Attachment D

Hydrology and Groundwater Assessment

Melbourne Jet Pipeline Project

Melbourne Airport Jet Pipeline Project

Hydrology and Groundwater Assessment

Viva Energy Australia

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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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Name	Kristen Isbel	Name	Josh Mahon
Title	Environmental Consultant	Title	Manager – Environment and Planning

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1 Introduction

1.1 Background

Viva Energy Australia (Viva Energy) is proposing to construct and operate a new jet fuel pipeline to support the growing fuel needs at Melbourne Airport.

As Australia's second largest airport, annual passenger numbers for Melbourne Airport are expected to almost double by 2042 – increasing from 37 million to more than 76 million per year (APAM, 2022). In line with this projected increase in passenger numbers, the requirement for jet fuel is expected to increase significantly and is expected to exceed the capacity of the existing fuel supply infrastructure. Notwithstanding future growth, jet fuel supplied via the existing pipeline system is already being supplemented by trucking operations from Geelong and Melbourne's inner-city suburbs. The development of the pipeline would provide faster replenishment of fuel stocks, provide an alternative to current and escalating dangerous goods vehicle movements and provide a more robust fuel supply chain.

The proposed project aims to:

- help meet the increasing demand for jet fuel and support future growth at Melbourne Airport
- increase the supply security of jet fuel which will contribute to the Victorian state economy
- reduce the reliance on road transport for jet fuel supply with fewer trucks required to deliver fuel to the airport.

1.2 Scope and purpose of this assessment

Aurecon was engaged to conduct a Hydrology and Groundwater Assessment for the project including the following tasks:

- Review baseline condition of surface water and groundwater features in the footprint and adjacent Study Area
- Advise Viva Energy of relevance and adequacy of existing data and any significant gaps in the data which should be addressed during more detailed studies.
- Review surface water issues in the investigation area including stream flows, the flooding regime, water quality and the potential impact of the design on these matters
- Review groundwater users in the investigation area and the potential impact of the design on these matters
- Recommend necessary ameliorative actions to minimise any adverse impact on groundwater and surface water during construction and operation.

1.3 Project proposal

The project proposes the construction and operation of a new pipeline to form a direct connection between the jet fuel storage infrastructure at Melbourne Airport and the existing Altona to Somerton pipeline that follows the southern boundary of Tullamarine (located south of the Western Ring Road (M80)).

The project would commence at a section of the Altona to Somerton pipeline located south of the Western Ring Road (M80) (near the Airport Drive exit) and link into the existing Melbourne Airport joint user hydrant installation (JUHI) facility (located at Marker Road, Tullamarine) (**Figure 1-1**).

Figure 1-1 **Proposed pipeline location**

The project comprises the following key operational components:

- The new pipeline will be approximately 6.7 kilometre (km) in length and fully buried for its entire length to a minimum depth of 1200 mm below ground level (bgl) with a 7 to 10 metre (m) permanent final easement.
- Pig launcher and receiver sites located at each end of the pipeline. These are used to launch instruments during initial commissioning of the pipeline to clear any debris or water and during operation to record any defects in the pipe.
- An impressed current cathodic protection system (ICCP) to protect the pipe. The ICCP is a system which comprises anode beds and power supply.
- Inlet and outlet metering stations which provide flow analysis for the leak detection system.

Pipeline construction is proposed to commence in Q3 of 2024 and the pipeline is proposed to be operational by Q3 of 2025. This is subject to Viva Energy Board approvals, land access, finalisation of design, award of Contracts and procurement timeframes and is subject to the grant of project approvals within certain timeframes.

A specialised rotary trenching machine or excavator will be used to dig the trenches along the pipeline route. Any material removed will be placed on the side of the trench (stockpiled), within the construction set up area. Trenchless construction will be used in more complex or environmentally sensitive areas. Trenchless construction methods using Horizontal Directional Drilling (HDD) or thrust boring are proposed for seven sections along the alignment (KP50 – KP925, KP1400 – KP1575, KP2250 – KP4150, KP4300—KP4350, KP4475 – KP4525, KP4750 – KP4875 and KP6050 – KP6650) and will pass under the following watercourses:

- Steele Creek North (crossing at approximately KP500 with a minimum clearance depth of 12.00 m and at approximately KP2375 with a minimum clearance depth of 6.00 m).
- Steele Creek North Branch (crossing at approximately KP3275 with a minimum clearance depth of 6.22 m)

This will require construction areas with maximum sizes of approximately 70 m by 70 m for exit locations and 70 m by 90 m for entry locations and will also act as the site offices and temporary laydown areas.

When commissioned, the pipeline would be owned, operated and maintained by Viva Energy. A final easement of 7 m in crown and reserve land and 10 m in private land will be required for operational and maintenance requirements of the pipeline. Following the reinstatement of land as part of the pipeline construction, the land would be generally returned to its previous use. The project has been designed with an operational life of 40 years.

2 Legislation, Policy and Guidelines

This section summarises the current legislative requirements and guidelines for the project relevant to groundwater and surface water.

2.1 Commonwealth legislation

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is Commonwealth legislation that provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, termed Matters of National Environmental Significance (MNES). Under the EPBC Act, an action that has, will have, or is likely to have, a significant impact on a MNES must be referred to the Commonwealth Minister for the Environment. The Minister will then determine whether the proposed action requires formal assessment and approval under the EPBC Act.

2.1.2 National Water Quality Management Strategy

The National Water Quality Management Strategy (NWQMS) is a joint approach by the Australian and New Zealand governments to improving water quality in waterways. The objective of the NWQMS is to achieve sustainable use of water resources, by protecting and enhancing their quality, while maintaining economic and social development. The NWQMS provides a framework for the development and implementation of management plans for catchment, aquifer, coastal waters and other water bodies, by community and government. The NWQMS includes a number of guidelines covering water quality benchmarks, groundwater management, diffuse and point sources, sewerage systems, effluent management, and water recycling. The guidelines relevant to the Project include:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000 / ANZG, 2018).
- Australian Guidelines for Water Quality Monitoring and Reporting.

2.1.3 Airports Act 1996

The *Airports Act 1996* and the associated Airports (Environment Protection) Regulations 1997 aim to establish a Commonwealth system of regulation of, and accountability for, activities at airports that generate, or have potential to generate pollution and promote improving environmental management practices for activities carried out at airport sites. Of specific relevance to this risk assessment in Schedule 2 of the regulations is the setting of ‘accepted limits’ for freshwaters for selected chemical parameters above which there may be adverse effects:

- Inorganic toxicants including metals (levels defined in Schedule 2 Section 1.03)
- Nutrients (levels defined in Schedule 2 Section 1.03)
- Organic toxicants including fuels and oils (levels defined in Schedule 2 Section 1.03)
- Pesticides (levels defined in Schedule 2 Section 1.03)
- Physical-chemical parameters including dissolved oxygen, faecal coliforms, pH, temperature and turbidity (levels defined in Schedule 2 Section 1.02)

For work within the Airport Boundary, Viva Energy must take all reasonable and practicable measures to prevent the generation of pollution, or if prevention is not reasonable or practicable, to minimise the generation of pollution during construction and operation of the pipeline.

2.2 State legislation

2.2.1 Environment Protection Act 2017

The primary legislation is the *Environment Protection Act 2017* (EP Act), which supersedes the *Environmental Protection Act 1970*. It creates the legislative framework to protect the environment and came into effect on 1 July 2021. The Environment Protection Authority Victoria (EPA Victoria) has implemented a broad range of statutory instruments and policies, subordinate legislation and tools under the EP Act. This includes the Environmental Reference Standard (ERS) (**Section 2.2.4**), which sets environmental values for water, land and air, and mechanisms for regulation of the discharges to these elements of the environment.

The EP Act aims to prevent pollution and environmental damage by setting environmental objectives and establishing programs to meet them. The EP Act establishes the powers, duties and functions of the EPA Victoria. These include the administration of the EP Act and any regulations and orders made pursuant to it, issuing works approvals, licences, permits, pollution abatement notices and implementing National Environment Protection Measures.

2.2.2 Planning and Environment Act 1987

Victoria's statutory land use planning system operates through Planning Schemes, which are subordinate legislation under the *Planning and Environment Act 1987*. Planning Schemes set out policies and provisions for the use, development and protection of land. The Planning Policy Framework recognises the impacts of natural hazards, including flood, and sets strategies for development to be located away from flood hazard areas.

The planning schemes have been reviewed as they provide information on the flood hazards for an area. A pipeline license under the *Pipeline Act 2005* must consider the information shown in the planning schemes, however approval under the Act is not required for a pipeline that requires a licence under the *Pipelines Act 2005* (Vic).

2.2.3 Pipelines Act 2005

The *Pipelines Act 2005* (Vic) (the Act) and associated Pipelines Regulations 2017, provide a regulatory framework under which the development of a proposed pipeline must follow. An Environmental Management Plan is required in Part 7 of the Pipelines Regulations 2017. This includes:

- A description of the existing environment that may be affected by the pipeline operation, identifying relevant values and sensitivities of that environment pipeline
- identify and assess the residual risks to the environment (i.e. following mitigation) arising directly or indirectly from the pipeline operation
- environmental performance objectives and standards, against which the performance by the licensee to eliminate or minimise the risks identified in accordance with regulation 45 so far as reasonably practicable are to be measured.

2.2.4 Environmental Reference Standard

Under the *Environment Protection Act 2017* (**Section 2.2.1**), State Environment Protection Policy (Waters) is no longer subordinate legislation and has been replaced by the ERS and the Environment Protection Regulations 2021 (the Regulations). Part 5 of the ERS, however, has largely adopted the segments, environmental values (beneficial uses), indicators and objectives from the State Environment Protection Policy (Waters).

In groundwater, total dissolved solids is used to distinguish segments. This is because the salinity of groundwater affects its use and TDS is an effective way to classify and distinguish the environmental values relevant to groundwater.

In surface waters, segments and subsegments are identified that describe areas differentiated by their baseline conditions, sensitivities to pollution, and environmental values. This is based on:

- Characteristics of the water quality, such as pH, nutrients, salinity and dissolved oxygen
- Physical characteristics, such as waves, currents, substrate and altitude
- Ecological characteristics of the environment, such as biological communities and habitat types
- Climatic influences, such as rainfall, temperature, and climate variability
- Population pressure and surrounding land use.

In Part 5 of the ERS, environmental values are the water dependent ecosystems, their ecosystem services and human uses that require water to be of a suitable quality to support that use or value within a specific segment. The indicators and objectives for water to support the identified environmental value/s are specified in the ERS for groundwater and surface water.

The ERS is a tool that can be used to assess the impacts on human health and the environment that may result from a proposal or activity, or from existing environmental conditions on a site.

2.2.5 Water Act 1989

The *Water Act 1989* provides the legal framework for water management and use across Victoria, including the issuing and allocation of water entitlements and the provision of water services by state-owned water corporations and catchment management authorities.

Under the *Water Act 1989*, the designated waterways, regional drainage and floodplain management authority for the Project area is Melbourne Water.

Melbourne Water is one of ten floodplain management authorities which operate across Victoria. They deliver statutory floodplain management functions under the *Water Act 1989*.

In addition to managing the major water, sewerage and drainage networks across Greater Melbourne, Melbourne Water provides integrated drainage and flood management services including identifying floodplains and preserving their ability to safely convey and store floodwaters, as well as coordinating flood investigations and flood mitigation plans, and monitoring floods when they occur. It has a key role in ensuring that new buildings and works in known floodplain areas do not adversely create additional flood risks.

2.3 Council Guidance

2.3.1 Hume City Council Integrated Water Management Plan 2020 – 2025

The Hume Integrated Water Management Plan 2020-2025 is an update to the Integrated Water Management Action Plan 2014–2017 and actions from that plan. The plan concentrates on:

- Responding to current climate change impacts and the future projections, focusing on the urban heat island effect and impacts on open space management and the stormwater system.
- Development of legislation and policy direction at the State Government level, particularly the Integrated Water Management Framework for Victoria (DELWP, 2017) and the Healthy Waterways Strategy (Melbourne Water, 2017).
- The identified need to protect and enhance community and environmental assets including streetscapes, waterways, native habitat and recreational opportunities.
- Meeting Council's increased water demand as urbanised areas increase and climate change impacts are experienced.

2.3.2 Brimbank Council Construction Environmental Management Plan

A Stormwater and Sediment Control Plan (Element 3 Construction Environmental Management Plan) designed to reduce the risk of harm to the natural environment and community during the construction phase of a development is requested during detailed design stage. The template includes stormwater measures, excavation work, site entries, drainage & sediment control, washing & clearing up and vegetation components. These are based on EPA Victoria Guidance (**Section 2.4**).

2.4 Other Guidance

A number of guidelines and strategies are relevant to surface water management for the Project, including:

- Applying the Flood Provisions in Planning Schemes (DELWP, 2015).
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality, (ANZG, 2018; ANZECC &ARMCANZ, 2000).
- Australian Rainfall and Runoff 2019 (Australian Government, 2019).
- Construction – guide to preventing harm to people and the environment (EPA Publication 1820) (EPA,2021).
- Construction Techniques for Sediment Pollution Control (EPA Publication 275) (EPA, 1991).
- Environmental Guidelines for Major Construction Sites (EPA Publication 480) (EPA, 1996).
- Environmental Management Plan. Rev 2, Sept 2021 (Melbourne Airport, 2021).
- Environmental Reference Standard, Section 93 of the Environment Protection Act 2017. Victorian Government Printer.
- Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria (DELWP, 2016).
- Guidelines for Development in Flood Affected Areas (DELWP, 2019).
- Guidelines for Renewable Energy Installations (State of Victoria Country Fire Authority, 2022).
- Maintaining water sensitive urban design elements (EPA Publication 1226) (EPA, 2008).
- Managing soil disturbance (EPA Publication 1894) (EPA, 2020).
- Technical Guidelines for Waterway Management, (Department of Sustainability and Environment , 2007)
- Victorian Floodplain Management Strategy (DELWP, 2016).
- Victorian Waterway Management Strategy (DEPI, 2013).

3 Methodology

The approach to the water investigation included:

- Consultation with relevant authorities (**Section 3.1**)
- Collate and evaluate freely available existing groundwater and surface water information, including any previous studies (**Section 3.2**)
- Carry out information gap analysis (**Section 3.3**)
- Site walkover (**Section 3.4**)
- Impact assessment framework for surface water and ground issues based on the potential impacts and mitigation measures applied (**Sections 3.5** and **3.6**)
- Identification of water permits or approvals likely to be required for works completion (**Section 3.7**)

Based on this information, identification of any constraints, sites or precincts of significance with regards to water features has been completed. The methodology for each of these tasks is detailed below.

3.1 Consultation with relevant authorities

Requests for information submitted to the relevant authorities are detailed in **Table 3-1**.

Table 3-1 Request for information log

Request number	Request date	Entity	Description	Outcome
W01	29/04/2022	Brimbank Council	Flood extent mapping in the proposed pipeline corridor – ArcGIS friendly preferred format Stormwater drainage network for Council owned assets - ArcGIS friendly preferred format Water quality data / reports for North Steele Creek, Steele Creek and Maribyrnong River – preferred format Excel	Assessment based on council online resources.
W02	29/04/2022	Hume Council	Flood extent mapping in the proposed pipeline corridor – ArcGIS friendly preferred format Stormwater drainage network for Council owned assets - ArcGIS friendly preferred format Water quality data / reports for North Steele Creek, Steele Creek and Maribyrnong River – Excel friendly format preferred	Assessment based on council online resources.
W03	29/04/2022	Melbourne Airport	Stormwater drainage network – ArcGIS friendly preferred format Water permits / licences required to conduct works	Data received from the Airport and is presented in the GIS portal. Other information sourced from online resources.
W04	29/04/2022	Melbourne Water	Guidance on impact assessment expectations Guidelines related to construction works mitigation measures affecting drainage, flood, river flows, water quality	Melbourne water confirmed the utility installation permit process for both the water main location and Steele Creek HDD crossing in a meeting on 17/11/2022. Assessment also based on online resources.
W05	02/06/2022	Melbourne Airport	Permissions for land access (**Section 3.4**)	Access granted 16/08/2022

3.2 Publicly available information review

Information that is publicly available has been summarised in **Table 3-2** below. These data sources were reviewed and relevant information was summarised in this report.

Table 3-2 Summary of publicly available data

Sub-discipline	Data source/s	Information
General (including aquatic ecology)	State of Catchments / CMA Annual Reports information ▪ www.awe.gov.au/environment/epbc/protected-matters-search-tool ▪ Vro.agriculture.vic.gov.au Catchment for each sub-discipline listed ▪ Mapshare.vic.gov.au/mapsharevic/	Catchment areas, Ramsar wetlands, nationally important wetlands, Australian Marine Parks, Key Ecological Features, Protected Matters Search Tool
Meteorology	Climate data ▪ www.bom.gov.au/climate/data	Using the Melbourne Airport weather station at similar elevation to the proposed site, historic rainfall, temperature, evapotranspiration variability, humidity and climate change predictions can be produced graphically using a 5 year + dataset.
Drainage	Drainage maps ▪ vro.agriculture.vic.gov.au Topography maps ▪ elevation.fsdf.org.au ▪ vvg.org.au	Maps can highlight delineated sub-catchments, drainage network with names of watercourses as well as inferred flow directions
Flood extent and behaviour	Flood behaviour ▪ www.ses.vic.gov.au/plan-and-stay-safe/flood-guides Flood extent ▪ discover.data.vic.gov.au/dataset/victoria-flood-database/	Flood extent in Project Footprint and along major arterial routes to the site
Hydrology	Water data ▪ data.water.vic.gov.au/ Public Land ▪ mapshare.vic.gov.au/MapShareVic/	Major creeks and sub-catchments. Data from gauging stations and historic flow variability. Licences for public land
Geomorphology	Geology: ▪ www.vro.agriculture.vic.gov.au ▪ www.vvg.org.au ▪ www.mindat.org	Geology maps and morphology
Water quality	Melbourne Water ▪ https://portphillipwesternport.rcs.vic.gov.au/themes/waterways/ WaterWatch ▪ www.vic.waterwatch.org.au EPA Victoria ▪ https://www.epa.vic.gov.au/for-community/current-projects-issues/pfas-in-maribyrnong-catchment	Port Phillip and Western Port Regional Catchment Strategy Citizen science water quality data for Steele Creek at AJ Davis Reserve PFAS in the Maribyrnong catchment

3.3 Gap analysis

A matrix of information was collated for each sub-discipline indicating if it was fit-for-purpose and that there was sufficient detail of information / data available to support the assessment (**Section 6.2**). Areas with insufficient information were partially addressed in the site walkover (**Section 3.4**). Any residual gaps will be brought-forward to a recommendations section for additional studies (**Section 6.3**).

3.4 Site walkover

Site visits were conducted on 11 August 2022 and 26 August 2022. Five sites were selected using the following four criteria:

- Main surface water feature on the blue line drainage network traversing, or close to, the pipeline corridor
- Safe and easy entry via publicly accessible routes
- Sites down-gradient from pipeline corridor to capture baseline conditions in area receiving stormwater runoff from the pipeline corridor
- Spatial coverage through Study Area

The first site visit included:

- Walkovers and visual observations / photographs of waterbodies near the proposed pipeline route (**Table 3-3** and **Figure 3-1**).
- Completion of AUSRIVAS Physical Habitat Assessment Sheets (eWater, 2022). Surface water investigations were undertaken at locations outside the Melbourne Airport boundary (**Table 3-1**).
- Water quality testing with a handheld meter at Steele Creek North (Location 1) for dissolved oxygen (concentration and % saturation), electrical conductivity, pH and turbidity

The second site visit included physical observations / photographs at two locations within the boundary of Melbourne Airport (**Table 3-3** and **Figure 3-1**). The implications of not having on-site information on watercourses within the Melbourne Airport Boundary are discussed in **Section 6.2**.

Table 3-3 Summary of the site walkover locations

Location Name	Location Address	Surface Water Type	Visual observation / photograph log	AUSRIVAS physical-chemical assessment	Water quality reading taken
Location 1	Barrie Rd	Creek – Steele Creek North Downstream	✓	✓	✓
Location 2	McLaren St	Storm Water – Steele Creek North Upstream	✓	✓	✗**
Location 3	Koala Cr	Creek – Moonee Ponds Creek	✓	✓	✗**
Location 4	Corner of Link Road and Airport Drive	Swale – Steele Creek North Branch	✓	✗*	✗*
Location 5	Airport Drive	Flood Detention Basin and Raingarden	✓	✗*	✗*

Key: * = Unable to access to Melbourne Airport land on day of site investigation; ** = No safe access point to sample water

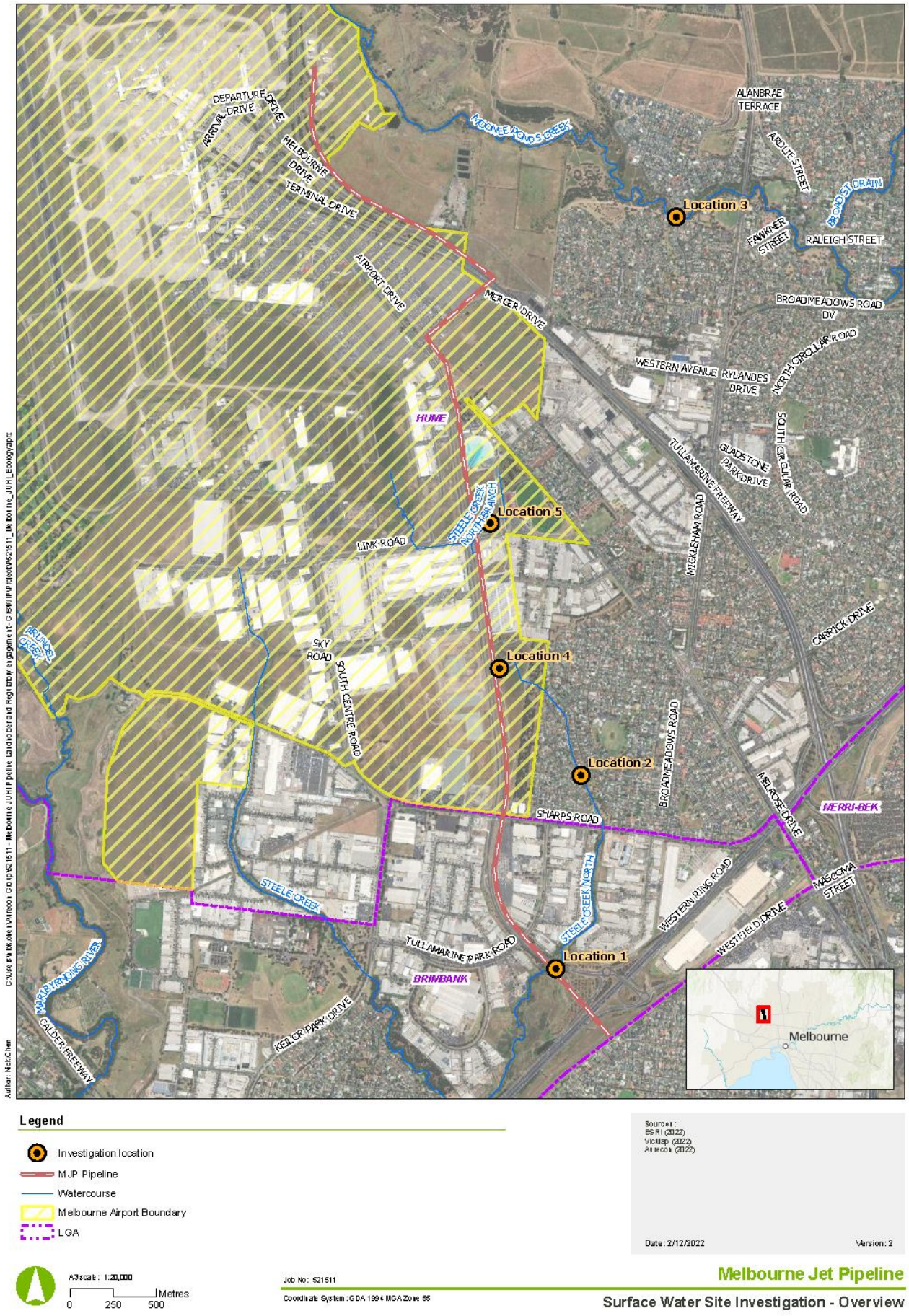

Figure 3-1 **Site walkover locations**

3.5 Impact Assessment Framework

For the purposes of the assessment, the degree of impact depends upon sensitivity of water receptors to impact and the intensity, duration, magnitude and potential spatial extent of these potential impacts. The following sections discuss and define impact magnitudes, receptor sensitivity and impact significance.

3.5.1 Magnitude of impacts

The magnitude of a potential impact is essential to the determination of its level of significance on sensitive receptors. For the purposes of this assessment, impact magnitude is defined as being comprised of the nature and extent of the potential impacts. The impact magnitude is divided into three categories (**Table 3-4**).

Table 3-4 Criteria for magnitude of impact

Magnitude of impact	Description
Low	Localised impact that is temporary, short-term and either unlikely to be detected or effectively mitigated through standard environmental safeguards. Impact that only affects a small / limited area of a watercourse or sub-surface water (e.g. < 20 m distance of the banks between the pipeline chainage transects).
Medium	Impacts are medium term and need specific safeguards to mitigate impact. An impact that extends beyond the immediate pipeline chainage transect (e.g. > 20 m distance of the creek).
High	A long-lasting change, resulting in substantial / possibly irreversible change to the environment. An impact that is widespread, affecting an entire creek / or aquifer down-gradient from the pipeline.

3.5.2 Sensitivity

To assess the significance of potential impacts on receptors, categories were applied to each of the features. The categories are split into three discrete groups as described in **Table 3-5**.

Table 3-5 Criteria for sensitivity of the receiving environmental receptors

Sensitivity of receiving environment	Description
Low	The receptor is in poor to moderate condition with minimal natural features and a large amount of anthropogenic influence. The receptor is not listed on any regulatory registers as being of conservation significance and / or is low community value.
Medium	The environment is in moderate to good condition despite some anthropogenic influence. There are other examples of this type of environment represented in the Study Area, it is not unique. The area contains some elements listed on regulatory registers as having conservation significance and / or has some community value.
High	The environment is largely intact and unimpacted by anthropogenic influence. The type of environment is unique to the area and irreplaceable. The area is listed on regulatory registers as being of high conservation significance. There is high community value associated with the environment.

3.5.3 Significance of impact

The significance of a potential impact is a function of the significance of the impact receptor, the sensitivity of the receptor and the magnitude of the potential impact. Although the sensitivity of the receptor will not change (i.e. is generally determined qualitatively by the interaction of the receptor's condition, adaptive capacity and resilience), the magnitude of the potential impact is variable and may be categorised quantitatively to facilitate the prediction of the significance of the potential impact.

Once the receptor was identified, and the sensitivity of the receptor and the magnitude of the potential impact was determined, the assessment of the significance of the potential impact was derived through use of a three-by-three matrix (**Table 3-6**).

Table 3-6 Significance assessment matrix

Magnitude of potential impact	Sensitivity of receiving environment		
	Low	Medium	High
Low	Negligible	Low	Moderate
Medium	Low	Moderate	High
High	Moderate	High	Major

3.6 Mitigation Measures

Mitigation measures are means to prevent, reduce or control any adverse geomorphological effects of the Project, and include restitution for any damage to the environment caused by those effects through replacement, restoration, compensation or any other means.

The proposed mitigation measures for this project follow typical industry mitigation and management practices.

Mitigation measures are the result of an iterative process that took place between the baseline condition assessment and environmental effects prediction. The proposed mitigation measures for the identified geomorphological effects are summarised in **Section 5**.

3.7 Water permits / approvals

3.7.1 Minor waterways works and build over Melbourne Water assets

Consent from Melbourne Water is required before performing any minor works on or surrounding waterways (Melbourne Water, 2019) or building any structures close to assets (Melbourne Water, 2013). This includes:

- Bank stabilisation – repairing beds and banks that have eroded or collapsed due to the natural elements
- Desilting – removing silt deposits or from around structures
- Bore hole testing, monitoring or other works
- Assets include easements, water mains, sewage pipes, access pits / man-holes, drainage pipes and channels

Melbourne Water protects its rights of access to ensure it is able to fulfil its statutory obligations relating to the installation and maintenance of assets. Following consultation with Melbourne Water it is understood that this permit does not apply for HDD crossing under Steele Creek North (**Table 3-1**) and that other stormwater assets are owned by Melbourne Airport.

3.7.2 Utility installation near Melbourne Water assets

Separate conditions are applicable for utility cables / pipe installations near, or crossing Melbourne Water assets / easements (Melbourne Water, 2013).

For open cut underground assets that involve excavating soil to form a trench, enabling new infrastructure to be laid/ repaired/ removed, which is then backfilled the requirements are:

- A 1 m minimum vertical clearance between the utility and asset

- Concrete cut-offs must be constructed
- Soil compaction to 95% - 98%
- Ground surface to be returned to original condition as per Melbourne Water requirements

For passing over pipes the requirements are:

- Any utility must be self-supporting in the event maintenance is undertaken on the Melbourne Water asset
- Minimum vertical clearance of 0.6 m above asset
- No joints to be located within 2.0 m of the asset (must be outside the joint free area).

For passing under pipes the requirements are:

- Must be cased in concrete or similar protective material
- Must have a minimum clearance of 1.0 m for open cut and 2.0 m for boring installation methods
- No joints to be located within 2.0 m of the asset (must be outside the joint free area)

For waterways and constructed channels, boring a small tunnel drilled through soil enabling new infrastructure to be laid is the preferred methodology and the requirements are:

- Engineering calculations must be supplied to confirm no soil up thrust/down thrust occurs during boring
- No settlement is to occur following installation - air pockets are to be avoided.
- Must have a minimum vertical clearance of 2 m, measured from the hard invert level of the bed of the waterway/channel
- Manholes/parallel utilities require a horizontal clearance of 5-10 m from the bed and bank area for future channel/waterway works or maintenance
- No joints are permitted under the channel/waterway or within 5.0 m from the bed and bank area
- Disturbance to waterways / land / vegetation will be kept to a minimum and the affected areas replanted / reinstated upon completion of the works
- If boring is not possible geotechnical survey and environmental submissions are required to support any altered proposals.

Detailed plans and a formal application must be submitted to Melbourne Water for investigation. In addition, Viva Energy must investigate and ensure legal requirements are met regarding significant flora, fauna and archaeological sites of significance.

To prevent further erosion of waterway beds and banks or protect assets, there are specific engineering solutions that would need to be incorporated at detailed design for approval. Any works undertaken without Melbourne Water approval would be considered illegal under the Water Act (**Section 2.2.5**).

Viva Energy is responsible for the cost of the maintenance and repair of facilities used to supply water to construction works under Clause 6.5.10 Supply of Water to the Works (Melbourne Water, 2019).

Water must not be taken from a metered service or private trunk service without the written approval of the owner. In addition, water must not be taken from Melbourne Water mains when water restrictions are in force. Viva Energy must obtain permission from Melbourne Water for the use of water required for construction purposes (Melbourne Water, 2019). Water from alternative sources must be obtained at the Project's expense.

3.7.3 Council Development Guidance

A Stormwater and Sediment Control Plan (Element 3 Construction Environmental Management Plan) may be required as part of the Permitting Process (**Section 2.3.2**).

If the property is in an area that is liable to flooding, consent is needed in order to build the pipeline (Brimbank Council, 2022).

3.7.4 Other guidance

Other guidance that should be followed includes:

- Site Environmental Awareness Training (Melbourne Water, 2017)
- Principles of erosion management under Clause 6.13.1 (Melbourne Water, 2017)
- Structures built near assets are required to meet Melbourne Water's foundation criteria and overland flow path standard clearance requirements to ensure the safety of the proposed structures and existing pipe networks.
- Generally structures are not permitted over Melbourne Water assets, however some structures may be approved if minimum clearance conditions are met, the structure is non-permanent and can be fully removed. Eaves and overhangs are not permitted.

If the Project requires a discharge licence to the environment, licencing under EP Act and water quality outlined in the ERS, ANZECC & ARMCANZ 2000 and ANZG, 2018 need to be considered.

These conditions do not preclude the need to obtain other relevant approvals and operation of other legislations such as the *Airports Act 1996* (**Section 2.1.3**).

4 Existing Conditions

Existing conditions on a regional and local scale have been reviewed in relation to the project and hydrological and hydrogeological matters of interest. The review was based on Lotsearch reports that were retrieved for the entire proposed pipeline alignment, up to a buffer radius of 1 km. Copies of the Lotsearch reports have been provided in the Aurecon Environmental Site Assessment (ref: 521511-100000-REP-EN-0007) prepared as part of this project.

4.1 Geology

It is important to consider the geological setting of the project on a regional and local scale with respect to identifying potential surface water and groundwater impacts posed from and to the project during construction and operational phases. These natural water resources have extensive reach and are heavily interrelated to topography and existing soil and rock characteristics. As such, any identifiable impacts may also be several kilometres downstream or downgradient of the project.

A review of the geological surface mapping of Sunbury at 1:50,000 scale presented in the Lotsearch reports indicated that the site consists of a number of different geological groups. **Table 4-1** describes the geological groups in association with the geological age and lithology.

Table 4-1 Site-specific geology

Geological Age	Formation	General Description
Quaternary	Newer Volcanic Group – basalt flows (Neo): generic	Alkali basalt (major proportion); tholeiitic basalt (major proportion); alluvium (minor proportion); tuff (minor proportion)
	Alluvium (Qa1): generic	Gravel material (significant); sand (significant); silt material (significant)
	Granite-derived colluvium (Qc4): generic	Sand (all)
	Tullamarine Basalt (Nuu): generic	Basalt (all)
	Waste deposits (Qhw): generic	Fill (all)
Tertiary	Red Bluff Sandstone (Nbr): generic	Conglomerate (significant); sandstone (significant)
	Colluvium (Qc1): generic	Diamictite (dominant); gravel material (significant); sand (significant); silt material (significant)
Silurian	Melbourne Formation (Sxm): generic	Sandstone (major proportion); siltstone (major proportion)
	Melbourne Formation (Sxm): hornfels	Hornfels (all)

The 1:50,000 ‘Sunbury’ Sheet indicates that most of the deposits are Quaternary aged New Volcanics; however the north and south regions within the 1 km buffer zone shows veins and deposits of tertiary-aged formations. North to north-east of the alignment shows veins of Red Bluff Sandstone within Tullamarine Basalt. There are small deposits of Alluvium (gravel, sand and silt) and Colluvium (predominantly Diamictite).

Adjacent (east) to the proposed alignment, a large waste deposit of organic and non-organic fill is shown. South of the proposed alignment, similarly, is predominantly Quaternary aged New Volcanics. A large vein of Colluvium (predominantly Diamictite) is indicated in the south-south-west flowing through the centre of the proposed alignment to the north. The Colluvium in the local region (south-west) is surrounded by a thin deposit of Tertiary aged Red Bluff Sandstone. Both the Tertiary aged Colluvium and Red Bluff Sandstone present with the Quaternary aged New Volcanics indicating there may be present deposits in former depressions of the underling surface during volcanic activity.

Silurian bedrock underlies the Tertiary units and directly below Quaternary units where the Tertiary units have fully eroded. This is seen irrespectively in the north of the proposed alignment. It suggests that a large significant period of weathering and erosion occurred during the geological history of precinct. The Silurian bedrock within the area is classified as Melbourne Formation (sandstone and siltstone).

4.1.1 Soil landscapes

The soil in the project footprint is predominantly Chromosol (Lotsearch report; Atlas of Australian Soils), consisting of red friable earths and acidic texture contrast soils on the higher fertile plain, to grey cracking clays on the low plains (Biosis, 2019). Locally, the proposed alignment in the north indicates a shift from Chromosol to Sodosol. The range in soils supports the vast ecosystems (Stony Knoll Shrubland, Plains Grassy Woodland Plains Grassland and Plains Grassy Wetland). A review of Lotsearch historical aerials from 1931, 1945, 1960, 1980 and 1990 indicate that active airport areas close to the pipeline footprint (runways, taxiways, terminals, hangers, etc.) have undergone major ground disturbing works. The natural soil profile of the area is sandy clay, however it is difficult to determine the fill from sandy clay in some areas. The proposed area is generally flat. The site-specific soil classification is described in **Table 4-2**.

Table 4-2 Site specific soil description

Soil Order	Soil Description	Distance
Chromosol	Dissected plateaux at low elevation: plains of hard alkaline red soils association with dark cracking clays Grey and brown cracking clays Low rounded hills of various soils (D) with boulder strewn slopes incised, often gorge-like, stream valleys of undescribed soils.	0 m onsite
Sodosol	Undulating to hilly, dissected by streams with narrow to moderate expanses of flats Gentle to steep slopes of hard acidic, yellow mottled soils with some areas of shallow grey-brown sandy soils on upper slopes and various (D) soils including leached sands on mid and lower slopes Flats and former swampy areas of dark cracking clays and smaller areas of other soils with peaty surfaces; small areas of units Ob6 in the western part, and Pb3 in the south-eastern part of the unit.	812 m north

The Victorian Soil Type classification further narrows the description of the soil at the proposed site. Regionally, brown Dermosols is the major soil type, however there is a large portion of unassigned soil to the east and south of the proposed alignment. Locally, there are five varying soil types to the north of the proposed alignment – Brown Dermosols, Black Vertosols, Brown Sodosols, Grey Sodosols, and Grey Dermosols. The south is largely unassigned soil with Brown Dermosols and Sodosols presenting as the only soil types.

4.1.2 Potential acid sulfate soil and rock

The proposed alignment (both north and south) lies within a soil region that is assigned a ‘C’ classification by the National Acid Sulphate Soil Atlas. This classifies the site as having an ‘Extremely Low Probability of Occurrence’ of ASS indicating a 1-5% chance of occurrence. North 812 m from the proposed alignment location is a class ‘B’ classification soil section. Class B has ‘Low Probability of Occurrence with 6-70% chance of occurrence’.

4.2 Climate

The Melbourne region has a temperate climate and generally experiences mild winters and warm summers. Rainfall is relatively uniform throughout the year, but generally higher during the winter and spring months (June–November).

Typically, streamflow in the region's rivers reflects the distribution of rainfall throughout the year. Higher streamflows and storage inflows occur during June–November; less streamflow occurs during the summer months (December–February).

Climate change has led to higher intensity storms and increases in temperature. Higher intensity storms result in higher runoff volumes and the increase in temperature increases evaporation rates which can lead to a reduction in groundwater recharge. Lower recharge to groundwater in the near future will in turn lead to lowering of the groundwater table, resulting in a reduction in base flow into the Moonee Ponds Creek. Climate change, however, is unlikely to have a significant impact on this project due to the short duration of construction phase and the lack of operational phase disturbance to the water cycle.

More detailed information on climate data for the project footprint can be found in **Appendix A**.

4.3 Topography and drainage

The site's topography and regional geography suggests that groundwater flows south-west towards the Maribyrnong River. The alignment shifts from 115 mAHD (north) to 55 mAHD (south). Geologically, the area has been shaped by volcanic activity, forming sheets of basalt (bluestone) which consequently formed steep banks as the river cut through the plain (Melbourne Water, 2021).

The general overland topography shows that the pipeline cuts across contours decreasing from 115 mAHD in the northern section to 60 mAHD in the southern section at the Steele Creek North crossing (**Figure 4-1**). An inferred north-south overland drainage pathway is indicated. Stormwater drainage generally follows the proposed alignment, with extensive networks around Mercer Drive between Tullamarine Freeway and Airport Drive, and this continues to follow Airport Drive until the Sharps Road intersection.

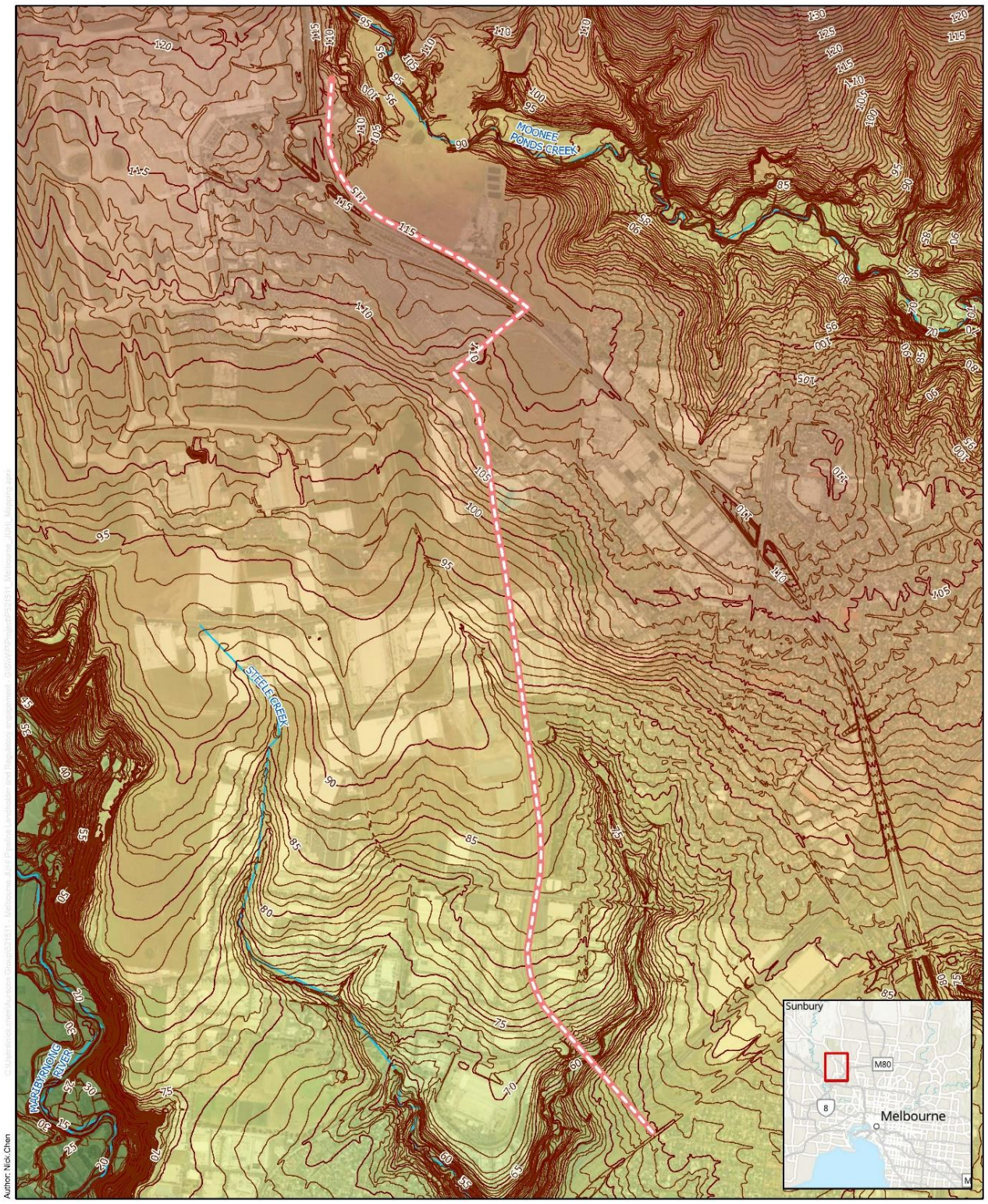

Figure 4-1 Site topography and drainage

4.4 Hydrogeological setting

4.4.1 Aquifers and aquifer properties

Regionally, groundwater is anticipated to flow in a southerly direction towards Port Philip Bay. Groundwater intercepts surface water along the Maribyrnong River, west of the proposed alignment confirming the shallow nature of the water table in the region. Perched seepage flows will, however, occur along the soil and rock interface and may also occur within fractured zones and joints in the bedrock. Groundwater levels and seepage flows will fluctuate and are likely to increase following periods of extended wet weather.

Locally shallow aquifers form in higher permeability areas and groundwater flow is predominantly horizontal with vertical flow occurring via fissures/fractures that cross-cut bedding (Department of Agriculture, Water and the Environment, 2019). The perched aquifers along the project alignment are described as fractured or fissured, extensive aquifers of low to moderate productivity. The water table over nearly half of the northern alignment is between 5-10m depth and are as shallow as 5 m in the southern alignment (**Table 4-3**).

Table 4-3 Summary of water table depth within the proximity of the project

Pipeline area	Depth to Water table	Percent Of Site Area
Northern Alignment	10 to 20 m	58
	5 to 10 m	42
Southern Alignment	10 to 20 m	60
	5 to 10 m	35
	Less than 5 m	5

4.4.2 Hydrological landscape mapping

The study area encompasses two different hydrogeological landscapes – the Newer Volcanic Group and Colluvium. Site-specific monitoring data shows that groundwater levels are between 5 – 25 m bgl with some shallow perched aquifers at 5 m. Groundwater is expected to flow immediately from east to west towards the airport runways and in the direction of Arundel Creek and the Maribyrnong River and then southerly towards Port Philip Bay.

4.4.3 Groundwater resources and user

A search of the Visualising Victoria's Groundwater Bore explorer identified 102 registered bores within the buffer zone of the pipeline. The identified bores have the following registered uses:

- Domestic and Stock = 5
- Investigation = 58
- Industrial = 1
- Irrigation = 1
- Observation = 16
- Unknown Use = 21

Bores were reported to range in depth from between 0.0 m bgl to 25 m bgl. Many of the bores within the 1 km buffer of the alignment are no longer monitored (inactive) with only two bores still actively monitored. **Appendix B** details the 102 bore ID's, locations, primary uses and monitoring status.

Visualising Victoria's Groundwater Bore explorer also identified a groundwater restricted use zone within the proximity of the project at a former landfill and waste depot. The groundwater restricted use zone, EPA IBIS ID 7001012, is restricted for:

- Drinking water
- Livestock water supply
- Irrigation of crops and parks
- Water used for recreational purposes

  Water used for industrial purposes

4.4.4 Groundwater quality

Groundwater quality has low - moderate salinity potential (based on the Victorian Statewide Watertable Salinity Map). This defines that groundwater falls into Segment A2-B (low salinity) and Segment C or D (moderate salinity). Environmental values identified from the Environmental Reference Standard for these two segments are listed in **Table 4-4**. As discussed in **Section 4.4.3**, however, the type of groundwater bores in the area are primarily groundwater monitoring bores (investigation bores) and some domestic and stock bores indicating that the current primary use of groundwater is for environmental purposes (i.e. providing base flow to waterways). **Table 4-4** shows that at least 81 percent of groundwater below the site area has low salinity.

Table 4-4 Groundwater salinity concentrations

Area with Proposed Site	TDS Concentration	Groundwater segment	Environmental values*	Percent Of Site Area
Groundwater (north)	1,000 – 3,500 mg/l	A2 or B*	▪ Water dependent ecosystems and species ▪ Potable mineral water supply ▪ Agriculture and irrigation (irrigation) ▪ Agriculture and irrigation (stock watering) ▪ Industrial and commercial use ▪ Water-based recreation (primary contact recreation) ▪ Traditional Owner cultural values ▪ Buildings and structures ▪ Geothermal properties	81
	3,500 – 7,000 mg/l	C or D**	▪ Water dependent ecosystems and species ▪ Agriculture and irrigation (stock watering) ▪ Industrial and commercial use ▪ Water-based recreation (primary contact recreation) ▪ Traditional Owner cultural values ▪ Buildings and structures ▪ Geothermal properties	19
Groundwater (south)	1,000 – 3,500 mg/l	A2 or B*	▪ Water dependent ecosystems and species ▪ Potable mineral water supply ▪ Agriculture and irrigation (irrigation) ▪ Agriculture and irrigation (stock watering) ▪ Industrial and commercial use ▪ Water-based recreation (primary contact recreation) ▪ Traditional Owner cultural values ▪ Buildings and structures ▪ Geothermal properties	100

* Not suitable for potable water supply (desirable nor acceptable) ** Not suitable for agriculture and irrigation (irrigation) and potable water supply (desirable nor acceptable)

4.4.5 Groundwater dependant ecosystems

Ecosystems that rely on groundwater for some or all of their water requirements are classified as Groundwater Dependent Ecosystems (GDE).

Desktop investigations using the Bureau of Meteorology's GDE Atlas and Visualising Victoria's Groundwater Bore Explorer identified that Steele Creek North and Moonee Ponds Creek are registered aquatic and terrestrial GDEs within the buffer zone of the Site. Maribyrnong River is also a registered GDE.

4.5 Catchment and surface water environment

4.5.1 Regional

The project is located within the broader Port Philip Bay and Westernport Catchment Management Area and specifically within the Maribyrnong Catchment (**Figure 4-2**). The CMA consists of the Werribee Catchment, Maribyrnong Catchment, Yarra Catchment, Dandenong Catchment and Westernport Catchment.

The Maribyrnong catchment region covers an area of approximately 1,450 km^2, comprising approximately 10 per cent natural vegetation, 80 per cent agriculture land and 10 per cent urban land (Melbourne Water, 2022). The catchment includes the 41 km long Maribyrnong River – the second major river in the region – which begins on the southern slopes of the Great Dividing Range, in the Cobaw Ranges. It includes a number of important waterways and wetlands, including Stony, Moonee Ponds and Deep Creeks and the Jacana, Pipemakers Park and Queens Park wetlands. The lower 15 km of the Maribyrnong River flows through urban areas (Melbourne Water, 2022).

Most of the Maribyrnong catchment consists of dissected, upland volcanic plains with deeply entrenched waterways (Melbourne Water, 2022). The northern edge and a strip running down the Deep Creek consist of sedimentary rocks with areas of granite and gneiss.

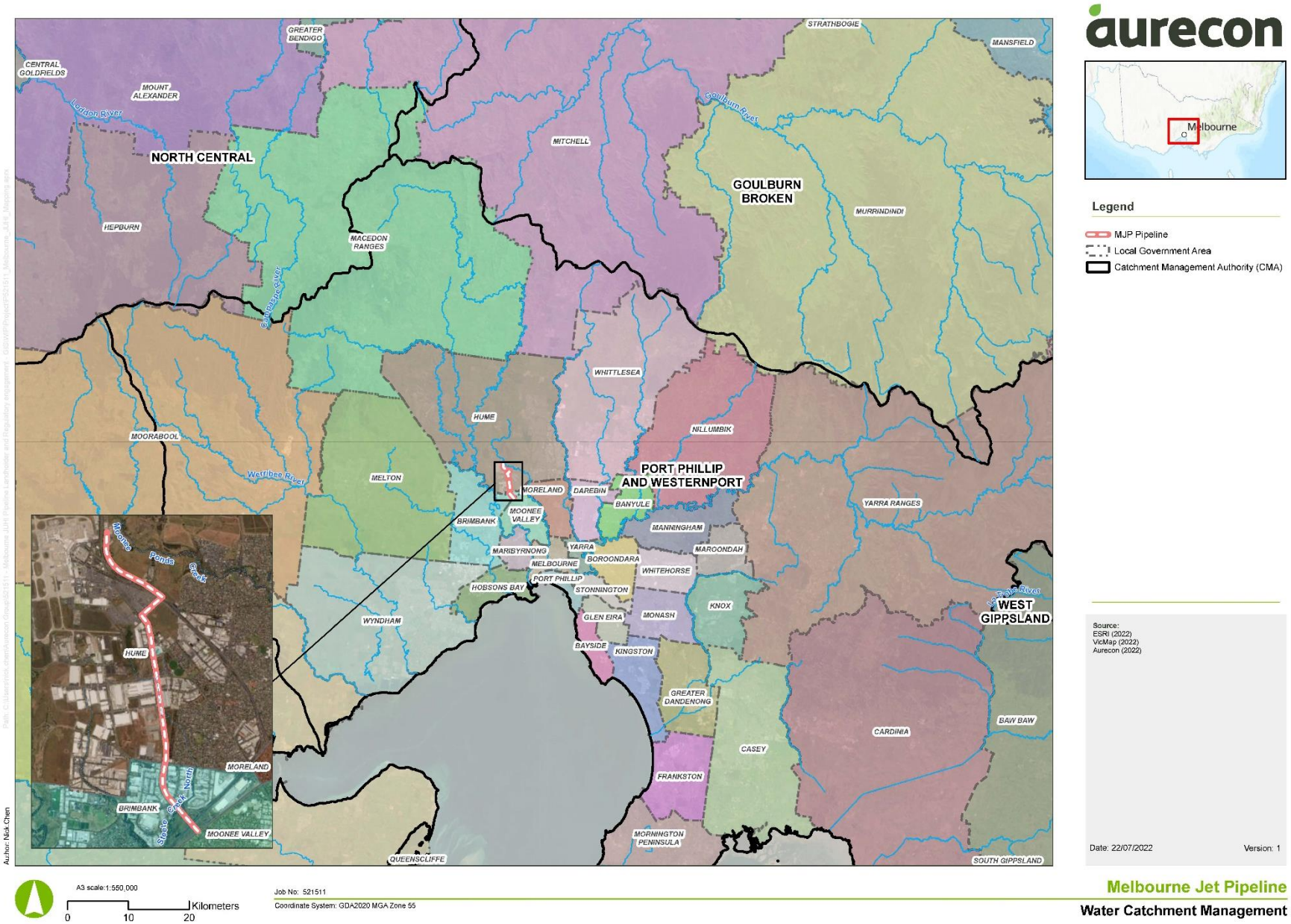

Figure 4-2 **Port Phillip Bay Catchment Map**

4.5.2 Local

Waterways

Construction for the project would be within the catchments of Steele Creek North and Moonee Ponds Creek (**Figure 3-1**). Both of these creeks are likely to receive stormwater runoff via overland flow from Project Land given the proximity of the waterway to the proposed alignment. The other waterways connected to the project are stormwater drainage networks and wetlands catchment areas located along the boundaries of Melbourne Airport. **Table 4-5** outlines the catchment region and water retailer for the locations of highest potential surface water runoff contamination. The pipeline alignment passes beneath Steele Creek Reserve.

Table 4-5 Water catchment summary of waterbodies with potential of surface water runoff from the project

Site Walkover Location Access	Water Body Type	Water Body Name	Metropolitan Water Retailer	Catchment Management Authority	Drainage and Waterway Asset
Location 1	Creek	Steele Creek North	Greater Western Water	Port Phillip	No
Location 2	Stormwater to Creek	Steele Creek North Drain	Greater Western Water	Port Phillip	No
Location 3	Creek	Moonee Ponds Creek	Yarra Valley Water	Port Phillip	No

These receiving waters fall into the Urban segment under the Environmental Reference Standard (**Section 2.2.4**), comprising areas within the urban growth boundary for Metropolitan Melbourne (as shown on the metropolitan fringe planning schemes set out in Section 46AA of the *Planning and Environment Act 1987*) and as such are 'highly modified' freshwater stormwater drains / waterways. Both Steele Creek North and Moonee Ponds Creek are major tributaries of the Yarra River running through urban Melbourne.

Steele Creek North

Steele Creek North is a second order watercourse sourced near the Value Car Park car park which runs north – south for approximately 5.5 km before discharging into the Steele Creek at the Western Ring Road. It surfaces to the south of the car park / taxi rank as a broad open floodplain with no defined channel. It is culverted under Link Road and then flows through the stormwater harvesting system (**Appendix D**). Following this, it forms a concrete v-shaped drainage channel through Tullamarine Linear Reserve. It is culverted under Sharps Road and breaks out into a natural channel with a 40 m buffer vegetated corridor for the remainder of its length. It is ephemeral along its entire course forming chain-of-ponds.

Steele Creek North Branch

Steele Creek North Branch is a first order drainage channel which joins Steele Creek North south of Link Road. It is sourced at Melrose Drive and at first flows east – west before flow south-westerly and flowing into Steele Creek North after approximately 1 km. It flows in an open grassed swale between Watson Drive and Airport Drive before being culverted under the road and flowing underground to the confluence with Steele Creek North.

Moonee Ponds Creek

Moonee Ponds Creek is sourced approximately 6 km north of Melbourne Airport at Oaklands Junction and runs north – south, flanking the eastern side of the airport and eventually flowing into the Yarra River at Docklands.

Stormwater drainage

A complex stormwater drainage network is present within the project area. There are 44 crossings of stormwater drainage pipes into the pipeline corridor (**Appendix C**).

Water-sensitive urban design practices were, and continue to be, incorporated in all new designs, ranging from car parks to warehouses. The use of bioswales and rain gardens was initiated to reduce the required size of water mains and improve water quality through local detention and bioretention treatment. Stormwater drainage at Melbourne Airport is managed through an extensive drainage network. Vegetated swales, drainage pits, subsurface pipes, retention basins, raingardens and gross pollutant traps are currently in use and are expected to be upgraded. Current site management practices that are in place to minimise potential contamination export included spill response, construction site audits, erosion/ sediment control, street sweeping and regular stormwater pit maintenance. Previous investigations of water quality monitoring and stream health identified the need to increase the resilience of receiving waterways to airport stormwater flows. There is evidence of degraded habitats in some reaches of Moonee Ponds Creek, Arundel Creek and Deep Creek making them more susceptible to impacts from stormwater flows.

Surface water quality

The Maribyrnong River scores poorly for water conditions with the majority of the 11 criteria in 2018 assessment of waterway values and conditions allocated a Moderate or Low score as shown in **Table 4-6** (Melbourne Water, 2022).

Table 4-6 Waterway values and conditions in the Maribyrnong catchment

Waterway conditions	2018 state	2018 trajectory	2068 target
Stormwater	Moderate	Moderate	High
Physical form	Moderate	Low	Moderate
Water for the environment	Moderate	Low	High
Vegetation quality	Moderate	Low	Moderate
Vegetation extent	Low	Low	High
Instream connectivity	Low	Low	Moderate
Water quality – environment	Moderate	Low	Moderate
Access	Low	Low	Moderate
Litter	High	Moderate	High
Water quality – recreational	High	Moderate	High
Participation	Moderate	Low	Very high

Melbourne Water has rated Steele Creek's water quality as 'Poor' for the past 20 years. The major sources of pollution have been VicRoads' freeways, Melbourne Airport, Essendon Airport, local industries and businesses, and local roads (Friends of Steele Creek, 2015). Historic Waterwatch data at a site on Steele Creek at AJ Davis Reserve is presented against indicators and objectives in the Environmental Reference Standard for Tributaries of Werribee and Maribyrnong Rivers for Urban Segments in **Table 4-7**.

Table 4-7 Water quality indicators comparison to ERS Values

	Sample number	Total phosphorus (µg/L)	Dissolved oxygen (% satn.)		Turbidity (NTU)	Electrical conductivity (µS/cm)	pH (pH units)	
Percentile		75th percentile	25th percentile	Maximum	75th percentile	75th percentile	25th percentile	75th percentile
ERS Value		≤110	>60	130	≤30	≤3,000	≥6.5	≤8.2
Steele Creek at AJ Davis Reserve	13*	460**	80 (n = 1)	80 (n = 1)	15	1,120	8.6	9.6

Key: *Except where indicated (n = 1); **Phosphate data only available; = Inside range = Equal to range = Outside range

Turbidity and electrical conductivity levels appear to be within the expected ERS ranges for urban systems. Elevated phosphorus concentrations and pH levels were evident from this analysis. Dissolved oxygen data cannot be interpreted as only one data point was available. This comparison reflects on poor water quality conditions at the site and the need for contemporary datasets for Steele Creek North (see below and **Appendix E**). Furthermore, to assess beneficial uses suitability in the watercourses there is a need to compare against a more complete set of water quality indicators that have not been measured at these sites including total phosphorus, total nitrogen and toxicants (e.g. metals).

A search of publicly available databases outlined in **Table 3-2** provided limited water quality data in the area. Water monitoring data from Water Measurement Information System and Waterwatch returned no current sites within the area with sufficient data to provide an understanding of the existing conditions of Moonee Ponds Creek, Steele Creek North or Steele Creek North Branch. Surface water quality readings were, therefore, taken during the site walkover on 11 of August (**Table 4-8**) (**Appendix D**). All readings were within a healthy aquatic range.

Table 4-8 Surface water quality readings from the site walkover

Site Location	Temperature (°C)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Sat.)	pH	Turbidity (NTU)
ERS Value	nv	< 3,000	nv	60 - 130	6.5 – 8.2	< 30
Steele Creek North	9.8	293	7.41	65.9	7.26	24
Moonee Ponds Creek	9.6	nd	nd	81.1	7.64	21

Key: nv = No value; nd = no data; = Inside range = Equal to range = Outside range = No ERS value

Water quality testing by Melbourne Airport has shown high levels of per- and poly- fluorinated substances (PFAS) at the airport (EPA Vic, 2020). They also found high levels of PFAS in surrounding waterways, including:

- Arundel Creek
- Deep Creek
- Maribyrnong River
- Steele Creek.

Advice has also been issued for people to restrict consumption of fish from the Lower Maribyrnong and Lower Yarra Rivers due to elevated levels of polychlorinated biphenyls (EPA Vic, 2020).

4.6 Flooding

Large severe floods within the project footprint generally occur as a result of a moist warm airflow from northern Australia bringing moderate to heavy rainfall over a period of 12 hours or more following a prolonged period of general rainfall (Victoria State Emergency Service, 2022). The period of general rainfall “wets up” the catchments and (partially) fills both the on-stream dams and the natural floodplain storage. These combine to increase the runoff generated during the subsequent period of heavy rainfall.

Large but less severe floods result from sequences of cold fronts during winter and spring that progressively wet up the catchments and fill the on-stream dams and the natural floodplain storage.

Water level changes in watercourses within the Study Area are expected to rise and fall quickly. Modelled 1-in-100 year riverine flood extents provided by DELWP (current as of 5 February 2018) were reviewed for the pipeline corridor and in a 1 km radius buffer around the project (**Figure 4-3**). Flood flows are constrained within the bankfull channel for Moonee Ponds Creek, Steele Creek and Steele Creek North with no overtopping onto adjacent land indicated in the mapping. The only other potential flood feature identified on the mapping was the ‘Urbnsurf’ Surf Park located at 309 Melrose Drive, Tullamarine (**Figure 4-3**). No online searches could confirm if 1-in-100 year flood events would be contained within the footprint of the property (**Section 6.2**).

The DELWP mapping includes riverine flood risk but does not include flash flooding and overland flows from short duration, high intensity rainfall (usually associated with thunderstorm activity with more than 20mm/hour rainfall intensity). This could cause localised flooding close to the project footprint along overland flow paths when the local stormwater drainage system surcharges, especially on blocked or capacity impaired drains. Such events, which are mainly confined to the summer months, do not generally create widespread flooding since they only last for a short time and affect limited areas. Flooding from these storms occurs with little warning and localised damage can be severe. The Steele Creek North Branch and confluence of Steele Creek North and Steele Creek are both identified in State Emergency Service mapping as part of the 1-in-100 year Flash Flood Extent for Brimbank City Council and Hume City Council Local Flood Guides (Victoria State Emergency Service, 2022). The spatial extent of the Steele Creek North Branch flood area is approximately 250 m width x 750 m length. The spatial extent of the Steele Creek North and Steele Creek flood area is considerably smaller at approximately 200 m width x 400 m length. It has not been possible, however, to verify the source of this information nor the date of map publication (**Section 6.2**). The mapping is possibly outdated and redundant as the road network on the mapping does not include Airport Drive (Sharps Road – Melrose Drive/Mercer Drive), and associated stormwater infrastructure, which was opened in 2015.

Figure 4-3 **Riverine 1-in-100 year flood risk close to the pipeline corridor**

4.7 Sensitive environments and water users

4.7.1 Water users

Over 350 bird species are recorded in the Maribyrnong Catchment of which 95 species are riparian specialists (Melbourne Water, 2022). There are a number of threatened freshwater fish species including the Australian Grayling, Yarra Pygmy Perch and Australian Mudfish, and threatened frog species include the Growling Grass Frog, Brown Toadlet and Southern Toadlet. Much of the higher quality vegetation and macroinvertebrate value areas, however, are in the forested upper catchment with degradation increasing towards the lower reaches including in the project footprint.

An assessment of waterway values in the Maribyrnong Catchment has shown that current ecological values are low but that social values (e.g. amenity, community connection and recreation use) are high (Melbourne Water, 2022) (**Table 4-9**).

Table 4-9 Assessment of waterway values and conditions in the Maribyrnong catchment

Waterway values	2018 state	2018 trajectory	2068 target
Birds	Moderate	Moderate	Moderate
Fish	Low	Low	Moderate
Frogs	Moderate	Low	Moderate
Macroinvertebrates	Moderate	Low	High
Platypus	Moderate	Very low	Moderate
Vegetation	Low	Very low	Moderate
Amenity	High	Moderate	High
Community connection	High	Moderate	Very high
Recreation	High	Moderate	Very high

Steele Creek North provides aquatic habitat in the study area (Aurecon, 2022). The waterway supports isolated patches of riparian woodland comprising a healthy canopy of River Red-gums and shrubs such as Blackwood, Lightwood and Tree Violet. Given the industrial setting, dumped rubbish was observed near this stretch of the creek. Weed cover was high with introduced grasses dominating the margins. Common Froglet was heard calling in the inundated grassy margins of the creek (Aurecon, 2022). The section of the creek in the study area comprised various habitat features including rocks, instream vegetation including Cumbungi and Rush, and flowing water which would provide habitat for additional frog species. The riparian habitat along Steele Creek North is likely to support habitat for native fauna including birds, frogs, reptiles and arboreal mammals.

Growling Grass Frogs inhabit waterways and other aquatic habitats in southeast Australia, including the greater Melbourne region. They are listed as Vulnerable under the EPBC Act. Key habitat features for the species includes submerged vegetation for egg-laying, rocks and logs for basking, permanent freshwater lagoons for breeding and cracks, as well as debris and dense vegetation for refuge. Potential habitat for the Growling Grass Frog exists along Steele Creek North despite the quality and diversity of habitats in the section of the creek that dissects the study area being low (Aurecon, 2022). A recent record of the species from late 2018 also exists from Steele Creek, less than 500m southwest of the study area. This suggests that the species is present in the area and is likely to occasionally utilise the riparian habitat in the project site. The study area dissects Steele Creek North where it passes under Airport Drive. As such, this part of the creek is already exposed to a high degree of disturbance from shadowing, noise and disturbance. Additionally, this section of the creek has a high weed cover and rubbish has been dumped near to the margins, namely where vehicle access is available off Airport Drive and the end of Barrie Road. As such, the

likelihood of the Growling Grass Frog dispersing beyond the margins of the creek in this location is extremely low.

A Protected Matters Search indicated that permanent inundated parts of the channels of Steele Creek North and Moonee Ponds Creek may also support the following aquatic species:

- *Galaxiella pusilla* (Eastern Dwarf Galaxias), Vulnerable Species or species, habitat likely to occur within area
- *Nannoperca obscura* (Yarra Pygmy Perch), Vulnerable Species or species habitat may occur within area
- *Prototroctes maraena* (Australian Grayling), Vulnerable Species or species habitat may occur

4.7.2 Native vegetation

Native vegetation was recorded in the study area, though was largely limited to small patches of riparian woodland within the floodplain of Steele Creek North, as well as isolated patches of native grassland in both the north and south of the alignment (Aurecon, 2022). No threatened flora listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were deemed to have a moderate or high likelihood of occurrence in the study area due to lack of suitable habitat. Black Wattle (*Acacia mearnsii*) was recorded in the Study Area along the Steele Creek North directly downstream from the Airport Drive Crossing in the southern alignment. It is known to grow in river corridors (Rojas-Sandoval & Pasiecznik, 2015) and has a large water demand (Dye & Jarmain, 2004). A FFG Act Protected Flora permit would be required to remove this species from public land (Aurecon, 2022). Clearance can also destabilise soils and leave them prone to erosion (Dye & Jarmain, 2004).

4.7.3 Wetlands

There are no Ramsar-listed wetlands nor any Nationally Important Wetlands (Directory of Important Wetlands) within 1 km of the proposed project site.

4.7.4 Water dependent ecosystems

There are a number of water dependent ecosystems within the proximity of the project. Desktop investigations using the Bureau of Meteorology's GDE atlas and visualising Victoria's Groundwater Bore explorer identified that Steele Creek North and Moonee Ponds Creek both shows that there are several registered aquatic and terrestrial GDE's. The development is not expected to impact Moonee Ponds Creek, however may impact Steele Creek North. Maribyrnong River is also a registered GDE and while it is outside the project's proximity, it must be considered

5 Impact Assessment

Potential impacts arising from construction and operation of the pipeline on the water environment and outline measures to avoid or minimise those impacts have been outlined in the tables below, as follows:

- Drainage (**Section 5.1**)
- Flood (**Section 5.2**)
- Groundwater (**Section 5.3**)
- Sensitive environments / water users (**Section 5.4**)

The sensitivity of the surface water system (including Moonee Ponds Creek and Steele Creek North) and underlying Volcanic Group and Colluvium aquifer (northern alignment) was considered as ‘low’ due to:

- Absence of areas containing elements listed on regulatory registers (e.g. *Water Management Act, 2000*)
- Deeper groundwater table (compared to the southern alignment)
- Groundwater restricted use zone
- Highly urbanised / industrialised land-use
- Lack of active groundwater bores in the Study Area
- Modified nature of the surface water systems

The sensitivity of the underlying Colluvium aquifer (northern alignment) was considered as ‘medium’ due to:

- Shallower groundwater table (compared to the southern alignment)
- Perched seepage / fractured zones flows leading to higher groundwater-surface water connectivity
- Improved water quality (compared to the northern alignment)

The sensitivity of the flood detention basin on Melbourne Airport land (**Appendix D**) was considered as ‘high’ due to the important function of retaining stormwater flows and reducing flood risk on the Tullamarine residential area to the east of the Study Area.

The mitigation measures identified will be developed in more detail into specific methods within a Construction Environmental Management Plan (CEMP).

5.1 Drainage

Table 5-1 Potential drainage impacts

Impact code	Phase	Impact description	Pre-mitigation risk rating	Mitigation measures	Post-mitigation risk rating
D01	Construction	Stockpiles would obstruct localised overland flows. Stockpiles are susceptible to mobilisation of sediments which may be transported to drainage lines.	▪ Low sensitivity ▪ Medium magnitude (short time frame impacts but could extend beyond immediate pipeline corridor) ▪ Low significance	The project is considered to pose a low impact as the requirement for excavation is limited to small trench areas along the pipeline corridor. Construction methodology for the pipeline has been selected to reduce excavation and concreting requirements. In addition, there are no perennial watercourses in the immediate vicinity of the Project area. Nevertheless, a CEMP would be required to mitigate any risk regarding stockpiles. Minimising the number of stockpiles and the area / duration that the stockpiles are exposed would reduce risk. Locating stockpiles away from drainage lines and where they will be least susceptible to wind erosion. Refer to EPA Publication 1895 for further mitigation measures.	▪ Low sensitivity ▪ Low magnitude (short time frame impacts and unlikely to extend beyond pipeline corridor to water receptors) ▪ Negligible significance
D02	Construction	Construction material / waste or sedimentation transported to drainage lines, impacting natural or existing drainage regimes by impeding drainage and reduction of environmental values such as visual amenity and aquatic ecosystem health.	▪ Low sensitivity ▪ Medium magnitude (short time frame impacts but could extend beyond immediate pipeline corridor) ▪ Low significance	Construction waste and material should be properly managed on site, to reduce the risk of such materials ending up in the grassed swales and drainage structures along the proposed project area. A CEMP should be prepared to outline storage of materials and waste. The risk of waste being trapped along perimeter fencing and in drainage will be specifically addressed in this document. Land cover will be maintained to protect against erosion risk. Refer to EPA Publication 1834 for further mitigation measures. Weather forecasts should be considered when planning earthwork and ground disturbing activities. Where practicable, earthwork and ground disturbing activities must be avoided during periods of heavy rainfall or high winds. Prior to the commencement of ground disturbing work, any stormwater pits, drains or any open channels in close proximity to work sites should be protected. Stormwater pits along Airport Drive subject to sediment deposits should be fitted with appropriate sediment controls such as kerb inlet protectors, (geofabric) filter material to capture sediments, and/or gully pit baskets (e.g. Enviropod, Ecosol Litter Basket or similar). Routine visual inspections should be undertaken regularly while carrying out works within the vicinity of Moonee Ponds Creek, Steele Creek North Branch or Steele Creek North watercourses (circa 100 m) to identify any sedimentation impacts.	▪ Low sensitivity ▪ Low magnitude (short time frame impacts and unlikely to extend beyond pipeline corridor to water receptors) ▪ Negligible significance

Impact code	Phase	Impact description	Pre-mitigation risk rating	Mitigation measures	Post-mitigation risk rating
D03	Construction	The construction of the pipeline will require excavation of material for open trenches (depth approximately 1.5 m). At a minimum, excavations will be required to cross multiple roads and industrial areas. This could lead to requirement to dewater and discharge waters back into the receiving environment, increasing flow volumes.	▪ Low sensitivity ▪ Medium magnitude (short time frame impacts but could extend beyond immediate pipeline corridor) ▪ Low significance	Clean stormwater would be diverted away from open trenches to prevent stormwater runoff from flowing over disturbed sites and to reduce the volume of water collected in the depressions to only include 'dirty' disturbed area runoff and direct rainfall input. Weather forecasts should be considered when planning earthwork and ground disturbing activities. Where practicable, earthwork and ground disturbing activities would be avoided during periods of heavy rainfall or high winds. Trenching extent would be staged to reduce the duration and amount of exposed soils. Prior to the commencement of trenching work, any stormwater pits, drains or any open channels in close proximity should be protected. Stormwater pits along the pipeline corridor subject to sediment deposits should be fitted with appropriate sediment controls such as kerb inlet protectors, (geofabric) filter material to capture sediments, and/or gully pit baskets (e.g. Enviropod, Ecosol Litter Basket or similar). Any required excavations and stockpiling as a result of trenching will be managed with a CEMP which will include erosion and sedimentation controls and dewatering management of excavations (including water capture, storage, treatment and discharge protocols, if required). Refer to EPA Publication 1895 for further mitigation measures.	▪ Low sensitivity ▪ Low magnitude (short time frame impacts and unlikely to extend beyond pipeline corridor to water receptors) ▪ Negligible significance
D04	Construction / Operation	Changes to the topography as a result of excavation has the potential create changes to local flow paths. It may also cause areas for water to pool and create localised waterlogging issues.	▪ Low sensitivity ▪ Low magnitude (short time frame and localised impacts) ▪ Negligible significance	Changes to the topography as a result of trench construction should be minimal. Thus, impacts will be managed. Disturbed areas would be reinstated as soon as practicable with ground cover / surfacing suitable for the site conditions (e.g. size of area to be stabilised; topography; soil type; and duration of work). At least 70% ground cover (combined plant and/or mulch) is considered necessary to provide satisfactory erosion control.	▪ As pre-mitigation
D05	Operation	An increase of impervious surface area due to construction of the concrete foundations may increase surface runoff and increase the risk of local flooding / drainage impacts.	▪ Low sensitivity ▪ Low magnitude (short time frame and localised impacts) ▪ Negligible significance	Changes to the land use and topography will be limited due the design chosen for this project, i.e. minimal aboveground infrastructure is proposed and limited areas of hardstand are to be incorporated. The impact of impermeable surfaces compared to existing condition is negligible. Concentrated flow pathways off impermeable hardstand will be stabilised to prevent erosion. The points of discharge to adjacent roadside swales / cross-drainage will not be altered.	▪ As pre-mitigation

Impact code	Phase	Impact description	Pre-mitigation risk rating	Mitigation measures	Post-mitigation risk rating
D06	Operation	Existing drainage infrastructure may not provide sufficient conveyance capacity for the project infrastructure as well as to account for increase of runoff volume to the existing swales.	▪ Low sensitivity ▪ Low magnitude (short time frame and localised impacts) ▪ Negligible significance	Changes to the land use and topography will be limited due the design chosen for this project, i.e. minimal aboveground infrastructure is proposed and limited areas of hardstand are to be incorporated. Infrastructure should be located on higher ground and / or appropriately elevated to account for the impacts of local drainage conditions with critical works elements a minimum of 300 mm above Steele Creek North Branch, Moonee Ponds and the Steele Creek North Raingarden 1% AEP flood level. Flash flood risk within the pipeline corridor appears to be minimal and stormwater conveyance is therefore assumed to exceed runoff volumes.	▪ As pre-mitigation
D07	Operation	Stormwater from the inlet and receiver stations with potential hydrocarbon contamination will need to be removed.	▪ Low sensitivity ▪ High magnitude (long lasting and diffuse impacts to watercourses) ▪ Moderate significance	The bunds are either end of the pipeline would be used during commissioning of the pipeline and then once every 10 years to undertake a metal loss assessment. At all other times the bund valve would be open and stormwater that falls on it would be diverted to a soak pit and there is not expected to be any fuel release. During the metal loss assessment, the bund valve would be closed and any spillage contained in the bund and sump. Any spillage would be removed by portable pumps and tank and would be taken offsite for waste appropriate treatment / disposal. After the metal loss assessment, the bund floor would be cleaned and the bund re-opened. The rest of the yard will be gravel crushed rock under skids such as the meters and the pig launcher barrel. All product handling is done by hard piping. Any storm water falling on the gravel / crushed rock areas (which are regarded as clean areas as equipment in these locations have no drains or sample points) will drain naturally as occurs currently. When pigging or changing filters, the bunds are to be closed and any spillage recovered using pump and portable tank. As there is a storm water system in the area, storm water falling on the bund will be hard piped to an oily water separator (SPEL) at the outlet station only and from there to clean stormwater as per drainage layout (Asia Pacific Fuels Operations, 2021). Consideration of bund areas away from drainage outlets, open drains and watercourses.	▪ Low sensitivity ▪ Low magnitude (short time frame impacts and unlikely to extend beyond bund / sump to water receptors) ▪ Negligible significance

5.2 Flood

Table 5-2 Potential flood impacts

Impact code	Phase	Impact description	Pre-mitigation risk rating	Mitigation measures	Post-mitigation risk rating
F01	Construction	Stripping of topsoil and excavations may increase flood risks downstream of the project by increasing runoff.	▪ Low sensitivity ▪ Low magnitude (short time frame and localised impacts) ▪ Negligible significance	The requirement for excavation is limited to small trench areas of construction reducing excavation and concreting requirements. In addition, there are no perennial watercourses in the immediate vicinity of the Project area. The points of discharge to adjacent roadside swales / cross-drainage have not been altered. Opportunities to intercept and retard peak stormwater flows should be investigated such as beneficial water reuse (vegetation planting / site amenities). Any local impacts will be mitigated through a CEMP. Refer to EPA Publication 1834 for further measures.	▪ As pre-mitigation

5.3 Groundwater

Table 5-3 Potential groundwater impacts

Impact code	Phase	Impact description	Pre-mitigation risk rating	Mitigation measures	Post-mitigation risk rating
GW01	Construction	The development of the project will increase the imperviousness of ground surface within the project site footprint, which could produce more runoff during storm events and decrease groundwater recharge.	▪ Low sensitivity ▪ Low magnitude (short time frame and localised impacts) ▪ Negligible significance	During construction, hydrogeology impacts may be mitigated through implementation of stormwater management measures such as on-site detention that limit off-site runoff volumes to acceptable levels as part of the CEMP. Drainage designs should adhere to the Infrastructure Design Manual (Local Government Infrastructure Design Association, 2020) Operation stage hydrogeologic impacts may be mitigated through water balance modelling of the site operation to estimate the volumes of water reuse and off-site discharge when the design has adequately progressed.	▪ As pre-mitigation
GW02	Construction	High groundwater table requiring dewatering and possible treatment / disposal during HDD works. Impact to other groundwater users.	**Northern Alignment** ▪ Low sensitivity (low water table ▪ Low magnitude (short time frame and localised impact) ▪ Negligible significance	The drilling would be conducted by a specific HDD rig which is operated by a specialist contractor. Drilling muds are used while drilling the hole to stabilise the open hole and seal the hole to prevent groundwater inflow. Therefore there is no need for dewatering during the HDD process.	▪ As pre-mitigation
			Southern Alignment ▪ Medium sensitivity (shallow water table, perched seepage / fractured zones flows and improved water quality ▪ Medium magnitude (short time frame but impacts could translocated down-gradient and into Steele Creek North) ▪ Moderate significance		**Southern Alignment** ▪ Medium sensitivity (shallow water table, perched seepage / fractured zones flows and improved water quality ▪ Low magnitude (short time frame and impacts not anticipated to down-gradient users) ▪ Low significance

Impact code	Phase	Impact description	Pre-mitigation risk rating	Mitigation measures	Post-mitigation risk rating
GW03	Construction	High groundwater table requiring dewatering and possible treatment / disposal during trench excavation works. Impact to other groundwater users.	**Northern Alignment** ▪ Low sensitivity (low water table ▪ Low magnitude (short time frame and localised impact) ▪ Negligible significance **Southern Alignment** ▪ Medium sensitivity (shallow water table, perched seepage / fractured zones flows and improved water quality ▪ Medium magnitude (short time frame but impacts could translocated down-gradient and into Steele Creek North) ▪ Moderate significance	Where excavation depths are likely to intercept groundwater, a Dewatering Plan as part of the CEMP should be developed. Where excavations require dewatering, adopt a construction method that minimises the dewatering period. Minimise the duration that trench sections are open, and divert surface water runoff away from the excavations, to reduce the potential for poor quality runoff impacting groundwater. Install trench breakers adjacent to watercourses, wetlands and steep slopes to minimise trench inflows. Implement trench compaction procedure including the design of the backfill to take into account the density and permeability of the surrounding soil. Trench work starts at approximately KP925, thus avoiding the Steele Creek North channel in the Southern Alignment where groundwater levels are shallow. Although it is not anticipated that any neighbouring bore will be impacted by dewatering, it is possible there is unregistered bores nearby, or a slightly greater than predicted distance of drawdown influence may occur. If this is the case, and any neighbouring bores are considered likely to be impacted by the Project within 100 m of an area of dewatering then the location, condition and functionality of the bore must be visually confirmed and make-good arrangements will be agreed in consultation with affected landholders, if required.	**Northern Alignment** ▪ As pre-mitigation **Southern Alignment** ▪ Medium sensitivity (shallow water table, perched seepage / fractured zones flows and improved water quality ▪ Low magnitude (short time frame and impacts not anticipated to down-gradient users) ▪ Low significance
GW04	Construction	Impacts associated with contaminated groundwater and disposal	**Northern Alignment** ▪ Low sensitivity (low water table ▪ Moderate magnitude (short time frame but potential impact beyond immediate pipeline corridor) ▪ Low significance	Baseline groundwater sampling demonstrated that quality generally was within screening levels (Aurecon, 2022). The exception to this was PFOS levels in soil bore number 3 50 m from the Southern alignment Steele Creek North crossing point. Manage extracted groundwater as follows: ▪ Dispose groundwater in accordance with the ERS and EPA Guidelines and all relevant approvals processes with relevant authorities ▪ Groundwater from areas that have been identified as contaminated must not be discharged to the environment	**Northern Alignment** ▪ Low sensitivity (low water table ▪ Low magnitude (short time frame and localised impact) ▪ Negligible significance

Impact code	Phase	Impact description	Pre-mitigation risk rating	Mitigation measures	Post-mitigation risk rating
			Southern Alignment ▪ Medium sensitivity (shallow water table, perched seepage / fractured zones flows and improved water quality ▪ Medium magnitude (short time frame but impacts could translocated down-gradient and into Steele Creek North) ▪ Moderate significance	▪ (land, waterways). If required, engage with the local water authority to develop a trade waste agreement for sewer discharge. This agreement would specify the levels of contamination to allow for sewer discharge. ▪ Contaminated groundwater must either be treated onsite, depending on contaminant encountered (this may require approval from the EPA Victoria) or disposed offsite to an EPA Victoria licensed facility. Alternatively, a construction approach may be adopted where contaminated groundwater is left in-situ (i.e. not abstracted or disturbed).	**Southern Alignment** ▪ Medium sensitivity (shallow water table, perched seepage / fractured zones flows and improved water quality ▪ Low magnitude (short time frame and localised impacts) ▪ Low significance
GW05	Operation	If the bell holes (constructed at the entry and exit points to facilitate joining of the pipe) intersect the water table it is assumed they will require dewatering.	**Northern Alignment** ▪ Low sensitivity (low water table ▪ Moderate magnitude (short time frame but potential impact beyond immediate pipeline corridor) ▪ Low significance	Follow process described in GW05	**Northern Alignment** ▪ Low sensitivity (low water table ▪ Low magnitude (short time frame and localised impact) ▪ Negligible significance

Impact code	Phase	Impact description	Pre-mitigation risk rating	Mitigation measures	Post-mitigation risk rating
			Southern Alignment ▪ Medium sensitivity (shallow water table, perched seepage / fractured zones flows and improved water quality ▪ Medium magnitude (short time frame but impacts could translocated down-gradient and into Steele Creek North) ▪ Moderate significance		**Southern Alignment** ▪ Medium sensitivity (shallow water table, perched seepage / fractured zones flows and improved water quality ▪ Low magnitude (short time frame and localised impacts) ▪ Low significance

5.4 Sensitive water environments / water users

Table 5-4 Potential sensitive water environments and water users impact

Impact code	Phase	Impact description	Pre-mitigation risk rating	Mitigation measures	Post-mitigation risk rating
W01	Construction	Pig launcher and receiving sites located at each end of the pipeline to clear any debris or water and during operation could lead to mobilisation of sediments into receiving watercourses (Steele Creek North), deposition of fine sediments impacting aquatic flora and fauna (particulate bound contaminants e.g. metals). Potential for elevated oxygen demand leading to decreased dissolved oxygen. Impacts to surface water quality and quantity environmental values such as aquatic ecosystems and recreational activities for waterbodies down-gradient of the project area such as Steele Creek North and Maribyrnong River	▪ Low sensitivity ▪ Medium magnitude (short time frame impacts but could extend beyond immediate pipeline corridor) ▪ Low significance	Any works are required to adhere to the *Environment Protection Act 2017* and associated ERS to reduce surface water pollution. Redirect waste from the pipe away from watercourses and capture / treat, if necessary. The project is considered to pose a minimal-low impact to surface water quality due to the distance and lack of tributaries located in the vicinity of the Project area as well as the lack of hydrological connectivity to key watercourses.	▪ Low sensitivity ▪ Low magnitude ▪ Negligible significance
W02	Construction	Potentially harmful chemicals and substances (e.g. oils, grease, petrol etc.) accidentally released during construction spills or as result of maintenance works, refuelling and inappropriate storage or handling. This could lead to soil contamination, leaching of contaminants to groundwater or conveyance of contaminants in runoff to waterways.	▪ Low sensitivity ▪ Medium magnitude (short time frame impacts but could extend beyond immediate pipeline corridor) ▪ Low significance	Earthworks should be avoided, if possible, during forecast high rainfall events to reduce the risk for large areas of exposed soil during overland flow events. Erosion and sedimentation controls as part of the CEMP should be prepared to reduce soil erosion and mobilisation of sediments from the site during earthworks activities. The storage, transport, use and handling of all hazardous substances must be in accordance with relevant legislation (Dangerous Goods Act 1985, Dangerous Goods (Storage and Handling) Regulations 2012, Occupational Health and Safety Act 2004, Occupational Health and Safety Regulations 2017 and Australian Standard AS1940 - 2017 Storage and Handling of Flammable and Combustible Liquids) Storage areas for hazardous substances must not be located	▪ Low sensitivity ▪ Low magnitude (short time frame impacts and localised impacts) ▪ Negligible significance

Impact code	Phase	Impact description	Pre-mitigation risk rating	Mitigation measures	Post-mitigation risk rating
		Cement / concrete has a high oxygen demand and high levels of chromium and aluminium, which are highly toxic to aquatic ecosystems. If these materials are not set prior to rainfall events, there is potential for runoff from the site into watercourses. Leakage from construction worker ablation and toilet facilities or wastewater collection points with subsequent runoff into receiving watercourses.		within 20m of any drainage inlets, open drains or watercourses. Storage areas for hazardous substances must include secondary containment controls such as permanent or portable bunding so that the capacity of the bund is sufficient to contain at least 110% of the volume stored. Areas where hazardous substances are frequently used and handled must be located on impervious hardstand with appropriate bunding so any spills can be confined and cleaned up. Spill kits must be readily available in close proximity to areas where hazardous substances are stored, used and handled. Relevant personnel must be trained in the use of spill kits. All spills of hazardous substances must be cleaned up and any resulting waste material must be contained and disposed of at an appropriately licensed facility. Fuel and chemical containers or fuel containing equipment such as generators must be transported on spill trays. Fuel containing equipment such as generators or pumps must be self-bunded or located within a bunded area. Plant, equipment and vehicles must be refuelled within designated refuelling areas. Where practicable, refuelling areas must not be located within 20m of any drainage inlet or open drain/ drainage line. Where this separation distance cannot be maintained, drain seals must be in place prior to refuelling activity. Refuelling areas must be located on impervious hardstand with appropriate bunding and, where practicable, be graded to a spill collection point. Inspection of ablation facilities and wastewater storage systems on a regular basis should be performed. Leakages should be reported immediately and remediated. These controls should be prepared in accordance with the Environment Protection Authority (EPA) Publication 1894 for additional mitigation measures. These impacts are considered low due to the distance to nearby waterways as well as the lack of hydrological connectivity to key watercourses (Maribyrnong River and Moonee Ponds Creek).	

Impact code	Phase	Impact description	Pre-mitigation risk rating	Mitigation measures	Post-mitigation risk rating
W03	Construction	The construction of the pipeline will require some excavation. Excavations will be required across multiple roads. This could lead to mobilisation of sediments into receiving watercourses, exposure of unknown contaminated land finds which could subsequently impact local water quality and dewatering to remove groundwater from excavated areas and the water is not disposed of properly. Increased sediment and nutrient load runoff from the site into receiving watercourses causing a deterioration in water quality.	▪ Low sensitivity ▪ Medium magnitude (short time frame impacts but could extend beyond immediate pipeline corridor) ▪ Low significance	Clean stormwater would be diverted away from open trenches to prevent stormwater runoff from flowing over disturbed sites and to reduce the volume of water collected in the depressions to only include 'dirty' disturbed area runoff and direct rainfall input. Weather forecasts should be considered when planning earthwork and ground disturbing activities. Where practicable, earthwork and ground disturbing activities would be avoided during periods of heavy rainfall or high winds. Trenching extent would be staged to reduce the duration and amount of exposed soils. Prior to the commencement of trenching work, any stormwater pits, drains or any open channels in close proximity should be protected. Stormwater pits along the pipeline corridor subject to sediment deposits should be fitted with appropriate sediment controls such as kerb inlet protectors, (geofabric) filter material to capture sediments, and/or gully pit baskets (e.g. Enviropod, Ecosol Litter Basket or similar). Any required excavations and stockpiling as a result of trenching will be managed with a CEMP which will include erosion and sedimentation controls and dewatering management of excavations (including water capture, storage, treatment and discharge protocols, if required). Refer to EPA Publication 1895 for further mitigation measures.	▪ Low sensitivity ▪ Low magnitude (short time frame impacts and localised impacts) ▪ Negligible significance
W04	Construction / Operation	At creek crossings, horizontal directional drilling for trenchless construction may lead to subsidence / macropores developing in the creek bed leading to infiltration and loss of surface water to shallow groundwater system	▪ Low sensitivity ▪ Medium magnitude (short time frame impacts but could extend beyond immediate pipeline corridor) ▪ Low significance	Specialist operators will drill a hole beneath the surface at a shallow angle. Ground disturbance will be minimal and clearance depths have been defined. Geotechnical stability of the drilled material and voids has been assessed. Operations carefully planned and highly engineered to minimise disturbance to environmentally sensitive areas.	▪ Low sensitivity ▪ Low magnitude (short time frame impacts and localised impacts) ▪ Negligible significance

Impact code	Phase	Impact description	Pre-mitigation risk rating	Mitigation measures	Post-mitigation risk rating
W05	Construction / Operation	At creek crossings, horizontal directional drilling for trenchless construction may lead to subsidence / macropores developing in the creek bed leading to up-gradient transfer of contaminated drillers mud or soils into watercourses	▪ Low sensitivity ▪ Medium magnitude (short time frame impacts but could extend beyond immediate pipeline corridor) ▪ Low significance	Drilling muds are designed to stabilise and seal the hole and therefore movement into the aquifer system and subsequently upward gradient movement into the creek will be very limited. Bentonite drilling muds used are inert and biodegradable as they are commonly used in the groundwater bore drilling industry. Soils have low / no detectable contamination in areas close to HDD activities (Aurecon, 2022). After use the drilling muds are required to be disposed as per EPA regulatory requirements. The HDD contractor will provide a risk assessment for blow out. At this point of time the HDD under Steele Creek is 4m but with no impact on cost if the risk assessment so recommends we can provide a greater cover. HDD works specification will require a HDD contractor and their specialist advisors to carry out separate and discrete geotechnical and hydrogeological survey for the final cover distance to avoid blow out.	▪ Low sensitivity ▪ Low magnitude (short time frame impacts and localised impacts) ▪ Negligible significance
W06	Operation	If pesticides are used to reduce weeds within the site, runoff could cause the pesticides to be transported to nearby watercourses.	▪ Low sensitivity ▪ Medium magnitude (short time frame impacts but could extend beyond immediate pipeline corridor) ▪ Low significance	The project is considered to pose a low impact to surface water quality due to the distance and lack of watercourses located in the vicinity of the Project area. Possible mitigation measures may include using pesticides at during dry periods and the use of lower-risk pesticides. Design should include water treatment devices within the drainage system to treat particulate-bound runoff from the Project area. Refer to EPA publication 1226 for WSUD stormwater treatment options. See W02 for handling, storage and use of hazardous substances.	▪ Low sensitivity ▪ Low magnitude (short time frame impacts and localised impacts) ▪ Negligible significance
W07	Operation	Pipeline leak with subsequent contamination of watercourses or groundwater	**Watercourses** ▪ Low sensitivity ▪ High magnitude (widespread impact affecting a creek down-gradient from the pipeline) ▪ Moderate significance	The pipeline would be constructed, commissioned, operated and maintained in full compliance with AS2285 – including ongoing operational surveillance, inline inspection and continuous monitoring by an online leak detection system.	▪ Low sensitivity ▪ Medium magnitude (impacts extend beyond the immediate pipeline and need specific safeguards) ▪ Low significance

Impact code	Phase	Impact description	Pre-mitigation risk rating	Mitigation measures	Post-mitigation risk rating
			Northern Alignment ▪ Low sensitivity (low water table ▪ Medium magnitude (short time frame but potential impact beyond immediate pipeline corridor) ▪ Low significance **Southern Alignment** ▪ Medium sensitivity (shallow water table, perched seepage / fractured zones flows and improved water quality ▪ Medium magnitude (short time frame but impacts could translocated down-gradient and into Steele Creek North) ▪ Moderate significance		

6 Conclusions and Recommendations for Further Work

This water assessment identifies the low risks that can be managed on site with typical good practice processes and the residual risks that cannot be as easily mitigated (**Section 6.1**). It also identified knowledge gaps in relation to water and subsequent recommendations are made in **Section 6.2** on any further investigations that would be required.

6.1 Conclusions

Seven potential drainage impacts, one flood potential impacts, five groundwater potential impacts and seven sensitive environmental potentials impacts all with negligible-low residual risk were identified. All these negligible-low residual risk impacts can be managed satisfactorily with application of typical good practice site management (as detailed in **Section 5**).

There were no residual moderate to high risks for the Project regarding water issues. The project has been designed with an operational life of 40 years and no impacts associated with decommissioning have been considered in this report.

6.2 Gap Analysis

The required consultation and open-source data for the project was identified in the methodology (**Section 3.1 and Section 3.2**, respectively). A matrix of information is shown below in **Table 6-1** for each sub-discipline covered in this report indicating where information or data was unavailable to support the assessment (as described in **Section 3.3**).

Table 6-1 Water report gap analysis

Issue code	Sub-discipline	Section	Limitation	Suggested action/s
I01	Flood	**Section 4.6**	Unable to ascertain flood risk from 'Urbnsurf' Surf Park located at 309 Melrose Drive, Tullamarine.	Confirm that the 1-in-100 year event does not extend beyond the property perimeter at pipeline corridor KP 3,500 - 3,700 m
I02	Flood	**Section 4.6**	Unable to confirm relevance of spatial extent of 1-in-100 year flash flooding.	Verify source and publication date of 1-in-100 year Flash Flood Extent mapping for Brimbank City Council and Hume City Council Local Flood Guides (Victoria State Emergency Service, 2022).
I03	Groundwater	**Section 1.3**	Project strategy for water supply to satisfy construction demand is unclear	Viva Energy to consider water demand for construction period and secure appropriate water source

Issue code	Sub-discipline	Section	Limitation	Suggested action/s
I04	Sensitive water environments / water users	**Section 3.4**	Access to watercourses within the Melbourne Airport boundary was not granted for site investigations where water testing was undertaken.	Additional testing to be undertaken at Locations 4 and Location 5 (as described in **Section 6.3.3**) prior to construction commencing to capture baseline conditions for monitoring regime.
I05	Sensitive water environments / water users	**Section 3.4**	No safe access to Steele Creek North (upstream) and Moonee Ponds Creek watercourses for site investigations.	Additional testing to be undertaken at Location 2 and Location 3 (as described in **Section 6.3.3**) prior to construction commencing to capture baseline conditions for monitoring regime.

6.3 Recommendations for further work

6.3.1 Water Permits

Prior to construction all works near water will require an 'Installation of a utility near waterways or water mains' permit (**Section 3.7.2**). The application number for this permit is MWA-1259839.

It is unlikely the Project will require a works on waterways permit (consent for minor waterway work) which pertains specifically to direct impacts to the waterway e.g. bank stabilisation, sediment and erosion controls (**Section 3.1** and **Section 3.7.1**). No culvert crossings and / or bridge crossings are proposed for the Project.

6.3.2 Construction Environment Management Plan

A construction environment management plan will be required prior to construction. Specific water issues to be addressed include:

- Accidental chemical spillage emergency plan
- Dewatering requirements and disposal plan for open trenches and HDD bell holes. This will include an understanding of the underlying hydrology (water levels, flow direction and rates, groundwater quality), a description and justification for the proposed dewatering effluent disposal method and an unexpected encounter protocol to determine how water management should proceed. Within the Melbourne Airport boundary, the Dewatering Plan will require APAM Environment and Sustainability Team review and approval prior to commencement of dewatering works.
- Erosion and sediment control plan
- Flood Preparedness Plan to be prepared for the Project based on the PMF design event, which would be incorporated into the CEMP (or the Site Emergency Response Plan)
- Horizontal Directional Drilling approach for trenchless construction at Steele Creek North crossings
- Off-site water supply strategy
- Stormwater management measures such as on-site detention that limit off-site runoff volumes to acceptable levels

6.3.3 Surface water quality monitoring program

It is recommended that surface water quality testing be undertaken in waterways on and adjacent to the site, particularly downstream from where construction will be undertaken. The testing results should be used to establish a baseline for assessing future impacts resulting from the proposed Site. The following parameters should be tested:

- Dissolved oxygen (% satn.)
- Electrical conductivity (µS/cm)
- pH (pH units)
- Total nitrogen (µg N /L)
- Total phosphorus (µg P /L)
- Turbidity (NTU)

Observations for coarse debris, oil sheens and odours should also be recorded. The ERS Urban Segment values (**Section 4.5.2**) should be used as a trigger for investigations in the case of exceedances.

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Appendix A – Climate Review

A summary of general climatic conditions in Melbourne were reviewed in **Section 4.2**. This appendix provides a detailed review of climatic conditions near the project footprint, using data from the BoM Melbourne Airport Automatic Weather Station (#(#086282). This weather station is located adjacent to the north of the proposed alignment. It was selected due to completeness of data records, elevation being similar to the project footprint (113 m AHD) and record length.

A-1 Temperature and Relative Humidity

Temperature at Melbourne Airport has been increasing yearly, however seasonal trends remain similar. The warm season lasts three months, from early December to mid-March (**Figure A-1**). The mean maximum temperature is 26.6°C for the summer months. From mid-May through to early September, the temperature is much lower. The coldest month recorded is July, with the lowest temperature of 5.7°C.

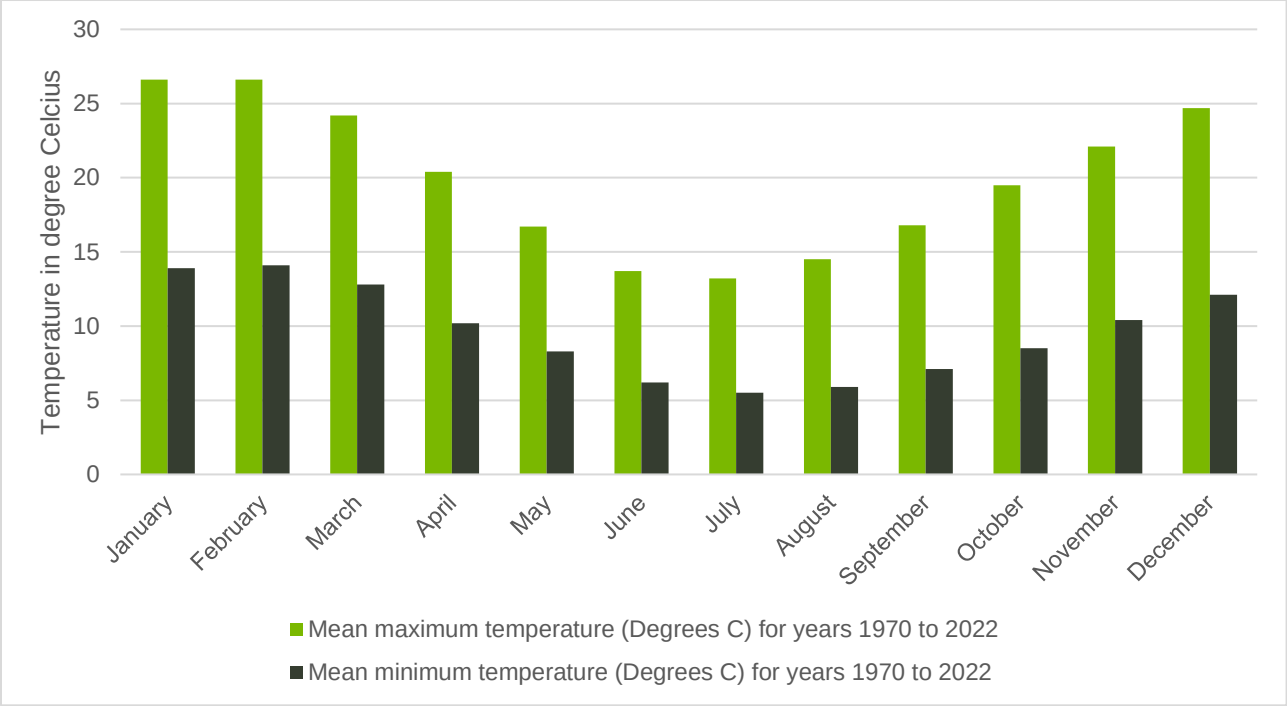


Figure A-1 **Monthly average maximum and minimum temperature from 1970 to 2022 (all years)**

The average maximum and minimum temperature in the last five years (**Figure A-2**) shows similar trends. On average, 2019 indicates to be a slightly warmer year, higher summer temperatures and warmer winter temperatures. This corresponds to the decrease in average rainfall (**Section A-3**) during that year. The data does not suggest that on average the winter and summer months are getting warmer, however, it does show that temperature is strongly associated with rainfall.

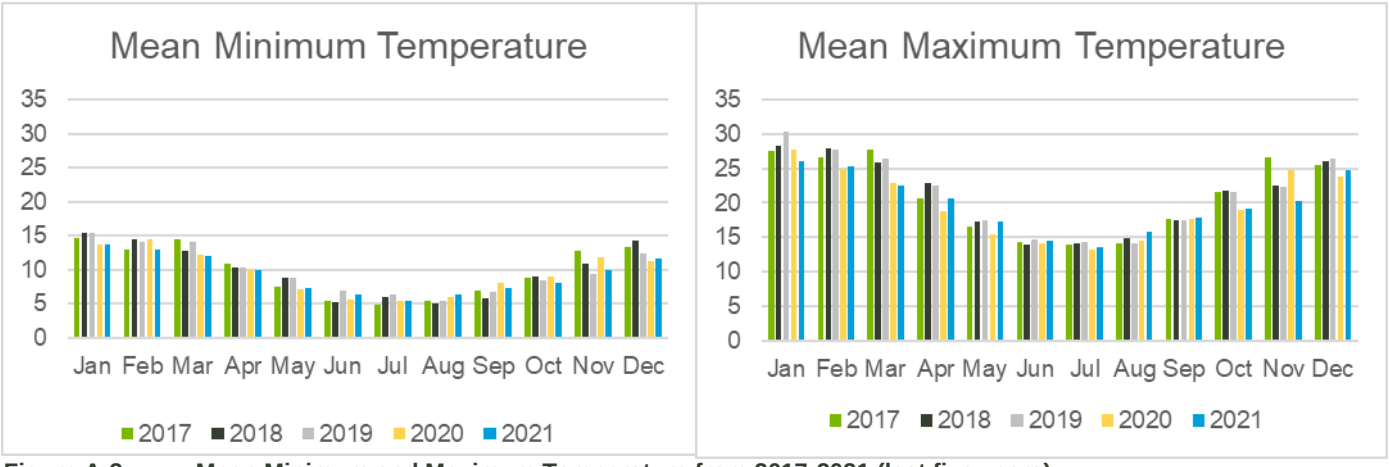


Figure A-2 **Mean Minimum and Maximum Temperature from 2017-2021 (last five years)**

Temperature and humidity have been measured between 1970 to 2010. No data after 2010 has been reported on the BoM website. The 9am comparison shows a greater difference between humidity and temperature than the 3pm comparison (**Table A-1**). This correlates with current climate models of afternoon latent heat. as temperature decreases, relative humidity increases (Figure.

Table A-1 Statistical summary of the Melbourne Airport 9am and 3pm Temperature and Relative Humidity

Statistic Element	Mean 9am temperature (Degrees C)	Mean 9am relative humidity (%)	Mean 3pm temperature (Degrees C) for years 1970 to 2010	Mean 3pm relative humidity (%) for years 1970 to 2010
January	18.1	65	24.3	44
February	18	69	24.8	44
March	16.6	70	22.5	47
April	14.2	72	19	52
May	11.3	79	15.6	60
June	8.7	83	12.6	67
July	8	81	12	65
August	9.1	77	13.2	59
September	11.3	72	15.2	56
October	13.6	66	17.6	52
November	15	67	20.2	49
December	16.8	64	22.4	45
Annual	13.4	72	18.3	53
Number of Years	40	40	40	40
Start Year	1970	1970	1970	1970
End Year	2010	2010	2010	2010

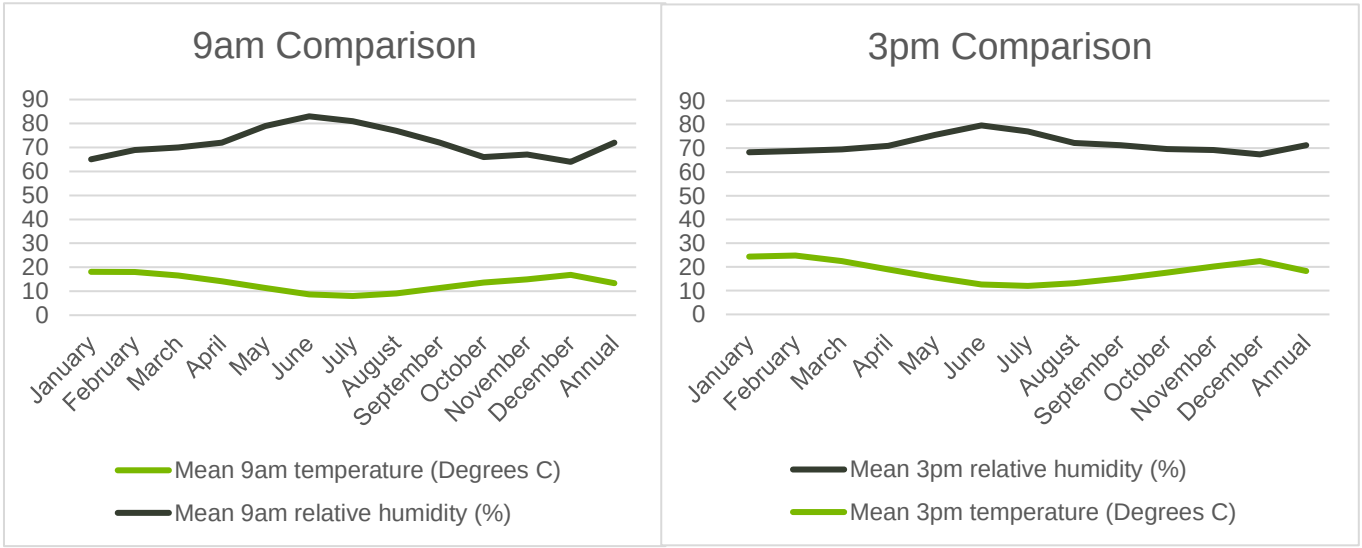


Figure A-3 Melbourne Airport 9am and 3pm temperature and relative humidity comparison

Relative humidity is highest in the coldest months (May, June, July and August) (**Figure A-3**). However, the data for relative humidity ceased in 2010, therefore it is difficult to apply these same trends and statistics to current data sets.

A-2 Wind

Wind patterns and variability at Melbourne Airport are highly dependent on local topography and other factors. Instantaneous wind speed and direction vary more widely than hourly averages. Data from BoM indicate that the windiest months are between July and January with average 3pm wind speeds of 22.74 km/h (**Table A-2** and **Figure A-4**). The windiest month of the year at Melbourne Airport is late August to early September.

Table A-2 Statistical summary of mean wind speed at Melbourne Airport

Statistic Element	Mean 9am wind speed (km/h) for years 1970 to 2010	Mean 3pm wind speed (km/h) for years 1970 to 2010
January	18.5	22.3
February	17	21.2
March	16.9	20.6
April	16.7	19.9
May	17.2	19.7
June	18.3	20.8
July	20.2	22.7
August	21.6	23.9
September	22.1	24.4
October	21.8	23.5
November	19	22.4
December	18.7	22.7
Annual	19	22
Number of Years	40	40
Start Year	1970	1970
End Year	2010	2010

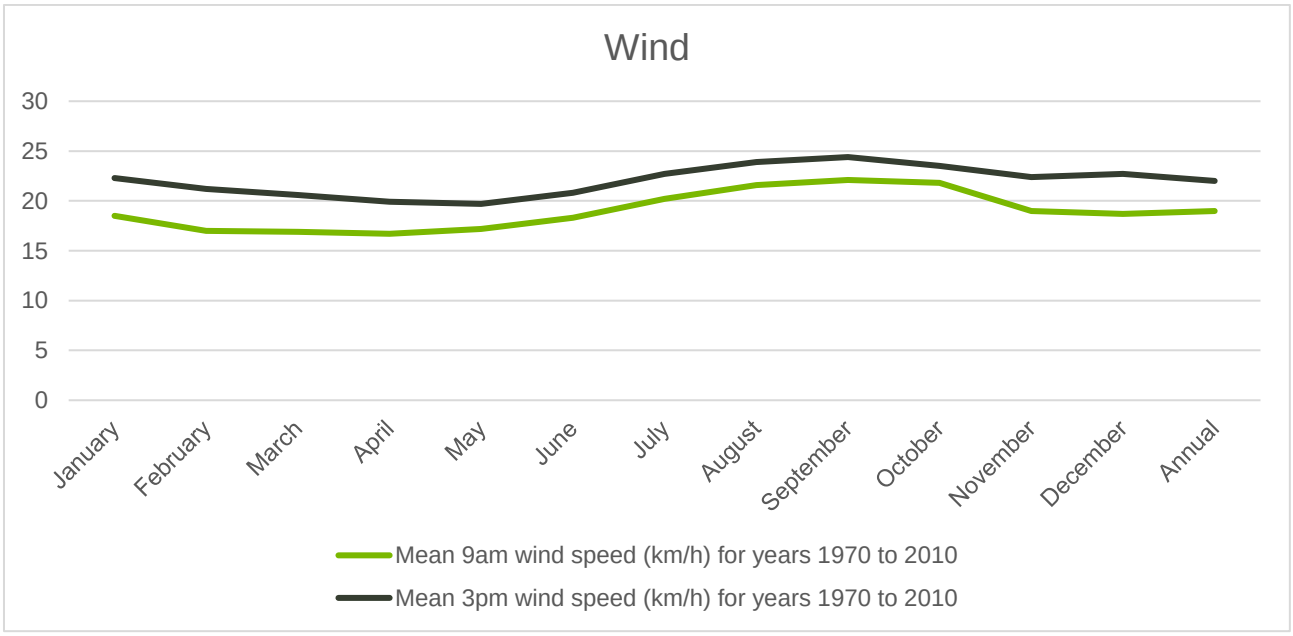


Figure A-4 Graphical average wind speed for Melbourne Airport

A-3 Rainfall and Evaporation

A review of the historical data associated with this station reveals the following:

- Annual long term 50 year median rainfall of 554.6 mm / annum (**Figure A-5**).
- Mean Annual Evaporation of 500 mm / annum.
- Wetter than average years recorded rainfall in excess of 820.8 mm (**Figure A-5**).
- Drier than average years recorded rainfall less than 310.2 mm (**Figure A-5**).
- Higher rainfall during the spring and early summer months (August–December) compared to late summer – late autumn (January – July).
- Relatively warm and dry years on record for Melbourne Airport in the previous 15 years included 2002, 2005, 2006, 2009 and 2019 (Bureau of Meteorology, 2021). The high temperatures experienced were likely due to the influence of the El Niño.

- Slightly wetter than average years included 1977, 1974, 1987, 1988, 1999, 2001 and 2013 resulting from Southern Lows developing and establishment of La Niña events in the Pacific Ocean (Bureau of Meteorology, 2021).

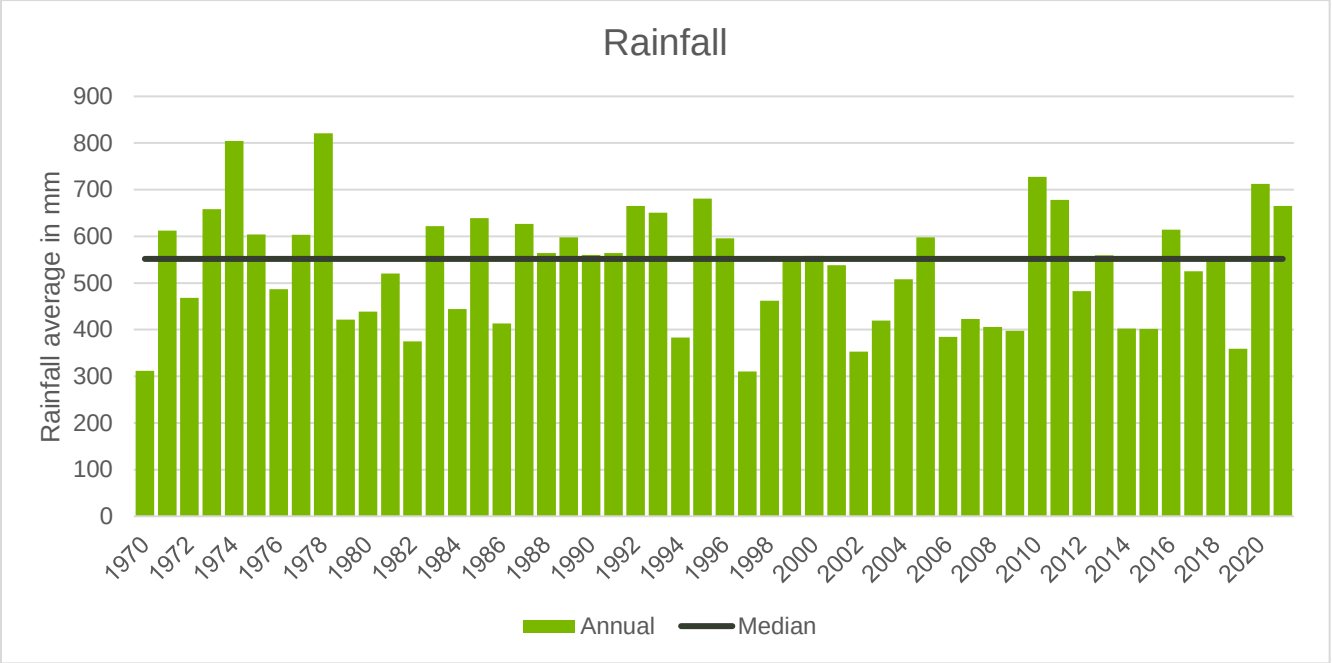


Figure A-5 Average annual measured rainfall– Melbourne Airport (1970 - 2021)

The above trends have implications for hydrological behaviour, with a net surplus of rainfall to support stormwater runoff to surface water bodies and infiltration / recharge to the groundwater system on an annual basis.

A-4 Climate Change

Climate change has the potential to influence the general environmental water balance as well as groundwater availability, soil and water salinity and water quality in the area surrounding the project footprint. Study results documented in *"Greater Melbourne Climate Projections 2019"* (Clarke JM, Grose M, Thatcher M, Round V & Heady C., 2019) have been used in this report to assess expected local climatic changes.

The projected changes have been modelled using selected climate variables (median, 10th and 90th percentile) data from 1986 to 2005. The results presented in **Table A-3** summarise the 5 km downscaled results for greenhouse gas emissions scenarios RCP 4.5 and RCP 8.5 in Metropolitan Melbourne.

Table A-3 Projected climatic changes for the project study area

	Percent change in near future (%) (2020-2039)			Percent change in far future (%) (2080-2099)		
State planning Scenario	Rainfall	Evaporation	Relative Humidity	Rainfall	Evaporation	Relative Humidity
Metropolitan Melbourne scenario RCP 4.5	-4	+8.2	-1	-8	+18.9	-2.0
Metropolitan Melbourne scenario RCP 8.5	-9	+10.1	-1.4	-20	+34.8	-4.1

These rainfall and evaporation changes, modelled with the Global Climate Model indicate that higher intensity storms will result in higher runoff volumes, whereas the increased evaporation rates will likely lead

to reduced recharge. Lower recharge to groundwater in the near future will in turn lead to lowering of the groundwater table, resulting in a reduction in base flow into the Moonee Ponds Creek.

Appendix B – Groundwater users register

Bore ID	Area	Date	Easting (MGA)	Northing (MGA)	Bore type	Primary Use	Monitoring Status
97000	TULLA	26/04/1974 0:00	311352.2	5828216.2	Groundwater	Groundwater Investigation	P
97001	TULLA	4/05/1974 0:00	311708.2	5828199.2	Groundwater	Groundwater Investigation	P
97002	TULLA	4/05/1974 0:00	311378.2	5828229.2	Groundwater	Groundwater Investigation	P
97003	TULLA	10/05/1974 0:00	311340.2	5828216.2	Groundwater	Groundwater Investigation	N
97004	TULLA	25/06/1980 0:00	311030.4	5828376.4	Groundwater	Observation	P
97005	TULLA	2003	311838.1	5827702.4	Groundwater	Observation	P
97006	TULLA	1980	311780.2	5827358.7	Groundwater	Observation	P
97007	TULLA	4/08/1980 0:00	311133.4	5828013.7	Groundwater	Observation	Y
97008	TULLA	2/06/1905 0:00	310932.7	5826118.4	Groundwater	Observation	Y
97011	TULLA	31/12/1970 0:00	311016.2	5828791.2	Groundwater	-	P
97012	TULLA	3/02/1972 0:00	311505.2	5828227.2	Groundwater	-	P
97013	TULLA	11/02/1972 0:00	311316.2	5828369.2	Groundwater	-	P
97014	TULLA	11/02/1972 0:00	311483.2	5828558.2	Groundwater	-	P
97016	TULLA	18/09/1973 0:00	311647	5828057	Groundwater	Observation	P
97017	TULLA	11/10/1974 0:00	311479.6	5828582.5	Groundwater	Observation	P
97021	TULLA	8/02/1977 0:00	311497.1	5828034.3	Groundwater	Observation	P
97022	TULLA	10/02/1977 0:00	311684.2	5828377.2	Groundwater	-	P
97023	TULLA	8/02/1977 0:00	311684.2	5828377.2	Groundwater	-	N
97027	TULLA	31/01/1980 0:00	311748.3	5828011.4	Groundwater	Groundwater Investigation	P
97028	TULLA	29/01/1980 0:00	311748.1	5828011.5	Groundwater	Groundwater Investigation	P
109741	TULLA	26597	311835.1	5827948.8	Groundwater	Observation	P
109742	TULLA	26597	311835.5	5827948	Groundwater	Observation	P
109743	TULLA	6/02/1980 0:00	311163.2	5828282.2	Groundwater	Groundwater Investigation	P
109744	TULLA	6/02/1980 0:00	311163.2	5828282.2	Groundwater	Groundwater Investigation	P
109745	TULLA	8/02/1980 0:00	311707.3	5828500.2	Groundwater	Groundwater Investigation	P
109746	TULLA	8/02/1980 0:00	311707.3	5828500.2	Groundwater	Groundwater Investigation	P
127807	TULLA	1/08/1994 0:00	311623.2	5828764.2	Groundwater	Groundwater Investigation	N
127808	TULLA	1/08/1994 0:00	311553.2	5828964.2	Groundwater	Groundwater Investigation	N
127810	TULLA	2/08/1994 0:00	311763.2	5829104.2	Groundwater	Groundwater Investigation	N
127811	TULLA	2/08/1994 0:00	311833.2	5828884.2	Groundwater	Groundwater Investigation	N
142815	TULLA	25/02/1999 0:00	312113.2	5827984.2	Groundwater	Groundwater Investigation	N
142816	TULLA	24/02/1999 0:00	312113.2	5827984.2	Groundwater	Groundwater Investigation	N
142817	TULLA	25/02/1999 0:00	312113.2	5827984.2	Groundwater	Groundwater Investigation	N
142818	TULLA	24/02/1999 0:00	312113.2	5827984.2	Groundwater	Groundwater Investigation	N
142819	TULLA	23/02/1999 0:00	312113.2	5827984.2	Groundwater	Groundwater Investigation	N
142820	TULLA	22/02/1999 0:00	312113.2	5827984.2	Groundwater	Groundwater Investigation	N
WRK051766	TULLA	-	311804	5827953	Groundwater	Observation	N
WRK051766	TULLA	-	311804	5827953	Groundwater	Observation	N
WRK051767	TULLA	1/06/2011 0:00	312255	5828390	Groundwater	Observation	N
WRK051767	TULLA		312255	5828390	Groundwater	Observation	N
WRK058911	TULLA	1/11/2010 0:00	312151	5827960	Groundwater	Observation	N
WRK058911	TULLA	-	312151	5827960	Groundwater	Observation	N
WRK071617	TULLA	5/06/2012 0:00	311500	5828675	Groundwater	Observation	N
WRK098694	TULLA	5/06/2017 0:00	310984	5828700	Groundwater	Groundwater Investigation	N
WRK098695	TULLA	5/06/2017 0:00	311025	5828669	Groundwater	Groundwater Investigation	N

Bore ID	Area	Date	Easting (MGA)	Northing (MGA)	Bore type	Primary Use	Monitoring Status
WRK098696	TULLA	5/06/2017 0:00	311058	5828698	Groundwater	Groundwater Investigation	N
WRK098697	TULLA	1/06/2017 0:00	311049	5828742	Groundwater	Groundwater Investigation	N
WRK098698	TULLA	2/06/2017 0:00	311016	5828723	Groundwater	Groundwater Investigation	N
WRK098699	TULLA	1/06/2017 0:00	311039	5828791	Groundwater	Groundwater Investigation	N
WRK098705	TULLA	5/06/2017 0:00	311047	5829035	Groundwater	Groundwater Investigation	N
WRK098706	TULLA	5/06/2017 0:00	311023	5829035	Groundwater	Groundwater Investigation	N
WRK098707	TULLA	2/06/2017 0:00	310998	5828974	Groundwater	Groundwater Investigation	N
WRK098708	TULLA	2/06/2017 0:00	311014	5828994	Groundwater	Groundwater Investigation	N
WRK098709	TULLA	1/06/2017 0:00	311055	5828980	Groundwater	Groundwater Investigation	N
WRK098710	TULLA	5/06/2017 0:00	311027	5828951	Groundwater	Groundwater Investigation	N
WRK098711	TULLA	2/06/2017 0:00	311004	5828876	Groundwater	Groundwater Investigation	N
WRK098712	TULLA	2/06/2017 0:00	311004	5828922	Groundwater	Groundwater Investigation	N
WRK098713	TULLA	1/06/2017 0:00	311064	5828929	Groundwater	Groundwater Investigation	N
WRK960887	TULLA	-	311836.2	5827698.2	Groundwater	Groundwater Investigation	N
WRK983414	TULLA	-	311197	5825447	Groundwater	-	N
WRK985352	TULLA	-	312492	5826836	Groundwater	-	N
WRK986006	TULLA	-	310288	5826527	Groundwater	-	N
WRK988754	TULLA	-	311636	5828004	Groundwater	-	N
WRK988755	TULLA	-	311670	5828030	Groundwater	-	N
Note: Y (Yes actively monitored), N (Not actively monitored), P (Previously monitored)							

Appendix C - Stormwater Drainage Network Crossings

Source: P521511 Melbourne JUHI Pipeline Geoportal

Sequential crossing number	Pipeline KP cross point (m) plus additional project features	Drainage area
1	700 – 750	Tullamarine Park Rd
2	750 – 800	
3	1,200 – 1,250	Airport Dr
4	1,450 – 1,500	Airport Dr – Sharps Rd
5	1,450 – 1,500	
6	1,450 – 1,500	
7	1,450 – 1,500	
8	1,500 – 1,550	
9	1,500 – 1,550	
10	1,500 – 1,550	
11	1,500 – 1,550	
12	1,500 – 1,550	
13	2,350 – 2,400	Steele Creek North - Raingarden
14	2,350 – 2,400	
15	2,400	
16	2,500 – 2,550	Airport Dr
17	2,650 – 2,700	
18	2,650 – 2,700	
19	2,750 – 2,800	
20	2,750 – 2,800	
21	2,800 – 2,850	
22	2,800 – 2,850	
23	3,050 - 3,100	Toll Buildings
24	3,050 - 3,100	
25	3,050 - 3,100	
26	3,100 – 3,150	Watson Dr
27	3,100 – 3,150	
28	3,100 – 3,150	
29	3,100 – 3,150	

Sequential crossing number	Pipeline KP cross point (m) plus additional project features	Drainage area
30	3,150 – 3,200	
31	3,150 – 3,200	
32	3,250 – 3,300 Additional work space	Logistics buildings in Steele Creek North catchment
33	3,250 – 3,300	
34	3,250 – 3,300	
35	4,300 – 4,350	Wait Zone
36	4,300 – 4,350	
37	4,500 – 4,550 Additional work space	Value Car Park
38	4,650 Additional work space	
39	4,850	
40	5,400	
41	6,100 HDD Pit Work Area	Gowrie Park Dr including Astrojet Centre and Short-Term Car Park
42	6,350	Caldwell Dr
43	6,450	Centre Rd
44	6,500 – 6,550	

Appendix D - Photograph log and visual observations of watercourses

Location 1 – Steele Creek North downstream

- Restricted area
- Thick, dense vegetation with limited maintenance
- High volume is river grasses and noxious weeds
- Dirt access road down to creek
- High volume of rubbish, graffiti and foreign objects near and in the creek bed
- Water – no odour, dark muddy brown colour, no signs of wildlife, no sheen, relatively still

Site Access	River/Creek	Sampling Point
		

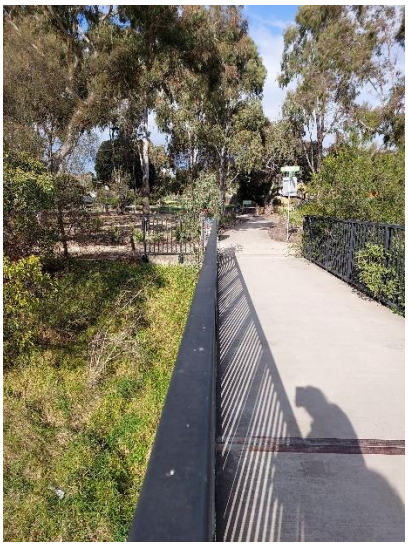
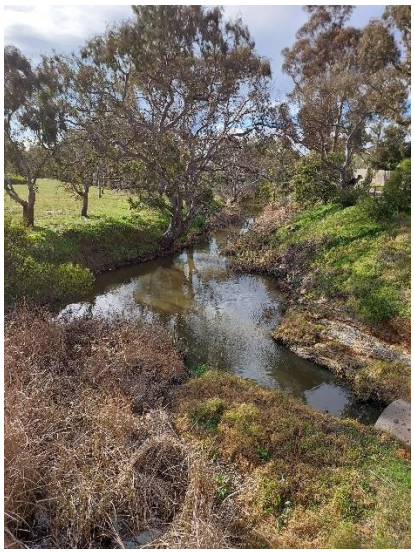
Location 2 – Steele Creek North upstream

- Residential area
- Maintained vegetation, mowed grasses, limited weeds.
- Fencing surrounding drain – no access
- Low flow water in drain
- Water – no odour, slightly clear brown colour, no signs of wildlife, no sheen, moving

Site Access	Upstream view	Downstream view
		

Location 3 – Moonee Ponds Creek

- Residential area
- Maintained vegetation, mowed grasses, limited weeds, high banks to river
- Park and walking trail access with bridge over river
- Low water level
- Water – no odour, dark brown murky colour, no signs of wildlife, no sheen, slow moving

Site Access	River/Creek	Attempted Sampling Point
		

Location 4 – Steele Creek North Tributary

- Grassed area between Airport Drive (west), Watson Drive (east) and Link Road (south)
- North-Arm and South-Arm channels both discharging under Airport Drive
- Maintained vegetation, mowed grasses, limited weeds, high banks to river
- Tussock grasses and sedge vegetation

- Dry channels at time of observations except around culvert where enlarged / deepened pools of stagnant water are present
- Visible bubbles / film on surface of water around culverts, no odour, dark brown murky colour

South-Arm Channel looking west towards Airport Drive

Erosion of axillary stormwater channel discharging into South-Arm Channel at Watson Drive

Stormwater grated inlet draining grassed roadside swale discharging into catch pit on Airport Drive

North-Arm Channel with Culvert (left hand side) under Airport Drive

Close up of South Arm culvert showing extensive non-native macrophyte growth and stagnant water with surface film

Location 5 - Flood Detention Basin and Raingarden

- Residential area
- Maintained vegetation, mowed grasses, limited weeds, high banks to river
- Park and walking trail access with bridge over river
- Low water level
- Water – no odour, dark brown murky colour, no signs of wildlife, no sheen, slow moving

A 100,000 m³ flood detention basin was built to protect the residents living downstream from flooding. A 7,000 m² sedimentation basin with a rain garden was also constructed. Runoff from the airport area is mechanically treated and this stormwater harvesting scheme produces over 130 megalitres of treated stormwater per year. Recipients of the reused water including:

- Car-washing facilities
- Cooling towers
- Irrigation of Essendon Football Club
- The tri-generation plant
- Toilet flushing

The scheme has reduced the Melbourne Airport's overall water consumption and dramatically improved the water quality of the Steele Creek North catchment.

Far south extent of retention basin looking northwards	**North extent of retention basin looking northwards towards raingarden**
	
Raingarden	Stormwater pit cover on Airport Drive
	

Appendix E – AUSRIVAS Physical Habitat Assessment Sheets

FIELD SAMPLING AND HABITAT ASSESSMENT SHEETS (ver 7 9/2/99

Adapted by Dan Evans 10/08/2022 for the specific use on MJFP Project

DATE 11/8/22 **TIME** 9:00 AM **LOCATION CODE** 1 (Barrie St)
RIVER Steele Creek North **LOCATION**
RECORDERS NAME KI **PHOTOGRAPH NUMBER (S)**
MAP DRAWN/MODIFIED **AIR TEMPERATURE** °C
RAIN IN LAST WEEK ? Y [ ] N [X]

AMG
LATITUDE S 37.71491 **LONGITUDE** E 144.87125

RIPARIAN VEGETATION

Width of riparian zone[1]: estimated / measured left bank[2] ~1.5 m
estimated / measured right bank[2] ~0.6 m

Vegetation type:	% Cover of riparian zone[3]	Description
trees (>10m)	30	small eucalyptus / natives
trees (<10m)	70	tall eucalyptus, leaf coverage
shrubs / vines	20	spiky, prickly weed / shrubs
grasses / ferns / sedges	90	river grasses

Vegetation cover of river[4]: <5% [ ] 6-25% [ ] 26-50% [ ] 51-75% [ ] >76% [ ]

[1] Area where waterway interacts with vegetation. [2] Facing downstream. [3] From 'Plan' view, estimation of outline cover; may total >100%. [4] Estimate as at midday. [5] Total may be >100%. [6]. From edge of water to cleared land.

MEASUREMENTS:

Stream Width[6] (m) 1 ~5.6 (Max.) 2 ~1.24 (Min.) 3 ~2 (Mean) **channel width[7]** ~4.6 m **bank height[8]** ~2.5 m

Water Temperature[9] (°C)	9.8	**pH[9]**	7.26
Conductivity[9] (uS/cm,ambient)	293.3	**Alkalinity..(mg/L).....**	NA
Conductivity (uS/cm @ 25 °C)	NA	**Turbidity[9] (NTU)**	24.29
Dissolved Oxygen[9] (mg/l)	7.41		
% Sat. Dissolved Oxygen	65.9		

Flow velocity[11] (m/sec)

/ / /

[6] From edges of water. [7] From tops of banks. [8] From water surface vertical to top of bank. [9] Measured/sampled from riffle area. [10] Within 'Reach' ie. 5 times mean water width either side of riffle sampling site. [11] Mid-channel buoyant projectile method (i.e time for a stick to travel known distance)

RIVER location 1 DATE 11/8/22 LOCATION CODE

OBSERVATIONS (Indicate appropriate number in box)

WATER ODOURS: 1. normal 2. sewage 3. petroleum 4. chemical 5.stormwater 6. musty [ ]

WATER OILS: 1. slick 2. sheen 3. globs 4. flecks 5. none [ ]

TURBIDITY: 1. clear 2. slight 3. turbid 4.opaque/liquid silt (clay like) [ ]

PLUME: 1. little 2. some 3. lots [ ]
(amount of fine sediment generated when kick-sampling)

SEDIMENT OILS: 1. absent → 2. light 3. moderate 4. profuse [ ]

SEDIMENT ODOURS: 1. normal 2. sewage 3. petroleum 4. chemical 5. anaerobic 6. none 7. other..... [ ]

FLOW LEVEL: (relative to "water mark" ie. **normal inundation level shown by limit of terrestrial grasses, or by eroded area**, or boundary in bank sediment types).
1. No flow (dry / isolated) 2. Low (<water mark) 3. Moderate (=) 4. High 5. Flood (>water mark) [ ]

Bare ground above normal inundation level shown by above: Left bank.....% Right bank.....%

SEDIMENT DEPOSITS: 1. none 2. sludge 3. sand 4. floc/silt (very light) 5. other [ ]

LOCAL CATCHMENT EROSION (within sight of site) 1. none 2. moderate 3. heavy [ ]

LOCAL Non-Point Source POLLUTION: no evidence 2. potential.....3. obvious..... [ ]

Point Source Pollution: 1. STP 2. road 3. other.....unknown..... [ ]

DAMS / BARRIERS (local) 1. present upstream / downstream 2. absent 3. river regulated [ ]

BRAIDING: 1. yes no. of channels ..... 2. no [ ]

SITE CLASSIFICATION: 1. steep valley 2. broad valley 3. wetland/bog 4. heath 5. plains 6. natural riparian meadow
(indicate >1 if required) [ ]

LANDUSE: Left Bank[2] 1. Native forest 2. Forestry 3. Native pasture 4. Grazing 5. Cropped 6. Residential 7. Industrial 8. Recreational [ ]

LANDUSE: Right Bank[2] 1. Native forest 2. Forestry 3. Native pasture 4. Grazing 5. Cropped 6. Residential 7. Industrial 8. Recreational [ ]

VEGCAT (for AUSRIVAS)
1. Urban/Residential 2. Intensive agriculture/some residential 3. Some forestry/agriculture(eg grazing) 4. Native forest/natural vegetation [ ]

BARS: (bed surface protruding from water & forming a bar) .....%

RIVER LOCATION 1 DATE 11/8/22 LOCATION CODE.....

REACH[10]

Length of Reach[10] not measured. metres.

SUBSTRATUM DESCRIPTION (% cover):

			PHI
Bedrock		[.....]	-9.5
Boulder	(>256mm)	[.....]	-9.0
Cobble	(64-256mm)	[.....]	-6.5
Pebble	(16-64mm)	[.....]	-4.5
Gravel	(2-16mm)	[.....]	-2.0
Sand	(0.06-2mm)	[.....]	2.0
Silt	(0.004-0.06mm)	[.....]	6.5
Clay	(<0.004mm)	[.....]	9.5

ORGANIC SUBSTRATUM (% cover of inorganic substrate)

Detritus (sticks, wood, CPOM[14]**)** [.....]

Muck/Mud (black, very fine organics) [.....]

FPOM/CPOM categories 1= <5%
2 = 5 - 20 %
3 = >20 %

Moss	**0**	**1**	**2**	**3**	**4**	**(percent of reach covered by)**
Filamentous algae	**0**	**1**	**2**	**3**	**4**	**(percent of reach covered by)**
Macrophytes	**0**	**1**	**2**	**3**	**4**	**(percent of reach covered by)**

0= <10% 1=10-35% 2=35-65% 3=65-90% 4=>90%

[10] 'Reach' :ie. 5 times mean water width either side of riffle sampling site.

[14] Coarse Particulate Organic Material.

RIVER..... DATE LOCATION CODE

LOW GRADIENT STREAMS

Habitat Parameter	Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal substrate/ available cover	Greater than 50% of substrate favourable for epifaunal colonisation and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonisation potential (logs/snags are not newly fallen and not transient)	30-50% mix of stable habitat; well-suited for full colonisation potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newly fallen logs but not yet "seasoned" (may rate at high end of scale)	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat obvious; substrate unstable or lacking.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 **4** 3 2 1 0
2. Pool substrate charaercterisation	Mixture of substrate materials with gravel and firms prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud or clay; mud may be dominant, some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
Score	20 19 18 17 16	15 14 13 **12** 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool variability	Even mix of large/shallow, large/deep, small/shallow and small/deep pools present	Majority of pools large/deep; very few shallow	Shallow pools much more prevalent than deep pools	Majority of pools small/ shallow or pools absent
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 **0**
4. Channel alteration	Channelisation or dredging absent or minimal; stream with normal pattern	Some channelisation present, usually in areas of bridge abutments; evidence of past channelisation, ie, dredging (greater than past 20 yrs) may be present, but recent channelisation is not present.	Channelisation may be extensive; embankments or shoring structures present on both banks; and 40 – 80% of stream reach channelised and disrupted.	Banks shored with gabion or cement, over 80% of stream reach channelised and disrupted. Instream habitat greatly altered or removed entirely.
Score	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 **4** 3 2 1 0
5. Sediment deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravels and/or fine sediment; 5-30% (20-50% for low gradient streams) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low gradient streams) of the bottom affected; sediment deposits at obstructions, constrictions and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low gradient streams) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
Score	20 19 18 17 16	15 14 13 12 11	10 9 **8** 7 6	5 4 3 2 1 0

RIVER..... DATE..... LOCATION CODE.....

LOW GRADIENT STREAMS

Habitat Parameter	Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was a staright line. (Note: channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 2 to 3 times longer than if it was a staright line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was a staright line.	Channel straight; waterway has been channelised for a long distance.
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
7 Channel flow status	Water reaches base of both lower banks, and minimal amount of channel substrate exposed.	Water fills >75% of available channel or <25% of channel substrate exposed	Water fills 25-75% of available channel and/or riffle substrates are mostly exposed	Very little water in channel and mostly present as standing pools.
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
8. Bank vegetative protection (score each bank)	More than 90% of the streambank surfaces covered by native vegetation, including trees, understorey shrubs or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or nor evident; almost all plants allowed to grow naturally	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well represented; disruption evident but not affecting full plant growth potential to any great extent	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank is very high; vegetation has been removed to 5 cm or less.
Score	**Left bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
Score	**Right bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
9. Bank stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent small areas of erosion mostly healed over; 5 –30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
Score	**Left bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
Score	**Right bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
10. Riparian Vegetative zone width (score each bank)	Width of riparian zone >18 m; human activities (ie roads, lawns, crops etc.) have not impacted zone.	Width of riparian zone 12-18 m; human activities have impacted zone only minimally.	Width of riparian zone 6-12 m; human activities have impacted zone a great deal.	Width of riparian zone <6 m; little or no riparian vegetation due to human activities.
Score	**Left bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
Score	**Right bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**

Total score_____

FIELD SAMPLING AND HABITAT ASSESSMENT SHEETS (ver 7 9/2/99

Adapted by Dan Evans 10/08/2022 for the specific use on MJFP Project

DATE 11/8/22 TIME 12PM LOCATION CODE LOCATION 2 (McELAREN ST)
RIVER Steele Creek North LOCATION McLaren St.
RECORDERS NAME KI PHOTOGRAPH NUMBER (S)
MAP DRAWN/MODIFIED AIR TEMPERATURE °C
RAIN IN LAST WEEK ? Y [ ] N [ ]

AMG
LATITUDE LONGITUDE

RIPARIAN VEGETATION

Width of riparian zone[1]: estimated / measured left bank[2] ~3 m
estimated / measured right bank[2] ~3 m

Vegetation type:	% Cover of riparian zone[3]	Description
trees (>10m)	—	
trees (<10m)	—	
shrubs / vines	—	
grasses / ferns / sedges	~50	

Vegetation cover of river[4]: <5% [ ] 6-25% [ ] 26-50% [ ] 51-75% [ ] >76% [ ]

mostly concrete drainage walls.

[1] Area where waterway interacts with vegetation. [2] Facing downstream. [3] From 'Plan' view, estimation of outline cover; may total >100%. [4] Estimate as at midday. [5] Total may be >100%. [6]. From edge of water to cleared land.

MEASUREMENTS:

Stream Width[6] (m) 1 5 (Max.) 2 1 (Min.) 3 — (Mean) **channel width[7]** ~5 m **bank height[8]** ~3 m

Water Temperature[9] (°C)	—	**pH[9]**	—
Conductivity[9] (uS/cm,ambient)	—	**Alkalinity..(mg/L).....**	—
Conductivity (uS/cm @ 25 °C)		**Turbidity[9] (NTU)**	—
Dissolved Oxygen[9] (mg/l)	—		—
% Sat. Dissolved Oxygen	—		

No reading taken.

Flow velocity[11] (m/sec)

/ / /

[6] From edges of water. [7] From tops of banks. [8] From water surface vertical to top of bank. [9] Measured/sampled from riffle area. [10] Within 'Reach' :ie. 5 times mean water width either side of riffle sampling site. [11] Mid-channel buoyant projectile method (i.e time for a stick to travel known distance)

RIVER DATE LOCATION CODE

OBSERVATIONS (Indicate appropriate number in box)

WATER ODOURS: 1. normal 2. sewage 3. petroleum 4. chemical 5.stormwater 6. musty [ ]

WATER OILS: 1. slick 2. sheen 3. globs 4. flecks 5. none [ ]

TURBIDITY: 1. clear 2. slight 3. turbid 4.opaque/liquid silt (clay like) [ ]

PLUME: 1. little 2. some 3. lots [ ]
(amount of fine sediment generated when kick-sampling)

SEDIMENT OILS: 1. absent 2. light 3. moderate 4. profuse [ ]

SEDIMENT ODOURS: 1. normal 2. sewage 3. petroleum 4. chemical 5. anaerobic 6. none 7. other..... [ ]

FLOW LEVEL: (relative to "water mark" ie. **normal inundation level shown by limit of terrestrial grasses, or by eroded area**, or boundary in bank sediment types).
1. No flow (dry / isolated) 2. Low (<water mark) 3. Moderate (=) 4. High 5. Flood (>water mark) [ ]

Bare ground above normal inundation level shown by above: Left bank.....% Right bank.....%

SEDIMENT DEPOSITS: 1. none 2. sludge 3. sand 4. floc/silt (very light) 5. other [ ]

LOCAL CATCHMENT EROSION (within sight of site) 1. none 2. moderate 3. heavy [ ]

LOCAL Non-Point Source POLLUTION: no evidence 2. potential.....3. obvious..... [ ]

Point Source Pollution: 1. STP 2. road 3. other..... [ ]

DAMS / BARRIERS (local) 1. present upstream / downstream 2. absent 3. river regulated [ ]

BRAIDING: 1. yes no. of channels ..... 2. no [ ]

SITE CLASSIFICATION: X
(indicate >1 if required) 1. steep valley 2. broad valley 3. wetland/bog 4. heath 5. plains 6. natural riparian meadow [ ]

LANDUSE: 1. Native forest 2. Forestry 3. Native pasture 4. Grazing 5. Cropped
Left Bank[2] 6. Residential 7. Industrial 8. Recreational [ ]

LANDUSE: 1. Native forest 2. Forestry 3. Native pasture 4. Grazing 5. Cropped
Right Bank[2] 6. Residential 7. Industrial 8. Recreational [ ]

VEGCAT (for AUSRIVAS)
1. Urban/Residential 2. Intensive agriculture/some residential
3. Some forestry/agriculture(eg grazing) 4. Native forest/natural vegetation [ ]

BARS: (bed surface protruding from water & forming a bar) .....%

RIVER..... **DATE**..... **LOCATION CODE**.....

REACH[10]

Length of Reach[10].....metres.

SUBSTRATUM DESCRIPTION (% cover):

			PHI
Bedrock		[.....]	-9.5
Boulder	(>256mm)	[.....]	-9.0
Cobble	(64-256mm)	[.....]	-6.5
Pebble	(16-64mm)	[.....]	-4.5
Gravel	(2-16mm)	[.....]	-2.0
Sand	(0.06-2mm)	[.....]	2.0
Silt	(0.004-0.06mm)	[.....]	6.5
Clay	(<0.004mm)	[.....]	9.5

ORGANIC SUBSTRATUM (% cover of inorganic substrate)

Detritus (sticks, wood, CPOM[14]**)** [.....]
Muck/Mud (black, very fine organics) [.....]
FPOM/CPOM categories 1= <5%
2 = 5 - 20 %
3 = >20 %

Not Applicable.

Moss	**0**	**1**	**2**	**3**	**4**	**(percent of reach covered by)**
Filamentous algae	**0**	**1**	**2**	**3**	**4**	**(percent of reach covered by)**
Macrophytes	**0**	**1**	**2**	**3**	**4**	**(percent of reach covered by)**

0= <10% 1=10-35% 2=35-65% 3=65-90% 4=>90%

[10] 'Reach' :ie. 5 times mean water width either side of riffle sampling site.
[14] Coarse Particulate Organic Material.

RIVER..... DATE..... LOCATION CODE.....

LOW GRADIENT STREAMS

Habitat Parameter	Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal substrate/ available cover	Greater than 50% of substrate favourable for epifaunal colonisation and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonisation potential (logs/snags are not newly fallen and not transient)	30-50% mix of stable habitat; well-suited for full colonisation potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newly fallen logs but not yet "seasoned" (may rate at high end of scale)	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat obvious; substrate unstable or lacking.
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
2. Pool substrate charactcris ation	Mixture of substrate materials with gravel and firms prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud or clay; mud may be dominant, some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
3. Pool variability	Even mix of large/shallow, large/deep, small/shallow and small/deep pools present	Majority of pools large/deep; very few shallow	Shallow pools much more prevalent than deep pools	Majority of pools small/ shallow or pools absent
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
4. Channel alteration	Channelisation or dredging absent or minimal; stream with normal pattern	Some channelisation present, usually in areas of bridge abutments; evidence of past channelisation, ie, dredging (greater than past 20 yrs) may be present, but recent channelisation is not present.	Channelisation may be extensive; embankments or shoring structures present on both banks; and 40 – 80% of stream reach channelised and disrupted.	Banks shored with gabion or cement, over 80% of stream reach channelised and disrupted. Instream habitat greatly altered or removed entirely.
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
5. Sediment deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravels and/or fine sediment; 5-30% (20-50% for low gradient streams) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low gradient streams) of the bottom affected; sediment deposits at obstructions, constrictions and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low gradient streams) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**

RIVER.....DATE.....LOCATION CODE.....

LOW GRADIENT STREAMS

Habitat Parameter	Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was a staright line. (Note: channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 2 to 3 times longer than if it was a staright line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was a staright line.	Channel straight; waterway has been channelised for a long distance.
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 (0)**
7 Channel flow status	Water reaches base of both lower banks, and minimal amount of channel substrate exposed.	Water fills >75% of available channel or <25% of channel substrate exposed	Water fills 25-75% of available channel and/or riffle substrates are mostly exposed	Very little water in channel and mostly present as standing pools.
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**(5) 4 3 2 1 0**
8. Bank vegetative protection (score each bank)	More than 90% of the streambank surfaces covered by native vegetation, including trees, understorey shrubs or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or nor evident; almost all plants allowed to grow naturally	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well represented; disruption evident but not affecting full plant growth potential to any great extent	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank is very high; vegetation has been removed to 5 cm or less.
Score	**Left bank 10 9**	**8 7 6**	**5 4 3**	**2 1 (0)**
Score	**Right bank 10 9**	**8 7 6**	**5 4 3**	**2 1 (0)**
9. Bank stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent small areas of erosion mostly healed over; 5 –30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
Score	**Left bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
Score	**Right bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
10. Riparian Vegetative zone width (score each bank)	Width of riparian zone >18 m; human activities (ie roads, lawns, crops etc.) have not impacted zone.	Width of riparian zone 12-18 m; human activities have impacted zone only minimally.	Width of riparian zone 6-12 m; human activities have impacted zone a great deal.	Width of riparian zone <6 m; little or no riparian vegetation due to human activities.
Score	**Left bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
Score	**Right bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**

Total score_____

FIELD SAMPLING AND HABITAT ASSESSMENT SHEETS (ver 7 9/2/99

Adapted by Dan Evans 10/08/2022 for the specific use on MJFP Project

DATE 11/8/22 TIME 3PM LOCATION CODE LOCATION 3
RIVER MOONEE PONDS CREEK LOCATION KOALA CR
RECORDERS NAME K.I PHOTOGRAPH NUMBER (S)
MAP DRAWN/MODIFIED AIR TEMPERATURE °C
RAIN IN LAST WEEK ? Y [ ] N [ ]

AMG
LATITUDE LONGITUDE

RIPARIAN VEGETATION

Width of riparian zone[1]: estimated / measured left bank[2] 5+ m
estimated / measured right bank[2] ~2 m

Vegetation type:	% Cover of riparian zone[3]	Description
trees (>10m)	5	
trees (<10m)	5	
shrubs / vines	10	
grasses / ferns / sedges	80	

Vegetation cover of river[4]: <5% [ ] 6-25% [ ] 26-50% [ ] 51-75% [ ] >76% [ ]

[1] Area where waterway interacts with vegetation. [2] Facing downstream. [3] From 'Plan' view, estimation of outline cover; may total >100%. [4] Estimate as at midday. [5] Total may be >100%. [6]. From edge of water to cleared land.

MEASUREMENTS:

Stream Width[6] (m) 1 8 (Max.) 2 2 (Min.) 3 5 (Mean) **channel width[7]** ~1.2 m **bank height[8]** ~5 m

Water Temperature[9] (°C)	9.6	**pH[9]**	7.64
Conductivity[9] (uS/cm,ambient)	–	**Alkalinity..(mg/L).....**	—
Conductivity (uS/cm @ 25 °C)	–	**Turbidity[9] (NTU)**	21.34
Dissolved Oxygen[9] (mg/l)	84.2		
% Sat. Dissolved Oxygen	81.1		

Flow velocity[11] (m/sec)

...../..... ...../..... ...../.....

[6] From edges of water. [7] From tops of banks. [8] From water surface vertical to top of bank. [9] Measured/sampled from riffle area. [10] Within 'Reach' :ie. 5 times mean water width either side of riffle sampling site. [11] Mid-channel buoyant projectile method (i.e time for a stick to travel known distance)

RIVER..... DATE..... LOCATION CODE.....

OBSERVATIONS (Indicate appropriate number in box)

WATER ODOURS: 1. normal 2. sewage 3. petroleum 4. chemical 5.stormwater 6. musty [ ]

WATER OILS: 1. slick 2. sheen 3. globs 4. flecks 5. none [ ]

TURBIDITY: 1. clear 2. slight 3. turbid 4.opaque/liquid silt (clay like) [ ]

PLUME: 1. little 2. some 3. lots [ ]
(amount of fine sediment generated when kick-sampling)

SEDIMENT OILS: 1. absent 2. light 3. moderate 4. profuse [ ]

SEDIMENT ODOURS: 1. normal 2. sewage 3. petroleum 4. chemical 5. anaerobic 6. none 7. other..... [ ]

FLOW LEVEL: (relative to "water mark" ie. **normal inundation level shown by limit of terrestrial grasses, or by eroded area**, or boundary in bank sediment types).
1. No flow (dry / isolated) 2. Low (<water mark) 3. Moderate (=) 4. High 5. Flood (>water mark) [ ]

Bare ground above normal inundation level shown by above: Left bank.....% Right bank.....%

SEDIMENT DEPOSITS: 1. none 2. sludge 3. sand 4. floc/silt (very light) 5. other [ ]

LOCAL CATCHMENT EROSION (within sight of site) 1. none 2. moderate 3. heavy [ ]

LOCAL Non-Point Source POLLUTION: no evidence 1. 2. potential.....3. obvious..... [ ]

Point Source Pollution: 1. STP 2. road 3. other..... [ ]

DAMS / BARRIERS (local) 1. present upstream / downstream 2. absent 3. river regulated [ ]

BRAIDING: 1. yes no. of channels ..... 2. no [ ]

SITE CLASSIFICATION: 1. steep valley 2. broad valley 3. wetland/bog 4. heath
(indicate >1 if required) 5. plains 6. natural riparian meadow [ ]

LANDUSE: Left Bank[2] 1. Native forest 2. Forestry 3. Native pasture 4. Grazing 5. Cropped 6. Residential 7. Industrial 8. Recreational [ ]

LANDUSE: Right Bank[2] 1. Native forest 2. Forestry 3. Native pasture 4. Grazing 5. Cropped 6. Residential 7. Industrial 8. Recreational [ ]

VEGCAT (for AUSRIVAS)
1. Urban/Residential 2. Intensive agriculture/some residential
3. Some forestry/agriculture(eg grazing) 4. Native forest/natural vegetation [ ]

BARS: (bed surface protruding from water & forming a bar) .....%

RIVER..... **DATE**..... **LOCATION CODE**.....

REACH[10]

Length of Reach[10].....metres.

SUBSTRATUM DESCRIPTION (% cover):

			PHI
Bedrock		[.....]	-9.5
Boulder	(>256mm)	[.....]	-9.0
Cobble	(64-256mm)	[.....]	-6.5
Pebble	(16-64mm)	[.....]	-4.5
Gravel	(2-16mm)	[.....]	-2.0
Sand	(0.06-2mm)	[.....]	2.0
Silt	(0.004-0.06mm)	[.....]	6.5
Clay	(<0.004mm)	[.....]	9.5

ORGANIC SUBSTRATUM (% cover of inorganic substrate)

Detritus (sticks, wood, CPOM[14]**)** [.....]

Muck/Mud (black, very fine organics) [.....]

FPOM/CPOM categories 1= <5%
2 = 5 - 20 %
3 = >20 %

Moss	**0**	**1**	**2**	**3**	**4**	**(percent of reach covered by)**
Filamentous algae	**0**	**1**	**2**	**3**	**4**	**(percent of reach covered by)**
Macrophytes	**0**	**1**	**2**	**3**	**4**	**(percent of reach covered by)**

0= <10% 1=10-35% 2=35-65% 3=65-90% 4=>90%

10 'Reach' :ie. 5 times mean water width either side of riffle sampling site.

14 Coarse Particulate Organic Material.

RIVER..... DATE..... LOCATION CODE.....

LOW GRADIENT STREAMS

Habitat Parameter	Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal substrate/ available cover	Greater than 50% of substrate favourable for epifaunal colonisation and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonisation potential (logs/snags are not newly fallen and not transient)	30-50% mix of stable habitat; well-suited for full colonisation potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newly fallen logs but not yet "seasoned" (may rate at high end of scale)	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat obvious; substrate unstable or lacking.
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
2. Pool substrate charaercterisation	Mixture of substrate materials with gravel and firms prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud or clay; mud may be dominant, some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
3. Pool variability	Even mix of large/shallow, large/deep, small/shallow and small/deep pools present	Majority of pools large/deep; very few shallow	Shallow pools much more prevalent than deep pools	Majority of pools small/ shallow or pools absent
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
4. Channel alteration	Channelisation or dredging absent or minimal; stream with normal pattern	Some channelisation present, usually in areas of bridge abutments; evidence of past channelisation, ie, dredging (greater than past 20 yrs) may be present, but recent channelisation is not present.	Channelisation may be extensive; embankments or shoring structures present on both banks; and 40 – 80% of stream reach channelised and disrupted.	Banks shored with gabion or cement, over 80% of stream reach channelised and disrupted. Instream habitat greatly altered or removed entirely.
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
5. Sediment deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravels and/or fine sediment; 5-30% (20-50% for low gradient streams) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low gradient streams) of the bottom affected; sediment deposits at obstructions, constrictions and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low gradient streams) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**

RIVER..... DATE..... LOCATION CODE.....

LOW GRADIENT STREAMS

Habitat Parameter	Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was a staright line. (Note: channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 2 to 3 times longer than if it was a staright line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was a staright line.	Channel straight; waterway has been channelised for a long distance.
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
7 Channel flow status	Water reaches base of both lower banks, and minimal amount of channel substrate exposed.	Water fills >75% of available channel or <25% of channel substrate exposed	Water fills 25-75% of available channel and/or riffle substrates are mostly exposed	Very little water in channel and mostly present as standing pools.
Score	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**
8. Bank vegetative protection (score each bank)	More than 90% of the streambank surfaces covered by native vegetation, including trees, understorey shrubs or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or nor evident; almost all plants allowed to grow naturally	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well represented; disruption evident but not affecting full plant growth potential to any great extent	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank is very high; vegetation has been removed to 5 cm or less.
Score	**Left bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
Score	**Right bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
9. Bank stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent small areas of erosion mostly healed over; 5 –30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
Score	**Left bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
Score	**Right bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
10. Riparian Vegetative zone width (score each bank)	Width of riparian zone >18 m; human activities (ie roads, lawns, crops etc.) have not impacted zone.	Width of riparian zone 12-18 m; human activities have impacted zone only minimally.	Width of riparian zone 6-12 m; human activities have impacted zone a great deal.	Width of riparian zone <6 m; little or no riparian vegetation due to human activities.
Score	**Left bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
Score	**Right bank 10 9**	**8 7 6**	**5 4 3**	**2 1 0**

Total score

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