Chapter 4

Project description

This chapter describes the design, construction and operation of the proposed Viva Energy Gas Terminal Project (the project). The purpose of this chapter is to provide a description of the project and its components, and to provide a clear understanding of the scope of works that will be assessed in the Environment Effects Statement (EES). The project description outlines all of the project components which have been assessed in the EES and are being put forward for regulatory approvals subject to the outcomes of the EES.

4.1 Project overview

Viva Energy Gas Australia Pty Ltd (Viva Energy) is planning to develop a floating gas terminal using a ship known as a floating storage and regasification unit (FSRU) which would be continuously moored at Refinery Pier in Corio Bay, Geelong. The key objective of the project is to facilitate supply of a new source of gas for the south-eastern Australian gas market where there is a projected supply shortfall in coming years.

The FSRU would store liquefied natural gas (LNG) received from visiting LNG carriers and regasify the LNG as required to meet residential, industrial, and commercial customer demand.

The FSRU would be up to 300 metres (m) in length, 50m in breadth and 65m in height, with the capacity to store approximately 170,000 cubic metres (m^3) of LNG. LNG would be received from visiting LNG carriers that would moor directly adjacent to the FSRU for approximately 36 hours. The FSRU would store the LNG in cryogenic storage tanks at a temperature of about 160 degrees Celsius below zero (–160°C).

The FSRU would receive up to 160 petajoules of LNG per annum (approximately 45 LNG carriers) depending on demand. The number of LNG carriers would also depend on their storage capacity, which could vary from 125,000 to 180,000m^3 of LNG.

When required, the FSRU would convert the LNG back into a gaseous state by heating the LNG using seawater (a process known as regasification). The gas would then be transferred through the 3-kilometre (km) aboveground pipeline from the FSRU to the treatment facility where odorant and nitrogen would be added, where required, to meet Victorian Transmission System (VTS) gas quality specifications. Nitrogen injection would occur when any given gas cargo needs to be diluted to meet local specifications. Odorant is added as a safety requirement so that the normally odourless gas can be smelt when in use. From the treatment facility, the 4km underground section of the pipeline would transfer the natural gas to the tie-in point to the South West Pipeline (SWP) at Lara.

The FSRU is anticipated to operate for approximately 20 years. The floating gas terminal would be located adjacent to, and on, Viva Energy's Geelong Refinery. Viva Energy will be able to draw on their long experience as a Major Hazard Facility (MHF) operator to operate the project and the co-location provides opportunity for potential synergies between the refinery and the project, such as the reuse of FSRU seawater discharge within the refinery for cooling water.

An overview of the project components is shown in **Figure 4-1**.

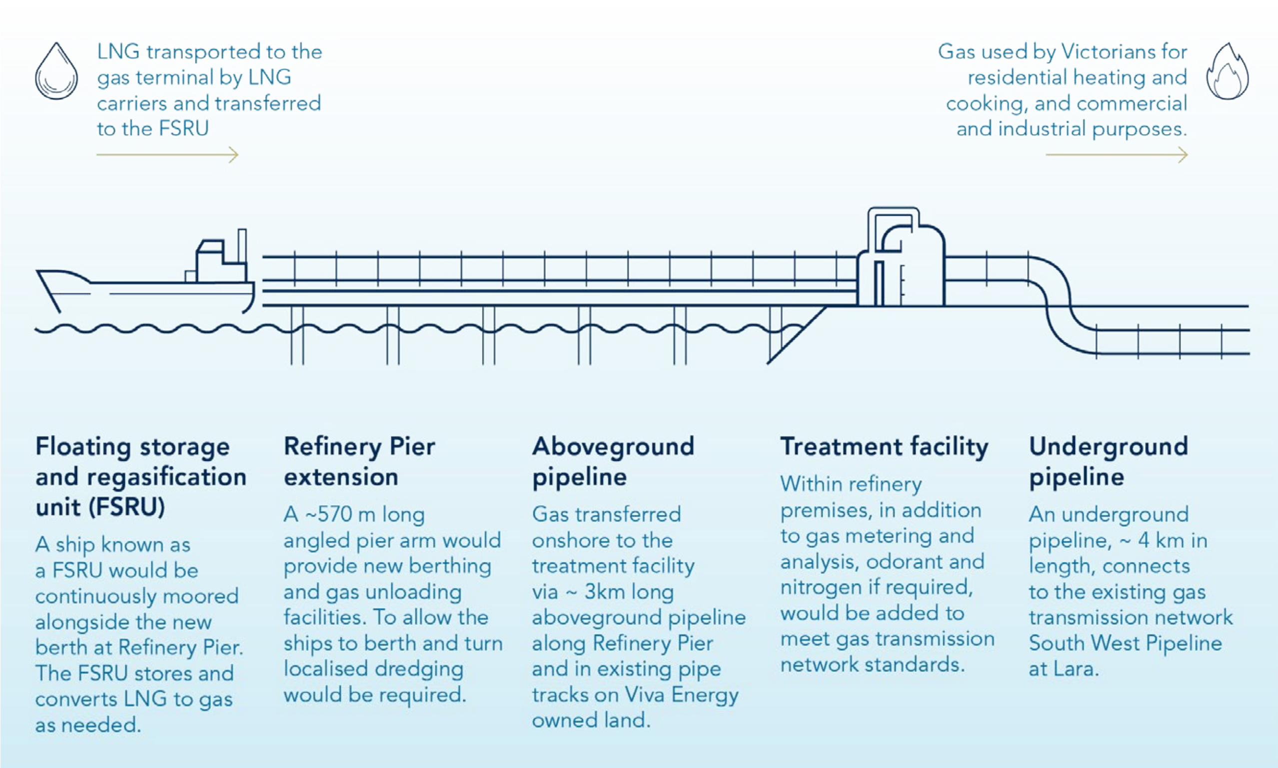

Figure 4-1 Overview of project components

4.1.1 Project components

Key components of the project include:

- Extension of the existing Refinery Pier with an approximately 570m long angled pier arm, new berth and ancillary pier infrastructure including high pressure gas marine loading arms (MLAs) and a seawater transfer pipe connecting the seawater discharge points on the FSRU to the existing refinery seawater intake
- Continuous mooring of an FSRU at the new Refinery Pier berth to store and convert LNG into natural gas. LNG carriers would moor alongside the FSRU and unload the LNG
- Construction and operation of approximately 3km of aboveground gas pipeline on the pier, and within the refinery site connecting the FSRU to the new treatment facility
- Construction and operation of a treatment facility on refinery premises including gas metering and analysis, and odorant and nitrogen injection (if required)
- Construction and operation of an underground gas transmission pipeline, approximately 4km in length, connecting to the SWP at Lara.

These components are described in more detail in the following sections, with an overview shown in **Figure 4-2** and **Figure 4-3**.

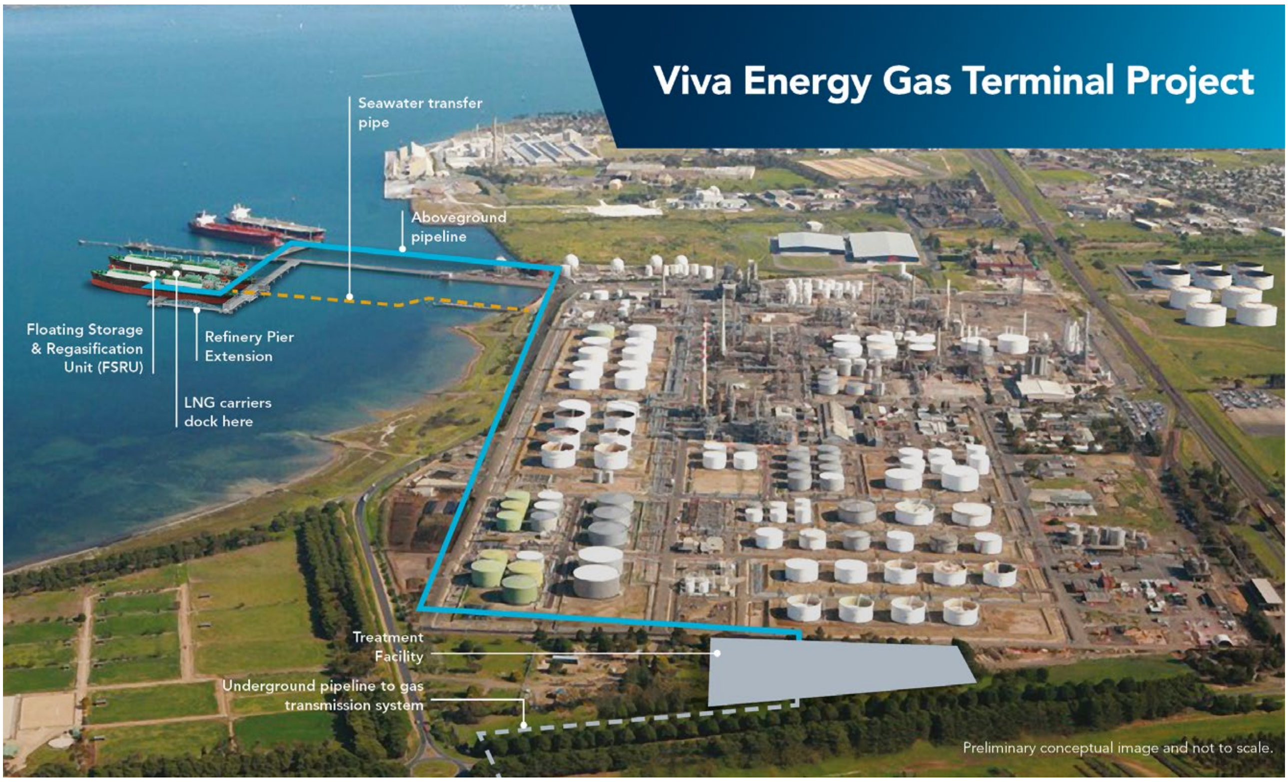

Figure 4-2 Project aerial of main components

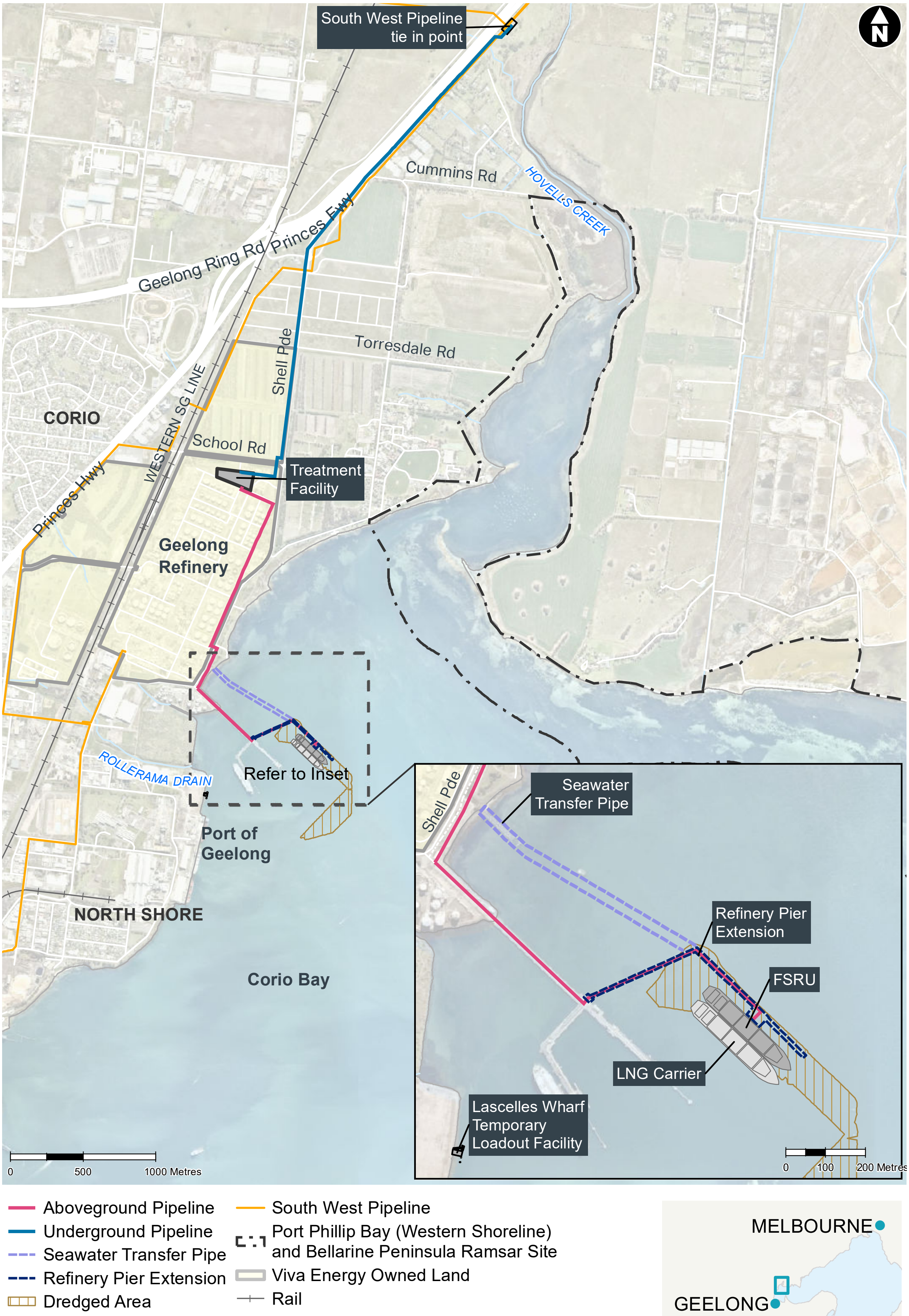

Figure 4-3 Project overview

4.2 History of the Refinery Pier area

Refinery Pier was established in association with Shell Refinery (now the Viva Energy refinery) in 1954. Berths 1 and 2 were constructed in 1954 and berths 3 and 4 were constructed in 1962. The Corio Channel was subsequently deepened at Shell's request in order to allow for tankers to access the pier. The expansion of the channel between Refinery Pier and Pt. Richards was completed in 1958, widening the channel to 91.4m and deepening it to 10.9m. At this time, freighters, tugs and tankers all frequented the area.

Shipping channels within the Port of Geelong have an extensive history of dredging. Shipping channels have been progressively enlarged and modified over time, since dredging works first began in 1854 in order to allow for safe ship access to the port. A number of dredging works and programs have been undertaken in the Port of Geelong, and in particular within the Refinery Pier area. In 1980, capital and maintenance dredging was undertaken at Lascelles Wharf adjacent to Refinery Pier. In 1996-1997, the Channel Improvement Program was undertaken involving capital dredging in a number of locations including Lascelles Wharf and Refinery Pier. A total of 4.5 million m^3 of material was dredged over this entire program.

In more recent years, the Corio Bay Safety Adjustment Program was undertaken to make changes in the channel alignments and available water depths in the City Bend and at the junction of the Hopetoun and Corio Channels. This program in particular involved dredging adjacent to Refinery Pier No. 4 in 2015.

The existing Corio Channel and berths at Refinery Pier currently have a maintained dredged depth of 12.3m.

4.3 Refinery Pier extension

Refinery Pier currently has four berths in use for importing and exporting liquid hydrocarbons to and from the Viva Energy Geelong Refinery. The proposed Refinery Pier extension would be Refinery Pier No. 5, located to the north-east of Refinery Pier No. 1. The new pier arm would be positioned to allow sufficient clearance between an LNG carrier berthed alongside the FSRU and a vessel berthed at the existing Refinery Pier No. 1. The new pier arm would be connected to the existing pier by a new trestle and consist of a vehicle roadway, pedestrian access, and a pier head. The angled pier extension would be approximately 570m in length, with a pier head of approximately 35m by 35m.

The pier head would accommodate two high-pressure gas marine loading arms (MLAs). These are made up of rigid sections of pipe, connected by swivel joints to transfer gas from the FSRU to the aboveground pipeline which would be installed on the pier extension pipe rack. Other associated infrastructure which would be installed on the pierhead includes a hydraulic power unit, electrical control cabinet, utility systems including firefighting system and ship-to-shore connections and a separate gangway tower for access to the FSRU. The FSRU mooring configuration would consist of four mooring dolphins and two berthing dolphins as shown in Figure 4-4.

LNG carriers visiting Refinery Pier would transit the existing Port of Geelong shipping channel which is maintained at a minimum depth of 12.3m by Ports Victoria. No dredging of the channel through Corio Bay would be required to accommodate the LNG carriers, however an estimated 490,000m^3 of seabed sediment would be removed from a localised area of 12 hectares (ha) adjacent to the existing shipping channel. This is to provide sufficient water depth at the new berth and within the swing basin to allow the LNG carriers to turn and berth safely. Figure 4-5 shows the location and area of the new berth and swing basin and the updated waterside restriction zone.

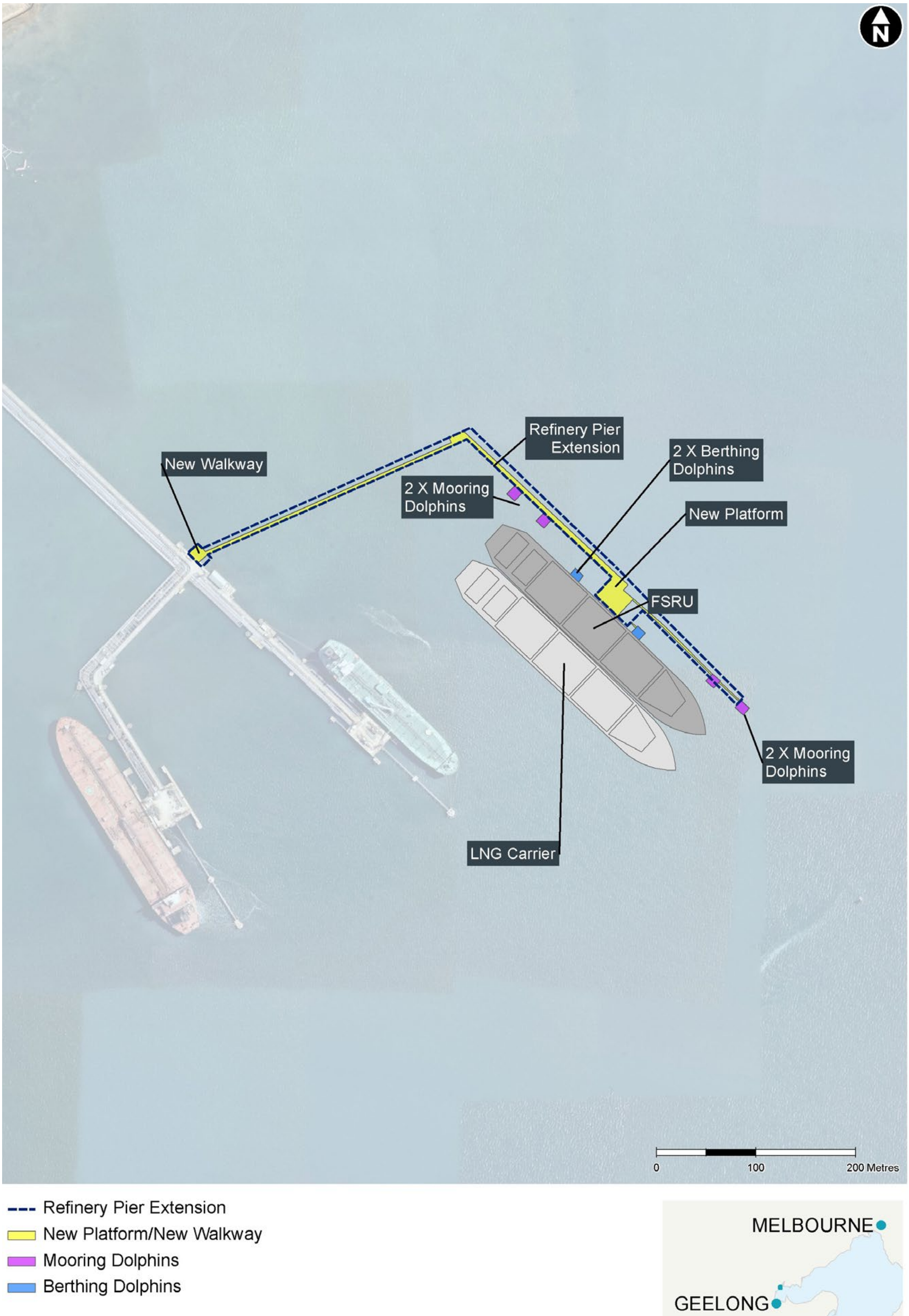

Figure 4-4 Refinery Pier No.5 infrastructure and berthing configuration

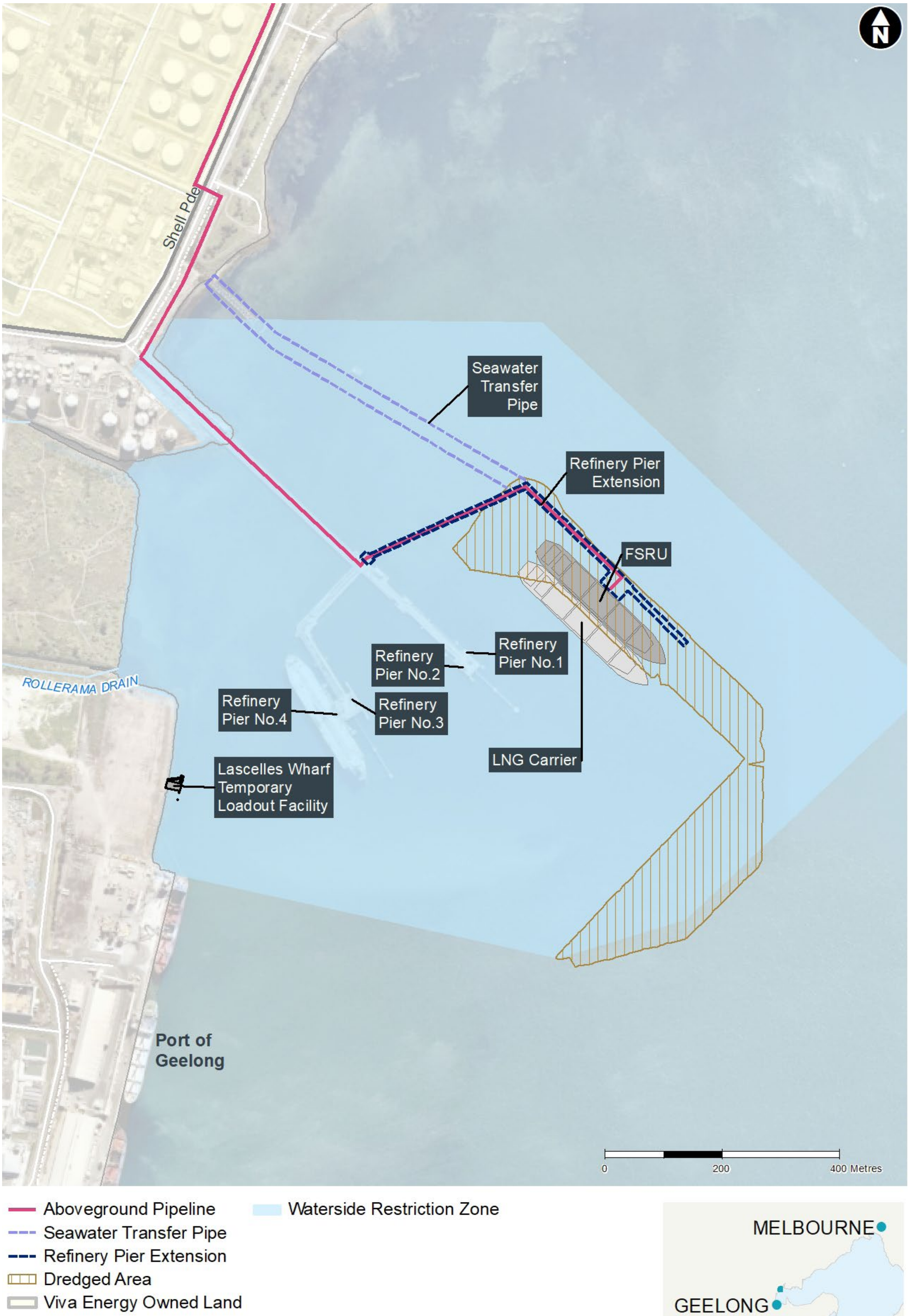

Figure 4-5 Refinery Pier No.5

4.4 Floating storage and regasification unit (FSRU)

An FSRU vessel approximately 300m long, 50m in breadth and 65 m in height with a maximum draft of approximately 55m (distance from the water level to highest point on the vessel) would be continuously moored at the new berth at Refinery Pier.

The FSRU has four key functional elements:

- Receiving LNG from LNG carriers
- Storing LNG
- Converting LNG to high-pressure natural gas
- Injecting gas into the pipeline through marine loading arms.

4.4.1 Receiving LNG

Periodically, LNG carriers would arrive at Refinery Pier and berth alongside the FSRU to deliver LNG via a flexible hose connection. Depending on gas demand, LNG carriers would visit Refinery Pier approximately every 20 days or every 8 days at maximum demand periods. The LNG carriers would carry between 125,000 and 180,000m^3 of LNG. Up to 45 LNG carriers would arrive each year, depending on the gas demand and their storage capacity.

The LNG carriers would berth next to the FSRU with the assistance of four tugboats for up to 36 hours while LNG is transferred into the cargo tanks of the FSRU. Purpose-built flexible hoses would be used to transfer LNG from visiting LNG carriers to the FSRU. These hoses would be stored on the FSRU.

Once the transfer of LNG is complete, LNG carriers would depart from their berth alongside the FSRU with the assistance of four tugboats and leave the port.

4.4.2 Storing LNG on the FSRU

The FSRU would have the capacity to store approximately 170,000m^3 of LNG. The FSRU is a double-hulled ocean-going vessel that would store the LNG in a liquid state at very low temperatures. The cargo tanks on board the FSRU are purpose built to store LNG with primary and secondary barriers further supported by insulation and intervening spaces. These cargo tanks are designed to insulate and keep the LNG cargo at cryogenic temperatures (approximately –160°C) and to prevent leakages and isolate the cargo from the hull structure.

Boil-off gas (BOG) management facilities would also be in place on the FSRU to capture small amounts of natural gas that evaporates from LNG in the cargo tanks. The BOG would be used to fuel the onboard generators for operation of pumps and other equipment used onboard. Excess BOG would potentially be directed into the refinery natural gas system to be used as a fuel at times where BOG production surpasses FSRU generator demand. The need for BOG piping connecting the FSRU to the refinery natural gas system would be determined during detailed design. If required, BOG would be compressed on the FSRU and transferred via a hose connection to piping that would run along the pier structure. This connection would provide an additional source of natural gas for the refinery. The flow of BOG into the refinery natural gas system would be controlled using pressure control and priority would be given to BOG from the FSRU to reduce refinery gas consumption from the transmission network. The FSRU BOG injection point would be located near the existing fuel gas injection points at the refinery.

4.4.3 Converting LNG back to gas on the FSRU

When gas is needed, the FSRU would convert LNG to its gaseous form, via a process called 'regasification'. The regasification unit located on board the FSRU would be typically located near the bow or centre of the vessel. The FSRU would be able to operate in different regasification modes which are described in detail in the following sections. For the project the usual regasification mode is 'open loop mode', where seawater would be continuously drawn in to the FSRU and used as the medium to heat the LNG into a gaseous state. The FSRU would also be able to operate in closed loop regasification mode (where water is continuously recycled within the vessel) and combined loop regasification mode (where a combination of modes may be used to heat seawater if it falls below a specified temperature).

Seawater would be continuously drawn into the FSRU through the vessel sea chest or dedicated water inlet ports in the hull. Two intakes would be located on the FSRU, one on the port side approximately five metres below the sea surface, and one starboard side approximately eight metres below the sea surface. The FSRU seawater intakes would be designed to reduce inlet velocities to approximately 0.15 m/s to allow mobile marine organisms to swim away. The intakes would be fitted with grilles spaced appropriately to prevent the entrainment of fish and other matter into the FSRU.

A simplified diagram of the proposed seawater intake and discharge configuration in open loop regasification mode is show in **Figure 4-6**.

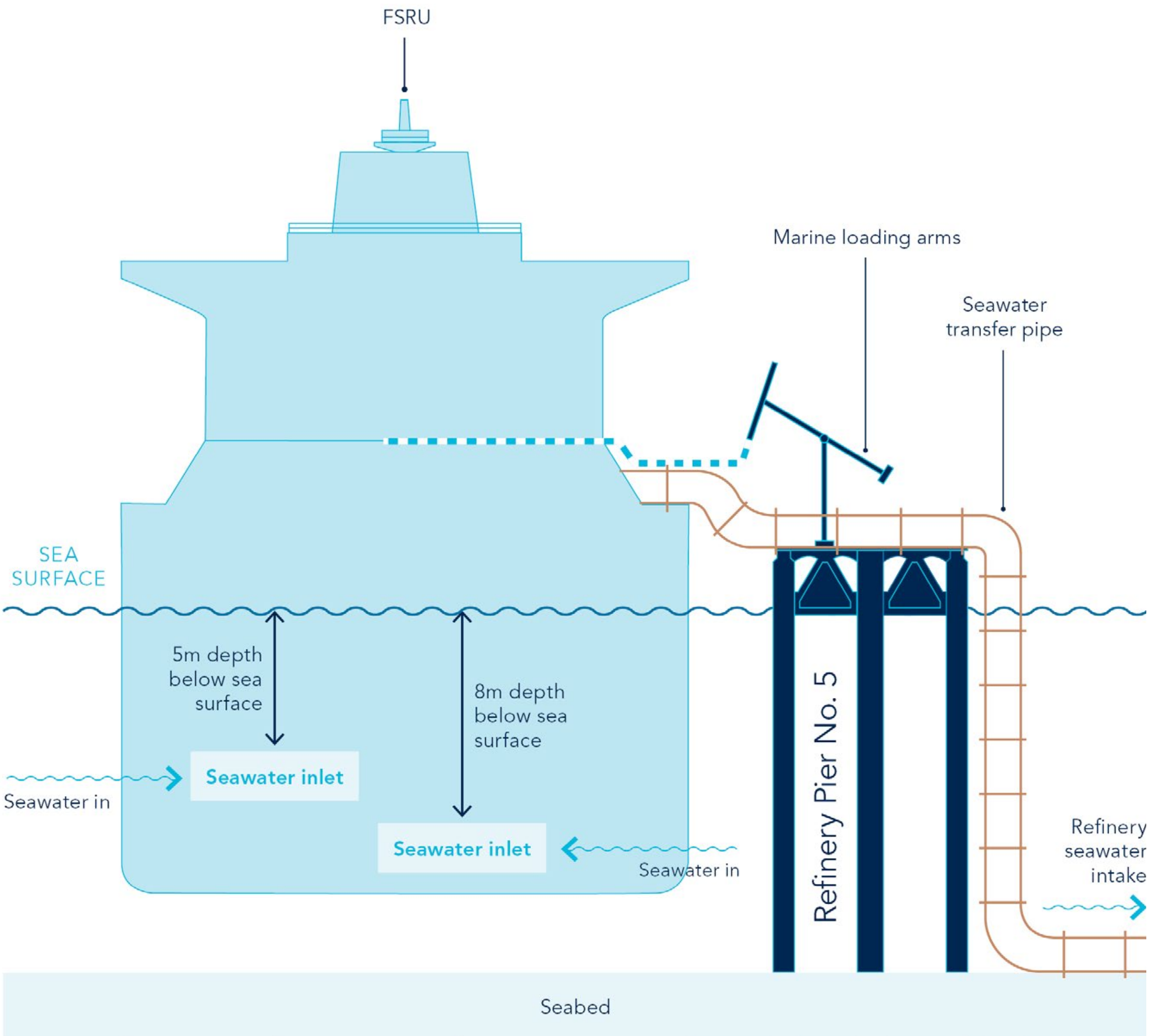

Figure 4-6 Open loop regasification seawater intake and discharge (not to scale)

To prevent marine growth in the FSRU heat exchange system, a small portion of the seawater intake would be subject to an electrolysis process. Electrolysis breaks up the naturally occurring salt molecules (sodium chloride) in seawater and produces hypochlorite. The water with hypochlorite is injected into the seawater coming into the FSRU to reduce biofouling of heat exchange equipment. Discharge of seawater from the FSRU would contain some short-lived residual hypochlorite after it has been used for regasification. When FSRU seawater discharge is directed to the refinery for reuse, the refinery would slightly reduce the volume of hypochlorite that would normally be added at the seawater intake to account for the small amount of residual hypochlorite in the FSRU discharge (hypochlorite is generically termed chlorine throughout this EES).

Open loop regasification

Open loop regasification on the FSRU would use seawater from Corio Bay to heat the LNG. For this project seawater would be continuously drawn in via intakes, pass once through a heat exchange system and would then be redirected to the refinery for reuse as cooling water via a seawater transfer pipe. In open loop mode, the FSRU would typically discharge the seawater directly back to the sea at 7°C below ambient seawater temperature. However, the project has identified a synergy between the FSRU and the refinery that would avoid discharging the chilled water directly back into the sea with the exception of the limited times when the refinery requires less cooling water than FSRU production rates due to maintenance activities. The energy used to pump the seawater through the heat exchanger would consume about 1.5% of the send out gas for power generation. Open loop is the most commonly used system globally for FSRUs. The project also allows for open loop operation where all or part of the FSRU chilled water could be discharged via a diffuser located on Refinery Pier. This discharge option would only be required in very limited circumstances. Figure 4-7 shows a simplified diagram of how the open loop regasification mode would work.

Closed loop regasification

Closed loop regasification would use gas-fired steam boilers to heat a closed loop of circulating seawater within the FSRU as an intermediate heating medium for heat exchange in the LNG regasification trains. Around 500m^3 of seawater from Corio Bay would be required to fill the FSRU heat exchange piping. The seawater would then be continually circulated in the heat exchange process instead of being discharged from the FSRU as per open loop mode. Seawater would only be discharged to Corio Bay when the FSRU reverts to open loop (usual) mode or if maintenance is required (anticipated to be annually). Discharged seawater from the closed loop process would be around 5 °C warmer than the ambient seawater temperature. Figure 4-8 shows a simplified diagram of how the closed loop regasification mode would work.

This mode would use 2.5% of the send out gas to heat the circulating fluid to vaporise the LNG compared to 1.5% for open loop (Songhurst 2017). This contributes to an increase in greenhouse gas emissions when compared to open loop operation and reduces the regasification plant output. Due to the environmental and economic implications as well as the synergy identified between the FSRU and the refinery, closed loop is not the preferred mode of regasification for the project and would only be required in very limited circumstances as described in the next section.

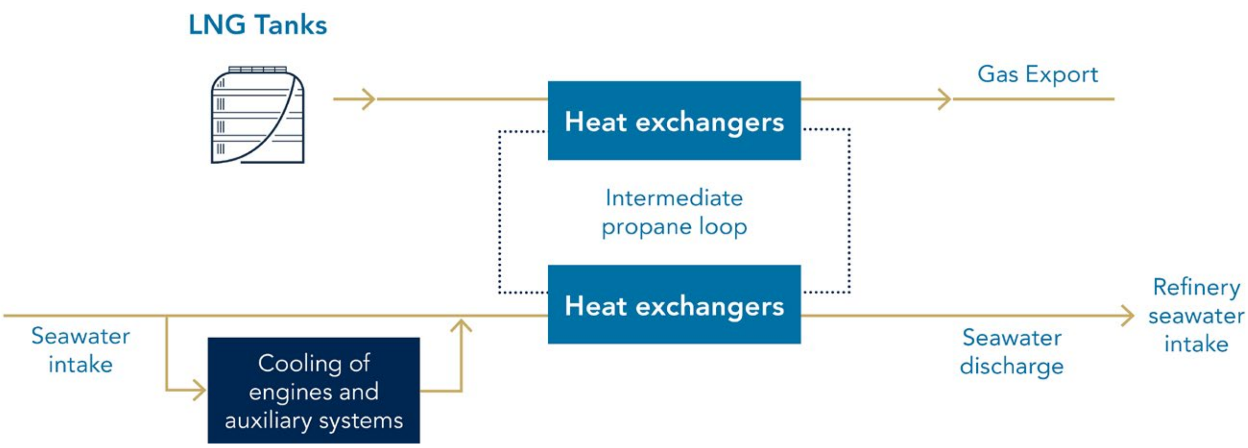

Figure 4-7 Open loop regasification process

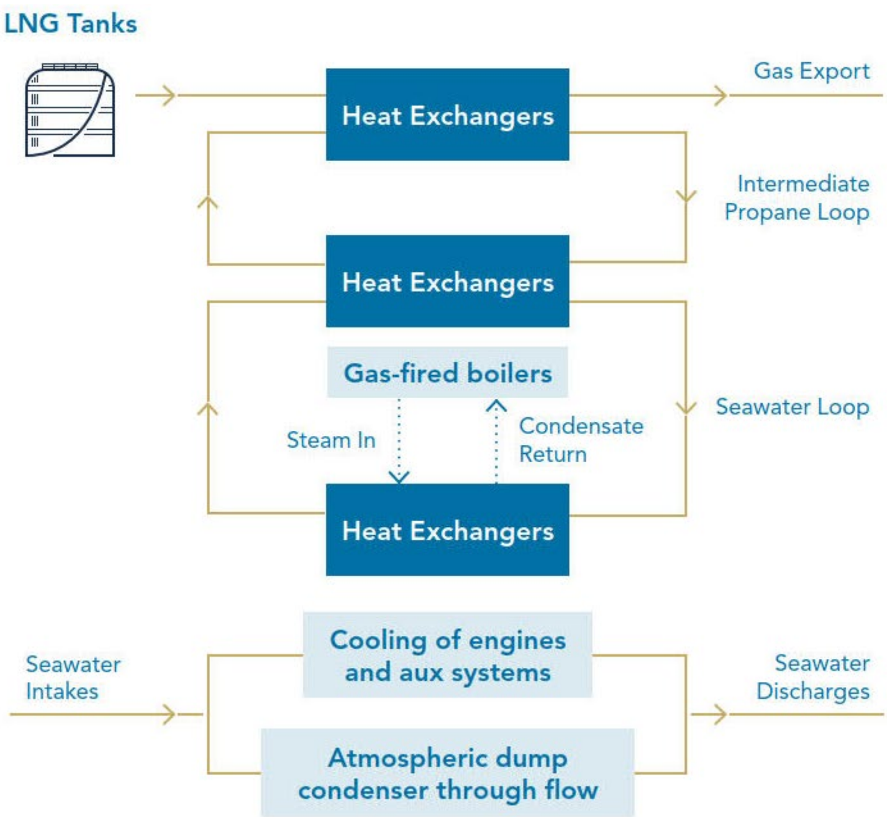

Figure 4-8 Closed loop regasification process

Combined loop regasification

The FSRU would also have the ability to operate in both open and closed loop, which is referred to as 'combined loop'. The combined loop mode would operate similar to open loop mode; however, seawater would be heated via steam from gas-fired boilers prior to reaching the regasification system on the FSRU. The seawater would be continuously drawn into the FSRU through seawater inlets and heated by heat exchange with steam. Seawater use associated with combined loop regasification mode would be the same as seawater use for open loop regasification. This mode would be used when the ambient seawater temperature is below a certain temperature and needs to be heated for effective and efficient regasification.

Proposed mode of regasification and indicative production profile

Operating modes

Open loop operation with refinery reuse of FSRU discharge

The usual regasification mode of the FSRU for this project would involve open loop operation with the transfer of seawater from the FSRU via a pipe to the refinery intake as described in the previous section. The project being assessed in this EES also provides for open loop operation with discharge of FSRU water via a diffuser located under the proposed pier extension. Both discharge modes could be utilised at times during project operation as described below. Both of these discharge modes have been assessed in the impact assessment, and both form part of the project being put forward for regulatory approvals subject to the outcomes of the EES.

Most FSRUs around the world operate in open loop mode and discharge directly into the receiving waters in which they are located. In contrast, the usual mode of operation proposed for this project (described below) makes use of the synergy created by having the FSRU proximal to the Viva Energy refinery and provides a significant environmental enhancement through reuse of the FSRU discharge water for refinery cooling purposes. The potential impacts and environmental benefits associated with this mode of operation are discussed in later sections of the EES.

For the project, the FSRU discharge would replace all or some of the existing intake requirements of the refinery from Corio Bay with the amount of replacement being determined by the production rate of the FSRU at any given time. For example, there would be days where seawater discharge from the FSRU is lower than the approximate 350 ML/day intake requirements of the refinery (e.g., when the production rate for the FSRU is low due to reduced gas demand). In this situation, the refinery would simply draw the remaining volume of seawater required for cooling through the existing refinery seawater intake as is done at present. The recycled refinery cooling water would be discharged from the existing refinery discharge points with similar residual chlorine content to the current refinery discharge and a temperature closer to ambient conditions in Corio Bay than the current refinery discharge.

Specifically, the open loop regasification mode of operation involves the chilled discharge water from the FSRU (approximately 7°C below ambient temperature) being transferred via a pipe to the refinery inlet for reuse in the refinery as cooling water. The refinery currently uses approximately 350 ML/day of seawater for cooling purposes (e.g., cooling of equipment within the refinery) which heats the seawater to approximately 9°C above the entry temperature at its point of discharge back into Corio Bay. Reuse of the FSRU discharge as refinery cooling water would reduce the temperature of the warmed seawater discharged to approximately 2°C above the entry temperature when the discharge volume of the FSRU is 350 ML/day. In the event that the FSRU discharge was lower than 350 ML/day, the refinery cooling water discharge would be greater than 2°C above the entry temperature due to less chilled water being piped into the refinery but still significantly lower than the current refinery discharge temperature.

The usual open loop mode of operation proposed is an environmental enhancement as:

- It removes the need for two separate water intakes and two separate discharges from the refinery and the gas import terminal project if they were to be operated independently and without the synergy of co-location
- The project involves no change in the existing refinery seawater intake rate of 350 ML/d, no change to the existing refinery discharge rate of 350 ML/d, no change to the existing refinery chlorine concentration at the four refinery discharge points and a reduction in the temperature of the discharge plumes.

Open loop operation with diffuser

The project being assessed in this EES also provides for the direct discharge of some, or all, of the FSRU discharge water into Corio Bay via a diffuser located under the Refinery Pier extension.

The diffuser would only be required in the event that the refinery was permanently decommissioned in the future and the option for reuse of the FSRU discharge water in the refinery was no longer available. While the potential impacts of the diffuser have been assessed in the EES to enable its introduction in the event of a refinery closure, there would be no requirement for its use at the commencement of the project as the refinery is planned to be operational at that time.

Consideration was also given to whether there would be any periods where refinery demand for cooling water was lower than the volumes of water being discharged from the FSRU necessitating use of the diffuser for discharge of the surplus water. The only times where there would be potential for this to occur would be during refinery maintenance shutdowns. The refinery conducts significant maintenance shutdowns on average every second year where up to half of the refinery is taken offline for 2-3 months. During these times, cooling water is still required for the operational part of the refinery and is in the range of 200-250 ML/day. Based on this level of demand for cooling water even during refinery maintenance periods and based on the projected seasonal FSRU production rates shown in **Table 4-1** below, the FSRU would still be the primary source of cooling water for the refinery during refinery maintenance and there may be no requirement for diffuser use.

The major planned refinery shutdowns are conducted during spring or autumn every second year and not in winter which is the only time where a surplus of FSRU discharge water would be expected. Based on forecast gas production rates during these times (**Table 4-1**), the FSRU would be producing an estimated 208 ML/day of discharge water. As such, it is likely that all of the discharge water would still be required by the refinery for cooling purposes during shutdowns with little or no requirement for use of the diffuser. Major refinery shutdowns are planned events with long lead times so there is certainty over the timing and scope of maintenance activity.

On the basis that the refinery is still planned to be operational at the commencement of the project and requiring 350 ML/day of cooling water, and that there are currently no planned major maintenance shutdowns reducing refinery cooling water demand until 2028, construction of the diffuser may occur at some point after the project became operational. In the event that there was the potential for surplus water to be generated, the FSRU production rates and water output would be managed to match the refinery demand of 200-250 ML/day of cooling water if the diffuser was not constructed at the time. Any planned decommissioning of the refinery in the future would provide ample lead time for diffuser construction which would be required for project operation in this situation.

The potential impacts associated with both discharge of FSRU water through the refinery and via the diffuser on the pier extension have been assessed in detail in this EES and are outlined in later sections.

Closed loop operation

The project being assessed in the EES also makes provision for use of the FSRU in closed loop mode which would be utilised in very limited instances where discharge water may not be able to be transferred to the refinery. Closed loop is not preferred as the usual operating mode as it uses up to 2.5% of the LNG cargo to heat the LNG and has higher greenhouse gas emissions than open loop operation. Notwithstanding this, closed loop operation also forms part of the project being put forward for regulatory approvals subject to the outcomes of the EES to enable its use in the limited instances outlined below.

Closed loop operating mode would only be utilised in the unlikely event that the FSRU was unable to discharge water through the seawater transfer pipe to the refinery, for example, during FSRU maintenance or due to a pump or pipe failure. Under this scenario, the refinery would simply revert to its current process of drawing 350 ML/day of cooling water through the existing refinery intake and discharging through its existing discharge points consistent with its operating licence and the FSRU would operate in closed loop mode. The reason that closed loop operation would be utilised in this eventuality is that it does not involve an ongoing water intake (after initial intake of approximately 500m^3 of seawater) or have any ongoing water discharge from the FSRU associated with the regasification process as the seawater is continuously recycled within the FSRU. This is important as the EES has not assessed the refinery and the FSRU operating independently and in parallel with separate seawater intakes and discharges in operation at the one time.

The potential impacts associated with the closed loop regasification mode have been assessed in detail in this EES and are outlined in later sections.

Production profile

The estimated gas production profile for the project is shown in **Table 4-1**. This indicative profile is based on typical gas demand rates throughout the year. The FSRU is anticipated to produce up to 500 TJ/day of gas which would require approximately 300 ML/day of seawater for the regasification process. On a limited number of peak demand days, the gas production rate would fluctuate throughout the day, but the maximum daily flowrate of seawater would be 350 ML/day.

In all cases, the seawater consumption and the associated seawater discharge is below 350 ML/day which is the worst-case scenario adopted for the marine modelling and environmental impact assessment and is consistent with the current discharge and operating licence for the refinery.

Table 4-1 Indicative production profile

Season	Estimated gas production (TJ/day)	No. of regasification trains	Seawater consumption (ML/day)
Summer (Dec – Feb)	250	1	148
Autumn (Mar – May)	350	2	208
Winter (Jun – Aug)	500	2	300
Spring (Sept – Nov)	350	2	208

The three operating modes for the FSRU outlined in this section are being put forward for regulatory approvals subject to the outcomes of the EES and provide flexibility and an ability to respond to changing circumstances. The potential impacts associated with all three operating modes have been thoroughly assessed in the EES and are considered to be able to meet the evaluation objectives established for the EES.

The usual open loop operating mode proposed for the project makes use of the synergy of locating the project adjacent to the existing Geelong refinery and results in very little change to existing water intake and discharge conditions, and in fact, has a positive change in the current discharge temperature associated with the refinery.

Seawater transfer pipe

Seawater discharged from the FSRU during regasification is proposed to be transferred to the existing refinery via a single pipe. Figure 4-9 shows the existing refinery seawater intake, the four licensed discharge outlets and the proposed location of the seawater transfer pipe from the FSRU. The FSRU seawater discharge would be directed into the existing refinery seawater intake through a submerged high density polyethylene (HDPE) pipe that would sit approximately 2 metres below the seabed to enable the cooled seawater to be effectively delivered and reused within the refinery. The pipe would be directed into the existing refinery seawater intake to prevent any cold seawater discharged from the FSRU escaping into Corio Bay.

The seawater transfer pipe would start at the FSRU and connect to the overboard manifold system located at the front and rear of the vessel. The pipe would then run from the vessel into piping installed on the new pier arm via flexible hoses. The seawater transfer pipe would then transition from the pier down into the seabed and would run towards the refinery seawater intake. A single DN1200 pipe is proposed to minimise the pipeline size and a trenched option to install the pipe beneath the seabed was selected to protect the pipe and ensure the pipe remains submerged during low tide. The location of the seawater transfer pipe and the overboard manifold system in shown in Figure 4-10.

FSRU water use

During operation, the FSRU would use seawater for a range of purposes, with regasification being the primary water using activity as described in previous sections. The FSRU water usage rate for regasification would vary depending on the mode of operation and the rate of gas production.

In addition to regasification, the FSRU would use seawater for the following purposes during operation:

- Emergency fire water
- Water curtain (a spray to ensure there is no direct contact between LNG carriers and the hull of the FSRU in the event of an LNG spill)
- Cooling water for machinery (main generator and auxiliary cooling water)
- Ballast water during LNG transfer.

Cooling water from the generators and auxiliary machine systems would be redirected to the open loop regasification cycle for reuse rather than being directly discharged to Corio Bay.

Ballast water would be taken on to the FSRU as well as discharged from FSRU to maintain vessel stability and longitudinal strength. During regasification, the FSRU would take in seawater as ballast to compensate for the reduction of LNG volume in the cargo tanks. The ballast water would then be discharged to sea during LNG transfer from the next visiting LNG carrier. LNG carrier would arrive full of LNG and would not need to discharge ballast water on arrival. As the LNG carrier unloads their cargo, they would take on ballast water to compensate for the reduction in cargo volume.

Periodic and continuous seawater flows associated with FSRU water usage during operation in open loop and closed loop are outlined in Table 4-2. The seawater consumption rates for open loop are based on the proposed winter gas production rate of 500 TJ/day. Seawater intake and discharges for combined loop would be the same as for open loop.

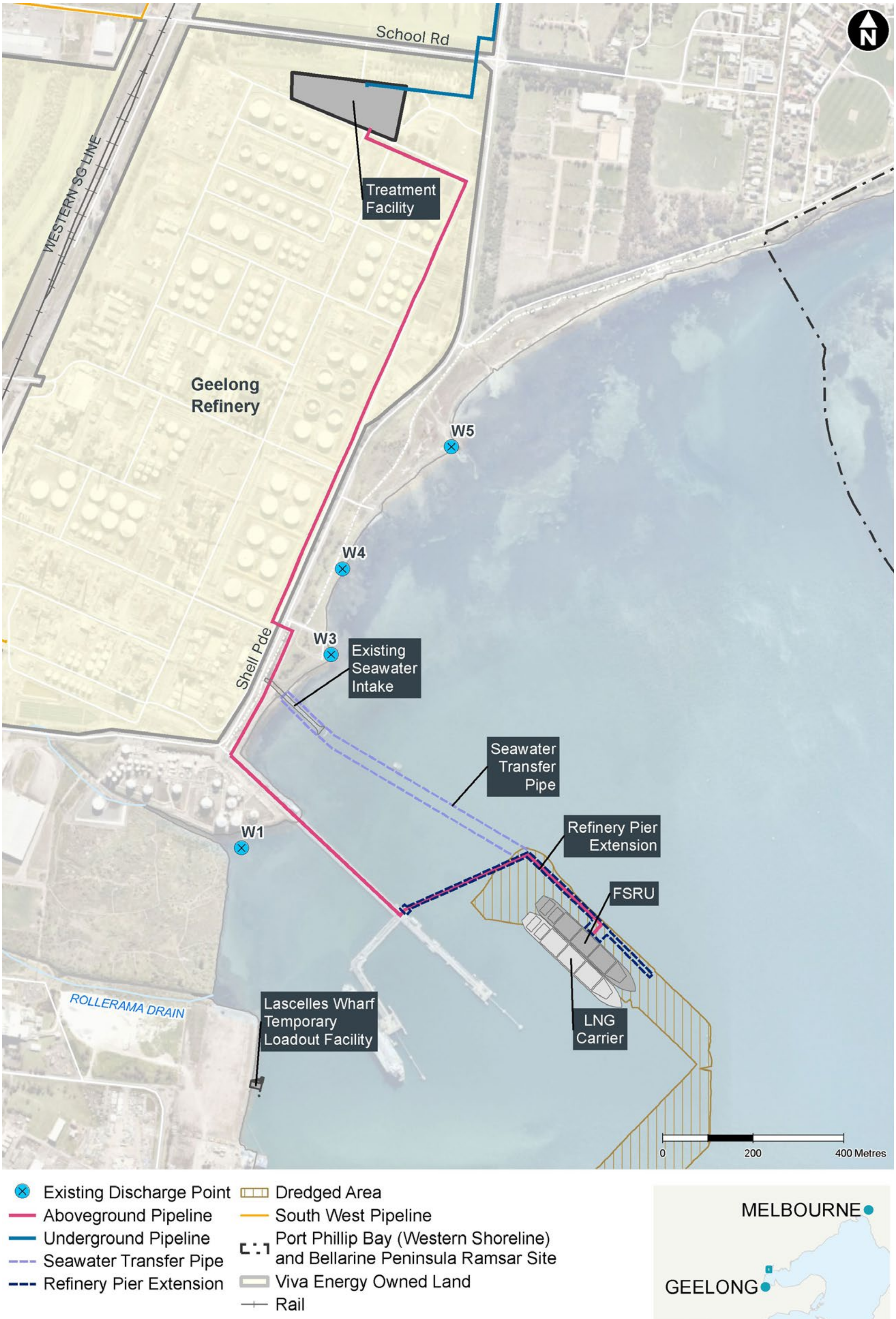

Figure 4-9 Refinery seawater intake and discharge outlets

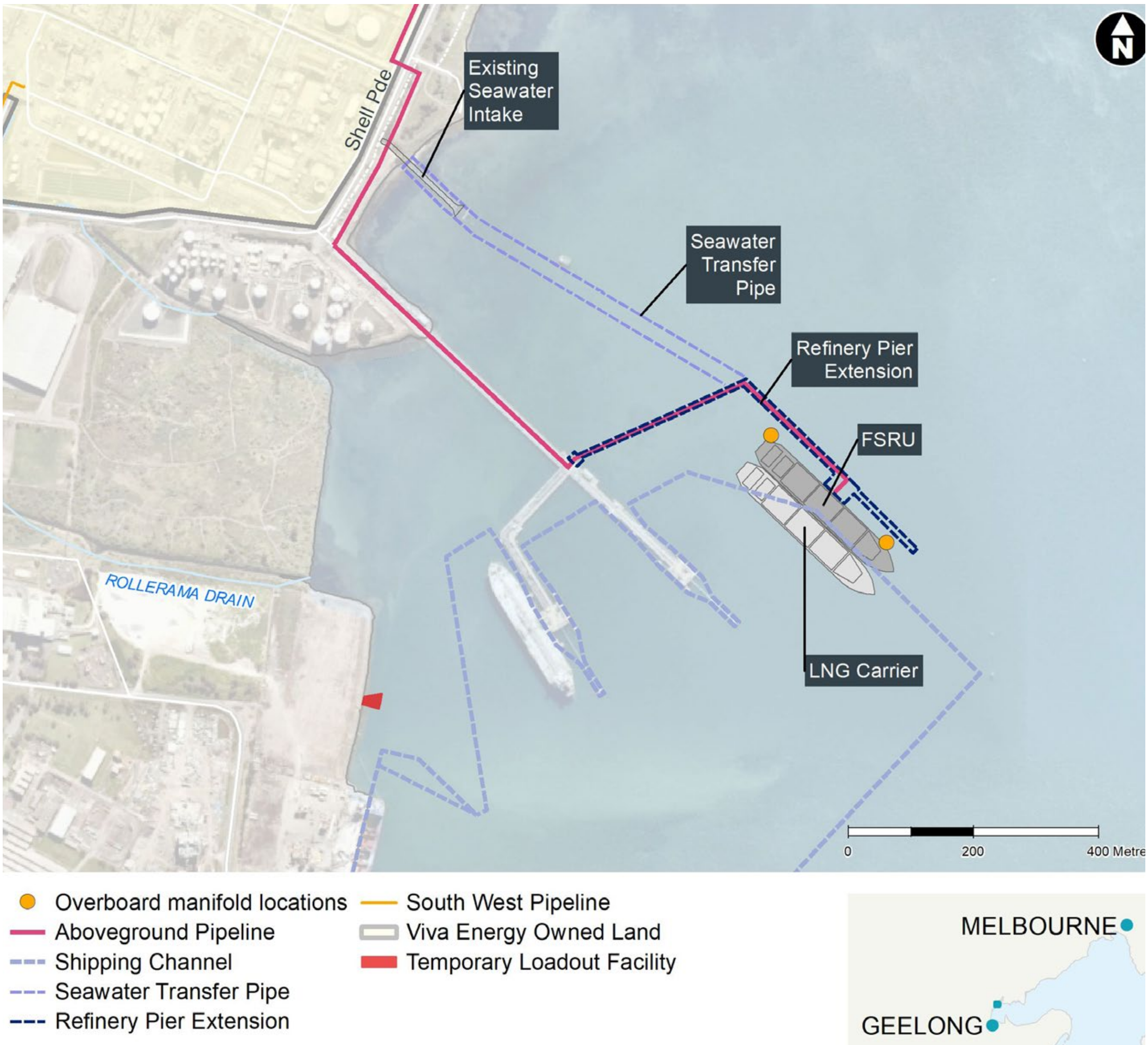

Figure 4-10 Seawater transfer pipe and overboard manifold locations

Table 4-2 FSRU seawater use

Water usage	Assumptions	Maximum consumption rates (ML/day)		Temperature difference
		Open loop	Closed loop	
Periodic flows				
Ballast water during LNG loading	Maximum ballast capacity	42	42	-
Water curtain		4.5	5.8	-
Fire water	Fire water system would be tested for 1 hour every 2 weeks	1.6	1.6	-
Continuous flows				
Heating for regasification operation	Based on gas production rate of 500 TJ/day	300	-	-7°C
Cooling of freshwater generators		2.1	2.1	+8°C
Regas backflush filter	Regas filters would be flushed for 1 hour each day	0.6	-	-
Cooling of auxiliary machinery systems		-	45.5	+5°C
Cooling of main generators		-	16.6	+7.5°C
Cooling of atmospheric dump condenser	The temperature difference is based on full steam dumping. If all excess BOG can be exported to shore through BOG management, steam dump is not required, and the dump condenser seawater cooling system would not be running.	-	80.4	+16.5°C

4.4.4 Summary of FSRU specifications

A summary of the FSRU specifications is provided in **Table 4-3**.

Table 4-3 Summary of FSRU operation specifications

FSRU	
Vessel specifications	
FSRU length	Approximately 300m
FSRU breadth	Approximately 50m
FSRU height (from the lowest point of the vessel to the highest point)	Approximately 65m
Maximum draught (distance from the water level to highest point on the vessel)	Approximately 55m
LNG storage capacity	Approximately 170,000m^3
Number of LNG cargo tanks	4
LNG storage temperature	Approximately -160°C
Number of regasification trains	3
Maximum regasification train output	250 mmscf/day (per train)
FSRU gas send out capacity	Maximum output 750 mmscfd/day
Flexible hoses required on board to receive LNG	4 x 10-inch hoses
Flexible hoses required on board to return vapour	2 x 10-inch hoses
Seawater intakes	2 intakes (one starboard and one port side) Port side approx. 5m below waterline Starboard side approx. 8m below waterline
Seawater intake velocity	< 0.15 m/s
Number of dual-fuel engines	4
Number of regasification boilers	2

4.4.5 Injecting the gas into the pipeline

Following regasification on the FSRU, the natural gas would be transferred into the supporting gas infrastructure on the pier. Two high-pressure gas MLAs located on the pier head would transfer the natural gas to the aboveground pipeline. The natural gas would flow through the 3km aboveground pipeline on Refinery Pier and within the refinery to the treatment facility located at the northern end of the refinery.

4.4.6 FSRU case study

The number of FSRUs operating worldwide has been steadily increasing over a number of years and by 2020, the number of FSRUs worldwide had increased to approximately 43 vessels. There are currently FSRUs operational in Europe, Asia, North America and South America with a number of proposed projects looking to expand into other continents.

There are currently no operational FSRU projects in Australia, however, two projects have been approved and these are described below together with an outline of the conditions imposed as part of the project approvals to avoid, minimise or manage potential impacts associated with an FSRU.

Outer Harbor LNG Project, South Australia – Venice Energy

The Outer Harbor LNG Project involves the mooring of an FSRU at a newly constructed berth located adjacent to existing berths at Pelican Point Road, Outer Harbor. The facility will be located in the Port of Adelaide Outer Harbor industrial area between the existing Berth 8 dedicated grain loading wharf and the Pelican Point Power Station, approximately 1.6km from the nearest residential properties.

Following the award of Crown Sponsorship to the project by the South Australian State Government in 2020, the Development Application was approved in December 2021.

Conditions of the Development Approval relevant to the FSRU are outlined below:

4. Preparation of a Marine Pest Management Plan including:
   - Prior to the FSRU entering SA waters a Biofouling Management Plan shall be provided for a risk assessment of the FSRU vessel and actions to be taken as advised to manage biofouling.
   - Ballast water management should be managed in accordance with IMO Ballast Water Management Convention.
5. Preparation of an Operation Water Quality Monitoring Plan including:
   - Thermal and chemical discharge validation monitoring following commencement of operations and proposal of contingency measures should the measured parameters exceed predictions.
   - Residual chlorine level at point of discharge from FSRU is 0.1mg/L maximum.
   - Reporting requirement if seawater cycling exceeds 288,000m^3/day.
6. Preparation of a Waste Management Plan.

Port Kembla Gas Terminal, New South Wales – Squadron Energy

The Port Kembla Gas Terminal involves the mooring of an FSRU at Berth 101 in Port Kembla's Inner Harbour. The facility will be located in the Port Kembla Inner Harbour industrial area adjacent to the Port Kembla Coal Terminal coal export berth (Berth 102), approximately 2km from the closest residential properties.

The project was declared Critical State Significant Infrastructure by the NSW Government in June 2018. Development Consent was issued following review of the project's Environmental Impact Assessment in April 2019.

Conditions of the Development Consent relevant to the FSRU are outlined below:

1. Design and construct the water intake on the FSRU to minimise entrainment of aquatic organisms and plankton.
2. Preparation of a Water Quality Verification and Monitoring Program including:
   - Verification monitoring following commencement of operation and identification of contingency measures to address any exceedances of predicted cold water impacts or total residual chlorine concentrations, residual risk of acute toxicity or chemical by-products or measures to reduce the entrainment of marine biota in the water intakes.
   - FSRU discharge to comply with total residual chlorine of no more than 0.02mg/L and temperature limit of no less than 7 degrees Celsius below ambient water temperature.
   - Discharge rate from FSRU regasification process not to exceed 13,000m3/hour and annual average rate not to exceed 8,125 m3/hour.
3. The FSRU must not be operated using marine diesel oil for more than 72 hours in any calendar year while berthed at the site (unless otherwise authorised by Commonwealth law).
4. Preparation of an Air Quality Verification and Management Program including:
   - Verification monitoring following commencement of operation and identification of contingency measures to address any exceedances of predicted ground level concentrations and impacts on sensitive receivers.
5. Preparation of an Emergency Plan and Safety Management System.

The Viva Energy Gas Terminal Project differs from the two proposed projects described above due to the synergy identified between the FSRU and the Geelong Refinery. The two proposed Australian projects described above involve direct discharge of seawater to the marine environment following use in the regasification process onboard the FSRU. A literature review and discussions with FSRU providers suggests that most or all operational FSRUs around the world discharge direct to the environment. The project being assessed in this EES provides a major environmental enhancement in that it would involve reuse of the FSRU discharge water in the adjacent Geelong Refinery for cooling water purposes. This is a positive response to the General Environmental Duty (GED) introduced by the *Environment Protection Act 2017* which puts an increased responsibility on organisations to be proactive in the assessment and minimisation of their impact on the environment. Reuse of the FSRU discharge water for cooling purposes in the adjacent refinery and discharge through the existing refinery discharge points differentiates this project from others and has major environmental benefits including:

- Enabling the refinery and FSRU to operate synergistically with only one seawater intake and discharge for both facilities compared with two intakes and discharges if the operations were standalone
- Improving the water quality of the existing refinery discharge by reducing the temperature of the discharge from approximately 9 degrees above ambient to 2 degrees above ambient
- Co-location of the FSRU with the refinery, which has been discharging residual chlorine and warm water into Corio Bay for more than 60 years, has enabled detailed investigations of the impacts of the current discharge to be assessed. This empirical evidence is important as it provides a baseline for assessment of the proposed discharge from the project which is an improvement on the current discharge and also enabled field testing and verification of modelling results for residual chlorine and temperature.

Publicly available information on FSRU approvals and performance in other parts of the world is limited. Notwithstanding this, the potential marine impacts of seawater discharges, residual chlorine and entrainment of small marine biota into seawater intakes are well understood. These issues are examined in detail in subsequent sections of this EES.

4.5 Treatment facility

The treatment facility would receive the natural gas from the FSRU via the aboveground pipeline. The treatment facility would be located in an existing laydown area within the refinery approximately 80m by 120m in size. Gas would be treated at the facility to ensure that it meets Australian gas quality standards before entering the VTS.

The treatment facility would include a liquid nitrogen storage and injection facility, odorant storage and injection skid, gas quality analyser, gas flow metering, temporary pig receiver and pig launcher tie-in assemblies, and cold vent to enable the pipeline to be depressurised for maintenance or during an emergency. Odorant would be injected to give the gas (which is naturally odourless) an odour so it has a distinct smell, in order to meet Australian standards. At the treatment facility, the pipeline would change from aboveground to underground, and the pig launcher tie-in assembly would be installed just before the pipeline goes underground, with the pig to be received at the SWP tie-in location at Lara. A pig launcher is a device that is used to support the cleaning and maintenance of a pipeline, by launching a 'pig' through a pressurised container to travel the length of the pipeline.

In order to meet the necessary gas quality specifications for the gas markets in south-eastern Australia as defined by Australian Energy Market Operator (AEMO), nitrogen blending would be required to adjust the quality (i.e., calorific value) of natural gas cargos that have a very high energy density. The amount of nitrogen required to meet the required specifications limit would vary from cargo to cargo depending on the gas composition. Viva Energy currently sources nitrogen gas directly from a third-party co-located with the refinery for activities such as purging, drying, pigging and pressure testing. However, it is unlikely that a third party would be able to supply the required maximum rate of nitrogen necessary for the project and additional facilities would be required.

It is anticipated that up to 460 tonnes per day of nitrogen would be required depending on how 'rich' or 'lean' the gas is. To discharge 170,000 m^3 of 'rich' natural gas continuously at 500 TJ/day from the FSRU, it would take approximately 9 days.

To meet the nitrogen demand, the treatment facility would comprise of 4 liquid nitrogen storage vacuum insulated vessels containing up to 1200m^3 of liquid nitrogen. An example of these vessels is shown in **Figure 4-11**. Nitrogen would be sourced from a variety of existing nitrogen providers by truck to both refill this storage volume but also to supplement the nitrogen consumed during rich LNG cargo campaigns.

Figure 4-11 Horizontal liquid nitrogen storage vessels (source: Cryeng Group 2018)

The liquid nitrogen from the vacuum insulated vessels would be pumped using high pressure discharge pumps from storage pressures of 450kilopascals (kPa) to 11,000kPa up to the natural gas pipeline pressure which can range between 45,000 to 98,000kPa. The liquid nitrogen would be pumped into a vaporiser that absorbs heat from the air to vaporise the nitrogen back to its gaseous state. An example of an ambient air vapouriser is shown in **Figure 4-12**.

Figure 4-12 Ambient air vapourisers

4.6 Pipeline

The total length of the DN600 pipeline (about 600mm or 24" in diameter) from the FSRU to the tie-in point at the South West Pipeline (SWP) would be approximately 7km, in two sections: one an aboveground 3km section from the FSRU to the treatment facility, the other an underground 4km section from the treatment facility to the SWP tie-in point at Lara.

The preferred route, as shown in **Figure 4-14**, would run along the new pier extension in a pipe track to the existing Refinery Pier pipe tracks.

Onshore, the pipeline route would run along the existing pipe track east of Shell Parade, passing through a road under-crossing to an existing refinery pipe track. The route would then run north in the refinery pipe track to an existing laydown area where the treatment facility would be located.

From the treatment facility, a buried gas transmission pipeline, approximately 4km in length, would transfer the gas to the SWP tie-in point at Lara. It is intended, as far as practicable, to locate the proposed pipeline within or adjacent to already disturbed easements or licensed road reserve areas held by Viva Energy within the existing infrastructure corridor.

The depth of cover for the underground section of the pipeline would be in accordance with the requirements of AS/NZS 2885 and the pipeline would be buried such that the top of the pipe is a least 1.2m below the surface and could be deeper in some sections depending on the location of existing assets, such as transmission lines. Along the underground pipeline route, pipeline markers would be provided to indicate the pipe name and service consistent with existing practices for buried oil and gas pipelines.

Both the aboveground and underground sections of the pipeline would comply with AS/NZS 2885 and APGA Code of Environmental Practice. The construction and operation of both pipelines would be undertaken in compliance with Environment Management and Safety Management plans, as required by the *Pipelines Act 2005* and Pipelines Regulations 2017, and as accepted by the relevant Minister.

Figure 4-13 The existing Refinery Pier pipe track

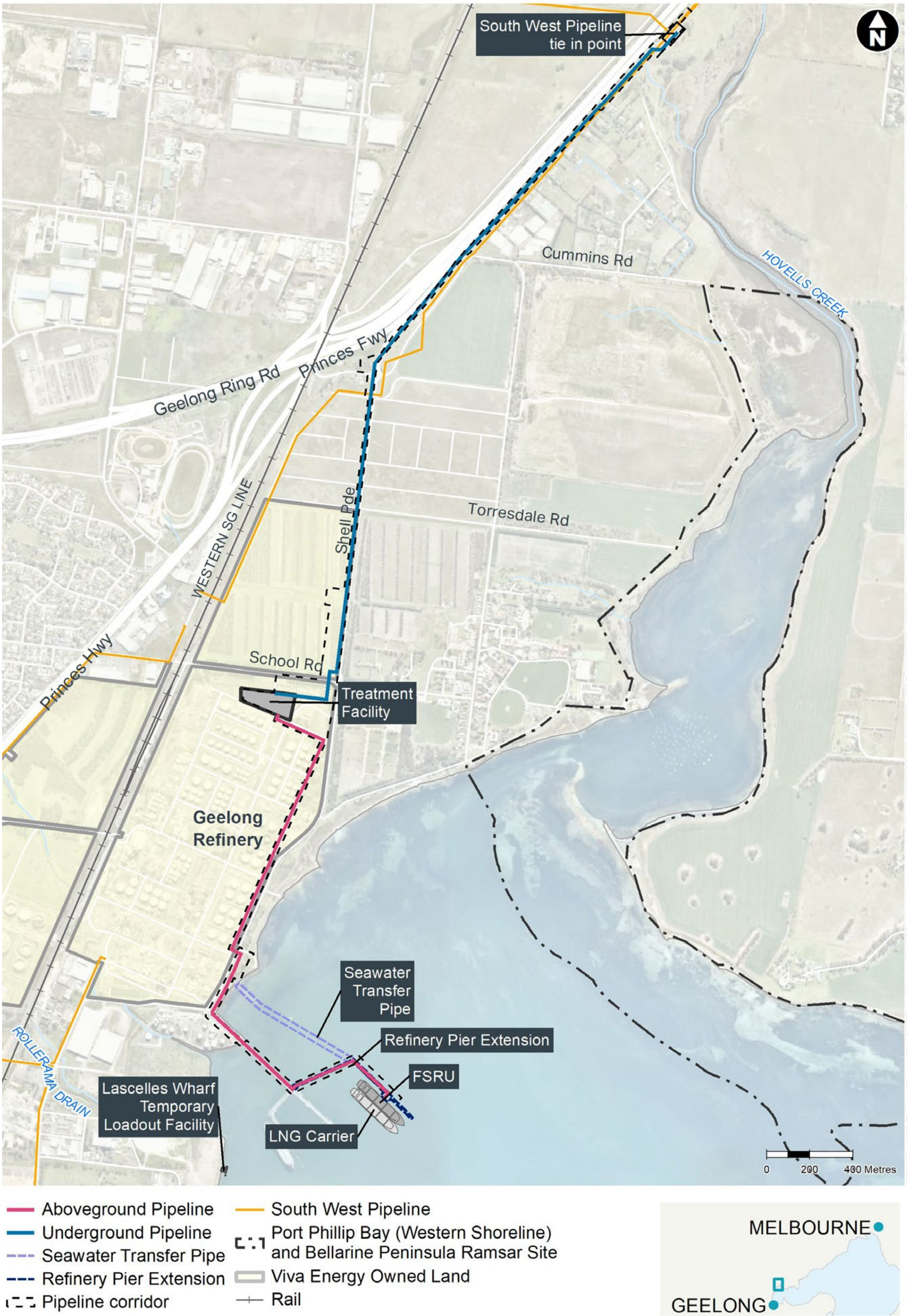

Figure 4-14 Pipeline route

4.6.1 Tie-in facility

The tie-in point to the SWP would be within the APA owned and operated Lara City Gate station. Equipment proposed to be located at the tie-in point include allocation for a temporary pig receiver and underground connection to SWP. The facility would be designed for the temporary connection of a removable pig receiver to receive the pig launched from the treatment facility.

The APA owned facility is automated and would continue to operate unmanned under normal operating conditions. No lighting or security fencing in addition to that already present would be installed.

4.7 Utilities and site features

4.7.1 Lighting

Additional lighting would be provided on the new pier arm and treatment facility to allow for safe operational access. Lighting would be designed to minimise light spillage into surrounding areas, while still providing sufficient lighting for security purposes and safe working conditions.

4.7.2 Security

The existing waterside restriction zone for Refinery Pier would be extended to cover the Refinery Pier No.5 extension and movement of the FSRU and LNG carrier into position at the berth as shown in **Figure 4-5**.

The aboveground pipeline and treatment facility would be located within security access points as per the MHF licence for the Geelong Refinery and restricted access points as controlled by GeelongPort and Maritime Security Identification Card (MSIC) licensing requirements. An MSIC is a nationally consistent identification card that states the holder is cleared to work unescorted or unmonitored in a maritime security zone.

In addition, all facilities would have closed circuit television (CCTV) overview to manage operations and security risk.

4.8 Construction

This section describes the construction and commissioning activities of the project, which includes the indicative construction schedule, methodologies, construction sites and laydown areas, expected workforce numbers and disciplines, types of equipment and anticipated traffic during construction. The key construction activities are:

- Localised dredging to allow the FSRU and LNG carriers to berth at Refinery Pier and excavation of a shallow trench for the seawater transfer pipe
- Construction of a temporary loadout facility at Lascelles Wharf
- Construction of a new pier extension and supporting infrastructure via a pier head
- Installation of an aboveground pipeline and treatment facility
- Installation of an underground (buried) pipeline.

There are no construction activities required for the FSRU component of the project. The vessel would be built, commissioned and all production and safety systems verified prior to being brought to site.

4.8.1 Indicative construction schedule

Indicative durations and schedules for the construction and commissioning of the project components are shown in **Table 4-4**. This schedule would be reviewed as the design matures and is subject to change to ensure the execution of the scope is the completed in the safest and most efficient manner. Construction for the entire project is expected to commence in the third quarter (Q3) of 2022 and take approximately up to 18 months.

Construction would be undertaken by qualified specialists and contractors that understand the site conditions and techniques required to construct the project safely. The following sections detail the techniques and equipment that would be used to construct the key project components.

Table 4-4 Indicative construction schedule

Construction activity	Description	2022		2023				2024		Activity duration	Overall duration
		Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2		
Dredging	Mobilise dredging equipment (vessels, barges, equipment)									1 month	5 months
	Dredging and spoil disposal									4 months	
Pier, offshore pipelines and supporting infrastructure	Temporary loadout facility									1 month	18 months
	Mobilise piling and construction equipment									1 month	
	Piling									6 months	
	Pier modularised components fit-out and installation (with pipeline)									10 months	
	MLAs and pier head facilities installation									2 months	
	Electrical and instrumentation cable pulls and terminations									4 months	
	Seawater transfer pipe installation to refinery inlet channel									3 months	
	Mechanical completion, walkdowns, punchlist clearance, handover									2 months	
	Pre-commissioning									2 months	
	Commissioning									3 months	
	Final demobilisation									1 month	

Construction activity	Description	2022		2023				2024		Activity duration	Overall duration
		Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2		
Aboveground and underground pipeline	Mobilisation									1 month	12 months
	Pipeline construction (pier guardhouse to treatment facility)									3 months	
	Pipeline construction (treatment facility to SWP tie in)									4 months	
	Hydrostatic testing									1 month	
	Reinstatement									1 month	
	Pre-commissioning									1 month	
	Commissioning									1 month	
	Final demobilisation									1 month	
Treatment facility	Site preparation and temporary facilities set up									4 months	18 months
	Civil works (drains, foundations etc.)									3 months	
	Nitrogen and odorant facilities installation									8 months	
	Mechanical completion, walkdowns, punchlist clearance, handover									2 months	
	Pre-commissioning									2 months	
	Commissioning									3 months	
	Final demobilisation									1 month	

4.8.2 Localised dredging

Localised dredging of seabed sediments would commence prior to starting construction of the pier extension with a forecast start date in Q4 2022. Dredging would occur for a period of approximately eight weeks. A preliminary assessment of the most appropriate dredging equipment to minimise potential impacts has been undertaken based on past dredging activity and forms the basis of this methodology.

An estimated 490,000m^3 of dredged material would be required to be removed adjacent to the existing shipping channel to provide sufficient water depth at the new berth and within the swing basin for visiting LNG carriers to turn over an area of approximately 12ha. The new berth pocket would be dredged to a depth of 13.1 metres and the swing basin would be dredged to a depth of 12.7 metres. Figure 4-15 shows the location and dimensions of the area to be dredged. It is planned to deposit the dredged material within the existing dredged material ground (DMG) in Port Phillip Bay to the east of Point Wilson. The location of the Point Wilson DMG is shown in Figure 4-16.

A barge-mounted backhoe dredger (BHD) would be used to remove sediments, with the spoil placed into split hopper barges for transport to the spoil disposal ground. Given the transit time to the proposed spoil disposal ground at the Point Wilson DMG which is located 14 nautical miles (NM) (26km) from the dredging area, it is envisaged that two to four hopper barges may be required, with tugboats, to maintain production. The existing channels would be utilised for passage of the hopper barges.

In addition to the localised dredging described above, a small volume of sediments would be excavated to create a trench for the installation of the seawater transfer pipe between Refinery Pier No. 5 and the existing refinery seawater intake (refer to Section 4.8.3).

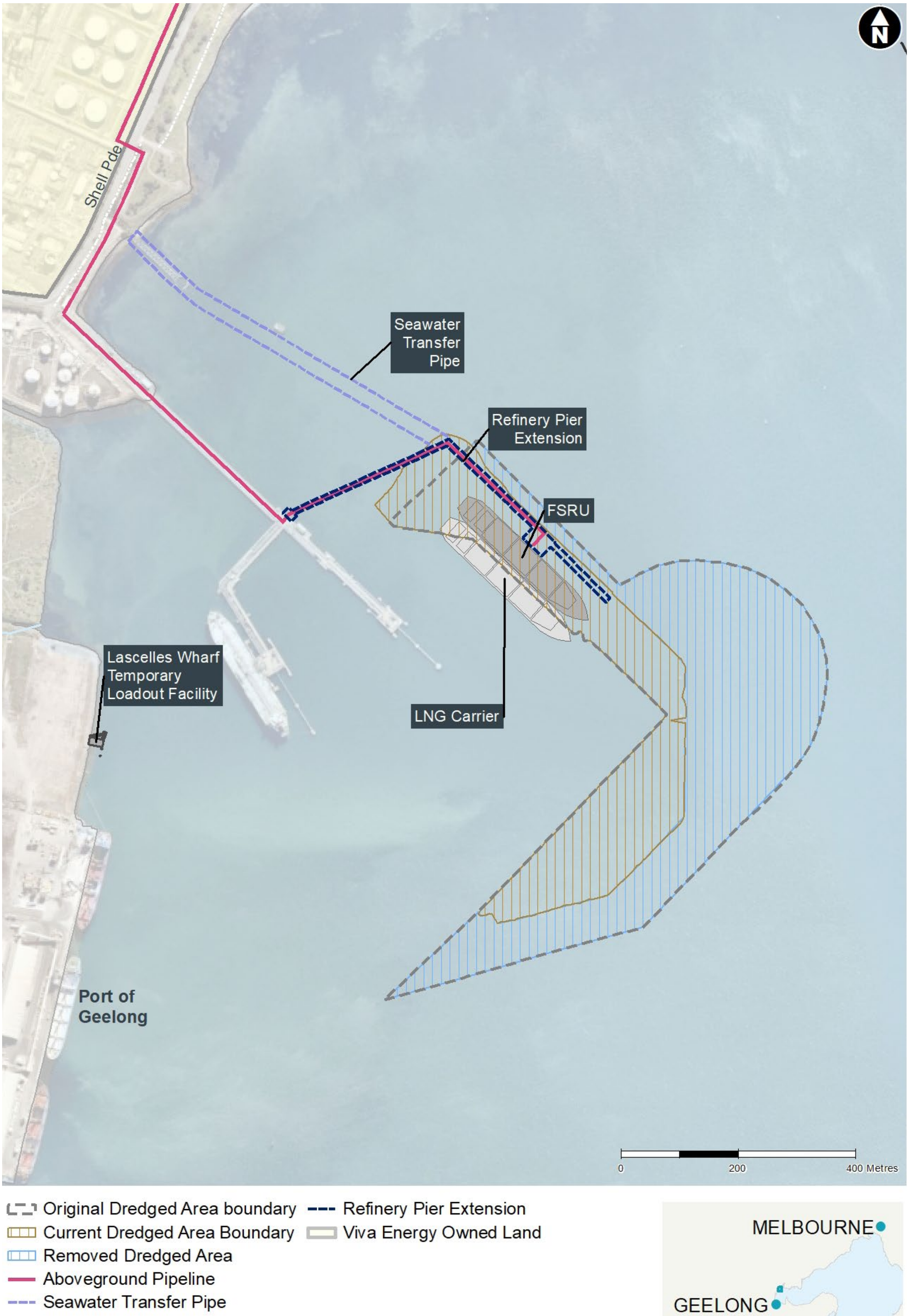

Figure 4-15 Dredged area

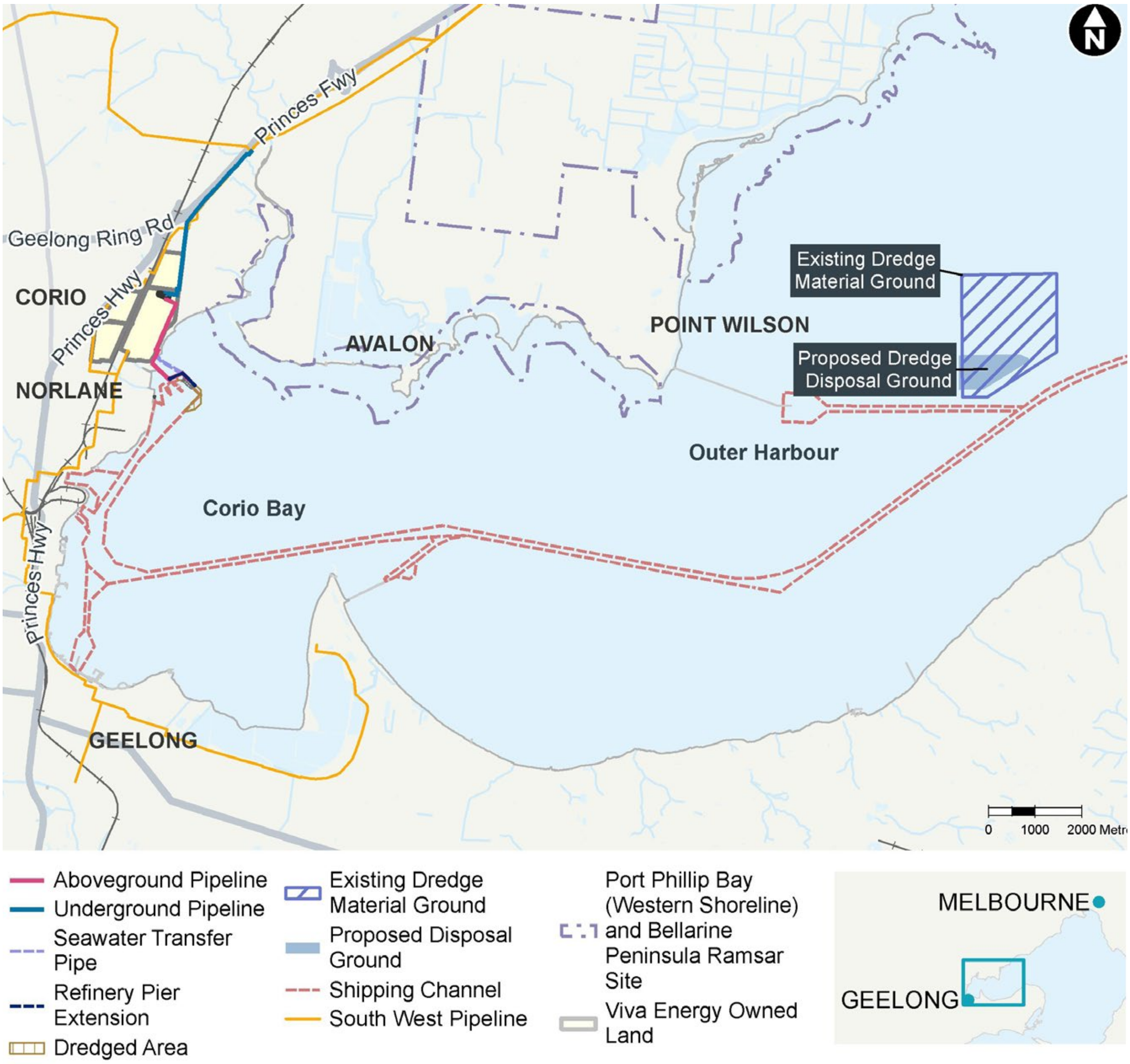

Figure 4-16 Proposed Dredged Material Ground in relation to the dredging site

Dredging methodology

Dredging with a BHD is not a continuous process and consists of a cycle of operations including the following:

- Dredging: soil is excavated through the use of a combined back-and upward movement of the boom, stick and bucket of the backhoe
- Lifting: the boom and stick is moved upwards to lift the bucket above the water once it is full
- Swinging: the bucket is swung above the transport barge by rotating the excavator on the turntable
- Unloading: the bucket is then rotated and tips the material onto the transport barge
- Swinging empty: following the completion of discharge, the excavator is swung back to its last dredging location
- Lowering and positioning: the boom is then lowered, and the stick and bucket is moved to the new starting position. With the aid of survey and crane monitoring system, the bucket excavates material at the desired location and depth.

The BHD would be located on a pontoon. One barge would be moored alongside the BHD and would be filled to capacity. Once the barge is full, it would be un-moored from the pontoon and would travel to the Point Wilson DMG and would dispose of the material while the other barge is moored alongside the BHD. A typical BHD and spoil barge are shown in **Figure 4-17** and **Figure 4-18**.

For each pontoon position, an area as large as practicably possible would be dredged (effective dredging area). On completion of dredging within this area, the pontoon would relocate to a new position behind the previous one. The following steps are required to move the pontoon:

- Lower the pontoon by slacking the spud wires
- Place the bucket on the seabed
- Lift main spuds
- Move pontoon astern to the next working position (step), by pushing out the cylinder of the stepping or tilting spud (the excavator assists in this operation by guiding the movement with the bucket)
- Once the cylinder is pushed out completely the main spuds are lowered again
- Lift stepping or tilting spud
- Move the stepping or tilting spud to its starting position with an inwards movement of it cylinder
- Lower stepping spud
- Lift pontoon upward by spud wires so that a stable dredging position can be maintained
- Recommence dredging.

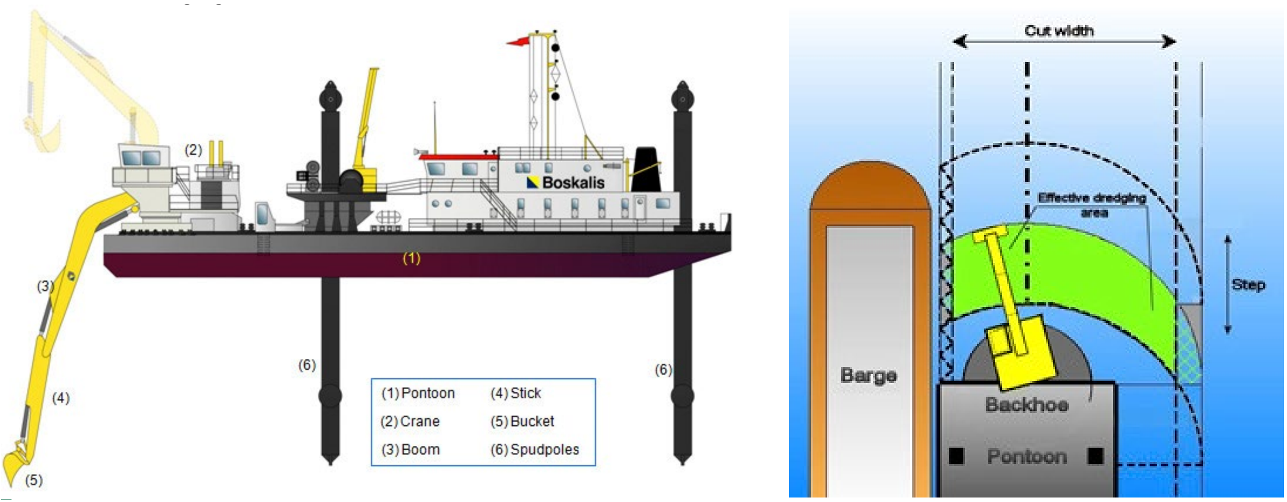

Figure 4-17 Typical BHD work method

Figure 4-18 BHD with a spoil barge moored alongside

4.8.3 Refinery Pier extension

Construction of the Refinery Pier extension would be carried out in a way that would limit the impact on existing operations at Refinery Pier and within the refinery. Due to access limitations and distance from shore, it is anticipated that the new pier would be constructed primarily from the water using crane barges. To facilitate construction of the Refinery Pier extension, a temporary storage and loadout facility would be constructed and located in the existing Geelong port at Lascelles Wharf (pending agreement with GeelongPort), as shown in **Figure 4-19**. Lascelles Wharf has been used in the past as a load out facility for infrastructure projects.

Construction of a new, temporary southern dock as part of the loadout facility would consist of the installation of 10 piles supporting a pre-cast concrete slab. The 10 piles include four fender piles, four jetty piles and two abutment piles.

Hydraulic hammers would be used to drive the piles and works are anticipated to occur over four weeks and within normal working hours (refer to **Section 4.8.10**). The southern dock would be the first construction activity to take place in order to facilitate the refinery pier extension.

The temporary facility would be used for the following activities:

- Crew access/changes (to/from) floating barge worksites
- Storage area for steel fabricated items such as piles and pipe racks
- Pre-staging of equipment (e.g., piles, modules, pre-cast concrete)
- Pre-installation of utilities/gas piping into pipe racks
- Loadouts of modularised structures for installation by the crane barge.

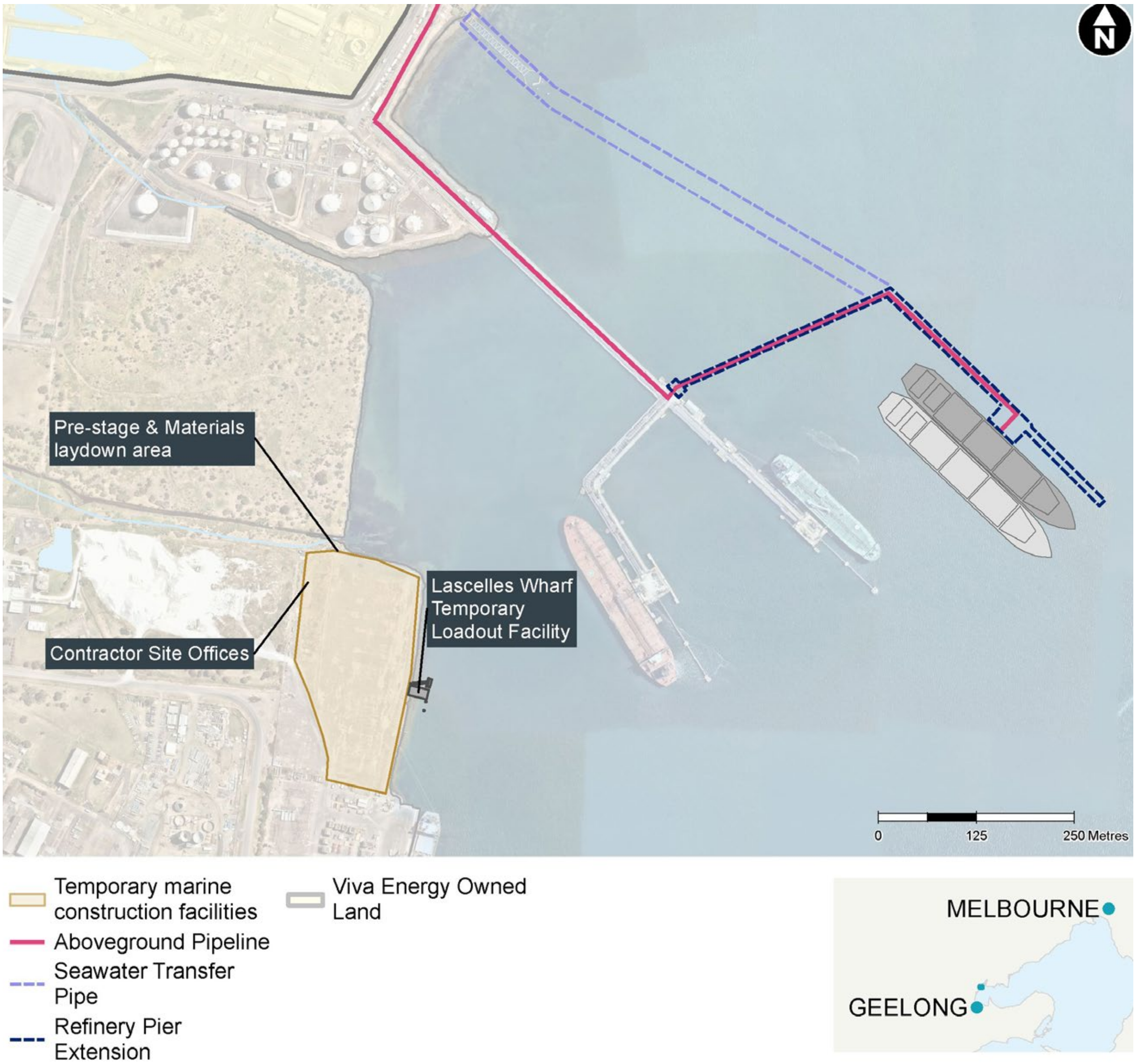

Figure 4-19 Temporary construction storage facilities

The refinery pier roadway, pier head and dolphins would comprise pre-cast concrete and pre-fabricated steel modular components supported in full spans on vertically driven steel piles. Piles would be driven by cranes mounted on floating piling barges.

The use of pre-cast concrete and pre-fabricated steel modular components would minimise disturbance to existing pier operations and reduces on-site works. Concrete and steel components would be transported to site by flat top service barges and lifted into position with the crane barge. The construction works would be assisted by support vessels, such as safety boats, crew vessels, tugs, flat top service barges and multicats.

Activities associated with the construction of Refinery Pier are outlined in Table 4-5.

Table 4-5 Refinery Pier extension construction activities

Pier Installation	Construction activity
Piling	Pier construction would start with pile driving activities to install piles with a barge. The piles would be delivered on a flat top barge moored alongside the piling barge. The piles would be lifted, pitched and driven in with the piling barge. Piles would be mostly vertical, this to enable an easier installation method. The initial indicative geotechnical data from the existing pier suggests the seabed would be suitable for pile driving however if alternate conditions are encountered it may be required to drill through harder layers to get to the required foundation level. 
Seawater Diffuser	In the event that the Geelong Refinery closes and reuse of the FSRU discharge water in the refinery for cooling water is no longer an option, a 300 m long diffuser with 100 small high-velocity ports would need to be installed by divers supported by a small crew vessel alongside the jetty structure. The diffusers would be installed via floating sections in-between the pile rows to be bolted-up by divers. A smaller land-based crane on the pier would perform some lifting and pre-installation of spools the diffuser sections tee-off from the main Seawater header. The diffuser would need to be positioned under the pier such that it is at least 0.5m below the seawater surface at Lowest Astronomical Tide (LAT).
Roadway	The pier roadway would have a priority in the construction schedule to enable access to the pier and installation of the steel pipe rack modules with the crane barge. The construction of the pier roadway would most likely start at the existing pier working out to the new pier head. It is anticipated that prefabricated steel headstocks or pre-cast concrete headstocks would be progressively placed and connected to the piles followed with the installation of the roadway panels and pipe rack modules.

Pier Installation	Construction activity
	The use of in-situ concrete would be minimised, however, relatively small quantities of in-situ concrete may be required for the pier head and/or unloading platform slabs. The concrete would be delivered by a Roll on Roll off (RORO) barge with sideboards. The concrete may be placed using a concrete pump or a kibble. Small quantities of grout would be required to secure the deck planks which would be batched using a mixer on site.
Mooring and Berthing Dolphins and Catwalks	The piles for the dolphins would be driven ahead of the delivery of the topsides platform. The prefabricated dolphin heads would be lifted and installed using the crane barge where they are then grouted into place. The dolphin topsides would be fully fitted out with all the necessary furniture including fenders, quick release hooks, rails etc. Catwalks which enable pedestrian traffic to and between the dolphins would be lifted into position using a crane barge.
Topsides Platform	The topsides platform would be pre-fabricated at an onshore location and would be lifted into position by a crane barge or heavy lift vessel, either in multiple modules or as a single lift, dependent on the design and crane lift capacity. An example of an installation of steel fabricated module with heavy lift vessel is shown below. 
Fixed gangway tower and Catwalks	The gangway tower, would be mounted on a pier mooring structure with the aid of a crane barge.

Equipment

The construction barges used to install the pier extension would include a piling barge, a crane barge and a flat top material barge. The crane barge would be used to lift and install the piles, roadway structure, pipe racks and all other ancillary marine equipment. The flat top material barge would be used to store and supply the various materials, equipment and infrastructure components to the crane barge for installation works.

The barges are moved with the assistance of tugboats, to manoeuvre and anchor the barge into position. The crane barges would be equipped with anchors and spud piles to ensure a stable mooring position. The material barge would be moored alongside the crane barge. The barges are expected to remain on site for the duration of the works.

A summary of the equipment required for construction of the Refinery Pier extension is outlined in Table 4-6.

Table 4-6 Equipment required

Equipment	Quantity	Description
Piling barge	1	A large flat top barge (approx. 40-60m in length) with a 300-600 tonne crane mounted to the barge. The barge would be equipped with a minimum of 4 points mooring system and spud piles
250 to 600 tonne crane barge	1	The 180-210ft crane barge would be equipped with a crawler crane. The crane size would be determined by the weight of the modules and equipment that needs to be installed.
180ft flat top barge	2 or 3	The flattop barges would be used as service barge for the transport, delivery and storage of materials and equipment
Tugboats	1 - 3	Tug with bollard pull 8-15 tonne would be used for the movement of the barges
Multicat	1	The multicat would be used for material deliveries, movement of barges and anchor handling
Crew vessel / Safety boat	1 or 2	Crew vessel would be utilised for transport of personnel to and from the marine base/yard to the works site.
Piling hammer	1	Piling hammer size would be determined by the pile design and geotechnical conditions
Generators, compressors welding machines	To be confirmed during detailed design	Several smaller support equipment would be used

Pier infrastructure

It is expected that the installation of pier infrastructure, including all piping from the FSRU, would also be undertaken using crane barges. This includes all associated utilities and services piping to/from the refinery.

The seawater transfer pipe would run along the straight arm of the new pier in a pipe rack, however, unlike all other piping that would run along the pier arm back towards the existing Refinery Pier, the seawater discharge pipe would continue down into the seabed and would then travel into the existing refinery seawater intake.

The aboveground pipeline is proposed to travel from the FSRU, along the new pier extension and the existing Refinery Pier, through the existing refinery site up to the proposed treatment facility. All pipeline lengths to be located on the new pier extension would be pre-installed in pipe racks and fully integrated into each modularised frame component before being lifted into position on top of the pile spans. This would decrease 'work over water' by having the pipeline already installed in the pipe racks and is expected to increase productivity. An example of a pipe rack installation is shown in **Figure 4-20**.

Figure 4-20 Installation of steel pipe rack with a crane barge

For the section of the pipeline located on the existing Refinery Pier, it is anticipated that pipeline lengths would be transported from the onshore pre-staging location and placed into position onto existing pipe tracks via a crane barge. The pipe lengths would be welded into position up until the point where the pipeline transitions from the pier into the onshore pipeline section.

Hydrostatic testing of the pipeline would be conducted once construction is complete through the length of the pipeline from the FSRU to the land-based demarcation point where the pipeline transitions onshore.

Activities associated with the construction of pier infrastructure are outlined in **Table 4-7**.

Table 4-7 Pier infrastructure construction activities

Infrastructure	Construction activity
Marine loading arms (MLAs)	MLAs would be installed from the water using a floating barge with a crane. The MLAs would be fixed to the pier head platform. The MLAs would be connected to gas piping which would be lifted into place from the barge and installed. Installation of loading arms with a crane barge is shown in the image below. 
Piping pre-installed to pier modularised sections	All piping would be pre-installed in pipe racks to the length of the steel modularized pier sections and would then be lifted into place with these modules. Following installation of the modules, the spools would need to undergo the following activities in-situ with upstream/downstream installed spools: welding, stress relieving, testing and surface protection. Transportable temporary works (including scaffolding) to facilitate in-situ pre-heat, welding, testing and surface treatment would be employed along the length of the pier.
Piping mounted to existing Refinery Pier	Piping installed on the existing Refinery Pier would predominately be lifted into location by a crane barge where welding, stress relieving, testing and surface protection would be carried out in-situ. Transportable temporary works (including scaffolding) to facilitate in-situ pre-heat, welding, testing and surface treatment would be employed along the length of the pier.
Electrical and instrumentation installation	The transformer, substation, control panels, lighting and CCTV system would be pre-assembled and placed in position by a crane barge. Electrical cables would be winched and reeled with temporary rollers from the land out to the pier topsides.
Firefighting system	The firewater monitors would be installed via a crane barge and would be flanged-bolted to the firewater piping from the piping rack which would travel to connect into the existing firewater supply lines on the existing Refinery Pier.
Fixed gangway tower	The gangway tower would be mounted on a pier mooring structure with the aid of a crane barge.

Seawater transfer pipe

The seawater transfer pipe is proposed to run from the FSRU along the new pier arm and beneath the seabed to the refinery seawater intake. The seawater transfer pipe would consist of a single DN1200 HDPE pipe. Approximately 8,800m^3 of sediment would be excavated from the seabed, creating a trench to install the seawater transfer pipe at an approximate depth of 2m below the seabed. It is proposed that the excavated material would be reused to backfill the trench, creating a mound over the pipe. A trenched option to install the pipeline beneath the seabed was selected to protect the pipe and ensure the pipe remains submerged during low tide.

Trenching activities are anticipated to occur over a period of two weeks and work would be conducted within EPA normal working hours (refer to **Section 4.8.10**).

Once installed the pipe would require periodic inspection by divers to ensure that the pipe is stable beneath the seabed and has not been damaged.

4.8.4 Aboveground pipeline

Pipe lengths for the aboveground pipeline section that runs from the onshore end of Refinery Pier up to the treatment facility, as shown in **Figure 4-21**, would be transported via trucks and placed into position by cranes onto pipe tracks within the existing pipe trench compound. Key equipment would be transported using existing access tracks adjacent to the above ground element of the works. Temporary access to the area of foreshore immediately adjacent to the existing pipe trench compound may be required during construction to facilitate pipe lay activities.

Where available, existing pipe tracks would be used to support the pipe and any new tracks required would be installed. Should there be a need for a dedicated road under-crossing (new culvert) at Shell Parade for the proposed pipeline then this would be installed by either a trenchless method or conventional trenching. Construction of the aboveground pipeline would be undertaken in accordance with a Construction Safety Management Plan (CSMP) approved by Energy Safe Victoria (ESV).

4.8.5 Treatment facility

Construction of the treatment facility would comprise the following scopes of work:

- Initial earthworks and civil construction for foundations
- Mechanical installation of vendor equipment packages
- Completions scope to hookup and confirm all disciplines are mechanically complete and installed per design, including Piping, Mechanical, Electrical, Instrumentation and Controls.
- Pre-commissioning and first energisation and testing of individual components
- Commissioning at a system-based level to confirm design parameters function as specified.

These construction works would be undertaken by specialist crews across key distinct phases of works as outlined in **Table 4-8**. Construction of the treatment facility would take approximately 18 months.

Figure 4-21 Aboveground pipeline from Refinery Pier to the treatment facility

Table 4-8 Construction works for the treatment facility

Construction phase	Activity	Description
1	Site set-up	Site set up within the defined treatment facility footprint is required to provide a safe and efficient area for construction activities. This includes constructing temporary access roads in and out of the construction site, temporary fencing, and site offices with associated facilities (ablutions, lunchrooms etc.), equipment/material lay-down and pre-staging areas, clearing of vegetation, and relocating existing services if required.
2	Earthworks	Existing ground levels would be excavated/built up and levelled to the required design levels. The topsoil may be required to be replaced with engineered fill.
3	Civil works	Steel reinforced concrete foundations and footings would be installed. The permanent buildings, equipment and supports would be fixed on to these.
4	Installation and Mechanical Completion (Piping, Mechanical, Electrical, Instrumentation)	Once the concrete foundations are installed, the foundation supports, and equipment would be installed. This involves ensuring equipment is level and can be bolted up without over-stressing connections. Specialist crews would install structural supports, mechanical equipment, piping spools, electrical equipment, cabinets and panels, cabling, and instrumentation (temp/pressure/flow instruments etc.)
5	Pre-commissioning	Pre-commissioning would involve energised testing activities conducted to confirm the functionality of individual components. Hydrostatic testing of piping would also be conducted during this phase. This proves that all components and associated control loops, shutdown systems, utility supplies etc. are in a required state of readiness for system-based commissioning.
6	Commissioning	Commissioning involves undertaking activities to verify that the equipment is operating in accordance with specified requirements, and to demonstrate that the system meets the design intent and any regulatory compliance requirements. Commissioning would confirm whether the facility is ready to bring product in. Activities are carried out at a systems-based level on multiple items of equipment, which may involve simulated condition testing and control narrative tests to confirm that facility operating ranges can be managed safely. Most supporting equipment would be fully operational and processing systems would be brought to a state of operational readiness pending startup activities.
7	Roads, landscaping and reinstatement	Closeout activities within the treatment facility would involve construction of a permanent entry road, pavement, landscaping and permanent fencing. Reinstatement of construction areas which are not part of the final facility would also occur.

4.8.6 Underground pipeline

Pipeline construction would comply with all relevant codes and standards including ASNZS2885.1-2018: Pipelines – Gas and liquid petroleum (design and construction) and the Australian Pipelines and Gas Association Code of Environmental Practice. The construction would be in accordance with the environmental requirements to be specified in a Construction Environmental Management Plan (CEMP) prepared in compliance with the *Victorian Pipelines Act 2005* and Pipeline Regulations 2017 and approved by the relevant Minister before construction.

Construction of the underground pipeline would also be undertaken in accordance with a Construction Safety Management Plan (CSMP) approved by Energy Safe Victoria (ESV). The CSMP would be prepared in accordance with ESV's Safety Management Plan Preparation and Submission for Pipelines guideline document.

Construction of the underground pipeline would take approximately four months across key distinct phases of works as outlined in **Table 4-9**.

Prior to commencement of the underground pipeline construction, a construction right of way (construction ROW) would be established, clearly identified and fenced off where required. Typically, this would be between 15 to 20m wide. Micro-siting of the pipeline route and pipeline corridor would occur where feasible to avoid impacts to sensitive areas and minimise disturbance. The minimum width for a construction ROW for trenching is approximately 10m for small trench sections.

The construction ROW would include a work area in addition to the pipeline easement, nominally 15m, for various activities. The construction ROW would facilitate movement pipe laying equipment, trenching, pipe laydown areas, welding and coating activities, light and heavy vehicle travel, directional drilling set-up areas, truck turning areas, and soil storage areas. **Figure 4-22** shows a typical layout for a construction ROW.

Once the construction ROW is delineated, vegetation would be removed and placed in a stockpile on the edge of the construction ROW. Although vegetation along the proposed pipeline corridor has been highly modified and comprises of primarily exotic grasses and planted exotic and native trees, vegetation removal would be minimised through appropriate placement of additional work areas required to complete construction. Topsoil would then be removed and stockpiled in windrows, separate to vegetation and subsequent trench spoil stockpiles (the soil removed from the excavated trench). This material would preserve embedded seed stock and nutrient required for rehabilitation.

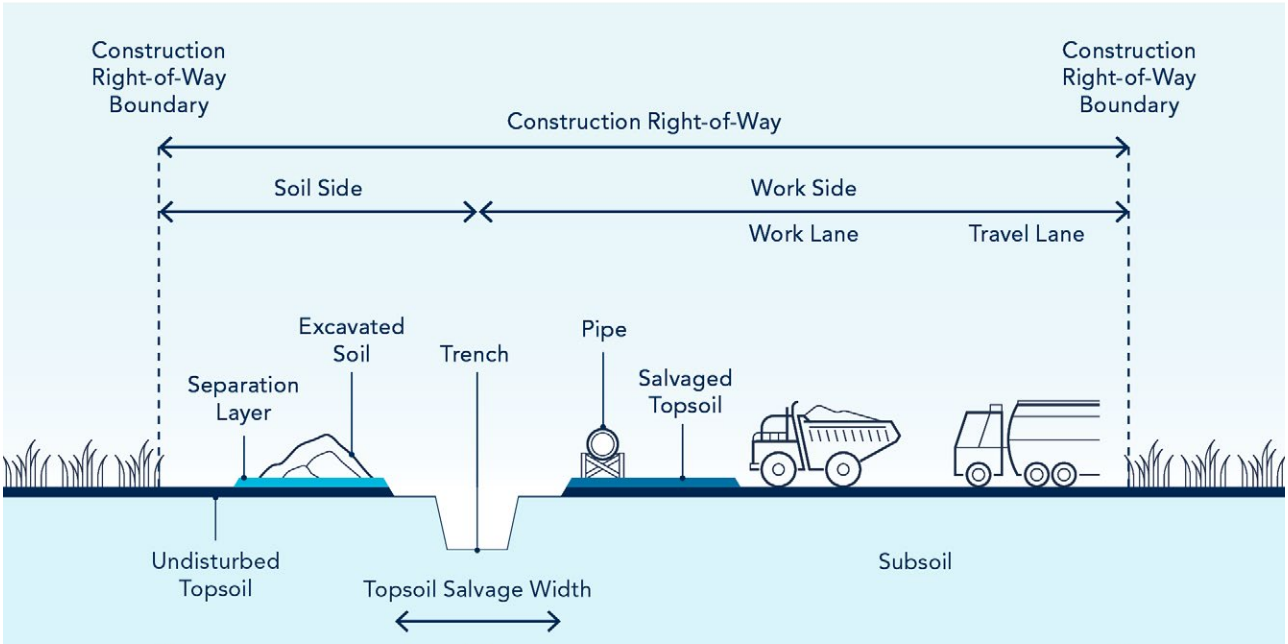

Figure 4-22 Typical construction ROW layout for a pipeline

A trench would be excavated along the proposed pipeline route, and the material removed from the trench set aside for use as pipeline bedding, padding and backfill. Excavators would be used to excavate the pipe trench. Trenches would typically be excavated to a depth of approximately two metres to achieve a required depth of cover of 1.2 metres to the natural ground level. Trenchless construction (horizontal directional drilling (HDD) or thrust-boring) would be used to construct the proposed pipeline in areas that are not suited to ordinary trenching techniques, such as at intersections with major roads or other key pieces of infrastructure. Trenchless construction would involve drilling a hole beneath the surface at a shallow angle and then pushing or pulling a welded length of pipe through the hole without disturbing the surface.

Pre-coated pipes would be delivered and laid on the ground ("strung") within the construction ROW ready for welding. The pipe would then be welded into longer pipe strings with welds being inspected for integrity by non-destructive testing techniques using x-ray or ultrasonic equipment. The welded joint (approx. 250-300mm either side of the weld) would then be coated to protect against corrosion. The coating process would involve abrasive blasting to clean the pipe steel prior to applying the coating over the weld margin.

After final quality assurance checks, a bedding layer of fine material would be laid into the pipe trench and the pipe would be lowered into the trench using specialist pipe layer tractors or excavators. When the pipe is in place, it would be backfilled with suitable fill material ("padding") to protect the pipeline coating from stones or other sharp objects. Lowered in pipe strings would then be tied-in and the pipeline made complete. Once the pipeline is installed, reinstatement of the construction Right of Way would commence with subgrade preparation, topographical contour re-establishment and respreading topsoil across the ROW. The ROW would be rehabilitated to its pre-existing condition as far as is practicable.

The pipeline would be pressure-tested to ensure the welds are structurally sound and there are no leaks present, by filling it with water and increasing the pressure at set increments until the set pressure is reached and then a hold period occurs prior to depressurisation and dewatering.

A typical pipeline construction sequence is shown in Figure 4-23.

Pipeline construction sequence and activities are described in Table 4-9.

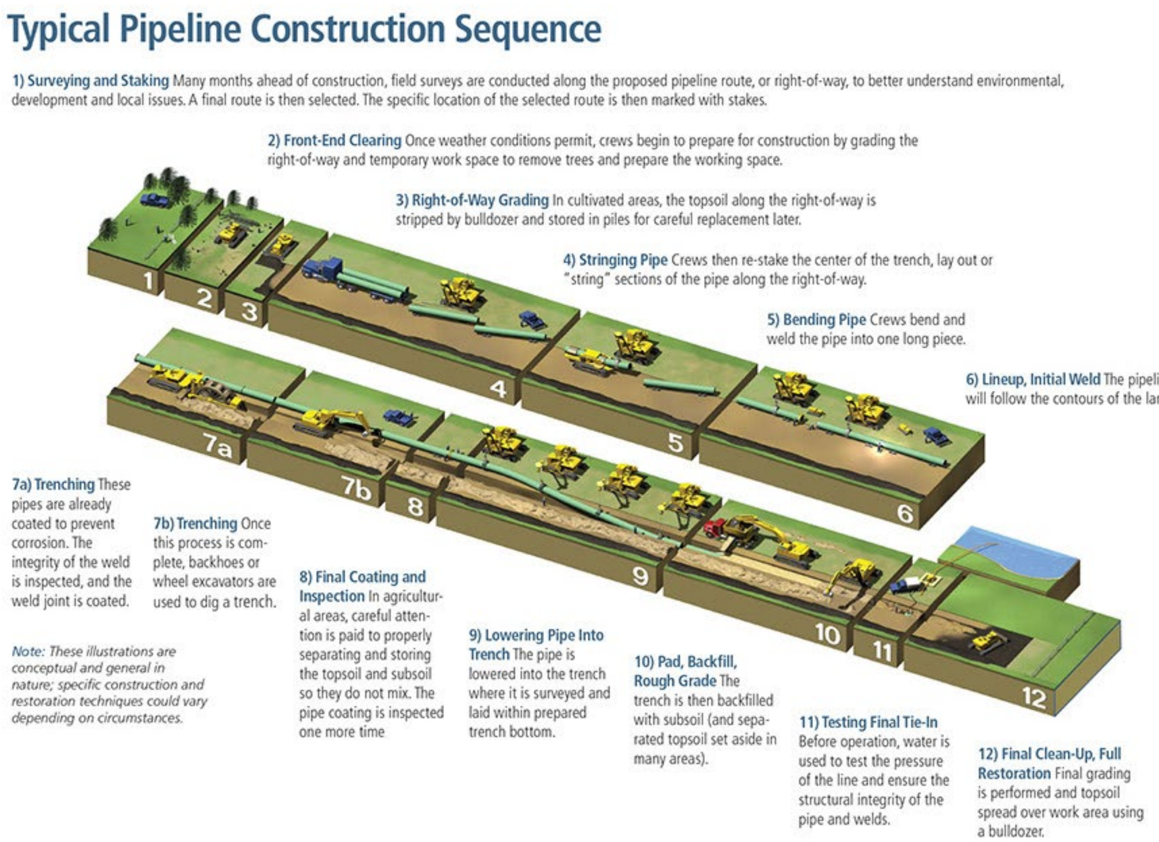

Figure 4-23 Pipeline construction sequence

Table 4-9 Pipeline construction activities

Construction sequence	Activity	Description
1	Surveying and Staking	Establishment of the construction boundaries (as negotiated with associated landowners/property stewards), setting out 'no-go' areas on the construction ROW (inclusive of sensitive areas) and following through with off-set centerline marking post clearing and grading.
2	Front-End Clearing	Clearing of vegetation and topsoil within the construction ROW would be required to provide a safe and efficient area for construction activities.
3	Right-of-Way Grading	A nominated depth of topsoil (usually 75-150mm) would be removed from across the construction ROW using excavators and graders with the material to be stockpiled on the side of the construction ROW (within the agreed construction ROW footprint). Stockpiles of soil would be placed longitudinally on the construction ROW.
4	Stringing Pipe	Stringing would involve distributing pipe segments along the construction ROW on sandbags and wooden skids in preparation for welding.
5	Bending Pipe	Where required, pipe lengths would be bent using a hydraulic bending machine (known as 'cold bending') to match changes in either elevation or direction of the alignment. Hot bends would utilise mandrel bent pipe for more acute pipeline direction changes – these bends would be produced off-site.
6	Lineup, Initial Weld	Specialised construction crews would weld pipe segments together manually or using an automated welding process. Pipe segments can be welded into strings of up to approximately 1.5 kilometres in length, however, this would be determined by the number of topographical features such as existing services, water and road crossings and landholder access breaks required. All welds would then be cleaned and sanded by abrasive blasting and coated to prevent corrosion.
7a	Weld Inspection	All welds would then be examined for quality using either X-ray or ultrasonic inspection techniques. Any unacceptable defects in the welds would either be repaired or replaced and tested again.
7b	Trench excavation	Excavators would be used to dig the trench to lay the pipeline in. Trenches would typically be excavated to a depth of approximately 2 metres to achieve a depth of cover of about 1.2 metres to the natural ground level. Excavated material would be stockpiled to the spoil side of the trench area and would be reused during backfilling activities.
8	Final Coating and Inspection	The pipe coating would be inspected and tested for defects immediately before lowering the pipe into the trench.
9	Lowering Pipe into Trench	Pipe segments would be positioned on wooden skids and sandbags to protect the pipe coating from damage. The welded pipe strings would be lifted off the wooden skids/ sandbags and lowered into the trench using pipelayer tractors or excavators.

Construction sequence	Activity	Description
10	Pad Backfill, Rough Grade	Fine grained bedding and padding material may be placed around the pipe to protect the pipe coating from damage due to materials in the excavated spoil. Bedding and padding material would be either imported using trucks or, where the excavated material is suitable, produced by sieving the excavated material on site. After lowering-in, the strings would be welded together (a 'tie-in') in the trench. The trench would then be backfilled using the excavated spoil, and excess excavated material may be used to re-establish surface contours or collected and transported for disposal at appropriately licensed facilities in accordance with EPA Victoria's waste classification and spoil transportation requirements.
11	Testing and Final Tie-in	The pipeline would be pressure tested before commissioning to ensure that the pipeline is structurally sound and without leaks. This is done through a process called hydrostatic testing whereby sections of the pipeline (test sections) are filled with water and then pressurised. Water is used in pipeline testing rather than air due to the extremely high risk associated with the compressed air – particularly during decompression.
12	Final Cleanup, Full Restoration	Disturbed areas would be re-profiled to a stable landform consistent with original contours and drainage lines and vegetated with shallow-rooted vegetation where appropriate with its land use and in consultation with landowners.

Horizontal Directional Drilling (HDD)

Trenchless construction (including boring or horizontal directional drilling (HDD)) would be used to install the underground pipeline in some areas where open trenching techniques are not suitable, such as at intersections with roads.

Several segments of HDD are proposed along the proposed underground pipeline route as follows:

- HDD-01: 850m long at a depth of 25m to the north east beneath the Princes Highway – Shell Parade Off Ramp and parallel with the Princes Freeway and Macgregor Court
- HDD-02: 300m long at a depth of 17m to the south beneath the Rennie Street – Shell Parade roundabout and parallel with Shell Parade
- HDD-03 and HDD-04 (to be confirmed): along Macgregor Court, parallel with the Princes Freeway

The installation of a pipeline by HDD involves drilling a pilot hole at a shallow angle beneath the surface from an entry point on one side of the crossing to an exit point on the other side of the crossing, as shown in **Figure 4-24**. The entry and exit pits are typically about 3 metres wide, 5 metres long and 2 metres deep. The hole is enlarged by reaming to allow for the welded pipe string to be pulled back through the drill hole from the exit point to the entry point without damaging the coating.

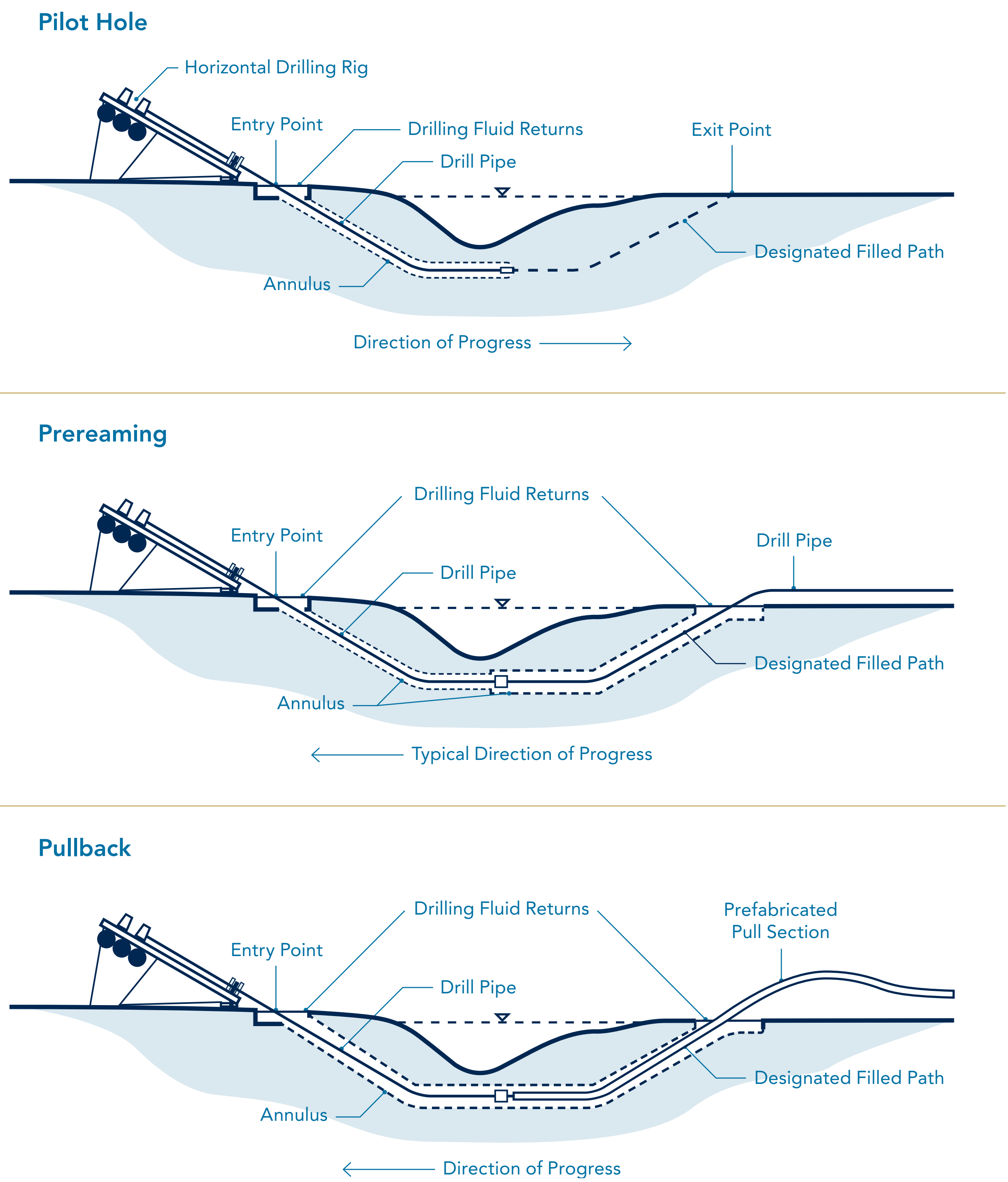

Figure 4-24 Typical HDD process

Following drilling and installation of the pipe along the HDD section, bell holes would be constructed at the entry and exit points to enable joining of the pipe (known as tying-in). A bell hole is an enlarged hole that allows machinery to operate within it, and to tunnel under the relevant constraint. These HDD tie-in bell holes would be approximately 5m long, 5m wide, and 2.5m deep. The pipeline string is then welded to adjoining sections of the pipeline. Once the pipe string is installed and tied into the main section of the pipeline, the entry and exit points are remediated.

Drilling is undertaken by a specific HDD rig that is operated by a specialist contractor. The size of the HDD rig and its associated footprint could potentially comprise of a drill rig operation area of 30m by 30m on both the drill rig side and on the pipe side of the location being drilled. A typical rig for moderate length HDDs likely encountered on this project is a 150-250 tonne unit similar to the machine shown in **Figure 4-25**.

Figure 4-25 Typical HDD machine in operation

Drilling mud is used to hydraulically drive the drilling head, as a coolant, to wash in-situ material (cuttings) from the drilled hole and to seal and line the hole to facilitate insertion of the pipe. The primary clay used for drilling mud is bentonite, a non-toxic, naturally occurring mineral clay, which is added to fresh water to produce a 'mud'. Cuttings are screened, removed at the HDD rig and the drilling mud is recycled. Screened cuttings would be re-used where possible, however if this is not possible, cuttings would be diverted to skip bins before disposal in landfill in accordance with EPA Victoria's waste classification and transportation requirements.

While HDD avoids surface disturbance, it may require management of other environmental risks such as geotechnical constraints (fissures and cracks, unconsolidated substrata and subsurface scour potential), which may prevent HDD from being able to be used. Other trenchless construction methodologies would be used such as thrust- boring where HDD is deemed unsuitable.

The duration of construction at each HDD site is dependent on length and geological conditions (rock, unstable material, fissures and loss of mud). It is anticipated that HDD-01 would take up to 35 days, while HDD-02 would take up to 25 days. HDD construction may occur 24 hours a day during reaming and cleaning of longer sections and pullback of the pipe string which is typically completed within a day.

Thrust-boring

Shallow horizontal boring (referred to as thrust boring or micro-tunnelling) involves constructing a horizontal bore hole for installing the pipeline beneath sensitive surface features, roads and underground services.

Bell holes are excavated on both sides of the sensitive feature to the depth of the adjacent trench and graded to match the slope of the pipeline. A bell hole is an enlarged hole allowing a boring machine wider than the width of the trench to operate within it to tunnel under the relevant constraint. Entry bell holes would be approximately 10m long, 4m wide and typically 4m deep. The exit bell hole would typically be 7m long, 4m wide and up to 4m deep.

The boring machine is located within the entry pit, which uses a hydraulic ram to jack the pipe section, behind a cutting head, in a straight line through the round to the receiving pit.

The method is not suitable for boring under features where a greater depth is required, such as a major waterway. In these instances, HDD construction methodology would be used. A typical thrust bore set up is shown in Figure 4-26.

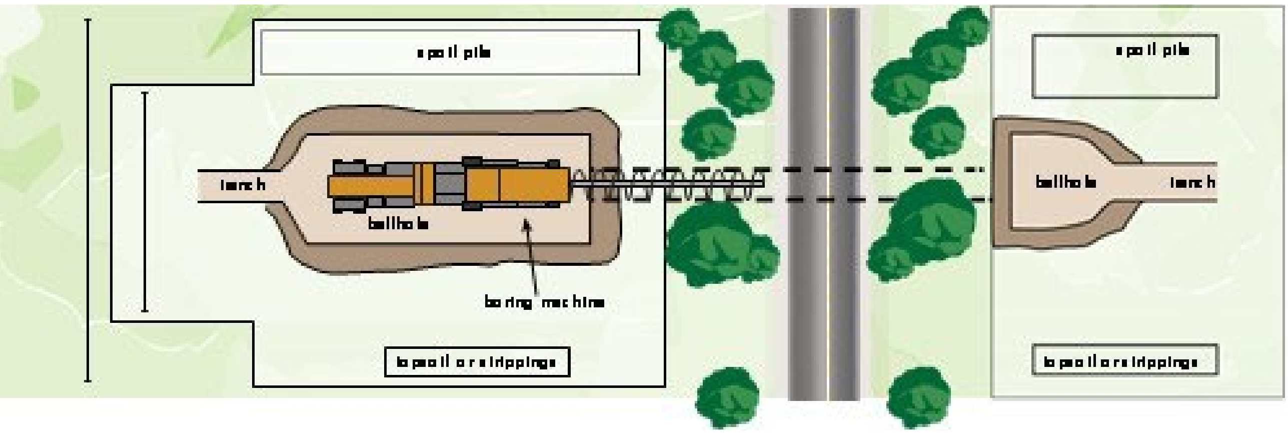

Figure 4-26 Typical thrust bore set up

One segment of thrust-boring is proposed along the proposed underground pipeline route as follows:

- TB-01: Beneath School Road

It is anticipated that the construction of this segment would take up to 2 weeks, with 5 days of noise generating operations. Thrust-boring would occur within normal working hours.

The anticipated trenching, HDD and thrust bore segment locations along the proposed underground pipeline route is presented on **Figure 4-27**.

Pipeline testing and commissioning

Prior to installation, the pipeline coating would be tested to ensure it is of a satisfactory standard. If the pipeline fails a coating integrity test pre-installation, the pipeline would be repaired and subsequently installed.

The pipeline would be pressure tested before commissioning to ensure it passes strength and leak tests. This is done through a process called hydrostatic testing whereby sections of the pipeline (test sections) are filled with water and then pressurised. A hydrostatic test plan would be developed and approved by Energy Safe Victoria before testing.

Post installation coating testing would also occur following hydrotesting. Coating can safely be repaired with the pipeline either in-service or depressurised.

Before hydrostatic testing, each pipeline test section would be cleaned internally by pigs propelled by compressed air. The test section would then be filled with water and pressurised. The pressure would be increased for approximately four hours to assess the strength of the test section. The pipeline would then be subjected to a leak test for a minimum of 24 hours to determine if the section is leak free. The hydrostatic testing process, including the time taken to clean, fill, test, drain and dry, would take approximately eight days for a single test section.

The exact sequence and timing of hydrostatic testing would depend on the final construction schedule, availability of water and the final hydrostatic test design of the pipeline. However, it is anticipated that the pipeline would be hydrostatically tested in two to four sections of variable lengths.

Hydrostatic testing of the onshore sections of pipeline would require approximately 1.9 megalitres (ML) of water in total (1.4ML for the underground pipeline and 0.5ML for the aboveground pipeline). Reuse of test water between two adjacent test sections would be undertaken where possible to reduce the amount of water required. Break tanks would be used to transfer water between test sections. It is possible that chemicals to control biological growth and corrosion may be added to the hydrostatic test water, however, this would be dependent on the final configuration of hydrostatic test sections and the availability of water. Water for hydrostatic testing would be sourced from the refinery fresh water supply, which is recycled water sourced from Barwon Water.

Once testing is complete, hydrostatic test water would be treated and disposed of within the refinery water treatment system.

Following pipeline testing and drying, the pipeline would be gauged using a geometry pig capable of measuring the internal surface of the pipe. Any defects would be located, assessed and rectified.

The pipeline would then be commissioned following completion of hydrostatic testing. Commissioning would proceed sequentially from the point where commissioning gas was available and subsequently on completion of the nominated sections.

Figure 4-27 Proposed construction methodology for underground pipeline route sections

Commissioning would be in accordance with an Energy Safe Victoria approved plan and procedure prepared during the detailed design and construction phase of the project and would include as a minimum the following activities:

- Instrument calibration
- Control system functionality
- Safety system testing
- Purging of air and gas filling
- Pressurisation
- Testing and commissioning of stations and valves.

The treatment plant injection lines and associated piping/valving would then be tied-in to the pipeline following commissioning.

Construction Right of Way rehabilitation

Rehabilitation of the construction ROW and all temporary facilities, temporary access tracks and extra work areas would begin as soon as practicable after the completion of the construction activities. Restoration of ground cover would occur within 1.5 months. It is important that rehabilitation is undertaken as soon as practicable to minimise topsoil and subgrade degradation.

Seasonal constraints can play a significant part in the success of the construction ROW rehabilitation. Traditional wet winter and spring seasons are a significant barrier to successful rehabilitation outcomes (wet weather and cold temperatures can cause difficulties in machine operation) with soil horizon mixing and low regrowth also a risk. Rehabilitation of the construction footprint would be undertaken in accordance with good pipeline construction principles to reinstate existing topography and appropriate vegetation in consultation with the landholder. Appropriate reinstatement methods would be included in the CEMP.

4.8.7 Lighting and security

Dredging

Dredging is anticipated to be undertaken 24/7 and work would be staffed at all times and would not require additional security beyond the normal monitoring of equipment (e.g., CCTV in Engine rooms).

Localised deck lighting would be on-board the BHD to assist with night-shift operations and standard navigation lights (as per maritime requirements) would be present on the BHD, tugs and barges.

Refinery Pier extension and infrastructure

At the proposed temporary storage and loadout facility, perimeter fencing, CCTV and lighting would be provided by and controlled by GeelongPort, with potential for additional lighting to be supplied by the contractor. It is anticipated that activities would be conducted on day shift only, with possible exceptions being:

- Hydrotesting of piping / pipelines (required exclusion zones and hold-periods)
- Critical installation activities that cannot be stopped safely at the completion of the day shift
- Required vessel/barge movements as required by GeelongPort.

Where night works are required, activity-based lighting would be used.

Pipeline

Along the onshore pipeline route, temporary perimeter fencing would be erected around bell-holes and open trenches to inhibit personnel from unintentionally falling in.

When not in operation (i.e., during nights/ weekends), construction equipment and machinery would be locked and left in place with shutters pulled down. Motion sensitive cameras with 4G connectivity would be placed on the construction equipment and machinery (e.g., camera fixed to an excavator boom) and this would send a notification to responsible personnel if activated.

Moveable vehicles (such as trucks and trailers) would have smaller tools and equipment locked within vehicles and at the end of each shift these vehicles would travel back to the fenced temporary construction facilities area.

Activities that may require night-shift work are:

- HDD construction, which may occur 24 hours a day during reaming of longer sections and pullback of the pipe string which would be used at sealed road crossings where access is required on a 24-hour basis.
- Hydrotest activities (hold period is 24 hours).

Where night works are required, activity-based lighting would be used.

Treatment facility

Permanent fencing currently exists around the perimeter of proposed treatment facility and temporary construction facilities allotments. Minor modifications to the boundaries of this fencing would be made to ensure it aligns with the final designed area plot plans, in addition to turnstiles and boom gates per entry/exit as illustrated in **Figure 4-28**.

Temporary construction lighting would be erected in required areas to ensure the perimeter is adequately visible for security monitoring. A CCTV trailer and rapid deployment CCTV cameras would be utilised to monitor for incursions.

Activities that may require night-shift work are:

- Hydrotest activities (hold period is 24 hours).

Where night works are required, activity-based lighting would be used.

4.8.8 Temporary facilities, traffic and laydown areas

During the construction phase of the project there would be temporary construction facilities for site offices, toilets/ablutions and workshop areas. Indicative locations for these are shown in **Figure 4-29**.

The construction traffic and laydown areas have been selected to ensure minimum disruptions to neighbouring institutions and industries and to minimise disruption to the operating refinery. **Figure 4-30** and **Figure 4-31** shows the indicative routes for construction traffic and laydown areas for the project.

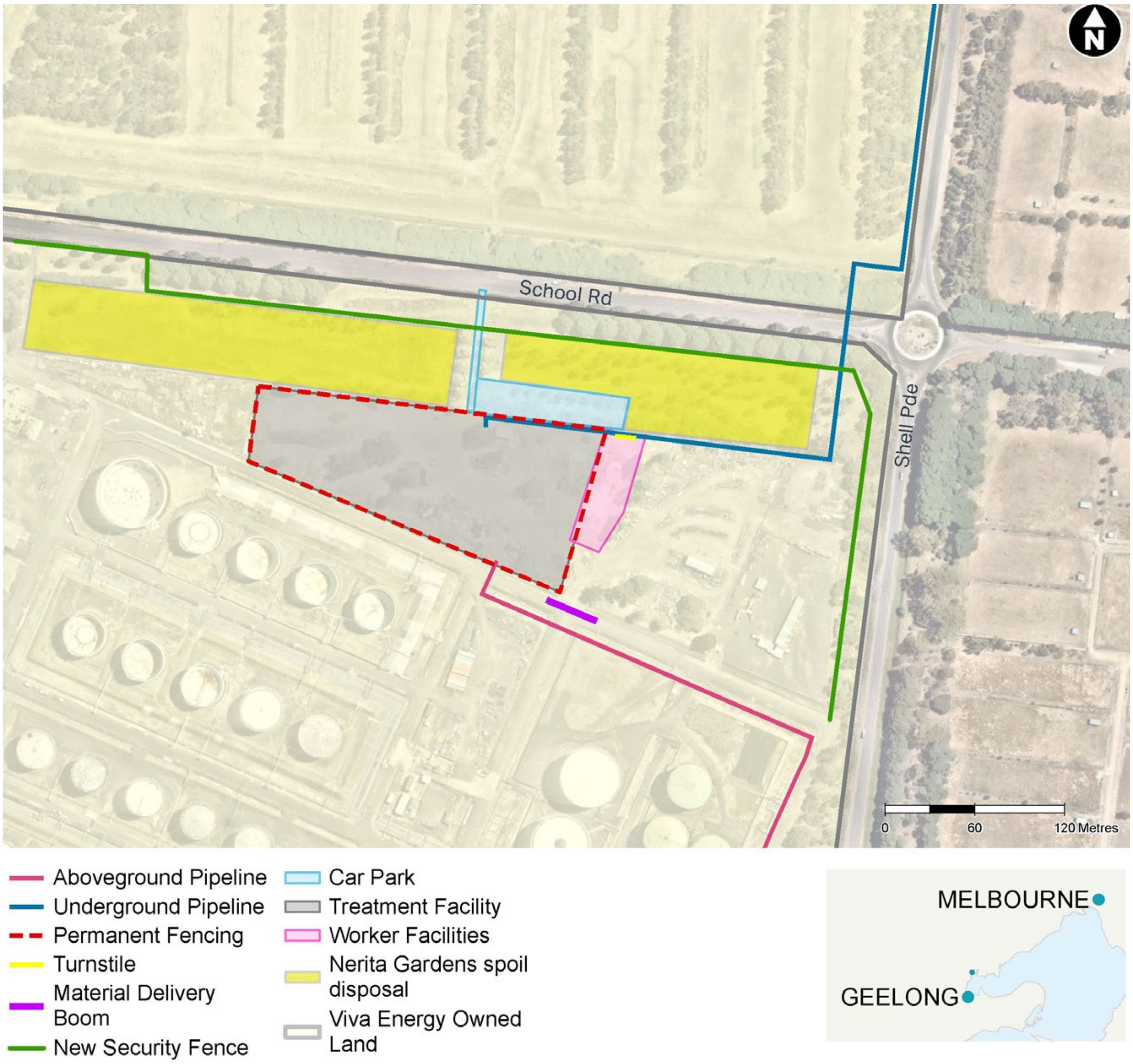

Figure 4-28 Security fencing and access overview of the treatment facility

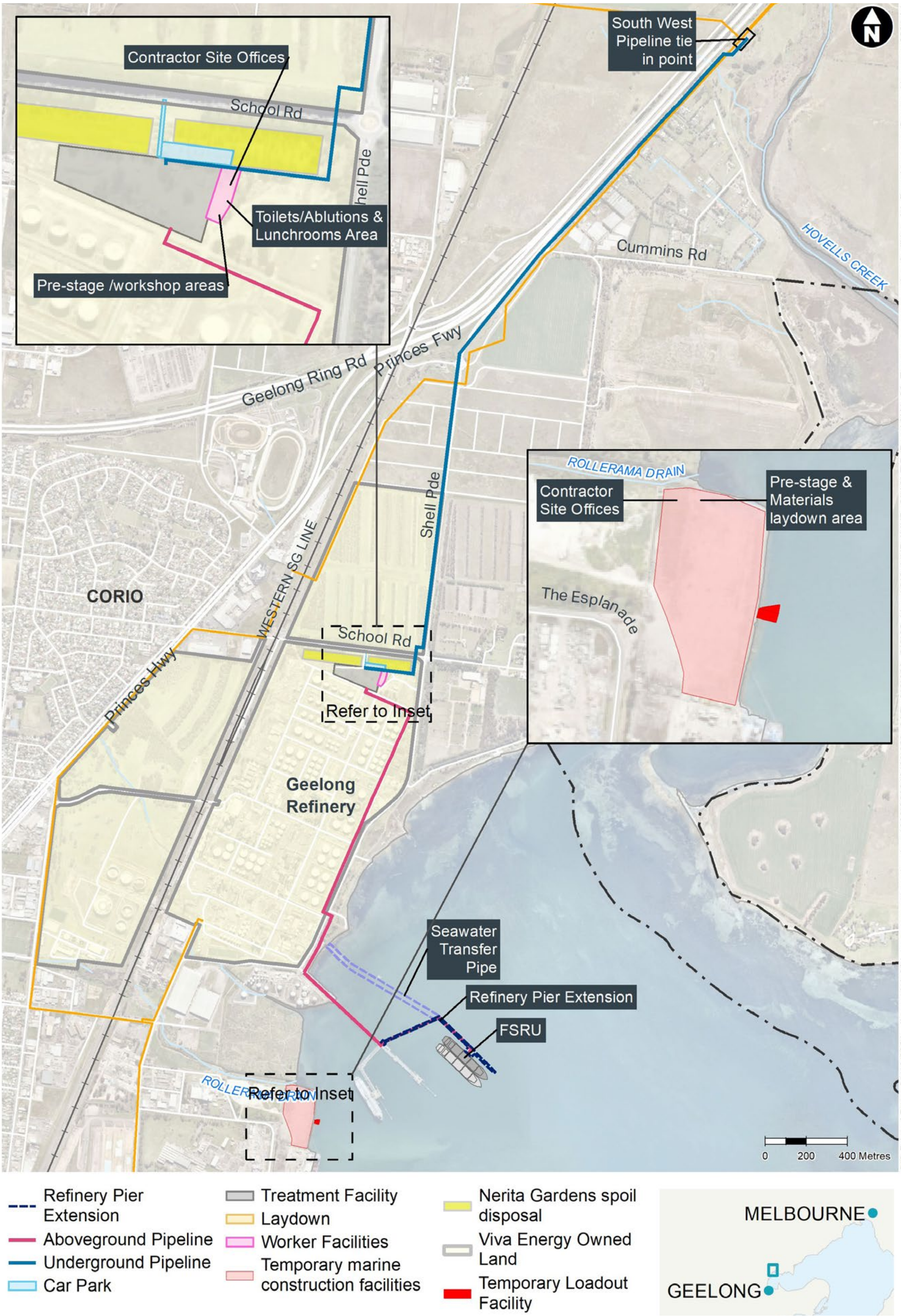

Figure 4-29 Temporary facilities for construction activities

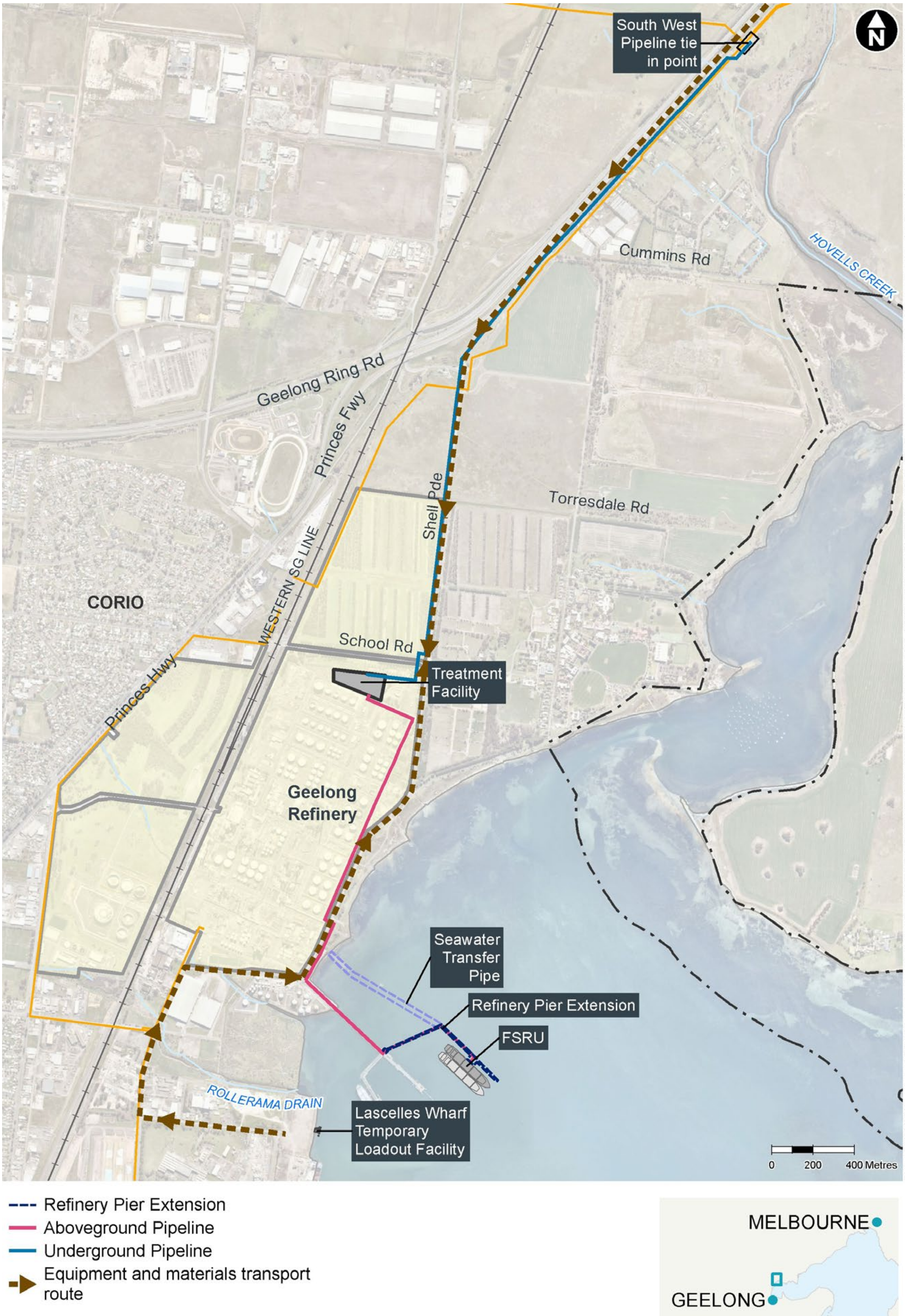

Figure 4-30 Forecast equipment and materials transportation route

Figure 4-31 Forecast construction traffic and potential road closures

4.8.9 Construction equipment

A range of equipment will be required to undertake the scope of construction work for each project component. The key construction activities and the associated equipment required is outlined in **Table 4-10**.

Table 4-10 Indicative construction equipment, plant and vehicles required for the project

Activity	Equipment/Plant	Vehicles
Dredging	Backhoe dredge Hopper barges Tugs Hydrographic survey vessel crew vessel Telehandler Crane	Forklift
Pier construction	Backhoe dredge Floating barge with crawler crane Materials barge Franna crane Air compressor Generator Elevated work platform Excavator Scaffolding Pumps Sub-stations Angle grinder Asphalt paver Circular bitumen saw compactor Crane bulldozer drill Front end loader Skid steer loader – small, rigid-frame, engine-powered machine with lift arms used to attach a wide variety of labour-saving tools or attachments Harvester machine Hydraulic torque wrench Kerbing machine Mulcher Roller Welding machine Road grader – to create flat surfaces	Tugboats Work crew boats Tabletop truck (8T) Truck (2T) Waste truck Deliveries truck Water truck Concrete truck Semi-trailer Tractor Dump truck Vacuum truck Welding truck Light vehicles (4x4 wagons or utes)

Activity	Equipment/Plant	Vehicles
Pipelines & treatment facility	Fork lift / Telehandler Tractor post driver Excavator (20T - 36T) Backhoe Mulcher Grader (12M or 14M) Pipe bending machine Compressor Drying unit Pumps (Fill & Dewater for Hydro) Sideboom – for installing the pipe in the trench Water cart Generator system Mud system Guidance system HDD rig Compactor Padding machine – to backfill the trench Loader Piling rig to drive poles into soil as foundation support Thrust-bore equipment (including power pack, track frame and drilling rig, trench shield)	Light vehicles (4x4 wagons or utes) Hiab truck (truck-mounted forklift/crane) Fuel truck Float (50T) Semi-trailer 10T truck Crew cab truck Tip truck Extendable trailer Spray truck 4x4 Vacuum truck Welding truck Concrete trucks Road roller Street sweeper

4.8.10 Construction workforce

During construction of the Refinery Pier extension and pier infrastructure, it is forecast that at the peak of construction approximately 100 people would be employed to execute the dredging, pier and pier infrastructure scopes of work. It is assumed these crews would work between 06:00-17:30 on weekdays and 06:00-17:00 on Saturdays and Sundays. Refinery Pier extension Sunday work activities would be carried out in accordance with EPA 1834 and would consist of tasks such as painting, electrical terminations, yard cleanup, assembly of steel work and barge/vessel movements. It would exclude activities such as pile driving, blasting and trenching.

For the aboveground pipeline, treatment facility and underground pipeline, it is forecast that at the peak of construction approximately 160 people would be employed to complete the scope of works. It is assumed these crews would work between 06:00-17:30 on weekdays and 07:00-17:00 on Saturdays.

It is anticipated that work may be required to be undertaken outside of the standard hours outlined above. Activities that may require work outside of these hours include:

- Pipeline HDD activities
- Pipeline hydrostatic testing activities
- Critical installation activities that cannot be stopped safely at the completion of the day shift
- Vessel/barge movements as required by GeelongPort.

Where night-shift work is required, adequate lighting would be supplied.

Table 4-11 provides an overview of the indicative workforce numbers for the construction for each project component and the standard working hours associated for each.

Table 4-11 Indicative workforce numbers for each construction activity

Activity	Workforce	Standard working hours
Refinery Pier extension & Infrastructure	100	06:00- 17:30 Weekdays 06:00- 17:00 Saturdays & Sundays
Aboveground pipeline	50	06:00- 17:30 Weekdays 06:00- 17:00 Saturdays
Underground pipeline	65	
Treatment facility	70	

Works may be undertaken outside of these standard hours during HDD and hydrostatic testing activities or if project schedule requires

4.8.11 Construction waste

The project would generate a range of waste materials during the construction phase, which would primarily result from the following activities:

- Dredging of approximately 490,000m^3 of material required in the existing shipping channel adjacent to Refinery Pier No.5 to provide sufficient water depth at the new berth and within the swing basin for LNG carriers to turn
- Excess spoil materials from the treatment facility earthworks and civil foundations (such as the slab for nitrogen storage and injection equipment)
- Small amounts of excess spoil may result from constructing supports and drilling under roads for the aboveground pipeline installation
- Waste from excavation/trenching (such as soil/spoil)
- Waste from construction materials (such as cables, wiring, cuttings, welding rods, bolts, rags)
- Waste from equipment and material deliveries such as plastic/timber packaging
- Waste from site office activities (such as paper, food scraps, cans/bottles)
- Excavated sediment from the installation of the seawater transfer pipe is proposed to be reused to backfill the excavation, creating a mound over the seawater transfer pipe.

Management of excess spoil materials from earthworks, excavation and trenching may trigger requirements under the waste duties as part of the general environmental duty under the *Environment Protection Act 2017*. This would involve the requirement to classify the waste and undertake associated duties and management controls that are applicable for certain types of waste. Management of waste that is found to be contaminated would also be required in accordance with the contaminated land duties as part of the general environmental duty.

Temporary construction facilities, including site offices, kitchen facilities and portable toilets would be made available during construction of the project. Wastewater would we appropriately managed by licenced contractors. Water used during pipeline hydrotesting of the pier pipeline and onshore pipeline would be reused or recycled where possible. If water quality does not allow for this, water would be transported, treated and disposed of by licensed waste contractors.

Different types of waste would be generated during construction activities for the underground pipeline, particularly in respect to activities along the pipeline construction ROW. These include:

- Wastes from survey, clearing the ROW and trenching
- Wastes from transportation and storage of pipe
- Pipeline coating waste
- Drilling cuttings and excess soil and rock (spoil)
- Drilling muds
- Welding/grinding waste (for example, spent welding rods)
- Machinery waste.

Cleared vegetation, topsoil and subsoil would be generated during construction of the underground pipeline. This material would be returned to the construction ROW as a part of rehabilitation and are therefore not considered to be waste and not included in the waste inventory.

The dredged material would be disposed of within the existing DMG in Port Phillip to the east of Point Wilson. The location of the Point Wilson DMG is shown in **Figure 4-16**.

Excess spoil material from the treatment facility earthworks would be disposed of within the refinery spoil grounds which are illustrated below in yellow highlight in **Figure 4-32**.

All other project construction wastes would be reused or recycled where practicable. Any excess spoil or other materials that are not deemed acceptable for disposal with the refinery spoil grounds would be collected and transported by licensed waste contractors for disposal at appropriately licensed facilities.

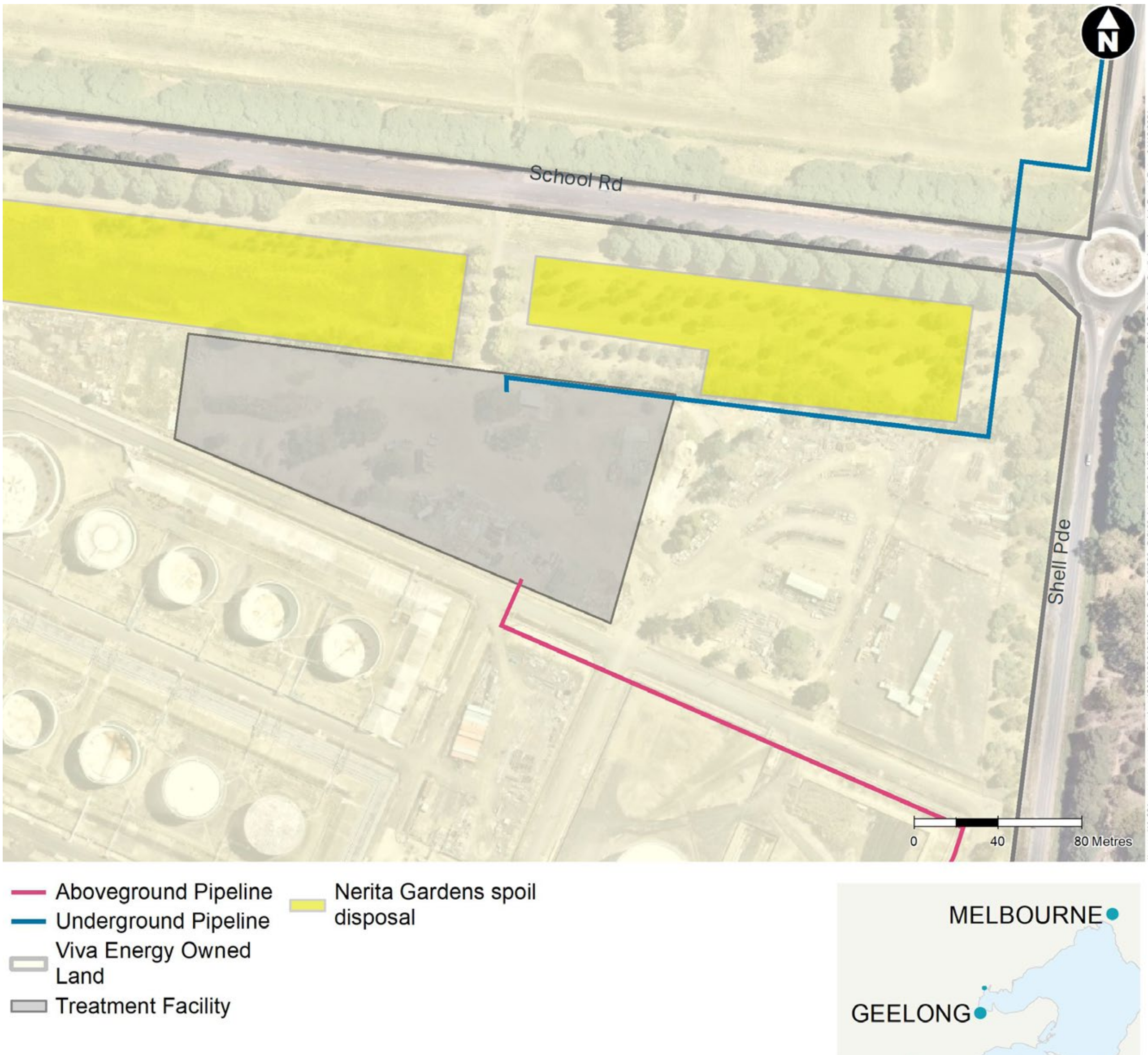

Figure 4-32 Onsite spoil disposal location

4.9 Operation and maintenance

The project life is anticipated to be approximately 20 years. The project would operate 24 hours a day, 7 days a week, in line with the refinery's existing hours of operation and as required by gas demand. LNG carriers arriving at the Refinery Pier may arrive at any time of day, which would be communicated with the harbour master.

4.9.1 FSRU operation

The FSRU would be continuously moored at the newly constructed Refinery Pier No. 5 as shown in **Figure 4-4**. The FSRU would remain as an operational ship and able to be moved as required, such as in extreme weather events or for maintenance activities.

The FSRU would receive LNG from regularly scheduled LNG carriers from external suppliers. It is anticipated that up to 45 LNG carriers would visit the gas terminal annually, dependent upon LNG carrier capacity and operational demand. The LNG carrier would moor alongside the FSRU for around 24-36 hours while they transfer their LNG cargo, still under atmospheric pressure, into the cargo holds of the FSRU. During arrival and departure operations the LNG carrier would be assisted by four tugboats.

4.9.2 Seawater use and reuse

As outlined in previous sections and **Table 4-1**, the FSRU would require a seawater intake volume of around 148ML/day during the summer months. During the shoulder months of spring and autumn it is anticipated that the FSRU would require approximately 208ML/day of seawater. The seawater consumption rate for the FSRU in winter is expected to be approximately 300ML/day (refer to **Section 4.4.3** and **Table 4-1**). On a limited number of peak demand days, the gas production rate would fluctuate throughout the day, but the maximum daily flowrate of seawater would be 350,000m^3/day.

As outlined in previous sections and in Chapter 3: *Project alternatives and development*, a potential synergy was identified between the FSRU cold water discharge and the seawater intake for cooling water currently used at the refinery. The current total cooling water licensed flowrates through the refinery are 350ML/day. As this is a similar volume of seawater that would be discharged from the FSRU, the refinery cooling water flowrate could be offset by the FSRU cold water discharge flow rate (refer to **Section 4.4.3**).

Full reuse of the seawater discharge from the FSRU would have significant environmental benefits, however, there would be days where seawater discharge from the FSRU is lower than the intake requirements for the refinery (e.g., when the production rate for the FSRU is low due to reduced demand). In the event that this does occur, the refinery would draw the remaining volume of seawater required through the existing refinery seawater intake. Conversely, there would be days where seawater discharge from the FSRU would exceed the intake requirements for the refinery (e.g., when parts of the refinery are shut for maintenance or no longer operational). In the event that this does occur, excess seawater from the FSRU would be discharged to Corio Bay through a diffuser located under the new pier.

The refinery has four existing seawater discharge outlets designated W1, W3, W4 and W5 as shown in **Figure 4-9**. The largest of the discharges is W1 which is the main discharge channel located south of the Refinery Pier. W1 has a maximum licenced discharge of 228ML/day and is the largest of the four discharges.

Table 4-12 shows the discharge flowrates, discharge temperature and residual chlorine levels for each discharge outlet with and without the project at peak flow (350ML/day). As shown in **Table 4-12** the refinery currently uses approximately 350 ML/day of seawater for cooling purposes which heats the seawater to approximately 9°C above the entry temperature at its point of discharge back into Corio Bay. Reuse of 350ML/day of FSRU discharge as refinery cooling water would reduce the temperature of the warmed seawater discharged by 7°C to approximately 2°C above ambient seawater temperature.

Table 4-12 Impact of the FSRU discharge on the refinery outlet cooling water temperature

Cooling water outlet location	Existing refinery discharge			Future refinery discharge		
	Flowrate (ML/day)	Temperature relative to ambient (°C)	Residual chlorine (mg/L)	Flowrate (ML/day)	Temperature relative to ambient (°C)	Residual chlorine (mg/L)
W1	228	+8	0.06	228	+1	0.06
W3	2	ambient	0.18	2	-7	0.18
W4	35	+9	0.06	35	+2	0.06
W5	85	+10	0.05	85	+3	0.05
Total flow / Average temperature and residual chlorine	**350**	**+9**	**0.06**	**350**	**+2**	**0.06**

4.9.3 FSRU maintenance and monitoring

The FSRU would be manned on a 24-hour continuous shift basis to supervise, operate and maintain the facility and ensure high uptime and safe operations. The FSRU would have an adequate level of spares and consumables, storage space, workshops and maintenance support facilities to achieve gas delivery consistent with customer demand.

FSRU performances, including gas send-out flow, pressure, temperature over periods of time, and internal fuel consumption, would be monitored, recorded and reported. A monitoring and testing program would be implemented to guarantee the FSRU environmental impacts remain within limits approved by regulators and authorities. The monitoring and testing program would include, but not limited to, air emissions, greenhouse gas emissions and seawater discharges from the FSRU.

The FSRU would be inspected in accordance with Flag State and Classification Society requirements which would include annual, intermediate (every 2.5 years) and renewal (every 5 years) surveys. The FSRU would also be regularly inspected in accordance with the Ship Inspection Report Programme (SIRE) from the Oil Companies International Marine Forum (OCIMF). A Performance Based Inspection (PBI) program would also be developed and submitted to the Australian Maritime Safety Authority (AMSA) for approval.

4.9.4 Port navigation/shipping traffic

The LNG carriers would enter Port Phillip Bay through the Heads and wait for appropriate tide before transiting through Point Richard channel, Wilson Spit channel, Hopetoun channel and finally Corio channel before arriving at Refinery Pier where the FSRU would be located.

LNG carriers with LNG storage capacities ranging from 125,000m^3 to 180,000m^3 are expected to visit the terminal, with occasional visits from small-scale LNG vessels (approximately 30,000m^3 capacity). LNG carrier dimensions would be within limits defined by Ports Victoria (e.g., length less than 300m, beam less than 50m and draft less than 11.9m). Navigation restrictions dependent on environmental conditions, particularly wind speed, would be imposed on LNG carriers by Ports Victoria.

Depending on demand, LNG carriers would visit Refinery Pier at a frequency of every 20 days to every 8 days at maximum demand. Up to 45 LNG carriers would arrive each year, depending on the gas demand and their storage capacity. At maximum demand, 45 extra ship movements from LNG carriers would represent an increase of 3.8% above existing shipping movements within the Port of Geelong.

Port Phillip pilots would have control of the LNG carriers between the pilot boarding location and the terminal. A maximum of four tugs are anticipated to escort and support LNG carriers to/from Refinery Pier No.5.

Seabed levelling activities would be required every 5 years for a duration of up to 7 days to maintain the depths and levels at the berth pocket and swing basin. This activity would be undertaken by Ports Victoria as maintenance of the berth pocket and swing basin falls under its management.

4.9.5 Treatment facility operation

The treatment facility would likely be operated by Viva Energy Refinery operators, with a control panel overview located on either the FSRU or within the refinery.

Key operational activities undertaken at the treatment facility would be the regular truck deliveries of nitrogen and odorant as well as maintenance and inspection activities. Refinery operators would complete regular rounds of inspection at key inspection points. The frequency of maintenance would be as per manufacturer or vendor specifications.

Further information on the frequency of nitrogen and odorant truck deliveries is outlined in **Section 4.9.7**.

4.9.6 Pipeline easement maintenance and monitoring

Following construction and land remediation, the pipeline easement would be managed through the following activities:

- Land stability
- Preventing excavation or construction of dwellings/structures over the pipeline or within immediate proximity, in accordance with *Pipelines Act 2005*
- Revegetation
- Weed management and removal
- Water crossing covers.

Pipeline markers would be installed along the route and at road crossings in accordance with AS2885 to inform the public of the buried pipeline and to avoid inadvertent incidents.

Pipeline integrity would be managed through routine pigging operations to confirm integrity across the entire buried section of pipeline.

4.9.7 Operational traffic

During operation of the project, traffic would primarily be associated with the transport of nitrogen onsite to the treatment facility. Nitrogen would be sourced from a variety of existing nitrogen providers by truck to both refill this storage volume but also to supplement the nitrogen consumed during rich LNG cargo campaigns.

Nitrogen trucks would deliver nitrogen onsite outside of normal 9am-5pm working hours. It is anticipated that five nitrogen trucks per day would travel to site for 120 days of the year, and three nitrogen trucks per day would travel to site for 120 days of the year. There would be no nitrogen truck deliveries for the remaining days of the year. It should be noted this is a conservative estimation and would be dependent on how rich or lean incoming LNG cargoes are. Nitrogen trucks would travel from Altona (33%), Dandenong (33%) and Port Kembla (34%). The proposed route for nitrogen trucks in and out of the refinery site is shown in Figure 4-33.

Odorant trucks are anticipated to visit less frequently than nitrogen trucks. Odorant trucks with a 2,500-litre vessel capacity would deliver odorant to the facility up to 10 times per year. The proposed route for the odorant trucks would be the same route proposed for nitrogen trucks.

Other sources of additional traffic during operation of the project would be from the workforce travelling to and from site. The only additional workforce for the project's operation is associated with FSRU operations and maintenance crews. The workforce would travel from Melbourne and Geelong and would utilise onsite parking next to the pier gatehouse within Viva Energy owned land.

4.9.8 Operational workforce

The operational workforce would require 50 to 70 employees to operate the FSRU on a 24 hour, 365 day per year basis. The gas import terminal management would be provided by 1 to 2 employees responsible for gas scheduling, business partner interfaces and regulator interfaces. The project would leverage existing Refinery personnel for inspection and maintenance services.

Figure 4-33 Proposed nitrogen truck movements

4.9.9 Operational waste

The FSRU is classed as an oceangoing LNG carrier and is required to follow MARPOL regulations. This implies that while the FSRU is anchored/moored the vessel is not allowed to discharge any potentially oily water (e.g., bilge) to sea, even though the water would be treated in a separator to have an oil content below 15 parts per million (ppm).

Produced bilge water, grey water, sludge and sewage would be collected, treated as required and stored in holding tanks onboard the FSRU. The tanks would be emptied periodically to a barge or truck via flexible connections or piped onshore, and the content sent to an external authorised treatment plant.

A sludge tank would collect sludge from marine diesel oil (MDO) and lube oil (LO) purifiers. The sludge would then either be pumped to deck for discharge to shore or pumped to a Sludge Dewatering Unit where the sludge would be separated into bilge water and pumped to the Bilge Holding Tank and oil residue which would be pumped to the Oily Bilge Tank.

The Oily Bilge Tanks would contain oil residue from drains, drip trays, oil separators, sludge dewatering unit. The oily bilge (sludge) would be pumped to deck for discharge to a barge or truck for offsite disposal.

Bilge water is collected in a dedicated holding tank. From here it may either be pumped to deck for discharge to a barge or truck for offsite disposal or pumped to the Oily Bilge Separator where the bilge water would be treated to an oil content of less than 15ppm and sent to the Clean Bilge Tank. Oil discharge from the separator would be sent to the Oily Bilge Tank.

4.10 Decommissioning

The FSRU, which would continue to be an ocean-going vessel throughout the operation of the project, would leave Corio Bay on completion of the project life to be used elsewhere.

Key decommissioning activities for the project may include:

- Decommissioning of the temporary loadout facility at Lascelles Wharf following the completion of construction
- Decommissioning of the above ground infrastructure, if no longer required
- Surplus operational material, including Spotleak 1005 (odorant) and liquid nitrogen returned to suppliers or consumed within other local applications
- Depressurisation and purging of the pipeline.

Decommissioning activities may change, subject to legislative requirements at the time and potential repurposing of the infrastructure at the end of the project life.