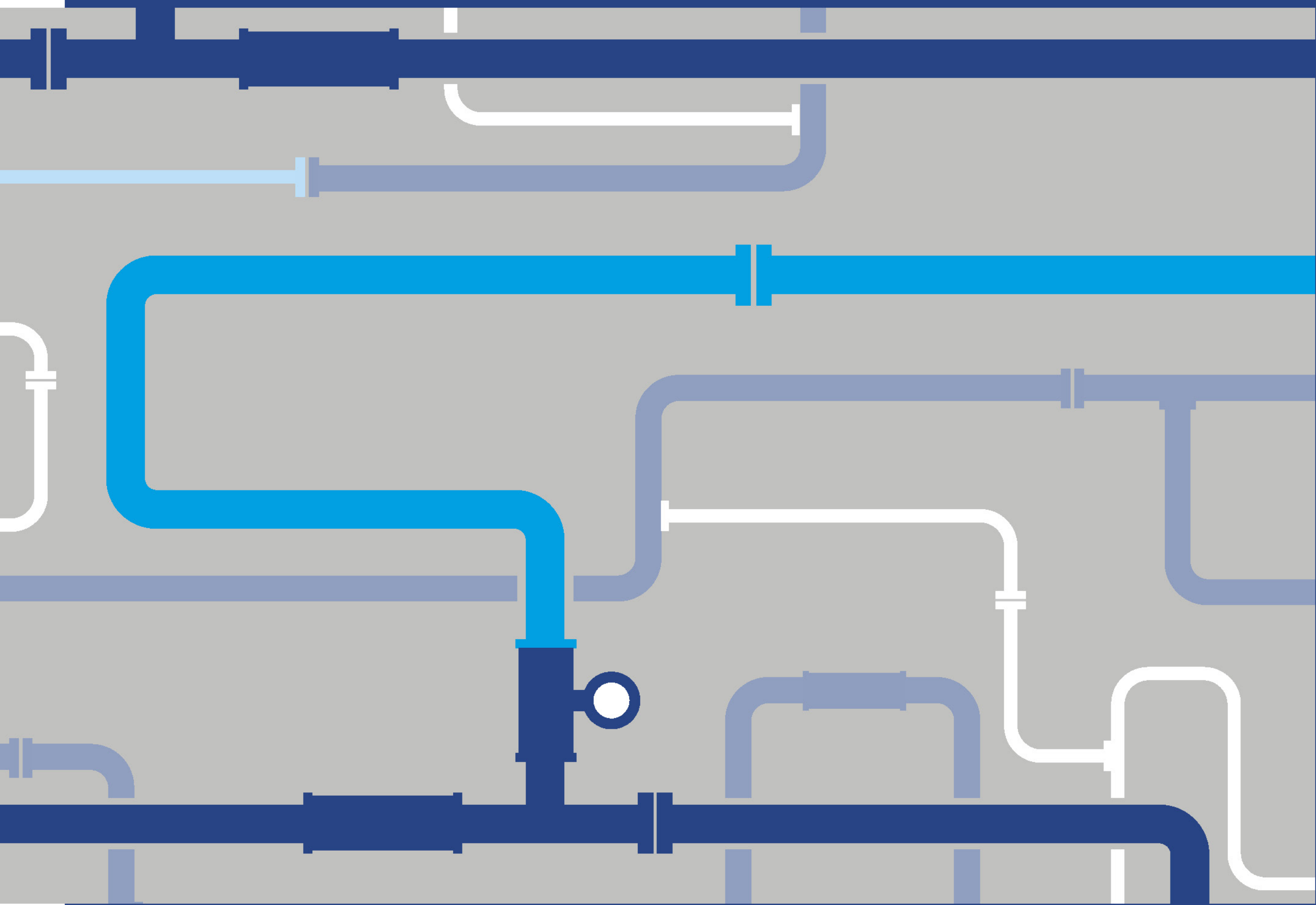
chapter 3

project development.



Environment Effects Statement | May 2021

western outer ring main

a project of apa

Contents

Chapter 3

3.1 Introduction

This chapter describes the development of the Western Outer Ring Main Project (the Project) and explains how the current form of the Project was selected for assessment in this Environment Effects Statement (EES).

The EES scoping requirements for the Project require that the proponent document the process undertaken to identify and assess project alternatives and designs, including how and why alternatives were shortlisted or discounted. The scoping requirements state that the depth of investigation of alternatives should be proportionate to their potential to minimise potential adverse effects as well as meet the Project objectives. In addition, the scoping requirements require a discussion of the implications for Victoria should the Project not proceed. Alternatives assessed and summarised in this chapter are focused on pipeline alignment alternatives and construction methodologies.

The rationale for the Project and implications should the Project not proceed are outlined in Chapter 2 *Project rationale*.

3.2 Project history

Prior to the creation of the WORM project which forms the subject of this EES, the anticipated need for a high-pressure pipeline loop between the west and the north/east was first identified by APA and discussed with the Australian Energy Regulator (AER) over ten years ago.

In January 2017, APA submitted a business case to the AER focused on securing an easement for the Project. This business case was based on the expectation that the Project would be a critical project needed for Victoria in the future, and that securing land for this infrastructure would be increasingly difficult over time given the urban growth anticipated to occur north and west of Melbourne in the coming years. APA also simultaneously submitted a separate business case for interim improvements to the Brooklyn and Winchelsea Compressor Stations to increase the capacity of the South West Pipeline (SWP) to refill the Iona Underground storage facility (UGS) and manage supply risks in the short-term.

Australian Energy Market Operator (AEMO) then released its *Gas Statement of Opportunities* (GSOO) document in March 2017 and the *Victorian Gas Planning Report 2017* (VGPR) which confirmed a greater urgency to progress the full WORM project to completion to help address anticipated gas supply shortfalls, forecast at that time by winter 2018. This need was due to network capacity constraints leading to the inadequate refilling of the Iona UGS, and the closure of the Hazelwood Power Station which was expected to place greater capacity constraints on the SWP as a result of the Laverton gas powered generation in Melbourne's west operating more frequently. As such, in April 2017 APA resubmitted an updated business case known as the 'APA VTS Access Arrangement 2018–2022' to the AER for the full WORM project. This was approved by the AER in 2017.

3.3 Overview of project development process

Figure 3-1 provides an overview of the key phases in the development of the Project with further details on the steps undertaken within each stage provided in the following sections of this chapter.

Figure 3-1 Project development process overview

Project inception	• Problem definition • Agreement of key project objectives • Define study area and core project components
Early investigations	• Information gathering, desktop investigation and on-site surveys of study area • Constraints mapping • Initial stakeholder engagement (landowners, regulatory agencies, other stakeholders)
Options evaluation framework	• Development of a qualitative and quantitative evaluation criteria for the Project • Apply weightings to criteria and create assessment tool known as a multi-criteria analysis (MCA)
Potential pipeline route options	• Identify potential pipeline route options • Assess route options using MCA for the Project
Confirmation of preferred route option	• Submission of business case to AER • Confirmation of preliminary pipeline alignment (preferred option) for further stakeholder engagement • Pipeline route refinement
Obtain regulatory approvals	• State and Commonwealth approvals (including EES process - current phase)
Pipeline construction and operation	• Construct pipeline by 2022 • Pipeline operational from Q3/4–2022

The Project which forms the subject of this EES was developed through a series of project development phases, following AER's approval of the 2018-2022 Access Arrangement for the VTS and the WORM business case.

APA have engaged with a range of key stakeholders throughout various phases of the Project development process. Further details of consultation undertaken for the Project and key outcomes of stakeholder engagement are set out in Chapter 6 *Community and stakeholder consultation*.

3.4 Project inception

As noted in Section 3.2, the AEMO GSOO and VGPR in 2017 confirmed the need for the Project to address network capacity constraints, and the 2017 APA business case for the 'APA VTS Access Arrangement 2018-2022' responded to the identified need.

The Project's business case was developed in accordance with Rule 79 "Capital expenditure will be incurred by the prudent service provider acting efficiently in accordance with accepted good industry standard practice" of the National Gas Rules (AEMC, 2021). The National Gas Rules govern access to natural gas pipeline services and elements of broader natural gas markets. APA demonstrated this rule through these three criteria:

- Identification of need – the Project was needed to fulfil storage quickly to meet peak supply needs
- Identification and evaluation of alternatives – the Project was identified as the best alternative to meet the Project objectives, as approved by the AER
- Efficient execution – to demonstrate efficient execution APA relies on procurement processes, importantly the public tender process for significant components.

As part of the Project's inception, APA established the key Project objectives to guide delivery which are discussed in Chapter 1 *Introduction*. At the core of these objectives was the need for APA to ensure the Project's compliance with the Victorian Pipelines Act 2005 (Pipelines Act) and the Pipeline Regulations 2017. In particular the Project sought to align with the objectives of the Pipelines Act by:

- Following the process outlined in the Pipelines Act to determine the most efficient and suitable route for each pipeline
- Ensuring sound consultation processes were undertaken as part of the Project planning, construction and operation
- Protecting workers and the public from environmental, health and safety risks resulting from the construction and operation of the Project
- Ensuring that the Project would be constructed and operated in a way that would minimise adverse environmental impacts and have regard for the need for sustainable development.

During project inception, a study area was also defined for the Project to form the focus of preliminary investigations for potential pipeline alignment options. The location of the study area was informed by the fact that a new high-pressure pipeline connection between the VTS and the SWP in Victoria's west, would most logically occur between the Plumpton Regulating Station (western end of the SWP) and the Wollert compressor station (eastern end of the Western Outer Ring Main and southern end of the Victorian Northern Interconnect).

3.5 Early investigations

From early 2018, APA has undertaken a comprehensive investigation process to identify and consider the various opportunities and constraints within the Project study area which would later inform potential pipeline alignment options.

Desktop assessments, site inspections and early stakeholder consultation was undertaken and used to compile a database of spatial and contextual information for analysis.

Early engagement with the four relevant local government authorities within the study area (Melton City, Hume City, Whittlesea City and Mitchell Shire) was undertaken, in addition to engagement with the Department of Environment, Land, Water and Planning (DELWP), VicRoads, VicTrack, Victorian Planning Authority and SP AusNet.

Key considerations that informed the study area investigation and route selection process included[1]:

- Environmental and heritage constraints including any areas of high biodiversity or heritage value to avoid and minimise impacts where possible
- Topographical features including terrain, vegetation cover, waterways and existing land use and development characteristics
- Utility or transport infrastructure corridors to determine opportunities for co-location of proposed infrastructure with complementary uses
- Future land-uses and locations of urban growth in accordance with Strategic Plans and land-use strategies
- Geotechnical and hydrological characteristics including areas of slope greater than 10 per cent, ground stability, presence of rock and soil type to inform the constructability of the Project
- Social impact and community values, including identifying valued local assets and considering land owner interests and access arrangements in the Project area.

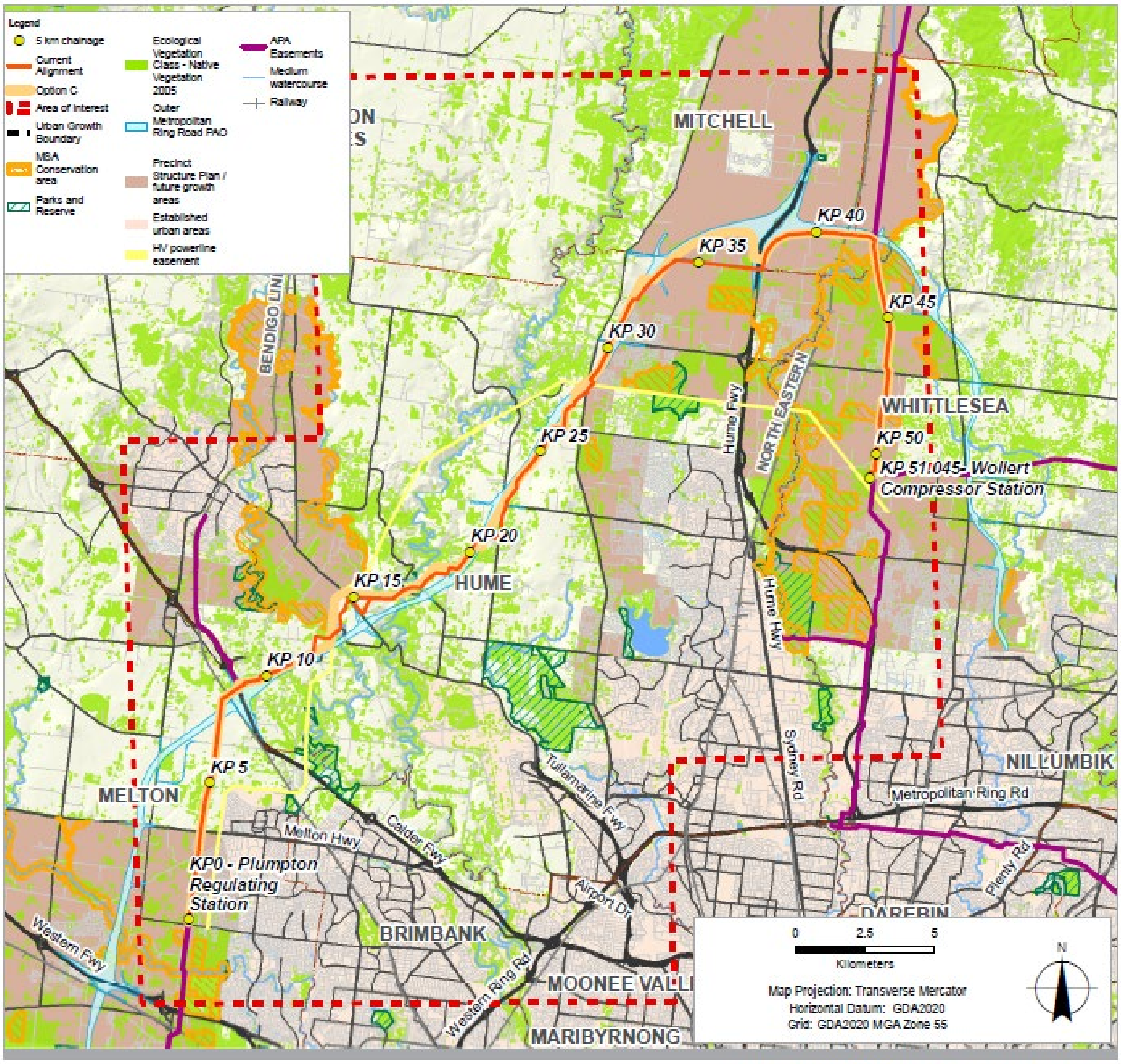
The key features are described further in Table 3-1 and Figure 3-2 provides an overview of key features present within the study area.

[1] APA (2019) Route Options Report, page 10–12.

Table 3-1 Key features within study area

Theme	Key features
Natural Environment	Located within the Victorian Volcanic Plain bioregion which historically supported grassland and grassy woodland communities and has had a long history of agricultural use.
	Existing areas of remnant vegetation present including some of very high conservation significance, such as grassland and grassy woodland communities considered to be critically endangered.
	Some habitat in the region supports populations of threatened flora and fauna species, most notably the Golden Sun Moth, Growling Grass Frog, Striped Legless-Lizard, Spiny Rice-flower and Matted Flax-Lily.
	Several national parks and conservation reserves present including the Organ Pipes National Park, Woodlands Historic Park, Holden Flora Reserve, Mount Ridley and Craigieburn Grassland nature conservation reserves, and conservation areas prescribed under the Melbourne Strategic Assessment (MSA).
	Major watercourses including Jacksons Creek, Emu Creek, Deep Creek and Merri Creek, and topographic constraints including steep valleys around majority of these creek beds and several mountains and hills including Mount Fraser, Mount Ridley, Bald Hill, Redstone Hill, Mount Ridley, Woody Hill and Summer Hill.
Urban Development/Infrastructure	Comprises land both within and outside of the Urban Growth Boundary. At the time of investigation, the study area included eighteen Precinct Structure Plan (PSP) areas.
	Existing residential and industrial urban development present particularly in the southern and eastern parts of the study area at Taylors Hill, Hillside, Diggers Rest, Caroline Springs, Bulla, Greenvale, Mickleham, Merrifield, Roxburgh Park, Kalkallo, Craigieburn, Somerton and Epping.
	Major facilities present include Melbourne Airport, Calder Park Raceway, the Commonwealth quarantine station at Mount Ridley, and Melbourne Water operated assets at Greenvale Reservoir and the Kalkallo retarding basin.
	Several existing and proposed linear infrastructure easements were also identified and considered for co-location potential of the WORM. This includes the proposed Outer Metropolitan Ring/E6 transport corridor (OMR/E6); existing transport corridors including the Sunbury and Craigieburn rail lines, the Calder and Hume freeways and arterial roads; an AusNet 500kV high voltage overhead powerline easement; an APA pipeline easement associated with the Sunbury Pipeline, Keon Park to Wollert pipeline and the VNI; and drainage reserves in the region.
Heritage	Features of Aboriginal and European cultural heritage significance, including sites listed on the Victorian Heritage Register and Inventory such as the Holden cobbled stone road, Mickleham Avenue of Honour, Merri Creek, Jacksons Creek and other places of regional significance.

Figure 3-2 Key Features Overview Map



Data source: APA, 2020; GHD, 2020; DELWP, Vicmap, 2020 Created by:sacevedo

3.6 Climate change considerations

Development of the design has taken into account potential risks to the Project due to climate change. In response to feedback from the Technical Reference Group during development of the EES, a high-level risk assessment was conducted for the Project to document the potential impacts of climate change, using the Victoria Climate Projections Technical Report 2019. The risk assessment provided confirmation that the design approach and operational management system appropriately addresses the potential impacts of climate change.

The risk assessment was performed in accordance with the Australian Standard AS 5334:2013 Climate change adaptation for settlements and infrastructure – A risk-based approach.
The assessment addresses the requirements of Section 17 (3) of the *Climate Change Act 2017* (CC Act). The risk assessment was undertaken for the Project infrastructure for the extremely plausible scenario of future greenhouse gas emissions, which is also referred to as the “Business as usual” scenario by the Intergovernmental Panel on Climate Change. The assessment considered current conditions as well as two future time horizons - 2030 (near term) and 2050 (long term) when identifying climate risks.

Historic climate data and climate projection data was sourced from the Victoria Climate Projections Technical Report 2019, Goulburn Climate Projections 2019, and the Bureau of Meteorology (Tatura Institute of Sustainable Agriculture 1986-2005 data) 2019. Based on the climatic projections, a total of 16 climate change risks (direct and indirect) were identified for Project infrastructure relating to five major climate hazards: extreme temperature, extreme rainfall, drought, bushfire and storm.

The risk assessment considered existing and planned controls that would mitigate the potential impacts associate with the 16 identified climate change risks. These existing and planned controls are typically standard design features or adaptation measures adopted by APA which would significantly reduce the likelihood of occurrence and consequences of potential impacts. Examples of relevant controls include:

- Designing infrastructure to withstand temperatures above climate projections
- Design of electrical equipment for the 1:100 year flood event Designing the pipeline with consideration of potential erosion risks
- Undertaking regular inspections during operation to identify signs of change, such as subsidence
- APA's Bushfire Management Plan.

After taking into account the existing and planned controls that would be adopted by APA, all residual risks potentially resulting from climate change were rated as low across the current, 2030 and 2050 time horizons.

The construction period would be in the very short term (late 2021 to mid 2022) and is relevant to the current time period only. Climate change risks in this time horizon do not warrant specific mitigation and would be appropriately accounted for through current construction techniques and adherence to appropriate construction guidelines (such as EPA Publication 1834: Civil construction, building and demolition guide).

3.7 Options evaluation framework

To assess the various options for a pipeline alignment for the Project, APA developed a set of qualitative and quantitative evaluation criteria.

The evaluation criteria were developed in line with the objectives of the Pipelines Act, the *Australian Pipelines and Gas Association (APGA) Code of Environmental Practice and Australian Standard 2885: Pipelines – Gas and Liquid Petroleum*.

Once criteria were identified, a ranking and scoring system was then applied to the criteria using a multi-criteria analysis (MCA) assessment approach. The MCA approach is typically used for large-scale infrastructure projects where various design options and competing factors need to be considered and balanced.

The evaluation criteria and weightings used in the MCA for the options evaluation is depicted in Table 3-2.

It should be noted that the options evaluation framework was developed and used for identification and assessment of options in 2018 to 2019. While the evaluation criteria were developed in line with the objectives of the Pipelines Act, the criteria align with relevant considerations under the EE Act and EPBC Act.

Table 3-2 Evaluation criteria and weightings[2]

Parameter	Criteria	Weighting
Environment and heritage	Special biodiversity values, length of MSA conservation areas intersected, length of threatened ecological communities intersected, extent of remnant vegetation, watercourses, wetlands, floodplains, registered heritage sites, cultural heritage sensitivity, native title claims, amenity impacts (noise, dust, visual)	20%
Community	Potential community benefit, community safety, impacts to known areas of high value to the community	20%
Land	Variation in number of parcels intersected between options, residential tenure (current or zoned), industrial tenure, resource tenure (production), resource tenure (exploration), forestry tenure, conservation tenure, future land use conflicts	20%
Capital cost	Approvals cost, offset cost, labour costs, land procurement costs and capital costs	15%
Relative length	Relative length of each pipeline option	5%
Constructability	Design and engineering complexity, terrain and geology risks, complex crossings, space for efficient construction, logistics and access for construction, worker safety	5%
Operability	Operational complexity, pipeline third party damage risk, worker safety, soil types, rehabilitation and easement maintenance risks	5%
Infrastructure	Number of State and Federal roads, local roads and railways intersected	5%
Approvals	Complexity of approval pathway, length of existing or proposed infrastructure easements followed, schedule impact of approval pathway	5%
Total		**100%**

2 APA (2019) Route Options Report, page 18–19.

3.8 Pipeline route options

Route options for the Project, in its various forms, have been under consideration since at least 2007 and have been the subject of discussion with AER/AEMO since 2012.

As part of the 2017 AER business case submission, APA originally identified four route options for the Project:

- Following the existing Sunbury pipeline easement, the OMR, Gunns Gully Road and the existing VNI easement south to Wollert (47.1 km in length)
- Following the Sunbury pipeline easement, OMR and Wildwood Road, traversing cross country to the north east through rural land, crossing the OMR near Donnybrook Road, crossing the Hume Highway between Donnybrook Road and Gunns Gully Road and then following the VNI south to Wollert (47.3 km in length)
- Following the same route as Option 1 to Mickleham Road but then following the Ausnet 500 kV easement through Mount Ridley to Wollert (39.3 km in length)
- Following the same route as Option 1 to Gunns Gully Road but then continuing to follow the OMR through the intersection with the VNI (50.1 km in length).

The fourth option above was the route included in the approved AER business case.

Given the rate of development occurring in the northern and western growth areas (largely associated with the progress of Precinct Structure Plans in the area), APA undertook a further program of updated site investigations in late 2018 and early 2019 to review and revise the route options for the Project and ensure the most current land-use conditions for the study area were considered. The outcome of this review was the identification of five route options in 2019 to connect the Wollert compressor and Plumpton regulating stations, described as Options A, B, C, D and E. These five options were assessed through the MCA aligning with the objectives of the Pipelines Act.

A copy of the *Route Options Report - Western Outer Ring Main Project (APA, March 2019)* is publicly available on the APA Project website[3]. The scoring matrix results for all five options provides further details and metrics used in the assessment process and is provided at Attachment 3 of the 2019 Route Options Report.

The five route options are shown in Figure 3-3.

All five route options feature the following common characteristics:

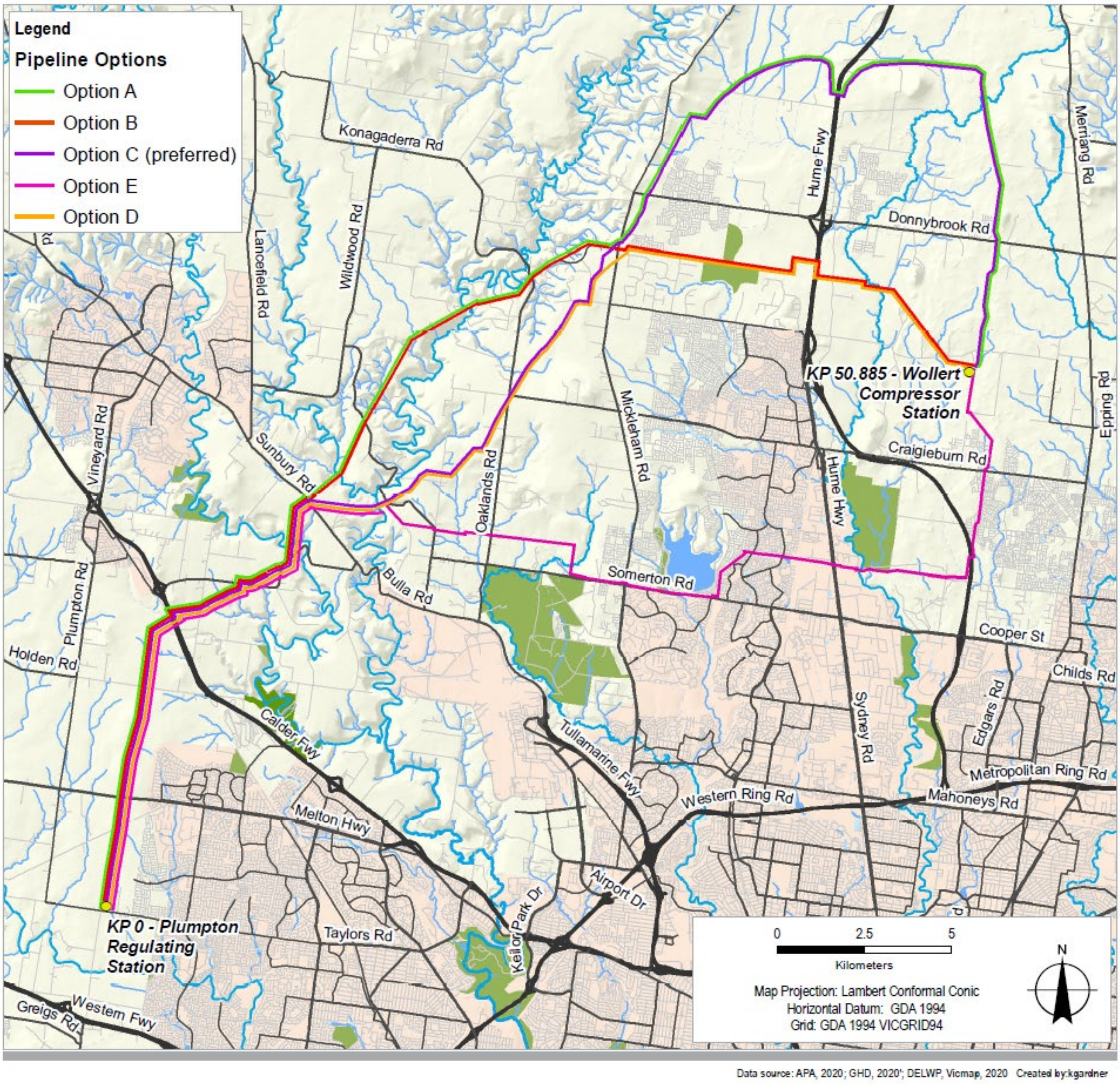
- Share a common alignment in the southern part of the Project area, between the Plumpton Regulating Station (KP 0) to the Sunbury Road crossing (KP 14.8)
- All route options follow part of the existing AusNet 500kV high voltage powerline easement alignment for approximately 2 kilometres south of the Sunbury Road crossing (KP 14.8)
- All cross the Sunbury rail line and Calder Freeway (KP 8.8) before traversing in a north-easterly direction through land in the Green Wedge A Zone.

[3] https://www.apa.com.au/globalassets/about-apa/our-projects/western-outer-ring-main-project/western-outer-ring-main-project-route-options-report.pdf.

The route options vary in length with the preferred route (Option C) being nearly 12 kilometres longer than the shortest route option considered, due to the environmental, land use, cost and accessibility objectives achieved by this option[4].

The key features of each route option are summarised in Table 3-3.

Figure 3-3 Route Options (APA Options Report, 2019)



4 APA (2019) Route Options Report.

Table 3-3 Options characteristics summary

Option/Ranking	Route Length/Capital Cost	Environment/Heritage	Land/Infrastructure/Approvals	Constructability/Operability
A / Ranked 5th (least preferred)	• 50.4 km – second longest alignment option • Highest capital cost largely due to alignment length and constructability constraints	• Environmental impact would be higher than preferred option C, given it traverses a greater number of wetlands (3), Melbourne Strategic Assessment (MSA) conservation areas (approx. 1.7 km) and mapped areas of remnant vegetation, threatened ecological communities and habitat for threatened species (7.3 km) • Second highest risk to areas of Aboriginal cultural heritage sensitivity (CHS) traversing approximately 5.1 kilometres of CHS	• The northern section of this route travels a greater distance north (in rural areas) from established urban growth north of Melbourne (same as Option C). As such the route avoids residential or commercial tenure • Co-locates with AusNet 500kV power easement for over 12 kilometres • Increased approvals and land tenure complexity expected due greater environmental impacts anticipated and co-location requirements with AusNet easement	• Poor for constructability and operation largely due to the approximately 12 kilometre section of the alignment within AusNet's power easement • Traverses areas within the power easement with sloping terrain and risk of landslip near Deep Creek • Option A and B both had over 7 kilometres of alignment traversing land with a slope of greater than 10% presenting greater ground stability and terrain risks. This was much higher than Options C, D and E with between approximately. 1.3 and 2.6 kilometres of slope-impacted alignment respectively,

Option/Ranking	Route Length/Capital Cost	Environment/Heritage	Land/Infrastructure/Approvals	Constructability/Operability
B/ Ranked 4th (second least preferred option)	• 39.6 km – shortest alignment option • Second lowest capital cost largely due to shorter alignment length	• Greatest environmental impact expected from this alignment • Alignment features the longest intersect with MSA conservation areas (approximately 3.5 km) and mapped areas of remnant vegetation, threatened ecological communities and habitat for threatened species (approximately 9.2 km) • Alignment also traverses land within the Mount Ridley Nature Conservation Reserve, land affected by the Environmental Significance Overlay, and a high number of waterways near Deep Creek and along the AusNet 500 kV power easement • Traverses area with sloping terrain and risk of landslip along part of easement near Deep Creek valley	• This alignment co-locates with the AusNet 500 kV easement for most of its length (approximately 22 kilometres) • The alignment requires residential and industrial tenure as the northern section of the alignment cuts through the northern growth corridor at Mickleham where urban development and higher density subdivision is present • Increased approvals complexity expected due greater environmental impacts anticipated and co-location requirements with AusNet easement • This option also requires tenure through the Mount Ridley Nature Conservation Reserve	• Very poor for constructability and operation largely due to the substantial section of the alignment (approximately 22 kilometres) within AusNet's power easement. This includes 12 kilometres of shared alignment with Option A within this power easement • Shares part of its alignment with Option A which traverses areas within the power easement with sloping terrain and risk of landslip near Deep Creek • Similar to Option A it traverses approximately 7 kilometres of land with a slope greater than 10% • Traverses congested parts of the easement further east (part of alignment not shared with Option A) where greater operational complexity and worker safety risks are expected

Option/Ranking	Route Length/Capital Cost	Environment/Heritage	Land/Infrastructure/Approvals	Constructability/Operability
C/ Ranked 1st (preferred option)	• 51.5 km – longest route alignment • Second highest capital costs largely due to alignment length	• Least environmental impact expected compared to other options • Alignment achieves the greatest avoidance of MSA conservation areas (approx. 1.6 km traversing conservation areas) • Alignment has second shortest impact length of mapped areas of remnant vegetation, threatened ecological communities and habitat for threatened species (approx. 5.7 km) • Alignment intersects fewer areas of potential Aboriginal cultural heritage sensitivity than Options A, B and E • Alignment would use an existing crossing at Merri Creek established for the Victorian Northern Interconnect Expansion project	• Northern section of route travels a greater distance north (in rural areas) from established urban growth north of Melbourne • Avoids requiring tenure on land holdings with residential, industrial or conservation uses • Follows a similar alignment to the part of the proposed OMR which traverses the study area	• Achieves the best outcomes in terms of construction and operational complexity – largely due to avoidance of urban encroachment, easement/access constraints and steep terrain • Option C has more (18) complex crossings (along with A and E) than Options B and D (16). These complex crossing require trenchless construction methods contributing to higher capital costs
D/ Ranked 2nd (second preference option)	• 40.1 km – second shortest alignment • Lowest capital cost largely due to shorter alignment length	• Greater environmental impact expected than preferred Option C • Second longest intersected length of MSA conservation areas (approx. 3.4 km) and impacts required at the Mount Ridley Nature Conservation Reserve • Alignment has second longest impact length through mapped areas of remnant vegetation, threatened ecological communities and habitat for threatened species (approx. 7.7 km) • Alignment also traverses land within the Environmental Significance Overlay, particularly in Mickleham, the southern parts of Donnybrook and north-western parts of Wollert • Alignment would require new crossing at Merri Creek where records of Growling Grass Frog have been identified	• The northern section of the alignment (which is shared with Option B) cuts through the northern growth corridor at Mickleham where urban development and higher density subdivision is present • Residential and industrial tenure required, in addition to tenure through the Mount Ridley Nature Conservation Reserve • Northern section of route co-locates with AusNet 500 kV power easement for approximately 9 kilometres	• Constructability scores relatively well given the alignment's length and avoidance of steep terrain associated with creek beds to the west of the study area • Operability also scores relatively well however is less preferable than Option C given extra complexities being located within the AusNet easement and closer to urban encroachment

Option/Ranking	Route Length/Capital Cost	Environment/Heritage	Land/Infrastructure/Approvals	Constructability/Operability
E/ Ranked 3rd (third preference option)	• 42.8 km – third shortest option • Middle-range capital cost (third highest and lowest)	• Due to its location through established urban areas (disturbed land) this alignment has the shortest impact length through mapped areas of remnant vegetation, threatened ecological communities and habitat for threatened species (approx. 5.5 km). Note this impact length is only 200 metres less than Option C however • Overall Option E is expected to have greater environmental impact than preferred Option C as it traverses approximately 750 metres more through MSA conservation areas than Option C (Option E has approx. 2.3 km impact length through MSA conservation areas compared to approx. 1.6 km for Option C) • This option also intersects land in Epping North covered by the Vegetation Protection Overlay and identified as having high and medium habitat significance at regional and local level; and conservation areas east of Somerton and west of Epping, including part of the Craigieburn Grassland Nature Conservation Reserve • Has the longest impact area of all routes on areas of cultural heritage sensitivity (approx. 5.5 km)	• The alignment comprises the southern-most route of all options considered • The alignment crosses the northern growth corridor just south of the Greenvale Reservoir, traversing established urban areas including Greenvale, Roxburgh Park and Somerton • This alignment would require tenure across a larger number of land holdings compared to other options given its southern-alignment through areas of higher density subdivision • This option largely avoids co-location within the AusNet easement	• This option was scored the poorest in terms of constructability and operability • The alignment traverses constrained urban areas adjacent to Somerton Road, the Greenvale Reservoir, drainage easements bordered by residential areas at Craigieburn/Roxborough Park, and a rail siding at the Somerton Intermodal Terminal • This alignment carries the greatest risk of construction amenity impacts on established residential and commercial uses, and operational risks due to location in congested urban areas

3.9 Confirmation and refinement of pipeline alignment following options assessment

3.9.1 Confirmation of pipeline alignment

Through the MCA process, Option C was identified as the preferred route option and preliminary pipeline alignment (PPA) that would form the basis of further engagement with directly affected landowners and relevant stakeholders.

Despite being the longest route alignment identified (almost 12 kilometres longer than then shortest route proposed) and the second costliest option, Option C was assessed as being the optimum alignment for satisfying key criteria which the Project weighted with the greatest importance, being environment and heritage, community and land considerations. Option C also scored well in terms of constructability and operability overall.

The second preference (Option D) and third preference (Option E) are acknowledged as feasible alternatives for the Project's objectives. These alternatives share part of their alignments with preferred Option C, with the differences in alignment shown in Figure 3-3.

Option D provides the next best route alignment should Option C not proceed. Both routes share a common alignment for the majority of their lengths. The northern section of Option D's alignment is approximately 11 kilometres shorter than Option C and would result in lower overall capital cost for the Project's delivery. Despite this, Option D is expected to result in greater environmental impacts for Victoria and would require direct access to a much larger number of properties than Option C as it cuts across the northern growth corridor further south and much closer to established growth area development.

This alternative would also require tenure through the Mount Ridley Nature Conservation Reserve and a new crossing at Merri Creek with potential impacts on Growling Grass Frog habitat in the area. It would have significantly more environmental impact on endangered ecological communities and remnant native vegetation which have been identified in Mickleham near the Mount Ridley Nature Conservation Reserve, and also in the eastern parts of Mickleham, southern parts of Donnybrook and north-western parts of Wollert. This includes intersects with MSA conservation areas and land affected by various Environmental Significance Overlays in the City of Hume and City of Whittlesea.

This alternative would also face significantly greater construction and operational issues than the preferred Option C, particularly given its approximate 9 kilometre section following the AusNet power easement which would bring increased safety and design constraints to the Project.

Option E shares about 16.5 kilometres of its alignment with Option C then takes the southern-most alignment of all five route options investigated. It is the only route option that cuts directly through established urban development within the northern growth area corridor (near Somerton). Given that the northern (Wollert-end) of its alignment largely traverses established urban areas, this route is expected to have lesser impact to remnant native vegetation than most other routes. The route however does traverse some pockets of higher biodiversity value (endangered and vulnerable ecological communities including the Craigieburn Grassland Nature Conservation Reserve and land covered by the Vegetation Protection Overlay in Epping North).

Option E would require land tenure across a high number of properties including residential and industrial land. It fares poorly in terms of ongoing operability, with higher risk of third-party damage, operational complication and related safety risk, due to its location within constrained areas of established urban growth.

This alternative faces greater construction issues than the preferred Option C, given its passage through constrained pockets adjacent to Somerton Road, the Greenvale Reservoir, drainage easements, and bordering residential areas particularly at Craigieburn and Roxborough Park.

Option C is considered the preferable route option:

- It achieves strong alignment with the objectives of the Pipeline Act and EE Act
- It avoids environmental impacts to the greatest extent possible, particularly to areas of high biodiversity value including the Mount Ridley Nature Conservation Reserve, adjoining MSA conservation areas and Merri Creek
- It avoids requiring land tenure or direct location on properties with established residential, industrial or conservation uses and it traverses a lower number of properties than other options
- It minimises location within existing high-voltage transmission easements which would add design, construction and operational complexity to the Project.

Following confirmation of Option C as the preferred route option, APA progressed this option to the regulatory approvals scoping phase including referral under the EE Act and referral under the EPBC Act to confirm the approvals pathways. Through these processes and the subsequent preparation of the EES and technical studies, the alignment was further refined as outlined in Section 3.9.2.

3.9.2 Refinement of pipeline alignment

Through stakeholder consultation and engagement with landowners and VicRoads (now the Department of Transport (DoT)) from early 2019 and through the EES preparation to early 2021, further route refinement was undertaken with a number of changes being incorporated as a result:

- Minor alignment changes at the crossings of Jacksons Creek, Sunbury Road and Deep Creek to better respond to terrain, more closely follow property boundaries and avoid impacts to urban growth land within the Sunbury South PSP area
- Refinements to the alignment's position relative to the OMR/E6 transport corridor at various locations in relation to the interface between the two projects (as discussed below)
- Amendment of the alignment between Gunns Gully Road and the Hume Freeway to reduce the overall alignment length by following Gunns Gully Road rather than the OMR/E6 transport corridor further to the north to optimise the crossing location at the Hume Freeway.

A risk assessment has been undertaken by APA and the DoT to assess the potential impact of the WORM pipeline on the future development of the OMR/E6 Transport Corridor, based on the preliminary OMR/E6 concept design undertaken by DoT. Where the WORM poses an unacceptable risk to development (design, construction and operation) of the OMR/E6 transport corridor, DoT has provided APA with specific requirements relating to the alignment, design and construction methodology to reduce these risks. These specific requirements, including those outlined further below, have focussed on changes to the vertical and/or horizontal alignment of the pipeline at critical locations and construction specific requirements for works within the OMR/E6 Public Acquisition Overlay (PAO).

DoT's requirements considered during the Project's development phase include, but are not limited to:

- Re-alignment of the pipeline at:
  - Calder Freeway Interchange (KP 9)
  - Oaklands Road (KP 20)

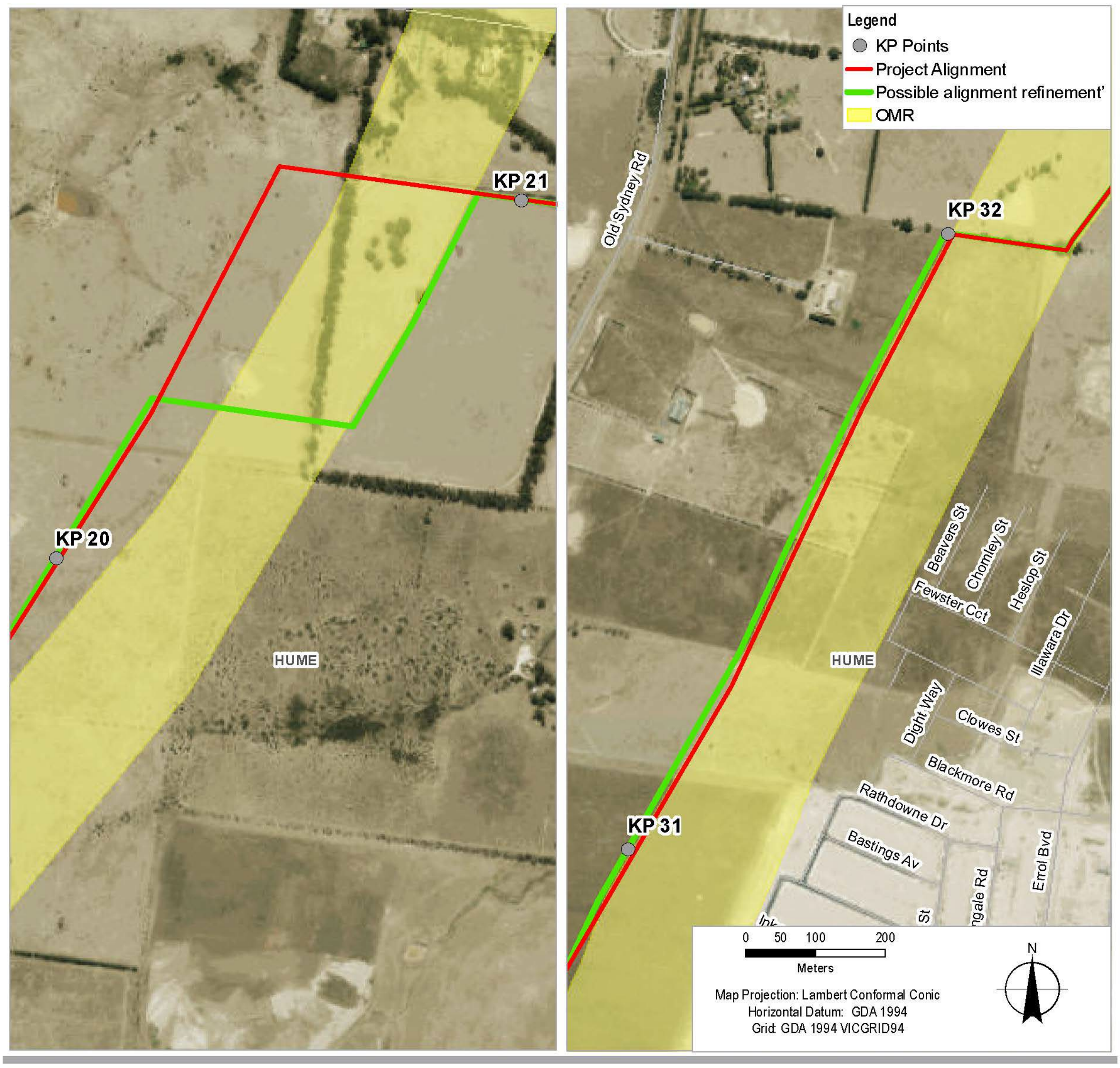
   – Mickleham Road to north of Donnybrook Road (KP 28 to 32)

- The alignment of the pipeline to extend beyond all ramp infrastructure within the PAO with no bends and no access pits within the PAO, unless otherwise agreed with DoT
- Pipeline easement width reduced from 15 metres to 10 metres at locations within the OMR/E6 PAO.

The refinements at Oaklands Road (KP20) and Mickleham Road to north of Donnybrook Road (KP 28 to 32) are illustrated in Figure 3-4. These have not been specifically assessed in the EES but are within the study area of relevant studies. Supplementary assessment would be undertaken as refinements are progressed. Key considerations in reviewing these refinements would be:

- Land parcels – no additional parcels involved
- Heritage – no relevant registered Aboriginal heritage places
- Biodiversity – areas have been surveyed and no additional impacts would be predicted.

Figure 3-4 Refinements in consideration at Oaklands Road and Mickleham Road



Data source: APA, 2020; GHD, 2020'; DELWP, Vicmap, 2020 Created by:kgardner

The route has also been further refined in response to additional field surveys (including biodiversity and cultural heritage) and design/constructability assessments undertaken between mid-2019 and early 2021 including through the EES technical study assessments with adjustments in pipeline alignment to:

- Avoid established tree-lines along some property boundaries and scattered native trees
- Reduce the construction footprint impacts of the pipeline (refer Section 3.11.3)
- Avoid dams and wetlands
- Reduce pipeline crossing lengths/construction footprints across established roads or waterway crossings (requiring introduction of some right-angle bends in the pipeline)
- Avoid suitable habitat for protected fauna under state and federal legislation including refined alignment of the pipeline to avoid 2.8 ha of grassy woodland including 10 large trees at five locations (KP 22.6, KP 8.7, KP 14.8, KP 28, KP 41)
- Avoid grassland protected under state and federal legislation or other native vegetation including refined alignment of the pipeline at Bulla-Diggers Rest Road (KP 10.6 – 10.8 and KP 11.5 – 12), St Johns Road (KP 18.9 – 19.1), Oaklands Road (KP 20.1 – 21.3), Donnybrook Road (KP 29 and KP 33)
- Avoid Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains (SHWTLP)
- Minimise clearing of riparian vegetation through siting in existing disturbed area at Merri Creek and reducing corridor width from 30 metres to 20 metres at Jacksons Creek.

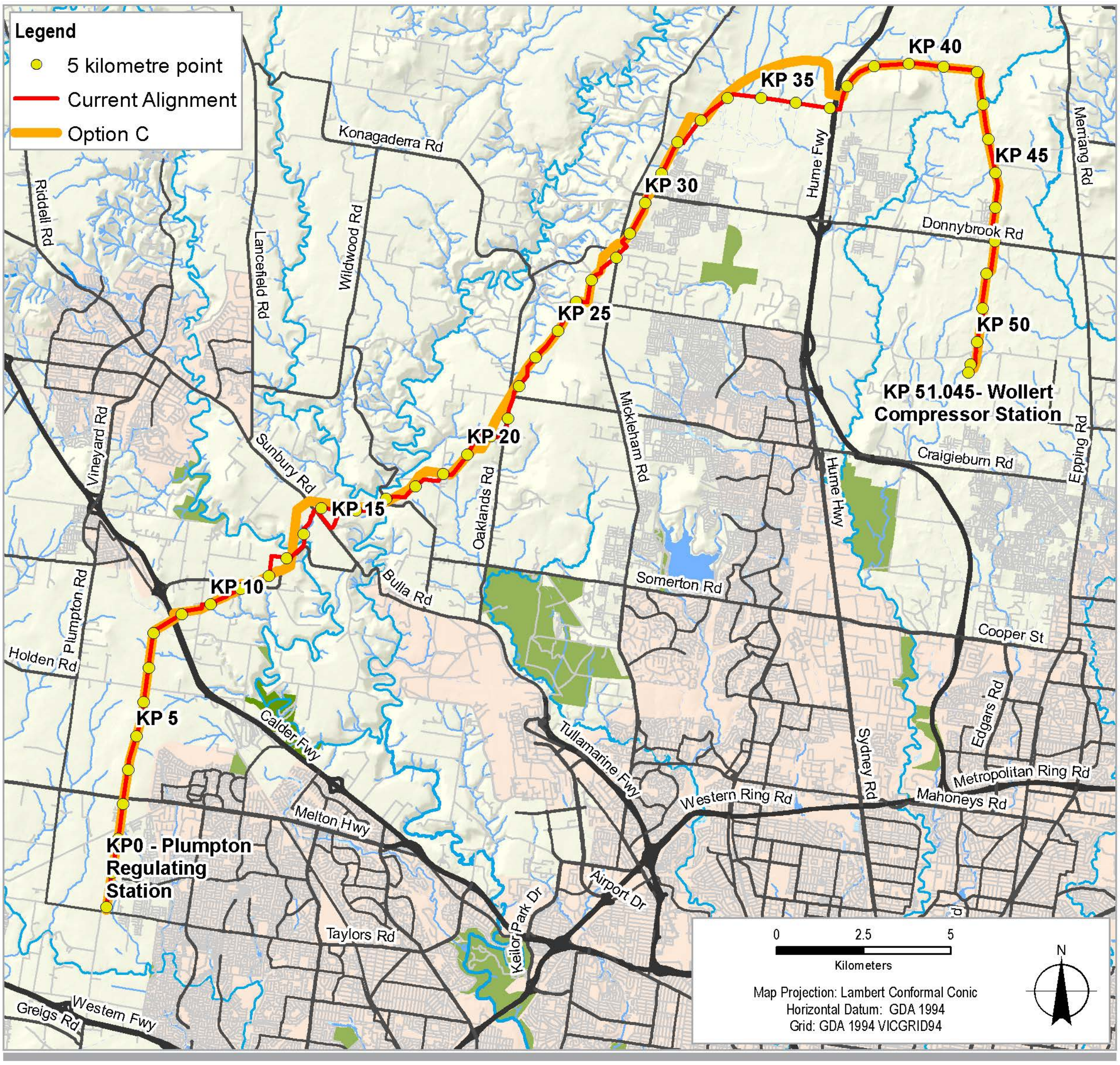
In considering all pipeline alignment refinements outlined above, APA assessed the social and environmental impacts of the refinements including:

- Additional landowners involved in the change, landowner engagement and potential impacts to landholders
- Biodiversity desktop assessment and field survey where necessary (where potential biodiversity impact and outside the MSA) to understand the existing vegetation and habitat and potential impacts
- Cultural heritage review of archaeological potential
- Constructability and associated environmental impacts such as geotechnical conditions.

The adjustment between Option C and the final alignment assessed in the EES is shown in Figure 3-5.

Further alignment refinements would continue to be considered as stakeholder and landowner engagement continues and detailed design is progressed.

Figure 3-5 Option C and refined option in EES



Data source: APA, 2020; GHD, 2020'; DELWP, Vicmap, 2020 Created by:sacevedo

3.10 Confirmation of above ground facilities

Above-ground facilities required for the Project include three main line valves (MLV) and facilities at the Wollert Compressor Station.

The location of MLV is broadly driven by the guidance in AS/NZS 2885.1 for the lengths of pipeline between MLV in urban areas. The considerations for the specific location of each MLV is the operability and maintainability of site. This consideration usually locates MLV adjacent to roads for ease of access by vehicle and mains power. The MLV equipment and layout is a standard design used for MLV on all parts of the VTS.

The existing Wollert compressor station has 3 Solar Saturn gas compressors in Station A, and 2 Solar Centaur 50 gas compressors in Station B. The additional compressor would be installed within Station B area, in the hard stand area to the west of the existing 2 compressors and an end of line scraper station and a regulating station in the City Gate area to the north of the facility. All new equipment proposed would be installed within the existing APA facility at Wollert with siting driven by the arrangement of the existing facility. Following ecological and cultural heritage surveys undertaken between July 2019 and February 2020, the proposed construction footprint for the upgrade of the Wollert compressor facility has been revised to avoid an area of cultural heritage sensitivity and minimise impact to a patch of trees.

3.11 Development of design and construction methodology

This section presents options considered in the development of design for the pipeline and for the Wollert Compressor Station, and options considered for key aspects of construction methodology, including trenched and trenchless construction techniques. The factors that contributed to the selected design and construction techniques are outlined below.

3.11.1 Pipeline diameter

APA's original design was based on a 500 mm diameter pipeline.

In early 2021, AEMO and APA were requested by users of the Victorian gas Declared Transmission System through the Victorian Gas Planning Report process to consider expansion options to address the probable gas supply scenarios. One of these expansion options was to utilise a 600 mm diameter pipeline instead of the proposed 500 mm pipeline. It was considered that the increased diameter would:

- Increase ability in the future for the South West Pipeline to respond to changes in gas supply under a staged approach
- Provide winter demand gas and security of supply for peak demand services
- Provide for future sources of gas to the East Coast Gas Grid
- Assist with more efficient outcomes of capital deployment, considering the Victorian regulator model associated with this asset base.

The width of the construction corridor for the 500 mm diameter pipeline would be sufficient to accommodate the construction of a 600 mm diameter pipeline. The construction corridor would require minor revisions to the area at two HDD locations to accommodate the greater bending radius of the 600 mm pipeline. The HDD pit would be slightly larger at:

- Melton Highway, where the construction corridor would extend on either side by approximately 30 m compared to the 500 mm option
- Deep Creek, where the construction corridor would extend by approximately 30 m on the eastern side across Wildwood Road compared to the 500 mm option.

The physical differences between the 600 mm diameter pipeline design and 500 mm diameter pipeline alternative options are summarised in Table 3-4.

A slightly deeper and wider trench would be required to accommodate the 600 mm diameter pipeline design. There would be no difference in construction equipment or duration of activities between the 600 mm diameter pipeline design and 500 mm diameter pipeline alternative scenarios.

The 600 mm diameter pipeline design has been assessed in the EES as this would be the slightly extended impact compared to the 500 mm option.

Table 3-4 Pipeline design factors – 500 mm and 600 mm

Pipeline design factors	DN600	DN500
Pipe size (mm)	610	508
Wall thickness (mm)	13.4	12.7
Grade	X52	X52
kg/m	197.14	155.12
Length (km)	51	51

3.11.2 Compressor technology and engine alternators at Wollert Compressor Station

The compressor selection is based on the required compression power requirements for the Project. When compared to steam-turbines and diesel propulsion systems, the Solar Centaur 50 Gas Turbine (GTC) offers greater power for a given size and weight, high reliability, long life, and offers a more convenient operation.

No two vendors will produce identical machines for direct comparison of power output vs thermal efficiency. However, the thermal efficiency of the selected GTC is considered industry best practice and it is also within the typical Simple Open Brayton Cycle operating envelopes for gas turbines. It is representative of a best practice, effective and efficient compression equipment for a typical long-distance gas pipeline. Solar Turbines is a reputable international company with a long history of supply, service and overhaul of gas compression and gas turbine equipment in Australia.

The design development assessed the GTC and an alternative electric drive compressor for the new additional compressor unit at Wollert. The compressor option selection process considered the required compression power requirements for the Project, consistency with technical assessments already undertaken for the EES, environmental impacts relevant under the scoping requirements, and both the development and ongoing costs.

When compared with the GTC, the electric drive option had generally lower air emissions than the equivalent GTC. However, it required additional electrical infrastructure to support power to the equipment, including approximately 100 metres of overhead 66kV sub-transmission feeders from Summerhill Road and support structures, an electricity substation, a transformer at Summerhill Road and underground cabling. The electric drive option was also predicted to generate higher noise emissions based on a qualitative assessment of the equipment involved.

Based on the compression power requirements, efficiency, and potential environmental effects, the GTC technology was selected.

Diesel Engine Alternators (DEA) and Gas Engine Alternators were alternative technology options considered for backup power supply. DEAs were selected as the better alternative due to quicker instantaneous start up time, less maintenance issues and being more cost effective. Both alternatives were considered in the EES air quality assessment (Technical report G Air quality).

3.11.3 Pipeline depth

The minimum pipeline depth of cover along the pipeline alignment is selected based on the following factors and guidelines

- Guidelines within AS/NZS2885.1:2018
- Crossing requirements of local authorities and third party utility/asset owners
- SMS study workshop outcomes
- Construction efficiency adjustments.

While the standard 750 mm depth of cover would apply to most of the pipeline, an increased depth is provided beneath major watercourses, road and rail crossings for protection of both the pipeline and third party asset. The minimum depth would be selected based on consideration of the above criteria and engagement with third party asset owners.

Where the pipeline crosses the OMR/E6 PAO, the following depth of cover would apply:

- Range from 1.2 metres to 5 metres from the surface level to the obvert level of the pipe
- Depth requirements will be determined during detailed design with due consideration to location specific matters such as future transport and drainage infrastructure requirements.

3.11.4 Construction methodology

Construction corridor width

In some locations, the construction corridor width has been refined and/or reduced in response to localised considerations, in particular relating to biodiversity values.

The application of the standard 30 m wide construction corridor or a reduced width was confirmed following consideration of constructability and environmental benefit. This was informed by workshopping with ecological specialists and APA design and construction teams.

Key locations where the construction corridor has been reduced to avoid and minimise impacts on significant environmental values include:

- Jacksons Creek reduction from 30 m to 20 m
- Merri Creek reduction from 30 m to 25 m
- Conservation Area 34a in the Northern Growth Corridor (KP 42.5 – KP 43.3) reduction from 2.49 ha to 2.39 ha
- KP 23 area micro-realignment to avoid several large trees and reduction of width from 30 m to 25 m to avoid native vegetation impacts
- Wollert Compressor Station reduction by 1.25 ha to avoid the population of Tough Scurf-pea
- Morefield Court (KP 11) by 0.20 ha containing known Striped Legless Lizard from 0.69 ha to 0.49 ha
- Eight parcels where Golden Sun Moth have been confirmed to occur (Calder Freeway road reserve, KP 8.7; Duncans Lane, KP 9.6; Sunbury Rd, KP 14.8; St Johns Road road reserve, KP 18.9; Oaklands Road, KP 21.6; Craigieburn Road, KP 22.6; 2LP130336, KP 51; 1PS733045, KP 22.6; North Eastern Line rail reserve, KP 41; Donnybrook Rd, KP 47) – reduction in width of 3.76 ha.

Trenched and trenchless construction methodology

In some cases, due to the presence of areas of high ecological significance, existing assets or other constraints, the pipeline would be constructed using trenchless construction techniques such as horizontal directional drilling (HDD) or shallow horizontal boring, to avoid construction disturbance within the sensitive area.

Key areas where trenchless construction techniques would be used instead of the regular open trench technique include:

- Selected watercourses
- Sealed road crossings, to avoid traffic disruption.

In considering crossing methodology alternatives, a number of factors contribute to the selection of appropriate construction techniques. Particular consideration was given to trenchless construction options at the crossings for the three main waterways, Deep Creek, Jacksons Creek and Merri Creek. Table 3-5 outlines the relevant factors and how they contributed to assessment of construction options at Jacksons Creek, Deep Creek, and Merri Creek.

All crossings where trenchless construction would be used are set out in Chapter 4 *Project Description.*

Table 3-5 Factors in deciding crossing technique – Jacksons Creek, Deep Creek and Merri Creek

	Factor	Comment
1	**Geology** – the type of geology at a crossing location determines the risk of pipeline construction methodologies.	**Jacksons Creek:** Geotechnical investigation conducted at Jacksons Creek indicated layers of gravelly sand and gravel layers. This type of geology is considered a significant risk to HDD techniques, as it is not conducive to maintaining borehole stability. **Deep Creek:** Geotechnical investigation conducted at Deep Creek indicated extremely weathered Siltstone and Mudstone layers. This profile should provide a good medium for drilling however Sandy Gravel/Gravel layers indicated in some geotechnical boreholes may pose some stability issues. **Merri Creek:** Geotechnical investigations at Merri Creek indicated some presence of gravely clay within 2 metres depth, overlaying basalt. Given this underlying presence of bedrock, the risk of erosion is lower, and therefore open trenching can be readily managed with standard controls.
2	**Length of pipeline crossing** – selection of an overall HDD length takes into consideration the pipe radius limiting stresses imposed on the pipe, adequate cover under the creek and exit angles to reduce pipe over bend.	**Jacksons Creek:** The depth of cover below the lowest point of the creek would be 2 metres. The angle of the approach for the creek crossing for a pipe of this size (600 mm) and grade of steel would require a bore length of more than 460 metres to achieve the required minimum pipe string radius in order to avoid compromising the integrity of the steel pipe and its corrosion protective coating. Drilling over this length, and in the gravelly geological conditions that would be encountered, would significantly increase the risk of multiple uncontrolled fluid losses to the surrounding environment being experienced (see Hydrofracture). **Deep Creek:** The total length of HDD at this location would be approximately 400 m. Construction footprint at the HDD entry and exit pit locations on each side of the Creek would need to be maintained for HDD rig set up and access of around 50 m by 100 m due to existing terrain conditions. **Merri Creek:** The total length of HDD at this would be approximately 300m (based on achieving a minimum depth below the lowest point of the creek and required entry/exit angles). Construction footprint at the HDD entry and exit pit locations on each side of the Creek would need to be maintained for HDD rig set up and access of around 50 m by 50 m compared to a 30 m standard width construction corridor.

	Factor	Comment
3	**Hydrofracture risk** – this is influenced by the geological conditions. Drilling fluid (generally a bentonite based fluid) is required to assist in the drilling process, and in areas of fractured rock, or in areas where the rock is at risk of fracturing, may escape from the drill hole to surface waters or the surrounding environment (known as a 'frac-out'). The exit points from such fracture points need not be limited to the immediate area of the drill so that, depending on site specific fracture paths, the discharge point of the fugitive fluid may be tens to hundreds of metres from the actual drill path. Hydrofracture can also cause significant problems with maintaining borehole stability, affect cutting carrying capacity of the drilling fluid and thereby reducing its ability to clean the borehole. These issues would have a significant impact on the ultimate success of the bore.	**Jacksons Creek:** Hydrofracture is considered a major risk for Jacksons Creek crossing, due to the gravelly geological conditions posing a risk not only to bore stability but also hydrofracture. **Deep Creek:** Risk of hydrofracture for Deep Creek is considered low as the alignment is positioned for the majority of its length in the 'Extremely Weathered Siltstone/Siltstone' strata and the depth of cover under creek minimum 16 metres. **Merri Creek:** Risk of hydrofracture if HDD were adopted is considered moderate at this location due to the presence of gravelly clay, however a detailed assessment has not been undertaken.
4	**Exit angle requirements** – the exit angle of the pipe when it is pulled back through the HDD borehole can cause damage or failure of the pipe if the bend is too great at its highest point. The aim is to keep the exit angle as flat as possible to reduce the height of the overbend required to facilitate the pulling of the pipe into the borehole.	**Jacksons Creek:** To facilitate the drill exiting the ground prior to change in alignment direction, a steep exit angle would be required. The proposed exit angle is much steeper than what would generally be recommended and would create issues with management of the tail string, as well as overbend management (length and height of drill need to stay within an acceptable bend radius). **Deep Creek:** No overbend would be required as the exit angle has been designed to match the upslope beyond the exit point. **Merri Creek:** A detailed HDD assessment has not been undertaken however overbend is expected to be mitigated through design of entry and exit angles at this location.

	Factor	Comment
5	**Pipe stringing and pull back arrangement** – to minimise damage to the pipeline during the HDD pullback process, it is preferable to string out the pipe in one full length to facilitate ease of insertion into the borehole. This may require additional construction space to be able to set up pipe stringing for HDD, depending on the angle of the pipeline alignment and terrain.	**Jacksons Creek:** In order to minimise risks during the drilling process, it is preferable to string out the pipe in one full length to achieve a continuous pipe pull operation. To lay out the full pipe string (more than 460 metres), the pipe would need to be placed in a direct line north of the proposed exit pit location (north of Jacksons Creek). This would take the pipe string outside the designated construction corridor through the landowner's paddock, currently being utilised for the cultivation of wheat, and would require significant additional temporary construction footprint to accommodate the HDD entry and exit pits and set up areas. **Deep Creek:** At the exit location to keep the pipe string within the designated construction easement two strings would be required as there is not enough room beyond the exit point location before the pipe alignment turns to the west. **Merri Creek:** Pipe string would be kept within the designated construction corridor as the pipeline alignment is straight (additional space so no additional space required for HDD stringing is not required). A HDD option would require an access track for construction of the pipeline between the Merri Creek and Beveridge railway crossing to the north of Merri Creek (between approximately KP 41 to KP43). APA has considered two options for access to complete all works between KP 41 - KP 43: • Option 1 - utilise the VNIE easement to construct a new access track (3.4 km length x 5-10 m wide) from Beveridge Road. This would require a larger construction footprint to be utilised with additional impacts from the stripping topsoil and vegetation removal to create an all-weather access track for construction. This will also require negotiations with new landowners for the Project along the access track within the VNIE easement. • Option 2 - install temporary access track over Merri Creek with a 5-10 metre width. This would require stripping of topsoil and vegetation removal directly in and on either side of Merri Creek. This would also require placement of rock and flume pipe in the creek to facilitate temporary access for construction. Utilising Merri Creek via Option 2 to get access will have a smaller footprint rather than introducing a 3.4 km access track as described in Option 1. An open trench option would not require use of the VNIE easement to create an additional access track (as per option 1) an additional access track, as APA would utilise the construction corridor for access (south of Merri Creek from Donnybrook Road). The construction footprint required for an open trench option would be reduced to 25 metres width corridor directly within the Creek to minimise impacts. This is proposed to occur in a previously disturbed section of the creek corridor which is an existing APA easement. This is a smaller footprint than Option 1 and a similar footprint to Option 2. To avoid any direct impacts on Merri Creek a 3.4km access track will need to be constructed to the north of the creek to complete all works between KP 41 to KP43.

	Factor	Comment
6	**Environmental conditions and geomorphology** – environmental conditions can include terrestrial and aquatic habitat, flow conditions, slope and geomorphology of the riverbed and riverbanks, which can influence the type of construction technique considered.	**Jacksons Creek:** The riparian woodland vegetation on the west bank is intact, dense and has a healthy mix of deep-rooted trees and ground cover vegetation. The east bank is more open and exposed with limited ground storey vegetation. The field assessment recorded scattered native shrub and tree species (*Eucalyptus* species) flanking Jacksons Creek in the vicinity of the proposed waterway crossing. Large trees which provide important habitat value have also been recorded inside (one) and near the construction corridor. Some clearing of vegetation is evident and the pipeline crossing falls in the most degraded part of the creek, where Growling Grass Frogs are least likely to occur. Open trench construction would disturb Growling Grass Frog habitat whereas HDD would not. Platypus are known to be present in Jacksons Creek. However, the field assessment indicated the overall condition of the waterway is poor, with the presence of a silt layer in-stream further lowering the quality of habitat present at this waterway. Impacts associated with open trench construction at Jacksons Creek on flora and fauna values are assessed in 7.6.4, 7.6.6 and 7.6.8 of Chapter 7 *Biodiversity*. Within the upstream reach there is a sharp meander bend in the creek and some minor erosion of the stream banks evident. A grade rock structure providing protection to the stream bed is located immediately upstream of the Project. The Project location is within a relative straightened reach of stream. Two sections of riffles are characterised by shallow depths with fast, turbulent water agitated by rocks and vegetation. The reach scale geomorphology at Jacksons Creek contains alluvial terraces on both sides of the stream and is known to be sensitive and therefore some ongoing bed and bank erosion processes are expected. The modelled channel velocities are greater than 1.5 m/s and water pressure is greater than 300 newton per square metre (Nm^2), indicating a relatively high potential for stream bed and bank erosion. Given the steep gradient of the channel within this reach and steepening of the gradient moving further upstream form the Maribyrnong confluence, there is a higher erosion potential for Jacksons Creek compared to Deep Creek or Merri Creek. Specific additional control measures would need to be developed to reduce the likelihood of erosion at the Jacksons Creek crossing. Erosion impacts to river health, surrounding property and infrastructure associated with open trench construction at Jacksons Creek are assessed in section 8.8.3 of Chapter 8 *Water*.  *Jacksons Creek looking east, immediately downstream of crossing location. Source: site photo (GHD, 2020)*

	Factor	Comment
		Deep Creek: The riparian woodland vegetation of both banks is intact, dense and has a healthy mix of deep-rooted trees and ground cover vegetation. On the west side the riparian zone is protected, and the east bank is more exposed. The field assessment recorded scattered native shrub and tree species (*Eucalyptus* species) flanking Deep Creek in the vicinity of the proposed waterway crossing. Large trees which provide important habitat value have also been recorded both inside and near to the construction corridor. Growling Grass Frogs have been recorded within Deep Creek. There is a low likelihood of platypus being present in Deep Creek. The field assessment indicated the overall condition of the waterway is poor. The Project crossing location is within a relatively straightened section of the stream which extends from the Emu Creek confluence upstream and continues downstream. There is a section of riffles characterised by shallow depths with fast, turbulent water agitated by rocks and vegetation. The reach scale geomorphology at Deep Creek also contains alluvial terraces and is known to be sensitive and therefore some ongoing bed and bank erosion processes are expected. The modelled channel velocities are greater than 1.5 m/s and stream powers are greater than 300 Nm^2, indicating a relatively high potential for stream bed and bank erosion.  *Deep Creek looking west at crossing location. Source: site photo (GHD, 2020)*

	Factor	Comment
		Merri Creek: The riparian woodland vegetation of the banks and channel is dense with a healthy mix of deep-rooted trees and ground cover vegetation along the waterway, which provides protection of both sides of the waterway. The field assessment recorded native shrub and tree species (Tea tree *Leptospermum* species and *Eucalyptus* species) flanking Merri Creek in the vicinity of the proposed waterway crossing. Large trees which provide important habitat value have also been recorded near to the crossing. The crossing area does not contain large trees or shrubs. The crossing area is within a Growling Grass Frog Conservation Area established under the Biodiversity Conservation Strategy which would be disturbed at the crossing due to open trench construction or with temporary access (Option 2) proposed for HDD construction. There is a low likelihood of platypus being present in Merri Creek. The field assessment recorded varying in-stream habitat quality, with aquatic habitat in the vicinity of the pipeline crossing being of poor quality. Impacts associated with open trench construction on flora and fauna values at Merri Creek are assessed in sections 7.6.4, 7.6.6 and 7.6.8 of Chapter 7 *Biodiversity.* Within both the upstream and downstream reaches there are sharp meander bends. The Project crossing location is on a meandering section of Merri Creek which continues downstream, with relatively quiet water flowing through a thickly vegetated stream bed. There is a section of riffles characterised by shallow depths with fast, turbulent water agitated by rocks and vegetation. At the location of the construction corridor, the creek is ephemeral. The reach scale geomorphology is very different to Jacksons and Deep Creek due to the large exposures of basalt in the channel walls. The modelled channel velocities are less than 1.5 m/s and stream powers are expected to be low, indicating a lower potential for stream bed and bank erosion compared to Jacksons Creek and Deep Creek. The presence of basalt at relatively shallow depths would also limit the depth and extent of future bed erosion. Erosion impacts to river health, surrounding property and infrastructure associated with open trench construction at Merri Creek are assessed in section 8.8.3 of Chapter 8 *Water*.  *Merri Creek at pipeline crossing location looking north. Source: site photo (GHD, 2020)*
7	**Demonstrated potential for rehabilitation**	**Merri Creek:** The crossing location would be co-located with an existing APA pipeline easement that was previously trenched in 2014. The rehabilitation works associated with this previous pipeline construction have been effective and remain stable, where the works are now concealed by vegetation cover. APA has not undertaken similar works previously at Jacksons Creek or Deep Creek.

Following the assessment, it was determined that Jacksons Creek and Merri Creek would be constructed using open trench methodologies and Deep Creek would be constructed using HDD methodology. Trenchless construction methodology has lower environmental impact at the crossing point as it does not require disturbance directly to the watercourse and hence would minimise impact to the existing waterway and surrounds. HDD does require an area for entry and exit pit locations and set up areas. HDD methodology must be technically feasible to be considered as an option.
A summary of the key considerations for the selected methodology is provided in Table 3-6.

Table 3-6 Selected methodology - summary of key considerations

Location	HDD	Open trench	Selected methodology
Jacksons Creek	Potential for high risk of hydrofracture due to the geology not being conducive to maintaining borehole stability. Overbend of pipe required at exit. Requires additional construction footprint for pipe stringing in private property currently used as a wheat cultivation paddock.	Relatively high potential for stream bed and bank erosion based on modelled flows of greater than 1.5 m/s. Some riparian woodland and large trees present that could provide fauna habitat, however the selected pipeline alignment crossing proposed falls in the most degraded part of the creek and the quality of habitat in the waterway is poor.	Open trench – has been selected due to major risks associated with HDD. Specific environmental mitigation measures and rehabilitation proposed for the Project will manage risks associated with erosion for works in waterways.
Deep Creek	Low risk of hydrofracture due to the geology providing a good medium for drilling, with some potential stability issues. No overbend required. No additional construction footprint required for stringing of the pipeline.	Relatively high potential for stream bed and bank erosion due to modelled flows of greater than 1.5 m/s. Some riparian woodland and large trees present that could provide fauna habitat. Growling Grass Frogs have been recorded within Deep Creek.	HDD – geology at this location would enable drilling to avoid the relatively fast-flowing waterway and minimise environmental impacts directly in watercourse.
Merri Creek	Moderate hydrofracture risk due to geology. Overbend not expected. Requires a new temporary access track (3.4 km x 5-10 m wide) from Beveridge Road to facilitate construction of HDD works and pipeline construction between the railway line and Merri Creek (KP 41-43) or as an alternative a temporary access track would need to be constructed across Merri Creek for the duration of construction works.	Low potential for erosion due to presence of basalt at relatively shallow depths and modelled flows of less than 1.5 m/s. Some riparian woodland and trees present in the vicinity of the proposed pipeline that could provide fauna habitat, however the habitat in the immediate vicinity of the proposed pipeline crossing is of poor quality. Works within the watercourse will be undertaken within the existing APA easement that currently exists for the VNIE pipeline. The VNIE pipeline has been previously open cut in this area and reinstated.	Open trench – has been selected to minimise any additional impacts associated with additional access requirements. Temporary access across Merri Creek is required to facilitate construction works between the rail crossing and Merri Creek (KP 41-43). Works will be contained within an existing APA easement directly in Merri Creek to minimise additional impacts. Specific environment mitigation measures and rehabilitation proposed for the Project will manage risks associated with erosion for works in waterways.

3.12 Obtain regulatory approvals

This EES is the key assessment process to inform regulatory approvals for the Project under Victorian and Commonwealth legislation.

Further information on the Legislative Framework and EES Assessment Framework applicable to the Project can be found at Chapter 5 *Evaluation and assessment framework*.

3.13 Construction and operation of pipeline

Subject to obtaining all required regulatory approvals for the Project, the Project is expected to be constructed over a period of six to nine months and be operational by mid-late 2022.

Prior to construction, APA would secure land access for the pipeline construction and easement, and acquire land for the three MLVs. The acquisition of land for the Project MLVs is minor and small in size. While part of the Project is in existing easement area (between KP 0 – KP 8.8 and KP 41.1 – KP 51), a new easement would be reserved for the area between KP 8.8 and KP 41.1. EMM LU3 provides for compensation for land would be agreed and paid to directly affected landholders and provided in accordance with the *Pipelines Act 2005* and the *Land Acquisition and Compensation Act 1986*. Engagement with directly affected landholders commenced in 2018 and would continue with individual negotiations through to agreement.

The construction and operation are described in Chapter 4 *Project Description*. Following appointment of a construction contractor, construction methodology would be developed and refined further in accordance with the Project approval conditions.

3.14 What if the Project does not proceed ('no-project' scenario)?

As discussed in Chapter 2 *Project rationale*, AEMO have identified in the *Victorian Gas Planning Report 2020* and *Victorian Gas Planning Report 2021* that Victoria is at risk of a gas supply shortage during high-demand periods from winter 2023 onwards due to a combination of uncertainty in future gas supply for the state, and also network capacity constraints including the lack of a high-pressure gas connection between the Iona UGS and the balance of the VTS system in Victoria's north and east.

If the Project (as proposed or a feasible alternative route) does not proceed and a high-pressure connection is not established prior to winter 2023, then gas supplied from future sources which are largely expected to occur in Victoria's east would need to continue to be transferred through the low-pressure pipeline network of central Melbourne in order to be stored at the Iona UGS for winter.

Despite adequate gas supply in Victoria's east, the existing network capacity constraints would mean that the amount of excess gas that can be transferred from the east to the west over summer would be limited and would not be sufficient to meet Iona UGS's storage requirements for Victoria's winter peak in gas demand from 2023.

This would result in a further tightening of the supply-demand balance for gas and result in adverse energy security, efficiency and affordability in Victoria as potential gas shortages over winter would impact households, businesses and also the ability of gas-fired power generators to produce alternative forms of energy for Victorians when they need it most. More efficient gas transmission would also facilitate the development of the renewable energy sector (refer to Section 2.3.3).

As discussed in Chapter 2 *Project Rationale*, the Victorian Government has highlighted the importance of gas security, reliability and affordability in supporting the State’s transition to a cleaner energy future. Should the Project not proceed, renewable energy facilities which use gas-fired peaker power stations to provide a firm back-up supply to support intermittent renewable generation, may face operational challenges and uncertainty, both in times of peak demand and as the renewable energy sector continues to develop over the coming years. The Project focuses on stabilising the supply-demand balance for gas by enhancing the operational efficiency of Victoria’s network infrastructure and efficiently transferring gas volumes around the state to meet Iona UGS's storage requirements. No direct changes to gas production rates or user demand across Victoria are expected to occur as a result of the network improvement works.

The Project supports the important role gas would continue to play in the state’s energy mix – acknowledging gas comprises a small yet critical component of this mix.

Further information on the Project rationale and the implications of the no-project scenario is provided in Chapter 2 *Project Rationale*.

This EES has documented a comprehensive assessment of the predicted benefits and adverse impacts from the construction and operation of the Project. These potential residual impacts are described in the impact assessment Chapters 7 to Chapter 18 and related technical reports. Chapter 20 *Conclusion* provides an overview of the Project's predicted impacts.

Key predicted impacts that would not occur if the Project does not proceed include social impacts caused from construction. Impacts include:

- Temporary impacts to residents and communities from construction noise, vibration or dust emissions during construction
- Temporary changes to amenity for residents and the community and community facilities as a result of the Project's construction activities
- Temporary occupation by construction activities, could impact agri-business and reduce property productivity
- Property access could be disrupted to a small number of properties with changed access arrangements required.

Key predicted permanent impacts that would not occur if the Project does not proceed include:

- Environmental impacts caused by disturbance or removal of native vegetation and fauna habitat, and disturbance of waterways
- Impacts to existing Aboriginal cultural heritage.

Should the Project not proceed, these predicted environmental and social impacts would not occur.