Arriscar Pty Limited
ACN 162 867 763
www.arriscar.com.au

Sydney
Level 26
44 Market Street
Sydney NSW 2000
T: +61 2 9089 8804

Melbourne
Level 2 Riverside Quay
1 Southbank Boulevard
Southbank VIC 3006
T: +61 3 9982 4535

INDEPENDENT REVIEW OF SAFETY RISKS

Narrabri Gas Project (SSD 14_6456)

For NSW Department of Planning, Industry and Environment

17 March 2020

DOCUMENT HISTORY AND AUTHORISATION

Rev	Date	By	Description	Check	Approved
A	20 Sept 2019	PS	Draft for client review.	JL / JPM	PS
0	17 Mar 2020	PS	Final report.	JPM	PS

1 INTRODUCTION

Arriscar Pty Ltd (Arriscar) was engaged by the NSW Department of Planning, Industry and Environment (DPI&E) to undertake an independent review of the risks to public safety for the proposed Narrabri Gas Project (NGP) development (SSD 14_6456).

The proposed NGP development includes:

- developing a new gas field, with a target peak production rate of 200 terajoules per day;
- developing a range of associated infrastructure to support the gas field operations, including a gas processing facility and produced water gathering systems;
- exporting gas from the site; and
- progressively rehabilitating the site.

2 SCOPE

The scope of the review relates to the 'Public Safety' requirements for the NGP development, as outlined in the Secretary's Environmental Assessment Requirements (SEARs).

The SEARs for the NGP development require that the Environmental Impact Statement (EIS) must address the following specific issues:

- **Public Safety** – including:
  - an assessment of the likely risks to public safety, paying particular attention to potential bushfire risks, the potential for gas leaks, the transport, handling and use of any dangerous goods;
  - a preliminary hazard analysis in accordance with *Hazardous Industry Planning Advisory Paper No. 6 - Guidelines for Hazard Analysis* (DPE, 2011); and
  - consideration of appropriate setbacks and/or asset protection zones for well heads, gas processing facilities and other infrastructure to manage risks.

The EIS for the proposed NGP development was the primary document reviewed (Principally Chapter 25 and Appendix S); however, the applicant also provided additional information to address specific queries raised by the reviewers. These additional documents are listed in the Comment Response Sheet (CRS).

Public safety aspects that are not covered by HIPAP No. 6 (e.g. Including health risks from fugitive emissions, dam safety, sub-surface gas flows, etc.) were excluded from the scope of this review.

The land use safety planning risk criteria referred to in HIPAP No. 6 (And described in more detail in HIPAP No. 4 – *Risk Criteria for Land Use Safety Planning*) may be relevant to the consideration of setbacks and/or asset protection zones. Therefore, these considerations were included in this review.

3 APPROACH

To comply with the SEARs, the preliminary hazard analysis (PHA) for the NGP development is required to comply with the *Hazardous Industry Planning Advisory Paper (HIPAP) No. 6 Hazard Analysis*, and therefore must incorporate:

1. Identification of the nature and scale of all hazards at the facility, and the selection of representative incident scenarios;
2. Analysis of the consequences of these incidents on people, property and the biophysical environment;
3. Evaluation of the likelihood of such events occurring and the adequacy of safeguards;
4. Calculation of the resulting risk levels of the facility; and
5. Comparison of these risk levels with established risk criteria and identification of opportunities for risk reduction.

The SEARs also include additional specific requirements, such as requiring consideration of appropriate setbacks and/or asset protection zones (Refer to Section 2).

The documents submitted by the applicant were reviewed and the findings are included in Section 4. The key assessment criteria (Acts & Regulations / Standards / Guidelines) used during the review are listed in the CRS (e.g. SEARs, HIPAP No. 4, HIPAP No. 6, etc.).

Observations raised with the applicant during the review are listed in the CRS and were categorised based on their relative importance with respect to the assessment criteria.

4 FINDINGS

4.1 Project Description

The EIS submitted by the applicant did not include some information required to undertake the review (e.g. locations of sensitive receptors, 'shut-in' gas pressures, etc.). Therefore, additional information and clarifications were sought from the applicant (Refer to CRS and Attachments).

The applicant advised that final design information was not available for some equipment and some safety systems. This is consistent with HIPAP No. 6 (Section 1), in which it is noted that: "A PHA may be based on limited information since complete data on the design and precise safeguards may not be available at the initial stage. The PHA should be as final and comprehensive as the available information allows."

The applicant has advised that safety systems have not generally been factored into the PHA (including the supplementary QRA for the Leewood facility), which should provide some conservatism in the risk results; however, if the development is approved, then it will be important to ensure that the final design is thoroughly assessed in the post approval studies (particularly the Final Hazard Analysis).

4.2 Hazard Identification

The EIS submitted by the applicant did not appear to address some potentially hazardous events (e.g. hazards and risks associated with drilling, wellhead intervention / workover, well and gathering line decommissioning and abandonment, etc.). Therefore, additional information and clarifications were sought from the applicant (Refer to CRS and Attachments).

4.3 Consequence Analysis

The EIS submitted by the applicant did not include the consequence analysis results for some potentially hazardous events (e.g. a release of gas from a well that is 'shut-in'). Therefore, additional information and clarifications were sought from the applicant (Refer to CRS and Attachments).

4.4 Frequency Analysis

The EIS for the NGP (Principally Chapter 25 and Appendix S), and the applicant's responses to the questions raised during the review (Refer to CRS and Attachments), included frequency analysis results for some potentially hazardous events (e.g. leak frequencies for the identified representative release events).

It is reported in the EIS for the NGP (Appendix S, Section 4.3.2) that: "For buried non-steel pipes such as used in the gas gathering lines it was assumed that the same loss of containment frequency as used for buried steel pipelines would apply. This is conservative because the HDPE gathering lines are not subject to the same corrosion mechanisms as would apply to the steel pipelines." The EIS did not provide evidence to support this statement. Whilst corrosion mechanisms will differ, other failure modes may be more significant for HDPE pipes (e.g. failure due to an external fire) and the review has not confirmed that this is a conservative assumption.

4.5 Risk Analysis and Assessment

The EIS submitted by the applicant included a qualitative risk analysis and assessment against the Department's risk criteria for land use safety planning (Refer to Appendix S (Section 4.3.6) of the EIS for the NGP)). The applicant concluded that the Department's risk criteria are met based on the hazard ranges determined by quantitative consequence analysis and the correspondingly larger distances to sensitive receptors. Consequently, the cumulative individual risk contours and societal risk 'FN Curve' were not presented in the EIS.

The applicant's conclusion appears reasonable for the CSG wells and gas gathering system due to their remote location; however, it was not clear if this was a valid conclusion for the Leewood Central Gas Processing Facility (CGPF) and the Medium-Pressure (MP) Trunkline. Therefore, a Quantitative Risk Assessment (QRA) for these facilities was sought from the applicant (Refer to CRS – ID # 10 & 18).

The applicant submitted two supplementary documents: (i) *Leewood Central Gas Processing Facility and Medium Pressure Trunkline Quantitative Risk Assessment*; and (ii) *Assumption Register for Leewood CPF and Medium Pressure Trunkline Quantitative Risk Assessment*. Cumulative individual risk contours, and a societal risk 'FN Curve', for the Leewood CGPF and MP Trunkline are presented in the supplementary QRA.

The findings, with respect to each of the DPI&E's risk criteria for land use safety planning, are as follows:

Risk Criteria	Findings
Individual Fatality Risk	Cumulative individual fatality contours for the Leewood CGPF and MP Trunkline are presented in the supplementary QRA. The 1 pmpy cumulative individual fatality risk contour for the Leewood CGPF extends beyond the site boundary and reaches an existing adjacent rural residence. Therefore, the applicant has proposed to relocate the CGPF infrastructure 75 m to the west. This reduces the risk at the adjacent rural residence to less than 1 pmpy. It is reported in Section 2.4.2.1 (d) of HIPAP No. 4 that the 'Individual fatality risk levels for industrial sites at levels of 50 in a million per year (50×10^{-6} per year) should, as a target, be contained within the boundaries of the site where applicable'. It is noted that, even with relocation of the CGPF infrastructure, the 50 pmpy risk contour is not wholly contained within the site boundary and the 1 pmpy risk contour still extends up to c. 300 m from the site boundary. If the development is approved, then it should be demonstrated in the Final Hazard Analysis (FHA) that the risks have been reduced through implementation of technically feasible risk reduction measures in the final design (As required in HIPAP No. 6, Sections 2.2 and 8.2). Ideally, implementation of such measures should be used to ensure the 50 pmpy individual fatality risk contour at the Leewood CGPF is wholly contained within the boundary of the site. The cumulative individual fatality risk for the MP Trunkline does not reach 1 pmpy at any location.

Risk Criteria	Findings
	The DPI&E criteria for industrial, open space, commercial and sensitive uses are mostly not applicable in this case as the surrounding land is zoned for rural uses (Zone RU1 Primary Production) or forestry uses (Zone RU3 Forestry). However, some future permissible uses (e.g. camping grounds, dwellings) in Zone RU1 could be affected by the extent of the cumulative individual fatality contours for the Leewood CGPF.
Property Damage or Injury Risk from Heat Radiation (4.7 or 23 kW/m^2) or Overpressure (7 or 14 kPa)	A cumulative individual injury risk contour (Heat radiation at 4.7 kW/m^2) is presented in the supplementary QRA for the Leewood CGPF. The 50 pmpy risk contour extends beyond the site boundary and reaches an existing adjacent rural residence. Therefore, the applicant has proposed to relocate the CGPF infrastructure 75 m to the west. This reduces the injury risk (Heat radiation at 4.7 kW/m^2) at the adjacent rural residence to less than the Department's 50 pmpy risk criterion. The applicant has concluded that the DPI&E criterion for injury risk (Overpressure at 7 kPa) has been met based on the findings of the consequence analysis (Refer to *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* and CRS – ID # 9). This appears to be a reasonable conclusion, particularly if the CGPF infrastructure is relocated 75 m to the west (see above) (Note: The maximum distance to 7 kPa is reported to be 125 m in the EIS for the CGPF – Appendix S, Section 4.3.2). The DPI&E criteria for property damage risk (Heat radiation at 23 kW/m^2 or overpressure at 14 kPa) only apply for neighbouring potentially hazardous installations or at land zoned to accommodate such installations. These criteria are not applicable in this case as the surrounding land is zoned for rural uses (Zone RU1 Primary Production) at the Leewood CGPF and for forestry uses (Zone RU3 Forestry) at the CSG wells (including gas gathering network and Bibblewindi facility). The cumulative risks of property damage or injury risk from heat radiation or explosion overpressure appear to comply with the DPI&E's corresponding risk criteria.
Acute Toxic Injury Risk and Risk of Irritation	The applicant has concluded that the DPI&E criteria for acute toxic injury or irritation have been met based on the findings of the consequence analysis (Refer to EIS Appendix S, Section 4.3.4); however, it is also acknowledged that the "exact type of biocide to be used … is yet to be determined". Additional assessments are to be conditioned if the development is approved (Refer to Section 5.2).

Risk Criteria	Findings
Societal Risk	The cumulative FN curve for the Leewood CGPF and the MP Trunkline is reported in Section 3.2 of the *Leewood Central Gas Processing Facility and Medium Pressure Trunkline Quantitative Risk Assessment* and appears to comply with the DPI&E's corresponding risk criteria.
Risk to Biophysical Environment	A qualitative assessment has been undertaken to demonstrate compliance with the DPI&E's risk criteria for damage to the biophysical environment (Refer to HIPAP No. 4, Section 2.4.4 and attached CRS – ID # 1). It is acknowledged that a spill of the identified materials (e.g. caustic soda, citric acid, sodium hypochlorite, hydrochloric acid, etc.) is unlikely to result in long term damage to an extensive area and the controls to mitigate a release are expected to be addressed through compliance with relevant standards (e.g. bunding of odorant tanks). The applicant has estimated the likelihood of a bushfire being caused by the development at 1/70 years. It is reported that this is a "fire of any size …, including those with a very small effect distance that are contained within the site" (Refer to *Response to Arriscar follow up questions* - Attachment 2).
Qualitative Risk	An assessment against the DPI&E's qualitative risk criteria (Refer to HIPAP No. 4, Section 2.2) was not included in the EIS. Additional assessments are to be conditioned if the development is approved (Refer to Section 5.2).

5 OVERALL FINDINGS & RECOMMENDATIONS

5.1 Overall Findings

The review focussed on issues deemed to be material to the public safety risks, the findings of the PHA and the proposed setback / asset protection distances. The overall findings of this review should not be interpreted as an endorsement of all aspects of the applicant's safety assessments. For example, whilst the review has not confirmed that the applicant's use of failure frequencies for steel pipes will be conservative for HDPE pipes (Refer to Section 4.4), this may not be material to the overall findings of the PHA. Other similar issues were identified during the review.

On balance, despite the issues identified during the review (Refer to CRS), the 'Public Safety' aspects of the proposed NGP appear to have been addressed in the EIS (Principally Chapter 25 and Appendix S) and in the applicant's responses to the questions raised during the review (Refer to CRS and Attachments).

If the development is approved, then additional safety assessments and monitoring / auditing requirements have been recommended for inclusion in the development consent conditions (Refer to Section 5.2).

5.1.1 Assessment of Likely Risks to Public Safety

The likely risks to public safety (such as potential bushfire risks, the potential for gas leaks and the transport, handling and use of Dangerous Goods) have been addressed in the EIS (Principally Chapter 25 and Appendix S) and in the applicant's responses to the questions raised during the review (Refer to CRS and Attachments).

The applicant has estimated the likelihood of a bushfire being caused by the development at 1/70 years. It is reported that this is a "fire of any size …, including those with a very small effect distance that are contained within the site" (Refer to *Response to Arriscar follow up questions* - Attachment 2). If the development is approved, then a Bushfire Management Plan (BMP) should be prepared in consultation with relevant stakeholders (It is noted that the applicant has committed to undertaking a BMP) and periodic independent Hazard Audits should be undertaken to verify implementation of the control measures identified in the BMP.

5.1.2 Preliminary Hazard Analysis

The applicant has advised that safety systems have not generally been factored into the PHA (including the supplementary QRA completed for the Leewood facility), which should provide some conservatism in the risk results; however, if the development is approved, then it will be particularly important to ensure that the final design is thoroughly assessed in the post approval studies (particularly the Final Hazard Analysis (FHA)). A more comprehensive FHA will be required than would have been the case if a more finalised design had been considered in the PHA.

If the development is approved, the risk reduction provided by the safety systems included in the final design should be demonstrated in the FHA.

The DPI&E individual fatality risk criteria for industrial, open space, commercial and sensitive uses are mostly not applicable in this case as the surrounding land is zoned for rural uses (Zone RU1 Primary Production) or forestry uses (Zone RU3 Forestry). However, some future permissible uses (e.g. camping grounds, dwellings) for Zone RU1 could be affected by the extent of the cumulative individual fatality contours for the Leewood CGPF (as presented in the *Leewood Central Gas Processing Facility and Medium Pressure Trunkline Quantitative Risk Assessment*). If the NGP

development is approved, then depending on the extent of the risk contours presented in the FHA, Narrabri Council may need to consider future development controls in the vicinity of the CSG facilities, particularly in the vicinity of the Leewood CGPF.

5.1.3 Setbacks and/or Asset Protection Zones

CSG Wells

Clarifications were sought from Santos regarding the dimensions of the fenced off areas surrounding the CSG wellheads and gas infrastructure (Refer to CRS, ID # 8). The response from Santos included the following clarification:

> "The project description in the EIS identifies that well pads will be approximately 100 x 100 metres in size (refer to Figure 6-21 in Chapter 6 of the EIS). This 100 x 100 metre well pad will be partially rehabilitated once production has commenced however will remain fenced throughout the operational life of the well. Wellhead and gas infrastructure will be located within a fenced 50 x 50 metre 'safety zone' within the operational well pad. Only water infrastructure, such as break tanks, and potentially temporary flares would be located on the operational well pad, outside of the safety zone. The potential for offsite impacts will be taken into account in layout optimisation during the design phase."

Therefore, depending on the layout of the equipment within the operational well pad area, the separation distance from the wellhead and gas infrastructure to the boundary of the outer fenced 100 x 100 metre well pad area will range from 25 m to 50 m.

For an operating well that is not 'shut-in', the maximum extent of the 'off-site' impacts would appear to be c. 8 m to 25 m beyond the boundary of the outer fenced 100 x 100 metre well pad area (Based on the 'worst-case' consequence analysis results at a gas pressure of 620 kPag presented in Appendix S (Table 4-15) of the EIS for the NGP). However, the smaller, more likely, events may be fully contained within the outer fenced 100 x 100 metre well pad area (Based on the consequence analysis results presented in Appendix S (Appendix B) of the EIS for the NGP).

For a 'shut-in' well, the maximum extent of the 'off-site' impacts would appear to be c. 23 m to 46 m beyond the boundary of the outer fenced 100 x 100 metre well pad area (Based on the 'worst-case' consequence analysis results at a gas pressure of 1,400 kPag presented in *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1)).

Whilst some 'off-site' impact may be credible for a 'worst-case' event, it would appear that the outer fenced 100 x 100 metre well pad area may provide an adequate set-back on a safety risk basis (Noting that the individual and societal risk criteria in HIPAP No. 4 would apply for the land uses at the proposed CSG well locations) and it is reasonable to optimise the layout of equipment during the design phase. It is recommended that this be demonstrated in the Final Hazard Analysis.

Leewood CGPF

The applicant has proposed to relocate the CGPF infrastructure 75 m to the west to ensure the cumulative individual fatality risk at the adjacent rural residence is less than 1 pmpy (Refer to Section 4.5). It is not possible to establish the final positioning ('set-back') of the CGPF infrastructure; however, this should be a key consideration in the FHA (see above).

5.2 Recommendations

5.2.1 Hazard-Related Conditions of Consent

1. If the development is approved, then the observations that were conditionally closed during the review should be addressed by specific consent conditions. The matters to be addressed in these consent conditions are listed in the attached CRS for each conditionally closed observation.

   Note: The standard hazard-related conditions of consent, as outlined in the HIPAP No. 12 *Hazards-Related Conditions of Consent*, are expected to address many of the issues identified during this review; however, some additional recommendations are included in the attached CRS and/or below (e.g. an independent pre-commissioning audit, operating limits for the wells, reporting of key safety performance indicators, etc.).

2. Hazardous areas should be identified and classified for the CSG wells during detailed design phase and only equipment suitable for these areas should be installed (as per Section 2.3.4 of the *Code of Practice for Coal Seam Gas, Well Integrity*). This should also be undertaken for the other facilities associated with the NGP (Leewood CGPF, etc.).

5.2.2 Monitoring and Auditing of NGP Operations

3. Safety-related key performance indicators (KPIs) should be developed, monitored and periodically reported by the applicant (e.g. via a publicly accessible website in a similar manner to the reporting of environmental monitoring results or compliance / safety reports). The initial set of KPIs should be established following submission of the post approval studies and prior to commencement of operations. The KPIs should then be reviewed during subsequent Hazard Audits and may be varied as required. For example, the KPIs could relate to:

   - Data on Wellhead Reportable Leaks (as defined in the *Code of Practice for Coal Seam Gas, Well Integrity*) and equivalent leaks from other infrastructure (e.g. gas gathering network, Leewood CGPF, etc.);
   - Data on fire incidents (e.g. whether due to gas release or other causes);
   - Other 'lead indicator' data that is particularly relevant to the public safety assessment (e.g. wellhead pressures, completion of scheduled maintenance, leak testing, internal / external auditing of key management plans such as the BMP, etc.).

4. Two independent audits have been recommended: (i) an initial pre-commissioning audit; and, (ii) ongoing periodic Hazard Audits (Also see 'Hazard-Related Conditions of Consent' above). These audits should complement the auditing that will be undertaken by the applicant (e.g. auditing of safety policies and safety management plans" as per Section 2.2.3 of the *Code of Practice for Coal Seam Gas, Well Integrity*) and the audits / inspections undertaken by relevant Regulators.

   Verification of the control measures identified in the pre- and post-approval studies and plans (e.g. PHA, FHA, HAZOP study, Bushfire Management Plan, etc.) and proposed by the applicant in response to this review (Refer to CRS) should be a key focus of the two recommended audits.

5.2.3 Code of Practice for Coal Seam Gas, Well Integrity

5. It is reported in Section Preliminary f) of the *Code of Practice for Coal Seam Gas, Well Integrity*, that: "This document will be reviewed 1 year after commencement and then every 2 years or as necessary due to regulatory change or changes in industry standards." The current document is dated September 2012 and it is not clear if it has been periodically reviewed. Some referenced standards have been updated since September 2012 (e.g. API Recommended Practice 53) and it may be appropriate to undertake a review of the Code of Practice if this has not already occurred.

5.2.4 Future Development Controls

6. As noted in Section 4.5, some future permissible uses (e.g. camping grounds, dwellings) for Zone RU1 could be affected by the extent of the cumulative individual fatality contours for the Leewood CGPF. If the NGP development is approved, then depending on the extent of the risk contours presented in the FHA, Narrabri Council may need to consider future development controls in the vicinity of the CSG facilities, particularly in the vicinity of the Leewood CGPF.

COMMENT RESPONSE SHEET (CRS)

1. INTRODUCTION

Review Ref. #: CRS No. 1

Review Revision #: 3

Scope of Review

The scope of this review relates to the 'Public Safety' requirements, as outlined in the Secretary's Environmental Assessment Requirements (SEARs), for the proposed Narrabri Gas Project (NGP) development (SSD 14_6456).

Document(s) Reviewed

Title	Ref. #	Rev.	Date
Assumption Register for Leewood CPF and Medium Pressure Trunkline Quantitative Risk Assessment	-	-	8-Aug-2019
Leewood Central Gas Processing Facility and Medium Pressure Trunkline Quantitative Risk Assessment	-	-	28-Jun-2019
Response to Arriscar follow up questions	-	-	2-May-2019
Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project	-	-	24-Apr-2018
Narrabri Gas Project, Response to Submissions	-	-	-
EIS for the NGP: Chapter 25 – Hazard and risk	-	-	31-Jan-2017
EIS for the NGP: Appendix S – Hazard and risk assessment	-	-	31-Jan-2017

Assessment Criteria (Acts & Regulations / Standards / Guidelines)

Title	Ref. #	Rev.	Date
Applying SEPP 33	DOP HAZ_002	-	Jan-2011
Assessment Guideline – Multi-Level Risk Assessment	DOP HAZ_003	-	Jan-2011
Environmental Planning and Assessment (EP&A) Act and Regulations	-	-	May-2017
HIPAP No. 4 – Risk Criteria for Land Use Safety Planning	DOP HAZ_007	-	Jan-2011
HIPAP No. 6 – Hazard Analysis	DOP HAZ_009	-	Jan-2011
HIPAP No. 10 – Land Use Safety Planning	DOP HAZ_013	-	Jan-2011
Locational Guidelines – Development in the Vicinity of Operating Coal Seam Methane Wells	-	-	May-2004
Secretary's Environmental Assessment Requirements (SEARs) for the NGP EIS (Also included in Appendix A of the EIS)	SSD 14_6456	-	27-Sept-2016
SEPP No 33 – Hazardous and Offensive Development	1992 No 129	-	31-Jul-2014

Other Supporting Documents and References

Title	Ref. #	Rev.	Date
Code of Practice for Coal Seam Gas, Well Integrity	-	-	Sept-2012
Final Report of the Independent Review of Coal Seam Gas Activities in NSW ('Chief Scientist's Final Report')	-	-	Sept-2014

Title	Ref. #	Rev.	Date
Independent Review of Coal Seam Gas Activities in NSW, Information paper: Abandoned wells	-	-	Sept-2014
Independent Review of Coal Seam Gas Activities in NSW, Background Paper on Horizontal Drilling	AGR-1721	0	Oct-2013
Independent Review of Coal Seam Gas Activities in NSW, Information paper: On managing the interface between coal seam gas activities and other land uses (Setbacks)	-	-	Sept-2004
Onshore petroleum reporting and data submission	INT16/17668	1.0	Mar-2016
Risk management – Principles and guidelines	AS/NZS ISO 31000:2009	-	2009
Risk management guidelines – Companion to AS/NZS ISO 31000:2009	SA/SNZ HB 436:2013	-	2013

2. OBSERVATIONS

All observations relating to the document(s) reviewed (Refer to Section 1) are tabulated below. Each observation is categorised as follows.

Category 1

This category includes significant observations that may directly affect the overall assessment of the document/s being reviewed.

These observations require immediate resolution and are particularly important if information (including data and results) in the document/s being reviewed will be subsequently used in other documents.

Category 2

This category includes significant observations that may directly affect the overall assessment of the document/s being reviewed, but which do not require immediate resolution.

Category 3

An observation that should be addressed in the next revision of the document/s being reviewed. No immediate response is required for these observations.

This category includes minor observations that are unlikely to have a significant impact on the overall assessment of the document/s being reviewed. These are recorded for completeness and are expected to be addressed when the document is re-issued but are not in themselves enough to warrant a re-issue of the document.

Query

An observation that has no immediate or direct impact on the overall assessment, but where the Reviewer is seeking clarification or is seeking to highlight something for the Project's attention.

Comment

An observation providing supporting information, or an assumption made by the Reviewer during the review process. It provides information relevant to the review process and does not require a response.

Note: A cross-reference to the Acts & Regulations, Standards and Guidelines considered during the review (As listed in Section 1) is generally only included for each of the Category 1, 2 and 3 observations.

3. STATUS OF OBSERVATIONS

Category	Total Raised	Open	Conditionally Closed	Closed
1	7	0	6	1
2	11	0	10	1
3	0	0	0	0
Query	0	0	0	0
Total =	**18**	**0**	**16**	**2**

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
1	**EIS for the NGP: Appendix S, Executive Summary, Preliminary Risk Screening (Page i)** It is a requirement of the SEARs to undertake "a preliminary hazard analysis in accordance with Hazardous Industry Planning Advisory Paper No. 6 - Guidelines for Hazard Analysis (DPE, 2011)". Therefore, the screening approach from Applying SEPP 33 is not relevant and a full PHA must be undertaken in accordance with HIPAP No. 6. Once a site has been identified as triggering a PHA, all potentially hazardous materials need to be considered irrespective of the quantity. As noted in *Applying SEPP 33* (p.54): "It should be noted that the PHA required by SEPP 33 should cover all materials that may present a hazard and not just those where the quantities are above the screening threshold." The PHA has omitted some materials from the risk assessment on the basis that do not reach the threshold quantities. This is incorrect and all potentially hazardous materials must be included in the risk assessment (Including consideration of all potential hazards due to release, fire, decomposition, inadvertent mixing, etc.).	1	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** The materials identified in Appendix T3 of the EIS (e.g. caustic soda, citric acid, sodium hypochlorite, hydrochloric acid, etc.) do not typically contribute to the risk of fatality, injury or property damage off-site. Whilst these may cause damage to the biophysical environment, control measures are readily available and addressed in relevant standards (e.g. requirements for bunding). If the development is approved, then a Final hazard analysis (FHA) will be required. The FHA should be based on the final design and should take account of all relevant safeguards. Conditionally closed.	Conditionally Closed	If the development is approved, then the risks for all materials that may present a hazard to people, property or the biophysical environment (e.g. bulk diesel storage) at all of the potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) associated with the final design should be specifically addressed in the Final Hazard Analysis (FHA). All relevant safety measures included in the final design (e.g. bunding, etc.) should be specifically addressed in the FHA.
2	**EIS for the NGP: Appendix S, Table 1.1 (Pages 2-3)** It is reported in Table 1.1 that the gas field development will include "conversion or upgrade of existing exploration and appraisal wells to production in addition to the 850 new wells". The hazards and risks associated with the existing wells, including their "conversion or upgrade", do not appear to have been included in the PHA.	2	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** This observation has not been fully addressed. For example: • Whilst the hazard register has been amended to show the applicable project phase for each risk scenario, it is still not clear whether the hazards	Conditionally Closed	If the development is approved, then: • A Hazard and Operability (HAZOP) Study should be undertaken for all potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) associated with the development. The scope of the HAZOP study should also include the "conversion or upgrade" of existing wells.

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
			and risks have been specifically considered for these phases. It is noted that the list of scenarios has not been changed. • Conversion of existing wells has not been clearly addressed in the risk assessment. This may be because multiple causes have been grouped under each scenario. • The number of wells to be converted has not been specified and there are no scenarios specifically for conversion activities. • Some control measures are presented to reduce the risk (from initial to residual) that are already included for the initial risk assessment (e.g. for Scenario 5, buried gas gathering lines and community awareness are presented as controls to reduce the risk from Medium to Very Low; however, these controls are already included in the 'Inherent design standards and operational practices applied' column). The qualitative assessment and lack of specific data provided by Santos do not enable a third party to assess the acceptability of the hazards and risks associated with the existing wells, including their "conversion or upgrade". **Project Response 2 (2-May-2019)** Refer to: *Response to Arriscar follow up questions* (Attachment 2). **Review Response 2 (12-Sep-2019)** Although still reliant on a qualitative evaluation that the risk is low, the control measures identified in response to this query appear to be reasonable (e.g. emergency shutdown and manual isolations, etc.).		• A Safety Management System should be developed and implemented in accordance with HIPAP No. 9 *Safety Management.* Note: The scope of SMS should include all of the potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.). For the CSG wells, it is expected that the Safety Management Plan required for the NSW *Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012) will largely address the requirements of HIPAP No. 9. • An independent audit should be undertaken prior to commissioning to verify implementation of the control measures identified in the PHA / FHA and HAZOP and listed in response to this observation. • Periodic independent Hazard Audits should be undertaken to verify implementation of the control measures identified in the PHA / FHA and HAZOP and listed in response to this observation. Note: The scope of both independent audits should include all of the potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.). For the CSG wells, both audits should also include an assessment of the implementation of the control measures listed in the NSW *Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012), including (but not limited to) the: • Safety Management Plan;

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			Santos has advised that "Well integrity assessments would also be conducted in accordance with the NSW *Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012) prior to installing pumps and connecting wells to the gathering network". Conditionally closed.		• Incident and emergency management arrangements; • Electrical engineering safety systems (hazardous areas); • Maintenance and Monitoring Plan (M&MP); • Risk assessments undertaken for specific operations (e.g. drilling, etc.); • Measures to ensure well integrity (pressure testing, leak monitoring, etc.).
3	**EIS for the NGP: Appendix S, Section 1.4 (Page 6)** 'Sensitive receptors' have been defined relative to the Leewood and Bibblewindi facilities, but have not been identified for the other facilities (e.g. wells, gas gathering lines). All relevant land uses should be identified and considered to demonstrate compliance with *all* relevant risk criteria in HIPAP No. 4. For example, the following categories of use are included in Section 2.4.2.1 of HIPAP No. 4 for assessment of individual fatality risk: • Hospitals, schools, child-care facilities, old age housing • Residential, hotels, motels, tourist resorts • Commercial developments including retail centres, offices and entertainment centres • Sporting complexes and active open space • Industrial uses	1	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** The locations of the 'sensitive receptors' have been provided. This observation is Closed.	Closed	

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
4	**EIS for the NGP: Appendix S, Section 2.1 (Page 14)** The PHA "has been undertaken without consideration of standard design and operational systems" and a preliminary configuration for the wells has not been included in the PHA. Similarly, the configuration of the existing exploration and appraisal wells has not been presented in the PHA. Will these be reconfigured? In Section 1 of HIPAP No. 6, it is acknowledged that "A PHA may be based on limited information since complete data on the design and precise safeguards may not be available at the initial stage. The PHA should be as final and comprehensive as the available information allows." The complete absence of well configuration information in the PHA is not consistent with HIPAP No. 6, particularly when there are existing exploration and appraisal wells and preliminary design information might be based on wells that are already being operated by Santos.	1	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** The supplementary information provided in response to this observation is adequate; however, it is still not clear why this information was not presented in the EIS. This observation is Conditionally Closed.	Conditionally Closed	If the development is approved, then: • The FHA should include a Quantitative Risk Assessment for all potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) associated with the development. • A Hazard and Operability (HAZOP) Study should be undertaken for all potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) associated with the development. • An independent audit should be undertaken prior to commissioning to verify implementation of the control measures identified in the PHA / FHA and HAZOP and listed in response to this observation. • Periodic independent Hazard Audits should be undertaken to verify implementation of the control measures identified in the PHA / FHA and HAZOP and listed in response to this observation. Note: The scope of both independent audits should include all of the potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.). For the CSG wells, both audits should also include an assessment of the implementation of the control measures listed in the NSW *Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012) – Also refer to ID # 2. • Key safety performance indicators should be periodically monitored and reported to

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
					verify compliance with the key data and assumptions in the PHA/FHA (e.g. operating well pressures, shut-in well pressures, frequency of leaks, etc.).
5	**EIS for the NGP: Appendix S, Section 2.3.5 (Page 20)** The only risk criteria cited from HIPAP No. 4, and subsequently considered in the PHA, are for injury from heat radiation, explosion overpressure, and toxic exposures. The PHA must demonstrate compliance with *all* criteria in HIPAP No. 4, including: individual fatality risk (HIPAP No. 4, Section 2.4.2.1), injury risk (HIPAP No. 4, Section 2.4.2.2), property damage and accident propagation (HIPAP No. 4, Section 2.4.2.3) and societal risk (HIPAP No. 4, Section 2.4.3). It should also consider the qualitative risk criteria (HIPAP No. 4, Section 2.2) and the risk to the biophysical environment from accidental emissions (HIPAP No. 4, Section 2.4.4). Furthermore, it is reported in Section 2.4.2.1 (d) of HIPAP No. 4 that the *'Individual fatality risk levels for industrial sites at levels of 50 in a million per year (50 x 10^{-6} per year) should, as a target, be contained within the boundaries of the site where applicable'*. This has not been demonstrated in the PHA.	1	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** This observation has not been fully addressed. For example: • Compliance has not been fully demonstrated with the criteria for the risk to the biophysical environment from accidental emissions and fires (HIPAP No. 4, Section 2.4.4). **Project Response 2 (2-May-2019)** Refer to: *Response to Arriscar follow up questions* (Attachment 2). **Review Response 2 (12-Sep-2019)** Refer to ID # 1. If the development is approved, then a Final hazard analysis (FHA) will be required. Conditionally closed.	Conditionally Closed	If the development is approved, then the FHA should include a Quantitative Risk Assessment for all potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) associated with the development. Compliance with *all* quantitative and qualitative criteria in HIPAP No. 4 should be specifically demonstrated in the FHA. Where HIPAP 6 criteria are satisfied, it should also be demonstrated in the FHA that the final design reduces risks through implementation of technically feasible risk reduction measures that do not jeopardise the financial or technical viability of the facility (As required in HIPAP No. 6, Sections 2.2 and 8.2). Ideally, implementation of such measures should be used to ensure the 50 pmpy individual fatality risk contour at the Leewood CGPF is wholly contained within the boundary of the site.
6	**EIS for the NGP: Appendix S, Section 2.3.7 (Page 21)** Different operating conditions do not appear to have been addressed in the PHA. For example, the pressure may be significantly higher when a well is 'shut in'.	2	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** The shut-in pressure is a critical parameter as this is being used to justify the minimum safe separation	Conditionally Closed	If the development is approved, then a condition of consent should be included to limit the maximum operating pressures for the gas wells to the maximum pressures assessed in the PHA and *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). If the proponent determines a

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
	Different operating conditions should be considered in the PHA to ensure the assessment is a 'conservative best estimate' (HIPAP No. 4, Section 5).		distance. Justification for this pressure (which is noted to be less than has been reported for early/intermediate stages of operation for other CSG developments) should be provided. **Project Response 2 (2-May-2019)** Refer to: *Response to Arriscar follow up questions* (Attachment 2). **Review Response 2 (12-Sep-2019)** Noted and conditionally closed.		need to increase these maximum operating pressures, then this should be considered a modification to the consent and should require submission of an updated PHA to the Department. If the development is approved, then the final design of any above ground equipment associated with the HP pipeline (e.g. at the Leewood tie-in) should be specifically addressed in the Final Hazard Analysis.
7	**EIS for the NGP: Appendix S, Section 4.2.4 (Page 39)** It is reported that "During the operational phase, some transport of dangerous goods will be required to support project activities." Does this include the transport of dangerous goods during the other phases (construction, drilling, decommissioning, etc.)? If not, the transport movement in Section 4.2.4 should be amended accordingly.	2	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** The qualitative assessment and lack of specific data provided by Santos do not enable a third party to assess the acceptability of the risks associated with DG transport during all phases. However, the materials identified in Appendix T3 of the EIS (e.g. caustic soda, citric acid, sodium hypochlorite, hydrochloric acid, etc.) do not typically pose a significant risk of fatality, injury or property damage during transport. Whilst a spillage may cause damage to the biophysical environment, control measures are readily available and addressed in relevant standards (e.g. requirements for packaging, spill response, etc.). Therefore, this observation is Conditionally Closed.	Conditionally Closed	If the development is approved, then the FHA should include an assessment of the risks for all materials that may present a hazard to people, property or the biophysical environment during transport to or from all of the potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) and for all phases of the project. All relevant safety measures that will be implemented to manage the risks of DG transport (e.g. requirements for packaging, spill response, etc.) should be specifically addressed in the FHA.

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
8	**EIS for the NGP: Appendix S, Section 4.3.2 (Page 46)** It is reported that 'consequence effect distances reach up to 50m downwind of the release point which is contained within the well-pad area of approximately one quarter of a hectare after partial rehabilitation. Therefore, none of the wellhead scenarios analysed in this PHA has offsite impacts'. One quarter of a hectare equates to 2500 m^2, so the well-pad will have approximate dimensions of 50m x 50m. Therefore, even if the wells are located as far from the pad boundary as possible, i.e. the centre of the well pad, then the distance from the well to the well pad boundary would be approximately 25m. Some incidents will therefore have an off-site impact (c.f. Table 4-15 of EIS for the NGP: Appendix S). Furthermore, the photograph (Figure 1-3) shown in Section 1.5.1 of Appendix S of the EIS would appear to show infrastructure that is relatively close to the fence line boundary. The conclusion that 'none of the wellhead scenarios analysis in this PHA has offsite impacts' needs to be reconsidered in the PHA.	2	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** A 100 x 100 m fenced off area is now identified in the response in addition to the 50 x 50 m fenced off area. However, this observation has not been fully addressed as some infrastructure is still likely to be within 50 m of the 100 x 100 m fenced off area. **Project Response 2 (2-May-2019)** Refer to: *Response to Arriscar follow up questions* (Attachment 2). **Review Response 2 (12-Sep-2019)** Depending on the layout of the equipment within the operational well pad area, the separation distance from the wellhead and gas infrastructure to the boundary of the outer fenced 100 x 100 metre well pad area will range from 25 m to 50 m. Therefore, some incidents may have a potential off-site impact (c.f. Table 4-15 of EIS for the NGP: Appendix S and *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1): Observation 6). It should be demonstrated in the Final Hazard Analysis that the final layout of the equipment has been optimised to minimise the safety risk beyond the boundary of the outer fenced 100 x 100 metre well pad area. Conditionally closed.	Conditionally Closed	If the development is approved, then: • All wellhead and gas infrastructure should be located within the fenced 50 x 50 m 'safety zone'. • It should be demonstrated in the Final Hazard Analysis that the final layout of the equipment has been optimised to minimise the safety risk beyond the boundary of the outer fenced 100 x 100 metre well pad area.

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
9	**EIS for the NGP: Appendix S, Section 4.3.2 (Page 46)** It is reported that "No explosion overpressure analysis was performed at the wellheads as it is assumed the area is open and there is insufficient confinement and congestion to result in an explosion." A similar assumption is reported for other gas release locations. This assumption does not appear to have considered the presence of trees, which may potentially provide sufficient obstacles for generation of a vapour cloud explosion. The PHA should clearly demonstrate that a VCE is not credible based on the proposed clearance of vegetation around all of the potential sources of a gas release. If a VCE is credible, then the risk associated with such events should be assessed against the relevant risk criteria in HIPAP No. 4.	2	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** This observation has not been fully addressed. For example: • Some release cases are identified with LFL at up to 222 m (Table 2 in response to CRS No. 1). Could this reach congested areas? • Leaks from the underground pipework could still occur to atmosphere; however, these have not been considered in the analysis. **Project Response 2 (2-May-2019)** Refer to: *Response to Arriscar follow up questions* (Attachment 2). **Review Response 2 (12-Sep-2019)** Noted and closed.	Closed	
10	**EIS for the NGP: Appendix S, Section 4.3.6 (Pages 54-55)** The *cumulative* risk must be assessed against each relevant risk criterion (Refer to HIPAP No. 6, Section 7.1). The findings presented in the PHA do not appear to be based on the *cumulative* risk. For example, in Section 4.3.2 of the PHA, the risk associated with Bibblewindi is only assessed for the worst-case scenario. The Bibblewindi site, as shown in Figure 1.4, has a six existing exploration and appraisal wells (Three located within the site boundary and three within approximately 300m of the site). It is reported in Table 1.1 that exploration and appraisal	1	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** This observation has not been fully addressed. Based on the size of the well infrastructure (Refer to ID # 4), locations of the wells relative to the identified 'sensitive receptors' (Refer to ID # 3) and risk profiles for similar wells at other developments (Refer to *Locational Guidelines – Development in the Vicinity of Operating Coal Seam Methane Wells*), this observation is Conditionally Closed for the wells (Refer to proposed consent conditions in ID #1).	Conditionally Closed	If the development is approved, then the FHA should include a Quantitative Risk Assessment for all potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) associated with the development. Compliance with *all* quantitative and qualitative criteria in HIPAP No. 4 should be specifically demonstrated in the FHA. It should also be demonstrated in the FHA that the risks have been reduced through implementation of technically feasible risk reduction measures in the final design (As

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
	wells will be converted to production wells. The cumulative risk from all sources has not been used to demonstrate that the offsite risk criteria have been satisfied. Furthermore, an assessment of the individual risk of fatality and societal risk (both of which are currently omitted from the PHA) must be based on the cumulative risk for *all* potential events (i.e. including all potential outcomes – fire, explosion, bush fire, etc.).		However, this observation is Open for the Leewood facility due to the closer proximity to sensitive receptors, presence of more infrastructure (including some wells) and the tie-in to the proposed high pressure pipeline. A full QRA should be undertaken for the Leewood facility to demonstrate compliance with all of the Department's risk criteria for land use safety planning (HIPAP No. 4). Also refer to ID # 18. **Project Response 2 (2-May-2019)** Refer to: *Response to Arriscar follow up questions* (Attachment 2). **Review Response 2 (9-May-2019)** Open. **Project Response 3 (28-Jun-2019 and 8-Aug-2019)** Refer to: (i) *Leewood Central Gas Processing Facility and Medium Pressure Trunkline Quantitative Risk Assessment*; and (ii) *Assumption Register for Leewood CPF and Medium Pressure Trunkline Quantitative Risk Assessment*. **Review Response 3 (12-Sep-2019)** If the development is approved, then a Final hazard analysis (FHA) will be required. Conditionally closed.		required in HIPAP No. 6, Sections 2.2 and 8.2). Ideally, implementation of such measures should be used to ensure the 50 pmpy individual fatality risk contour at the Leewood CGPF is wholly contained within the boundary of the site.
11	**EIS for the NGP: Appendix S, Section 4.4.2 (Pages 55-61)** Whilst there are no risk criteria in HIPAP No. 4 specifically relating to protection of the environment from bush fires, the Department's criteria for the protection of the biophysical environment are as follows (HIPAP No. 4, Section 2.4):	1	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** This observation is Open.	Conditionally Closed	If the development is approved, then: • A Bushfire Management Plan (BMP) should be developed in consultation with relevant stakeholders. • An independent audit should be undertaken prior to commissioning to verify

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	• Industrial developments should not be sited in proximity to sensitive natural environmental areas where the effects (consequences) of the more likely accidental emissions may threaten the long-term viability of the ecosystem or any species within it. • Industrial developments should not be sited in proximity to sensitive natural environmental areas where the likelihood (probability) of impacts that may threaten the long-term viability of the ecosystem or any species within it is not substantially lower than the background level of threat to the ecosystem. It is also reported in Section 2 of HIPAP No. 4 that: "Risk criteria are set with the understanding that no aspect of living can be risk free but that any imposed risk should be very small in the context of the generally accepted background risk". The PHA has not demonstrated that the *cumulative* risk of initiating a bush fire from the proposed 850+ wells and associated gas gathering and processing facilities is low relative to the background risk and compliant with the Department's criteria for the protection of the biophysical environment.		The likelihood of a bushfire being caused by the development has been estimated at 1/70 years. This is not insignificant relative to the background risk (c. 1/10 years). **Project Response 2 (2-May-2019)** Refer to: *Response to Arriscar follow up questions* (Attachment 2). **Review Response 2 (12-Sep-2019)** The applicant has estimated the likelihood of a bushfire being caused by the development at 1/70 years. It is reported that this is a "fire of any size …, including those with a very small effect distance that are contained within the site" (Refer to *Response to Arriscar follow up questions* - Attachment 2). If the development is approved, then a Bushfire Management Plan (BMP) will be required. Conditionally closed.		implementation of the control measures identified in the BMP. • Periodic independent Hazard Audits should be undertaken to verify implementation of the control measures identified in the BMP.

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
12	**EIS for the NGP: Appendix S, Section 5 (Pages 61-64)** It is reported in Section 3 of HIPAP No. 6 that: "Even where the facility complies with numerical risk criteria, recommendations for reducing the likelihood and consequences of hazardous events on people, property and the biophysical environment should be made where technically feasible solutions will not adversely affect the economic viability of the project." Such recommendations have not been included in the PHA. Furthermore, it is a requirement of the SEARs that "appropriate setbacks and/or asset protection zones for well heads, gas processing facilities and other infrastructure to manage risks" be established. These are not clearly defined in the PHA (Noting that this will require additional assessment to ensure all relevant operations, facilities and risk criteria have been considered in the PHA – See other observations in this CRS).	1	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** This observation is Conditionally Closed. Also refer to ID # 8 and 10.	Conditionally Closed	Also refer to ID # 8 and 10. If the development is approved, then: • A minimum safe separation distance is to be maintained between all potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) and all relevant land uses. • The required minimum safe separation distance is to be verified in the Final Hazard Analysis.
13	**EIS for the NGP: Appendix S, Appendix A** The PHA refers to hazards and risks associated with the construction and operations phases of the project. The potential hazards and risks associated with other phases of the proposed development (e.g. drilling, wellhead intervention / workover, well and gathering line decommissioning and abandonment) do not appear to have been addressed in the PHA. All phases of the proposed development should be considered in the PHA.	2	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** This observation has not been fully addressed. Whilst an additional column has been added to the Risk Register, insufficient evidence has been provided to demonstrate that the risks for all phases of the proposed development have been systematically considered in the PHA.	Conditionally Closed	If the development is approved, then: • The FHA should include a Quantitative Risk Assessment for all potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) associated with the development. All phases of the proposed development should be considered in the FHA. • A Hazard and Operability (HAZOP) Study should be undertaken for all potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) associated with the development. The HAZOP Study

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
			Project Response 2 (2-May-2019) Refer to: *Response to Arriscar follow up questions* (Attachment 2). **Review Response 2 (12-Sep-2019)** Santos has advised that the "risk register was developed through workshops with engineers, field operators and relevant professionals" and that additional risk assessments will be undertaken, including "assessments focusing on each specific project phase and every activity to be conducted as part of the project". If the development is approved, then a Final hazard analysis (FHA) and a Hazard and Operability (HAZOP) Study will be required. Conditionally closed.		should consider all phases of the proposed development (e.g. drilling, wellhead intervention / workover, well and gathering line decommissioning and abandonment, etc.). • An independent audit should be undertaken prior to commissioning to verify implementation of the control measures identified in the PHA / FHA and listed in response to this observation. • Periodic independent Hazard Audits should be undertaken to verify implementation of the control measures identified in the PHA / FHA and listed in response to this observation. Note: The scope of both independent audits should include all of the potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.). For the CSG wells, both audits should also include an assessment of the implementation of the control measures listed in the NSW *Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012) – Also refer to ID # 2.
14	**EIS for the NGP: Appendix S, Appendix A** The hazard register does not appear to include hazards and risks from blowouts during the drilling phase.	2	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** The qualitative assessment and lack of specific data provided by Santos do not enable a third party to assess the acceptability of the risks associated with blowouts.	Conditionally Closed	If the development is approved, then: • The FHA should include a Quantitative Risk Assessment for all potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) associated with the development. All phases of the proposed development should be considered in the FHA.

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			This observation is Open. **Project Response 2 (2-May-2019)** Refer to: *Response to Arriscar follow up questions* (Attachment 2). **Review Response 2 (12-Sep-2019)** If the development is approved, then a Final hazard analysis (FHA) and a Hazard and Operability (HAZOP) Study will be required. Conditionally closed.		• A Hazard and Operability (HAZOP) Study should be undertaken for all potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) associated with the development. The HAZOP Study should consider all phases of the proposed development (e.g. drilling, wellhead intervention / workover, well and gathering line decommissioning and abandonment, etc.). • An independent audit should be undertaken prior to commissioning to verify implementation of the control measures identified in the PHA / FHA and listed in response to this observation. • Periodic independent Hazard Audits should be undertaken to verify implementation of the control measures identified in the PHA / FHA and listed in response to this observation. Note: The scope of both independent audits should include all of the potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.). For the CSG wells, both audits should also include an assessment of the implementation of the control measures listed in the NSW *Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012) – Also refer to ID # 2.

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15	**EIS for the NGP: Appendix S, Appendix A** The hazard register does not appear to include hazards and risks from other activities in the state forests (e.g. external threats such as logging, controlled back burning, other infrastructure, recreational activities (use of 4WDs, etc.). These should be included PHA (As per Section 4.1 of HIPAP No. 6).	2	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** The qualitative assessment and lack of specific data provided by Santos do not enable a third party to assess the acceptability of the risks associated with other activities in the State Forest. This observation is Open. **Project Response 2 (2-May-2019)** Refer to: *Response to Arriscar follow up questions* (Attachment 2). **Review Response 2 (12-Sep-2019)** Noted and conditionally closed.	Conditionally Closed	If the development is approved, then: • An independent audit should be undertaken prior to commissioning to verify implementation of the control measures identified in the PHA / FHA and listed in response to this observation. • Periodic independent Hazard Audits should be undertaken to verify implementation of the control measures identified in the PHA / FHA and listed in response to this observation. Note: The scope of both independent audits should include all of the potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.). For the CSG wells, both audits should also include an assessment of the implementation of the control measures listed in the NSW *Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012) – Also refer to ID # 2.
16	**EIS for the NGP: Appendix S, Appendix A** The hazard register does not appear to include hazards and risks from 'malicious acts'. These should be included in the PHA (As per Section 4.1 of HIPAP No. 6).	2	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** The qualitative assessment and lack of specific data provided by Santos do not enable a third party to assess the acceptability of the risks associated with 'malicious acts'. This observation is Open.	Conditionally Closed	If the development is approved, then: • An independent audit should be undertaken prior to commissioning to verify implementation of the control measures identified in the PHA / FHA and listed in response to this observation. • Periodic independent Hazard Audits should be undertaken to verify implementation of the control measures (e.g. locked valves, etc.) identified in the PHA / FHA and listed in response to this observation.

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
			Project Response 2 (2-May-2019) Refer to: *Response to Arriscar follow up questions* (Attachment 2). **Review Response 2 (12-Sep-2019)** Noted and conditionally closed.		Note: The scope of both independent audits should include all of the potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.). For the CSG wells, both audits should also include an assessment of the implementation of the control measures listed in the NSW *Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012) – Also refer to ID # 2.
17	**EIS for the NGP: Appendix S, Appendix A** The hazard register does not appear to include hazards and risks due to the presence of other infrastructure within the pipeline corridor (i.e. It is understood that the new medium pressure gas pipeline (864mm diameter) will be in a corridor that already contains an existing 257mm diameter gas pipeline flowing from Bibblewindi to Wilga Park Power Station and will contain a new 132kV power transmission cable). These should be included in the PHA (As per Section 4.1 of HIPAP No. 6).	2	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** The qualitative assessment and lack of specific data provided by Santos do not enable a third party to assess the acceptability of the risks associated with other infrastructure within the pipeline corridor. This observation is Open. **Project Response 2 (2-May-2019)** Refer to: *Response to Arriscar follow up questions* (Attachment 2). **Review Response 2 (12-Sep-2019)** Noted and conditionally closed.	Conditionally Closed	If the development is approved, then: • The FHA should include a Quantitative Risk Assessment for all potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) associated with the development. All phases of the proposed development should be considered in the FHA. • A Pipeline Safety Management Study (PSMS) should be undertaken with participation by all relevant stakeholders (including any other operators with equipment in the pipeline corridors). • An independent audit should be undertaken prior to commissioning to verify implementation of the control measures identified in the PHA / FHA, PSMS and listed in response to this observation. • Periodic independent Hazard Audits should be undertaken to verify implementation of the control measures identified in the PHA / FHA, PSMS and listed in response to this observation.

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
18	**EIS for the NGP: Appendix S, Appendix A** The hazard register does not appear to include hazards and risks associated with the power generation plant at Leewood. Other activities (e.g. pig launch and recovery) are also omitted. A more detailed and comprehensive assessment should be included in the PHA for the equipment and operations at the Leewood facility.	2	**Project Response 1 (24-Apr-2018)** Refer to: *Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project* (Attachment 1). **Review Response 1 (13-Jun-2018)** This observation is Open. Refer to ID # 10. **Project Response 2 (2-May-2019)** Refer to: *Response to Arriscar follow up questions* (Attachment 2). **Review Response 2 (9-May-2019)** This observation is Open. Refer to ID # 10. **Project Response 3 (28-Jun-2019 and 8-Aug-2019)** Refer to: (i) *Leewood Central Gas Processing Facility and Medium Pressure Trunkline Quantitative Risk Assessment*; and (ii) *Assumption Register for Leewood CPF and Medium Pressure Trunkline Quantitative Risk Assessment*. **Review Response 3 (12-Sep-2019)** If the development is approved, then a Final hazard analysis (FHA) will be required. Conditionally closed.	Conditionally Closed	If the development is approved, then the FHA should include a Quantitative Risk Assessment for all potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) associated with the development. Compliance with *all* quantitative and qualitative criteria in HIPAP No. 4 should be specifically demonstrated in the FHA. It should also be demonstrated in the FHA that the risks have been reduced through implementation of technically feasible risk reduction measures in the final design (As required in HIPAP No. 6, Sections 2.2 and 8.2). Ideally, implementation of such measures should be used to ensure the 50 pmpy individual fatality risk contour at the Leewood CGPF is wholly contained within the boundary of the site.

Santos Ltd
ABN 80 007 550 923
Santos Centre
GPO Box 1010
Brisbane Queensland 4001
Telephone: 61 7 3838 3000
Direct: 61 7 3838 3861
www.santos.com

24 April 2018

Mr Mike Young
Director Resource Assessments
NSW Department of Planning and Environment
GPO Box 39
Sydney NSW 2001

Dear Mr Young

Thank you for the opportunity to provide a response to Arriscar Pty Ltd's questions in relation to the Narrabri Gas Project. Attached is the responses that have been prepared in consultation with the relevant technical consultants for the project.

Santos would be happy to meet with Arriscar Pty Ltd to discuss the responses or provide further information as considered necessary.

Yours sincerely,

Neale House
Manager, Environment and Water
Santos Limited

Att. 1

Attachment 1: Response to Arriscar Pty Ltd's questions on the Narrabri Gas Project

Background

Arriscar Pty Ltd was engaged by the NSW Department of Planning and Environment (DP&E) to undertake a peer review of the hazard and risk technical appendix (Appendix S – GHD 2016) within the Narrabri Gas Project (NGP) Environmental Impact Statement (EIS). Arriscar's peer review raised 18 issues which are addressed in the response below.

Observation 1 - EIS for the NGP: Appendix S, Executive Summary, Preliminary Risk Screening (Page i)

It is a requirement of the Secretary's environmental assessment requirements (SEARs) to undertake "a preliminary hazard analysis in accordance with *Hazardous Industry Planning Advisory Paper No. 6 - Guidelines for Hazard Analysis* (DPE 2011)". Therefore, the screening approach from Applying SEPP 33 is not relevant and a full preliminary hazard analysis (PHA) must be undertaken in accordance with HIPAP No. 6.

Once a site has been identified as triggering a PHA, all potentially hazardous materials need to be considered irrespective of the quantity. As noted in *Applying SEPP 33* (DPE 2011a) "It should be noted that the PHA required by SEPP 33 should cover all materials that may present a hazard and not just those where the quantities are above the screening threshold." The PHA has omitted some materials from the risk assessment on the basis that they do not reach the threshold quantities. This is incorrect and all potentially hazardous materials must be included in the risk assessment (including consideration of all potential hazards due to release, fire, decomposition, inadvertent mixing, etc.).

Response:

HIPAP 6 has been followed in accordance with the SEARs including hazard identification, qualitative risk assessment of all identified hazards and further semi-quantitative assessment of materials with the potential for offsite risk.

The SEARs noted the requirement for the transport, handling and use of dangerous goods to be assessed as part of public safety. The SEARs referenced SEPP 33 in Appendix 1, therefore, all potentially hazardous materials, irrespective of their quantities, have been assessed qualitatively in the risk register (Appendix A to EIS Appendix S), as required for a PHA. Those that exceed the threshold quantities in SEPP 33 were assessed in further detail semi-quantitatively.

Example risks captured in the risk register that include materials below the SEPP 33 thresholds are:

ID 2: An uncontrolled loss of containment of a small quantity (<100 L) of liquid chemicals or dangerous goods. Examples may include diesel, drilling fluids, oils, lubricants, corrosion inhibitor, acids, caustic soda, biocide, triethylene glycol etc.

ID 3: An uncontrolled loss of containment of liquid chemicals or dangerous goods (>100 L). Examples may include diesel, drilling fluids, oils, lubricants, corrosion inhibitor, acids, caustic soda, biocide, triethylene glycol etc.

Diesel is not a dangerous good for transport, and is therefore not included in the SEPP 33 risk screening. As it is a combustible liquid and has the potential to pose an offsite risk, it was included in the qualitative assessment at Risk ID 2 and 3 as described above. To assist in the qualitative assessment of risk, pool fire consequence modelling was performed for the proposed storage volumes of diesel at Bibblewindi (30,000 L) and Leewood (100,000 L). As tank and bund sizing is yet to be finalised, a conservative assumption was made to assess the heat radiation impacts of a pool fire contained in a 20 m diameter bund. This bund size is assumed to be sufficient to contain 100 per cent of the volume of the largest diesel storage tank.

Pool fire modelling indicates that for a 20 m diameter pool fire of diesel, the 4.7 kW/m^2 heat radiation extends up to 38 m downwind and the 35 kW/m^2 heat radiation level is not reached. These results indicate that the potential for injury from diesel pool fires could be up to 38 m from the bund and there is limited risk of fatality. On the basis of diesel storage being located away from the site boundary in accordance with AS1940:2017 (Standards Australia 2017), it is not anticipated that there would be any offsite impacts from the storage of diesel. Therefore, diesel was not carried forward into the semi-quantitative assessment, and the risk of diesel fires causing offsite fatality, injury, property damage or damage to the biophysical environment is considered to be very low.

Observation 2 - EIS for the NGP: Appendix S, Table 1.1 (Pages 2-3)

It is reported in Table 1.1 that the gas field development will include "conversion or upgrade of existing exploration and appraisal wells to production in addition to the 850 new wells".

The hazards and risks associated with the existing wells, including their "conversion or upgrade", do not appear to have been included in the PHA.

Response:

The existing exploration and appraisal wells that will be converted and operated as production wells were included in the assessment.

To convert pilot wells to production, the wells would be connected to the gas and water gathering network. Pumps and other surface infrastructure may be upgraded, but changes would be minimal.

These modifications, and their potential for offsite risks, are consistent with some of the works undertaken in the installation of new wells. Therefore, these have been considered as part of the construction risks in the risk register (ID 4).

Observation 3 - EIS for the NGP: Appendix S, Section 1.4 (Page 6)

'Sensitive receptors' have been defined relative to the Leewood and Bibblewindi facilities, but have not been identified for the other facilities (e.g. wells, gas gathering lines).

All relevant land uses should be identified and considered to demonstrate compliance with all relevant risk criteria in HIPAP No. 4. For example, the following categories of use are included in Section 2.4.2.1 of HIPAP No.4 for assessment of individual fatality risk:

- **Hospitals, schools, child-care facilities, old age housing;**
- **Residential, hotels, motels, tourist resorts;**
- **Commercial developments including retail centres, offices and entertainment centres;**
- **Sporting complexes and active open space; and**
- **Industrial uses.**

Response:

Figure 1 below shows the location all sensitive receivers within a three kilometre buffer zone of the project area with respect to the project infrastructure.

There are 114 sensitive receivers within the project area at relatively low density. A further 103 sensitive receivers were identified within three kilometres of the boundary of the project area. All of the 114 sensitive receivers identified within the project area are residential dwellings, except for an unmanned University of Sydney Cosmic Ray Field Station.

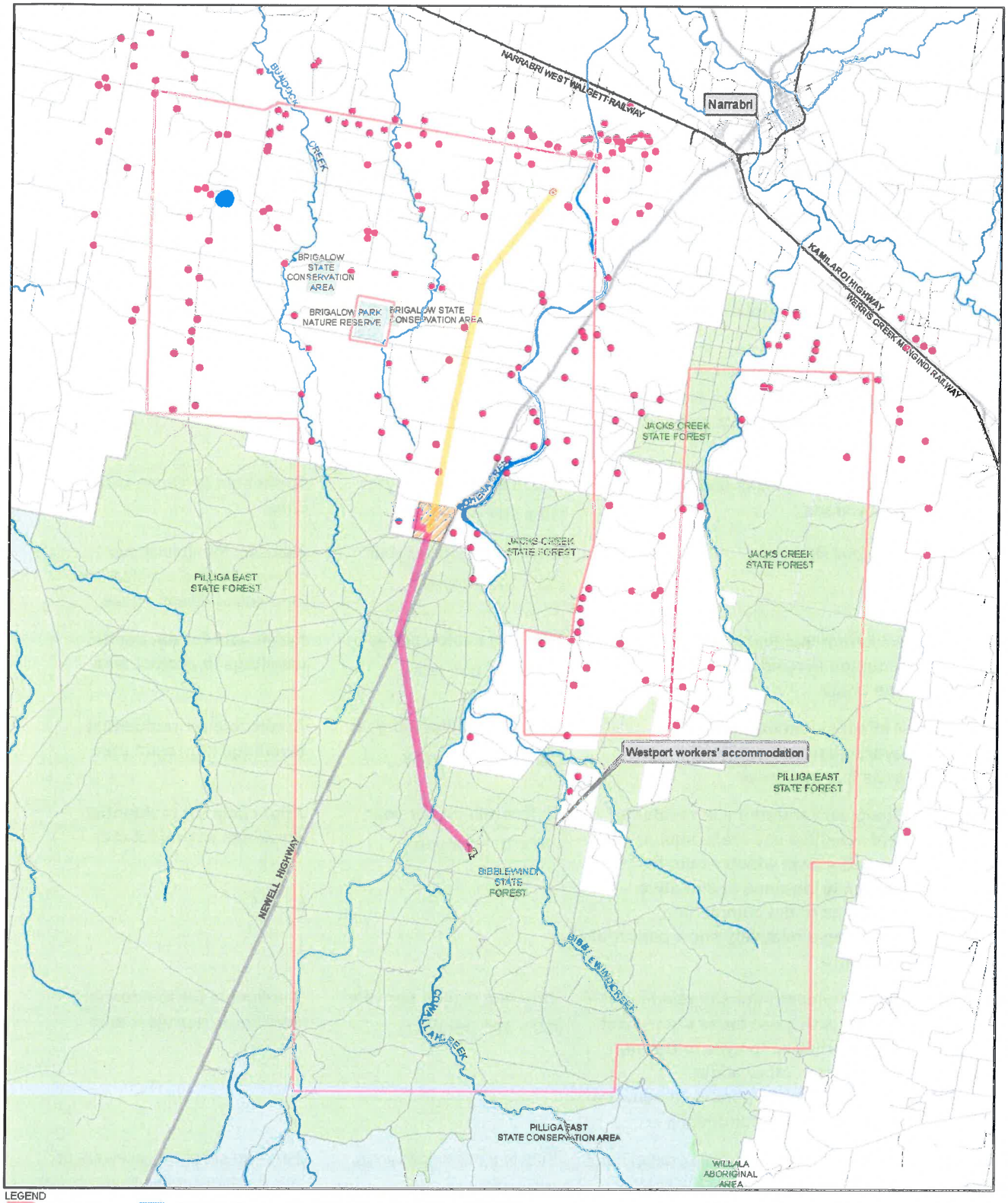
Yarrie Lake, located in the north west of the project area is a popular recreational area where people gather and use the recreational facilities on site as well as the lake itself. This is recognised and acknowledged through the Field Development Protocol which applies a surface infrastructure exclusion area to the Yarrie Lake Reserve, plus a 50 m buffer zone.

Approximately two thirds of the project infrastructure will be located within State forest. While the public can access the State forest for recreational activities, other than Yarrie Lake, there are no additional mapped facilities or places of interest within the project area where the public would gather.

Westport workers' accommodation is located approximately 5 km ENE from Bibblewindi, which is well beyond the furthest consequence effect distance for a jet fire, fireball or blast overpressure from an explosion as assessed within the EIS. It is considered a sensitive receiver, and therefore, project infrastructure will be sited in accordance with regulatory requirements and applicable standards in respect of buffer distances to this location.

Other than the identified residential and active open space sensitive receiver (Yarrie Lake), there is no land use in the vicinity of the project area that would create locations of increased (non-transient) public exposure to the project infrastructure. There are no schools, hospitals, child-care facilities, old age housing, commercial developments, or industrial uses within the project area. The nearest school is the Narrabri West Public School, approximately six kilometres north east of the project area.

Therefore, only the HIPAP 4 (DPE 2011b) residential and active open space risk criteria (Section 2.3.5 of Appendix S) for fatalities and injuries is applicable based on the project area.



Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Figure 1 Sensitive receivers

For context, the NSW HIPAP 4 risk criteria for fatality, injury and property damage are summarised in Table 1. For clarity, the HIPAP 4 criteria that are relevant to project's hazard and risk assessment have been bolded.

Table 1 NSW HIPAP 4 risk criteria

Category	Land use	Maximum tolerable risk	Relevance
Fatality	Hospitals, schools, child-care facilities and old age housing developments	Half in a million per year (0.5×10^{-6} per year)	N/A - no sensitive receivers of this category in the area
Fatality	**Residential developments and places of continuous occupancy (hotels / resorts)**	**One in a million per year (1×10^{-6} per year)**	**Applicable for residential dwellings in project area**
Fatality	Commercial developments, including offices, retail centres, warehouses with showrooms, restaurants and entertainment centres	Five in a million per year (5×10^{-6} per year)	N/A - no sensitive receivers of this category in the area
Fatality	**Sporting complexes and active open space areas**	**Ten in a million per year (10×10^{-6} per year)**	**Applicable to Yarrie Lake only**
Fatality	Industrial sites	Fifty in a million per year (50×10^{-6} per year)	Assessment against this criteria will be a consideration for detailed design phase.
Injury	**4.7 kW/m^2 incident heat flux radiation at residential and sensitive use areas**	**Fifty in a million per year (50×10^{-6} per year)**	**Applicable for residential dwellings in project area**
Injury	**7 kPa incident explosion overpressure at residential and sensitive use areas**	**Fifty in a million per year (50×10^{-6} per year)**	**Applicable for residential dwellings in project area**
Injury	**Toxic concentrations in residential and sensitive use areas should not exceed a level which would be seriously injurious to sensitive members of the community following a relatively short period of exposure**	**10 in a million per year (10×10^{-6} per year)**	**Applicable for residential dwellings in project area**
Irritation	**Toxic concentrations in residential and sensitive use areas should not cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community**	**Fifty in a million per year (50×10^{-6} per year)**	**Applicable for residential dwellings in project area**
Property damage	23 kW/m^2 incident heat flux radiation at neighbouring potentially hazardous installations or at land zoned to accommodate such installations	Fifty in a million per year (50×10^{-6} per year)	N/A - no sensitive receivers of this category in the area
Property damage	14 kPa incident explosion overpressure at neighbouring potentially hazardous installations, at land zoned to accommodate such installations or at nearest public buildings	Fifty in a million per year (50×10^{-6} per year)	N/A - no sensitive receivers of this category in the area

The exact location of wells is not yet known, however all wells will be sited in accordance with the Field Development Protocol (refer to EIS Appendix C). The Field Development Protocol applies for the life of the project, for each stage of development throughout infrastructure planning and design, construction, operation, decommissioning and rehabilitation, and takes into account environmental, social and cultural constraints. In respect of residences in the project area, unless a written agreement is in place with the relevant landholder, no project infrastructure will be located within 200 m of an occupied residence on that property.

All loss of containment scenarios for wells and gathering lines have assessed consequence distances of less than 200 metres (refer to Comment 5 response). Thus, although the exact location of the wells and gathering lines is not yet known, it is concluded that no sensitive receivers would be impacted from a loss of containment event from a well or the gathering system.

Observation 4: EIS for the NGP: Appendix S, Section 2.1 (Page 14)

The PHA "has been undertaken without consideration of standard design and operational systems" and a preliminary configuration for the wells has not been included in the PHA. Similarly, the configuration of the existing exploration and appraisal wells has not been presented in the PHA. Will these be reconfigured?

In Section 1 of HIPAP No.6, it is acknowledged that "A PHA may be based on limited information since complete data on the design and precise safeguards may not be available at the initial stage. The PHA should be as final and comprehensive as the available information allows." The complete absence of well configuration information in the PHA is not consistent with HIPAP No. 6, particularly when there are existing exploration and appraisal wells and preliminary design information might be based on wells that are already being operated by Santos.

Response

The risk assessment followed HIPAP 6 guidelines and was completed on the basis of a 'typical' well head and gathering system design as per the proponent's existing appraisal operations. For reference, example wellhead piping and instrumentation diagrams (P&ID) are included as **Error! Reference source not found.** and **Error! Reference source not found.**. Although the design has yet to be finalised for the wells, **Error! Reference source not found.** and **Error! Reference source not found.** show a typical design for which the loss of containment events have been assessed.

Typical surface infrastructure at a gas well includes the well head, a gas and water separator, metering skids, a diesel or gas generator, and a remote sensor telemetry unit. The telemetry unit provides real time information on well operations via a supervisory control and data acquisition (SCADA) system that has the ability to remotely shut in wells. That is, a well can be shut in from a location that is remote from the well itself. The wells will also have automated shutdown systems which will be triggered by pre-set operating parameters being exceeded. These systems are designed to minimise environmental, health and safety risks through a broad range of measures including automatic closure of fail-safe valve on depressurisation and emergency shutdown separate from process logic control system ensuring shut down capability in loss of power or system down event.

Using a typical design as the basis, consequence distances for credible "worst case scenarios" were determined involving well heads and gathering system releases. The likelihood of these events were also semi-quantitatively estimated. The configuration and final siting of wells and the gathering system will not affect the outcomes of the risk assessment, but rather, the risk assessment findings will form part of the well siting considerations in relation to sensitive receivers. In accordance with the Field Development Protocol, unless a written agreement is in place with the relevant landholder, no project infrastructure will be located within 200 m of an occupied residence.

The project is seeking approval to install up to 850 new production wells on a maximum of 425 well pads in the project area. The new production wells will be a combination of horizontal, vertical and deviated wells.

Installation of a new production well involves drilling the well, installation of the wellhead and supporting infrastructure, and connecting the well to gas and water gathering lines. Chapter 6 (Project description) of the EIS contains a more detailed description of the construction and operation of well infrastructure.

The configuration of existing infrastructure, including exploration and appraisal wells near the Bibblewindi gas compression facility, is shown in Figure 1-4 of EIS Appendix S and Figure 2 of this response.

Production well pads would be spaced at least 750 metres apart, depending on subsurface and surface conditions, environmental constraints, land access arrangements and subsurface characteristics. Each well pad would accommodate up to three well heads. Siting of the well pads will be conducted in accordance with the Field Development Protocol.

Design standards and typical controls for well heads and pipelines including controls to minimise the risk of gas release resulting in fire or explosion will be applied using the hierarchy of controls. This involves:

1. Elimination – for example, eliminating the presence of a dangerous good;
2. Substitution – use of an alternate less hazardous material;
3. Engineering – physical controls incorporated into design to prevent or mitigate risks;
4. Isolation – minimise inventory release or barriers to prevent exposure;
5. Administration – standard operating procedures; and
6. PPE – personal protective equipment.

During the design phase of the project, safety in design studies will be completed to identify and implement suitable controls according to the hierarchy and to minimise risks through design, particularly engineering controls. Further administrative controls will be used throughout the life of the project to manage any residual risks.

Some further design studies to be completed include:

- The pipelines will be the subject of a Safety Management Study that is compliant to Australian Standard AS 2885.1-2012 *Pipelines – Gas and liquid petroleum Part 1: Design and construction*. The proponent would undertake an initial Pipeline Safety Management Study early in the design phase to identify key engineering, design and physical controls, and then a detailed Pipeline Safety Management Study will be completed as part of the detailed design phase.
- All facilities will undergo Hazard and Operability (HAZOP) studies to identify and address any potential hazards or operability issues with the design during the design phase.
- Quantitative Risk Assessment (QRA) will be completed to assess the risks against the relevant planning criteria.

Figure 2: Example piping and instrumentation diagram 1

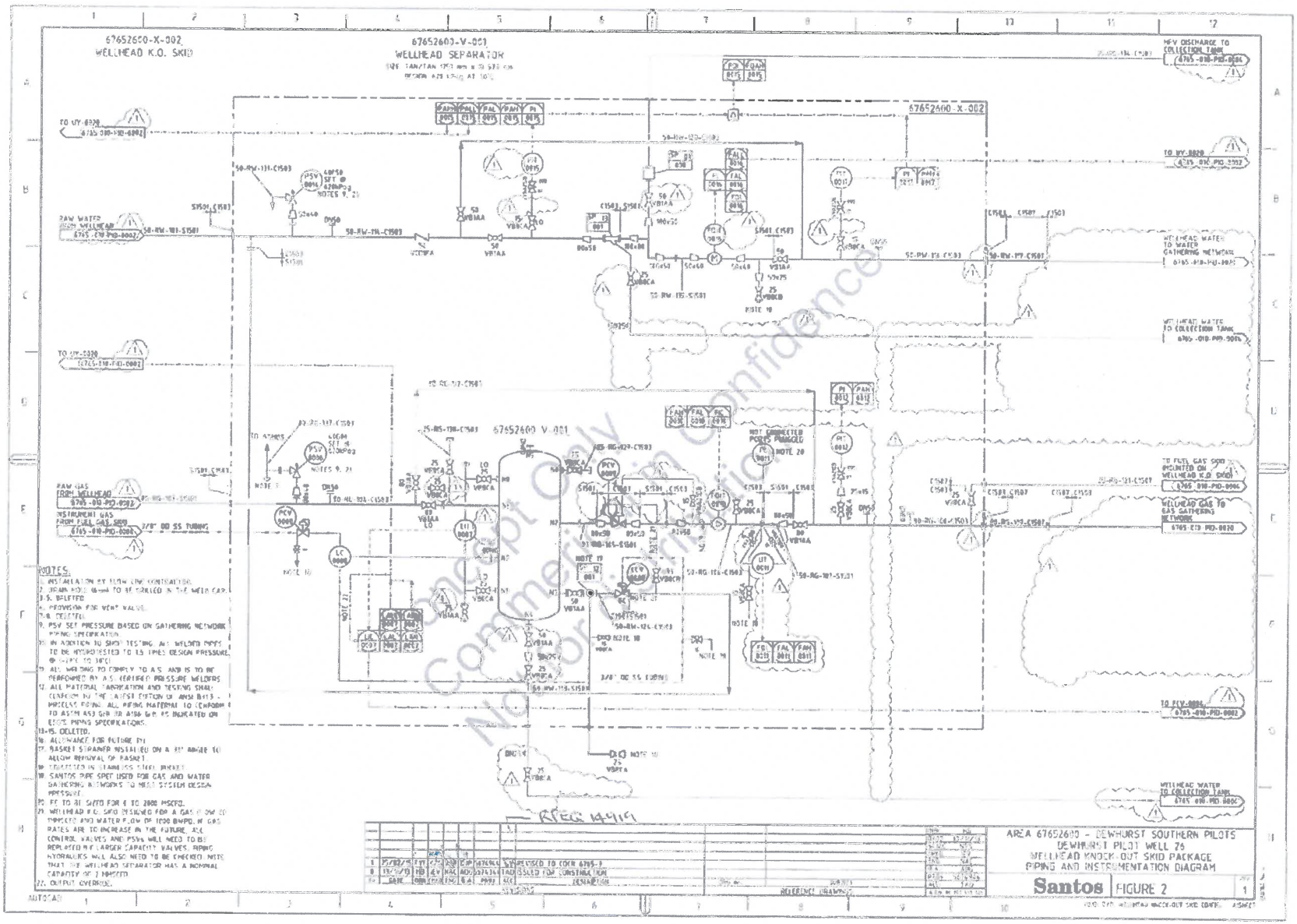
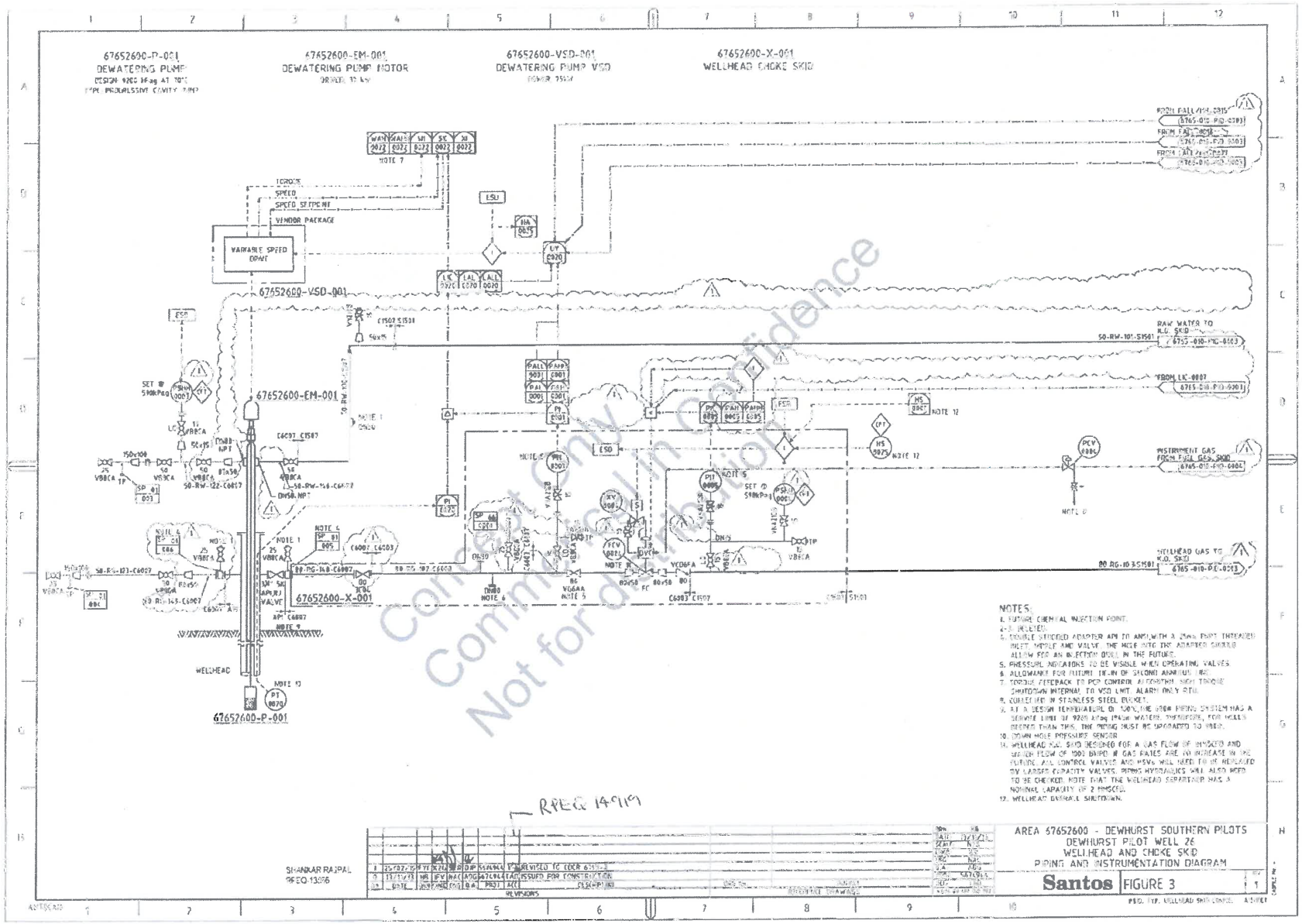


Figure 3: Example piping and instrumentation diagram 2



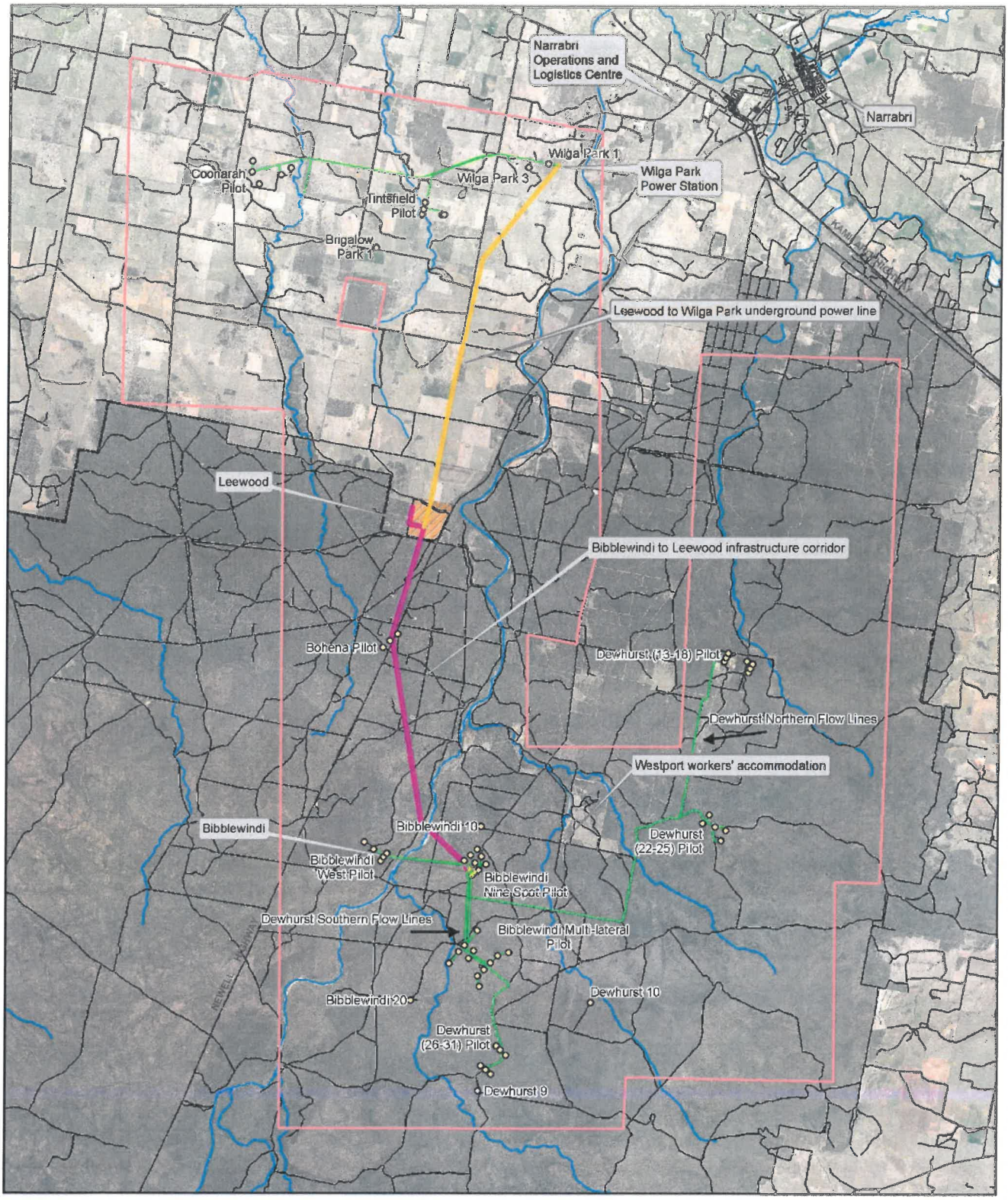


Figure 2: Existing infrastructure

All facilities would be designed and operated under the applicable Australian Standards and safety protocols. Applicable controls and design standards to be utilised in the project is as follows:

- Wells will be designed and constructed in accordance with the *NSW Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012), including the mandatory requirements for well control.
- All flammable and combustible liquids to be stored in accordance with AS1940:2017 *Storage and Handling of Flammable and Combustible Liquids*.
- All dangerous goods to be stored and transported in accordance with the *Australian Dangerous Goods Code*.
- Process controls such as pressure relief, shutdown valves for emergency isolation, flares, and hazardous area classification will be applied.
- All electrical equipment installed within the gas processing facilities will be certified as appropriate for installation in a flammable / explosive environment resulting in low immediate and delayed ignition probabilities.
- Process infrastructure will have suitable set back distances from site boundaries.
- Wells and compression facilities will be fenced to restrict access and signage installed.
- Buried gas gathering lines with above ground valves that are metal and locked closed.
- Increase the depth of cover for buried pipelines where required.
- Appropriate signage would be installed in accordance with Australian standards to alert landholders to underground infrastructure.
- Incorporation of all new facilities into an operational safety management system including permit to work requirements, emergency shutdown, isolation and blowdown protocols, emergency response plan etc.
- All operational activities will have standard operating procedures to follow and personnel will be trained.
- Regular inspection and maintenance regimes will be developed.
- Fire and gas detection systems will be installed.
- The facilities will be operated under a safety management framework.

Observation 5: EIS for the NGP: Appendix S, Section 2.3.5 (Page 20)

The only risk criteria cited from HIPAP No. 4, and subsequently considered in the PHA, are for injury from heat radiation, explosion overpressure, and toxic exposures.

The PHA must demonstrate compliance with all criteria in HIPAP No. 4, including: individual fatality risk (HIPAP No. 4, Section 2.4.2.1), injury risk (HIPAP No. 4, Section 2.4.2.2), property damage and accident propagation (HIPAP No.4, Section 2.4.2.3) and societal risk (HIPAP No.4, Section 2.4 .3). It should also consider the qualitative risk criteria (HIPAP No. 4, Section 2.2) and the risk to the biophysical environment from accidental emissions (HIPAP No. 4, Section 2.4.4).

Furthermore, it is reported in Section 2.4.2. 1(d) of HIPAP No. 4 that the 'Individual fatality risk levels for industrial sites at levels of 50 in a million per year (50 x 10-6 per year) should, as a target, be contained within the boundaries of the site where applicable'. This has not been demonstrated in the PHA.

Response

EIS Appendix S report identified that all sensitive receivers in the project area, bar one unmanned facility, are residential dwellings and Yarrie Lake is categorised as an active open space. Therefore, only the HIPAP 4 residential and active open space risk criteria for fatalities and injuries apply to this project, as summarised in the response to Comment 3.

The preliminary risk screening identified some hazards that have the potential for offsite impacts. Detailed consequence analysis determined that the identified scenarios would not impact on nearby sensitive receivers. However, the likelihood and associated risk of these events were assessed semi-quantitatively and found to be of low or very low risk.

Based on the consequence effect distances not reaching any sensitive receivers, it may be concluded that all relevant HIPAP 4 criteria are met. Table 2 summarises the worst case consequence effect distances of the relevant HIPAP 4 criteria with respect to the distance to the closest sensitive receivers.

- Risks to people

The individual fatality and injury risk criteria in HIPAP 4 is met. Compliance with HIPAP 4 criteria requires the residential and active open space criteria to be applied, whilst all others are not applicable due to the limited categories of receptors in the project area.

As there are no consequences that impact sensitive receivers, and there are no large populations of people gathering around the facilities (e.g. sporting complexes, commercial developments), the project does not pose a significant societal risk, therefore the HIPAP 4 societal risk criteria is met.

Escalation events between facilities at Leewood have potential for off-site impacts. An example may be a jet fire from a compressor impinging on vessels in the power generation facility. However, the site layout would minimise the likelihood of these events, and therefore, these type of events do not pose a significant individual or societal risk.

When the project is at the detailed design stage, location specific individual risk (LSIR) contours for the site would be considered to confirm this.

- Risks to property

There are no other industrial developments in the project area, therefore, the potential for property damage is not expected at nearby facilities. As such, the potential of escalation from the project to adjoining facilities is not credible and the HIPAP 4 property damage criteria (heat radiation >23 kW/m2) is met.

- Risks to the biophysical environment

The biophysical environment has been assessed in detail in the relevant parts of the EIS (for example, Chapter 15 Terrestrial Ecology). The EIS Hazard and Risk Assessment (Appendix S) determined there is limited potential for toxic releases.

Fires leading to bushfire are assessed in Section 4.4 of EIS Appendix S and discussed further in the response to Comment 11 below.

The conclusions regarding loss of containment and the assessment of the offsite risk associated with those releases is based on the assumption of measures that are planned to be incorporated into the design and operation of the facilities. These measures have been summarised above (Comment 4 response).

Table 2 Worst case consequence effect distances and sensitive receivers – HIPAP 4

Scenario ID	Unwanted event	Distance to closest sensitive receiver	Distance to worst case consequence effects	HIPAP 4 criteria met*
1	Sudden loss of containment of significant quantities of water resulting from a catastrophic failure of pond wall	N/A – negligible offsite risk		
2	Uncontrolled loss of containment of small quantity (less than 100 L) of liquid chemicals or dangerous goods	N/A – negligible offsite risk		
3	Uncontrolled loss of containment of large quantities (greater than 100 L) of liquid chemicals or dangerous goods	350 m	Toxic injury: 70 m Toxic irritation: 100 m 4.7 kW/m^2 injury: 38 m 35 kW/m^2 fatality: not reached	Yes
4	Uncontrolled loss of containment of gas from well pad and well pad equipment at shut in pressure. Potential for fire.	>200 m	35 kW/m^2 fatality: 48 m Flash fire fatality: 54 m 4.7 kW/m^2 injury: 71 m	Yes
5	Uncontrolled loss of containment of gas from underground gathering lines (low pressure). Potential for fire.	>200 m	35 kW/m^2 fatality: 57 m Flash fire fatality: 79 m 4.7 kW/m^2 injury: 165 m	Yes
6	Uncontrolled loss of containment of gas from facilities (Bibblewindi). Potential for fire or explosion.	4,784 m	35 kW/m^2 fatality: 54 m Flash fire fatality: 61 m 4.7 kW/m^2 injury: 82 m 7 kPa injury overpressure: 62 m	Yes
7	Uncontrolled loss of containment of gas from underground Bibblewindi to Leewood pipeline (medium pressure). Potential for fire.	>2,000 m	35 kW/m^2 fatality: 139 m Flash fire fatality: 161 m 4.7 kW/m^2 injury: 386 m	Yes
8	Uncontrolled loss of containment of gas from facilities (Leewood). Potential for fire or explosion.	350 m	35 kW/m^2 fatality: 183 m Flash fire fatality: 222 m 4.7 kW/m^2 injury: 321 m 7 kPa injury overpressure: 125 m	Yes

*HIPAP 4 risk criteria is assumed to be met if the consequence effects do not reach sensitive receivers.

Observation 6 - EIS for the NGP: Appendix S, Section 2.3.7 (Page 21)

Different operating conditions do not appear to have been addressed in the PHA. For example, the pressure may be significantly higher when a well is 'shut in'.

Different operating conditions should be considered in the PHA to ensure the assessment is a 'conservative best estimate' (HIPAP No. 4, Section S).

Response:

The risk assessment in EIS Appendix S followed HIPAP 6 (DPE 2011) guidelines and was completed on the basis of 'typical' designs as per the proponent's operations. Based on this approach, consequence distances for credible "worst case scenarios" were determined involving releases from each type of infrastructure. The likelihood of these events were also semi-quantitatively estimated.

Wells may, on occasion, be required to be 'shut in' for operational or maintenance reasons. In these circumstances, the pressure of the shut in well will exceed that of operating wells. An anticipated average production casing well shut in pressure is approximately 1,400 kPa. Consequence analysis has been performed for the well shut in pressure of 1,400 kPa. The results are presented in **Table 3**.

Table 3 Consequence analysis results for well shut in

Scenario	Jet fire 35 kW/m^2 effect distance (m)	Jet fire 4.7 kW/m^2 effect distance (m)	Flash fire effect distance (m)
10 mm hole at 1,400 kPag	6.6	6.7	Not reached
50 mm hole at 1,400 kPag	26	36	20
100 mm full bore rupture at 1,400 kPag	48	71	54

As discussed in Section 4.3.2 of EIS Appendix S, the operational well pads will be subject to partial rehabilitation, however, it should be noted that the fencing around the outer boundary of the one hectare well pad will remain in place throughout the well's operational life. Thus, there is no public access within a radius of approximately 50 m surrounding the well head.

From Table 3, other than for a flash fire and the 4.7 kW/m^2 injury heat radiation from a full bore rupture, the consequence distance for a shut in well does not extend beyond the well pad boundary.

Modelling of consequence analyses of well shut in pressures is considered conservative based on the following:

- The wellhead infrastructure is designed for up to 3,000 psi (approximately 20,600 kPa). The wells are designed to have surface casing and production casing cemented to surface which creates multiple barriers. The multiple barrier well design is in line with the NSW WHS Regulations as well as the *NSW Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012).
- Regular monitoring takes place throughout the life cycle of all wells to ensure that all operations are within established parameters and in accordance with the relevant well design and regulatory requirements. This includes visual inspections, taking pressure readings and gas monitor testing for leaks.
- The proponent's NSW exploration and appraisal operations uses a Well Integrity Control Plan which outlines the safe management of all active or suspended wells as per company standards and the *NSW WHS (Mines and Petroleum sites) Regulation 2014*.
- Modelling results represent the unmitigated impacts of well pad releases, and therefore, the safeguards such as depressurisation and automated shutdown systems are not accounted for in the consequence modelling.
- The most credible full bore rupture scenario would be a vertical release through the pressure relief device, resulting in reduced consequence effect distances compared to a horizontal release. However, horizontal releases have been modelled as the worst case scenarios, as they produce the furthest consequence effect distances.

Conservative, worst case scenarios have been assessed for each of the project facilities to allow for the development of the design as the project progresses. For each type of infrastructure, the maximum anticipated pressure, pipe and vessel size, inventory and consequence types have been assessed. This includes full bore ruptures of the largest diameter pipe in each area, and catastrophic vessel ruptures of the largest vessel in the area.

Observation 7 - EIS for the NGP: Appendix S, Section 4.2.4 (Page 39)

It is reported that "During the operational phase, some transport of dangerous goods will be required to support project activities." Does this include the transport of dangerous goods during the other phases (construction, drilling, decommissioning, etc.)? If not, the transport movement in Section 4.2.4 should be amended accordingly.

Response:

All phases of the project have been included in the transportation assessment for dangerous goods (EIS Appendix S - Section 4.2.4). The risk register included construction and operation, with decommissioning now having been added to the register (see Attachment 1 and also refer to the response to Comment 13).

The causes involving transportation of liquid chemicals or dangerous goods have been included in the Risk Register (Appendix A to EIS Appendix S).

Observation 8 - EIS for the NGP: Appendix S, Section 4.3.2 (Page 46)

It is reported that 'consequence effect distances reach up to 50 m downwind of the release point which is contained within the well-pad area of approximately one quarter of a hectare after partial rehabilitation. Therefore, none of the wellhead scenarios analysed in this PHA has offsite impacts'.

One quarter of a hectare equates to 2,500 m^2 so the well-pad will have approximate dimensions of 50 m by 50 m. Therefore, even if the wells are located as far from the pad boundary as possible, i.e. the centre of the well pad, then the distance from the well to the well pad boundary would be approximately 25 m. Some incidents will therefore have an off-site impact (*c.f.* EIS Table 4-15 of Appendix S).

Furthermore, the photograph (Figure 1-3) shown in Section 1.5 of EIS Appendix S would appear to show infrastructure that is relatively close to the fence line boundary.

The conclusion that 'none of the wellhead scenarios analysis in this PHA has offsite impacts' needs to be reconsidered in the PHA.

Response:

Figure 1-3 in EIS Appendix S shows the fenced blue metal area of the well pad. Note that this is not the final operational size of a well pad. It is simply the fencing around the well head infrastructure. The fenced operational pad, and therefore, public exclusion zone, extends beyond this across the cleared area shown in Figure 1-3 in EIS Appendix S.

As discussed in Section 4.3.2 of Appendix S, the operational well pads will be subject to partial rehabilitation, however, it should be noted that the fencing around the outer perimeter of the one hectare well pad will remain in place throughout the operational life of the well. Thus, there can be no public access to an area approximating 100 m by 100 m that encloses the well head.

Therefore, there will be no 'offsite impacts' from the normal operating well head worst case consequence event. Additionally based on the Field Development Protocol (EIS Appendix C), this will not reach any sensitive receivers, and as noted in the response to Comment 3, there are no recorded public recreational facilities in the project area other than Yarrie Lake that would see the public congregate to increase exposure risk.

This assessment is considered conservative as the modelling results represent unmitigated impacts of well pad releases, and therefore, safeguards such as depressurisation and automated shutdown systems have not been accounted for in consequence modelling.

Observation 9 EIS for the NGP: Appendix S, Section 4.3 .2 (Page 46)

It is reported that "No explosion overpressure analysis was performed at the wellheads as it is assumed the area is open and there is insufficient confinement and congestion to result in an explosion." A similar assumption is reported for other gas release locations.

This assumption does not appear to have considered the presence of trees, which may potentially provide sufficient obstacles for generation of a vapour cloud explosion. The PHA should clearly demonstrate that a VCE is not credible based on the proposed clearance of vegetation around all of the potential sources of a gas release. If a VCE is credible, then the risk associated with such events should be assessed against the relevant risk criteria in HIPAP No. 4.

Response:

There is no fatality potential from vapour cloud explosions (VCEs) as a result of vegetation at the well pads as discussed below.

The potential for VCEs has been examined to determine if this is a credible outcome from a release of gas at the wellhead, which is located in the centre of the well pad. A calculation was performed using the Baker-Strehlow-Tang (BST) method to estimate what the positive overpressure would be if there was a vapour cloud explosion occurring from the wellhead. The calculation was conducted using very conservative assumptions including:

- A VCE occurring with partial blockage which prevents a flame front from expanding in one direction.
- Medium congestion (i.e. medium tree congestion) which means there is 10 per cent to 40 per cent obstacle blockage ratio per plane or at least two to three layers of obstacles.
- The cleared, operational well pad area is 50 m x 50 m (0.25 hectare), within a larger 100 m x 100 m (one hectare) rehabilitated, fenced well pad area.
- The closest trees are located 50 m from the wellhead (i.e. on the boundary of the fenced well pad area) and are assumed to be 30 m tall. There are no tall trees located within 50 m from the wellhead.
- Vegetation within the fenced, partially rehabilitated well pad area between 25 m and 50 m from the wellhead consists of low native grasses and shrubs (<2 m) and is not considered to provide sufficient congestion to enable accumulation of methane gas in high enough concentrations that would lead to an explosion.
- The volume of gas accumulation to be modelled is based on a 50 m radius from the wellhead to a height of 30 m.

The results from this analysis identified that the calculated flame speed Mach number of 0.05 is below the threshold of the lowest flame speed Mach number of 0.2 using the BST Positive Overpressure vs. Distance for Various Flame Speeds table (CCPS 2010). This confirms that the overpressure at the well pad boundary will be below 7 kPa, which is the overpressure representing a 10 per cent chance of injury and no chance of fatality (HIPAP 4).

The above is supported by experimental evidence that indicates that vapour clouds of methane can burn (at atmospheric temperatures), but do not readily explode. Experimental attempts have been made to initiate explosions involving methane clouds, however no explosion occurs (Lees 1996). Hence, a VCE at the well pad is not considered a credible scenario.

There is limited ability for gas accumulation and confinement including within the vegetation surrounding the gathering system and medium pressure pipeline, due to the pipework being underground. Therefore vapour cloud explosions are not credible. Similarly, Bibblewindi and Leewood facilities have less vegetation in proximity to cause the degree of congestion required for a VCE.

Observation 10 - EIS for the NGP: Appendix S, Section 4.3.6 (Pages 54-55)

The cumulative risk must be assessed against each relevant risk criterion (Refer to HIPAP No. 6, Section 7.1). The findings presented in the PHA do not appear to be based on the cumulative risk.

For example, in Section 4.3.2 of the PHA, the risk associated with Bibblewindi is only assessed for the worst-case scenario. The Bibblewindi site, as shown in Figure 1.4, has a six existing exploration and appraisal wells (three located within the site boundary and three within approximately 300 m of the site). It is reported in Table 1.1 that exploration and appraisal wells will be converted to production wells. The cumulative risk from all sources has not been used to demonstrate that the offsite risk criteria have been satisfied.

Furthermore, an assessment of the individual risk of fatality and societal risk (both of which are currently omitted from the PHA) must be based on the cumulative risk for *all* potential events (i.e. including all potential outcomes - fire, explosion, bush fire, etc.).

Response:

HIPAP 4 criteria for cumulative risk for individual fatality and societal risk are met on the basis that:

1. There are limited individual fatality consequences that extend offsite.
2. There are limited individual fatality consequences that overlap from multiple facilities.
3. The estimated likelihood of fire / explosion from gas release is low.
4. The presence of members of the public gathering in areas offsite close by to the facilities who would be affected by the fire / explosion is highly unlikely.

The PHA has addressed cumulative risk at each facility through the identification of all of the contributors to the risk (including leaks, ruptures and catastrophic failures), and the consequences of each potentially hazardous event.

These risks have been considered in the risk assessment (Section 4.3.1). The Risk Register (Attachment 1 to this memorandum) provides a qualitative assessment for each of the facilities within the project, taking into account the cumulative risk of all hazardous events.

The cumulative risk at each facility has been rated either low or very low after inherent design standards and operational procedures are implemented together with mitigation measures and management plans applied to further reduce risks. This is based on the remote or unlikely occurrence of injury caused by the events.

Based on the analysis presented below, it can be demonstrated that the offsite cumulative risk criteria in HIPAP 4 have been satisfied.

Consequence modelling has been undertaken to determine the distances that gas release events could reach for all contributors, and the likelihood (frequency) of these events has been semi-quantitatively estimated. The modelling considered the contribution of leaks, ruptures and catastrophic failures in piping and equipment within the facilities and applied the HIPAP 4 thresholds for radiation exposure and blast overpressure to determine the worst case consequence effect distances.

Smaller releases, or multiple releases occurring concurrently within the facility, do not extend the consequence effect distances further than the worst case scenarios modelled. The results are shown in **Table 4** below, including the semi-quantitative likelihood estimate for the worst case scenarios.

Individual fatality risk was considered as part of the modelling of gas release events (on the basis of 35 kW/m^2 heat radiation levels). The modelling did not identify any event in any facility with the ability to create a fatality (or injury) risk to a sensitive receiver.

Analysis of the scenarios where there is an individual fatality risk and societal risk to the public located offsite, posed by multiple events within the project infrastructure or between facilities that are close together is provided in **Table 4**.

There are other potential contributors to the individual fatality risk and societal risk to the public offsite, such as a bushfire caused by a fire started in the facilities or being struck by a missile released from an explosion within the facilities, but these are considered to be very small additions to the cumulative risk due to the nature of the project area.

All facilities will be designed to meet all regulatory and standard requirements, including off-site risk criteria.

The bushfire risk was qualitatively assessed in Section 4.4 of EIS Appendix S, and has been rated as medium. This is discussed further in the response to Comment 11.

Table 4 Cumulative Risk Scenarios

ID	Individual release scenarios	Worst case consequence scenario[1]	Consequence effect distances for an individual fatality risk	Offsite fatality risk	Semi quantitative likelihood estimate[2]	Potential multiple event scenarios	Cumulative offsite fatality risk	HIPAP 4 cumulative risk criteria met?
1	Production wells: Individual events identified that could occur at the wells include small 10 mm leaks through to rupture of 100 mm above ground pipe at operational and shut in pressures and catastrophic failures of vessels (e.g. separator).	100 mm hole at 1400 kPag (shut in pressure) leading to either a jet fire or a flash fire.	35 kW/m^2: 48 m Flash fire: 54 m	Single well on a well pad: Yes – flash fire consequence effects exceed the well pad boundary. Well pads with up to 3 wells: Yes - depending on the placement of the wells, jet fire and flash fire may exceed the well pad boundary.	Single well: 4.2E-08 p.a. 3 wells: 1.3E-07 p.a.	Multiple leaks from one well (piping or vessel). Leaks from up to 3 wells on a well pad.	Individual or multiple events leading to an offsite risk is credible. For a single well on the well pad, only a flash fire from a 100 m hole extends a short distance beyond the well pad boundary. As there is only one scenario with offsite fatality potential, there is a low cumulative offsite fatality risk surrounding the well pads with a single well. Due to the placement of wells where up to 3 are placed on a single well pad, both jet fire and flash fire effects may extend outside the well pad boundary. Although effects may extend outside the boundary, the semi-quantitative likelihood estimate for single well and 3 wells fire events from leaks is below the HIPAP 4 risk criteria.	Yes
		Fireball from a catastrophic failure of a vessel	35 kW/m^2: 2 m	No – all fireball fatality consequence effects remain within the well pad boundary.	1.6E-05 p.a.			

[1] A hole can result in either a jet fire from an immediate ignition or a flash fire from a delayed ignition. A rupture can result in either a fireball or explosion

[2] Semi quantitative estimate calculated by combining the frequency of release and the probability of ignition.

ID	Individual release scenarios	Worst case consequence scenario[1]	Consequence effect distances for an individual fatality risk	Offsite fatality risk	Semi quantitative likelihood estimate[2]	Potential multiple event scenarios	Cumulative offsite fatality risk	HIPAP 4 cumulative risk criteria met?
2	Gathering system: Individual events identified that could occur from the gathering system includes small 10 mm leaks from the pipeline through to rupture of 700 mm pipeline.	Full bore rupture (FBR) at the centre of the pipeline leading to either a jet fire or a flash fire.	35 kW/m^2: 57 m Flash fire: 79 m	Yes – pipeline FBR jet fire and flash fire extend beyond the right of way	3.0E-07 p.a.	None identified – it is not considered credible for multiple leaks or a leak and rupture to occur in the gathering system in the same area at the same time, therefore a rupture remains the worst case scenario	Individual events leading to an offsite risk is credible. Multiple events leading to an offsite risk is not credible. The full bore pipe rupture scenario from the gathering system has the potential for offsite fatality risk beyond the five metre right of way proposed for the duration of operation. Smaller leaks remain within the right of way distance. Although there is a potential for offsite fatality risk from pipeline ruptures, the cumulative semi quantitative frequency of fire events from ruptures is below the HIPAP 4 risk criteria.	Yes
3	Bibblewindi facility: Individual events identified that could occur at Bibblewindi include small 10 mm leaks through to rupture of 100 mm pipe and catastrophic failures of vessels.	100 mm hole at 2,000 kPag leading to either a jet fire or flash fire.	35 kW/m^2: 54 m Flash fire: 61 m	No – all fatality consequence effects remain within the site boundary	4.2E-08 p.a.	Leaks from / ruptures of multiple pipe sections.	Individual or multiple events leading to an offsite risk is not credible. There are a number of individual releases, some of which have fatality potential, however, based on the proposed facility siting, none of these extend offsite, and therefore there is no cumulative offsite fatality risk surrounding the facility from loss of containment events within Bibblewindi.	Yes
		Catastrophic failure of a vessel leading to either a Fireball or explosion.	35 kW/m^2: 11 m 35 kPa: 19 m	No – all fatality consequence effects remain within the site boundary	1.6E-05 p.a.	Leaks from / ruptures of piping and vessels.		

ID	Individual release scenarios	Worst case consequence scenario[1]	Consequence effect distances for an individual fatality risk	Offsite fatality risk	Semi quantitative likelihood estimate[2]	Potential multiple event scenarios	Cumulative offsite fatality risk	HIPAP 4 cumulative risk criteria met?
4	Medium pressure pipeline: Individual events identified that could occur from the pipeline includes small 10 mm leaks through to rupture of 864 mm pipe.	Full bore rupture (FBR) of the pipeline leading to either a jet fire or a flash fire.	35 kW/m^2: 139 m Flash fire: 161 m	Yes – pipeline FBR jet fire and flash fire extend beyond right of way	3.0E-07 p.a.	None identified – it is not considered credible for multiple leaks or a leak and rupture to occur in the pipeline in the same area at the same time, therefore a rupture remains the worst case scenario	Individual events leading to an offsite risk is credible. Multiple events leading to an offsite risk is not credible. The full bore pipe rupture scenario from the medium pressure pipeline has the potential for offsite fatality risk beyond the 30 m right of way proposed for the duration of operation. Smaller leaks remain within the right of way distance. Although there is a potential for offsite fatality risk from pipeline ruptures, the cumulative semi quantitative frequency of fire events from ruptures is below the HIPAP 4 risk criteria.	Yes
5	Leewood facility: Events identified that could occur at Leewood include small 10 mm leaks through to rupture of 250 mm pipe and catastrophic failures of vessels for the inlet pressure of 2,000 kPag and the post compression pressure of 6,500 kPag	100 mm hole at 2,000 kPag leading to either a jet fire or flash fire.	35 kW/m^2: 55 m Flash fire: 68 m	No – all fatality consequence effects remain within the site boundary	3.0E-07 p.a.	Leaks from / ruptures of multiple pipe sections. Leaks from / ruptures of piping and vessels.	Individual events leading to an offsite risk is credible. Multiple events leading to an offsite risk is not credible. Of the individual releases identified at Leewood, including the power station, the only scenario with the potential for offsite fatality consequences is a 250 mm pipe rupture of the post compression gas. As there is only one scenario that can have offsite fatality potential, the cumulative offsite fatality risk from pipe ruptures or catastrophic vessel failures is below the HIPAP 4 risk criteria.	Yes
		250 mm hole at 6,500 kPag leading to either a jet fire or flash fire.	35 kW/m^2: 183 m Flash fire: 222 m	Yes – pipeline FBR jet fire and flash fire extend beyond the site boundary	3.6E-07 p.a.			
		Catastrophic failure of a vessel leading to either a Fireball or explosion.	35 kW/m^2: 26 m 35 kPa: 29 m	No – all fatality consequence effects remain within the site boundary	1.6E-05 p.a.			

ID	Individual release scenarios	Worst case consequence scenario[1]	Consequence effect distances for an individual fatality risk	Offsite fatality risk	Semi quantitative likelihood estimate[2]	Potential multiple event scenarios	Cumulative offsite fatality risk	HIPAP 4 cumulative risk criteria met?
6	Bibblewindi gas compression and the 6 pilot wells surrounding it (refer to Figure 2)	Refer to ID 1 and 3	Refer to ID 1 and 3	Yes – flash fires from the well extends beyond the well pad boundary at shut in pressure	8.4E-08 p.a.	Leaks or ruptures from piping or vessels at Bibblewindi, coincident with a leak or rupture at a pilot well	The only individual release event that could occur at Bibblewindi, or from the wells that extend beyond the site boundary is a flash fire from a 100 mm hole at a well at shut in pressure. Since all Bibblewindi consequence effects remain onsite, the overlap of consequence effects from Bibblewindi and a pilot well only occur onsite. Although flash fire effects from a well may extend outside the boundary, the semi-quantitative likelihood estimate is low and remains below the HIPAP 4 risk criteria.	Yes
7	Production wells and the gas gathering system	Refer to ID 1 and 2	Refer to ID 1 and 2	Yes – jet fire or flash fire from rupture of the gathering system, and a flash fire from a 100 mm hole at 1,400 kPag (shut in pressure) at the well	3.4E-07 p.a.	Leaks or ruptures from piping or vessels at a well coincident with a leak or rupture from the gathering system where the well connects to the gathering system	Multiple events leading to an offsite risk is credible. There is a region where each well connects to the gas gathering system where multiple events causing fatality can overlap to give a higher cumulative risk. However, for offsite effects to occur at the well it must be at shut in pressure and it is highly unlikely that this will occur coincident with a gathering system event. Although there is a potential for offsite fatality risk from piping and pipeline ruptures, the cumulative semi quantitative frequency of fire events from ruptures is below the HIPAP 4 risk criteria.	Yes

ID	Individual release scenarios	Worst case consequence scenario[1]	Consequence effect distances for an individual fatality risk	Offsite fatality risk	Semi quantitative likelihood estimate[2]	Potential multiple event scenarios	Cumulative offsite fatality risk	HIPAP 4 cumulative risk criteria met?
8	Production wells and the medium pressure pipeline	Refer to ID 1 and 4	Refer to ID 1 and 4	Yes – jet fire from rupture of the medium pressure pipeline and flash fire from wells at shut in pressure	3.4E-07 p.a.	Leaks or ruptures from piping or vessels at a well and a leak or rupture from the medium pressure pipeline	Multiple events leading to an offsite risk is credible. In some areas there are wells in proximity to the medium pressure pipeline. Multiple events causing fatality can overlap to give a higher cumulative risk. Of those, that do have fatality potential, only ruptures of the medium pressure pipeline and 100 mm holes of the wells at shut in pressure extend offsite. Although there is a potential for offsite fatality risk from piping and pipeline ruptures, the cumulative semi quantitative frequency of fire events from ruptures is below the HIPAP 4 risk criteria.	Yes
9	Bibblewindi and the gas gathering system	Refer to ID 2 and 3	Refer to ID 2 and 3	Yes – jet fire and flash fire from rupture of the gathering system	3.4E-07 p.a.	Leaks or ruptures from piping or vessels at Bibblewindi and a leak or rupture from the gathering system Leak or ruptures from multiple gathering systems entering Bibblewindi	Multiple events leading to an offsite risk is credible. Where the gathering system enters Bibblewindi, there is potential for events to overlap to give a higher cumulative risk. Of those that do have fatality potential, only ruptures of the gathering system extend offsite. Although there is a potential for offsite fatality risk from pipeline ruptures, the cumulative semi quantitative frequency of fire events from ruptures is below the HIPAP 4 risk criteria.	Yes

ID	Individual release scenarios	Worst case consequence scenario[1]	Consequence effect distances for an individual fatality risk	Offsite fatality risk	Semi quantitative likelihood estimate[2]	Potential multiple event scenarios	Cumulative offsite fatality risk	HIPAP 4 cumulative risk criteria met?
10	Bibblewindi and the medium pressure pipeline	Refer to ID 3 and 4	Refer to ID 3 and 4	Yes – jet fire or flash fire from the medium pressure pipeline only	3.4E-07 p.a.	Leaks or ruptures from piping or vessels at Bibblewindi and a leak or rupture from the medium pressure pipeline where it leaves Bibblewindi	Multiple events leading to an offsite risk is credible at the boundary where the pipeline leaves the Bibblewindi Facility. In the area where the medium pressure pipeline exits the Bibblewindi facility, multiple events causing fatality can overlap to give a higher cumulative risk. Of those, that do have fatality potential, only ruptures of the medium pressure pipeline extend offsite. Although there is a potential for offsite fatality risk from pipeline ruptures, the cumulative semi quantitative frequency of fire events from ruptures is below the HIPAP 4 risk criteria.	Yes

ID	Individual release scenarios	Worst case consequence scenario[1]	Consequence effect distances for an individual fatality risk	Offsite fatality risk	Semi quantitative likelihood estimate[2]	Potential multiple event scenarios	Cumulative offsite fatality risk	HIPAP 4 cumulative risk criteria met?
11	Leewood and the medium pressure pipeline	Refer to ID 4 and 5	Refer to ID 4 and 5	Yes – jet fire or flash fire from rupture of the medium pressure pipeline and jet fire and flash fire from rupture of 250 mm 6,500 kPag pipe at Leewood	6.6E-07 p.a.	Leaks or ruptures from piping or vessels at Leewood and a leak or rupture from the medium pressure pipeline where it enters Leewood	Multiple events leading to an offsite risk is credible at the boundary where the pipeline enters the Leewood Facility. In the area where the medium pressure pipeline enters the Leewood facility, multiple events causing fatality can overlap to give a higher cumulative risk, however the majority of these remain within the site boundary. Of those that do have fatality potential, only ruptures of the medium pressure pipeline and ruptures of the 6,500 kPag compressed gas piping extend offsite (139 m and 183 m from the point of release respectively). Although there is a potential for offsite fatality risk from piping and pipeline ruptures, the cumulative semi quantitative frequency of fire events from ruptures is below the HIPAP 4 risk criteria.	Yes
12	Multiple well pads	Refer to ID 1	Refer to ID 1	Yes – flash fire consequence effects exceed the well pad boundary. Jet fire effects remain within the well pad boundary	4.2E-08 p.a.	Leaks or ruptures from multiple wells	Multiple events leading to an offsite risk is not credible. Pilot wells are 250 m apart and the production wells are to be placed at least 750 m apart. No consequence effects extend that distance, therefore there is no cumulative offsite fatality risk.	Yes

Observation 11 - EIS for the NGP: Appendix S, Section 4.4.2 (Pages 55-61)

Whilst there are no risk criteria in HIPAP No. 4 specifically relating to protection of the environment from bush fires, the Department's criteria for the protection of the biophysical environment are as follows (HIPAP No.4, Section 2.4):

- **Industrial developments should not be sited in proximity to sensitive natural environmental areas where the effects (consequences) of the more likely accidental emissions may threaten the long-term viability of the ecosystem or any species within it.**
- **Industrial developments should not be sited in proximity to sensitive natural environmental areas where the likelihood (probability) of impacts that may threaten the long-term viability of the ecosystem or any species within it is not substantially lower than the background level of threat to the ecosystem.**

It is also reported in Section 2 of HIPAP No. 4 that: "Risk criteria are set with the understanding that no aspect of living can be risk free but that any imposed risk should be very small in the context of the generally accepted background risk".

The PHA has not demonstrated that the cumulative risk of initiating a bush fire from the proposed 850+ wells and associated gas gathering and processing facilities is low relative to the background risk and compliant with the Department's criteria for the protection of the biophysical environment.

Response:

The location of the project area is based on the location of the gas resource. In 2005 the NSW Government dedicated parts of the Pilliga as State forest and set those areas aside for the purpose of 'forestry, recreation and mineral extraction, with a strategic aim to 'provide for exploration, mining, petroleum production and extractive industry' under the NSW *Brigalow and Nandewar Community Conservation Area Act 2005*. The parts of the project area on state land are located within this section of the Pilliga.

The EIS contains an extensive and detailed assessment of the impacts of the project on the natural environment. The ecology of the Pilliga has been fragmented and otherwise impacted by commercial timber harvesting and other human activities over the last century through:

- the establishment of more than 5,000 kilometres of roads, tracks and trails;
- the introduction of pest species; and
- the occurrence of wildfire.

Further detail can be found in the respective chapters of the EIS.

The bushfire risk assessment in Section 4.4 of EIS Appendix S addresses bushfire risk, bushfire context in relation to the project, and the risk activity analysis and mitigation of bushfires. The bushfire risk factors are summarised in Section 5.3 of EIS Appendix S. High intensity destructive bushfires have been experienced in the region at a frequency of about one in ten years; in the absence of the project. It is also noted that there have been oil and gas activities in the area since the 1960s, with no evidence of bushfire as a result of these activities.

Section 4.4.1 of Appendix S states that high intensity bushfires have occurred within the forested parts of the project area on approximately a decadal basis. High intensity destructive fires have occurred in 1951 / 2, 1957 / 8, 1974, 1978, 1982 / 3, 1997 (NPWS 2001) and 2006 (OEH 2012). Some of these fires burnt across large areas at high intensity and very quickly (NPWS 2001, OEH 2012).

For example, the 1997 fire burnt nearly 100,000 hectares of the 140,000 hectares burnt over a short period (NPWS 2001, OEH 2012).The 2006 fires burnt more than 74,000 hectares (740 km^2) in a single day (OEH 2012). Other very destructive fires have occurred within the region, but outside of what would be the project area. Such fires include the 2013 Wambelong fire near Coonabarabran, which resulted in large scale property losses (NSWRFS 2013, NSW Coroner 2015).

An estimate of the likelihood of a bushfire being started by the project may be based on the likelihood of a gas release being ignited and then escalating to a bushfire. The cumulative frequency of loss of containment events identified in the Hazard and Risk report (taking into account all project infrastructure including up to 850 new wells, buried pipelines and compression facilities), a fire event may occur in the order of once every 70 years. This is the potential frequency of a loss of containment event creating a fire of any size, including those that are limited to a very small effect distance and those that are contained within the site. For these fire events to escalate to a bushfire, the fire must be large enough and the conditions conducive for it to extend offsite to a vegetated area and not be extinguished in a suitable time. Therefore, the likelihood of the project leading to a bushfire is considered to be substantially less

than once in 70 years, which is considerably less than the frequency of historical fire events in the area, and is therefore small in the context of the generally accepted background risk.

The range of mitigation measures proposed by the proponent would reduce the likelihood of the bushfire arising from project related activities (including the operation of 850+ wells and associated gas gathering and processing facilities) to being within the lowest "remote" likelihood class. Based on this assessment, the cumulative bushfire risk from project related activities would still be low in the context of the generally accepted background risk from bushfires, started from a wide variety of different sources.

Observation 12 - EIS for the NGP: Appendix S, Section 5 (Pages 61-64).

It is reported in Section 3 of HIPAP No. 6 that: "Even where the facility complies with numerical risk criteria, recommendations for reducing the likelihood and consequences of hazardous events on people, property and the biophysical environment should be made where technically feasible solutions will not adversely affect the economic viability of the project." Such recommendations have not been included in the PHA.

Furthermore, it is a requirement of the SEARs that "appropriate setbacks and / or asset protection zones for well heads, gas processing facilities and other infrastructure to manage risks" be established.

These are not clearly defined in the PHA (Noting that this will require additional assessment to ensure all relevant operations, facilities and risk criteria have been considered in the PHA - See other observations in this CRS).

Response:

The planned controls to be implemented have been identified throughout EIS Appendix S and discussed in the response to Comment 4, above.

Although the HIPAP 4 criteria is met based on the planned controls that have been identified, additional details of recommended controls to be implemented to reduce the risks to as low as reasonably practicable (ALARP) include:

- Installation of automatic emergency shut down (ESD) on fire detection, low pressure detection and allow for manual operation.
- Provide a separate ESD system from the process logic control system to ensure shutdown capability in loss of power event.
- Provide emergency isolation valves on the Bibblewindi plant inlet to isolate the gathering network from the plant.
- Provide pressure safety valves (PSVs) on all vessels to blow down through the flare to prevent over-pressurisation.
- Provide backflow prevention where appropriate in gathering network and facility design to isolate events and minimise loss of containment.
- Removal of ignition sources so far as is reasonably practicable.
- Provide telemetry to allow ongoing monitoring of process parameters and ability to remotely shut in and adjust facilities.
- Develop a proactive programmed maintenance and monitoring, critical function testing and integrity management program including identification of critical process plant and equipment availability.

Final siting including consideration of required setbacks for facilities would be established during design. All facilities will be subject to HAZOP, undertaken during the front end and detailed design phases of the project with consideration of relevant guidelines and Codes of Practice.

The EIS hazard and risk assessment is an early study in the risk management process for the project, conducted in the concept stage to help determine whether the project and its activities can be safely located.

The proponent's risk management procedure ensures the effective and continued management of risks throughout the lifecycle of the Project. The procedure outlines how hazards are identified and managed to A(ALARP. In addition, as the project progresses through the various design phases, the requirements outlined in the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2014* will be met. This includes, but is not limited to:

- The establishment and implementation of a safety management system that includes performance standards, control measures, reviews and audits;
- The identification and risk assessment of all principal hazards using a comprehensive and systematic investigation and analysis; and
- The preparation of a Principal Hazard Management Plan for each principal hazard identified and Principal Control Plans.

Observation 13 - EIS for the NGP: Appendix S, Appendix A

The PHA refers to hazards and risks associated with the construction and operation phases of the project. The potential hazards and risks associated with other phases of the proposed development (e.g. drilling, wellhead intervention / workover, well and gathering line decommissioning and abandonment) do not appear to have been addressed in the PHA.

All phases of the proposed development should be considered in the PHA.

Response:

Activities associated with all phases of the project have been considered in the assessment. The risk register was developed through workshops with engineers, field operators and relevant professionals and presents the most significant risks for the project with the most likely causes provided. Not every activity undertaken as part of the project is listed in the register.

Additional text has been added to the 'Project Phase' column of the Risk Register (Attachment 1) to clarify this.

The risk register now refers to the following project phases:

- Construction (including drilling and wellhead installation);
- Operations (including well workover and maintenance); and
- Decommissioning (including rehabilitation).

Observation 14 - EIS for the NGP: Appendix S, Appendix A

The hazard register does not appear to include hazards and risks from blowouts during the drilling phase.

Response 14

Blowout loss of containment hazards during drilling have already been included in the Risk Register (Attachment 1 to this memorandum), ID 4 via identification of the cause of blowout, for example overpressure or equipment failure.

Observation 15 - EIS for the NGP: Appendix S, Appendix A

The hazard register does not appear to include hazards and risks from other activities in the state forests (e.g. external threats such as logging, controlled back burning, other infrastructure, recreational activities (use of 4WDs, etc.). These should be included PHA (As per Section 4.1 of HIPAP No. 6).

Response:

Specific external threat causes (and controls) have been included in the Risk Register (Attachment 1 to this memorandum).

The presence of other users of the State forest (e.g. for logging or recreational activities) is not a cause of a release of gas. It is the activities associated with damage to the facilities such as through third party interference that is the cause. The causes of damage such as third party excavation and impact from mobile equipment have already been included as causes. The controls such as fencing and buried pipeline depth of cover are also included.

Observation 16 - EIS for the NGP: Appendix S, Appendix A

The hazard register does not appear to include hazards and risks from 'malicious acts'. These should be included in the PHA (As per Section 4.1 of HIPAP No. 6).

Response:

Further to the response above, specific causes such as third party excavation or uncontrolled excavation are already included in the Risk Register (Attachment 1 to this memorandum). These are the actual causes of the risk regardless of intent.

Observation 17 - EIS for the NGP: Appendix S, Appendix A

The hazard register does not appear to include hazards and risks due to the presence of other infrastructure within the pipeline corridor (i.e. It is understood that the new medium pressure gas pipeline (864 mm diameter) will be in a corridor that already contains an existing 257 mm diameter gas pipeline flowing from Bibblewindi to Wilga Park Power Station and will contain a new 132 kV power transmission cable). These should be included in the PHA (as per Section 4.1 of HIPAP No.6).

Response:

The specific causes (and controls) listed in the Risk Register (Attachment 1 to this memorandum) refer to the means of gas release from infrastructure within the pipeline corridor. The presence of other infrastructure within the pipeline corridor is not a cause of a release of gas. It is the activities associated with constructing, operating and maintaining them such as excavation (third party or uncontrolled) in the vicinity. This has been considered in the risk assessment.

Observation 18 - EIS for the NGP: Appendix S, Appendix A

The hazard register does not appear to include hazards and risks associated with the power generations plant at Leewood. Other activities (e.g. pig launch and recovery) are also omitted. A more detailed and comprehensive assessment should be included in the PHA for the equipment and operations at the Leewood facility.

Response:

The specific causes (and controls) listed in the Risk Register (Attachment 1 to this memorandum) refer to the means of gas release (i.e. leaks, ruptures and catastrophic failures), and apply for all types of equipment within the Leewood facility (including the power generation plant), and all activities undertaken. In undertaking the assessment, all plant and equipment and activities have been taken into account.

The use of pig launcher and receiver stations for pipeline cleaning, inspecting and maintenance is a method seen worldwide and has been used for many years. Pig launching equipment is designed to include engineering safeguards (for example double isolation, double block and bleed and mechanical interlocks) and is always used with standard operating procedures. Small quantities of gas may be discharged as a result of launching and receiving the pig, however the launching / receiving vessel is depressurised to a safe location prior to inserting / removing the pig. When considering the operation of the gas processing facilities at Leewood, there are no additional significant risks associated with pipeline pigging activities.

ID #	Arriscar Observation from Peer Review 2017	Arriscar Observation 5 June 2018	Status	Response
1	**Arriscar Comment 1 - EIS for the NGP: Appendix S, Executive Summary, Preliminary Risk Screening (Page i)** It is a requirement of the Secretary's environmental assessment requirements (SEARs) to undertake "a preliminary hazard analysis in accordance with *Hazardous Industry Planning Advisory Paper No. 6 - Guidelines for Hazard Analysis* (DPE 2011)". Therefore, the screening approach from Applying SEPP 33 is not relevant and a full preliminary hazard analysis (PHA) must be undertaken in accordance with HIPAP No. 6. Once a site has been identified as triggering a PHA, all potentially hazardous materials need to be considered irrespective of the quantity. As noted in *Applying SEPP 33* (DPE 2011 a) "It should be noted that the PHA required by SEPP 33 should cover all materials that may present a hazard and not just those where the quantities are above the screening threshold." The PHA has omitted some materials from the risk assessment on the basis that they do not reach the threshold quantities. This is incorrect and all potentially hazardous materials must be included in the risk assessment (including consideration of all potential hazards due to release, fire, decomposition, inadvertent mixing, etc.).	The materials identified in Appendix T3 of the EIS (e.g. caustic soda, citric acid, sodium hypochlorite, hydrochloric acid, etc.) do not typically contribute to the risk of fatality, injury or property damage off-site. Whilst these may cause damage to the biophysical environment, control measures are readily available and addressed in relevant standards (e.g. requirements for bunding). Therefore, this observation is Conditionally Closed. Note: To conditionally close this observation, the following consent conditions will be recommended for inclusion in any development approval: The FHA is to include an assessment of the risks for all materials that may present a hazard to people, property or the biophysical environment (e.g. bulk diesel storage) at all of the potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) associated with the development.	Conditionally Closed	No further action required at this stage. During the design phase of the project, a FHA will be completed as per the requirements outlined in HIPAP 6 Hazard Analysis and any specific recommendations made by DP&E in the project approval stage. As required under HIPAP 6, the FHA will incorporate an updated hazard identification, consequence analysis, likelihood estimate and risk analysis based on the more detailed information available at the later project phase. The cumulative individual fatality, injury, societal and biophysical risk will be assessed against the criteria outlined in HIPAP 4 Risk Criteria for Land use Safety Planning. Note that chemicals will be stored and handled in accordance with relevant Australian Standards, including *AS 1940-2004 The storage and handling of flammable and combustible liquids*.
2	**EIS for the NGP: Appendix S, Table 1.1 (Pages 2-3)** It is reported in Table 1.1 that the gas field development will include "conversion or upgrade of existing exploration and appraisal wells to production in addition to the 850 new wells". The hazards and risks associated with the existing wells, including their "conversion or upgrade" do not appear to have been included in the PHA.	This observation has not been fully addressed. For example: Whilst the hazard register has been amended to show the applicable project phase for each risk scenario, it is still not clear whether the hazards and risks have been specifically considered for these phases. It is noted that the list of scenarios has not been changed. Conversion of existing wells has not been clearly addressed in the risk assessment. This may be because multiple causes have been grouped under each scenario. The number of wells to be converted has not been specified and there are no scenarios specifically for conversion activities. Some control measures are presented to reduce the risk (from initial to residual) that are already included for the initial risk assessment (e.g. for Scenario 5, buried gas gathering lines and community awareness are presented as controls	Open	The existing exploration and appraisal wells that will be converted and operated as production wells were included in the assessment, Table 2-1 of Chapter 2 in the EIS. Existing exploration pilot wells will be converted to production wells and connected to gathering facilities where warranted based on potential production volumes. Approximately 35 existing pilot wells are currently operating in PEL 238 and PAL2. If all of these were converted to production wells, this would increase the total number of production wells by around 4% over the life of the project (should all 850 production wells be drilled To convert pilot wells to production, the wells would be connected to the gas and water gathering network. Pumps and other surface infrastructure may be upgraded, but changes would be minimal. The activities undertaken as part of these minor works, and their potential for offsite risks, are the same or similar to the works undertaken for the connection of new well infrastructure, and are within the risk envelope assessed. Consistent with new wells to be drilled, specific controls have been identified for well conversions, such as: • ignition source control • automatic closure of failsafe valve on depressurisation • Blow Out Preventer on wellhead

ID #	Arriscar Observation from Peer Review 2017	Arriscar Observation 5 June 2018	Status	Response
		to reduce the risk from Medium to Very Low; however, these controls are already included In the 'Inherent design standards and operational practices applied' column). The qualitative assessment and lack of specific data provided by Santos do not enable a third party to assess the acceptability of the hazards and risks associated with the existing wells, including their "conversion or upgrade".		• a design that incorporates the maximum expected pressure in the well • emergency shutdown and manual isolations • carrying out operations and maintenance activities in accordance with Santos operations and maintenance procedures These controls are all applicable to the management of potential hazards arising from the conversion or upgrade of pilot wells. Well integrity assessments would also be conducted in accordance with the NSW *Code of Practice for Coal Seam Gas Well Integrity* (DTIRIS 2012) prior to installing pumps and connecting wells to the gathering network. The EIS, including the risk register and subsequent response to Arriscar feedback, demonstrates the hazards and risks of well conversion or upgrade can be appropriately managed, with residual risk being rated as very low.
3	**EIS for the NGP: Appendix S, Section 1.4 (Page 6)** 'Sensitive receptors' have been defined relative to the Leewood and Bibblewindi facilities, but have not been identified for the other facilities (e.g. wells, gas gathering lines). All relevant land uses should be identified and considered to demonstrate compliance with all relevant risk criteria in HIPAP No. 4. For example, the following categories of use are included in Section 2.4.2.1 of HIPAP No.4 for assessment of individual fatality risk: • Hospitals, schools, child-care facilities, old age housing; • Residential, hotels, motels, tourist resorts; • Commercial developments including retail centres, offices and entertainment centres; • Sporting complexes and active open space; and • Industrial uses.	The locations of the 'sensitive receptors' have been provided. This observation Is Closed.	Closed	No further action required.
4	**EIS for the NGP: Appendix S, Section 2.1 (Page 14)** The PHA "has been undertaken without consideration of standard design and operational systems" and a preliminary configuration for the wells has not been included in the PHA. Similarly, the configuration of the existing exploration and appraisal wells has not been presented in the PHA. Will these be reconfigured? In Section 1 of HIPAP No.6, it is acknowledged that "A PHA may be based on limited information since complete data on the design and precise safeguards may not be available at the initial stage. The PHA should be as final and comprehensive as the available information allows." The complete absence of well	The supplementary information provided in response to this observation is adequate; however, it is still not clear why this information was not presented in the EIS. This observation is Conditionally Closed. Note: To conditionally close this observation, the following consent conditions will be recommended for inclusion in any development approval: The FHA to include a Quantitative Risk Assessment for all potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities etc) associated with the development.	Conditionally Closed	No further action required at this stage. During the design phase of the project, a FHA will be completed as per the requirements outlined in HIPAP 6 Hazard Analysis and any specific recommendations made by DP&E in the project approval stage. As required under HIPAP 6, the FHA will incorporate an updated hazard identification, consequence analysis, likelihood estimate and risk analysis based on the more detailed information available at the later project phase. The individual fatality, injury, societal and biophysical risk will be assessed against the criteria outlined in HIPAP 4 Risk Criteria for Land use Safety Planning. Similarly, as per the requirements outlined in HIPAP 6 Hazard Analysis, additional assessments such as HAZOP and construction safety studies will be conducted in the appropriate project phases with implementation of the safety management system, emergency plans and audit protocols in the operational phase of the project. As identified in Appendix S of the EIS, all facilities would be designed and operated under applicable

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	configuration information in the PHA is not consistent with HIPAP No. 6, particularly when there are existing exploration and appraisal wells and preliminary design information might be based on wells that are already being operated by Santos.	A HAZOP study to be undertaken for all potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities etc) associated with the development. An independent audit of the control measures should be undertaken prior commissioning to verify that the control measures identified in the PHA / FHA and HAZOP have been implemented. Periodic independent Hazard Audits are to verify implementation of the control measures listed in the EIS and listed in response to this observation. Key safety performance indicators are to be periodically reported to verify compliance with the key data and assumptions in the PHA/FHA e.g. shut in well pressures, leak rates etc		Australian safety standards and protocols; this includes safety in design studies such as HAZOP and incorporation of all new facilities into an operational safety management system including auditing, routine monitoring and reporting requirements.
5	**EIS for the NGP: Appendix S, Section 2.3.5 (Page 20)** The only risk criteria cited from HIPAP No. 4, and subsequently considered in the PHA, are for injury from heat radiation, explosion overpressure, and toxic exposures. The PHA must demonstrate compliance with all criteria in HIPAP No. 4, including individual fatality risk (HIPAP No. 4, Section 2.4.2.1), injury risk (HIPAP No. 4, Section 2.4.2.2), property damage and accident propagation (HIPAP No.4, Section 2.4.2.3) and societal risk (HIPAP No.4, Section 2.4 .3). It should also consider the qualitative risk criteria (HIPAP No. 4, Section 2.2) and the risk to the biophysical environment from accidental emissions (HIPAP No. 4, Section 2.4.4). Furthermore, it is reported in Section 2.4.2. 1(d) of HIPAP No. 4 that the 'Individual fatality risk levels for industrial sites at levels of 50 in a million per year (50 x 10^{-6} per year) should, as a target, be contained within the boundaries of the site where applicable'. This has not been demonstrated in the PHA.	This observation has not been fully addressed. For example: Compliance has not been fully demonstrated with the criteria for the risk to the biophysical environment from accidental emissions (HIPAP No. 4, Section·2.4.4).	Open	Potential risks to the biophysical environment from the project have been assessed in detail by technical specialists in the relevant parts of the Environmental Impact Statement (EIS) and include management and mitigation strategies and plans to be implemented. These comprehensive studies have found the residual risk to the biophysical environment be low to very low. Please refer to the EIS and related technical appendices Chapter 11 Geology and Groundwater and Appendix F Groundwater Impact Assessment, Chapter 12 Surface Water Quality and Appendix G1 Managed Release Study (Bohena Creek), Chapter 14 Soils and Land Contamination, Chapter 15 Terrestrial Ecology and Appendix J1 Ecological Impact Assessment, Chapter 17 and Appendix L Air Quality Impact Assessment and Chapter 26 Social and Health and Appendices Appendix T1 Social Impact Assessment and Appendix T2 Health Impact Assessment and Appendix T3 Chemical Risk Assessment. Further, Santos has provided a summary table highlighting the specific risk criteria applicable to the project and the risk level assessed against that criteria. As stated in HIPAP No. 6, Section 8.1 - Assessment against risk criteria: “The complexities of assessing risk to the biophysical environment and case-to-case differences render it inappropriate to specify precise risk criteria in these cases.” Additionally, HIPAP No. 4 Section 2.4.4 states: “In the case of the biophysical environment, fire and explosion hazards are of less relevance in comparison to the effect of these hazards on people. Acute and chronic toxicity impacts are those that must be chiefly addressed. Generally, there is less concern over the effects on individual plants or animals. The main concern is instead with whole systems or populations.” Based on the above requirements highlighted from HIPAP 4 and 6, there are no specific criteria to assess risks to the biophysical environment, furthermore, the HIPAP requirements focus on toxic releases. For completeness, Santos has specifically assessed the risk of bush fires in Section 4.4 of EIS Appendix S and in response to Comment 11 raised in the initial observations. With regards to toxic materials, a conservative approach was taken to assume the biocide to be used will be a Class 6.1 toxic material (although the type of biocide is yet to be

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				selected). The qualitative risk assessment and semi-quantitative risk assessment again took a conservative approach to assume that large quantities of biocide could be released and subsequently heated to decomposition to produce toxic gases. Similarly, a conservative approach was taken for corrosives, assuming all Class 8 Corrosives used would be the higher risk Packaging Group II category and that large quantities could be released. However, as demonstrated by the range of safeguards identified, the likelihood of such events is very low. Both the qualitative and semi-quantitative assessment of toxic and corrosive materials indicate a low to very low risk of offsite impacts and therefore a low to very low risk to the biophysical environment. The information about the risks to the biophysical environment provided throughout the comprehensive environmental impact assessment process addresses the requirements of the relevant HIPAPs including HIPAP No. 4, Section 2.4.4.
6	**EIS for the NGP: Appendix S, Section 2.3.7 (Page 21)** Different operating conditions do not appear to have been addressed in the PHA. For example, the pressure may be significantly higher when a well is 'shut in'. Different operating conditions should be considered in the PHA to ensure the assessment is a 'conservative best estimate' (HIPAP No. 4, Section S).	The shut-in pressure is a critical parameter as this is being used to justify the minimum safe separation distance. Justification for this pressure (which is noted to be less than has been reported for early/intermediate stages of operation for other CSG developments) should be provided.	Open	During routine remote operation of a production well, the well is designed to be safely shut down in an emergency, (ESD) or remote shut-in/turned-on. In the event that a well is required to be shut-in remotely, a valve adjacent to the well head is closed, isolating the surface infrastructure including the gas and water separator and metering skid. To resume gas production after a sustained shut-down, an operator must first manually reopen the valve at the well head, managing the flow of gas to the separator until the desired operating pressure is reached. Whenever operators are on a well pad, a mobile gas detector is utilised. This process is aligned with start-up controls of CSG wells. The consequence analysis performed was considered conservative given wellhead infrastructure is designed for up to 20,600 kPa, and inlet piping designed for up to 9,290 kPag. The most credible full bore rupture scenario would be a vertical release through the pressure release device, resulting in reduced consequence effect distances compared to a horizontal release.

Attachment 2 – Response to Arriscar follow up questions

ID #	Arriscar Observation from Peer Review 2017	Arriscar Observation 5 June 2018	Status	Response
7	**EIS for the NGP: Appendix S, Section 4.2.4 (Page 39)** It is reported that "During the operational phase, some transport of dangerous goods will be required to support project activities." Does this include the transport of dangerous goods during the other phases (construction, drilling, decommissioning, etc.)? If not, the transport movement in Section 4.2.4 should be amended accordingly.	The qualitative assessment and lack of specific data provided by Santos do not enable a third party to assess the acceptability of the risks associated with DG transport during all phases. However, the materials identified in Appendix T3 of the EIS (e.g. caustic soda, citric acid, sodium hypochlorite, hydrochloric acid, etc.) do not typically pose a significant risk of fatality, injury or property damage during transport. Whilst a spillage may cause damage to the biophysical environment, control measures are readily available and addressed in relevant standards (e.g. requirements for packaging, spill response, etc.). Therefore, this observation is Conditionally Closed. Note: To conditionally close this observation, the following consent conditions will be recommended for inclusion in any development approval: The FHA is to include an assessment of the risks for all materials that may present a hazard to people, property or the biophysical Environment during transport to or from all of the potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) and for all phases of the project.	Conditionally Closed	No further action required at this stage. DG transportation will be conducted in accordance with the *Australian Dangerous Goods Transportation Code* (Edition 7.5 then Edition 7.6 from 1/07/2019) and will meet all regulatory requirements. During the design phase of the project, a FHA will be completed as per the requirements outlined in HIPAP 6 Hazard Analysis and any specific recommendations made by DP&E in the project approval stage. As required under HIPAP 6, the FHA will incorporate an updated hazard identification, consequence analysis, likelihood estimate and risk analysis based on the more detailed information available at the later project phase. The cumulative individual fatality, injury, societal and biophysical risk will be assessed against the criteria outlined in HIPAP 4 Risk Criteria for Land use Safety Planning.
8	**EIS for the NGP: Appendix S, Section 4.3.2 (Page 46)** It is reported that 'consequence effect distances reach up to 50 m downwind of the release point which is contained within the well-pad area of approximately one quarter of a hectare after partial rehabilitation. Therefore, none of the wellhead scenarios analysed in this PHA has offsite impacts'. One quarter of a hectare equates to 2,500 m^2 so the well pad will have approximate dimensions of 50 m by 50 m. Therefore, even if the wells are located as far from the pad boundary as possible, i.e. the centre of the well pad, then the distance from the well to the well pad boundary would be approximately 25 m. Some incidents will therefore have an off-site impact (*c.f.* EIS Table 4-15 of Appendix S). Furthermore, the photograph (Figure 1-3) shown in Section 1.5 of EIS Appendix S would appear to show infrastructure that is relatively close to the fence line boundary.	A 100 x 100 m fenced off area is now identified in the response in addition to the 50 x 50 m fenced off area. However, this observation has not been fully addressed, as some infrastructure is still likely to be within 50 m of the 100 x 100 m fenced off area.	Open	The project description in the EIS identifies that well pads will be approximately 100 x 100 metres in size (refer to Figure 6-21 in Chapter 6 of the EIS). This 100 x 100 metre well pad will be partially rehabilitated once production has commenced however will remain fenced throughout the operational life of the well. Wellhead and gas infrastructure will be located within a fenced 50 x 50 metre 'safety zone' within the operational well pad. Only water infrastructure, such as break tanks, and potentially temporary flares would be located on the operational well pad, outside of the safety zone. The potential for offsite impacts will be taken into account in layout optimisation during the design phase. As assessed in the qualitative and semi-quantitative risk assessments, the likelihood of a loss of containment event large enough that it could cause offsite impacts is very low. Importantly no loss of containment scenario events would reach sensitive receivers. The risk of well loss of containment events has been qualitatively and semi-quantitatively assessed using a conservative worst case scenario approach.

ID #	Arriscar Observation from Peer Review 2017	Arriscar Observation 5 June 2018	Status	Response
	The conclusion that 'none of the wellhead scenarios analysis in this PHA has offsite impacts' needs to be reconsidered in the PHA.			
9	**EIS for the NGP: Appendix S, Section 4.3 .2 (Page 46)** It is reported that "No explosion overpressure analysis was performed at the wellheads as it is assumed the area is open and there is insufficient confinement and congestion to result in an explosion." A similar assumption is reported for other gas release locations. This assumption does not appear to have considered the presence of trees, which may potentially provide sufficient obstacles for generation of a vapour cloud explosion (VCE). The PHA should clearly demonstrate that a VCE is not credible based on the proposed clearance of vegetation around all of the potential sources of a gas release. If a VCE is credible, then the risk associated with such events should be assessed against the relevant risk criteria in HIPAP No. 4.	This observation has not been fully addressed. For example: Some release cases are identified with LFL at up to 222 m (Table 2 in response to CRS No. 1). Could this reach congested areas? Leaks from the underground pipework could still occur to atmosphere.	Open	VCE from delayed ignition of gas associated with these sources of congestion is considered unlikely because methane is a light buoyant gas, highly dispersive in the atmosphere and infrastructure is designed to minimize ignition sources. **Vegetation surrounding clearing** Well pads: The potential for vegetation surrounding the well pads to create sufficient confinement to enable a VCE was described in detail within the previous response to Comment 9 and it was determined a VCE at the well pad is not considered a credible scenario. Gathering systems and the Bibblewindi to Leewood medium pressure pipeline: The same calculation that was used for the well pads (the Baker-Strehlow-Tang (BST) method) was used for the medium pressure pipeline, representing the worst case, or most conservative scenario. The calculation was performed using very conservative assumptions including: • VCE occurs with partial blockage which prevents a flame front from expanding in two directions (vertically restricted by the ground, sideways restricted by scrub either side of pipeline easement) • Medium congestion (i.e. medium tree congestion) which means there is 10% to 40% obstacle blockage ratio per plane or at least two to three layers of obstacles • Congestion of trees are located 15m from the pipe (based on a 30m wide easement) • Trees are 10m tall and surround the point of release on all four side at a distance of 15m from the pipeline i.e. a 30m x 30m square containment around the point of release. The results from the analysis determined the worst explosion overpressure that could be experienced at a distance 15m from the pipeline is 0.2 kPa. Referencing HIPAP 4 Table 7, an overpressure of this magnitude is expected to result in no fatality and very low probability of injury. Although this analysis has been performed, it should be noted that it is highly conservative. In reality, there is only confinement created by vegetation on two sides and the clearing of the pipeline easement enables the gas to disperse freely along the easement. As with the well pads, the above is supported by experimental evidence that indicates that vapour clouds of methane can burn (at atmospheric temperatures), but do not readily explode. Experimental attempts have been made to initiate explosions involving methane clouds, however no explosion occurs (Lees 1996). Hence, a VCE at the pipelines is not considered a credible scenario. Bibblewindi and Leewood: The cleared area surrounding the compression facilities is greater than the well pads and pipeline easement. On the basis of vegetation surrounding a clearing not being a credible source of congestion in those locations, it is also not considered credible at the compression facilities. **Within vegetation** If a flammable gas cloud accumulates in an area of vegetation and encounters an ignition source, it is highly unlikely that a VCE could occur. This has only been evidenced by

ID #	Arriscar Observation from Peer Review 2017	Arriscar Observation 5 June 2018	Status	Response
				dense, heavier than air gases and there is no known history of such an event occurring with a lighter than air gas such as methane. For a VCE to occur within vegetation, the following events would be required: • A large, sustained gas release occurs sufficient to create a gas cloud large enough to reach the vegetation; • The wind is sufficiently strong to allow the gas to reach the vegetation in flammable concentrations before it rises above the vegetation height; • There is no immediate ignition (e.g. the source of the loss of containment does not cause ignition); • The vegetation is sufficiently dense to form the level of congestion required to support a VCE; • The gas (while in a flammable concentration) encounters an ignition source; and • The gas ignites without the need to accumulate into a very large “pool”. As provided in Appendix S of the EIS and as per Table 2 in response to CRS No. 1, flash fire effect (LFL) distances extend up to 222m in the worst case release scenario from Leewood. The flash fire effect results are reported at the cloud centreline, as this is representative of the centre of the cloud that is within flammable concentrations. It should be noted, that as natural gas is lighter than air, the cloud centreline of an unignited flammable cloud is likely to rise rapidly. Therefore, the flash fire results reported in the EIS are conservative regarding the potential for accumulation in areas of congestion. Given the information provided above, it is considered very unlikely that a natural gas VCE could occur within vegetation surrounding the project facilities. However, for completeness, consequence analysis has been performed using the worst case release scenario from Leewood (6,500 kPa, 250 mm release). Using the Multi Energy Explosion Model in Phast, assuming 100% of the gas released is involved in the VCE and a confined strength of 5, the maximum overpressure created is 20 kPa. This is a conservative analysis, as in reality, not all the gas released would enter the vegetated area and a confined strength of 5 represents a moderate level of confinement (maximum is 10, where 8 or 9 is typically used for process units). The modelling also does not take into account the distance of the vegetation from the release source; rather it assumes the confined area is immediately within the vicinity of the point of release. From HIPAP 4, Table 7: Effects of Explosion Overpressure, 21 kPa represents a 20% chance of fatality to a person in a building. The probability of fatality to a person in the open would be substantially less (at 35 kPa there is a 50% chance of fatality in a building versus 15% in the open). In conclusion, there is a very low likelihood of a natural gas VCE occurring within vegetation and if it were to occur, there is limited potential for sufficient overpressure to be generated to cause fatality to individuals who may happen to be in the location at the time of the incident. **Buildings** The final source of congestion within the project area is created by buildings, identified as sensitive receptors (being ‘occupied residences’) within the EIS. As per Table 2 in response to CRS No. 1, no flash fire effects (even as measured conservatively at the cloud centreline) reach any sensitive receptors that could be areas

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				of congestion. This includes the furthest flash fire effect up to 222 m from Leewood, and along the length of gas gathering and pipeline network. Refer to Table 2 in response to CRS No. 1 for summary comparison of flash fire distances in comparison to the closest sensitive receptors that represent potential areas of congestion. As there are no unignited gas clouds within flammable concentrations that reach sensitive receptors, it is not considered credible for VCEs to occur at buildings. **References supporting low likelihood** Several authors have reviewed VCE incidents and found that methane gas VCEs are unlikely to occur. Below are some extracts that support the above argument that there is a low likelihood of natural gas / methane being involved in a VCE. • "This review has not found any historical records of LNG (methane) vapor cloud explosions in open areas with severity sufficient to cause secondary damage to tanks and pipes and consequently rapid escalation of an incident from a minor process leak to a major loss of inventory." *Graham Atkinson, Jonathan Hall and Alison McGillivray (2017), UK Health and Safety Executive (HSE), Review of Vapour Cloud Explosion Incidents, RR1113 Research Report, Section 2.1 Page 6.* • There is now considerable evidence that vapour clouds of methane at normal temperatures burn, but do not readily explode. Many experiments have been done in which attempts have been made to initiate explosions in methane clouds, but in which no explosion occurred." *Lees, F (1996) Loss Prevention in the Process Industries, 2nd Edition, Volume 2, Section 17.28.29 Methane and LNG combustion, Page 17/175.* • "With the exception of hydrogen, it would appear to be necessary that most flammable gases or vapours capable of causing VCEs, at the point of escape as well as in explosive mixtures with air, display a density greater than that of the ambient atmosphere. Such mixtures naturally tend to form low-lying, two dimensional clouds." *Gugan, K (1980) Unconfined Vapour Cloud Explosions, Page 104.*

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10	**EIS for the NGP: Appendix S, Section 4.3.6 (Pages 54-55)** The cumulative risk must be assessed against each relevant risk criterion (Refer to HIPAP No. 6, Section 7.1). The findings presented in the PHA do not appear to be based on the cumulative risk. For example, in Section 4.3.2 of the PHA, the risk associated with Bibblewindi is only assessed for the worst-case scenario. The Bibblewindi site, as shown in Figure 1.4, has six existing exploration and appraisal wells (three located within the site boundary and three within approximately 300 m of the site). It is reported in Table 1.1 that exploration and appraisal wells will be converted to production wells. The cumulative risk from all sources has not been used to demonstrate that the offsite risk criteria have been satisfied. Furthermore, an assessment of the individual risk of fatality and societal risk (both of which are currently omitted from the PHA) must be based on the cumulative risk for *all* potential events (i.e. including all potential outcomes - fire, explosion, bush fire, etc.).	This observation has not been fully addressed. Based on the size of the well infrastructure (Refer to ID# 4), locations of the wells relative to the identified 'sensitive receptors' (Refer to ID # 3) and risk profiles for similar wells at other developments (Refer to Locational Guidelines - Development in the Vicinity of Operating Coal Seam Methane Wells), this observation is Conditionally Closed for the wells (Refer to proposed consent conditions in ID #1). However, this observation is Open for the Leewood facility due to the closer proximity to sensitive receptors, presence of more infrastructure (including some wells) and the tie-in to the proposed high-pressure pipeline. A full quantitative risk assessment should be undertaken for the Leewood facility to demonstrate compliance with all of the Department's risk criteria for land use safety planning (HIPAP No. 4). Also refer to ID# 18.	Open Conditionally Closed for the wells	On the basis that Comments 1, 4, 7 and 12 have been conditionally closed subject to the completion of a FHA, Santos proposes this observation be addressed in the same manner. During the design phase of the project, a FHA will be completed as per the requirements outlined in HIPAP 6 Hazard Analysis and any specific recommendations made by DP&E in the project approval stage. As required under HIPAP 6, the FHA will incorporate an updated hazard identification, consequence analysis, likelihood estimate and risk analysis based on the more detailed information available at the later project phase. The cumulative individual fatality, injury, societal and biophysical risk will be assessed against the criteria outlined in HIPAP 4 Risk Criteria for Land use Safety Planning.
11	**EIS for the NGP: Appendix S, Section 4.4.2 (Pages 55-61)** Whilst there are no risk criteria in HIPAP No. 4 specifically relating to protection of the environment from bush fires, the Department's criteria for the protection of the biophysical environment are as follows (HIPAP No.4, Section 2.4): • Industrial developments should not be sited in proximity to sensitive natural environmental areas where the effects (consequences) of the more likely accidental emissions may threaten the long-term viability of the ecosystem or any species within it. • Industrial developments should not be sited in proximity to sensitive natural environmental areas where the likelihood (probability) of impacts that may threaten the long-term viability of the ecosystem or any species within it is not substantially lower than the background level of threat to the ecosystem. It is also reported in Section 2 of HIPAP No. 4 that: "Risk criteria are set with the understanding that no aspect of living can be risk free but that any imposed	This observation is Open. The likelihood of a bushfire being caused by the development has been estimated at 1/70 years. This is not insignificant relative to the background risk (c. 1/10 years).	Open	As documented in the response to Arriscar's comments the likelihood of a loss of containment creating a fire of any size is once in 70 years, including those with a very small effect distance that are contained within the site. A range of mitigation measures are in place which reduce the likelihood of project activities causing a bushfire to the lowest level of 'remote'. This is defined as 'requires exceptional circumstances, is unlikely even in the long-term, 100 year event' and the likelihood of the project leading to a bushfire is substantially less than once in 70 years. This is not significant relative to the background risk. For these fire events to escalate to a bushfire, the fire must be large enough and the conditions conducive for it to extend offsite to a vegetated area and not be extinguished in a suitable time. Also highlighted in the response to Arriscar's comments, there have been oil and gas activities in the area since the 1960s, with no evidence of bushfire as a result of these activities. Similarly, there are no known incidents within the CSG sector causing large scale bushfires. On the basis that there is no known history of such events and the estimated likelihood of this specific project causing a bushfire is substantially less than once in 70 years, at least an order of magnitude smaller than the local background risk, the cumulative risk of bushfires from the entire project is low. The EIS including risk register and subsequent response to Arriscar comments demonstrate the hazards and risks of bushfires to can be appropriately managed with residual risk rated as low. Santos is committed to making bushfire risk as low as reasonably practicable through the implementation of a bushfire management plan and is working with the NSW Rural Fire Service in relation to bushfire management for its exploration and appraisal activities in the Pilliga. It is noted that further information in relation to bushfire risk has been provided

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	risk should be very small in the context of the generally accepted background risk". The PHA has not demonstrated that the cumulative risk of initiating a bush fire from the proposed 850+ wells and associated gas gathering and processing facilities is low relative to the background risk and compliant with the Department's criteria for the protection of the biophysical environment.			in the RTS (refer Section 5.12 and 6.25.1 of the RTS) available at: http://www.majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=6456.
12	**EIS for the NGP: Appendix S, Section 5 (Pages 61-64).** It is reported in Section 3 of HIPAP No. 6 that: "Even where the facility complies with numerical risk criteria, recommendations for reducing the likelihood and consequences of hazardous events on people, property and the biophysical environment should be made where technically feasible solutions will not adversely affect the economic viability of the project." Such recommendations have not been included in the PHA. Furthermore, it is a requirement of the SEARs that "appropriate setbacks and / or asset protection zones for well heads, gas processing facilities and other infrastructure to manage risks" be established. These are not clearly defined in the PHA (Noting that this will require additional assessment to ensure all relevant operations, facilities and risk criteria have been considered in the PHA - See other observations in this CRS).	This observation is Conditionally Closed. Note: To conditionally close this observation, the following consent conditions will be recommended for inclusion in any development approval: A minimum safe separation distance is to be maintained between all potentially hazardous facilities (e.g. wells, gas gathering lines, compression facilities, etc.) and all relevant land uses. The required minimum safe separation distance is to be verified in the Final Hazard Analysis. Also refer to ID# 10.	Conditionally Closed	No further action required at this stage. During the design phase of the project, a FHA will be completed as per the requirements outlined in HIPAP 6 Hazard Analysis and any specific recommendations made by DP&E in the project approval stage. As required under HIPAP 6, the FHA will incorporate an updated hazard identification, consequence analysis, likelihood estimate and risk analysis based on the more detailed information available at the later project phase. The cumulative individual fatality, injury, societal and biophysical risk will be assessed against the criteria outlined in HIPAP 4 Risk Criteria for Land use Safety Planning.
13	**EIS for the NGP: Appendix S, Appendix A** The PHA refers to hazards and risks associated with the construction and operation phases of the project. The potential hazards and risks associated with other phases of the proposed development (e.g. drilling, wellhead intervention / workover, well and gathering line decommissioning and abandonment) do not appear to have been addressed in the PHA. All phases of the proposed development should be considered in the PHA.	This observation has not been fully addressed. Whilst an additional column has been added to the Risk Register, insufficient evidence has been provided to demonstrate that the risks for all phases of the proposed development have been systematically considered in the PHA.	Open	Activities associated with all phases of the project have been considered, as highlighted in the risk register, indicating to which phase each risk applies. The risk register was developed through workshops with engineers, field operators and relevant professionals and presents the most significant risks for the project with the most likely causes provided. The risk register is presented based on categorisation of risks using the type of consequences that may occur rather than listing each activity undertaken as part of the project. The causes and controls associated with each risk are clearly identified as they apply to each project phase. The risks associated with drilling are assessed as part of construction phases. Similar to Response 2 regarding well conversion from appraisal to production, well head maintenance, decommissioning and abandonment include many of the activities that are the same or similar as those associated with construction (including drilling, flowline, plant and equipment installation etc). The approach taken has ensured all relevant risks have been systematically considered and assessed. As discussed in the EIS and subsequent responses, Santos will implement its safety management system that incorporates the full life cycle of the project. This will also incorporate numerous risk assessments as the project progresses, including assessments focusing on each specific project phase and every activity to be conducted as part of the project. At the PHA phase, it is reasonable to highlight the relevant phases

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				at which each risk applies without listing every activity conducted within those phases, or repeating the risk assessment for the same risks that apply to multiple phases.
14	**EIS for the NGP: Appendix S, Appendix A** The hazard register does not appear to include hazards and risks from blowouts during the drilling phase.	The qualitative assessment and lack of specific data provided by Santos do not enable a third party to assess the acceptability of the risks associated with blowouts. This observation is Open.	Open	Blowout is a loss of containment consequence specifically related to Risk ID4 in the risk register of the PHA. As detailed in the previous response to this observation, blowouts have been considered through identification of the cause of the blowout e.g. overpressure, operator error or equipment failure and the controls have also been identified e.g. blow out preventer on wellhead, telemetry installed to allow ongoing monitoring and remotely operated shut in of wells, design incorporates maximum expected pressure in new well, carry out operations and maintenance activities in accordance with Santos operations and maintenance procedures, contractor management systems. In addition, specific consequence modelling was performed on well shut in scenarios, representing the maximum pressure excursion event that could occur from the well, which incorporates the worst case scenario blowout. At the PHA phase, it is appropriate to highlight the relevant causes of an event (in this case, a loss of containment of gas from a wellhead), the controls and associated project phase to which it applies. No new information is generated by repeating the risk assessment for each cause.
15	**EIS for the NGP: Appendix S, Appendix A** The hazard register does not appear to include hazards and risks from other activities in the state forests (e.g. external threats such as logging, controlled back burning, other infrastructure, recreational activities (use of 4WDs, etc.). These should be included PHA (As per Section 4.1 of HIPAP No. 6).	The qualitative assessment and lack of specific data provided by Santos do not enable a third party to assess the acceptability of the risks associated with other activities in the State Forest. This observation is Open.	Open	As stated in the previous response to this observation, specific external threat causes (and controls) have been included in the risk register. The presence of other users of the State forest (e.g. for logging or recreational activities) or the presence of other infrastructure is not a cause of a release of gas. It is activities that would damage facilities such as through third party interference that are potential causes. The causes of damage such as third party excavation and impact from mobile equipment have already been included as causes. The controls such as fencing, signage, buried pipeline depth of cover, landholder agreements and infrastructure corridor management plan are also included. It is appropriate to highlight the relevant causes of an event and the controls associated with those causes in the risk register rather than the type of activities undertaken in the project area (which are provided in the EIS in relation to the description of the surrounding area).
16	**EIS for the NGP: Appendix S, Appendix A** The hazard register does not appear to include hazards and risks from 'malicious acts'. These should be included in the PHA (As per Section 4.1 of HIPAP No. 6).	The qualitative assessment and lack of specific data provided by Santos do not enable a third party to assess the acceptability of the risks associated with 'malicious acts'. This observation is Open.	Open	As stated in the previous response to this observation, specific external threat causes (and controls) have been included in the risk register. The specific causes of people undertaking malicious acts such as third party excavation or uncontrolled excavation are already included in the risk register. These are the actual causes of the risk regardless of intent. Similarly, the controls have been identified such as depth of cover, locked valves, design features such as pipeline wall thickness etc. have also been included. It is reasonable to highlight the relevant causes (in this case, related to human interference) of an event in the risk register, regardless of intent.

Attachment 2 – Response to Arriscar follow up questions

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17	**EIS for the NGP: Appendix S, Appendix A** The hazard register does not appear to include hazards and risks due to the presence of other infrastructure within the pipeline corridor (i.e. It is understood that the new medium pressure gas pipeline (864 mm diameter) will be in a corridor that already contains an existing 257 mm diameter gas pipeline flowing from Bibblewindi to Wilga Park Power Station and will contain a new 132 kV power transmission cable). These should be included in the PHA (as per Section 4.1 of HIPAP No.6).	The qualitative assessment and lack of specific data provided by Santos do not enable a third party to assess the acceptability of the risks associated with other infrastructure within the pipeline corridor. This observation is Open.	Open	As stated in the previous response to this observation and in response to observation 15, specific external threat causes (and controls) have been included in the risk register. The presence of other infrastructure within the pipeline corridor is not a cause of a release of gas. It is the activities associated with constructing, operating and maintaining them such as excavation in the vicinity. It is reasonable to highlight the specific causes associated with the interaction with the other infrastructure e.g. third party excavation or uncontrolled excavation, and the controls that manage those causes e.g. infrastructure corridor management plan, work permit system, signage, emergency isolation capabilities and design in accordance with standards (including items such as cathodic protection, separation distances etc.).
18	**EIS for the NGP: Appendix S, Appendix A** The hazard register does not appear to include hazards and risks associated with the power generations plant at Leewood. Other activities (e.g. pig launch and recovery) are also omitted. A more detailed and comprehensive assessment should be included in the PHA for the equipment and operations at the Leewood facility.	This observation is Open. Refer to ID# 10.	Open	On the basis that Comments 1, 4, 7 and 12 have been conditionally closed subject to the completion of a FHA, this comment should be addressed in the same manner. During the design phase of the project, a FHA will be completed as per the requirements outlined in HIPAP 6 Hazard Analysis and any specific recommendations made by DP&E in the project approval stage. As required under HIPAP 6, the FHA will incorporate an updated hazard identification, consequence analysis, likelihood estimate and risk analysis based on the more detailed information available at the later project phase. The cumulative individual fatality, injury, societal and biophysical risk will be assessed against the criteria outlined in HIPAP 4 Risk Criteria for Land use Safety Planning.

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