APA Group

Safety Management Study
Wilton South East Precinct Development

Land Use Change
Moomba to Wilton Pipeline and;
Moomba to Botany Ethane Pipeline

DOCUMENT NO: 410-R-01

Prepared by

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November 13, 2017

REVIEW AND APPROVAL RECORD

<table>
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<tr>
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<th>DATE</th>
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</tr>
<tr>
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<td>3</td>
</tr>
</tbody>
</table>
APPENDICES

Appendix 1 Development Drawings
Appendix 2 ALARP Assessment
Appendix 3 SMS Register
Appendix 4 Attendee Register

Changes – Revision A to Revision 0

1. Each mark-up made by APA was accepted, and each comment considered and deleted.
2. A note was added to the summary to record that while the SMS undertook a qualitative ALARP assessment of residual threats, rather than a LOPA, the methodology used was acceptable to APA in this case.
3. Minor editorial corrections were made
1. **SUMMARY**

This document presents the findings of a Safety Management Study (SMS) assessed by Workshop of stakeholders on August 24, 2017.

The Workshop considered risks associated with the development of the Wilton – South East Precinct to APA’s Moomba to Wilton (MSP) natural gas pipeline and its Moomba to Botany ethane pipeline.

The SMS concluded that provided that each pipeline is provided with barrier protection in the form of a reinforced concrete slab or possibly a heavy polyethylene sheet, threats to the pipeline will be controlled to the standard required for these pipelines installed in a residential location class. This form of protection is consistent with the protection applied over each pipeline on the north side of Picton Road, associated with the Bingara Gorge residential development.

This protection is required to extend 1 measurement length (665 metres) south of the Maldon-Dumbarton rail corridor in the case of the MSP. The treatment is not required for the ethane pipeline in this area because it is adequately protected by increased burial depth provided by its construction method.

The protection is also required to extend 665 metres north from the development, over each pipeline. The SMS notes that much of the land on the north side of Picton Road is currently within the 1 measurement length distance of the Bingara Gorge residential development and arguably, should already be treated with barrier protection. The SMS did not resolve responsibility for this protection.

A number of other controls were identified and recorded as actions that are to be addressed prior to the development entering the construction stage. These are in addition to APA’s standard requirements for work in the vicinity of gas pipelines.

**NOTE:**

APA commented in its review that while the SMS format followed that in AS 2555.1, it did not follow APA’s current procedure to consider and document the effectiveness of threat controls using the Layer of Protection Analysis (LOPA) methodology. APA noted that it did not nominate this as a current requirement for SMS, and that it will accept the study as reported in this document.
2. BACKGROUND

2.1 GENERAL

The Moomba to Wilton Natural Gas pipeline was completed by The Pipeline Authority in 1976 to transport natural gas from Moomba to Wilton, and thence to Sydney, Wollongong and Newcastle in pipelines owned by AGL. In 1995 The Pipeline Authority constructed a pipeline to transport ethane from Moomba to Botany, to supply a feedstock for the (then) ICI olefines plant.

Both pipelines are now owned by APA.

At the time of construction, Wilton was a small country village, and land use through the region was broad rural. Urban expansion has resulted in progressive residential development at Wilton, progressing south toward Wilton Road. Some of these developments have changed the land use around APA pipelines and this has required treatment of the design and the pipeline to maintain public safety at the standard required for residential land use.

Over the past 3-4 years, planning has been undertaken for a large (15,000 lot) residential and commercial development centred on the Picton Road/Hume Highway intersection.

Walker Corporation is seeking development approval for a 3000 lot residential and light commercial development on the south east quadrant of the intersection. The development will cover approximately 700 metres of the easement containing the APA pipelines south from Picton Road. One of the development consent conditions is that APA agree that the pipeline safety will satisfy the requirements of the technical Standard, AS 2885, for high pressure gas and liquid petroleum pipelines installed in residential areas.

To achieve this, it is expected that treatment will be required to both the development’s design and the pipeline.

The method nominated in AS 2885 to assess pipeline safety is a Safety Management Study (SMS). This requires a comprehensive examination of threats to the pipeline and consequences from the pipeline. Where necessary the Study is required to identify additional controls required to reduce the risk to a tolerable level, and in some locations, to a level of “As Low As Reasonably Practicable” (ALARP).

AS 2885 requires that the Study is undertaken by the Pipeline Licensee (APA).

In this case APA requested that Walker Corporation engage Venton and Associates to prepare an analysis of threats and controls for presentation to a workshop of stakeholders for validation.

This report and its attachments presents the findings of the SMS.
3. PIPELINE PROPERTIES

3.1 GENERAL

The parameters of each pipeline are listed in Table 3-1.

The critical defect length and the Maximum Axial hole size were calculated by Venton. The remaining information was provided by APA or Walker.

| Table 3-1 Pipeline Parameters Relevant to SMS |
|-----------------|----------------|----------------|
| Item                  | Unit       | MSP                        | Ethane                    |
| Fluid                  |            | Compressed natural gas       | Dense phase ethane (pseudo liquid) |
| Outside Diameter       | mm         | 864                        | 219.1                      |
| Wall Thickness          | mm         | 9.2                        | 8.1                        |
| Pipe Material          |            | API 5L Grade X65            | API 5L Grade X60           |
| Design Pressure         | kPa        | 6895                       | 14895                      |
| Minimum Yield Strength  | MPa        | 448                        | 413.7                      |
| Hoop Stress at Design Pressure | % SMYS | 72                          | 49                         |
| Total Length            | Km         | 1299                       | 1375                       |
| Length within Development | km   | 0.75                       | 0.75                       |
| Measurement Length      | m          | 665                        | 590                        |
| Critical Defect Length  | mm         | 141                        | 118^1                      |
| Max. Axial hole for “No Rupture” | mm    | 94                         | 79^1                       |
| Distance between MLV’s  | km         | 17                         | 17                         |
| Estimated min. burial depth (locator) | mm | 1.4                     | 1.2                        |
| Coating                |            | Coal tar enamel            | Extruded HDPE             |
| Coating condition       |            | Good                       | Good                       |
| Known Integrity issues  |            | Nil                        | Nil                        |
| Current Location Class (per AS 2885.1) | | R2                      | R2                        |
| Location Class after Development | | T1                        | T1                        |
| Sign Spacing           |            | per R2                     | per R2                     |

Note 1: The relatively conservative wall thickness (for pressure) means that the pressure at which the hoop stress is 30% of specified minimum yield strength is 9.3 MPa. At and below this pressure the energy is insufficient to sustain fast tearing fracture. An MAOP reduction to approximately 13 MPa will extend the critical defect length to approximately that of the MSP.

In addition:

- The ethane pipeline was installed by horizontal directional drilling at crossings of the Hume Highway, the Cataract River and the crossing of the future Maldon - Dumbarton rail crossing. In these locations, the pipeline depth is sufficient to remove the risk of external interference by credible threats.
The MSP will require substantial relocation (by replacement or lowering) should the Maldon - Dumbarton rail be constructed. The development should provide an unencumbered area on the north-west side of the boundary between the development and the rail corridor for construction equipment.

The pipelines are operated from APA’s national control facility. APA maintains an area office for maintenance and service staff at Wilton. Isolation valves at Wilton and Yanderra can be closed remotely in the event of an emergency. Depressurisation following isolation is a manual operation.

Should an event occur that requires depressurisation, the MSP can be depressurised rapidly (over 3-4 hours) from facilities installed at each MLV. The ethane pipeline requires special depressurisation procedures which restrict the time to full depressurisation to several days.

APA will require the coating integrity to be tested using the DCGV method before development commences and again following completion of significant construction. Coating defects identified after construction may require rectification at the developers cost.

APA will require the easement to be delineated prior to construction using a temporary fence. The temporary fence is to be maintained until construction is completed.

APA will require compliance with a number of standard control methods during the development construction, including:

- Approval to Work
- Work Method Statements
- Statement of machine sizes
- Vibration monitoring obligations at nominated locations
- Gas Awareness training for people working within the easement
- Supervision of work at nominated locations (including road crossings)
- Where temporary easement crossings are required for construction equipment, installation of temporary load bearing structures in accordance with Drawing MW97-0144 (Temporary Heavy Vehicle Crossing for Ethane and Natural Gas Pipelines (Typical Vehicle Crossing)).
- Upgrade of pipeline warning signs to reflect the reduced spacing recommended by AS 2885.1 for residential location class.

3.2 **ETHANE PIPELINE – SPECIAL CONDITIONS**

This pipeline transports ethane as a dense phase fluid. In this state the fluid behaves similarly to a high vapour pressure liquid. The critical temperature is 32.2°C and critical pressure is 4.9 MPa.

At 20°C (nominal soil temperature) the fluid behaves as a compressed gas up to a pressure of 3.75 MPa, at which the density is 85.7 kg/m³. At a marginally higher pressure the gas condenses to a liquid with a density of 339.6 kg/m³. Further pressure increase to design pressure of 14.895 MPa increases the density to 417 kg/m³. (Note: These properties vary with the fluid or ground temperature).

When pressure is released (such as at a leak, or deliberately), the fluid is discharged as a liquid. The released liquid rapidly vapourises, to form a heavier than air vapour cloud. At atmospheric pressure residual liquid rapidly cools to a minimum temperature of approximately -88°C.
The consequences of these properties are:

- A pipeline leak will continue for a significantly longer period than an equivalent gas pipeline.
- The released fluid is denser than air, raising the possibility that released fluid forms a potentially explosive dense gas cloud, and that the cloud moves downhill under gravity, transporting the fluid to locations where ignition could cause an unexpected risk.
- Special procedures are required to depressurise the ethane pipeline to manage the low temperature associated with depressurisation, and to safely dispose of the dense, cold gas. The equipment required to manage this takes some time to mobilise, further extending the time to depressurise a pipe section, should this be required to manage a leak.
- The pipeline is less sensitive to fast tearing fracture than it would be if it transported gas at the same pressure because the pseudo liquid will depressurise rapidly to a sustained pressure that reflects the temperature-pressure equilibrium condition.
3.3 **Resistance to Penetration**

Venton calculated the parameters in Table 3-2 according to the methodology of AS2885.1 Appendix M.

<table>
<thead>
<tr>
<th>Tooth Type</th>
<th>“B” Value</th>
<th>CDL (mm)</th>
<th>“No Rupture” Length (mm)</th>
<th>Machine Size to Puncture (t)</th>
<th>Tooth Axial Length (mm)</th>
<th>Rupture or Leak</th>
<th>Puncture Diameter (mm)</th>
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<tr>
<td>MSP</td>
<td>B=1</td>
<td>141</td>
<td>94</td>
<td>&gt;45</td>
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<td>N/A</td>
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<tr>
<td></td>
<td>B=1.3</td>
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<td></td>
<td>&gt;45</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B=1</td>
<td></td>
<td></td>
<td>30</td>
<td>110</td>
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<td>71</td>
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<tr>
<td></td>
<td>B=1.3</td>
<td></td>
<td></td>
<td>25</td>
<td>96</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td></td>
<td>B=1</td>
<td></td>
<td></td>
<td>20</td>
<td>92</td>
<td>L</td>
<td>58</td>
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<tr>
<td></td>
<td>B=1.3</td>
<td></td>
<td></td>
<td>15</td>
<td>82</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Ethane</td>
<td>B=1</td>
<td>118</td>
<td>79</td>
<td>&gt;45</td>
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<td>N/A</td>
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<tr>
<td></td>
<td>B=1.3</td>
<td></td>
<td></td>
<td>45</td>
<td>136</td>
<td>R</td>
<td>118</td>
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<tr>
<td></td>
<td>B=1</td>
<td></td>
<td></td>
<td>40</td>
<td>136</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>B=1.3</td>
<td></td>
<td></td>
<td>25</td>
<td>96</td>
<td>L</td>
<td>62</td>
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<tr>
<td></td>
<td>B=1</td>
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<td></td>
<td>20</td>
<td>92</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>B=1.3</td>
<td></td>
<td></td>
<td>15</td>
<td>82</td>
<td>L</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>B=1</td>
<td></td>
<td></td>
<td>10</td>
<td>70</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Notes:
- B=1 is a factor that is deemed to satisfy the requirements of AS 2885.
- B=1.3 is a factor that is deemed to be required when a “no puncture” condition is required.
- When puncture occurs and the tooth axial length is greater than the CDL rupture will occur. For the purpose of this analysis, a margin of 10% is added to the tooth dimension as a small conservative allowance. *This definition is for assessment purposes only, since it is different from the AS 2885 definition for “no rupture” pipe.*
- N/A means that there is no puncture or leak.
- When puncture occurs the hole diameter is assumed to be the area of the tooth cross section when 50% of the tooth enters the pipe. The hole diameter provides a conservative basis for estimating the associated fluid discharge rate.

Venton calculated the mass flow and energy release rates for nominal hole sizes in the ethane pipeline, using the formulae in Crane handbook for liquid discharge through an orifice. These do not properly reflect the behaviour of dense phase ethane, but are considered to provide a reasonable estimate of the discharge for the purposes of this assessment.

The calculated values are presented in Table 3-3.
<table>
<thead>
<tr>
<th>Hole Diameter (mm)</th>
<th>Mass Flow from 14.9 MPa (kg/s)</th>
<th>Energy flow from 14.9 MPa (GJ/s)</th>
<th>4.7 kW/m² Radiation Contour</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>8.2</td>
<td>0.43</td>
<td>44</td>
</tr>
<tr>
<td>30</td>
<td>75.4</td>
<td>3.9</td>
<td>128</td>
</tr>
<tr>
<td>75</td>
<td>51.9</td>
<td>27.4</td>
<td>340</td>
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</table>

Table 3-3 Energy Release Rate - Ethane
4. WILTON SOUTH EAST PRECINCT DEVELOPMENT

4.1 GENERAL

The Wilton South East Precinct (WSEP) Development involves approximately 3000 lots bounded by Picton Road in the north, and the Maldon-Dumbarton rail corridor to the south (and west). The development is a component of the so-called Wilton New Town project, which will ultimately result in approximately 15,000 residential allotments constructed in each quadrant of the intersection between Picton Road and the Hume Highway, and including commercial, shopping and educational facilities.

To the north, the existing Bingara Gorge development will extend west to the Hume Highway, and south to Picton Road. Currently no residential development is contemplated between the Maldon-Dumbarton rail corridor and the Cataract River – this land will remain as semi-rural location class.

Specific development items include:

- The development is expected to take 15 years to full completion/occupancy.
- The first development stage will be in the western end, including the pipeline easement.
- Approximately 750 metres of pipeline easement is included in the development.
- Education facilities will be located at the eastern end of the development, approximately 2000 metres from the pipeline. The eastern end of the development is a higher elevation than the pipeline easement.
- The development will require Picton Road to be widened to 6 lanes.
- Power will be supplied from the regional substation constructed as part of the Bingara Gorge development on the north side of Picton Road. Residential/Commercial service transformers are expected to be small, and generally installed on land excised from a development block (not on footpaths).
- Sewage will be transferred using rising mains from zone collection pits. No gravity sewers will cross the easement.
- Services will cross the pipeline easement at constructed road crossings.
- No significant cuts will be made to land in the vicinity of the pipeline easement.
- Minor to modest (2 m maximum) filling is expected to be required at road crossings. Fill will be feathered to natural ground level beyond the road crossings.
- Planned roads are at “optimum” locations having regard to access obligations from Picton Road and the landform. This has resulted in 2 crossings being designed to cross the easement at an angle, rather than perpendicular.
- The development will be undertaken in stages. Stage 1 will be to the west of the easement, although planned road crossings will be made as part of the first Stage.
5. **SMS REVIEW WORKSHOP**

5.1 **OBJECTIVE**

The agreed Workshop objective was:

1. To consider the risks associated with the proposed WSEP development to the natural gas and ethane pipelines – and risks from the pipelines to occupiers/users of the development, and identify controls necessary to reduce the risk to a tolerable level.
2. To assess whether the risks are controlled to a level of ALARP in accordance with AS 2885.1 Clause 4.7.4.
3. To provide a basis for APA to agree to the development (with controls).

5.2 **ATTENDEES**

The Workshop was attended by representatives of the Developer and his Engineer, and from APA. Mr Venton of Venton and Associates facilitated the workshop. The attendees are listed in Table 5-1.

A representative from Wollondilly Council joined the Workshop briefly to ask whether there were any issues for Council. He departed shortly thereafter.

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
<th>Representing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phil Venton</td>
<td>Venton and Associates</td>
<td>Facilitator</td>
</tr>
<tr>
<td>Stuart Gander</td>
<td>Walker Corporation</td>
<td>Developer</td>
</tr>
<tr>
<td>Gerry Beasley</td>
<td>Walker Corporation</td>
<td>Developer/Planner</td>
</tr>
<tr>
<td>Carmela Pelaez</td>
<td>BG&amp;E</td>
<td>Developer Engineer</td>
</tr>
<tr>
<td>Ross Larsen</td>
<td>APA</td>
<td>Infrastructure Planning &amp; Protection</td>
</tr>
<tr>
<td>Chris Meades</td>
<td>APA</td>
<td>Pipeline Planning &amp; Protection</td>
</tr>
<tr>
<td>Martin Wong</td>
<td>APA</td>
<td>Mechanical Engineering</td>
</tr>
<tr>
<td>Sean Brokman</td>
<td>APA</td>
<td>Pipeline Operations</td>
</tr>
<tr>
<td>Mark Walker</td>
<td>Qenos/Gorodok</td>
<td>Ethane Pipeline</td>
</tr>
</tbody>
</table>

5.3 **METHODOLOGY**

The Workshop was conducted generally in accordance with the process outlined in AS 2885.1. Recognising that APA has in recent times undertaken SMS’s for residential developments on the north side of Picton Road, and assuming that controls required for the Walker residential development should be similar to those applied north of Picton Road, the Workshop concentrated on specific threats and consequences associated with the Wilton South East Precinct development.

The Workshop was conducted generally to the agenda shown in Table 5-2.
Table 5-2 Attendee List

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Lead Person</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>Facilitator</td>
</tr>
<tr>
<td>2</td>
<td>Project Overview presentation (including schedule)</td>
<td>Walker</td>
</tr>
<tr>
<td>3</td>
<td>Pipeline Design and Current Protection methods</td>
<td>APA</td>
</tr>
<tr>
<td>4</td>
<td>Pipeline integrity issues to be considered (coating, SCC, corrosion, existing flaws etc)</td>
<td>APA</td>
</tr>
<tr>
<td>5</td>
<td>APA minimum requirements (incl. those implemented north of Picton Rd)</td>
<td>APA</td>
</tr>
<tr>
<td>6</td>
<td>Workshop approach</td>
<td>Facilitator</td>
</tr>
<tr>
<td>7</td>
<td>Identify threats and controls, and assess the effectiveness of the controls through 4 headings:</td>
<td>Workshop</td>
</tr>
<tr>
<td></td>
<td>1. Masterplan design (general)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Site Construction phase</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Residential development phase</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Residential occupation phase</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Identify additional controls and where necessary, additional actions to reduce risk to “accepted”</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Risk Assess one or more “all controls fail” scenarios in each phase of the project</td>
<td>Workshop</td>
</tr>
<tr>
<td>9</td>
<td>Consider whether “controlled” risk satisfies the objective of AS 2885.1 Clause 4.7.4 (and determine whether a high-level workshop assessment is adequate – or whether a formal study is needed)</td>
<td>Workshop</td>
</tr>
<tr>
<td>7</td>
<td>Review workshop outcomes and reach a conclusion on whether the Development can proceed</td>
<td>Venton All Workshop Participants</td>
</tr>
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</table>

5.4 SUPPORTING DOCUMENTATION

In preparation for the Workshop documentation was provided by each of the participants to provide background on the development and the Licensee expectations in preparation for the Workshop.

Venton provided:

- An SMS record spreadsheet “APA - Safety Management Study - Walker Development - Wilton South East Precinct” identifying threats, controls and a preliminary risk assessment developed by Venton. This document formed the basis for the Workshop.
- Calculations of critical defect length and penetration resistance to AS 2885.
- A Draft Agenda.

Walker provided:

- Masterplan Layout and Gas Easement.pdf.
- Drawing 20170630_Wilton South East Precinct Current Layout.
5.5 THREAT ASSESSMENT – LAND USE CHANGE ASSESSMENT

The Workshop did not specifically determine the threats against which the pipelines were to be assessed for compliance with AS 2885, and in particular the high consequence area threats. Subsequent to the Workshop, Venton developed the following assessment using experience derived from a number of SMS studies involving residential development.

5.5.1 Commonly Adopted Excavator Threats

In semi-rural land that is not subjected to unusual threat activity, Licensee’s typically advise that the design threat should be a 30-35 tonne excavator equipped with twin pointed “tiger” teeth.

The assessment in Table 3-2 indicates that:

- each pipeline is expected to resist puncture from machines of this size, fitted with tiger teeth.
- each pipeline should resist puncture from smaller (20-25 tonne) machines fitted with single pointed ‘penetration’ teeth.

Experiments undertaken by Agility using 9.5 mm thick lower strength (X42) pipe reasonably support this assessment.

In residential land that is not subjected to unusual threat activity, Licensee’s typically advise that the design threat should be a 15-20 tonne excavator equipped with twin pointed “tiger” teeth. The smaller excavator threat recognises the fact that it is impractical (and unnecessary) to use large machines in residential areas for general excavation work (machines in the 5-10 t range are most often used).

5.5.2 SMS Threat

The excavator threat during the construction phase was assessed as:
• A 35t excavator fitted with tiger teeth, used for excavations associated with construction of the slab protection for the road crossings.
• A 10 t excavator fitted with tiger teeth, used for excavations associated with mechanical protection slabs.

The excavator threat during the residential phase was assessed as a 20 t excavator fitted with tiger teeth used for unauthorised excavation within the easement. **Table 3-2** indicates that each pipeline should reasonably resist penetration from these threats.

### 5.5.3 Mechanical Protection

The Workshop relied on advice from APA on the design of mechanical protection required to remove the risk of excavator damage to either pipeline. APA advised that their preferred protection is a reinforced concrete slab in accordance with Standard Drawing MW97-0144 (Temporary Heavy Vehicle Crossing for Ethane and Natural Gas Pipelines). This slab is 250 mm thick and extends approximately 1 metre on either side of the pipeline.

A concrete slab in accordance with this drawing is expected to be effective in preventing external interference to the pipeline from excavator, vertical boring and similar threats.

APA also advised that it has recently demonstrated that “heavy” polyethylene sheeting is as effective as concrete slabs, and it is more convenient to manage should it be necessary to remove it for pipeline maintenance. Unfortunately specific details were not provided to the Workshop.

The “heavy” polyethylene protection should be considered as an alternative to concrete slabs, subject to APA’s specification, and approval.

### 5.6 Mandatory Mechanical Protection

The topic was discussed under Agenda Item 5 (APA minimum requirements [incl. those implemented north of Picton Rd]). In that discussion APA advised that they had no mandatory requirements for the pipeline protection.

Notwithstanding this, toward the end of the Workshop, APA advised that they would require each pipeline to be protected against external interference for the length subjected to land use change AND for 1 measurement length north and south of the development. **Figure 5-1** illustrates the extent of the MSP measurement length for the new and existing residential developments.

The protection required is a concrete slab complying with Standard Drawing MW97-0144 (Temporary Heavy Vehicle Crossing for Ethane and Natural Gas Pipelines). APA advised that this requirement would provide the same level of external interference protection as applied to the pipelines in the Bingara Gorge residential area.

The Workshop noted that the Bingara Gorge residential development has changed the land use (within 1 measurement length on either side of the pipelines) to location class T1 practically to Picton Road, and consequently the absence of APA’s “mandated” protection on the north side of Picton Road means that the pipeline does not currently comply with the provision of AS 2885 in this location.

While the Workshop accepted that mechanical protection should be applied, the commercial responsibility for protection on the north side of Picton Road was not resolved.

Note: While the Workshop nominated reinforced concrete mechanical protection, it is recommended that the APA specified “heavy” polyethylene sheeting be considered, for both operational and cost reasons.
Figure 5-1  Location Class Assessment Area per AS 2885
6. WORKSHOP FINDINGS

6.1 GENERAL
The Workshop concluded that the risks to the pipelines could be controlled to the level required for high pressure pipelines installed in residential areas. The primary control is barrier protection applied over each pipeline to reduce the likelihood of a threat capable of puncturing either pipeline from contacting the pipeline. A number of other controls to address other threats were identified.

Each additional control was nominated as an action. Each action is required to be completed prior to work commencing.

6.2 FINDINGS THAT AFFECT THE SITE PLAN
The SMS first considered the control of threats associated with the site master plan, and specifically, threats associated with the development design in proximity to the pipeline easement.

Thirteen (13) actions were identified. Of these:

- No change to the development design was required.
- A portion of land is required to be preserved from development on the west side of the easement abutting the north side of the Maldon-Dumbarton rail corridor. This land is considered necessary to provide working space for APA to lower the MSP, should the rail construction proceed. The action on APA is to advise the dimensions or the parcel, while the corresponding action on Walker is to modify the development plan to provide this space.

  Note: The Workshop did not discuss the possibility of the land being returned to residential use once the construction activity is completed. However, Walker should provide for this possibility.

- Mechanical protection of both pipelines was required for the length of the development, and 1 measurement length on either side of the development. It is noted that:
  - The land use on the north side of Picton Road is currently residential (T1). Because of this, mechanical protection for the pipelines according to the methods used for Bingara Gorge development should be installed by APA irrespective of the status of the WSEP.
  - The ethane pipeline was installed by HDD from the Hume Highway to north of the Maldon-Dumbarton rail corridor. Mechanical protection for it terminates at the rail corridor.

The remaining actions are essentially procedural, and have minimal impact on the project cost.

6.3 FINDINGS THAT AFFECT THE SITE CONSTRUCTION
The Workshop considered threats to the pipeline associated with construction activities of the development (earthworks, road construction, utilities installation, landscaping and similar). Most of these threats are generic, reflecting issues that typically arise from a development of this type.

Eleven (11) actions were identified. None of the actions impact on the design of the development. Rather they identify procedural controls, or design check items that represent good practice.

6.4 FINDINGS THAT EXIST DURING RESIDENTIAL CONSTRUCTION
The Workshop considered threats to the pipeline (and from the pipeline to the community) that may arise from multiple building and services contractors accessing the site during the residential construction phase of the development.
Four (4) actions were identified under this category. None of the actions impact on the design of the development. Rather they identify procedural controls, or design check items that represent good practice.

6.5 **FINDINGS THAT AFFECT THE FUTURE OF THE DEVELOPED SITE**

The Workshop considered threats to the pipeline (and from the pipeline to the community) that are expected to occur throughout the foreseeable life of the development and the pipelines. During this phase, the pipelines are expected to be exposed to only minor threats because the activities are expected to be limited to road and services maintenance, and development of constructed residences. Moreover, the pipeline easement will be well marked, and APA’s community liaison program will inform the community of the presence of the pipelines.

One (1) action was identified, to develop a MOU with Council to ensure that APA is notified of any development or maintenance activity of which Council is aware, and which has the potential to impact on pipeline safety.

6.6 **ALL CONTROLS FAIL**

AS 2885.1 includes an obligation for each SMS to consider events that may occur should *all controls fail*.

The philosophy behind pipeline safety is that a number of physical and procedural controls are applied along the pipeline, each of which is either effective, or contributes to the effectiveness of controlling threats to the pipeline.

The *all controls fail* obligation provides a sense check that challenges the SMS findings (which usually conclude that controls are effective). Its purpose is to provide an assessment of the possible consequences of a threat which for some reason manages to escape the threat controls.

Venton proposed the assessment consider:

**Case 1:** A 10 mm diameter hole in either pipeline, resulting in an extended leak of the contained fluid, with subsequent ignition of the released fluid. A leak of this size is possible from an unidentified corrosion pit.

For this Case, the risk is assessed as *negligible* because:

- The radiation contour is modest (24 and 40 m to 4.7 kW/m²) for the gas and ethane pipelines respectively.
- Each pipeline is properly protected against external corrosion and is inspected periodically to identify corrosion using appropriate in-line technology.

**Case 2:** A 30 mm diameter hole in either pipeline, resulting in an extended leak of the contained fluid, with subsequent ignition of the released fluid. A hole of this size is a possible consequence of impact by an excavator of sufficient size to puncture the pipeline, and used with modest aggression. The hole is smaller than the critical defect and growth to rupture is not possible.

For this Case, the risk is assessed as *low* for each pipeline because:

- Each pipeline will be provided with barrier protection that will protect the pipeline from external interference threats. The consequence could only occur if the perpetrator worked recklessly to break the barrier and continue without care to the pipeline.
- The 4.7 kW/m² radiation contours were assessed as 112 m and 128 m for the gas and ethane pipeline respectively. The consequence of this event was assessed as *major*, but the barrier protection means that threat is scarcely credible.
Case 3: A 75 mm diameter hole in either pipeline resulting in an extended leak of the contained fluid, with subsequent ignition of the released fluid. A hole of this size is a possible consequence of an aggressive and extended impact by a HDD. Again, the hole size is smaller than the critical defect length of each pipeline and growth to rupture is not possible.

For this Case, the risk is assessed as *intermediate*, a result of *hypothetical* frequency and *catastrophic* consequence. This risk level was accepted because:

The 4.7 kW/m² radiation consequence distance is 185 m for the gas pipeline, and 340 m for the ethane pipeline. In a residential area, ignition of either plume will cause radiation levels that are likely to result in multiple fatalities, and significantly impact on supply.

The soil conditions in the WSEP area are expected to require HDD’s to use tools designed for rock or similar “hard” materials, and this environment will provide support to the drill string that will restrict its ability to deflect around the circumference of the MSP, and hence puncture is a likely consequence. The drill bit will probably deflect around the small diameter ethane pipeline, further reducing the frequency of an event that punctures the pipeline.

This risk level was accepted with management procedures because:

- Threats from HDD’s exist for all buried structures, particularly linear structures like pipelines. APA has procedures to manage this threat in all locations and these will be applied within the WSEP development.

- While in some locations where the likelihood of undetected HDD’s is higher concrete barrier protection may be used, it is difficult to justify in locations where there is no basis for increased frequency such as the WSEP.

- The likelihood of the threat actually existing largely controlled by the design and installation of services crossing the pipelines as part of the development phase. While it is not impossible for HDD’s to be required throughout the life of the development, it is expected that these will be planned and implemented with APA’s authorisation, and in accordance with APA’s requirements.
7. FUTURE

This SMS provides the basis for APA to advise authorities that they have no objections to the development consent subject to all actions being implemented, assessed and closed off prior to the development work commencing. This includes the various obligations for work in the vicinity of pipelines required by APA.

The SMS Worksheet provides space for the action to be described, for it to be assessed and if necessary an additional action implemented, and acceptance of the action. It is recommended that this, or an equivalent document is used for this purpose.

APA should review this site-specific SMS and transfer any relevant threats / actions to the SMS for each pipeline to ensure that they are retained for future reassessment in the periodic SMS revision required by AS 2885.
APPENDIX 1

Development Drawings
1. DIMENSIONS ARE IN MILLIMETRES
2. CONCRETE EXPOSURE CLASSIFICATION A2
3. CONCRETE MIX SHALL BE IN ACCORDANCE WITH RMS SPECIFICATION B80 ANNEXURE E, WITH A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 40MPa
4. MINIMUM COMPRESSIVE STRENGTH OF BLINDING LAYER SHALL BE 20MPa
NOTES

1. THIS IS ONLY A TYPICAL DRAWING. APA ENGINEERING MAY REQUIRE ADDITIONAL MEASURES DUE TO SITE CONDITIONS.
2. DOUBLE MARKER OFFSET SIGNS REQUIRED
   2.1. DANGER PLATE S98-12-3
   2.2. MARKER INSTALLATION S98-11-3
   2.3. OFFSET MARKER S98-9-2
   2.4. LOCATION FOR ONLINE MARKER POSTS S13-09-2
3. COMPACTED ROAD BASE RAMP OVER CONCRETE SLAB DEPTH OF ROAD BASE TO BE 250mm ABOVE SLAB
4. EXCAVATE 250mm OF TOPSOIL, CONCRETE INSTUT CAST CONCRETE SLAB CAST INSTUT 250mm THICK 20Mpa. MINIMUM 1 LAYER SLAB MESH PLACED CENTRALLY. CURING DURATION & COMPRESSION STRENGTH SHALL BE ASSESSED TO BE SATISFACTORY BY THE INSTALLATION/CONSTRUCTION SUPERVISOR. FOR APPROVAL BEFORE READY FOR STARTUP OPERATIONS.
5. FENCE TO BE INSTALLED IF NONE EXISTS TO ENSURE VEHICLE CROSSING IS USED AT ALL TIMES. REFER S92-10-6

SECTION A
APPENDIX 2

Land Use Change ALARP Assessment
# A2 GENERAL

Clause 4.7.4 of AS 2885.1 requires an assessment of at least 5 alternatives that could reduce the risk in locations where land use has changed from that for which the pipeline was designed, to a more demanding land use.

The alternatives considered in the assessment are required to be compared using the As Low As Reasonably Practicable (ALARP) methodology nominated in AS 2885. The definition is: The measure of whether ALARP has been achieved is if the cost of reducing the risk is grossly disproportionate to the benefit gained. The reduction in risk has to be insignificant when compared to the cost required.

The alternative chosen to control risk to the standard required for the new location class must demonstrate that it is ALARP.

The Workshop conducted a subjective ALARP assessment, which is documented in Section 6 of the SMS Record spreadsheet.

The Workshop noted that each pipeline practically satisfies the high consequence area obligations (no rupture and energy release rate ≤ 10 GJ/s) for the threats to which there is a reasonable likelihood of the pipelines being exposed in a residential area because of the conservative wall thickness of each pipeline.

Table A2-1 summarises the ALARP assessment. The assessment notes that the existing pipelines practically satisfy the residential (T1) location class obligations because of their wall thickness. However previous assessments by APA as part of the Bingara Gorge development considered that mechanical protection of each pipeline offered a significant risk reduction for a modest capital cost. The route identified for relocation of the pipelines is shown in Figure A2-1.

The costs of the other alternatives considered is 10+ times the cost or mechanical and procedural methods to achieve essentially the same risk reduction. Accordingly, the mechanical and procedural protection solution is considered to satisfy ALARP criteria, and it should be implemented.

<table>
<thead>
<tr>
<th>Risk Reduction Method</th>
<th>Risk Reduction provided</th>
<th>Assessed Cost</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do Nothing</td>
<td>Nil – Existing risk is nearly tolerable</td>
<td>Nil</td>
<td>Arguable that the existing pipelines satisfy no rupture and energy release rate for identified threats, but inconsistent with the risk reduction methods considered necessary for the Bingara Gorge development.</td>
</tr>
<tr>
<td>MAOP Reduction</td>
<td>Modest. It will reduce the radiation consequence distance for a given hole.</td>
<td>If each pipeline was fitted with MOP limiter, the cost is in the order of $10-15 million. If MAOP limiting facility was installed (duty/standby devices), the cost is likely to be in the order of $10-15 million.</td>
<td>The MSP currently operates at 60-70% of MAOP, in part a result of the distance from the Young compressor station. The ethane pipeline currently operates at a lower pressure.</td>
</tr>
</tbody>
</table>
### Table A2-1 ALARP Assessment Land Use Change

<table>
<thead>
<tr>
<th>Risk Reduction Method</th>
<th>Risk Reduction provided</th>
<th>Assessed Cost</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase the tolerable hole size for “no rupture”</td>
<td>to be in the order of $20 million</td>
<td>pressure lower than MAOP for the same reason.</td>
<td>Pipe replacement was not considered necessary in the Bingara Gorge development</td>
</tr>
<tr>
<td>Pipe Replacement</td>
<td>Risk Eliminated</td>
<td>The cost to replace both pipelines in the affected area is expected to be in the range of $10-14 million</td>
<td>Pipe replacement was not considered necessary in the Bingara Gorge development</td>
</tr>
<tr>
<td>Pipe Relocation</td>
<td>Risk Eliminated</td>
<td>Relocation of both pipelines along the south and east side of the development, and then north to the Wilton Gate station is approximately 6 km. The estimated cost for both pipelines is $19-24 million</td>
<td>Most costly option, but will resolve MSP crossing of the Maldon-Dumbarton rail, and resolve pipeline safety issues between the rail and Wilton Gate station.</td>
</tr>
<tr>
<td>Modify Land Use</td>
<td>N/A</td>
<td></td>
<td>Land use change is impractical.</td>
</tr>
<tr>
<td>Mechanical Protection and Procedural Controls</td>
<td>External interference threat is controlled. Risk reduced to low</td>
<td>Cost for both pipelines is estimated to be $2.6 million. This includes treatment of the affected easement and 125 m north of Picton Rd, and for the MSP, the distance to the Cataract River</td>
<td>This method is already assessed by APA as being ALARP for the pipeline in the Bingara Gorge development. The cost may be reduced if APA’s heavy polyethylene matting is used. The ethane pipeline is protected south from the Maldon-Dumbarton rail corridor by depth of cover, achieved by HDD. The cost to treat 665 metres of pipeline north of Picton Rd is approximately $1.6 million. APA/Walker to negotiate to determine responsibility for this work.</td>
</tr>
</tbody>
</table>
Figure A2-1 Pipeline Relocation Option (Blue Line)
APPENDIX 3

SMS Record
### APA - Safety Management Study - Walker Development - Wilton South East Precinct

#### 6.9 MPa

<table>
<thead>
<tr>
<th>Diameter</th>
<th>944 mm</th>
<th>Steel Grade</th>
<th>805-445 MPA Yield Stress</th>
<th>Critical Defect</th>
<th>Hoop Stress at MAOP</th>
<th>70% % of SMYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Thickness</td>
<td>9.2 MAOP</td>
<td>Initiation Toughness</td>
<td>Hoop Stress at Operating Press.</td>
<td>40-70</td>
<td>% of SMYS</td>
<td></td>
</tr>
<tr>
<td>Measurement Length</td>
<td>665 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 14.895 MPa

<table>
<thead>
<tr>
<th>Diameter</th>
<th>219.1 mm</th>
<th>Steel Grade</th>
<th>805-414 MPA Yield Stress</th>
<th>Critical Defect</th>
<th>Hoop Stress at MAOP</th>
<th>49.3 % of SMYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Thickness</td>
<td>8.1 MAOP</td>
<td>Initiation Toughness</td>
<td>Hoop Stress at Operating Press.</td>
<td>25-49</td>
<td>% of SMYS</td>
<td></td>
</tr>
<tr>
<td>Measurement Length</td>
<td>590 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Wall Thickness

**Measurement Length**: 665 m

- **Diameter**: 219.1 mm
- **Steel Grade**: X60
- **414 MPa Yield Stress**

#### Critical Defect

- **118 mm Hoop Stress at MAOP**

#### Initiation Toughness

- **25-49.3 % of SMYS**

#### Ethane

- **Pressure for hoop stress**: 30% SMYS
- **9.3 MPa**
- **Initiation Toughness**: 
- **Hoop Stress at Operating Press.**: 25-49.3 % of SMYS

#### Diameter

- **219.1 mm**
- **Steel Grade**: X60
- **414 MPa Yield Stress**

### Development Masterplan Issues

<table>
<thead>
<tr>
<th>Item</th>
<th>Pipeline Threat</th>
<th>Credible</th>
<th>Prevention by Design and/or Procedures</th>
<th>Failure mode if controls fail</th>
<th>Hazardous Event</th>
<th>Comments</th>
<th>Frequency</th>
<th>Severity</th>
<th>Risk</th>
<th>Actions</th>
<th>Action No.</th>
<th>Resp. Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Road crossings &lt; 2 dual carriageway and 1 single. External elect and external interference threat</td>
<td>Yes</td>
<td>Crossing designed and constructed to APA equipment. Construction supervised by APA. Use of APA Standard Drawing S-C-039-01</td>
<td>Design effective in controlling failure risk</td>
<td>No</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td><strong>AHA</strong></td>
<td>1</td>
<td>Walker (DB)</td>
</tr>
<tr>
<td>2</td>
<td>Where two pipelines cross at ±45° to pipelines - APA prefers close to 90° threat pipeline may need to be located in future, external roads and interference</td>
<td>Yes</td>
<td>Crossing designed and constructed to APA equipment. Construction supervised by APA. Use of APA Standard Drawing S-C-039-01</td>
<td>Design effective in controlling risk</td>
<td>No</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td><strong>AHA</strong></td>
<td>2</td>
<td>Walker (APA)</td>
</tr>
<tr>
<td>3</td>
<td>Sensitive Developments in measurement length</td>
<td>No</td>
<td>Standard wall thickness and burial depth</td>
<td>Other open spaces identified on the plan are &lt;10% and do not require consideration as sensitive areas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>AHA</strong></td>
<td>3</td>
<td>Walker</td>
</tr>
<tr>
<td>4</td>
<td>Potentially Sensitive Developments in measurement length</td>
<td>Yes</td>
<td>Standard wall thickness and burial depth</td>
<td>Block to 10 GJ</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>HDD Threats from services installation</td>
<td>Yes</td>
<td>Both pipelines are currently slotted and approved to location classification R2.</td>
<td>Additional protection must satisfy no rupture and energy release rate requirements of AS 2885 (Clause 7.2.7 and 7.2.3), and ALARP study (Clause 4.7.4).</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td><strong>AHA</strong></td>
<td>5</td>
<td>APA</td>
</tr>
</tbody>
</table>

### Actions

1. **Controls identified to be transferred to OCP**
2. **Detailed design to be approved by APA and specific construction controls issued.**
3. **Enhanced design may be required because of oblique crossing**
4. **Define sensitive land use per Hazards SEPP & having consideration of AS 2885.**
5. **Flood risk assessment required - see Action 6**
6. **ALARP report to be reviewed by APA, Facilitator, Participants and each to agree.**

### APA, Facilitator, Participants See Assessment at end of spreadsheet and in the report

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**Prepared by Venton and Associates**

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13/11/2017
**APA - Safety Management Study - Walker Development - Wilton South East Precinct**

**Diameter 864 mm Steel Grade X65 448 MPa Yield Stress Critical Defect 141 mm Hoop Stress at MAOP 72 % of SMYS 6.9 MPa Initiation Toughness**

**Wall Thickness 9.2 MAOP**

**Diameter 219.1 mm Steel Grade X60 414 MPa Yield Stress Critical Defect 118 mm Hoop Stress at MAOP 49.3 % of SMYS 14.895 MPa Initiation Toughness**

**Wall Thickness 8.1 MAOP**

**Ethane**

**Measurement Length 590 m Pressure for hoop stress 30% SMYS 9.3 MPa**

**Action Item Pipeline Threat Credible Prevention by Design and/or**

**External Interference**

**Failure mode if Hazardous**

**Comments**

**Frequency Severity Risk Actions**

**Action No. Resp. Person**

---

7 Both Changed isolation Valve Spacing Yes Nil

**Diameter 864 mm Steel Grade X65 448 MPa Yield Stress Critical Defect 141 mm Hoop Stress at MAOP 72 % of SMYS 6.9 MPa Initiation Toughness**

**Wall Thickness 9.2 MAOP**

**Ethane**

**Measurement Length 590 m Pressure for hoop stress 30% SMYS 9.3 MPa**

**Action Item Pipeline Threat Credible Prevention by Design and/or**

**External Interference**

**Failure mode if Hazardous**

**Comments**

**Frequency Severity Risk Actions**

**Action No. Resp. Person**

---

8 Both Future threat - Martin Dumbarton rd Yes N/A

**Diameter 864 mm Steel Grade X65 448 MPa Yield Stress Critical Defect 141 mm Hoop Stress at MAOP 72 % of SMYS 6.9 MPa Initiation Toughness**

**Wall Thickness 9.2 MAOP**

**Ethane**

**Measurement Length 590 m Pressure for hoop stress 30% SMYS 9.3 MPa**

**Action Item Pipeline Threat Credible Prevention by Design and/or**

**External Interference**

**Failure mode if Hazardous**

**Comments**

**Frequency Severity Risk Actions**

**Action No. Resp. Person**

---

9 Both Residential site and easement boundary threat from southern pipeline Yes Depth of cover >750 mm strength effectively protects against nodal external force

**Ethane**

**Measurement Length 590 m Pressure for hoop stress 30% SMYS 9.3 MPa**

**Action Item Pipeline Threat Credible Prevention by Design and/or**

**External Interference**

**Failure mode if Hazardous**

**Comments**

**Frequency Severity Risk Actions**

**Action No. Resp. Person**

---

10 Both Road cut (Easement boundary) threat from northern pipeline Yes Depth of cover >750 mm strength effectively protects against nodal external force

**Ethane**

**Measurement Length 590 m Pressure for hoop stress 30% SMYS 9.3 MPa**

**Action Item Pipeline Threat Credible Prevention by Design and/or**

**External Interference**

**Failure mode if Hazardous**

**Comments**

**Frequency Severity Risk Actions**

**Action No. Resp. Person**

---

11 Both Threat to people from pipeline damage 1 measurement length north or south of development No Existing installation and existing procedures

**Ethane**

**Measurement Length 590 m Pressure for hoop stress 30% SMYS 9.3 MPa**

**Action Item Pipeline Threat Credible Prevention by Design and/or**

**External Interference**

**Failure mode if Hazardous**

**Comments**

**Frequency Severity Risk Actions**

**Action No. Resp. Person**

---

12 Both Failure of either pipeline within 1 measurement length north or south of the development from a pre-existing pipeline condition Yes N/A

**Ethane**

**Measurement Length 590 m Pressure for hoop stress 30% SMYS 9.3 MPa**

**Action Item Pipeline Threat Credible Prevention by Design and/or**

**External Interference**

**Failure mode if Hazardous**

**Comments**

**Frequency Severity Risk Actions**

**Action No. Resp. Person**

---

13 MSP Coating degradation - maintenance appropriate in new subdivision Yes N/A

**Ethane**

**Measurement Length 590 m Pressure for hoop stress 30% SMYS 9.3 MPa**

**Action Item Pipeline Threat Credible Prevention by Design and/or**

**External Interference**

**Failure mode if Hazardous**

**Comments**

**Frequency Severity Risk Actions**

**Action No. Resp. Person**

---

14 Both Future extension of development south and west (beyond proposed rail) Yes Increased wall thickness and burial depth

**Ethane**

**Measurement Length 590 m Pressure for hoop stress 30% SMYS 9.3 MPa**

**Action Item Pipeline Threat Credible Prevention by Design and/or**

**External Interference**

**Failure mode if Hazardous**

**Comments**

**Frequency Severity Risk Actions**

**Action No. Resp. Person**

---

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### APA - Safety Management Study - Walker Development - Wilton South East Precinct

**MSP**

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Wall Thickness</th>
<th>Steel Grade</th>
<th>MAOP</th>
<th>Int. Toughness</th>
<th>MAOP</th>
<th>Hoop Stress at MAOP</th>
<th>Critical Defect</th>
<th>Pressure for hoop stress</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>384 mm</td>
<td>9.2 mm</td>
<td>X60</td>
<td>6.9 Mpa</td>
<td>219.1 mm</td>
<td>414 Mpa</td>
<td>49.3 % of SMYS</td>
<td>118 mm</td>
<td>9.2 MPA</td>
<td>APA could consider dispensation from load Limits during construction</td>
</tr>
</tbody>
</table>

**Ethane**

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Wall Thickness</th>
<th>Steel Grade</th>
<th>MAOP</th>
<th>Int. Toughness</th>
<th>MAOP</th>
<th>Hoop Stress at MAOP</th>
<th>Critical Defect</th>
<th>Pressure for hoop stress</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>219.1 mm</td>
<td>8.1 mm</td>
<td>X60</td>
<td>6.9 Mpa</td>
<td>219.1 mm</td>
<td>414 Mpa</td>
<td>49.3 % of SMYS</td>
<td>118 mm</td>
<td>9.2 MPA</td>
<td>APA could consider dispensation from load Limits during construction</td>
</tr>
</tbody>
</table>

### Phase 2 - Land Development Phase

#### 2.01 External loads from unauthorized construction equipment causing coating damage

15 Both

- Increased wall thickness and burial depth through the affected area

- Pipeline stress exceeds allowable
- No credible pipeline failure mode
- Possible damage to MSP coating

- Failure mode if controls fail: Pipeline stress exceeds allowable
- No need for controls
- Critical defect: 118 mm
- Hoop stress at MAOP: 49.3 % of SMYS
- APA could consider dispensation from load Limits during construction

#### 2.02A MSP

- Increased wall thickness and burial depth through the affected area
- Pipeline stress exceeds allowable
- No need for controls
- Critical defect: 118 mm
- Hoop stress at MAOP: 49.3 % of SMYS
- APA could consider dispensation from load Limits during construction

#### 2.02B Ethane

- Increased wall thickness and burial depth through the affected area
- Pipeline stress exceeds allowable
- No need for controls
- Critical defect: 118 mm
- Hoop stress at MAOP: 49.3 % of SMYS
- APA could consider dispensation from load Limits during construction

#### 2.03A MSP

- Increased wall thickness and burial depth through the affected area
- Pipeline stress exceeds allowable
- No need for controls
- Critical defect: 118 mm
- Hoop stress at MAOP: 49.3 % of SMYS
- APA could consider dispensation from load Limits during construction

#### 2.03B Ethane

- Increased wall thickness and burial depth through the affected area
- Pipeline stress exceeds allowable
- No need for controls
- Critical defect: 118 mm
- Hoop stress at MAOP: 49.3 % of SMYS
- APA could consider dispensation from load Limits during construction

#### 2.04A MSP

- Increased wall thickness and burial depth through the affected area
- Pipeline stress exceeds allowable
- No need for controls
- Critical defect: 118 mm
- Hoop stress at MAOP: 49.3 % of SMYS
- APA could consider dispensation from load Limits during construction

#### 2.04B Ethane

- Increased wall thickness and burial depth through the affected area
- Pipeline stress exceeds allowable
- No need for controls
- Critical defect: 118 mm
- Hoop stress at MAOP: 49.3 % of SMYS
- APA could consider dispensation from load Limits during construction

#### 2.05 Both

- Increased wall thickness and burial depth through the affected area
- Pipeline stress exceeds allowable
- No need for controls
- Critical defect: 118 mm
- Hoop stress at MAOP: 49.3 % of SMYS
- APA could consider dispensation from load Limits during construction

#### 2.06 Both

- Increased wall thickness and burial depth through the affected area
- Pipeline stress exceeds allowable
- No need for controls
- Critical defect: 118 mm
- Hoop stress at MAOP: 49.3 % of SMYS
- APA could consider dispensation from load Limits during construction

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## APA - Safety Management Study - Walker Development - Wilton South East Precinct

### Diameters

<table>
<thead>
<tr>
<th>Item</th>
<th>Pipeline Threat</th>
<th>Credible Threat?</th>
<th>External Interference</th>
<th>Prevention by Design and/or Procedures</th>
<th>Failure mode if controls fail</th>
<th>Failure Analysis Required?</th>
<th>Hazards/Event?</th>
<th>Comments</th>
<th>Frequency</th>
<th>Severity</th>
<th>Risk</th>
<th>Actions</th>
<th>Action No.</th>
<th>Resp. Person</th>
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</thead>
<tbody>
<tr>
<td>2.07</td>
<td>Both</td>
<td>No</td>
<td>NA</td>
<td>Earthworks design - Pipe excavation</td>
<td>No</td>
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<td>Yes</td>
<td>1</td>
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<td>APA</td>
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<tr>
<td>2.09</td>
<td>Pipeline damage (displacement following loading) resulting from inadequately stabilised batter in cut areas</td>
<td>No</td>
<td>NA</td>
<td>Earthworks design - Pipe excavation</td>
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<td>No</td>
<td>APA advise overmatching assessment not needed</td>
<td>&quot;May not be a credible threat. Workshop supports this conclusion.&quot;</td>
<td>*</td>
<td>*</td>
<td>6</td>
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<tr>
<td>2.10</td>
<td>Pipeline damage (displacement following loading) resulting from inadequately stabilised batter in cut areas</td>
<td>Yes</td>
<td>Pipeline cover</td>
<td>Earthworks design - Pipe excavation</td>
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<td>No</td>
<td>No</td>
<td>APA advise overmatching assessment not needed</td>
<td>&quot;May not be a credible threat. Workshop supports this conclusion.&quot;</td>
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<td>*</td>
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<tr>
<td>2.11</td>
<td>Erosion resulting from runoff concentrating in drains where fill is placed</td>
<td>Yes</td>
<td>Cover Pipeline wall thickness</td>
<td>Earthworks design - Pipe excavation</td>
<td>Low</td>
<td>No</td>
<td>No</td>
<td>APA advise overmatching assessment not needed</td>
<td>&quot;May not be a credible threat. Workshop supports this conclusion.&quot;</td>
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<td>2.12</td>
<td>Pipeline damage (displacement following loading) resulting from inadequately stabilised batter in cut areas</td>
<td>No</td>
<td>NA</td>
<td>Earthworks design - Pipe excavation</td>
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<td>No</td>
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<td>APA advise overmatching assessment not needed</td>
<td>&quot;May not be a credible threat. Workshop supports this conclusion.&quot;</td>
<td>*</td>
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<td>6</td>
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</table>

### Critical Defects

- Diameter: 864 mm
- Steel Grade: X65
- Yield Stress: 448 MPa
- Critical Defect: 141 mm
- Hoop Stress at MAOP: 6.9 MPa (72% of SMYS)

- Diameter: 219.1 mm
- Steel Grade: X60
- Yield Stress: 414 MPa
- Critical Defect: 118 mm
- Hoop Stress at MAOP: 14.895 MPa (49.3% of SMYS)

### Erosion Control

- Pipeline wall thickness
- Erosion control analysis
- Pipeline stability analysis

### Actions

- Thresh Excavation across a pipeline with impact on the pipeline
- Yes
- Cover Pipeline wall thickness
- Crossing will be at designated locations and construction of an approved design, under APA supervision.

### Environmental Controls

- Land development across easement
- No drainage will be constructed from roadway crossings
- No service roads extend to the pipeline
- See Threats #12 & #13

### Lighting

- Road Construction alongside a pipeline
- Installation of power and lighting poles
- See Threats #11 & #12

### Retention Pond Excavation

- No drainage will be constructed from roadway crossings
- No service roads extend to the pipeline
- See Threats #11 & #12

### No Additional Intended Excavations

- No additional intended excavations at cuts that extend into the easement
- Installation of power and lighting poles
- See Threats #11 & #12

---

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### APA - Safety Management Study - Walker Development - Wilton South East Precinct

**Diameter 864 mm Steel Grade X65 448 MPa Yield Stress Critical Defect 141 mm Hoop Stress at MAOP 72% of SMYS 6.9 MPa**

**Wall Thickness 9.2 MAOP MSP**

**Measurement Length 665 m**

**Diameter 219.1 mm Steel Grade X60 414 MPa Yield Stress Critical Defect 118 mm Hoop Stress at MAOP 49.3% of SMYS**

**Wall Thickness 8.1 MAOP Ethane**

**Measurement Length 590 m Pressure for hoop stress 30% SMYS 9.3 MPa**

### Items

<table>
<thead>
<tr>
<th>Item</th>
<th>Pipeline</th>
<th>Threat</th>
<th>Credits</th>
<th>Title</th>
<th>Event</th>
<th>Failure mode if controls fail</th>
<th>Failure Analysis Required</th>
<th>Hazards</th>
<th>Event</th>
<th>Comments</th>
<th>Frequency</th>
<th>Severity</th>
<th>Risk</th>
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<th>Action No.</th>
<th>Resp. Person</th>
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<tbody>
<tr>
<td>2.21</td>
<td>Both</td>
<td>Unintentional excavations at work that could damage to the easement surface</td>
<td>Yes</td>
<td>Damage is to the easement but not to the pipeline</td>
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<td>2.22</td>
<td>Both</td>
<td>Transformer near fault with earth potential rise affecting pipeline</td>
<td>Yes</td>
<td>Transformers located within the lot. Council don’t permit installation within road reserve.</td>
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<tr>
<td>2.23</td>
<td>Both</td>
<td>Stay current corrosion / cooling damage</td>
<td>Yes</td>
<td>Cathodic protection management includes periodic testing to ensure stay current corrosion source</td>
<td></td>
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<tr>
<td>2.24</td>
<td>Both</td>
<td>Construction of sewer parallel and adjacent to easement</td>
<td>No</td>
<td>Centre line is 6m from the boundary at the north and 14m from the boundary at the south</td>
<td></td>
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<tr>
<td>2.25</td>
<td>Both</td>
<td>Landscaping over the easement</td>
<td>Yes</td>
<td>increased wall thickness and cover. Pipework ~6m from easement boundaries Building</td>
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<tr>
<td>2.26</td>
<td>Both</td>
<td>External interference - utility works associated with the operation of a Zone Substation constructed to serve all or part of the development</td>
<td>No</td>
<td>Easement damage to properties (e.g. vertical boring, trenching)</td>
<td></td>
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<tr>
<td>2.27</td>
<td>Both</td>
<td>Construction of residential service connections on residential lots in proximity to a pipeline - easement stability</td>
<td>Yes</td>
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<tr>
<td>2.28</td>
<td>Both</td>
<td>Swimming pool construction and permanent structures on residential block in proximity to a pipeline - Easement instability</td>
<td>Yes</td>
<td></td>
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<tr>
<td>2.29</td>
<td>Both</td>
<td>External interference to the pipeline resulting from excavation works on sites resulting in procedural controls being non-effective</td>
<td>Yes</td>
<td>Easement damage leading to erosion</td>
<td></td>
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<td>APA</td>
</tr>
<tr>
<td>2.30</td>
<td>Both</td>
<td>External interference from construction activities associated with the sensitive area (e.g. vertical boring, trenching and security arrangements for school etc.)</td>
<td>Yes</td>
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<tr>
<td>2.31</td>
<td>Both</td>
<td>Construction activities adjacent to ROW preventing access to easement for pipeline maintenance</td>
<td>Yes</td>
<td></td>
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<tr>
<td>2.32</td>
<td>Both</td>
<td>Landowner (stakeholder) relationships formed because pipeline maintenance activities damage residential assets</td>
<td>Yes</td>
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<td>APA</td>
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</tbody>
</table>

### Summary

- **Phase 1 - Road / Commercial Construction**
  - **External interference - utility works associated with the operation of a Zone Substation constructed to serve all or part of the development**
    - No failure, no corrective action required.
  - **Construction of sewer parallel and adjacent to easement**
    - Centre line is 6m from the boundary at the north and 14m from the boundary at the south.
  - **Landscaping over the easement**
    - Increased wall thickness and cover.
  - **External interference - utility works associated with the operation of a Zone Substation constructed to serve all or part of the development**
    - No failure, no corrective action required.

- **Phase 2 - Residential / Commercial Construction**
  - **External interference from construction activities associated with the sensitive area (e.g. vertical boring, trenching and security arrangements for school etc.)**
    - Yes, failure may occur.
  - **Construction activities adjacent to ROW preventing access to easement for pipeline maintenance**
    - Yes, failure may occur.
  - **Landowner (stakeholder) relationships formed because pipeline maintenance activities damage residential assets**
    - Yes, failure may occur.

### Actions

- **APA review development electric power design**
  - Incorporate transformer impact assessment to AS 4853 in DCP
  - Walker
  - APA, Walker

### Notes

- **Easement damage leading to erosion**
  - Transformer failure and associated earth potential rise affecting pipeline.

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## APA - Safety Management Study - Walker Development - Wilton South East Precinct

### Diameter 864 mm Steel Grade X65 448 MPa Yield Stress Critical Defect 141 mm Hoop Stress at MAOP 72% of SMYS
- **Wall Thickness**: 9.2 mm MAOP

### Diameter 219.1 mm Steel Grade X60 414 MPa Yield Stress Critical Defect 118 mm Hoop Stress at MAOP 49.3% of SMYS
- **Wall Thickness**: 8.1 mm MAOP

---

### Phase 4 - Residential

#### 4.01 Both
- **General interference caused by activities associated with redevelopment, extensions, landscaping and similar activities**
  - **Prevention by Design and/or Procedures**: Increased wall thickness and cover. Pipelines ~6 m from easement boundaries Structural. Infrastructure development notification of APA for work done within XX m of the pipeline. APA's internal permit system.
  - **Failure mode if controls fail**: Infrastructure development notification of APA for work done within XX m of the pipeline. APA's internal permit system.
  - **Hazardous Event?**: No
  - **Comments**: Expected that these activities will be detected before there is an impact on the pipeline.
  - **Risk**: Low
  - **Actions**: Pursue developing MOU with council. Pursue developing MOU with council. APA is required to comply with AS2885.

#### 4.02 Both
- **External interference threats associated with future consolidation of residential blocks to high density use**
  - **Prevention by Design and/or Procedures**: Increased wall thickness and cover. Pipelines ~6 m from easement boundaries Structural. Infrastructure development notification of APA for work done within XX m of the pipeline. APA's internal permit system.
  - **Failure mode if controls fail**: Infrastructure development notification of APA for work done within XX m of the pipeline. APA's internal permit system.
  - **Hazardous Event?**: No
  - **Comments**: Currently the DCP will prohibit this form of development.
  - **Risk**: Low
  - **Actions**: See above to include in DCP. Pursue developing MOU with council.

#### 4.03 Both
- **Future expansion of a pipeline to incorporate looping or replacement of other pipelines**
  - **Prevention by Design and/or Procedures**: Increased wall thickness and cover. Pipelines ~6 m from easement boundaries Structural. Infrastructure development notification of APA for work done within XX m of the pipeline. APA's internal permit system.
  - **Failure mode if controls fail**: Infrastructure development notification of APA for work done within XX m of the pipeline. APA's internal permit system.
  - **Hazardous Event?**: No
  - **Comments**: The threat is expected to be controlled by proper construction - see Threat #209.
  - **Risk**: Low
  - **Actions**: See above to include in DCP. Pursue developing MOU with council.

#### 4.04 Both
- **Future expansion of a pipeline to incorporate looping or replacement of other pipelines**
  - **Prevention by Design and/or Procedures**: New pipeline sections will comply fully with the requirements of AS3883.
  - **Failure mode if controls fail**: New pipeline sections will comply fully with the requirements of AS3883.
  - **Hazardous Event?**: No
  - **Comments**: Can be determined by proper construction - see Threat #209.
  - **Risk**: Low
  - **Actions**: To be determined.

#### 4.05 Both
- **Erosion resulting from rainfall concentrating in drain where fill is placed in existing gullies**
  - **Prevention by Design and/or Procedures**: Minimum cover at gullies is greater than minimum. APA to consider 1.5MPa verification to reference pipeline.
  - **Failure mode if controls fail**: Minimum cover at gullies is greater than minimum. APA to consider 1.5MPa verification to reference pipeline.
  - **Hazardous Event?**: Yes
  - **Comments**: Pipeline warning marker to APA standard for T1.
  - **Risk**: Low
  - **Actions**: To be determined.

#### 4.06 Both
- **Slabbing and/ or toppings associated with redevelopment**
  - **Prevention by Design and/or Procedures**: Increased wall thickness and cover. Pipelines ~6 m from easement boundaries Structural. Infrastructure development notification of APA for work done within XX m of the pipeline. APA's internal permit system.
  - **Failure mode if controls fail**: Infrastructure development notification of APA for work done within XX m of the pipeline. APA's internal permit system.
  - **Hazardous Event?**: Yes
  - **Comments**: The threat is expected to be controlled by proper construction - see Threat #208.
  - **Risk**: Low
  - **Actions**: To be determined.

#### 4.07 Both
- **Erosion of an easement**
  - **Prevention by Design and/or Procedures**: Increased wall thickness and cover. Pipelines ~6 m from easement boundaries Structural. Infrastructure development notification of APA for work done within XX m of the pipeline. APA's internal permit system.
  - **Failure mode if controls fail**: Infrastructure development notification of APA for work done within XX m of the pipeline. APA's internal permit system.
  - **Hazardous Event?**: Yes
  - **Comments**: Pipeline warning marker to APA standard for T1.
  - **Risk**: Low
  - **Actions**: To be determined.

#### 4.08 Both
- **Pipeline warning marker to APA standard for T1.**
  - **Prevention by Design and/or Procedures**: Infrastructure development notification of APA for work done within XX m of the pipeline. APA’s internal permit system.
  - **Failure mode if controls fail**: Infrastructure development notification of APA for work done within XX m of the pipeline. APA’s internal permit system.
  - **Hazardous Event?**: Yes
  - **Comments**: Pipeline warning marker to APA standard for T1.
  - **Risk**: Low
  - **Actions**: To be determined.

#### 4.09 Both
- **External interference using smaller HDD techniques for cabling, gas, water, communication etc.**
  - **Prevention by Design and/or Procedures**: See Section 1
  - **Failure mode if controls fail**: All such connections made from front of property.
  - **Hazardous Event?**: No
  - **Comments**: No
  - **Risk**: Low
  - **Actions**: No

#### 4.10 Both
- **Internal interference using smaller HDD techniques for cabling, gas, water, communication etc.**
  - **Prevention by Design and/or Procedures**: Engineering design of earthworks and slope stabilisation batter
  - **Failure mode if controls fail**: Batter slopes are low and not expected to be unstable. Closest pipeline is located at least 6 m from the easement boundary.
  - **Hazardous Event?**: No
  - **Comments**: No
  - **Risk**: Low
  - **Actions**: No

#### 4.11 Both
- **External interference using HDD techniques for cabling, gas, water, communication etc.**
  - **Prevention by Design and/or Procedures**: Engineering design of earthworks and slope stabilisation batter
  - **Failure mode if controls fail**: Batter slopes are low and not expected to be unstable. Closest pipeline is located at least 6 m from the easement boundary.
  - **Hazardous Event?**: No
  - **Comments**: No
  - **Risk**: Low
  - **Actions**: No

#### 4.12 Both
- **Recreational access to the pipeline easement by the residents**
  - **Prevention by Design and/or Procedures**: Standard wall thickness and cover 15% patrols. Pipeline warning marker to APA standard for T1.
  - **Failure mode if controls fail**: Standard wall thickness and cover 15% patrols. Pipeline warning marker to APA standard for T1.
  - **Hazardous Event?**: No
  - **Comments**: No
  - **Risk**: Low
  - **Actions**: No

#### 4.13 Both
- **Recreational access to the pipeline easement by the residents**
  - **Prevention by Design and/or Procedures**: Easement damage, Erosion. No minimum cover at gullies is greater than minimum. APA to consider 1.5MPa verification to reference pipeline.
  - **Failure mode if controls fail**: Easement damage, Erosion. No minimum cover at gullies is greater than minimum. APA to consider 1.5MPa verification to reference pipeline.
  - **Hazardous Event?**: No
  - **Comments**: No
  - **Risk**: Low
  - **Actions**: No
### APA - Safety Management Study - Walker Development - Wilton South East Precinct

### D216 mm Steel Grade X60 414 MPa Yield Stress Critical Defect 118 mm Hoop Stress at MAOP 49.3 % of SMYS
- Diameter 216 mm
- Steel Grade X60
- Yield Stress 414 MPa
- Critical Defect 118 mm
- Hoop Stress at MAOP 49.3 % of SMYS
- Pressure for hoop stress 30% SMYS 14.895 MPa

### Ethane
- Diameter 80.4 mm
- Steel Grade X60
- Yield Stress 414 MPa
- Critical Defect 118 mm
- Hoop Stress at MAOP 49.3 % of SMYS
- Pressure for hoop stress 30% SMYS

### Action
- Item: Pipeline Threat

### Prevention by Design
- Failure mode if controls fail
- Hazards Event
- Comments
- Frequency
- Severity
- Risk

<table>
<thead>
<tr>
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<td>4.1</td>
<td>Both</td>
<td>Yes</td>
<td>No</td>
<td>Leak 6.4 GJ/s, radiation contour 24 and 14 m</td>
<td>Yes</td>
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<td>Minor</td>
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<td>PA to review requirements for the easement and issue when road is transferred to council. Pursue co use if required. Council crossing agreement</td>
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<td>4.2</td>
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<td>No</td>
<td>Leak 6.4 GJ/s, 4.7 kWh/m2 radiation contour 40 m</td>
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<td>4.3</td>
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### ALARP Assessment Level Use Change
- ALARP Alternative: Bus Reduction
- Cost: Low
- Comment: Low
<table>
<thead>
<tr>
<th>Item</th>
<th>Pipeline</th>
<th>Threat</th>
<th>Credible Threat</th>
<th>External Interference Protection</th>
<th>Prevention by Design and/or Procedures</th>
<th>Failure mode if controls fail</th>
<th>Failure Analysis Required</th>
<th>Hazardous Event?</th>
<th>Comments</th>
<th>Frequency</th>
<th>Severity</th>
<th>Risk</th>
<th>Actions</th>
<th>Action No.</th>
<th>Resp. Person</th>
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<tr>
<td>4.61</td>
<td>MSP</td>
<td>Yes</td>
<td>WSCR-Reduction</td>
<td>Currently complies with no rupture - minor reduction in consequence of a leak as a result of reduced flow rate.</td>
<td></td>
<td>Existing pipe complies with high consequence provisions at current maximum operating pressure. Will change if technically feasible to raise pressure to WSCR.</td>
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<td>4.63</td>
<td>Ethane</td>
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<td>WSCR-Reduction</td>
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<td>4.63</td>
<td>MSP</td>
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<td>Rip Replacement with No-Rupture Pipe</td>
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<td>Eliminated</td>
<td>Cost to replace is in the order of $8-10 million.</td>
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<td>Ethane</td>
<td>Yes</td>
<td>Rip Replacement with No-Rupture Pipe</td>
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<td>MSP</td>
<td>Yes</td>
<td>Pipeline relocation</td>
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<td>Pipeline relocation</td>
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<td>Modify Land Use</td>
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<td>4.65</td>
<td>Ethane</td>
<td>Yes</td>
<td>Control by Physical &amp; Procedural Methods</td>
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APPENDIX 3

Attendee Register
## ATTENDEE LIST

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
<th>Representing which Discipline or Project Interest</th>
<th>Signature</th>
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<tbody>
<tr>
<td>Phil Venton</td>
<td>Venton &amp; Associates</td>
<td>Facilitator</td>
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</tr>
<tr>
<td>Sharr Garder</td>
<td>Walker Corporation</td>
<td>Development</td>
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<tr>
<td>ROSS LAARSEN</td>
<td>APA</td>
<td>Gas pipeline</td>
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<tr>
<td>CARMELA RAEDEL</td>
<td>BTEC</td>
<td>Civil Engineering</td>
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<tr>
<td>Martin Wong</td>
<td>APA</td>
<td>Mech Eng</td>
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<td>SEAN BROWNING</td>
<td>APA</td>
<td>GAS PIPELINE</td>
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<tr>
<td>Mark Walshin</td>
<td>QVOS/Conserne</td>
<td>Ethane Pipeline</td>
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<td>CrossRef MEADES</td>
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