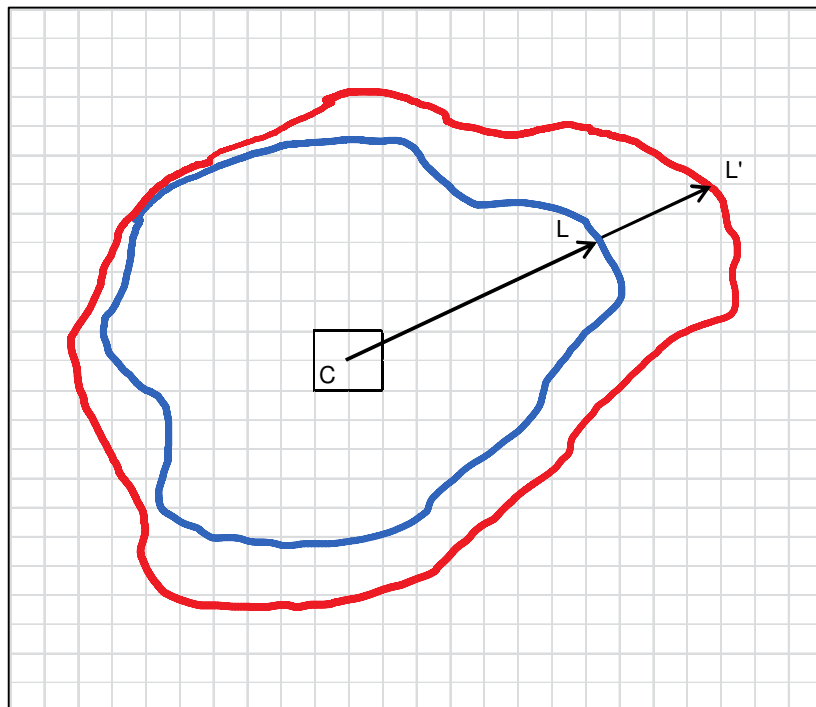


Figure 2 Risk Calculation Grid and LSIR Contour Plot

The software repeats the risk calculation for all events. The total risk at each point is the sum of the risks from all the separate events. To produce the risk contour plot the software finds grid points of equal risk and connects them, depicted by the blue contour.

The risk level can also be presented for a “slice” through the contour along a radial path. Figure 3 presents a hypothetical risk profile along the path outward from the risk source (point C) to the edge of the contour (point L) representing the summation of risk at each point with stacked bars. In the presented example, the acceptable risk criterion is overlaid as a horizontal yellow line. Considering a facility with two hazard scenarios, the distance to reach an acceptable risk level, or the exclusion zone, would be achieved at distance L.

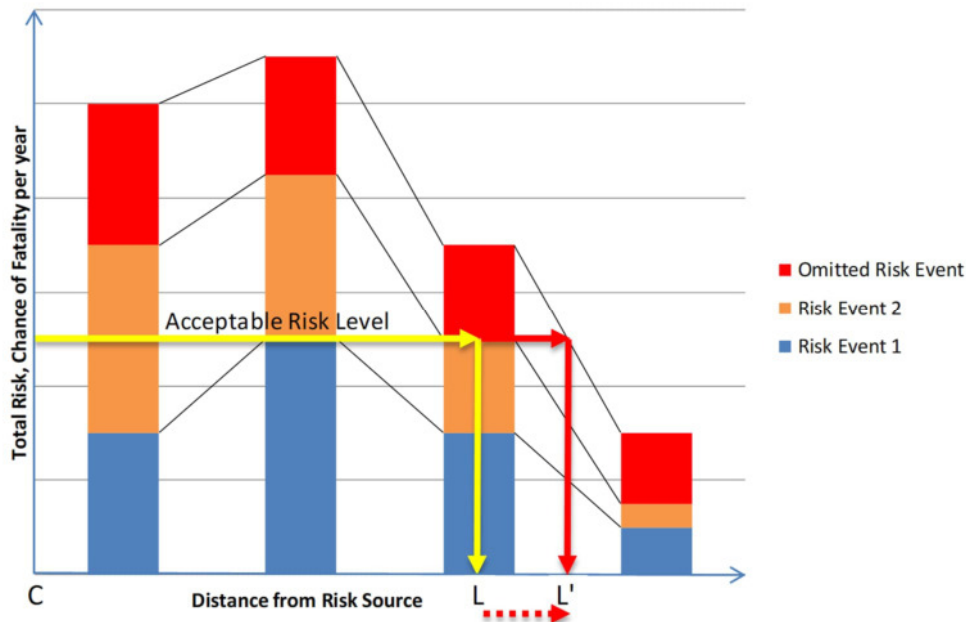


Figure 3 Risk Profile along a Radial Path Outward from the Risk Source

Figure 3 also indicates the effect of hazard omission; if the top bar in the stack represents a relevant risk event omission the spatial location of the acceptable risk level moves further out from the risk source to L' and would result in a shift in the risk contour plot, depicted by the red contour. It should be noted that it is not necessarily the case that the shift is of an equal amount around the whole contour.

4.3 Hazard Identification

In general, no issues of concern were identified with respect to Hazard Identification. The QRA Consultant has identified the range of hazards typical of the type of facilities being studied.

At well sites, produced hydrocarbons can have a significant presence of inert components, which can affect the flammability of well stream fluids. The QRA Consultant specifically identifies the following in Section 4.1 of the QRA Report:

- **Water Content** – The proportion of water in hydrocarbon liquids influences the flammability of the hydrocarbon and the QRA Consultant has followed the Oil and Gas UK, Fire and Explosion Guidance, May 2007, for water cuts over 50%, which indicates that the flames are significantly less radiative, and the overall heat flux to an obstacle can be reduced by 40% or more. The QRA Consultant has therefore assumed that a mixture remains flammable if it has a water cut of up to 125% (defined as mass of water/ mass of fuel x 100%), though not necessarily capable of supporting a stable flame in the absence of some other supporting mechanisms.
- **CO₂ Content** – For ignition of methane gas, studies have found that at CO₂ concentrations of 22–40% (v/v) it is possible for a self-sustaining flame to exist, but beyond these concentrations a pilot flame is required to aid combustion. Beyond 60% CO₂ the pilot flame has no effect and the mixture is completely inert.

This approach is generally accepted by the Oil and Gas Industry.

Methanol is the only toxic risk identified on the well sites. The QRA Consultant states that because the methanol tanks are stored at atmospheric conditions with a small inventory and banded, the methanol toxic risk is localised i.e. will not contribute to the risk contour of interest and therefore is excluded from the calculations. This decision is appropriate.

4.4 Leak Frequency Identification

In general, no issues of concern were identified with respect to Leak Frequency Identification.

The QRA Consultant identifies that the reference data used is from the OGP Process Release Frequency Database (QRA Report Section 3.2.2) to estimate the frequency of an individual leak of a particular size. The QRA Consultant has followed the OGP Guidance with respect to the use of Modification Factors (QRA Report Section 3.2.3 and Assumptions Register Section 3.3.4).

This is a common database used in QRAs and has been accepted by WorkSafe New Zealand and Regulators elsewhere and are generally accepted by the Oil and Gas Industry.

4.5 Ignition Probability Identification

No issues of concern were identified with respect to Ignition Probability Identification.

The QRA Consultant identifies in Section 3.2.4 of the QRA Report that the reference data used is from:

- International Association of Oil and Gas Producers (OGP), Risk Assessment Data Directory, Ignition Probabilities, Report No. 434-6.1 September 2019; and
- UKOOA IP Research Report, Ignition Probability review, Model Development and Look-up Correlations, January 2006

which have been used in QRAs accepted by Regulators in New Zealand and elsewhere. They are generally accepted by the Oil and Gas Industry.

The Immediate Ignition/Delayed Ignition ratio selected for ignition probability is 30:70 (Assumptions Register Section 3.5), which is also consistent with the recommendation in the UKOOA IP Research Report, Ignition Probability review, Model Development and Look-up Correlations, January 2006.

4.6 Event Trees Selection (flammable events)

No issues of concern were identified with respect to Consequence Models Selection. The QRA Consultant appears to have adopted Event Trees appropriate to the range of hazards typical of the type of facilities being studied. The nature of the Event Trees is *implied* in the discussion in the Assumptions Register, Section 3.7, Early and Delayed Ignition Probabilities and Section 3.8, Congested Area, rather than depicted schematically.

The QRA Consultant has appropriately allowed for a delay in response to gas leaks in the absence of gas detection at well sites, except for well site KA-8/18, which does have gas detection and automatic shutdown on confirmed gas leak. Todd Energy has confirmed that leaks in well sites without leak detection are identified indirectly through deviated process conditions, upon which personnel are despatched from Kapuni Production Station to the well site to investigate and initiate the relevant process management action. The QRA Consultant has made appropriate allowance for travel time in the calculation of delay in response. This is consistent with application of the Precautionary Approach.

4.7 Consequence Models Selection

No issues of concern were identified with respect to Consequence Models Selection. The QRA Consultant has exclusively used DNV-GL's consequence models.

4.8 Climate Data Identification

No issues of concern were identified with respect to Climate Data Identification. The QRA Consultant has sourced its data from the New Zealand National Climate Database for the Hawera Weather Station, which is approximately 18km from the facility.

4.9 Vulnerability Models Selection

In general, no issues of concern were identified with respect to Vulnerability Models Selection.

The QRA Consultant identifies in Section 3.2.5 of the QRA Report and Section 3.10 of the Assumptions Register, that the reference models used are from Dutch TNO Publication, CPR16E Methods for the Determination of Possible Damage ('The Green Book'), which has been used in QRAs accepted by Regulators in New Zealand and elsewhere. They are generally accepted by the Oil and Gas Industry.

The QRA Consultant has appropriately justified the assumption of no fatality outside the envelop of a flash fire (Assumption Register, Section 3.10.2).

4.10 Sensitivity Analysis

No issues of concern were identified with respect to the sensitivity analysis.

In general, the extent of the analysis scope for a well site in the base case is the well and downstream equipment and piping to the isolation valve on the gathering line that it is connected to. In addition to the normal inclusion of leak events representing a range of hole sizes, the base case includes consideration of well blowout. This is considered a conventional approach to defining the scope of analysis for this type of infrastructure when QRA is used to demonstrate outcomes under the Health and Safety at Work Act, 2015.

As the intent is to utilise the QRA information for land use planning in the immediate vicinity of well sites and noting that land use planning in the immediate vicinity of pipelines is managed under separate regulations, the QRA Consultant has defined a sensitivity case to bridge the difference in use case between Safety Case and land use planning and ensure a precautionary approach is adopted for quantifying offsite risk. To that end, the sensitivity case extends the analysis scope to include the length of aboveground gathering pipeline after the isolation valve up to the transition to belowground within the well site boundary. This approach is consistent with application of the Precautionary Approach.

The potential impact of a two-percentage point change in reliability of an ESD system has been explored separately by the QRA Consultant for the Kapuni Gas Treatment Plant QRA (reference: Section 8.1, Kapuni Gas Treatment Plant QRA Report, 610115-RPT-R0003, August 2021). The QRA Consultant noted that this level of change in reliability does not produce a material change in the risk contour of interest. ESD systems are subject to increased integrity management and consideration of larger changes in reliability are not justified. The QRA Consultant justified excluding repeating the examination of change in ESD system reliability for the well sites QRA based on this previous analysis. This approach is considered reasonable.

The QRA Report Addendum, dated November 2022, documents revision of the QRA analysis of Wellsite KA-04/14 to consider the impact of connecting the production from the KAP-J well to the pipelines at Wellsite KA-04/14. The analysis replaces the Base Case and Sensitivity Case in the main QRA Report for KA-04/14.

Further, the QRA Report Addendum documents additional sensitivity cases for Wellsite KA-1/7/19/20 to consider return to service of the facility's Low Temperature Separator capability, which, at the time of the QRA analysis and this review is operationally suspended.

Todd Energy has confirmed that there is no plan to bring the identified non-producing wells back online in the future and has directed the QRA Consultant not to calculate sensitivity cases for them in service. Todd Energy has indicated that in the unlikely event that this changes, it will arrange for the QRA to be updated to verify any impact on the risk contours. Further, it has indicated that engagement with South Taranaki District Council will be completed as part of this process and that a resource consent process may also be required. This approach is documented in Section 2.3 of the QRA Report.

It is recommended that the risk contours presented for the Sensitivity Cases nominated in Table 1 be used for Todd Energy's application for District Plan amendment. It should be noted that in a couple of cases the risk contours do not extend beyond the well site boundary.

Table 1 Recommended Risk Contour for District Plan

Wellsite	Recommended Risk Contour
KA-1, KA-7, KA-19 and KA-20	Sensitivity Case, QRA Report Addendum, Section 3.3, Figure 3-3. <i>Note: the risk contour of interest extends beyond most of the site boundary except for the north-east corner of the site.</i>
KA-2	QRA Report, Section 7, Figure 7-1 (no sensitivity case). <i>Note: the risk contour of interest extends beyond the site boundary in limited sections only to the east and south.</i>
KA-3	Not Calculated – wellsite is mothballed
KA-4 and KA-14	Sensitivity Case, QRA Report Addendum, Section 4.3.2, Figure 4-2. <i>Note: the risk contour of interest extends beyond the site boundary in limited sections only to the east, west and south.</i>
KA-5 and KA-10	The risk contour of interest is wholly contained within the site boundary (see QRA Report, Section 9, Sensitivity Case, Figure 9-2).
KA-6, KA-11 and KA-17	Sensitivity Case, QRA Report, Section 10, Figure 10-2. <i>Note: the risk contour of interest extends beyond the site boundary in a limited section of the north site boundary only.</i>
KA-8, KA-12, KA-15 and KA-18	Sensitivity Case, QRA Report, Section 11, Figure 11-2. <i>Note: the risk contour of interest extends beyond the site boundary in limited sections only to the north and west.</i>
KA-9, KA-16 and KW-03	Water only – no relevant risks.
KA-13	The risk contour of interest is wholly contained within the site boundary (see QRA Report, Section 12, Sensitivity Case, Figure 12-2).

5.0 Conclusion

In relation to the Environment Court's requirements for QRA risk contours to be used in the District Plan, the following findings are made:

- Appropriate QRA sensitivity analysis has been performed to identify the impact of including the aboveground portion of gathering lines within the well site downstream of the isolation valve to the well and well site equipment and piping.

It is AECOM's opinion that:

- The QRA fulfills the requirements, defined by the Environment Court via Court Minute, *Timeframes For Providing Fatality Risk Contours (18 September 2019)*, to be used "as is" in the District Plan.
- The 1×10^{-6} Location Specific Risk Contours presented in the Worley QRA Report, Revision 1, June 2022 and Addendum, November 2022 that are nominated in Table 1 of this report can be used for the purposes of the District Plan.
- The 1×10^{-6} Location Specific Risk Contours presented in the Worley QRA Report, Revision 1, June 2022 and Addendum, November 2022 that are nominated in Table 1 of this report:
 - takes into account the limitations of the QRA process and adopts a precautionary approach;
 - having so taken into account the limitations of the QRA process can be relied upon to represent the 1×10^{-6} fatality risk contour for the Kapuni Well Sites.

6.0 Standard Limitation

AECOM New Zealand Limited (AECOM) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Todd Energy Ltd and only those third parties who have been authorised in writing by AECOM to rely on this Report.

It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this Report.

It is prepared in accordance with the scope of work and for the purpose outlined in the purchase order dated 1 June 2021.

Where this Report indicates that information has been provided to AECOM by third parties, AECOM has made no independent verification of this information except as expressly stated in the Report. AECOM assumes no liability for any inaccuracies in or omissions to that information.

This Report was prepared between 31 January and 27 May 2022, revised 2nd December 2022, and is based on the information made available to AECOM at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred after this time.

This Report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This Report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Except as required by law, no third party may use or rely on this Report unless otherwise agreed by AECOM in writing. Where such agreement is provided, AECOM will provide a letter of reliance to the agreed third party in the form required by AECOM.

To the extent permitted by law, AECOM expressly disclaims and excludes liability for any loss, damage, cost or expenses suffered by any third party relating to or resulting from the use of, or reliance on, any information contained in this Report. AECOM does not admit that any action, liability or claim may exist or be available to any third party.

Except as specifically stated in this section, AECOM does not authorise the use of this Report by any third party.

It is the responsibility of third parties to independently make inquiries or seek advice in relation to their particular requirements and proposed use of the site.

Any estimates of potential costs which have been provided are presented as estimates only as at the date of the Report. Any cost estimates that have been provided may therefore vary from actual costs at the time of expenditure.

7.0 References

1. South Taranaki District Council, *South Taranaki District Plan*, 2021
2. Environment Court of New Zealand, *Timeframes For Providing Fatality Risk Contours (18 September 2019)*, *TEW v STDC – Minute 18 Sept 2019*, September 2019
3. Worley New Zealand Ltd, *Kapuni Wellsites – Quantitative Risk Assessment Report – Todd Energy Ltd., Revision 1*, June 2022
4. Worley New Zealand Ltd, *Kapuni Wellsites QRA – Assumptions Register – Todd Energy Ltd., Revision 1*, June 2022
5. New Zealand Government, *Resource Management Act*, 1991
6. New Zealand Government, *Health and Safety at Work Act*, 2015
7. New Zealand Government, *Hazardous Substances and New Organisms Act*, 1996 (Reprint as at 30 December 2018)
8. New Zealand Quality Planning, *Methods To Managing Effect Of Hazardous Substances In RMA Plans*, (Online), 28th October, 2019, <https://www.qualityplanning.org.nz/index.php/node/1149>
9. State of New South Wales Government, Australia, *Hazardous Industry Planning Advisory Paper No 4 (Risk Criteria for Land Use Safety Planning)*, January 2011
10. UK Health and Safety Executive, *Reducing Risks Protecting People - HSE's decision-making process*, December 2001
11. Netherlands Organisation for Applied Scientific Research (TNO) Publication, *CPR16E Methods for the Determination of Possible Damage ('The Green Book')*, 1992
12. Netherlands Organisation for Applied Scientific Research (TNO) Publication, *CPR18E Guideline for Quantitative Risk Assessment ('The Purple Book')*, 1999
13. Oil and Gas UK, *Fire and Explosion Guidance, Issue 1*, May 2007
14. Worley New Zealand Ltd, *Kapuni Wellsites – Quantitative Risk Assessment – Addendum – Todd Energy Ltd, Revision 0*, November 2022