Attachment B

Basis of Design

Melbourne Jet Pipeline Project

Melbourne Airport Jet Pipeline Project

Basis of Design

Viva Energy

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Document prepared by:

Aurecon Australasia Pty Ltd

ABN 54 005 139 873

Aurecon Centre
Level 8, 850 Collins Street
Docklands, Melbourne VIC 3008

PO Box 23061
Docklands VIC 8012
Australia

T +61 3 9975 3000
F +61 3 9975 3444
E melbourne@aurecongroup.com
W aurecongroup.com

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This Basis of Design has been reviewed by the following Aurecon Lead Discipline Engineers

Name	Title
Scott Veale	Principal Process Engineer
Raj Veedu	Lead Mechanical/ Piping/ Pipeline Engineer
Ameen Esam	Senior Civil / Structural Engineer
Keith Berry	Lead EI & C Engineer

Approval			
Name	Joanne Heath	Name	Dirk Smith
Title	Senior Process Engineer	Title	Project Director

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1 Project Overview

Viva Energy Australia (Viva Energy) is considering the construction of a new jet fuel pipeline to Melbourne Airport that would support Victoria's growing needs over the next 20-30 years.

The new pipeline would directly connect the existing Altona to Somerton (PL118) pipeline with the Melbourne Airport Joint User Hydrant Installation (JUHI), providing faster replenishment of fuel stocks and a more robust supply chain.

The pipeline, as well as the project, shall be referred to as the Melbourne JUHI Pipeline (MJP) within this document and other documents that form this project.

1.1 Purpose of Document

The purpose of this document is to describe the Basis of Design (BoD) for the MJP and associated facilities (Inlet and JUHI receival stations). The BoD also describes in brief the handling, batching and transfer of Jet A1 between parties.

The document aims to address the functions described below.

1.1.1 Project Parameters

As a design basis document, the primary focus is to describe the parameters that will govern the design work, including input conditions such as properties and environmental conditions, and output conditions such as the usage of the pipeline and other performance measures.

1.1.2 Statement of Design

This Basis of Design is also required to describe and briefly justify the major design decisions that are or have been made and accepted, including conceptual/feasibility design, for the purpose of fulfilling the overall functional requirements.

This document will be maintained throughout all project design stages to capture any future changes to the pipeline design, pipeline route or other items.

This document will be subjected to a design review with Viva upon re-issue of the revised Basis of Design.

1.2 Scope and Limitations

Revision B of this document has been prepared by Aurecon for Viva Energy Australia and may only be used and relied on by Viva Energy Australia for the purpose agreed between Aurecon and Viva Energy Australia as set out in Section 1.1 of this report.

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1.3 Abbreviations

Table 1 List of Abbreviations

Abbreviation	Definition
AC	Alternating Current
ANSI	American National Standards Institute
API	American Petroleum Institute
API MPMS	American Petroleum Institute Manual of Petroleum Measurement Standards
AS	Australian Standard
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CP	Cathodic Protection
CH	Chainage Point
DEP	Design & Engineering Procedure (Shell standard)
DN	Diameter Nominal
DPE	Dual Piston Effect
EFRD	Emergency Flow Restriction Device
ERP	Emergency Response Plan
ESV	Energy Safe Victoria
FBE	Fusion Bonded Epoxy
FEED	Front End Engineering Design
FAT	Factory acceptance testing
FC	Filter Coalescer
FJC	Field Joint Coating
FOC	Fibre Optic Cable
GIS	Geographic Information System
HART	Highway Addressable Remote Transducer
HAZID	Hazard Identification Study
HAZOP	Hazard and Operability Study
HBE	High Build Epoxy
HCA	High Consequence Areas
HDD	Horizontal Directional Drilling
IP	Ingress Protection
ICCP	Impressed Current Cathodic Protection
JHA	Job Hazard Analysis
JUHI	Joint User Hydrant Installation
KP	Kilometre Point
kPag	Kilopascals Gauge
LDS	Leak Detection System
LFI	Low Frequency Induction
LOR	Lock-O-Ring
MAOP	Maximum Allowable Operating Pressure
MOP	Maximum Operating Pressure
MIJ	Monolithic Insulation Joint
MJ	Megajoule
ML	Measurement Length
MLT	Metal Loss Tool
MLV	Mainline Valve
MSEP	Micro-Separometer
OHS	Occupational Health and Safety

Abbreviation	Definition
PEEK	Polyether ether ketone
P&ID	Piping and Instrumentation Diagram
PI	Pressure Indicator
PL	Pig Launcher
PR	Pig Receiver
PSL	Product Specification Levels
RAM	Reliability, Availability and Maintainability
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SACP	Sacrificial Anode Cathodic Protection
SAT	Site acceptance testing
SMS	Safety Management Study
SPE	Single Piston Effect
TQ	Technical Query
VDC	Voltage Direct Current
3LPE	3 Layer Polyethylene external pipe coating

1.4 Design Standards and Legislation Requirements

The pipeline shall be designed, constructed, tested, and operated in full compliance with the following (in order of precedence):

1. Mandatory Victorian legislation/regulations
2. Mandatory Australian statutory requirements
3. Mandatory Australian codes and standards
4. Mandatory Viva Energy Environmental Health and Safety standards
5. PL 6000 and Shell DEP piping design specifications
6. Shell DEPs agreed by Viva Energy and Aurecon to be used on this project
7. International codes and standards

The pipeline and associated facilities will be designed, constructed, and tested in accordance with AS 2885.0, AS 2885.1, AS 2885.2, AS 2885.5 and AS 2885.6. An AS 2885 Compliance Matrix has been developed for this project.

The pipeline and associated facilities shall be designed to satisfy all applicable Victorian legislation, in particular:

- Victorian Pipelines Act 2005
- Victorian Pipelines Regulations 2017

The Owner is responsible for operating and maintaining the pipeline in accordance with the conditions of Pipeline Licence(s) issued by the Victorian Government, and the relevant Australian Standards. In this document "Owner" has the same definition as "Licensee" in AS 2885.1.

The following table is a list of applicable standards and reference standards used on the project.

Table 2 List of Design Standards

Standard	Year of Issue	Name
American Petroleum Institute		
API 5L	2018	Specification for Line Pipe
API 6D	2021	Pipeline Valves
API RP 5L1	2009	Recommended Practice for Railroad Transportation of Line Pipe
API RP 5LW	2009	Recommended Practice for Transportation of Line Pipe on Barges and Marine Vessels
API RP 1102	2007	Steel Pipelines Crossing Railroads and Highways

Standard	Year of Issue	Name
API RP 1175	2022	Recommended Practice for Pipeline Leak Detection - Program Management
API 1130	2022	Computational Pipeline Monitoring for Liquids
Australian Standards		
AS/NZS 1020	1995	Control of Undesirable Static Electricity
AS/NZS 1170.0	2002	Structural Design Actions - Part 0: General Principles
AS/NZS 1170.1	2002	Structural Design Actions - Part 1: Permanent, Imposed and Other Actions
AS/NZS 1170.2	2021	Structural Design Actions - Part 2: Wind Loading
AS 1170.4	2020	Structural Design Actions - Part 4: Earthquake Actions in Australia
AS 1210	2010	Pressure Vessels
AS/NZS 1554.1	2014	Structural steel welding, Part 1: Welding of steel structures
AS 1657	2018	Fixed platforms, walkways, stairways and ladders - Design, construction and installation
AS/NZS 1768	2021	Lightning Protection
AS 2649	2007	Petroleum liquids and liquefied gases – Measurement – Standard reference
AS 2870	2011	Residential Slabs and Footings
AS 2885.0	2018	Pipelines – Gas and Liquid petroleum – General requirements
AS/NZS 2885.1	2018	Pipelines – Gas and Liquid petroleum Part 1: Design and construction
AS/NZS 2885.2	2020	Pipelines – Gas and Liquid petroleum Part 2: Welding
AS 2885.3	2012	Pipelines – Gas and Liquid petroleum Part 3: Operation and maintenance
AS 2885.5	2020	Pipelines – Gas and Liquid petroleum Part 5: Field pressure testing
AS/NZS 2885.6	2018	Pipelines – Gas and Liquid petroleum Part 6: Pipeline safety management
AS 1940	2017	The Storage and Handling of Flammable and Combustible Liquids
AS 2239	2003	Galvanic (sacrificial) anodes for cathodic protection
AS 2832.1	2015	Cathodic Protection of Metals - Pipes and cables
AS/NZS 3000	2018	Wiring Rules
AS/NZS 3500.3	2021	National plumbing and drainage code – Stormwater drainage
AS 3600	2018	Concrete Structures
AS/NZS 3678	2016	Structural steel – Hot-rolled plates, floor plates and slabs
AS/NZS 3679.1	2016	Structural steel – Hot-rolled bars and sections
AS/NZS 3679.2	2016	Structural steel – Welded sections
AS 4100	2020	Steel Structures
AS 4250.1	1995	Liquid hydrocarbons – Dynamic measurement – Proving systems for volumetric meters, Part 1: General principles
AS 4343	2014	Pressure Equipment Hazard Levels
AS 4678	2002	Earth-retaining structures
AS/NZS 4680	2006	Hot-dipped galvanized coatings on fabricated ferrous articles
AS 4853	2012	Electrical Hazards on Metallic Pipelines
AS/NZS 60079 Series	2009	Electrical apparatus for explosive gas atmospheres – Classification and design
AS 61508.0	2006	Functional safety of electrical/electronic/programmable electronic safety-related systems - Functional safety and AS 61508
AS 61508.1	2011	Functional safety of electrical/electronic/programmable electronic safety-related systems - General requirements
AS 61508.2	2011	Functional safety of electrical/electronic/programmable electronic safety-related systems -Requirements for electrical/ electronic/programmable electronic safety-related systems
AS 61508.3	2011	Functional safety of electrical/electronic/programmable electronic safety-related systems - Software requirements
AS 61508.4	2011	Functional safety of electrical/electronic/programmable electronic safety-related systems - Definitions and abbreviations

Standard	Year of Issue	Name
AS 61508.5	2011	Functional safety of electrical/electronic/programmable electronic safety-related systems - Examples of methods for the determination of safety integrity levels
AS 61508.6	2011	Functional safety of electrical/electronic/programmable electronic safety-related systems - Guidelines on the application of IEC 61508-2 and IEC 61508-2
AS 61508.7	2011	Functional safety of electrical/electronic/programmable electronic safety-related systems -Overview of techniques and measures
AS/IEC 61511.1	2018	Functional Safety—Safety Instrumented Systems for the Process Industry Sector
AS/IEC 61511.1	2018	Functional safety - Safety instrumented systems for the process industry sector, Part 1: Framework, definitions, system, hardware and application programming requirements
AS/IEC 61511.2	2018	Functional safety - Safety instrumented systems for the process industry, Part 2: Guidelines for the application of AS IEC 61511.1
AS/IEC 61511.3	2018	Functional Safety - Safety instrumented systems for the process industry sector, Part 3: Guidance for the determination of the required safety integrity levels
American Society of Mechanical Engineers		
ASME B16.5	2020	Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24, Metric/Inch Standard
ASME B16.10	2017	Face to Face and End to End Dimensions of Valves
ASME B16.34	2020	Valves – Flanged, Threaded and Welding End
ASME 16.47	2020	Large Diameter Steel Flanges
ASME B31.3	2020	Process Piping
ASME 36.10	2018	Welded and Seamless Wrought Steel Pipe
ASME Section VIII	2021	Unfired Pressure Vessels (acceptable alternative to AS 1210)
International Organisation for Standardisation		
ISO 15590-1	2018	Petroleum and natural gas industries - Induction bends, fittings and flanges for pipeline transportation systems - Part 1: Induction bends
ISO 1558-1	2015	Petroleum, petrochemical and natural gas industries — Cathodic protection of pipeline systems- Part 1: On-land pipeline
ISO 21809-1	2018	Petroleum and natural gas industries - External coatings for buried or submerged pipelines used in pipeline transportation systems - Part 1: Polyolefin coatings (3-layer PE and 3-layer PP)
ISO 21809-3	2016	Petroleum and natural gas industries - External coatings for buried or submerged pipelines used in pipeline transportation systems - Part 3: Field joint coatings
ISO 21809-5	2017	Petroleum and natural gas industries - External coatings for buried or submerged pipelines used in pipeline transportation systems - Part 5: External concrete coatings
British Standards		
BS 7910	2019	Guide to assessing flaws in metallic structures
Energy Institute		
EIJ/JIG 1530	2019	Quality assurance requirements for the manufacture, storage and distribution of aviation fuel to airports (A4)
EI 1550	2014	Handbook on equipment used for the maintenance and delivery of clean aviation fuel
API/EI 1581	2011	Specifications and qualification procedures for aviation jet fuel filter/separators
EI 1596	2006	Design and construction of aviation fuel filter vessels
Manufacturers Standardisation Society		
MSS SP-44	2019	Specification for Steel Pipeline Flanges
MSS SP-75	2019	Specification for High Strength, Wrought Butt Welding Fittings
MSS SP-97	2019	Integrally Reinforced Forged Branch Outlet Fittings – Socket Welding, Threaded, and Buttwelding Ends

In addition to the above standards, the following DEPs are relevant to the project, as shown in Table 3.

Table 3 List of DEPs referenced

Standard	Revision Date	DEP Name
01.00.02.13-Gen	Feb 2013	Process Engineering & Safeguarding Practices (PRENSAP)
01.00.09.10-Gen	Feb 2012	Operational Tagging Requirements
30.48.00.31-Gen	Feb 2013	Protective Coatings
30.10.60.30-Gen	Feb 2011	Welding on Pressurised Pipes
31.38.60.10-Gen		Hot Tapping on Pipelines
37.81.42.35-Gen	Feb 2014	Qualification of Girth Weld Inspection with Automated Ultrasonic Inspection (AUT) Systems
37.81.42.35-Gen Inf	Feb 2014	Qualification of Girth Weld Inspection with Automated Ultrasonic Inspection (AUT) Systems
30.48.00.31-Gen	Feb 2013	Protective Coatings for Onshore and Offshore Facilities
30.48.00.31-Inf	Feb 2013	Protective Coatings for Onshore and Offshore Facilities
30.48.00.32-Gen	Feb 2012	Coating of Fasteners
31.10.00.10-Gen	Sept 2013	Positive material identification (PMI) program
31.10.00.10-Gen Inf	Sept 2013	Positive material identification (PMI) program
31.22.10.35-Gen	Feb 2014	Manufacturing Report for Pressure Vessels
31.38.01.11-Gen	Feb 2014	Piping- General requirements- sections listed in s 2.1 only.
31.38.01.12-Gen Class 11011	Rev. I	Spec 11011 - CLASS 150 Piping Spec
31.38.01.12-Gen Class 61011	Rev. J	Spec 61011 - CLASS 600 Piping Spec
31.40.10.13-Gen	Feb 2011	Design of Pipeline Pig Trap Systems
31.40.20.33-Gen	Feb 2011	Linepipe Induction Bends
31.40.21.31-Gen	Sep 2011	Pipeline Isolating Joints
31.40.30.31-Gen	Feb 2011	External Polyethylene and Polypropylene Coatings for Line Pipe (Amendments/Supplements to ISO/DIS 21809-1:2009)
31.40.30.31-Gen Inf	Feb 2011	External Polyethylene and Polypropylene Coatings for Line Pipe (Amendments/Supplements to ISO/DIS 21809-1:2009)
31.40.30.37-Gen	Feb 2013	Field Joint Coatings
30.10.73.10-Gen	Sep 2003	Cathodic protection – Design and Engineering Practice
30.10.73.33-Gen	Sep 2011	Installation and commissioning of onshore cathodic protection systems
30.10.73.31- Gen	Sep 2011	Design of cathodic protection system for onshore buried pipeline
31.38.01.31-Gen	Feb 2014	Shop and field fabrication of piping
31.38.01.31-Gen inf	Feb 2014	Shop and field fabrication of piping
31.40.50.30-Gen	Sep 2011	Precommissioning of Pipelines
31.40.60.11-Gen	Sep 2002	Pipeline Leak Detection
32.10.03.10-Gen	Feb 2011	Instrumentation Symbols and Identification on Process Engineering Flow Schemes
32.30.20.11-Gen	Feb 2014	Fire, Gas and Smoke Detection Systems - Specification
32.30.20.13-Gen	Feb 2014	Intelligent Field Devices – Design and Configuration
32.31.00.32-Gen	Feb 2011	Instruments for Measurement and Control – Specification
32.31.00.34-Gen	Sep 2011	Instrumentation Documents and Drawings
32.31.09.31-Gen	Sep 2011	Instrumentation For Equipment Packages
32.32.00.11-Gen	Sep 2012	Custody Transfer Measurement Systems for Liquids
32.36.00.17-Gen	Feb 2013	Control Valves – Selection, Sizing and Specification
32.37.10.11-Gen	Sep 2012	Installation of On-line Instruments – Specification
32.37.20.10-Gen	Feb 2014	Instrument Signal Lines – Specification
32.71.00.10-Gen	Feb 2011	Plant Telecommunication
32.71.00.11-Gen	Feb 2013	Telecommunications Standards

Standard	Revision Date	DEP Name
32.80.10.10-Gen	Feb 2014	Instrumented Protective Functions (IPF)
33.64.10.10-Gen	Feb 2014	Electrical Engineering Design
33.64.10.17-Gen	Sep 2013	Application Of Protective Functions for Electrical Systems
33.64.10.32-Gen	Sep 2011	Electrical Network Monitoring and Control System for Industrial Networks
33.65.50.31-Gen	Sep 2013	Static Dc Uninterruptible Power Supply (DC UPS) Units
33.65.50.32-Gen	Sep 2013	Static A.C. Uninterruptible Power Supply Unit (Static A.C. UPS Unit)
33.65.60.30-Gen	Feb 2012	Solar Power Systems
61.10.08.11-Gen	Feb 2014	Field Inspection Prior to Commissioning of Mechanical Equipment
62.10.08.11-Gen	Feb 2013	Inspection and Testing of Instruments – Specification
63.10.08.11-Gen	Sep 2011	Field Commissioning of Electrical Installations and Equipment
70.10.70.11-Gen	Feb 2011	Preservation of New and Old Equipment Standing Idle
80.00.00.15-Gen	Feb 2013	Hazard and Operability (HAZOP) Study
80.36.00.30-Gen	Feb 2014	Relief Devices – Selection, Sizing and Specification
80.45.10.10-Gen	Feb 2014	Requirements for design of pressure relief, flare and vent systems
80.45.10.11-Gen	Feb 2012	Overpressure and Underpressure – Prevention and Protection
80.46.30.11-Gen	Feb 2014	Interlocking Systems for Pressure Relief Valves
80.64.10.10-Gen	Feb 2011	Electrical Safety Rules
80.64.10.11-Gen	Feb 2013	Static Electricity

2 Project Description

Melbourne's Tullamarine Airport is currently supplied with jet fuel via two pipelines to the existing Joint User Hydrant Installation (JUHI) terminal, as well as via road tankers.

The supply chain currently consists of the Altona to Somerton Pipeline (PL118) which is a 34 km DN 350 licenced pipeline (with an MOP of 5,171 kPag), supplying product from the Mobil Altona Refinery, Viva Newport Terminal and the Mobil Yarraville terminal to the JUHI Somerton Terminal, and the Somerton to Tullamarine Pipeline (PL119) which is a 10.5 km DN 150 pipeline supplying product from the JUHI Somerton Terminal to the JUHI Tullamarine Terminal. Additional fuel is trucked in as required to the JUHI Tullamarine Terminal in B-double road tankers and unloaded at the recently extended truck unloading facility. The JUHI capacity of the tank farm at Tullamarine has been recently increased with the addition of tanks T7 and T8.

In 2015, a feasibility study was conducted to increase the overall capability of the jet fuel supply. Three options were originally short-listed, named Option D, Option E and Option F. Option D described a new DN 350 lateral pipeline to the JUHI facility, with an alignment along the proposed corridor for the future Airport Rail Link. A feasibility study for Option D was developed for Viva Energy in December 2017.

Aurecon performed a route selection study (505045 Project Starburst – Route Options Study Report – Rev2.pdf) in 2019. A map of the proposed MJP, Altona to Somerton (PL118) Pipeline and the Somerton to Tullamarine (PL119) Pipeline is shown in Figure 1.

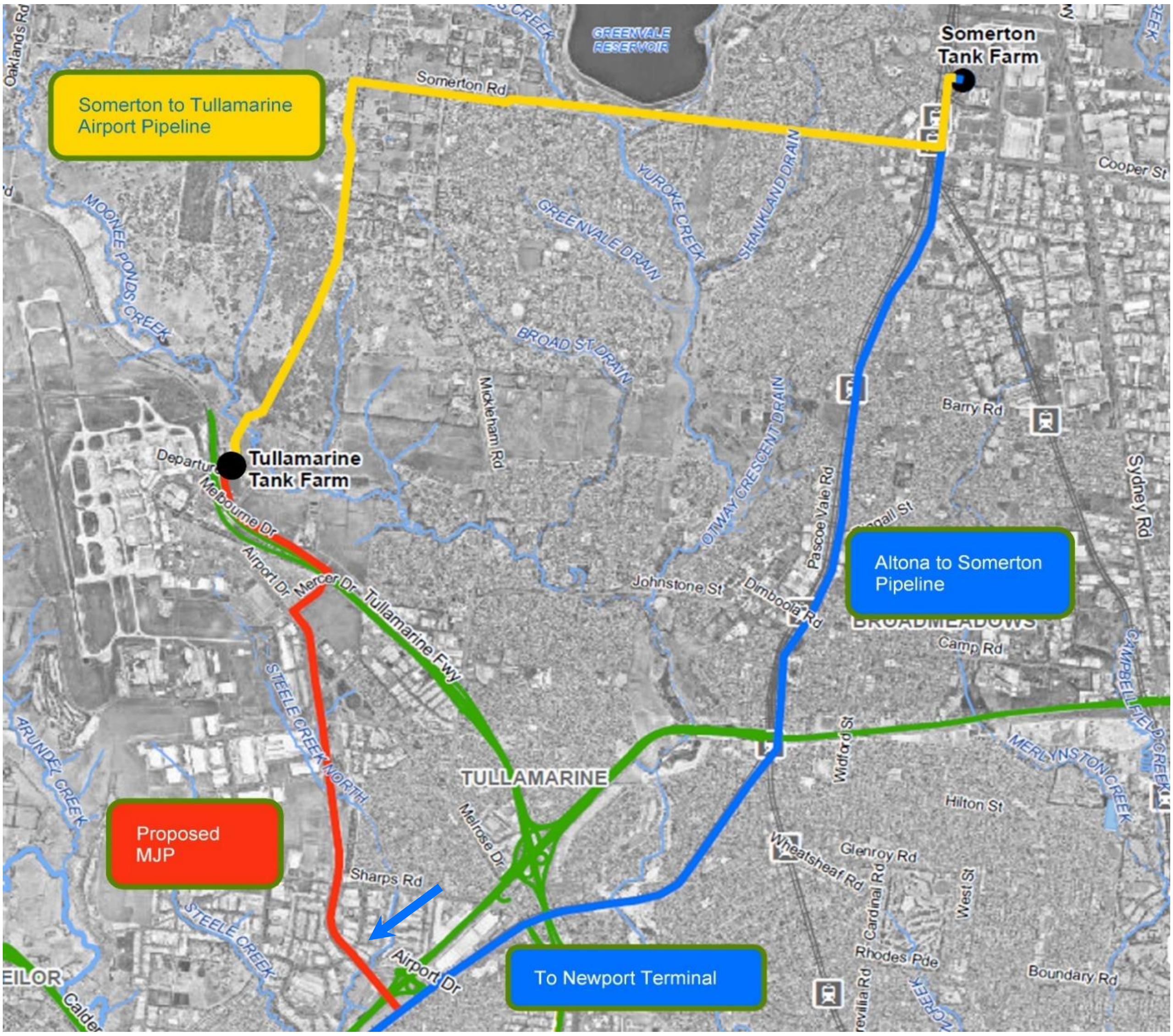

Figure 1 MJP Location Map

Table 4 Pipeline Description and Licence Numbers

Pipeline Number	Pipeline Description
PL118	Altona to Somerton Pipeline
PL119	Somerton to Tullamarine Pipeline

2.1 Pipeline Location & Features

The pipeline design parameters listed below are preliminary and are subject to changes based on required process conditions, safety management studies and future detail design work.

Further pipeline route optimisations and adjustments are to be considered as construction, environmental, cultural heritage, legislative and landowner requirements are better understood.

2.1.1 MJP Pipeline Route

The MJP pipeline route is being refined and currently the length is approximately 6.6 km.

The new lateral pipeline will tie in underground to the Altona to Somerton (PL118) Pipeline at approximately KP 21.79 on the Victrack rail reserve adjacent to Albion-Jacana ARTC tracks. Aboveground pigging facilities (positive batch isolation, pig launcher and inlet metering) shall be installed at the inlet station near the tie-in.

There will be a connection between the inlet tie-in pit, where two mainline valves are located at KP 21.79 and the inlet station. The MJP mainline starts at chainage point CH 0 at the pig launcher valve and ends at the pig receiver, with chainage numbers (CH) increasing in the direction of normal flow. From a pipeline licence description, the MJP starts at the downstream flange of EGV XV002 in the tie-in pit at KP21.79 and terminates at the pipework connection within the JUHI Tullamarine fuel farm (tie-in to tanks T7 and T8).

The pipeline will require a 20m wide construction corridor (ROW) (where feasible and as agreed with landowners under the consultation process), and a final easement of at least 6m as provided for under the Pipelines Act 2005 for operation. During consultation, an easement of preferably 6m either side of the MJP will be sought.

The project will use a combination of horizontal directional drilling (HDD), thrust boring, open cut and trenching to install the pipeline. The selected method and any transition from one method to another will consider as a minimum:

- Current and future land use
- Construction practicalities
- Minimisation of interference with existing users, infrastructure and where foreign services will clash with MJP and cannot be practically avoided.
- Minimisation of impact on sensitive environmental areas
- Cost considerations
- Appropriate final strength and properties of the installed line

Road crossings are anticipated to be thrust bored cased crossings with some HDD as required. The crossing of Steele Creek is recommended to be HDD.

Flow protection requirements will be defined by the Emergency Flow Restriction Device (EFRD) Study. A piggable check valve to reduce the consequences of any loss of containment at Steele Creek may be required to be installed as soon as possible after the HDD exit (requirement will be confirmed following EFRD Study).

An inlet station will be located 50m from the tie-in to PL118. A thrust bore casing (passing under the Melbourne Water main (at about CH -20) will connect the MLV's within the tie-in pit (XV001 and XV002) to the Inlet station. The Inlet Station fenced facility will comprise custody metering and a pig launcher.

It is proposed that the MJP receiver station will be located adjacent to the JUHI facility on APAM land (the lease of this land to VE is still to be formalised). From the receiver station, it is proposed the piping will run underground into the JUHI facility up to the tank 7 and 8 bund wall. After the bund wall, it will run aboveground along the bund wall up to the tie-in point to tanks 7 and 8. It will also be possible from MJP to supply direct into existing JUHI tanks 1, 2, 3, 4, 5 and 6 but under greatly reduced flow rates unless existing pipework and tank nozzles are upgraded. The receiver station facilities will include custody transfer metering, pressure and flow control, a pig receiver and filter water separators. Other MJP associated facilities are described later in this document.

2.1.2 Melbourne Airport Rail (SRL Airport)

The Victorian government have announced the new airport rail link will be known as SRL Airport. A dedicated dual track airport rail link will commence at Sunshine station and run along the Albion-Jacana corridor. The airport rail link will cross over the M80 highway and proceed to the Melbourne Tullamarine airport on a viaduct structure adjacent to Airport Drive.

The MJP will run parallel to the SRL Airport rail link from near Tullamarine Park Drive until Mercer Drive.

2.2 Pipeline Flow Regime

This design basis will refer to 3 flowrates as defined below:

- MJP maximum flow unconstrained by pump capacity: ~800m^3/h
- MJP maximum future target flow rate: 650m^3/h
- MJP current operating flow rate: 400m^3/h

The basis of the flow rates is further explained in 3.4.1 MJP Flow Rate Basis.

To minimise future re-work and pipeline outages the following design flow rates have been selected:

- Pipeline and pipework will be designed using the MJP maximum unconstrained by pump capacity (~800m^3/h)
- Flow meters will be designed to the MJP maximum unconstrained by pump capacity (~800m^3/h)
- Filter Water Separators will be each designed to the MJP current operating flow rate (400m^3/h)
  - 2 are proposed (duty/ standby) for initial operation and will require the addition of a third filter (duty/duty/standby) if flow rates are increased in the future.

As a batch transfer pipeline, the minimum flowrate that routinely occurs is zero and thus this must be considered in the pipeline design as per AS2885.1-2018 Clause 4.3.2.1.

2.3 Facilities

2.3.1 MJP Inlet Station Facility on the Altona to Somerton (PL118) Pipeline & the MJP Launcher

The MJP Inlet Station will include six hot-taps (Two DN350 hot taps with split Tee for the temporary by-pass, two DN100 hot taps with split Tee for installing vapour barrier air bags and two DN50 weldolet type hot tap fittings for drain / vent/ pressure equalising) on the pipeline at KP 21.79, between which a barred tee, MIJs as required and XV001 and XV002 will be installed. XV001 and XV002 are expanding gate valves to allow for in-line maintenance including seal replacements. The hot taps will be accessible via a single concrete pit.

The pig launcher station with metering facilities and associated valves will be located above ground in a fenced compound. It is proposed that this compound is to be accessed via an access track from the Westfield Drive roundabout, approximately half a kilometre to the northeast.

The pig launcher does not require over pressure protection as it is considered as a collection of piping assemblies as per AS2885 and will normally be isolated from the pipeline and depressurised.

2.3.2 JUHI & MJP Facilities (& Pig Receiver)

The downstream battery limit is the tie-in to the storage tanks at JUHI. The MJP will run underground up to the MJP receiver station, which is proposed to be located adjacent to the JUHI compound. An above ground motor actuated isolation valve, XV003, will be provided at the MJP outlet. XV003 will be fail closed. A flow control valve, FCV001, will be provided at JUHI, within the receiver yard. This is in addition to downstream flow control devices within the JUHI system but will be integrated with the JUHI SCADA system (which will require upgrading to cater for MJP movements).

Two new combined filter water separators (duty/standby initially) each designed for a flow of 400 m^3/h will be installed. This is based on one filter covering 100% of the expected operating flow of 400 m^3/h. Operation at increased flow rates following any pump upgrades will require an additional filter for a duty/duty/standby arrangement. Blanked flanges will be provided on the filter water separator skid to allow a third future filter water separator to be installed. The filter water separators area is bunded by concrete slab on ground and bund wall to eliminate any spills. For stormwater and oily water drainage, refer to Section 11.4.5.

The end of the pig receiver (PR) barrel skid at the JUHI end of the pipeline will be bunded. The bund shall be designed to slope towards a sump at one end. The bund will be connected to the existing APAM storm water system which passes though the receiver station land. For stormwater and oily water drainage, refer to Section 11.4.5.

The MJP will primarily supply fuel to Tanks 7 and 8, through appropriately sized pipework. Supply to Tanks 5 and 6 is possible at lower flow rates which can be set by operation of FCV001, located downstream of the MJP pig receiver. Supply to Tanks 1-4 is not considered as a feasible operation due to their small size (less than 0.7 ML).

The MJP receiver station design is subject to agreement with the adjacent JUHI facility operator ExxonMobil.

Currently Jet fuel transfers from the JUHI Somerton Terminal are protected by a relief valve sized for full flow of the DN150 Somerton to JUHI Tullamarine Terminal pipeline (PL119) Pipeline (Reference P&ID 0605-IP01-2). PSV2216 is set at 4500 kPag and relieves to 4500L blowdown tank TK34. Excess pressure in the T1-T6 fuel farm receipt piping is further protected for tanks 1-6 with a 550 kPag PSV directed to T5.

Over pressure protection of the JUHI piping from the MJP is provided by PRV010. The PSV is set at 1774 kPag and relieves to a 4500L blowdown tank, TK-001. The sizing of this PSV is documented in the PSV sizing Calculation: 521511-100000-CAL-CR-0001.

Each filter water separator will be protected by a fire case PSV which relieves into the new blowdown tank. The size of each relief valve has been calculated and documented in the PSV sizing Calculation: 521511-100000-CAL-CR-0001.

2.3.3 MJP Main Line Isolation

An isolation plan for the pipeline and associated facilities, 521511-100000-REP-CN-0011, has been prepared. Viva Energy have requested that in order to address environmental concerns, consideration of isolation is provided at Steele Creek. During the consultation process it is intended to gain acceptance of the authority responsible for Steele Creek as to the required level of protection. However, it is possible to install a piggable check valve as close as possible to the downstream end of the HDD, to prevent reverse backflow release of the pipeline’s inventory in the event of a loss of containment downstream of the creek (this was discussed at the PSMS and will be confirmed following EFRD Study).

2.4 Exclusions

Currently the flow through the Altona to Somerton Pipeline (PL118) (and hence through the MJP) cannot exceed 400 m^3/h due to constraints on the existing transfer pumps. The scope of all upgrades required to increase the flow above 400 m^3/h is outside the scope of this project. Viva Energy have indicated that these works are intended to be completed at a future date.

3 Design Parameters

3.1 Environmental Parameters

Table 5 Environmental Parameters

Design Parameter	Basis / Justification	Value
Design maximum ambient temperature	Bureau of Meteorology Decile 9 maximum temperature[1]	36°C
Design minimum ambient temperature	Bureau of Meteorology Decile 1 minimum temperature [1]	2.1°C
Design ground temperature range	Bureau of Meteorology Climate Data – Mean soil temperature at 100 cm is 12 to 23°C. Apply a slight margin to lower temperature (as this will be conservative).[2]	10°C to 23°C
Soil Conductivity	Assumed values for typical range of soil types.	0.5 – 2.2 W/(m.K)
Overall Heat Transfer Coefficient	Assumed value for typical pipeline	10 W/(m^2.K)
Annual Rainfall (mean)	Bureau of Meteorology mean annual rainfall [1].	535 mm
Flooding basis	Flooding interval >100 years.	The Land Subject to Inundation Overlay (LSIO) in the relevant planning scheme (Brimbank) identifies land subject to flooding or inundation in a 1 in 100 year flood event. The LSIO does not apply to any land in the vicinity of the MJP Inlet station. This also applies to Steele Creek in the vicinity of Airport Drive, which indicates that the stream does not overtop in events up to 1% AEP.
Design rainfall event	10% AEP & T_c = 5min + 12% Climate Change Effect (http://www.bom.gov.au/water/designRainfalls/revised-ifd/)	121 mm/hr
Geotechnical Data	To be determined	

3.2 Seismic Design Parameters

Pipeline and piping design will consider the risk and consequence of seismic activity on the pipeline and aboveground station piping. Design shall be in accordance with AS 1170.4, with a Hazard Factor of Z=0.09, based on the location of the project.

3.3 Geotechnical Design Parameters

Refer to 'Project Starburst Pipeline Geotechnical Investigation Report' dated 16 April 2019 for details on geotechnical investigations that have been completed during FEED. In addition, Geotechnical investigation is

1 Australian Government Bureau of Meteorology (BOM). (2018). Monthly climate statistics, All years of record. Retrieved from http://www.bom.gov.au/climate/averages/tables/cw_086282_All.shtml

2 Australian Government Bureau of Meteorology (BOM). (2018). Mean Monthly (includes annual) Soil Temperatures (based on all observations, grouped together), from 2010 to Sep 2018.

being carried out at the JUHI receiver station to confirm the soil properties for the design of foundations, access road and bench pavement. Further geotechnical investigations (including survey and soil testing) may be required along the pipeline route, and at the pipeline end facilities to enable the design of drilled crossings and the pipeline facilities. Soil properties used in the design of inlet and outlet foundations will be based on the results of the geotechnical investigation.

The pipeline route selection of the HDD sections relies on a geotechnical and hydrogeological report commissioned by RPV (MAR-AJM-PWD-PWD-REP-CGT-NAP-0000739). An HDD contractor will be required to carry out a gap analysis to determine if further investigations are necessary during detail design phase.

Soil testing for resistivity and contamination values along the route for the MJP have been performed separately.

3.4 MJP Process Design Criteria

Table 6 Process Design Criteria

Design Parameter	Basis / Justification	Value
MJP maximum future target flow rate	Future flow rate target (outside of current scope), refer to Section 4.1.1.	650 m^3/h
MJP current operating flow rate	Flow through the MJP is presently limited due to maximum pump capacity at Viva Newport.	400 m^3/h
Altona to Somerton (PL118) Pipeline MOP	Obtained from the PL 118 pipeline licence	5171 kPag
MJP design pressure	The selected design pressure allows some capacity for allowances, while still remaining below the ANSI Cl 600 flange rating.	6000 kPag
MJP minimum delivery pressure	As advised by Viva Energy, the minimum delivery pressure at the JUHI tie in is 1000 kPag which included 500-600 kPag allowance for new tank heads.	1000 kPag
MJP Operating Temperature Range (buried sections)	Margin based on ambient and soil temperatures	10°C to 30°C
MJP design maximum temperature	Design maximum temperature of 65°C set to avoid de-rating of materials as per AS 2885.1. Belowground sections will not exceed 65°C (due to distance from Newport). Aboveground sections will be designed to not exceed 65°C (i.e. through the use of shading/coating to prevent excessive heating through solar radiation).	65°C
MJP design minimum temperature	Design minimum temperature for belowground sections is set based on minimum soil temperature.	1°C
Aboveground facilities design minimum temperatures	Margin from minimum ambient temperature, refer Table 5.	1°C

3.4.1 MJP Flow Rate Basis

- MJP maximum unconstrained by pump capacity: ~800 m^3/h
  - This is the maximum possible flow rate through the pipeline if the pumping capacity was able to equal the pipeline design pressure. The hydraulic calculation, 521511-300000-CAL-CR-0001, indicates a maximum possible, unconstrained flowrate of approximately 950 m3/hr.
- MJP maximum future target flow rate: ~650 m^3/h
  - The number of passengers at Melbourne Airport is expected to increase from the current 31 million passengers a year to more than 64 million annual passengers by 2033, resulting in a projected increase of jet fuel demand by more than 100%. In 2015, Shell Aviation Australia identified a target flow rate of 650 m3/h to meet the 2033 demand. (The required upgrade to pumping at Newport to achieve the future target flowrate is not within the scope of this project. Data supplied to Viva from the

pump vendor indicates that flowrate of 565 m3/hr can be achieved by replacing the existing pump impellers with larger ones within the same pump casing.)

- MJP current operating flow rate: 400 m^3/h
  - Flow through the MJP is presently limited due to the maximum pump capacity at Viva Newport Terminal. Pump P-65118 (also known as G-7007), can produce 400 m3/h of flow at 2180 kPag. Operation at levels above this will require pump upgrades (as above).

Note that control of pressure surges may require the pipeline to be operated at a slightly lower flowrate than its hydraulic capacity. Refer to the control and operations philosophy, 521511-100000-REP-CN-0013, and the surge analysis calculation, 521511-300000-CAL-CR-0008, for further details.

3.4.2 Pipe Roughness

For the purposes of hydraulic modelling a roughness of 30 microns, in accordance with industry practice, will be adopted for both the unlined MJP and the Somerton to Altona Pipelines. The roughness selected is a typical value for unlined long transmission pipelines.

3.5 Design Life

The design life for the pipeline and associated facilities is 40 years.

3.6 Pipeline Elevations

Key elevations along the Pipeline route are listed below[3].

- Altona (start of the Somerton to Altona Pipeline): 4.9 m
- Newport: 16.0 m
- MJP tie-in at KP 21.79 of the Somerton to Altona Pipeline: 73.9 m
- MJP high point: 114.3 m
- MJP tie-in at JUHI: 100.4 m

3.7 Fluid Composition

The Jet A-1 fluid composition is detailed in the table below[4].

Table 7 Jet A-1 fluid composition

Property	Unit	Value
Density	kg/m^3 at 15°C	810.5
Viscosity - Dynamic	cP at 15°C	2.35
Flash Point	°C	38
Initial Boiling Point	°C	148.7
Freeze Point	°C	-85.9
Combustion		
Net Specific Energy	MJ/kg	43.10
Smoke Point	mm	23
Composition		
Total Acid Number	mgKOH/g	0.001
Aromatics	vol%	19.2
Sulphur	mg/kg	25
Active Sulphur Species (Doctor Test)	-	Nil
Impurities / Corrosion		

[3] Elevations based on DELWP 10 m DTM, Vicmap Elevation 2018, provided by the Department of Environment, Land, Water & Planning, https://www.data.vic.gov.au/data/dataset/vicmap-elevation-dtm-10m
[4] Fluid composition is based on the 'Geelong Refinery Certificate of Quality' provided by Viva Energy on the 19th Sep 2018.

Property	Unit	Value
Copper corrosion (2 hrs at 100°C)	-	ASTM D130 1a (slight tarnish, light orange, almost the same as freshly polished strip)
Existent Gum	mg/100 mL	<1
Water separation (MSEP), as per ASTM D3948	-	98
Shell Water Detector (GR 167)	-	Negative
Particulate matter, as per ASTM D5452	mg/L	0.2
Conductivity	pS/m	300 (average) .

3.7.1 Input to Hazardous Area Classification

For the purpose of hazardous area classification, launcher/receiver station drawings and specification of electrical and instrumentation equipment, Jet A1 is classified as follows.

A report will be developed during detailed design to capture further information hazardous area classification

Table 6 Jet A-1 Flammability data

Property	Unit	Value
Flash Point	ºC	38
Lower Flammability Limit	% Vol	0.7
Upper Flammability Limit	% Vol	5.0
Auto Ignition Temperature	ºC	210
Vapour Density		>1 (Air = 1)
Temperature Class		T3 (200ºC)
Gas Group		IIA
Classification		Flammable Liquid

3.8 Pipeline Inventory

The inventory of the proposed MJP is 600 m^3.

4 Methodology of Design

4.1 Stress Corrosion Cracking

Stress corrosion cracking is a form of corrosion that produces a loss of pipeline strength and may lead to failure. The rate of stress corrosion cracking is influenced by factors including the pipeline fluid temperature, soil conditions (including soil pH), and localised pipeline stress (due to pressure, temperature, or external loads).

Stress Corrosion Cracking of the MJP will be considered upon completion of the geotechnical investigation, which will inform soil corrosivity and soil strain factors. The variable of high temperature is not considered to be applicable because the product is sourced from ambient storage and conveyed through temperate underground conditions.

The pipe stress condition is expected to be mild due to the low design factor, moderate temperatures, and absence of other causes of elevated stress.

4.2 Low Temperature Excursions

AS 2885.1 Clause 4.5 requires that this be addressed, however as a liquid pipeline conveying fuel from tankage at ambient conditions, there are no identified scenarios for low temperature excursions outside the design temperatures stated.

4.3 Pipeline Fracture Control

The pipeline fluid is considered to be a stable liquid, with a minimum design pipe temperature above 0°C. For these conditions, as per AS 2885.1, Figure 5.3.2 and associated clauses, ductile tearing fracture is considered to be controlled. Line pipe and pipeline components will be procured with impact testing (Charpy toughness) results meeting or exceeding 40 J at 0°C. Due to requirement for each pipe to be an arresting pipe (location class T1), minimum Charpy toughness shall apply to each “Test Unit”, as well as the “all Test Unit” average. Please refer to fracture control plan, 521511-300000-REP-CN-0017, for further details.

4.4 Pipeline Fatigue

The fatigue basis for the MJP is dependent on the operating philosophy of the pipeline. As detailed in the Control and Operating Philosophy (521511-100000-REP-CN-0013), between transfers, the pipeline settles out to a pressure profile largely determined by hydrostatic head only. This is expected to result in a pressure on the order of 800 kPag at the pipeline inlet. As explained in the revised Control Philosophy, the currently understood operating method involves pressurising the pipeline to the dead-head pressure of the pump(s) before allowing flow to establish. The current pumps have an adequate pressure capability, however future pumps seeking to exploit the full design flow potential of the pipeline are likely to produce pressures very close to the Altona to Somerton (PL118) pipeline MOP of 5170 kPag, not only during start-up, but during maximum flow.

A conservative estimate of the range of the pipeline pressure cycles is thus 4400 kPa (800 kPag to 5200 kPag). Viva have confirmed there will be two to three cycles per day. Based on the design life of 40 years, approximately 40,000 pressure cycles will be required of the pipeline. Given the current nominated wall thickness of 11.8 mm (determined by internal and external pressure requirements and penetration), the AS 2885.1 fatigue life of the pipeline is calculated as more than 100,000 cycles. When considering the design pressure of 6000kPa, the fatigue calculations as per AS2885 guidelines indicate fatigue life of 39,652 pressure cycles (2.7 pressure cycles per day).

4.5 Safety in Design Process

The design will comply with all relevant statutory regulations and codes, corporate safety policies and codes, and industry codes of practice. The criteria for determining safe design will address construction, operation, and maintenance.

Safety Management Studies for the pipeline as per AS 2885.6 will be conducted during the design phases as per section 4.6.

Other safety-related studies that will be undertaken include:

- Hazard and Operability (HAZOP) study of the pipeline and facilities (one was completed during FEED and an additional HAZOP will be conducted upon completion of detailed design)
- Construction activities Hazard Identification Study (HAZID)
- Control Hazard and Operability Study (CHAZOP)
- Safety in Design (SiD) 521511-400000-TEM-OR-0002

4.6 Pipeline Safety Management Study

Two separate Safety Management Study (SMS) workshops are required.

1. Preliminary Safety Management Study (PSMS) at completion of FEED has been conducted to identify threats and mitigation measures. PSMS report will be submitted with the license application.
2. Detailed Design stage (SMS) at completion of detailed design

The following parameters and controls will be considered for the studies (as per AS 2885.6):

- Pipeline design parameters
- Location Class assessments, including definition of high consequence areas
- Typical threats in typical locations
- Location specific threats, particularly in high consequence areas and areas of high environmental sensitivity
- Radiation contours for 4.7 and 12.6 kW/m^2 in the event of penetration including both pool fire and jet fire.
- Energy release rate restrictions for location classes
- Non location specific threats
- Construction methodology and execution plan
- Construction equipment used
- Threats from future construction such as road widening, the new shared user path (SUP) and the Airport Rail Link (ARL)

4.7 Two Phase Flow in Pipeline

The vapour pressure of the fluid is very low (0.5 - 2 kPa), and the pressure in the pipeline would need to drop to below this value before break-out (or cavitation) may occur.

This is not considered a plausible scenario, even at high points of the pipeline.

4.8 Surge Analysis

A surge analysis of the pipeline has been completed, refer to 521511-300000-CAL-CR-0008 for results. The analysis indicates that the maximum possible flowrate in the pipeline is 770 m3/hr before overpressure of the pipeline (PL118) will occur.

4.9 Pipeline Stress Analysis

Pipeline stress shall be analysed in accordance with the limits set in AS 2885.1. Above ground piping will be stress analysed as per the applicable codes (AS2885.1 and ASME B 31.3).

4.10 Pipe Wall Thickness

The pipe wall thickness has been confirmed as 11.8mm in accordance with the requirements of AS 2885.1. The following list provides the criteria of relevance for this project:

- Pressure containment (primary)
- External interference protection (secondary)
- Thinning at the extrados of induction bends (to be generally protected using lean mix beam surrounds)
- Fatigue calculated based on design life (40 years) and expected number of pressure cycles per day, throughout the life of the pipeline
- Provisions for High Consequence Areas (HCAs) as defined in AS 2885.1 Section 4.7. The pipeline has been identified as in HCA for its entire alignment and the pipeline will be designed such that “RUPTURE” is not a credible scenario (except for the determination of ML) with hoop stress calculated to be less than 30% of the SMYS.
- Functional and environmental loads
- Buoyancy
- Stresses due to HDD activity
- Cognisance of procedural controls and ROW access controls

4.11 No Rupture, High Consequence Areas and Measurement Length

As per AS 2885.1 Section 4.7.2, a ‘no rupture design’ is required for T1 (HCA) location class and is applicable for this project. To meet this requirement, the hoop stress of the linepipe at design pressure is less than 30% of the SMYS (applicable as per AS 2885.1 Clause 4.7.2(a)).

AS 2885.1 states that the maximum allowable energy discharge rate shall be determined by the SMS.

Notwithstanding that the T1 location class is “high consequence”, there is no mandatory limit on energy release rate in GJ/s, due to the nature of the fluid being non-gas, non-high vapour-pressure, and with a flash point higher than 20°C.

4.12 Depth of Pipeline Cover

The pipeline will be buried for its entire length between the pig launcher and pig receiver. The depths of cover for the MJP are as follows:

- AS 2885.1, Table 5.4.2 requires a minimum of 900 mm typical depth of cover for T1 areas.
- It should be noted that PL118 minimum depth of cover throughout its route is 1200 mm and to be consistent with JUHI Somerton pipeline practice, within built up areas, 1200 mm cover for MJP is recommended and is shown on alignment plans. As per AS 2885.1, Table 5.4.2, the depth of cover may be reduced in rock if practical to a minimum of 600 mm.
- The depth of cover under freeways is a minimum of 2000 mm but actual depth will be determined during detail engineering and subject to approvals from Main Roads Department.
- The depth of cover for bored cased thrust crossings is a minimum of 1200 mm but the actual depth will be determined during detail engineering and subject to approvals from Main Roads Department, VicRoads, as well as other utilities operators and Melbourne Airport, where applicable.

The depths of cover listed in the above are minimum values and the cover at any location will be influenced by the location class, crossing method (open cut or direction drilling), likelihood of external loads, risk of third-party damage, and risk of erosion or scouring.

In particular, the cover at the Steele Creek crossing and the directionally drilled locations may be greater than the minimum depth.

4.13 Road Crossings

At all road crossings, the pipe installation is designed to resist the external loads imposed by traffic.

Pipe stresses from traffic loads at major highways crossings is calculated using the design methods of API RP 1102 and AS 2885.

Please refer to alignment sheets for the locations of major road crossings through HDD and thrust bores. There are no road crossings planned for the MJP through open trenches.

The geotechnical investigations undertaken along the pipeline route will be referred to identify rock areas and minimise construction risk. Further geotechnical investigations may be required.

5 Route and Geography

5.1 Pipeline Location Classification

The measurement length (ML) for the pipeline as calculated for a full-bore rupture event (refer calculation Radiation Contour Modelling Report 521511-100000-REP-PP-0001) for a 4.7 kW/m^2 radiation intensity is 150m (radius distance either side of the pipeline). The ML is applicable regardless of whether rupture is a credible event.

5.2 Primary Location Classification

Primary location class has been identified as residential (T1) for the entire MJP route.

5.3 Secondary Location Classification

- Location Class 'S' (Sensitive Use): An early learning centre has been identified within the calculated ML of the MJP.
- Location Class 'E' (Environmental): Steele Creek, a retention basin flowing into Steele Creek and the Skeleton Creek North Branch are within the calculated ML of the MJP.
- Location Class 'I' (Industrial): Industrial areas are within the calculated ML of the MJP.
- Location Class 'HI' (Heavy Industrial): The Tullamarine JUHI terminal is within the calculated ML for the MJP.
- Location Class 'CIC' (Common Infrastructure Corridor): A freight railway is within the calculated ML for the MJP.
- Location Class 'C' (Crowd): The Tullamarine Freeway and URBNSURF Melbourne are within the calculated ML for the MJP.

5.4 High consequence area assessment

The entire pipeline route is nominated as a high consequence area (HCA) based on location class of T1. The pipeline shall be designed such that rupture is not a credible failure mode.

6 Pipeline Description

6.1 Linepipe Material

Table 8 Linepipe Details

Parameter	Units	Value
Manufacturing Code	-	API 5L
Product Specification Level	-	PSL 2
Grade	-	X56 (Note 2)
Nominal Diameter	mm	DN 350
Length of line pipe required	m	7300
Maximum Design Factor for Pressure Thickness (Note 1)	-	0.72
Maximum Design Factor for Road Crossings (Note 1)	-	0.72
Wall Thickness	mm	11.8 (Note 3)
Lengths	m (nominal)	18 – random length
End Preparation	-	Bevelled
Testing	-	API 5L
Coating System	-	3-layer PE

Note 1: In line with recommendations of AS2885.1. The recommended value as per AS2885.1 is 0.8 (refer AS2885.1 Clause 5.4.3) and for road crossings, 0.72 (refer AS 2885 Clause 5.7.3 (c) (i) (A)). As a conservative approach 0.72 is used in the design. The design factor for end of the line assemblies (Pig launcher receiver stations) is used as 0.67 (Ref AS 2885.1 Table 5.4.3).

Note 2: The feasibility study identified X42 (12.8 mm) as an alternate potential grade of the linepipe. X56 was selected to reduce steel tonnage and as it is more resistant to penetration.

Note 3: Rupture is not a credible failure mode for the MJP pipeline since the calculated hoop stress is less than 30% of the SMYS (Refer AS2885.1 Clause 4.7.2).

6.2 Corrosion Protection

The design corrosion allowance, both internally and externally, is 0 mm.

There is no internal corrosion coating required for the pipeline as the supplied Jet A1 fuel is water-free.

However, it is recommended the internal barrels of the pig launcher and receiver are lined with an approved aviation fuel epoxy coating. The filter water separators will be constructed from stainless steel to improve the sampling quality from low point drains.

It is recommended that a 3-layer polyethylene (3LPE) coating system will be used to externally coat the linepipe, with an abrasive resistant overwrap (ARO) system used for HDD sections. The coating study completed during FEED was reviewed and the recommended 3LPE coating system is accepted in line with FEED recommendation.

Damage to the coating during construction will be controlled using a number of different methods, including:

- A performance qualification for the application of joint and pipeline component coatings.
- The coating must be installed as per the product specifications.
- Prior to installation in the pipe trench, HDD or thrust bore the total surface of the coated pipe must pass a DC Holiday test
- Strict construction supervision is to be employed to ensure that bedding and padding does not damage the coating.

6.3 Pipe External Coating

Refer to 521511-100000-SPE-MA-0001 for detailed information on recommended coating systems for pipeline and pipeline assemblies.

6.3.1 Main Pipeline

The main pipeline coating will be externally coated with 3-layer polyethylene (3LPE) in accordance with specification DEP 31.40.30.31 and ISO 21809-1. The coating systems are summarised in clause 6.2 - Corrosion protection and specification is provided in 521511-100000-SPE-MA-0001.

6.3.2 HDD

The 3LPE factory applied linepipe coating system shall be applicable to HDD sections of the pipeline. The geotechnical investigations reveal the HDD sections comprise hard basalt formation and it will be necessary to protect the 3LPE with an abrasive resistant overlay ARO such as Scar-guard fibreglass wrap or Denso Bore Wrap.

A recommendation will be issued for Viva review after seeking technical compliance statements from competitive coating suppliers and subsequent assessment.

6.3.3 Pipe Joint

Pipe field joint coatings (FJC) will be a Denso Viscowrap visco-elastic system (or approved equivalent), refer to the coating specification 521511-100000-SPE-MA-0001.

6.3.4 Induction Bends

Induction bend coatings will be Denso Viscowrap visco-elastic system (or approved equivalent. Refer to coating specification 521511-100000-SPE-MA-0001 for more details.

6.3.5 Pipeline Assemblies

6.3.5.1 Valve pit

Valve pit at the tie-in of MJP to existing Newport-Somerton pipeline (PL#118) contains the shut down valves XV-001, XV-002 and the MIJs and associated piping and valves. The valve pit is a watertight chamber and access is provided for access to the valves. Refer to coating specification 521511-100000-SPE-MA-0001 for details.

6.3.5.2 Pig Launcher Station

Pig launcher station at the inlet end of the MJP consists of pig launcher, meters, associated pipes, fittings and valves. The piping and equipment is considered as above ground systems, Refer to coating specification 521511-100000-SPE-MA-0001 for details..

6.3.5.3 Pig Receiver Station

Pig receiver station at the JUHI end of the MJP consists of pig receiver, meters, filter water separators, basket strainer associated pipes, fittings and valves. The carbon steel piping and equipment is considered as above ground systems. Refer to coating specification 521511-100000-SPE-MA-0001 for details. Filter water separator and downstream piping is stainless steel and no coating is required for the aboveground stainless steel piping. Please see sec 6.3.6 for the coating details of the stainless steel piping underground.

6.3.5.4 Underground Stainless-Steel Piping Downstream of FWS

The stainless-steel Gr 316/316L piping from the outlet of the filter water separators (FWS) tie into tanks 7 & 8. The piping runs underground before entering the tank farm. The underground stainless-steel piping will be coated. Refer to coating specification 521511-100000-SPE-MA-0001 for further details.

6.4 Pipe Internal Lining

The linepipe will not be internally lined, but some components such as pig launcher and receiver will be internally coated. Refer to coating specification 521511-100000-SPE-MA-0001 for further details.

6.5 Bends

Changes in direction will be achieved primarily by induction bends. Cold field bends are not allowed. Roped bends may be used if required. Bend radius for roped bends shall be minimum 250D as per AS/NZS 2885.1 Clause 10.7.5.

The minimum induction bend radius will be 5D, and 5D bends shall be used preferentially. Wall thinning of 10% is assumed in calculations of minimum wall thickness requirements.

Cold field bends will be limited to 1.7% coating strain (2° per diameter), which is conservative in terms of avoiding cracking of the coating. This amount is significantly less than the 5% mentioned by AS 2885 but is necessary to comply with the governing DEP/ISO standards.

The wall thickness requirements of AS 2885.1 shall prevail.

Buckle, ovality and strain requirements shall be as per AS 2885.1.

If it is elected during field works to undertake cold bends such bends shall be proven with internal gauges before lowering into trenches and joining with other pipeline lengths

6.6 Pipe Jointing

Welding procedures will be called for in the construction specification to be in accordance with the requirements of AS 2885.2 and B31.3 as applicable. Different procedures will be required for the various materials at the tie-in at KP21.79, for MJP pipeline, MJP assemblies and station piping and finally pipework within the JUHI fuel farm.

Transition pieces are required between PL118 line pipe and MJP due to difference in thicknesses (MJP is 11.8mm and existing pipeline is 7.94mm).

Locations nominated with ‘Golden welds’ will be further defined during detailed design in accordance with AS 2885.2.

6.7 Pipeline Restraint

Pipeline restraint may be required to prevent pipeline movement near ground transitions from over-stressing the aboveground piping systems. The preferred method of restraint is underground bends fixed with stabilised sand combined with flexible aboveground piping geometries.

In the event restraint cannot be achieved by using underground bends or where constraints on pipe alignment prevent this type of restraint, anchor blocks may be required.

Pipeline stress/flexibility analysis shall justify the required pipeline restraints. Refer to stress analysis report 521511-100000-REP-CN-0016 for further details.

6.8 Cathodic Protection (CP)

An impressed current Cathodic Protection system (ICCP) with 25 years of design life has been 90% detailed designed for the MJP pipeline from CH-50 (just after the Tie-In work area) to CH 6585 (entrance to the tank farm) as per the AS 2832.1-2015, DEP 30.10.73.31 and ISO 15589.1-2015.

A short underground section of the pipe will be stainless steel GR 316/316L (approximately 70m long, from the FWS outlet within the receiver station to the bund wall of JUHI Tank 7 and 8). This section is electrically isolated with a MIJ from the MJP and is excluded from the ICCP system design. However, an individual SACP system has been designed and specified for this buried stainless steel section. This section of the stainless steel pipe will be protected with a specified coating system as per Section 6.3.5.4 in addition to the CP system.

The CP system design current density and percentage of coating damage are as per ISO 15589 for FBE coating (current density for FBE coating is more conservative).

A temporary Sacrificial anode CP system for 1-year design life has been designed for the pipeline from CH 0.0 to CH.6585 as per AS 2832.1 and AS2239

The MJP pipeline from CH 0.0 to CH 6585 will be fully welded for electrical continuity along the pipeline.

The proposed locations for the ICCP anode beds are a minimum of 100m away from foreign buried metallic structures to mitigate the risk of interference with the other buried metallic structures.

Test points are proposed at crossing point with foreign pipes to allow potential testing of the MJP pipeline and foreign structures. Future MJP CP system stray current mitigation measures for foreign assets such as drainage bonds may be required in future, which are to be determined as part of the interference testing during the commissioning of the MJP CP System.

The MJP pipeline will run parallel to the proposed DC-electrified Melbourne Airport Rail and may be affected by DC stray current in future. Future stray current mitigation measures such as drainage bonds may be required in future, which are to be determined as part of an area test by the Victorian Electrolysis Committee after the MAR DC rail is operating. It is understood the viaduct SRL Airport rail shall be provided with high rail-to-earth electrical isolation to minimize stray current issues to other assets at a minimum.

Overhead and underground high-voltage power lines run parallel to the pipeline; therefore, LFI and EPR studies are required. Earth Potential Rise (EPR)/Low-Frequency Induction (LFI) study will be conducted to assess the electrical risk to the pipeline.

The EPR/LFI study is currently in progress and waiting for inputs from the power line owners (e.g. location of HV substations, HV tower earthing arrangement, earth fault current and clearance times etc.). Depending on the outcomes of the study, EPR/LFI mitigation measures such as the installation of asphalt pad or safety earth ring may be required at some cathodic protection test points or pipe above ground affixtures (e.g. valves) depending on the EPR/LFI risks.

6.9 Pipeline Marking

The pipeline location will be identified to third parties throughout its entire length, using a combination of marking techniques, appropriate to the third-party risk to the pipeline. In general, the following principles will apply (as per AS 2885.1):

- Warning marker signs will be placed at each change of direction, at fence lines, at foreign service crossings, and both sides of road, rail, and creek crossings.
- Warning marker signs will be placed at maximum intervals specified by AS 2885.1 (at a minimum of 50m as required by AS2885.1 table 4.10.1).
- Warning marker signs will be placed at 50 m intervals in road easements.
- Marker tape located at a minimum of 300 mm above the buried pipeline as required

In addition, the pipeline location will be made available to the appropriate authorities for marking on public mapping, to land holders, and emergency services. The information will also be provided to a one call “Dial Before You Dig” buried services information bureau.

Northings, eastings, and depth to MGA 94 will be taken at defined intervals with a DGPS.

Any exposed pipework within the inlet and receipt stations will be colour coded and labelled according to JUHI Tullamarine standards.

7 Installation and Operation

7.1 Pipeline Hot-Tap

The MJP Inlet Station will include six hot-taps (Two DN350 hot taps with split Tee for a temporary bypass, two D100 hot taps with split Tee for installing vapour barrier air bags and two weldolet type hot tap fittings for drain / vent/ pressure equalising) on the pipeline for the Pipeline 118 at KP 21.795, between which a barred tee, MIJs as required, to electrically isolate the motorised valves XV001 and XV002, will be installed. for operator safety. and XV001 will be installed. Two hot taps will be required on the Altona to Somerton Pipeline (PL118) at KP 21.795 in order to provide a tie-in for MJP. The hot tap will be according to specification 521511-200000-SPE-CN-001.

Pigging of the Altona to Somerton (PL118) Pipeline from Mobil Altona through to Somerton will remain unchanged. The MJP will be able to be pigged (MLT) between the PL at the Inlet station and the PR at the Receiver station using a winch system.

Viva Energy have indicated 24 hours as the maximum possible interruption period for the pipeline hot tap. To minimise the interruption to shipping, a temporary bypass of DN200 or DN250 (size TBC) will be installed around the tie-in point. The bypass will be removed upon completion of tie-in activities.

7.2 Pipeline Hydrostatic Testing and Related Tests

A pipeline hydrostatic test plan and construction Scope of Work will be generated during detailed design. Each HDD to be separately hydro tested, cleaned and dried to verify appropriate quality prior to insertion into the bore hole. Refer to 521511-100000-REP-CN-0015 for further details.

The pipeline will be subject to hydrostatic testing in accordance with AS 2885.5 – 2012, to establish the pipeline strength and verify the design pressure/MAOP. The hydrostatic test procedure for buried pipe will comprise an initial strength test, followed by a leak test. The duration of the leak test will allow for thermal stability along the test section and will meet the requirements for sensitivity of equipment and uncertainty of the measurements, as defined in AS 2885.5.

- The pressure strength test will be Type 1, as defined by AS 2885.1 clause 5.12.3 (no chance of yield).
- The unaccountable test fluid loss for each test section will not exceed the relevant values applicable to the Location Class, as referred in Table 5.1 of AS 2885.5 – 2012.
- Following this testing, the pipeline will be dried to a dewpoint of 0°C.
- The test pressure for MJP will be 1.25 times Design Pressure at the lowest point for 24 hours. (6000 kPa x 1.25)
- The system shall be soak tested as per Appendix A5 JIG 2 Aviation Fuel Quality Control and Operating Standards for Airport Depots and Hydrants.
- The details for the hydrostatic testing, cleaning, drying and Soak Testing Plan shall be included in the construction specification.

The sections to be hydrotested and the locations for ‘golden welds’ will be identified during detailed design.

7.3 Station and fuel farm Hydrostatic Testing

Where practical, prefabricated skids and assemblies will be fully hydro tested and then dried as part of Factory Acceptance Testing (FAT) before transport to site for Site Acceptance Testing (SAT). Skids will have a test pressure of 1.5 times MAOP as required by code. The completed system shall be soak tested as per Appendix A5 JIG 2 Aviation Fuel Quality Control and Operating Standards for Airport Depots and Hydrants.

7.4 Emergency Response Plan (ERP)

The pipeline operator will be required to develop comprehensive Emergency Response Plans (ERPs). Where necessary, provision will be made for storage and maintenance of emergency response equipment at the appropriate pipeline facilities.

All staff will undergo training in emergency scenarios and equipment prior to operation of the pipeline and at regular intervals during the operation of the pipeline.

7.5 Pipeline Management Systems

An operating Pipeline Integrity Management Plan (PIMP) and a new Pipeline Management System (PMS) will be developed by Viva Energy, for this new asset. As the MJP relies upon PL118 for the transmission of product, the MJP PIMP will need to closely integrate with the Altona to Somerton Pipeline (PL118).

7.6 Leak Detection

The MJP shall be fitted with an ATMOS leak detection system. The primary method of leak detection will be through pressure, temperature and flow monitoring. The LDS shall be capable of both static and dynamic leak detection and provide feedback to the SCADA control system for alarming.

A screening study of options for the Leak Detection System during FEED recommended Option 4 (ATMOS Pipe with AWAS DAU) as the most suitable. Consultation with the operator of PL118 will also take place to ensure if practical the systems are compatible. The table below lists leak volumes for various hole sizes, detection and system response times for a confirmed leak as per the Radiation Calculation Report 521511-300000-CAL-CR-0003.

Table 9 Leak volume by Detection and Response Time.

Parameter	Value			
	Worst-case 35 mm breach	Worst-case 120 mm breach	Worst-case 125 mm breach	Worst-case full-bore rupture
Volume release rate (m^3/s)	0.12	1.42	1.55	0.75[2]
Volume loss (m^3)[3] Valve Close (74s)	9	105	115	56
Volume Loss (m^3) Detect Leak (1min)	7.2	85.2	93	45
Total Volume Loss (m^3)	16	190	208	101

Note 1: Quoted velocity is the maximum velocity and does not directly correlate to discharge flowrate. Discharge flowrate is calculated from maximum velocity using the discharge coefficient of approximately 0.7.
2: Full-bore rupture is calculated by a different method that accounts for pressure drop along half the length of the MJP, while the rupture cases do not consider a pipeline pressure drop.
3: Total volume loss is calculated after a period of 1 minute 74 seconds corresponding to the time to detect a leak using the ATMOS system and then stop flow as described in 521511-300000-CAL-CR-0003 Section 3.2.

The ability of the system to identify the location of a detected leak is 100 m as specified by ATMOS.

7.7 Custody Transfer

Custody Transfer quality metering and associated external pressure and temperature transmitters shall be provided at both ends of the new MJP. These instruments will be interfaced with compatible NMI-approved flow computers with communications capability allowing product transfer information to be collected by upstream software packages. It is noted that the existing tank gauging system installed at JUHI may also serve as a point of custody transfer. Flow metering for custody transfer must comply with DEP 32.32.00.11, AS 4250.1, and AS 2649.

7.8 Shutdown Valves

At the MJP Inlet, the isolation valve (XV-002) is installed in a valve pit, as well as the new isolation valve in the Altona to Somerton (PL118) Pipeline (XV001). It is recommended both valves be installed in a manner which will allow repair/replacement of seals without shutting down PL118.

These valves are to be:

- Flange-ended (ASME B16.5 RF)
- Twin seal expandable gate valves with double isolation and bleed functionality

- Full bore
- Motorised
- Fail-in-position
- Fitted with position feedback
- Allows inline maintenance and seat replacement

At the JUHI receiver end, an aboveground isolation valve is to be installed at the end of line facilities inlet, downstream of the pig receiver. This valve, XV-003, will be of same type as XV-001 and XV-002. This valve is not installed on a piggable line, so it does not necessitate a fullbore valve, but for consistency, positive isolation and ease of maintenance the same type of valve is recommended. XV-004 is to be installed in the JUHI facility to prevent flow from the MJP line entering Tanks 1-6 or the Truck unloading area. It shall be a RB ball valve with SPE/SPE seals.

7.9 Communications

It has been confirmed by Viva Energy during the Design Review that the fibre optic communications (FOC) cable initially proposed for communications between JUHI and Newport/Altona, as well as the MJP Inlet Station, is not the preferred method and not required.

An extension of the existing JUHI communications 4G network will be required to integrate the new MJP control system. Currently this system provides control and monitoring functionality between all of the remote JUHI facilities.

The new control system equipment located at the Tullarmarine site will integrate via existing Ethernet networks.

8 Facility Design

8.1 Design Codes

At KP 21.79, the hot-tap, launcher and pipeline will be designed under AS 2885 using the “PL 6000” design specification. Other parts of the facility will be designed to ASME B31.3, with specification breaks clearly shown on P&IDs.

At the JUHI end, delineation of station and pipeline shall be as per AS 2885.1, Figure 4.1. Station piping will be designed in accordance with ASME B31.3.

8.2 Lighting

A lighting design for the Launcher and Receiver Stations will provide battery backed task lighting for operations and maintenance and safe access / egress.

Lighting at the launcher facility will be locally switched.

Lighting at the Tullamarine site will be controlled by the existing lighting timer in the switch room.

Access roads and tracks and any roadways within the facility perimeters will not be illuminated.

Lighting should be designed to minimise disturbance to any sensitive receptors including residences, fauna and flora.

For further details refer to Section 10 Instrumentation Design Criteria.

8.3 CCTV

CCTV will not be installed as part of this project at the launcher or receiver stations.

8.4 Pigging Facilities

A pig launcher and a pig receiver suitable for intelligent pigs shall be installed each end of the pipeline, designed to AS 2885 and DEP 31.40.10.13-Gen. The pipeline and pigging is only intended to operate in one direction. At JUHI, the options for capture of liquid slops from pigging operations is by using temporary bulki-bins.

The launcher and receiver will be fitted with Quick Opening Closures, mechanically interlocked to prevent opening whilst under pressure complying with the requirement of DEP 31.40.10.13-Gen .

One or more pig signallers with local indication will be installed to verify that the launched pig has cleared the launcher valve and barred tee. The pig signalling devices will be removable types with magnetic pig detection; they will have no interface with the control system. The pig receiver also will include a pig signaller at the end of the minor barrel to indicate that the pig is fully within the receiver. The pig signallers shall be non-intrusive strap on types allowing removal when not required.

For the piggable section of the pipeline, any tees with offtakes DN 200 and above shall be barred tees to prevent pig entrapment. (In the case of the tie-in to PL118 at KP21.79 the stopple fittings will have the coupons reinstalled to ensure a smooth passage for pigging along PL118.)

The design length of intelligent pig lengths for this pipeline (DN 350), is 6.5m. The pig launcher and receiver will be designed to suit these lengths.

Refer to 521511-100000-REP-CN-0010 for further details.

8.5 Underground Components

The design shall include a common pit for the stopple fittings at KP21.79 at the MJP Inlet Station and the MLV’s XV001 and XV002. The pit will be designed to allow maintenance crew to enter and carry out inspections with a confined space permit.

8.6 Bunding and Spill Containment

Permanent bunds are to be provided at the Inlet and Outlet stations around the pig handling areas only plus the Filter Water Separators (Outlet). There will be a 7.5m long x 2.3m wide bunded concrete slab on the ground at the end of the Pig Launcher Skid. The bund wall is 150mm high. There will be a sump at the corner of the bund to collect stormwater inside the bund and drain it into a soakaway pit nearby. The sump will have a knife gate valve to contain a spill event. The valve will always be open and closed manually during pigging operation. A sucker truck will drain out any spills after the pigging operation event before opening the sump valve. It is expected the Pipeline Integrity Metal Loss Tool (MLT) crew will provide suitable temporary equipment and use temporary IBC-type containers to receive drained liquids.

At the receiver station the bunding and containment will be connected to a SPEL Puraceptor. There will be a sump within each bund to collect stormwater inside the bund. Each sump will have a knife gate valve to enable isolation of the bund in case of emergencies, such as a fire.

The Puraceptor is a passive separator device with multiple chambers and a coalescer. It will separate rainwater from any residual Jet A1 present for discharge into the storm water system. The treated water will be discharged from the SPEL Puraceptor outlet to the nearest existing stormwater pit. It will require periodic emptying of any accumulated residues via a vacuum truck or similar device. It is easy and safe to maintain, with no entering of the tank required. The SPEL Puraceptor negates any need to connect to the JUHI oily water disposal systems.

The Receival/Filter Water Separator area at the JUHI end shall be provided with a blowdown tank (for PSV emissions and general draining) and a sample collection tank (for any sample disposal from the Aljac Samplers, which are expected to collected in a bucket and dumped into the tank). The two tanks must be accessible to forklift or pump truck to allow for routine draining.

During pigging operations, larger volumes may be required to be drained from the pigging stations. Task specific spill containment (e.g. bulk containers) shall be temporarily brought to the launcher and receiver sites so that materials drained can be appropriately captured and disposed of. Specific tees and attachment points have been provided at the launcher and receiver for this purpose.

8.7 Facility Fencing and Security

Above ground piping will be contained within security fenced compounds. The fence will be a 2.4 m high chain wire type, with gates of a similar design. All compounds shall have a vehicular access gate, in addition to an emergency gate on the opposite direction. The access gate size will be determined by the vehicle movement analysis. The fence of the Receiver station will be installed on 3 sides only and will tie into existing fence on the north side of the station.

All facilities shall be signposted with warning signs on all four sides and a facility sign near the vehicular gate.

A separate, permanent fenced compound with access gate (5 m wide) will be installed near the MJP Inlet Station on the Altona to Somerton (PL118) Pipeline easement to install the new MLV.

During MJP and station construction temporary fencing within allowable work areas will be specified.

8.8 Facility Access Roads

Facilities will have all-weather gravel access roads.

It is assumed for the design basis that for construction there is generally a 20 m right of way but this will be restricted in some areas. It is further assumed that a 6m access will be available post construction and that access to the 6m ROW will be achievable from adjacent public roads. The ROW will subject to agreements during the consultation process. To be confirmed once the MJP route is finalised.

8.9 Facility Compound Surfacing and Drainage

Facility compounds shall be compacted gravel (hardstand) over a weed mat for areas indicated as driving/access areas. Top 300mm soil will be removed and replaced with 450mm engineered fill placed in layers and compacted to 98% Standard Density.

8.10 Facility Lightning Protection

Design of pipeline termination points includes Monolithic Insulating Joints (MIJ) to protect the station facilities from stray currents and to allow the cathodic protection to operate.

The MIJs will be designed with surge diverters to protect them against high direct or induced currents caused by lightning strikes. An AS 1768 lightning risk assessment has been performed indicating a very low risk to the facility and there additional protection measures are not required. Facilities electrical supply will be protected from surge.

Pipe supports and structures will be bonded to the earthing system to ensure potential equalisation.

9 Design Philosophies

9.1 Operating and Control Philosophy

A separate document to the Design Basis will be prepared to define the operating philosophy of the asset and the required control and shutdown functions. Refer to the control and operation philosophy, 521511-100000-REP-CN-0013**.**

This control and operating philosophy will act as an input to the SMS.

9.2 Pressure Control Philosophy

The MJP is supplied from the Altona to Somerton (PL118) Pipeline, with no other sources. The MOP of the Altona to Somerton (PL118) Pipeline is 5,170 kPag, which is below the design pressure for the MJP (6,000 kPag).

It is assumed that the operators of the Altona to Somerton (PL118) Pipeline have instrumentation and other protections in place to positively prevent exceedance of the Altona to Somerton (PL118) MOP. These measures will therefore provide pressure protection for the MJP.

9.3 Fluid Velocity

The velocity corresponding to the MJP maximum unconstrained (by pump capacity) flowrate (~800 m^3/h) in the pipeline (mainline) is 2.6 m/s. If current pumping infrastructure is upgraded as proposed (~650 m3/h), the pipeline velocity will therefore be less than 2.6 m/s.

The velocity in ASME B 31.3 station piping and short sections of “pipeline assembly” pipe (other than mainline) within AS 2885 governance is 7.5 m/s for DN200 sections at a maximum flowrate of 800 m^3/h.

Note that the fluid service is very clean hydrocarbon liquid.

9.4 Pigging Philosophy

A separate pigging philosophy has been developed (Refer to 521511-100000-REP-CN-0010) to detail the type of pigging tools (MLT) that the pipeline will be able to accommodate, and any limitations on their operation. In summary, pig launching and receiving facilities will be designed to accommodate intelligent pigs of length up to 6.5m.

9.5 Operations Access and OHS Issues

All Viva Energy OHS guidelines and regulations with an effect on facility design will be complied with.

9.6 Fire Protection Philosophy and Provisions

No automated fire detection or suppression system is proposed for the MJP Inlet facility. AS 1940 requirements for fire extinguishers will be followed and will count the volume of above-ground piping towards the assessed “storage” volume.

No provision for active or passive fire protection is provided.

JUHI has an existing fire water ring main, which the project will tie into. No other fire detection and suppression exists in the area of the MJP receiver station.

Emergency response procedures for fire scenarios will be captured in the Operator’s emergency response plan (ERP).

9.7 Availability Philosophy

The availability of the pipeline is typically 99.5-100.0% as no components within the pipeline requires shutdown for maintenance (with the exception of seal replacements for XV-001, XV-001 and XV-003), and fuel transfers are conducted only intermittently. A formal Reliability, Availability and Maintainability (RAM) study will not be performed to quantify this.

9.8 Isolation Plan

A separate isolation plan document, 521511-100000-REP-CN-0011, details the isolation plan of the MJP, in accordance with the requirements of AS 2885.

Note that the existing Altona to Somerton (PL118) pipeline to which the MJP will be connected has in place effective means of pressurisation and depressurisation, and that this task is relatively straightforward for a liquid pipeline in batch transfer service. There are no significant temperature variations associated with pressurisation/depressurisation.

9.9 Sparing Philosophy

The design phase will determine from vendors of long lead equipment their recommended commissioning, operating and insurance spare parts.

Viva Energy will determine a sparing philosophy for the asset.

9.10 Operating & Maintenance Philosophy

The pipeline will be operated and maintained by the Owner in accordance with the requirements of AS 2885 suite of codes, specifically AS 2885.3, Pipelines—Gas and liquid petroleum, Part 3: Operation and maintenance.

9.11 Integrity Management

The pipeline and facility design shall consider future integrity management plans such that systems and activities can be performed without modification.

9.12 Environmental Management

The pipeline and facility design shall comply with all environmental guidelines and regulations including Pipelines Act 2005.

Environmental Management and mitigation measures would be implemented through a CEMP and a CSMP during construction and an Operational Environmental Management Plan (OEMP) and an Operational Safety Management Plan (OSMP) during operation. These plans would be developed in accordance with all applicable regulations and other enforceable policies and guidelines and capture the project specific mitigation measures that have been developed to address environmental, heritage, social, health and safety impacts of the pipeline.

10 Instrumentation Design Criteria

10.1 General Design

The general design of instrumentation shall be as follows:

- The definition in this specification of "Instrumentation" or "instrument(s)" shall not be limited to measuring and control devices, but shall include supporting equipment such as terminal boxes, terminals, ducting, cabling, tubing, and fittings etc.
- All equipment shall (unless agreed otherwise with Viva Energy) be sold and supported within Australia.
- All design and construction work shall comply with relevant codes and standards and satisfy all statutory requirements.
- Field equipment shall have an ingress protection (IP) rating appropriate for the installation location with a recommended minimum of IP67. Equipment which is to be installed indoors and mounted external to a marshalling cabinet shall have minimum ingress protection of IP54.
- All electrical equipment installed in Hazardous Areas shall be designed, installed, verified, and documented in accordance with AS/NZS 3000, and AS/NZS 60079 series.
- Field instruments will have units of measurement in SI (metric) units. The units of measurement shall be consistent with the pipeline, upstream and downstream facilities.
- In-line flanged instruments are to be rated to the pipe specification.
- Instrument materials of construction are to be specified to suit process conditions, regulatory requirements, and the environment.
- Material traceability certificates shall be provided for the wetted parts and pressure retaining parts on in-line instrumentation.
- Turndown will be considered, and the instrument will be suitable for the full expected operating range.
- Instruments requiring protection from the environment and some that require regular attention will be sheltered. Sunshades shall be fitted to all field instruments exposed to direct sunlight.
- Radio frequency interference from any device will not adversely affect any other device or signals.
- Field mounted instruments and control devices shall be designed to withstand the ambient conditions described in this document.
- Instrument performance/accuracy shall be sufficient to fulfil pipeline performance requirements (including National Measurement Institute, DEP, custody transfer and leak detection capabilities).
- Variation of instrument types and ranges shall be kept to a minimum.
- Smart type instruments utilising the HART protocol shall be used, where available.
- Where local indicators are required, local indicators and transmitters shall be combined. Separate local indicators may only be installed if necessary, for local operation and ease of reading.
- Any arrangement of instruments shall allow for the removal of a sensor/detector head while maintaining the integrity of the other sensors, e.g. in addressable systems.
- All materials and equipment shall be new, unused, and free of defects.

10.2 Instrument Systems

The following criteria shall apply to instrument systems:

- The materials of construction shall be suitable for the process conditions. Care shall be taken to ensure that the correct metallurgy is selected for installation of all process wetted parts.
- Power supplies for mains powered sites shall be 400VAC/230VAC, 50 Hz supply.
- The launcher facility is operated using a kicker line from the tie-in pipework taking flow from PL118..

- Signal transmission shall be:
  - Analogue signals 4-20 mA / 24VDC (HART)
  - Digital Input signals Potential Free Contact or NAMUR
  - Digital Output signals 24VDC

10.3 Transmitters

The following criteria shall apply to transmitters:

- Field transmitters shall operate using a 2 wire 4-20 mA loop powered signal where possible.
- Transmitters shall be factory calibrated as specified on the instrument data sheet. Calibration certificates and a complete list of the configuration parameters shall be provided by the manufacturer.
- Factory calibrated transmitters shall have their calibration verified in the field prior to commissioning.
- Transmitters located in areas exposed to lightning shall be specified with lightning and surge protection.
- Transmitters shall incorporate local indication where available.
- Stresses on instruments from piping are to be minimised. The manufacturer's torque limits must be complied with.
- Transmitter accuracy shall be within 0.5% of span.

10.4 Flow Measurement

- Flow meters are to be Coriolis type.
- Metering is to be suitable for the design flow as per Section 3.4.1.
- Flow metering is for the purpose of custody transfer metering and must comply with DEP 32.32.00.11 and AS 4250.1 and AS 2649.
- Refer to the Control Philosophy for more detail on the function of the flow meters.

10.5 Temperature Measurement

- RTDs shall be Class A rated for tolerance and accuracy.
- Temperature elements at buried locations are to be surface mounted to the pipeline with the sensing area adhered to the pipe.
- Thermowells shall be 50 mm flanged and tapered and be used with long weld neck nozzles. They shall not protrude into the pipeline if their position can interfere with operations involving scrapers / intelligent pigging tools.
- Local gauges shall be accurate to 1% of span.

10.6 Pressure Measurement

- If pressure measurement instruments are used for custody transfer, the 'Measurement Design Standard' provided by Viva Energy shall be used.
- Each pressure measuring device (gauge or transmitter) shall be installed with a separate 316SS isolation valve and bleed valve at the device in addition to the line-specification process isolation valve.
- Differential pressure instruments are to be fitted with a 316SS 3- or 5-valve manifold (depending on service and/or line class) and gauge pressure instruments are to be fitted with a 316SS 2-valve manifold. The valving shall allow for in-situ calibration of the instrument per JIG and Shell DEP requirements.
- The use of gauges shall be minimised and are only to be used for commissioning. Gauges shall be removed after commissioning.

- Gauges and transmitters with local displays are to be installed such that the reading may be clearly viewed, and the isolation valve is readily accessible.
- Local gauges shall be accurate to 1% of span.
- Local mounted pressure gauge cases shall be weatherproof, have a solid front design with blow out back protection.
- During normal operating conditions, local indication pointer position shall be at a position of approximately 60% of full range.

10.7 Solenoid Valves

The following criteria shall apply to solenoid valves:

- Solenoids shall be powered by 24VDC.
- Solenoid coils shall be designed for continuous duty.
- Solenoids shall be of a low power type (typically less than 5 watts).
- Solenoid enclosures shall be suitably IP rated for the installation environment.

10.8 Instrument Identification

The following criteria shall apply to instrument identification:

- Each item of equipment shall be identified by a unique tag number.
- Each junction box or local panel shall be labelled as per the project standard.
- Cables shall be labelled at both ends of the cable as per the project standard.
- Label material shall be stainless steel.
- Labels are to be installed with no sharp edges or protruding corners likely to cause injury to personnel working nearby.

10.9 Instrument Location and Mounting

The following criteria shall apply to instrument location and mounting:

- Gauge and direct mounted instruments may be supported directly by the pipeline or pipeline equipment. Other local instruments should be rigidly mounted on instrument supports, such as pipe stands, using manufacturer clamps, brackets, or holders.
- Instruments shall be accessible from grade where possible.
- All instrument pipework and fittings must be of a consistent type throughout the pipeline, that is they must be interchangeable.
- The selected compression tube fitting make shall be used throughout the whole installation.
- Standard tubing sizes shall be used. The minimum tubing size shall be DN15.

10.10 Wiring and Cabling

The following criteria shall apply to wiring and cabling:

- Instrument signal cables with 6 or more pairs shall be designed to have at least 2 spare pairs, or 30% spare pairs, whichever is greater.
- Instrument wiring shields and control system grounds with the exception of the 'Intrinsically Safe Earth' shall be connected to a common instrument ground bus with only one connection to the electrical ground system.
- Control signals to solenoid valves and other actuating devices shall be run in separate cables to that for monitoring signals.

- Each core of a cable shall be terminated at either end, i.e., instrument, junction box or marshalling panel.
- Crimp lugs, pins, boot lace ferrules, etc, shall be insulated type of industrial quality correctly sized for the cable and be installed using an appropriate ratchet crimping tool.
- Cables shall be run on cable tray and shall not be run in conduit unless otherwise agreed.
- Conductor sizes shall be compatible with the required loop impedance for the instrument that it is to supply, as well as voltage drop requirements.
- Cables used for low level signals (< 5VDC), serial communication or coaxial cables shall conform to the specific requirements of the equipment manufacturer. As a minimum, these cables shall be individually screened.
- For instrument cables that must be extended the preferred method is to use a junction box.
- Instruments shall be installed with sufficient cable to allow removal of the instrument from the process line without disconnecting terminations or unclipping cable supports. This should be provided by a neat coil of cable as it enters the instrument.

10.11 Earthing

All components shall be selected and sized to ensure a safe, robust installation that meets all statutory requirements under all conditions.

Instrument wiring shields and control system grounds shall be connected to a common instrument ground bus with only one connection to the electrical ground system. The field end of instrument and control cable earth conductors shall be left floating.

10.11.1 Shielding

Cable shields (or drain wires) shall be through connected from field mounted terminals and junction boxes to the designated instrument earth point. Separate terminals in sequence below the signal core terminals shall be provided in field junction boxes for termination of the shield.

10.12 Hydrotesting and Flushing Considerations

If hydrotesting can damage instrumentation, provision shall be made for removal of instrumentation or pressure isolation of instrumentation to allow line hydrotesting and flushing duties to be completed.

11 Civil / Structural Design Criteria

11.1 General Requirements

11.1.1 Environmental Conditions

Refer to Section 3.1 for environmental conditions for this project.

11.1.2 Design Life

According to Viva, design life for the project is 40 years (refer Section 3.5). For the purposes of structural design, a design working life of 50 years will be adopted in line with AS/NZS 1170 series.

11.1.3 Importance Level

The pipeline has redundancy through use of PL118 and PL119 as well as via road tankers and hence is not considered essential for post-disaster use, therefore in accordance with AS/NZS 1170.0, structures within this project shall have an Importance Level classification of 3 – Major Structures.

11.1.4 Annual Probability of Exceedance

In accordance with AS/NZS 1170.0, the annual probability of exceedance for ultimate limit state events, based on the design life and importance level given in in the preceding sections, are set out in the Table 10 below:

Table 10 Annual Probability of Exceedance

Structure Type	Design Life (Years)	Annual Probability of Exceedance	
		Wind	Earthquake
All elements	50	1:1000	1:1000

The annual probability of exceedance to be used for serviceability limit state is 1:25, as per AS/NZS 1170.0.

11.2 Geotechnical Information

Refer to Section 3.3 for details.

11.3 Design Loads

11.3.1 Permanent (Dead) Loads, G

11.3.1.1 Self-weight

Permanent loads shall include the self-weight of all structural elements, using the following densities:

- Concrete: 25kN/m^3
- Steel: 78.5kN/m^3

For other materials, values from AS/NZS 1170.1 shall be used. Weights of all building materials shall be included as dead load.

11.3.1.2 Superimposed Permanent Loads

Superimposed dead loads shall be considered as the weight of all materials forming loads on the structure that are not structural elements and which are likely to vary or be removed during operation or construction of the structure. Superimposed dead loads such as roof vents, lighting, weight of fluid or solids in tanks, piping, chutes and equipment including self-weight of cranes, laydown loads, equipment handling, lateral earth pressure, overloads due to blocked pipes, and equipment shall be considered. Provision shall be made for inertia forces, spillages, equipment overload.

The design engineer shall assess the possibility of the removal of these dead loads which will result in the most severe combination of stresses in the structure.

11.3.1.3 Equipment Loads

Equipment loads shall be provided by the Vendor.

11.3.2 Imposed (Live) Loads, Q

Design imposed loads shall be in accordance with AS/NZS 1170.1.

Equipment loads shall be provided by the Vendor.

Pipe stress loads shall be as provided by the piping department. Where not provided, loads may be calculated using standard coefficients of static friction – i.e. 0.30 for steel on steel.

11.3.3 Wind Loads, W

The design wind loads shall be designed in accordance with AS/NZS 1170.2 using the following parameters:

- Wind region A5
- Terrain Category 2
- Ultimate limit state design regional wind speed, V_{1000} = 46m/s
- Serviceability limit state design regional wind speed, V_{25} = 37m/s
- Wind direction multiplier, M_d = 1.0
- Terrain/ height multiplier, $M_{z,cat}$ Refer to Table 4.1 of AS/NZS 1170.2
- Shielding multiplier, M_s = 1.0
- Topographic multiplier, M_t = 1.0

The appropriate aerodynamic shape factor, C_{fig}, shall be assessed in accordance with AS/NZS 1170.2. The dynamic response factor, C_{dyn}, shall be taken as 1.0.

11.3.4 Earthquake loads, E_u

Earthquake loads shall be calculated in accordance with AS1170.4 using the following parameters:

- Site sub soil class: Ce (TBC)
- Hazard factor, Z = 0.09
- Probability factor, k_p = 1.3
- Earthquake design category = II

Seismic design parameters pending pipeline route geotechnical investigation interpretive report

Site sub soil class will be updated post Geotechnical investigation.

11.3.5 Load Combinations

Combinations of loads together with the appropriate ultimate load factors for strength, stability and serviceability limit states shall be in accordance with Section 4 of AS/NZS 1170.0.

11.3.6 Serviceability Requirements

Unless otherwise limited by requirements of piping that are sensitive to deflections or differential movements, all structural elements shall comply with deflections as per AS/NZS 1170.0, AS 3600 or AS 4100, where relevant.

11.4 Civil Works

11.4.1 General

The general requirements for design of civil works are details in Section 8.

11.4.2 Earthworks Design Levels

The stations bench design criteria as follows:

- Minimum slope across the platform: 4% (to be confirmed)
- All cut and fill batter slopes shall be 1V:4H (to be confirmed)
- Minimum 300mm topsoil to be stripped before backfilling.
- Minimum design subgrade CBR is 2% (to be confirmed)
- The Launcher Station level will be 150mm higher than the adjacent surrounding area and site access will be batter / transition the surface down from the station to the road level

11.4.3 Fencing

Security fencing shall be installed on foundation footings 150mm above the natural ground level. Fencing shall be designed in accordance with Drawing No. 521511-0000-DRG-CI-1003.

11.4.4 Access Roads and Hardstands

The access road into the stations have a width of 5m to accommodate a dual axle 8.5m Haib truck.
The pavements were designed assuming a total Equivalent Standard Axles (ESA's) of 25,000 on the road extension for the internal and external station pavements.

The layer works and surfacing as designed for the Pavement is as follows:

- 100mm thick, blended gravel
- 100mm thick, class 2/20 crushed rock, 20% crushed concrete
- 150mm thick, class 4/20 crushed rock, 100% crushed concrete
- Type A fill, CBR 2% (if required)

11.4.5 Drainage

Stormwater Drainage works are only expected at the JUHI tie-in where new drainage will be hard piped into the existing closed drainage system. There will be 2 v-drains (to be confirmed) on the JUHI site to carry the water from the yard into a newly installed pit to the connecting to the existing stormwater network.
Oily water drainage of the bunded areas at JUHI Receiver station is being developed. Viva Energy confirmed that SPEL system is the preferred option for the Oily water drainage. Any storm water or spills from the PR bund and filter water separator bund will pass through a SPEL (oily water separator) for treatment before discharging it to the nearest existing stormwater pit. SPEL is a Proprietary oily water system with endorsement by EPA as suitable to capture any releases.

For the bunded areas drainage, refer to section 8.6.

11.4.6 Cement Stabilised Sand

Cement stablished sand shall consist of with a minimum of 5% by weight of Portland cement type 'GP' and shall contain sufficient water to hydrate the cement. The cement stabilised sand shall be placed in loose 200mm thick layers and compacted. Sand shall be composed of clean, hard, strong, durable, uncoated particles resulting from natural or artificial disintegration of rock, and shall be free from injurious amounts of dust, lumps, flaky particles, shale, alkali, organic matter, loam, salt or other deleterious substances. Sand shall be in accordance with AS 2758.

11.5 Concrete Design Works

11.5.1 General

All concrete structures shall be designed in accordance with AS 3600 and 521511-100000-SPE-CV-0004 Reinforced Concrete. Civil/Structural Technical Specification to be developed during detailed design.

The limit state method of design shall be used, and appropriate serviceability checks shall be made.

11.5.2 Durability

11.5.2.1 Exposure Classification

Unless noted otherwise, the site Exposure Classification is B1.

11.5.2.2 Concrete Cover

The concrete cover to steel reinforcement shall be in accordance with AS 3600 to meet the design service life of the project. Table 11 summarises the concrete cover for the structural elements for the project:

Table 11 Concrete Cover

Concrete Elements	Nominal Cover (mm)
Cast against soil – unformed	60
Cast against soil – formed or on blinding	50
Piles	75
Above ground concrete	40
Precast concrete elements (steel forms with intense vibration)	30

11.5.3 Concrete Strength

The design of all concrete works shall be in accordance with AS 3600. Concrete Technical Specification 521511-100000-SPE-CV-0004 provide details of the concrete mix properties. Table 12 summarises the concrete grade for the structural elements within the project:

Table 12 Concrete Properties

Concrete elements	Min Compressive Strength @ 28 days (MPa)
Foundations	N32
Blinding	S15
External paving slabs, footpaths and minor paving	N32
Precast elements	N40
Piles	N40

11.5.4 Reinforcing Steel

All reinforcement and workmanship shall be in accordance with AS/NZS 4671 and be fabricated and installed in accordance with AS 3600.

Reinforcement shall comply with the requirements of AS/NZS 4671. The following reinforcement grades shall be used:

- Plain bars designated 'R' Grade 250N (f_y = 250 MPa)
- Deformed bars designated 'N' Grade 500N (f_y = 500 MPa)

- Mesh designated ‘SL’ or ‘RL’ Grade 500L (f_y = 500 MPa)

Stress development of reinforcement shall be in accordance with Clause 13 of AS 3600.

11.5.5 Concrete Foundations

11.5.5.1 General

Concrete foundations shall be designed in accordance with the recommendations outlined in the Section 3.3 and the geotechnical report for the project.

- Foundations shall be designed to comply with the following requirements:
- The maximum bearing pressure calculated using working loads (permissible stress design loads) shall be less than the maximum allowable bearing pressure specified in the geotechnical report.
- The maximum pile loads calculated using ultimate loads shall be less than the maximum ultimate capacities, including the geotechnical strength reduction factors, specified in the geotechnical report.
- Ground preparation in accordance with the Geotechnical report shall be undertaken prior to installation of foundations.
- The footing shall not overturn nor slide under the worst combination of stability limit state loads.
- The footing pedestal and base shall be proportioned with sufficient reinforcement to resist the maximum moments and shears resulting from all combinations of stability and strength limit state loads.
- Settlements calculated using serviceability limit state loads shall be within limits which can be accommodated by the structure or equipment supported on the foundation and any connecting piping and other services.
- The footing thickness shall be not less than 0.2 times the maximum plan dimension of the footing.
- Pedestal reinforcement can be reduced from 1% in accordance with Clause 10.7.1 of AS 3600.

11.6 Structural Steel Design

11.6.1 General

All steel structures shall satisfy the limit states for strength, serviceability and stability in accordance with the requirements of AS 4100 and 521511-100000-SPE-CV-0005 Structural Steelwork. Civil/Structural Technical Specification to be developed during detailed design.

The maximum slenderness ratio (l/r) for columns and bracing shall be 180.

Back-to-back angles and channels shall not be used unless the gaps are effectively sealed. Steelwork and connections shall be detailed to avoid pockets where water and dust can collect and initiate areas of corrosion.

11.6.2 Material Properties

All structural steel members supplied shall be of the following strength grades:

Table 13 Structural Steelwork Material Grades

Steel Member	Grade (MPa)
Hot rolled plates	250 to AS/NZS 3679
WB and WC	300 to AS/NZS 3678.2
UB, UC, PFC, EA and UA	300 to AS/NZS 3678.1
RHS, SHS and CHS	350 to AS/NZS 1163
Hot rolled flats	300 to AS/NZS 3679.1

No member substitutions shall be made without prior written approval.

11.6.3 Connections

All connections shall be designed in accordance with the requirements of the Australian Institute of Steel Construction publication, Design of Structural Connections.

Field connections shall generally be bolted except where it can be shown that welded connections are necessary or cost effective.

Flexible end plate connections shall generally be used for main beam connections where erection constraints do not restrict the use of this type of connection.

Web side plate connections shall generally be used for all secondary beam connections.

All connection plates shall have a minimum thickness of 10 mm.

The minimum bolt diameter for primary structural members shall be 20 mm and each individual member shall be connected with at least two bolts per connection.

All bolted connections of members subject to dynamic loads or reversal of stresses shall be designed as Grade 8.8, fully tensioned, friction type bolted connections with a coefficient of friction of 0.35.

All other bolted connections for primary structural members shall be designed using Grade 8.8 bolts tightened to ‘S’ condition in accordance with AS 4100.

Connections for purlins, girts, handrails, ladders and other minor members may be designed using snug tightened Grade 4.6 bolts (4.6/S).

All bolt holes shall be 2 mm larger than the bolt diameter except in the case of base plates which shall have holes 6 mm larger than the bolt diameter.

All shop fabricated connections shall be welded unless noted otherwise.

All welds shall be a minimum of 6 mm continuous fillet weld.

All butt welds shall be complete penetration full strength continuous welds.

11.6.4 Platforms, Walkways, Stairs and Ladders

Platforms, walkways, stairs and ladders shall be designed in accordance with AS 1657 and AS 4100.

Access stairs and walkways shall have a minimum clear width of 600 mm, with a preferred minimum width of 750mm.

The preferred arrangement for access stairs is with a riser height of 180 mm and going of 250 mm.

Monowills handrailing shall be installed in areas not exposed to wet, corrosive conditions.

Flooring shall generally be grating. Floor plate may be permitted where grating cannot be installed.

11.6.5 Grouting and Anchoring

Baseplates shall be grouted with a nominal 40 mm thickness of non-shrink grout. Grout types and installation methods shall be in accordance with the requirements of specification 521511-100000-SPE-CV-0006 Grouting and Anchoring. Civil/Structural Technical Specification to be developed during detailed design.

Anchor bolts shall preferably be Grade 4.6/S bolts (hot dipped galvanised). Anchor bolts shall be designed in accordance with the anchorage requirements of Section 19 of AS 3600.

Chemical anchors may be used instead of cast in-situ anchor bolts for minor equipment foundations, minor structural supports, instrument stands and cable tray and small pipe supports. Unless noted otherwise, chemical anchors shall be Hilti HAS rod with HIT-HY 200 injection adhesive, or approved equivalent.

11.6.6 Surface protection

All structural steel shall be hot-dipped galvanised in accordance with AS/NZS 4680.

12 Geology

Aurecon undertook a geotechnical site investigation and prepared the document 'Project Starburst Pipeline Geotechnical Investigation Report' dated 16 April 2019. The natural profile of the area was interpreted to represent Newer Volcanics. A generalised and simplified geotechnical model has been developed for the route and is shown in Table 14. For sub-surface conditions in a given localised area, the nearest individual borehole should be referred to in the geotechnical investigation report.

In addition, Geotechnical investigation is being carried out at the JUHI receiver station to confirm the soil properties for the design of foundations, access road and bench pavement. Further geotechnical investigations may be required in specific areas along the pipeline alignment.

Table 14 Geotechnical Model[5]

Material (4)	Generalised Description	Depth to Bottom of Layer (m)	Assessed Strength Parameters (3)		
		Generalised Borehole	Φ and Φ' (deg)	c_u and c' (kPa)	γ (kN/m³)
TOPSOIL. (1)	Silty clay / silty sandy clay of medium and high plasticity, stiff	0.25	0, 27	75, 3	18
SILTY CLAY (CH)	Silty clay, high plasticity, dark grey, very stiff to hard, trace fine to coarse grained gravel.	1.0	0, 29	200, 8	19
SILTY GRAVELLY CLAY / SILTY SANDY CLAY (CI – CH)	Basaltic clays ranging from medium to high plasticity, pale grey-brown, mottled grey-white; calcareous.	1.5	0, 27	100, 4	18
BASALT (2),(5)	Extremely weathered to distinctly weathered, very low to medium strength, dark grey-brown.	3.0	40	-	22

Note:

(1) It is noted that the Fill encountered in some of the boreholes hasn't been considered in the geotechnical model.
(2) Denotes borehole target depth of 3 m (EOH)
(3) Geotechnical parameter values have allowed for wetting and softening and are intended to be moderately conservative.
(4) Material descriptions have been generalised to accommodate different materials and depths across all boreholes.
(5) Depth to top Basalt is extremely variable (0.5 m – 2.9 m). Refer to section 5.3 of the current report.

Where:
Φ – undrained friction angle (degrees)
Φ' – drained friction angle (degrees)
c_u – undrained cohesion (kPa)
c' – drained cohesion (kPa)
γ_{bulk} – bulk unit weight (kN/m³)

[5] 505045 Project Starburst Pipeline Geotechnical Investigation Report dated 16 April 2019

Document prepared by

Aurecon Australasia Pty Ltd
ABN 54 005 139 873

Aurecon Centre
Level 8, 850 Collins Street
Docklands, Melbourne VIC 3008

PO Box 23061
Docklands VIC 8012
Australia

T +61 3 9975 3000
F +61 3 9975 3444
E melbourne@aurecongroup.com
W aurecongroup.com

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