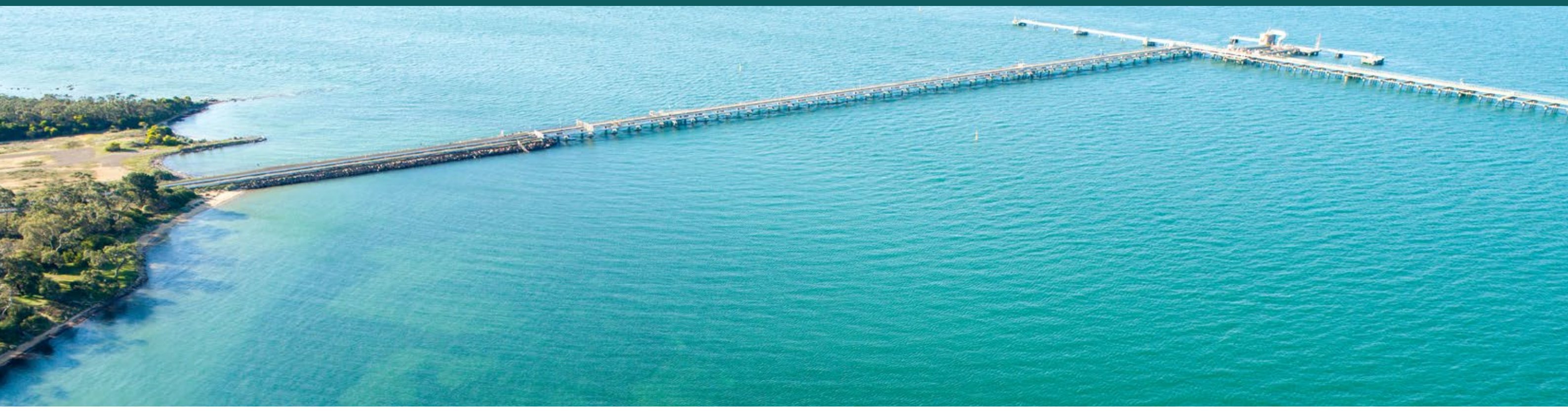
Chapter 3
Project development



3.1 Introduction

This chapter describes the development of the Gas Import Jetty and Pipeline Project (the Project) and provides a rationale for the current form of the Project selected for assessment in this Environment Effects Statement (EES). This chapter presents an overview of the identification and evaluation of feasible design alternatives for components of the Project, including relevant environmental considerations.

An explanation of the selection of the floating storage and regasification unit (FSRU) approach in preference to a land-based alternative and the rationale for selecting the proposed site for the FSRU is provided in **Chapter 2** *Project rationale*. Also included in **Chapter 2** *Project rationale* is an explanation of the selection process for the proposed pipeline alignment.

3.1.1 Relevant EES scoping requirements

Section 3.4 of the EES scoping requirements for the Project require that the EES should document the proponent's consideration of feasible alternatives and include an explanation of how specific alternatives were shortlisted for evaluation within the EES. The scoping requirements also require that the EES investigate and document the likely environmental, social and economic effects of the alternatives, particularly where these offer a potential to achieve beneficial environmental, social and economic outcomes and can meet the objectives of the Project.

Specifically, the scoping requirements require that:

- The effects of the preferred form of the Project be compared to those of other alternatives or to a 'no project' base case.
- Where appropriate, the assessment of environmental effects of feasible design alternatives address the matters set out in the scoping requirements.

In addition, 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 Project objectives.

Table 3-1 sets out the scoping requirements relating to the proponent's consideration of feasible alternatives and identifies where in the EES these have been addressed. The effects of the preferred form of the Project have been compared to alternatives and/or to a 'no project' base case in relevant EES assessments found in **Chapter 6** to **Chapter 22**.

Table 3-1: Relevant scoping requirements and where addressed in the EES

Scoping requirement	Where addressed in the EES
Documentation of the basis and rationale for the proposed Project	**Chapter 2** *Project rationale*
An explanation of the selection of the FSRU approach in preference to a land-based alternative	**Chapter 2** *Project rationale*
An explanation of the rationale for selecting the proposed site for the FSRU	**Chapter 2** *Project rationale*
An explanation of the rationale for selection of the proposed mode of regasification from the range of available options including variations in the FSRU design and potential to use a combination of both closed and open loop systems	**Section 3.2.4** of this chapter
An explanation of selection process for the proposed pipeline route	**Chapter 2** *Project rationale*
Identification and evaluation of design alternatives for any components of the Project	**Chapter 3** *Project development*
Environmental considerations, including a comparative description of the effects of each alternative on Matters of National Significance (MNES)	**Chapter 3** *Project development* Relevant environmental assessments set out in **Chapter 6** to **22**
Discussion of short, medium and long-term advantages and disadvantages.	**Chapter 2** *Project rationale* **Chapter 3** *Project development* Relevant environmental assessments set out in **Chapter 6** to **22**

3.1.2 Overview

As set out in **Chapter 2** *Project rationale*, the following investigations were carried out by AGL and APA in developing the Project:

- feasibility studies to import liquefied natural gas (LNG) as an alternative gas supply
- assessment of different LNG regasification and storage technologies, including onshore and floating options
- evaluation of potential sites for onshore storage or an FSRU
- a detailed selection process for the pipeline alignment.

The Crib Point Jetty and immediately adjacent landside area makes use of the existing, available infrastructure in a contextually appropriate setting (Port zoning and adjacent to the former BP refinery land). Potential environmental impacts are minimised as no dredging would be required and the landside facility would be able to be established on an already highly disturbed landside footprint.

The proximity of the Crib Point Jetty allows for connection of a new supply source into the Victorian gas market, ensuring security and reliability of gas supply to south-eastern markets.

The location is also a Ramsar site (Western Port Ramsar site) and so requires development to be particularly sensitive to its environs.

Using the Crib Point site as the starting point, APA investigated pipeline alternatives and land access options to identify the optimal routing of the pipeline to connect into the Victorian Transmission System (VTS).

Project design alternatives have been assessed having regard to the likely environmental, social, economic and safety effects and in consideration of key Project outcomes such as gas market requirements, cost, program implications and necessary approvals.

Following the assessment and selection of the FSRU approach and proposed site, the following investigations were carried out:

- design development of the proposed Gas Import Jetty Works, including the seawater intake and discharge on the FSRU
- assessment of regasification alternatives
- identification and evaluation of design alternatives for the Pipeline Works.

Further information on these investigations is provided in the following sections.

3.2 Gas Import Jetty Works design development

The following sections describe key aspects of the Gas Import Jetty Works design development including seawater intake and discharge port design, identification and assessment of regasification modes and the selection of the proposed regasification mode for the FSRU.

Once Crib Point Jetty was selected as the preferred site for the FSRU, key features of the FSRU including the seawater intake and seawater discharge ports were designed progressively. This included assessment of the different regasification modes (such as open and closed loop) and the volumes of seawater intakes and discharges under a range of operating scenarios, to develop a functional FSRU operating design that would operate efficiently and avoid or minimise adverse environmental impacts.

It is proposed that an FSRU would be purpose-modified overseas for use at Crib Point Jetty in Western Port. The modifications would include the various design concepts to minimise potential environmental impacts. The outcomes of the EES Technical Report A: *Marine biodiversity impact assessment* detail recommended mitigation measures to reduce potential risks of the Project and a monitoring program to verify that the predicted outcomes are met in practice.

3.2.1 Seawater intake

The design development of the regasification seawater intake on the FSRU has taken into consideration the following objectives:

- minimising intake and capture of large actively swimming marine organisms
- minimising entrainment of marine plankton, eggs and larvae.

The following briefly discusses how the objectives would be achieved. See EES *Technical Report A: Marine biodiversity impact assessment* for further information.

Position of seawater intake for regasification in the water column

The water surface and seabed are physical boundaries where movements of planktonic, pelagic biota (fish and cephalopods) and air breathing marine animals (seals, water rats, penguins) are most likely to be concentrated. The EES investigation recommended that entrainment risks can be mitigated through the design of the intake sea chests on the FSRU. An important parameter of sea chest design to reduce entrainment is locating the sea chest near mid-depth in the water column and away from the water surface and seabed. The water surface and seabed are where most drifting buoyant or dense material tend to accumulate.

The seawater intake for the heat exchange system would be installed in the sea chest within the hull of the FSRU and so move up and down with the tide. The water depth at the site is approximately 13 metres from seabed to sea surface at the lowest astronomical tide, with an additional three metres at highest tides. To minimise potential entrainment effects, the seawater intake would be positioned:

- at least three metres above the seabed
- at least two metres below the water surface.

Intake velocity for the regasification intake

The seawater intakes on the FSRU would be designed so that water is drawn into the intakes in a horizontal approach and the velocity would be limited to 0.15 metres per second. The intakes would be mounted to the hull of the FSRU so that the seawater is drawn in perpendicular to the ambient tidal currents. Some mobile vertebrate marine organisms such as fish cannot detect upward or downward currents, so the water must enter the intake horizontally to enable fish and other free–swimming marine biota the opportunity to detect the lateral currents and swim away from the intake.

The volume of water drawn into the intakes would be relatively constant, but the width (horizontal distance perpendicular to the screen) and depth (vertical distance above and below the screen) of the zone would vary as water currents change over the tide cycle. An understanding of this change has been used to select an appropriate position for the seawater intakes on the FSRU in the water column (see previous section).

Intake grille and screens

Grilles to be fitted to the FSRU seawater intakes would reduce the likelihood of larger mobile marine animals and drifting debris from entering the seawater heat exchange system and consist of a screening grille with vertical dimension spacing of 100 millimetres by 100 millimetres.

3.2.2 Discharge ports

The design of the discharge ports for the seawater used for open loop regasification has been an important consideration in understanding and subsequently minimising the effects of discharges from the FSRU.

During design development CEE undertook an assessment of several discharge options for the FSRU to identify a preferred discharge configuration (CEE 2018[1]) to carry forward into the assessment of potential impacts in the EES. This assessment considered five key factors:

- depth of water below the discharge ports
- angle of discharge from ports
- effect of water depth on dilution
- effect of discharge rate on dilution
- effect of number of ports on dilution.

The outcomes of this assessment are summarised in the following sections.

Depth of water below the discharge ports

The open loop discharged plumes of cooler seawater, which would also contain residual chlorine, are denser than the adjacent seawater and would therefore descend to the seabed. The shear between the descending plume and the ambient seawater causes mixing and dilution. The dilution of a descending plume increases with the depth of water from the discharge port to the seabed.

There are three factors that influence the depth of discharge water below the port to the seabed:

- location on the vessel – the discharge port (or ports) must be located below sea level so that the discharge does not form a visible disturbance on the water surface
- tides – as the vessel floats up and down with the tide, the discharge ports remain the same distance below the water surface at low tide and high tide, so the depth of water below the ports is greater at high tide
- vessel load – as the FSRU sits lower in the water when full, the ports will be deeper below the water surface for a full vessel than for an empty vessel.

1 <www.planning.vic.gov.au/__data/assets/pdf_file/0024/391434/Attachment-10A-Plume-Modelling-of-Discharge-from-LNG-Facility.pdf>

Angle of discharge from ports

The dilution depends on the length of the discharge plumes before they reach the seabed, which depends on the depth of water and the angle of discharge.

Initial dilution simulations explored the effect of the discharge angle on initial dilution. These simulations were made for discharge from a fully laden vessel at low tide. This case has the smallest depth of water below the port ('worst-case'). Five discharge angles were examined:

- horizontal
- 15 degrees below horizontal
- 30 degrees below horizontal
- 45 degrees below horizontal
- vertical (downwards).

Figure 3-1 shows the predicted initial dilution for the case of discharge from six ports of 0.45 metre diameter with a total discharge of 450,000 cubic metres per day (m^3/day) from a fully loaded vessel at low tide. With horizontal discharge, the dilution is predicted to be 20:1. The dilution decreases as the port angle declines below horizontal (tilted down) because the length of the plume between the port and the seabed shortens as the downward angle increases, so there is less interfacial mixing and thus lower dilution. The conclusion drawn from these predictions is that the ports should discharge horizontally to maximise dilution.

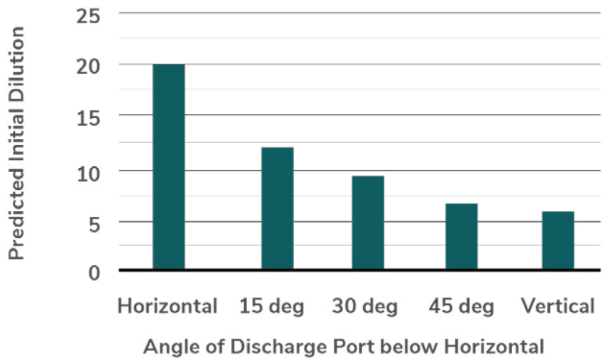


Figure 3-1: Modelled effect of discharge angle on initial dilution

Effect of water depth on dilution

The dilution increases with the length of the plume (or, for a horizontal discharge, the depth of water between the discharge port and the seabed). The second set of dilution simulations therefore explored the effect of water depth on initial dilution. These simulations were made for the 'worst-case' of slack water (the state of the tide when there is no movement as the direction reverses), and for various stages of the tide.

Four cases were examined using the six-port configuration:

- 10.2 metres – low tide and fully laden vessel
- 12.5 metres – low tide and empty vessel
- 13.2 metres – high tide and fully laden vessel
- 15.5 metres – high tide and empty vessel.

Figure 3-2 shows the predicted initial dilution for these depth cases with a discharge of 450,000 m^3/day. At low tide and with fully laden vessel, the initial dilution is 20:1. This is the lowest dilution for the six-port configuration.

At high tide, or with a partial or fully empty vessel, the depth below the water and the predicted initial dilution is greater. Thus over a tide cycle, and during the period when the LNG vessel was being unloaded, the dilution would vary from 20:1 to 26:1. It was apparent that depth of water is a significant parameter, and consideration of the stage of the tide was required to assess the environmental effects of the proposed discharge (see **Chapter 6** *Marine biodiversity*).

Effect of discharge rate on dilution

A higher rate of discharge results in lower dilution, while a lower rate of discharge results in higher dilution. For a fixed port diameter, the velocity decreases with the discharge rate, and so the momentum-induced mixing decreases with the discharge rate. This means there are two processes to be considered, which tend to counter-balance each other. The dilution increases as the discharge decreases, but also decreases as the velocity decreases.

Figure 3-3 shows the predicted initial dilution for these discharge cases (assuming the diameter of the discharge ports remains fixed). Overall, the dilution decreases as the discharge rate decreases, from a maximum of 20:1 at full flow to a minimum of 15:1 at 35,000 m^3/day per port. This shows the discharge velocity is more important than the discharge rate in determining dilution.

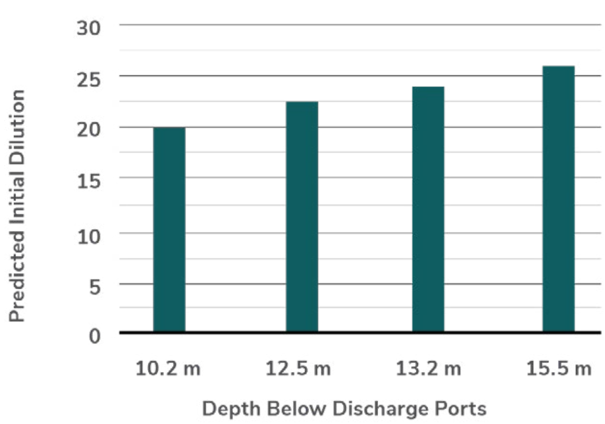


Figure 3-2: Effect of water depth on initial dilution

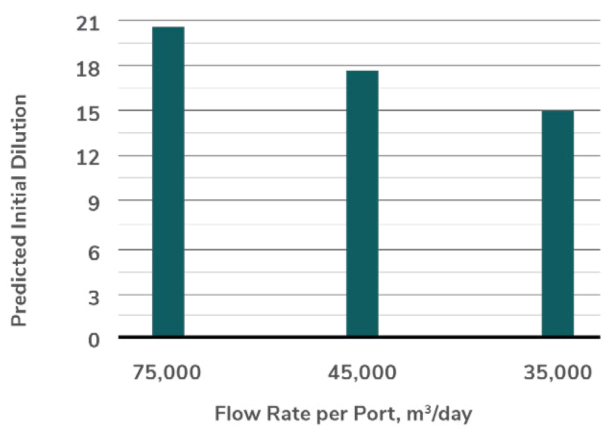


Figure 3-3: Effect of discharge rate on dilution for a six-port option

Effect of number of ports on dilution

Four port discharge options were evaluated to determine the effect of the number of ports on dilution:

- single port of 1.1-metre diameter on starboard side
- dual ports of 0.9-metre diameter (one on each side)
- four ports of 0.5-metre diameter (two on each side)
- six ports of 0.45-metre diameter (three on each side).

To examine the effect of the number of discharge ports on dilution, the minimum initial dilution for each of the four options has been calculated for the case of a fully loaded vessel at low tide with the maximum discharge rate of 450,000 m^3/day.

As discussed in the previous sections, higher dilution would be achieved when:

- it is high tide (compared with low tide)
- the vessel is nearly empty (as ports are higher above the seabed)
- the tidal velocity is higher than at slack water (see later discussion).

Figure 3-4 shows the predicted initial dilution for the four options concerning the number of ports. The single port option provides a dilution of 8:1 to 10:1 (from low tide to high tide); the two-port option provides a dilution of 9:1 to 12:1, the four-port option provides a dilution of 15:1 to 17:1; and the six-port option provides a dilution of 20:1 to 26:1. More ports produce a higher dilution, as would be expected. More than six ports cannot be feasibly installed on the FSRU due to physical constraints.

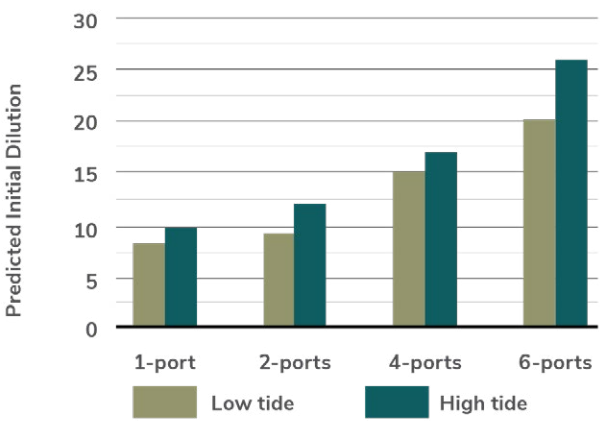


Figure 3-4: Effect of number of ports on dilution for a constant discharge

Based on the assessment undertaken by CEE (2018), to achieve effective dilution, the discharge ports should be horizontal, near the water surface and have a high discharge velocity (at least five metres per second).

A six-port discharge design was subsequently determined for the FSRU. This would:

- maintain a relatively strong water velocity to facilitate mixing of cooler seawater and return it to 0.5 degrees Celsius (°C) below ambient seawater
- facilitate mixing of residual chlorine to encourage decay to achieve concentrations below six micrograms per litre (µg/L) in accordance with the time-averaged Guideline Value for chlorine.

This six-port discharge design was used to assess potential impacts on the marine environment (see EES Technical Report A: *Marine biodiversity impact assessment*).

3.2.3 Port side discharge option

The hydrodynamic modelling carried out for the Project identified that when an LNG carrier was moored next to the FSRU, the LNG carrier would partially block the starboard-facing high velocity seawater discharges from the discharge ports. As mixing of the discharges is reduced during these instances, there is less initial dilution and a pool of colder water from the discharge forms in the space between the FSRU and the LNG carrier and sinks to the seabed.

An option to avoid this partial blockage was investigated. This would involve installing the discharge ports on the west (port) side of the FSRU. This would mean the discharge ports would face toward the Crib Point Jetty and the shore. This arrangement would have the benefit of a higher initial dilution when there is an LNG carrier moored beside the FSRU.

The option of locating the ports on the port (west) side was considered but has not been adopted for several reasons including:

- there is less water depth on the west side and so a lower initial dilution
- west-facing (port) ports would discharge the cooler seawater containing residual chlorine closer to the higher biodiversity areas in shallow and intertidal waters.

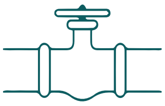
To provide a scientific basis for the assessment of the alternative discharge port location (on the port (west) side), a computer dispersion model prediction for that option was completed and the results are presented in Section 6 of EES Technical Report A: *Marine biodiversity impact assessment*.

3.2.4 Regasification alternatives

The FSRU converts stored LNG into natural gas via a process called regasification using an onboard regasification plant. A heat-exchanger is used as an interface to transfer heat from a heat source to the LNG in the regasification train. The regasification trains can operate in either open loop mode, which uses seawater as the heat source, or closed loop mode, which uses gas-fired boilers as the heat source.

Options to heat the LNG as part of the regasification process were examined and are summarised in **Table 3-2.** The optimum process depends on various factors including plant site location, climatic conditions, throughput capacities, energy efficiency, emissions and regulatory approvals.

The sections following the table describe the open loop and closed loop regasification processes in more detail. While ambient air heating can be an effective solution for FSRUs in warmer climates, it was not considered appropriate for the Gas Import Jetty Works due to the climatic conditions at Crib Point.



Regasification

Regasification is a process of converting LNG that is stored at -163 °C back to natural gas using the FSRU's onboard regasification plant.

Table 3-2: Regasification alternatives

Regasification process	Brief description	Advantages	Disadvantages
Open loop	Using seawater to heat the LNG. Seawater is continuously drawn in for the heat exchange process via intakes and subsequently discharged back to the sea. The energy used to pump the seawater through the heat exchanger consumes about 0.9 per cent of the total LNG stored on the FSRU.	• Simpler process – heat exchangers using seawater • Preferred technology globally • Lower greenhouse gas generation than the closed loop alternative	• Potential impact on marine environment from cooler seawater discharge and residual chlorine as a by-product of the antifouling process • Greater entrainment of small marine organisms during seawater intake
Closed loop	Using gas-fired steam boilers to heat a closed loop of circulating water within the FSRU as an intermediate heating medium for heat exchange in the LNG regasification trains. The water is typically refreshed annually for maintenance purposes. The energy used to heat the circulating fluid is around 3.3 per cent of the total LNG stored on the FSRU.	• Better regasification performance than open loop when the seawater temperature falls below 15 °C • Lower seawater intake and discharge than the open loop alternative	• Capital investment in boilers adds costs to the FSRU • Higher fuel consumption and operating costs • Higher greenhouse gas and other air emissions than the open loop alternative
Ambient air heating	Air is used as heating medium. Can be used in warmer climates using ambient air, or in cooler climates, using heated air.	• Does not use seawater as a heat source	• Better suited to warmer climates • Requires larger infrastructure • Can produce vapour fogs

Open loop regasification

In open loop regasification mode, seawater would be continuously drawn into the FSRU through seawater inlets on the side of the FSRU and circulated through the heat exchangers. The heat exchangers rely on two phases of heat exchange process:

- between seawater (as the heat source) and an intermediate fluid (propane)
- between propane and LNG.

Circulated seawater would be continuously discharged from the FSRU. The discharged seawater would be up to 7 °C below ambient seawater temperature, prior to any mixing.

Figure 3-5 provides a simplified diagram of open loop regasification.

Closed loop regasification

In closed loop regasification mode, around 500 cubic metres of seawater would fill the FSRU heat exchange piping. Once filled, the seawater inlet and outlet on the FSRU would be isolated and the water circulated within a closed loop. Seawater cooled in the heat exchanger is then reheated by steam from the gas–fired boilers and continually circulated in the process, instead of being discharged from the FSRU as per the open loop mode. See **Figure 3-6** for a simplified diagram of how the closed loop regasification mode operates.

The seawater used in the closed loop system would be discharged to Western Port when maintenance is required or if the system is switched to open loop mode. Discharged seawater from the closed loop process would be around 5 °C warmer than the ambient Western Port water temperature.

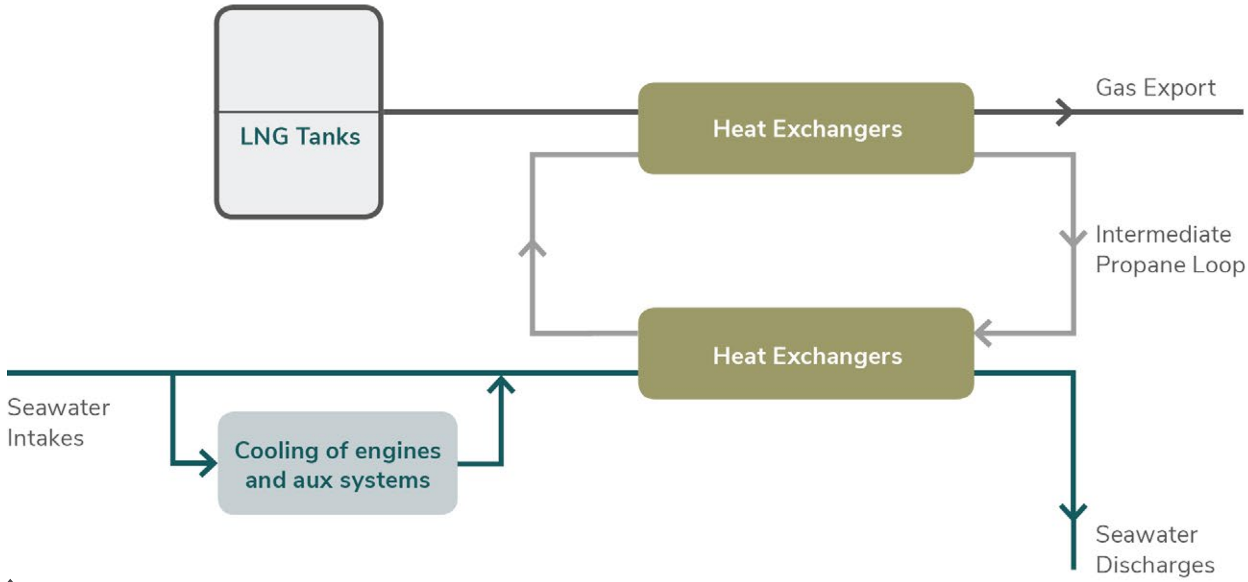


Figure 3-5: Open loop regasification process

A dump condenser is provided on the FSRU as a safety mechanism to remove the energy from any excess steam generated by the FSRU boilers. In normal operation, when in closed loop mode, there is no excess steam and water runs through the dump condenser without any change in temperature. However, if there is an unforeseen operational upset that causes a regasification train to shutdown unexpectedly, then the dump condenser is used to safely take away the energy of the excess steam until the system is fully shutdown. The dump condenser is also used to remove the heat from burning any excess boil-off gas if the minimum send out (MSO) compressor cannot be used for some reason.

Boil-off gas

Despite insulation of the tanks in which the LNG is stored which limits the admission of external heat, slight evaporation of the LNG will occur during storage, shipping and loading/unloading operations. This natural evaporation of small amounts of LNG is known as boil-off and results in boil-off gas that needs to be removed from the tanks to manage tank pressure.

When the FSRU is regasifying and sending out gas, boil-off gas is recovered and used as a fuel source in the generators on the FSRU, with any excess being recondensed back into a liquid and stored as LNG. Boil-off gas can also be compressed via a minimum send out compressor (MSO) onboard the vessel and delivered to the gas transmission network.

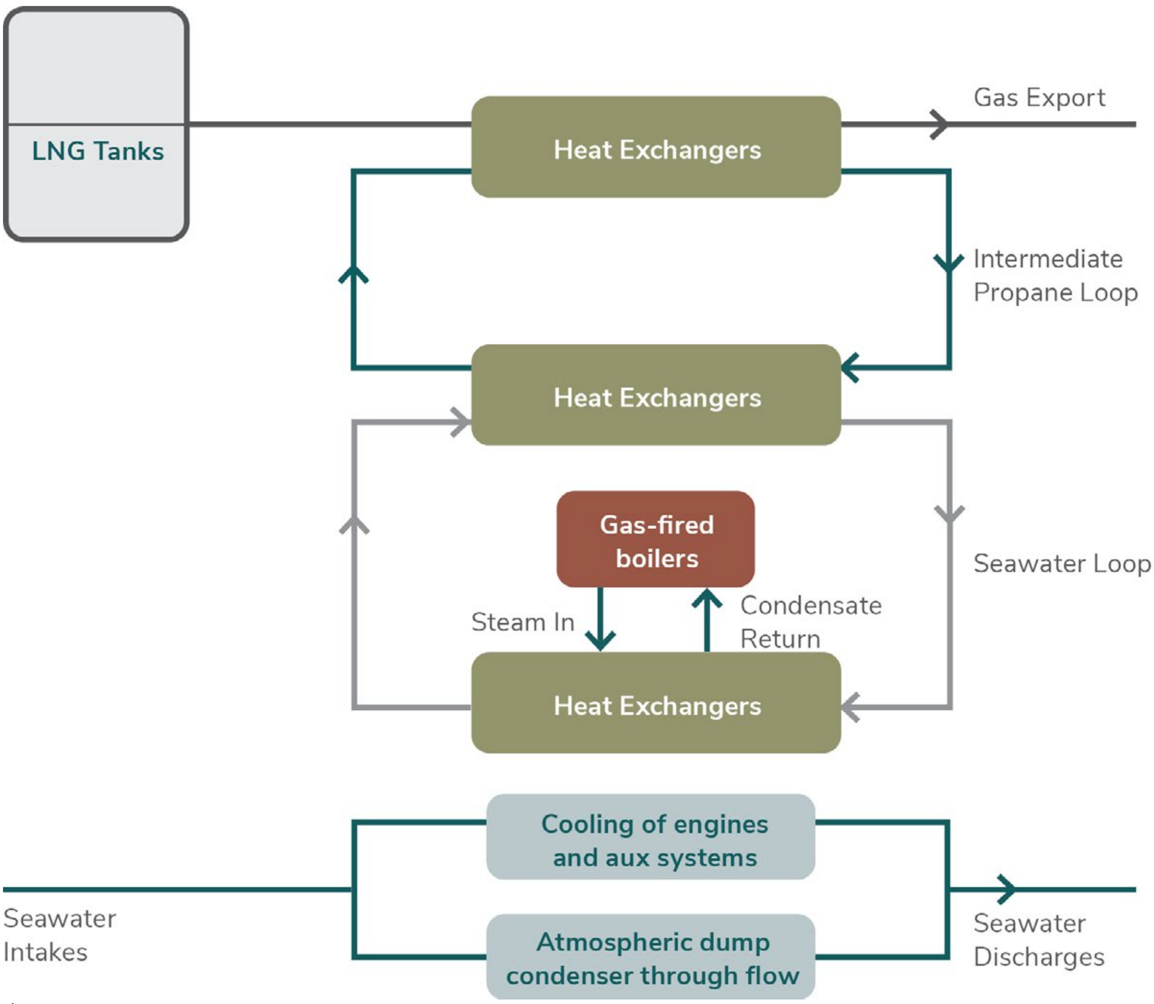


Figure 3-6: Closed loop regasification process

Combined loop regasification mode

In addition to being able to operate in open loop and closed loop regasification modes, the FSRU has been designed to operate in what is termed combined loop mode. The combined loop mode operates similar to open loop mode; however, seawater is heated via steam from gas-fired boilers prior to reaching the regasification system on the FSRU. The seawater is continuously drawn into the FSRU through seawater inlets and the seawater is heated by heat exchange with steam. Seawater use associated with combined loop regasification mode is the same as seawater use for open loop regasification shown in **Table 3-3**.

3.2.5 FSRU regasification seawater use

To assist in understanding the potential beneficial and adverse impacts of open and closed loop regasification, the seawater flows (intakes and discharges) were determined for a range of operating scenarios. These flows were then used to assess potential impacts.

In open loop mode each regasification train uses seawater for regasification of the LNG back to natural gas. This seawater is then discharged back to Western Port. All the pumps onboard the FSRU are fixed speed. While the gas export rate is variable, the required water flow used to heat the LNG is dependent on the number of regasification trains running, as shown in **Table 3-3**. The equivalent maximum gas production rate is also shown (as million standard cubic feet (mmscf) per day).

In closed loop mode, seawater is used for the heat exchange process which is continuously recirculated in a closed loop and heated by gas-fired boilers. Seawater is still used under closed loop for engine cooling purposes which is typical for all ship operations. The seawater intake and discharge volumes using closed loop mode do not change with gas production rate, as shown in **Table 3-3**.

The peak gas production rate of 750 mmscf of natural gas per day (three regasification trains operating at full capacity) would occur during discrete periods where demand for gas is high (that is during certain periods in winter). The FSRU would typically operate with one or two regasification trains operating.

Table 3-3: Maximum daily seawater flows (m^3/day) for open and closed loop regasification

Number of regasification trains in operation	Gas production rate (mmscf/day)	Number of seawater pumps in operation	Maximum regasification seawater flow rates (m^3/day)[1]	
		Open loop	Open loop	Closed loop[2]
1	50–250	2	156,000	
2	250–500	4	312,000	184,800
3	500–750	6	468,000	

Notes to table: Excluding cooling of freshwater generator and intermittent flows relating to ballast water, water curtain and fire testing water. Seawater flow rates associated with closed loop mode regasification are constant and not affected by the number of regasificationtrains in operation

3.2.6 Regasification assessments

The potential adverse and beneficial impacts of the FSRU operating in open loop and closed loop regasification modes are set out in the following technical reports and chapters of this EES:

- EES Technical Report A: *Marine biodiversity impact assessment* and **Chapter 6** *Marine biodiversity*
- EES Technical Report F: *Greenhouse gas impact assessment* and **Chapter 11** Greenhouse gas
- EES Technical Report G: *Air quality impact assessment* and **Chapter 12** *Air quality*
- EES Technical Report H: Noise and vibration impact assessment and **Chapter 13** *Noise and vibration*.

The key outcomes of these assessments are summarised in the following sections. The outcomes of the EES assessments of open and closed loop were used to select the FSRU regasification mode and a set of proposed FSRU operating parameters (see **Section 3.2.7** of this chapter).

Potential impacts on the marine environment

The use of seawater for regasification and other processes on the FSRU has the potential to impact small marine biota from entrainment and the return of cooler water to the sea (including exposure to residual chlorine in discharge seawater). As more seawater is used in open loop mode than in closed loop mode, the risk of impacts are higher.

As described in **Section 6.3** in **Chapter 6** *Marine biodiversity*, 53 individual potential risks to the marine environment from the construction and operation of the Project were identified and assessed in detail. The marine risk and impact assessment carried out for the Project identified that the main risks to the marine environment are associated with seawater use by the FSRU including:

- entrainment of plankton and other small biota in seawater taken into the FSRU for warming the LNG from a very cold liquid to a gas at ambient temperature, and other purposes
- discharge of chlorine-produced oxidants and products from the electrolysis of seawater used to control biofouling in the piping network and heat exchangers on the FSRU
- discharge of seawater colder than ambient, and also discharge of seawater warmer than ambient, from alternative modes of operation on the FSRU.

Entrainment of plankton and other small marine biota

Natural mortality rates for plankton and invertebrate larvae vary from about five per cent per day to more than 20 per cent per day. For the peak rate of gas production, the predicted rate of entrainment is 0.22 per cent after 14 days or 0.40 per cent after 28 days. This corresponds to an additional mortality rate for plankton of 0.014 per cent per day (assuming complete loss of viability of all plankton passing through the chlorination and piping system). The predicted contribution of entrainment is unlikely to have a significant effect on the Western Port ecosystem. There would be only a slight reduction in abundance amongst plankton species and a slight loss of fish eggs and larvae.

There is a small predicted decrease in primary productivity from phytoplankton in North Arm. There is no loss of organic carbon or nutrients due to entrainment. The organic carbon and nutrients in the plankton entrained will remain in North Arm and be cycled by bacteria and infauna.

The predicted entrainment effects from the FSRU on fish larvae and eggs would be highest in spring and summer when fish larvae and eggs are present in large numbers, reflecting the strong seasonal pattern in North Arm of Western Port. Spring and summer also coincide with the period when the majority of larvae that are important in terms of conservation, fishing and ecological values may be present in the water column in North Arm of Western Port.

The FSRU is expected to operate at the average rate of production for most months of the year including all spring and summer months. To ensure that there is not high entrainment in the peak season for the majority of fish eggs and larvae expected to be present in the water column in North Arm of Western Port, a limit on the continuous amount of seawater that can be drawn into the FSRU for regasification purposes is proposed during spring and summer (over any 14–day period).

The likelihood that a significant proportion of fish larvae would be entrained in the spring and summer period is very small. The modelling and assessment carried out for the Project also identified that the percentage of fish eggs and larvae that are predicted to be entrained into the FSRU is very small compared to the predicted loss via flushing to Bass Strait. The fish species that are present in North Arm are highly fertile and common throughout Western Port and elsewhere. Fish larvae and juvenile fish also enter Western Port from other breeding and nursery areas via Bass Strait.

Discharges

A key outcome from the modelling and assessment of chlorine and seawater temperature risks for the marine environment is the extent of the predicted area above the chlorine and seawater temperature Guideline Values. These areas above Guideline Values comprise the area where exceedances of the derived Guideline Values are predicted and are different for temperature and residual chlorine, as described in **Section 6.5** in **Chapter 6** *Marine biodiversity*.

The 'worst-case' modelled scenario for temperature and chlorine is when the FSRU is operating in open loop at peak regasification (i.e. all three regasification trains are operating with the largest seawater discharge rate) and an LNG carrier is berthed adjacent to the FSRU. The LNG carrier when berthed adjacent partially obstructs the discharge ports on the starboard side of the FSRU, decreasing the efficacy of mixing.

For all modelled scenarios including the worst-case, the predicted extent of the areas above temperature and chlorine Guideline Values is limited to the shipping basin and ship berthing areas within the Port of Hastings boundaries. This comprises seabed that has been previously dredged and is regularly subject to sediment resuspension by propeller wash from existing shipping activities at the Crib Point Jetty.

There is a significant distance between the areas above the temperature and chlorine Guideline Values and the various habitat types recognised under the Ramsar Convention. Due to the distance, the likelihood of there being any effect from the discharge on the subtidal reef or seagrass, estuarine areas, intertidal mud flats, intertidal forested wetlands, salt marshes, mangroves and waterbirds is low.

Greenhouse gas, air and noise emissions

The closed loop regasification mode would use around 3.3 per cent of the LNG cargo to power the gas-fired boilers for the regasification process. This is compared with 0.9 per cent of the LNG cargo when the FSRU is operating in open loop mode. Predicted greenhouse gas emissions would therefore be around four times higher under closed loop mode compared to open loop mode (247.1 kilotonnes carbon dioxide equivalent (kt CO2-e) per annum for closed loop compared with 66.4 kt CO2-e per annum for open loop under a 160 petajoules per annum modelled scenario).

Other air emissions would also be slightly higher when operating in closed loop mode, due to the need to operate the gas-fired boilers. Noise predictions at nearby sensitive receptors for the open and closed loop regasification modes are relatively similar, however the closed loop mode is the worst-case scenario due to operation of the gas-fired boilers.

3.2.7 Selection of the proposed FSRU regasification mode

The EES has assessed the significance of potential adverse impacts and environmental risks of operating in open and closed loop modes for a range of operating scenarios. These have been assessed:

- in an integrated manner
- in consideration of key requirements and objectives under statutory provisions (such as toxicant default guideline values for protecting aquatic ecosystems) and Project–specific performance criteria where statutory criteria are not available.

The purpose of assessing open and closed loop was to inform the selection of the FSRU regasification mode and the development of a set of proposed operating parameters for the FSRU that would:

- ensure the ability of the Project to provide gas supply certainty and security for gas customers in south–eastern Australia
- meet the relevant environmental evaluation objectives as established in the scoping requirements for the EES.

Based on the EES investigations, open loop regasification mode would be used by the FSRU. The main benefit of the open loop regasification mode is that seawater from Western Port can be used by the onboard regasification plant on the FSRU to heat the LNG. This is an efficient and readily available means of heating the LNG without using additional fuel to generate heat for LNG vaporisation. Greenhouse gas emissions from open loop mode are substantially less than closed loop mode (see **Chapter 11** *Greenhouse gas*).

Combined loop regasification mode would be used when the seawater intake temperature is close to 10 °C or below to improve operational efficiency with respect to regasification. This mode is unlikely to be used for more than 30 days during winter in any given year. The seawater flow volumes when using the combined loop regasification mode are the same as those for the open loop regasification mode.

Closed loop regasification could be used as an alternative to open loop regasification mode, however open loop is the preferred operation mode for the Project.

Proposed FSRU operating parameters

The EES assessments have identified open loop regasification at the proposed mean seawater flows outlined in **Table 3-4** as meeting the Project's gas production and environmental objectives. The operating parameters are expressed as mean daily seawater flows (m^3/day). This equates to a maximum daily seawater flow of 468,000 m^3/day for regasification in open loop, excluding intermittent and minor uses.

To minimise potential entrainment impacts during periods of the year when fish eggs and larvae are more prevalent in Western Port's North Arm, a 14-day average (mean) flow of 312,000 m^3/day is proposed between September and February (inclusive). Further discussion on potential impacts on the marine environment including predicted rates of entrainment is provided in **Chapter 6** *Marine biodiversity*.

Table 3-4: Proposed FSRU regasification operating parameters

Season	FSRU regasification mode	Mean daily seawater[1] regasification flows (m^3/day, 14-day average)	Equivalent gas production rate (mmscf/day)
Autumn and winter (Mar – Aug)	Open loop	468,000	500 - 750
Spring and summer (Sep – Feb)	Open loop	312,000	250 - 500

Notes to table: Excluding cooling of freshwater generator and intermittent flows relating to ballast water, water curtain and fire testing water.

3.2.8 Crib Point Receiving Facility

The location of the Crib Point Receiving Facility was determined by the selection of Crib Point as AGL's preferred site for the Gas Import Jetty Works. The siting of the facility is immediately west of the Jetty Infrastructure at Crib Point on land owned and managed by the Port of Hastings Development Authority. Considering the use of the jetty for the importation of LNG, this co-location of infrastructure within a single site is considered to minimise impact associated with the utilisation of land. The Crib Point Receiving Facility is required to be situated adjacent to the jetty so gas can be treated to sales quality with odorant and nitrogen (as required) before being exported to the VTS.

Approximately 2.8 hectares is required for the safe construction and operation of the facility.

Discussions were held with the owner of private land on the western side of the Esplanade about the potential to co-locate the facility and associated construction areas within this land. This area forms part of the former BP refinery, which is zoned for industrial development and is currently being used for intermittent industrial uses including the preparation of pipes for offshore oil and gas development. The owner of the land is considering the future development potential of the site and the impact of an operational above-ground gas pipeline facility may impede the future planning of the site for other uses. For this reason, the current location (that is land adjacent to Crib Point Jetty) was selected as the preferred location for the Crib Point Receiving Facility.

3.3 Pipeline Works design development

The following sections describe the design development of the Pipeline Works including refinement of the pipeline alignment, selection of pipeline facilities and the pipeline construction methodology.

3.3.1 Pipeline alignment refinement

Since the confirmation of the pipeline alignment, detailed design and landholder consultation has progressed, in accordance with the approved Pipeline Consultation Plan (18027-PL-A-0001), resulting in further alignment refinement. The changes and supporting reasons are outlined in **Table 3-5** below.

Table 3-5: Significant pipeline alignment revisions since the alignment was selected

Revision transitions	Details of change	Reason for change
1 – 2	• Use of private land to avoid the Esplanade road reserve between KP0 – KP1 • Better alignment of crossing of Baxter-Tooradin Road (KP23) • Termination of the pipeline at the Dore Road Valve Station identified as unviable	• Avoids vegetation removal within road reserve • Improved constructability • Avoid significant horse stud operation • Land availability for termination site limited
2 – 3	• KP11 – KP23 alignment moved into Baxter-Tooradin Road	• Avoids significant impact to Melbourne Water pipeline corridor • Avoids impact to Moonlit Sanctuary • Creates ability to avoid impacts to vegetation and waterways by HDD
3 – 4	• A number of minor alignment changes across the pipeline alignment to ensure perpendicular crossings of road corridors, waterways and known third party services (e.g. existing pipelines	• Resulting from constructability workshop and inputs on environmental constraints and land access
4 – 5	• Minor alignment refinement to continue co-location with existing Melbourne Water, Esso Australia pipeline corridors • Change to the final section of the pipeline alignment to allow for the positioning of the proposed Pakenham Pipeline Facility	• Change requested by landowner to ensure co-location of pipeline with existing infrastructure • Identification of the preferred location for the Pakenham connection point to the VTS
5 – 6	• Alignment revision to avoid future industrial land development within the former BP refinery site • Minor alignment refinement to continue co-location with existing Melbourne Water, Esso Australia pipeline corridors • Minor alignment changes to align further with property boundaries	• Avoidance of the maritime museum heritage place on the Victorian Heritage Register • Change requested by landowner to ensure co-location of pipeline with existing infrastructure, avoidance of impacts to future market garden areas and align with property boundaries
6 – 7	• Multiple minor revisions of the alignment and update to HDD locations	• Continuation of detailed design including design of HDDs • Less constrained construction methodology • Ongoing stakeholder consultation including with Ausnet Services regarding future development of their land
7 – 8	• Re-alignment of pipeline within the streets of Hastings based on further detailed design, information availability of existing assets (DBYD) and constructability review. • Multiple minor revisions of the alignment including the avoidance of small rural residential block, continuation of the co-location to existing infrastructure, and avoidance of land identified for strategic development	• Involvement of ECI contractors and site inspections to review alignment • Landowner feedback

Revision transitions	Details of change	Reason for change
8 – 9	• Minor route revisions through service proving, constructability assessments for Hastings street works, avoidance of landowner infrastructure and review of cadastre	• Continuation of detailed design and landowner feedback
9 – 10	• Construction footprint extended to allow for a water main south of the Crib Point terminal and additional laydown areas • Alignment moved along The Esplanade to avoid Telstra assets and reduce vegetation clearing • New alignment within rail corridor and other minor route realignments • Study area extended to investigate further options for the Pakenham Delivery Facility	• A water main was required to provide sufficient water pressure for the proposed firefighting water system at the Crib Point Receiving Facility • Targeted surveys identified threatened orchid • Use of the rail corridor provides for a significant reduction in impacts to the Hastings community, particularly during construction • Cultural heritage surveys recommend avoidance of areas • Continuation of detailed design and landowner feedback
10 – 11	• Construction footprint reduced to remove the water main south of the Crib Point terminal as firefighting provisions will be included at the Crib Point Receiving Facility • Refinement of HDD locations	• Construction footprint reduced to remove the water main south of the Crib Point terminal as firefighting provisions will be included at the Crib Point Receiving Facility • Refinement of HDD locations

The proposed pipeline alignment described and assessed by the different EES studies is described in **Chapter 4** *Project description* and shown in Attachment VII *Map book*.

3.3.2 Facility site selection

A number of above-ground facilities are required to condition the natural gas to meet the operating parameters of the VTS before injection and to meet safety requirements. These include:

- the above-ground Pakenham Delivery Facility situated adjacent to the Pakenham East rail depot to monitor and regulate the gas)
- two above ground mainline valves (MLVs) located at different points along the pipeline alignment to enable isolation of the pipeline in an emergency.

The selection of facility locations is described in the sections below.

Pakenham Delivery Facility

APA's existing Dore Road MLV was initially assessed as the termination point of the pipeline allowing connection into the VTS. Additional above-ground infrastructure associated with the pipeline is required and the ability to co-locate the required infrastructure into the existing facility was favoured. A site of approximately two hectares is required for this additional above-ground infrastructure.

Following detailed assessment and consultation with affected stakeholders, review of the availability of land to achieve this outcome and the suitability of pipeline alignments to this location, the site at the existing Dore Road pipeline facility was discounted. The primary reason for this relates to the location of the Urban Growth Boundary and preparation of the recently released Pakenham East Precinct Structure Plan (PSP) by the Victorian Government, which encompasses this existing pipeline facility. Siting the connection point to the VTS at this location would be incongruent with the objectives of the PSP.

A number of other potential locations for the Pakenham Delivery Facility were assessed by APA in seeking a connection point to the VTS as shown in **Figure 3-7**. For simplification of the engineering design, it was preferred to locate this facility on the existing Longford to Dandenong Pipeline (authorised under Pipeline Licence No. 75) and the Bunyip to Pakenham Pipeline (authorised under Pipeline Licence No. 135).

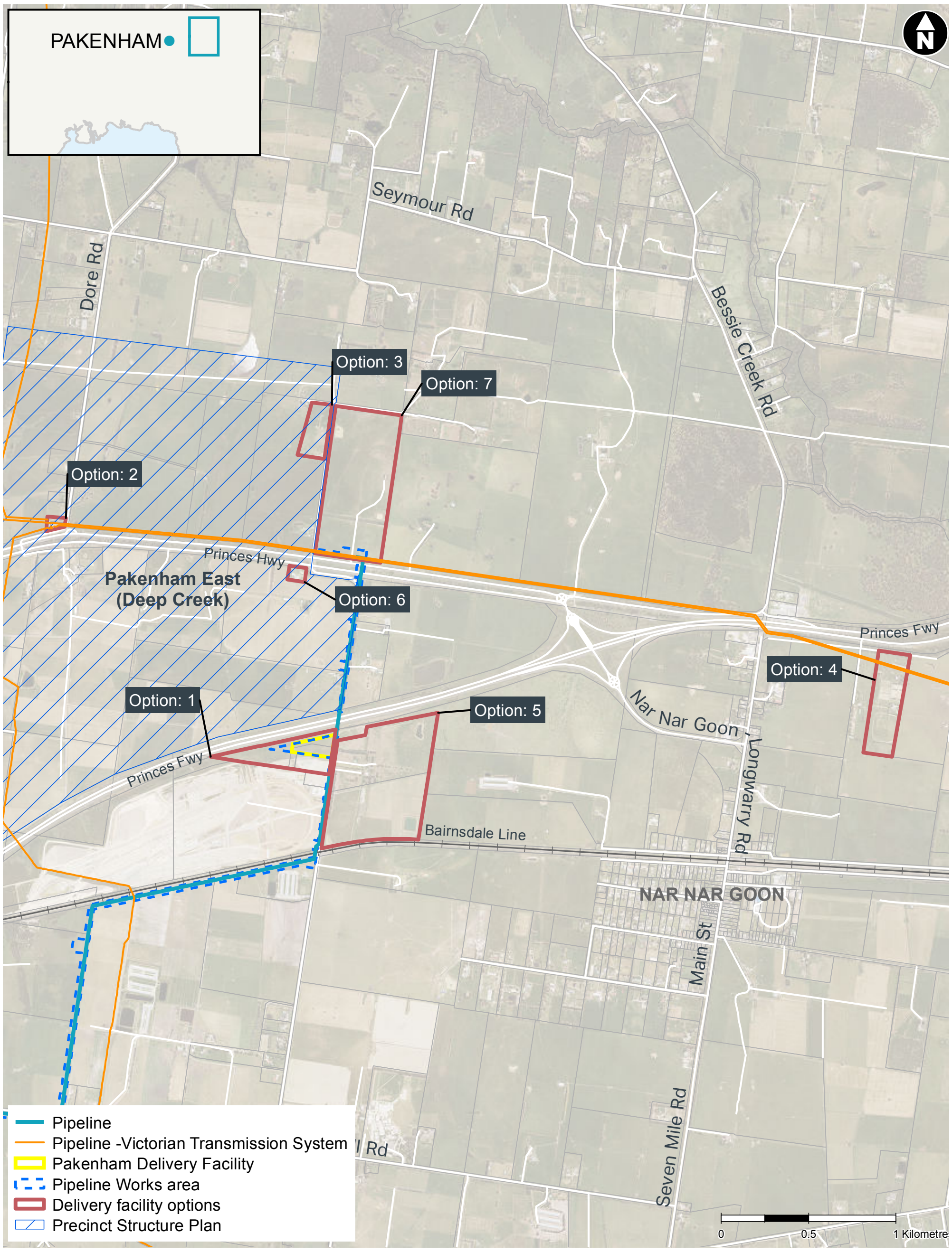


Figure 3-7: Pakenham Delivery Facility location options

A total of seven sites were assessed with APA selecting the current facility location adjacent to the existing Pakenham East rail depot. This has resulted in a small pipeline connection from this facility to the terminal point on the VTS. This connection location is outside the area of the Pakenham East PSP. A summary of the location assessment undertaken by APA is provided in **Table 3-6**.

Table 3-6: Pakenham Delivery Facility location options

Option	Location	Advantages	Disadvantages
1	Pakenham East rail depot (north-east corner) *Lot 4 on PS607403U and Lot 1 on PS1365564*	• Excess/surplus land not required for the construction of the rail depot • Public ownership (Public Transport Development Authority) – not affecting private landowners/occupiers • Site provides adequate construction and operational area with access to main thoroughfare (Oakview Lane – recently upgraded) • Adjacent to land developed for industrial development (rail infrastructure) and major road corridor (Princes Freeway) • Pipeline alignment minimises impact to land tenure/private landowners • Avoidance of impact to identified Growling Grass Frog habitat to the north of the acquisition area (no requirement to amend the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) approval conditions for the rail depot) • Land is located outside the Urban Growth Boundary	• Coordination required to avoid impact to operation of rail depot during construction of pipeline facility (ingress/egress from site) • Acquisition process complicated with public private partnership between Public Transport Victoria and Evolution Rail for the rail depot • Site requires subdivision and cadastral boundary adjustment (not straight freehold purchase) • Impact to registered Aboriginal Heritage Place – within area proposed for the facility • Engineering design required to cater for pipeline in a higher threat category (road reserve) – Oakview Lane and Mt Ararat Road South
2	Dore Road MLV *Lot 1 on TP709318 and Lot 1 on TP424541*	• Co-location of like gas transmission infrastructure (Dore Road MLV – part of the Longford Dandenong Pipeline) • Site on the existing Longford Dandenong Pipeline – benefit for engineering design • Site provides adequate construction and operational area with access to main thoroughfare (Dore Road) • Additional pipeline section within existing easement (1.7 km) for the Longford Dandenong Pipeline	• Additional land required outside the existing facility is located on land within the Urban Growth Boundary (not included in the draft Pakenham East PSP, which has undergone extensive consultation) • Commercial considerations of land availability and acquisition of residential land within the Urban Growth Boundary • 1.7 km pipeline length increase on the pipeline alignment • Property has a significant slope – require earthworks and levelling increasing the area of land required for the facility • Noise emissions and visual amenity of the facility required to consider surrounding residential land uses • Requires removal of established buffer vegetation around the existing facility site • Site requires subdivision and cadastral boundary adjustment (not straight freehold purchase)
3	Mt Ararat North Road – West *Lot 2 on PS436254*	• Site provides adequate construction and operational area with access to main thoroughfare (Dore Road) • Straight freehold purchase without need for subdivision and cadastral boundary adjustment of land • Larger site than required for immediate development (approximately four hectares) allowing for future gas transmission development opportunities	• Commercial considerations of land availability and acquisition of residential land within the Urban Growth Boundary • 0.8 km pipeline length increase on the pipeline alignment • 0.6 km of new easement required within private land (within or immediately adjacent to the Urban Growth Boundary) • Noise emissions and visual amenity of the facility required to consider surrounding residential land uses

Option	Location	Advantages	Disadvantages
4	Nar Nar Goon North Lot 6 on PS413098	• Site provides adequate construction and operational area with access to main thoroughfare (Princes Freeway) • Site on the existing Longford Dandenong Pipeline – benefit for engineering design • APA advised that land parcel is currently on market for sale • Site is located outside of the Urban Growth Boundary	• Site approximately 500 m from an educational facility (Saint James Primary Catholic School) • 4.4 km pipeline length increase on the pipeline alignment (and associated easement in private land) • Impact to additional eight privately owned land parcels • Difficulties in meeting commercial arrangement on purchase of land • Noise emissions and visual amenity of the facility required to consider surrounding residential land uses (residential dwelling immediately adjacent to site) • Site requires subdivision and cadastral boundary adjustment (not straight freehold purchase)
5	Oakview Lane *Three or four properties to the east of Oakview Lane and south of the Princes Freeway*	• Site provides adequate construction and operational area with access to main thoroughfare (Oakview Lane – recently upgraded) • Adjacent land developed for rail infrastructure and major road corridor (Princes Freeway) • Straight freehold purchase without need for subdivision and cadastral boundary adjustment of land • No/minor increase in length on the pipeline alignment	• Owners of land not willing to subdivide – land much larger than required by APA (approximately 17 – 45 ha) and therefore commercially unviable • Loss of agricultural land and impact to private land interests
6	Princes Highway *Lot 1 on PS425398*	• Quality access to main thoroughfare (Princes Highway)	• Site does not provide adequate construction and operational area for the required infrastructure • Commercial considerations of land availability and acquisition of residential land within the Urban Growth Boundary • Land identified in the Pakenham East PSP for future residential use • Current landowner infrastructure on land – would require demolition and removal • 0.2 km pipeline length increase on the pipeline alignment • Potential heritage asset identified in the Pakenham East PSP • Noise emissions and visual amenity of the facility required to consider surrounding residential land uses
7	Mt Ararat North Road – East *Lot 1 on TP103656*	• Site provides adequate construction and operational area with access to main thoroughfare (Mt Ararat Road North) • Site on the existing Longford Dandenong Pipeline – benefit for engineering design • No/minor increase in length on the pipeline alignment • Site is located outside of the Urban Growth Boundary (immediately adjacent to the west) • With the pipeline facility at this location, APA does not require land tenure within any other private land for the operation of the facility	• APA unable to reach commercial agreement with owner of land (number of acquisition options offered) • Loss of agricultural land and impact to private land interests • Pakenham East PSP identifies the land for potential future sports reserve • Noise emissions and visual amenity of the facility required to consider surrounding residential land uses (immediately adjacent to Urban Growth Boundary)

APA did seek to enter into agreements with other owners of land for the pipeline facility. Due to the location of the terminal point being within or in close proximity to the Urban Growth Boundary, agreeing commercial terms with these parties is cost prohibitive.

Mainline valves

The Pipeline Works are designed in accordance with Australian Standard AS2885: *Pipelines – Gas and Liquid Petroleum* that requires a number of mainline valves to be located along the pipeline alignment for safe operation and maintenance. The number, location and spacing of the mainline valves are dependent on the pipeline location classification and fluid type as defined in AS2885.

The first 12 kilometres of the pipeline between Crib Point and Hastings is classified as T1 land use (suburban) as defined in AS2885. AS2885 recommends 15 kilometres as the maximum spacing between mainline valves for T1 gas pipelines. Mainline valve 1 (MLV1) has been located at kilometre point 11.5 (at Denham Road, Hastings) to meet this requirement. Land impacts form part of the site selection as APA would require long-term land tenure of the property. The property selected for MLV1 is appropriately zoned for industrial use and within a property parcel used for cattle grazing.

The pipeline alignment between MLV1 and Pakenham has a mixed classification, but the majority of the pipeline is classified as R1 (rural). The pipeline designers have used the more stringent class of R2 (rural residential) to locate mainline valve 2 (MLV2), for which AS 2885.1 recommends 30 kilometres as the maximum spacing between mainline valves for R2 gas pipelines. MLV2 was therefore located approximately 28.5 kilometres from MLV1 and within 17 kilometres of the end of the pipeline. MLV2 would be located in a property parcel currently used for grazing at Bloomfield Lane, Cardinia.

3.3.3 Pipeline construction requirements and methodology

The pipeline construction methodology including right of way (ROW) layouts have been altered as a result of environmental assessment findings, landholder and other stakeholder consultation, existing asset identification, constructability and safety assessments.

Construction requirements

When identifying a preferred pipeline corridor, the preferred construction ROW width is 30 metres. The construction ROW footprint is generally determined by the size of the pipe, equipment used for installation, vegetation density and need for soil stockpiles.

A 30-metre ROW enables construction equipment to move around freely, avoid congestion and maintain safe distances between plant and personnel. During construction, soils excavated from the installation of the pipe would be stockpiled on the edge of the ROW before reinstatement. Reductions in the width of the ROW could impact efficiency and have potential safety implications.

Trenchless crossing methodology selection

As described in **Section 4.4.4** of **Chapter 4** *Project description*, trenchless crossing construction techniques such as HDD and shallow horizontal boring would be used at certain locations along the alignment. Trenchless crossings are typically used to avoid surface disturbance when crossing major watercourses, as well as sealed roads and railway crossings, but can be used to avoid or minimise disturbance to any surface feature considered to be highly sensitive.

Trenchless crossings avoid surface disturbance to the relevant feature but introduce other technical and environmental risks which must be managed. Geotechnical constraints (fissures and cracks, unconsolidated substrata and subsurface scour potential) may also impose design constraints on the use of trenchless crossings, or prevent this method being suitable in some areas. The benefits of trenchless crossings also need to be considered against additional cost and schedule implications.

The criteria used to inform the selection of trenchless crossing locations for the alignment are listed and discussed in **Table 3-7** below.

Table 3-7: Trenchless crossing selection criteria

Trenchless crossing criterion	Reasoning
1. Sealed public roads	*Sealed public roads typically convey significant volumes of traffic. Trenchless crossings of sealed roads enable interruption of these traffic flows to be avoided or significantly minimised relative to open trenching.*
2. Rail lines, including disused and non-operational rail lines	*Open trenching of rail lines and associated corridors would require significant disturbance to rail infrastructure, rendering the rail line inoperable until subsequent major rectification work was completed. Use of trenchless crossings avoids this disturbance and disruption to rail infrastructure and services.*
3. Wetlands listed under the Ramsar convention	*Wetlands listed under the Ramsar Convention are identified as wetlands of international importance. Use of trenchless crossings avoids direct disturbance to these wetlands.*
4. Major watercourses (as identified in Chapter 8 Surface water)	*Major watercourses typically convey significant volumes of water, either intermittently or continuously, and so have an elevated risk of sedimentation and bank instability if open trenching were used. Use of trenchless crossings typically eliminates these risks.*
5. Main drains with spoil banks within the Koo Wee Rup flood protection district	*The main drains within the Koo Wee Rup Flood Protection District are bordered by embankments which provide flood protection to the surrounding area. Crossing these main drains by trenchless techniques enables this flood protection to be maintained at all times.*
6. Highly sensitive biodiversity areas	*A highly sensitive biodiversity area supports the known or assumed presence of threatened species or ecological communities listed under the Flora and Fauna Guarantee Act 1988 (FFG Act) or EPBC Act. Trenchless crossing techniques would be employed in these areas when other mitigation measures are unable to reduce the residual risk to biodiversity to a level of 'moderate' or lower, as assessed by technical specialists.*
7. Residential, commercial or agricultural infrastructure	*Residential, commercial or agricultural infrastructure identified by a landholder and agreed by APA as likely to be significantly impacted or disrupted by open trenching, and where mitigation measures to reasonably mitigate impacts cannot be implemented, would be crossed by trenchless methods.*
8. Major services (water, gas, electricity, optic fibre)	*Interruption of major services (water, gas, electricity, optic fibre) by open trenching would cause significant service provision and cost implications to business providing these services and their customers. Trenchless crossings would allow operation of these services to continue uninterrupted.*
9. Highly sensitive historical heritage sites or Aboriginal cultural heritage places	*A highly sensitive historical heritage is defined as a site listed on Victorian or Commonwealth heritage lists (Victorian Heritage Register, National Heritage List, Commonwealth Heritage List, World Heritage sites). A highly sensitive Aboriginal cultural heritage site would be determined by the archaeologist completing Cultural Heritage Management Plans for the pipeline in consultation with the Registered Aboriginal Parties.* *Trenchless crossing techniques would be employed in these areas when other mitigation measures were unable to reduce the residual risk to heritage values below a level of 'high', as assessed by technical specialists.*
10. Other	*Trenchless crossings may be employed in other situations to those described above on an as needed basis. These situations may include insufficient space for safe construction by open trenching, presence of structures which preclude open trenching, schedule optimisation or interfaces with other construction projects.*

The consistent application of the criteria described in **Table 3-7** may not be feasible across the entire length of the pipeline alignment due to location-specific conditions. Locations where the criteria listed above were not applied, and reasons for this, are as follows:

- Kanowna Street, Hastings (KP8.4): Open cut construction is proposed adjacent to and within Kanowna Street, which is a minor unsealed road that provides access to facilities in the industrial and commercial estate between the Frankston–Flinders Road and the Stony Point rail line. Kanowna Street supports low volumes of traffic accessing a limited number of commercial and industrial facilities. Access to these facilities during construction would be maintained either by existing access from the Frankston–Finders Road or by providing access through the pipeline construction area. These arrangements were discussed with operators of the affected commercial and industrial facilities during door-knocking engagement in March 2019. Most stakeholders were not concerned about the pipeline alignment and the stakeholders engaged were satisfied with the arrangements discussed with them. A trenchless crossing of Kanowna Road is therefore not proposed.
- Denham Road, Hastings (KP11): Denham Road Farmhouse – horizontal bore used to cross the Heritage Inventory site, but the access track impacts the curtilage of the heritage site at the northern extent. There are no direct impacts on Denham Road Farmhouse.
- Tooradin Inlet Drain, Ridgeways Drain and south of Soldiers Road, Rythdale (KP37.2, KP37.6 and KP43): Open cut construction is proposed for Tooradin Inlet Drain, Ridgeways Drain and south of Soldiers Road. The Southern Brown Bandicoot, listed under the FFG Act and EPBC Act, is either confirmed present or assumed present at these locations. Trenchless crossings are not proposed at these locations due to constructability issues and landholder-imposed restrictions.

The specific locations where trenchless crossings are proposed are summarised in **Table 3-8** and **Figure 3-8**.

Table 3-8: Trenchless crossing locations

No.	Location	KP	Method
1	The Esplanade	0 - 0.1	Bore
2	Pipelines and large concrete structure to be avoided by HDD	0.8 - 1	HDD
3	Population of Merran's Sun-orchid (FFG Act listed) present	1.1 - 1.7	HDD
4	The Esplanade and Woolleys Road	1.8 - 1.9	Bore
5	Crossing of a hydrocarbon pipeline owned by Esso	2.9 - 3	Bore
6	A section of the Western Port Ramsar site within Warringine Park	4 - 4.4	HDD
7	Warringine Creek	4.6 - 5	HDD
8	Reid Parade and the Stony Point rail line	5 - 6	HDD
9	Coolstore Road and Hodgins Road Insufficient width for standard trenched construction in this area	6.5 - 6.9	HDD
10	Kings Creek	7 - 7.4	HDD
11	Intersection of Marine Parade and Frankston–Flinders Road	8.5 - 8.6	Bore
12	Stony Point rail line and Frankston–Flinders Rd	9 - 9.1	Bore
13	Easement containing 7 active hydrocarbon pipelines (oil, ethane, LPG, LFD/LIP liquids)	9.3 - 9.5	HDD
14	Remains of the Denhams Road Farmhouse, Victorian Heritage Inventory Site H7921-0119	11 - 11.1	Bore
15	Dwelling on McKinrdys Road	12.1 - 12.2	Bore
16	Population of River Swamp Wallaby-grass (FFG listed, EPBC Vulnerable)	13.3 - 13.7	HDD
17	Whitneys Road and a chicken broiler facility	16.8 - 17.2	HDD
18	Watson Creek and a section of the Western Port Ramsar site	18.8 - 19.4	HDD

No.	Location	KP	Method
19	Private property pond - Langwarrin Creek	20.9 - 21.3	HDD
20	HDD of two large dams adjacent to Vowell Drive which present significant constructability issues for open trenching due water management and saturated soils	22.5 - 23	HDD
21	Driveway providing access off Baxter–Tooradin Rd	24.4 - 24.4	Bore
22	Baxter–Tooradin Road	25 - 25	Bore
23	Fisheries Road and a driveway providing access off Fisheries Road	26.7 - 27	HDD
24	Adeneys Road (unsealed) and driveways to multiple residences The bore crossing also enables access to be maintained to the South Gippsland Highway HDD site	28.7 - 28.8	Bore
25	Rutherford Creek (constructed drain), South Gippsland Highway and Lynes Road (unsealed) HDD allows for a workable interface with a proposed water pipeline upgrade by Melbourne Water	29.6 - 30.2	HDD
26	Muddy Gates Lane and the disused Gippsland rail corridor Known populations of Swamp Everlasting (FFG listed, EPBC Vulnerable) and Swamp Fireweed (FFG listed, EPBC Vulnerable)	33.4 - 33.6	HDD
27	Manks Road, and known presence of the Southern Brown Bandicoot (FFG Listed, EPBC Endangered) in the road verge	34.3 - 34.4	Bore
28	Tooradin Station Road, and known presence of the Southern Brown Bandicoot (FFG Listed, EPBC Endangered) in the road verge	35.4 - 35.4	Bore
29	Dalmore Road and Dalmore Drain	38.8 - 38.9	Bore
30	Cardinia Creek/catch drain Known presence of the Southern Brown Bandicoot (FFG Listed, EPBC Endangered) and Growling Grass Frog (FFG Listed, EPBC Vulnerable Major drain with embankments for flood mitigation	40 - 40.3	HDD
31	Lower Gum Scrub Creek, Toomuc Creek, Deep Creek and Desalination Pipe, Ballarto Road. Known presence of the Southern Brown Bandicoot (FFG Listed, EPBC Endangered) Complex of major drains with embankments for flood mitigation. Buried powerlines and pipeline for the Victorian Desalination Plant at Wonthaggi	40.9 - 41.3	HDD
32	Soldiers Road West Drain and Soldiers Road (unsealed) Melbourne Water Pipeline	44.1 - 44.2	Bore
33	Koo Wee Rup Road Known presence of the Southern Brown Bandicoot (FFG Listed, EPBC Endangered)	46.5 - 46.7	HDD
34	Deep Creek/Pakenham Creek at McDonalds Road crossing Assumed presence for the Southern Brown Bandicoot (FFG Listed, EPBC Endangered)	49.2 - 49.4	HDD
35	Bald Hill Road	52.4 - 52.5	Bore
36	Pakenham Rail Crossing–Bairnsdale Line	55 - 55	Bore
37	Entrance to Pakenham East rail facility 24-hour access required	55.3 - 55.3	Bore
38	Princes Freeway	55.7 - 55.8	Bore
39	Princes Highway	56.6 - 56.7	Bore

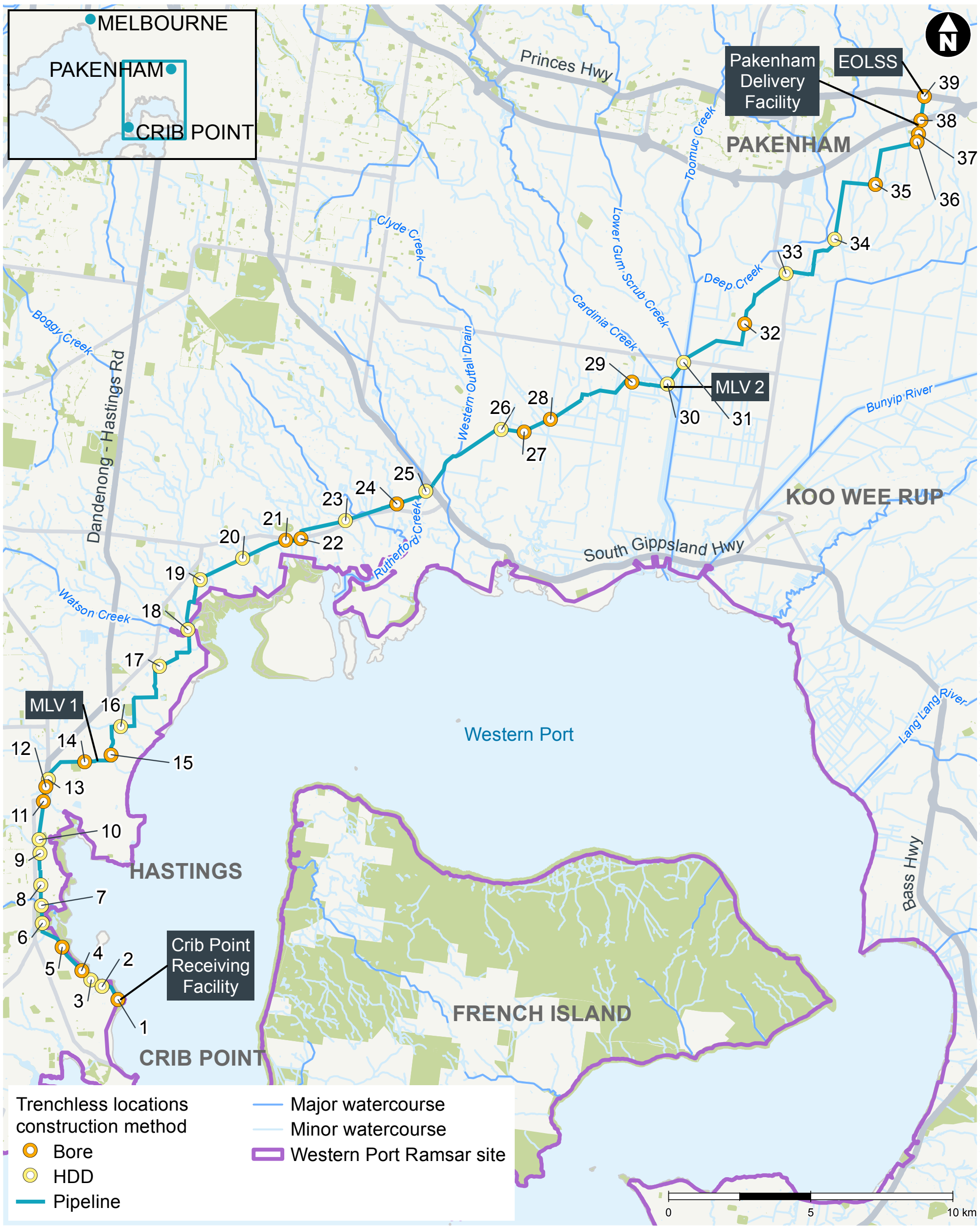


Figure 3-8: Trenchless locations

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK