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APA Crib Point Pakenham Pipeline Project
APA Transmission Pty Limited
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Crib Point Pakenham Pipeline Project

Hydrological and Hydrogeological Impact Assessment

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1.0 Introduction

APA Transmission Pty Limited, a wholly owned subsidiary of the APA Group (together referred to as APA), is proposing to construct and operate an approximately 56 km long high pressure gas pipeline (the **APA Project**) which will connect AGL's proposed Gas Import Jetty at Crib Point to the Victorian Transmission System (VTS), near Pakenham.

AECOM Australia Pty Ltd (AECOM) was engaged to collate the relevant information and prepare a summary of the hydrogeological and hydrological setting for the Project and outline the potential environmental impacts and proposed management and mitigation measures during its construction and operation.

This preliminary hydrogeological and hydrological impact assessment aims to be in a form suitable for submission as part of the referral of a project on the need for assessment under the *Environment Effects Act 1978*.

1.1 Project Overview

The APA Project incorporates an approximately 56 km long high pressure gas pipeline which will connect the Gas Import Jetty at Crib Point and the Victorian Transmission System (VTS), near Pakenham.

The proposed AGL gas importing jetty project will consist of a Floating Storage and Regasification Unit (FSRU) continuously moored at the existing Crib Point Jetty. The natural gas will then be transferred to APA's Crib Point Receiving Facility via a marine loading arm and jetty piping. The high pressure gas pipeline will transfer the generated gas from the Crib Point Receiving Facility to the APA Pakenham Delivery Facility where it is conditioned to maintain the operating parameters of the VTS before injection.

Construction is currently scheduled to commence at the Receiving and Delivering Facilities in June – July 2019. The pipeline construction is scheduled to commence in October 2019 with the pipeline system planned to be operational by March 2020. The exact timing is dependent on a number of factors including timing of the required approvals, access agreements with relevant stakeholders and weather conditions during construction.

1.2 Project Description

1.2.1 Components

The Crib Point Pakenham Pipeline (the APA Project) consists of the following components:

- Approximately 56 km of high pressure gas transmission pipeline with a diameter of 600mm with a minimum cover of 1.2 m from ground level.
- Two mainline valves (MLVs) will be situated along the pipeline at kilometre point (KP) KP12 and KP40. MLVs are provided as a means to isolate the pipeline in segments for maintenance, repair, operation, and for the minimisation of gas loss in the event that pipeline integrity is lost. Once isolated, the gas from the relevant pipeline section may be vented prior maintenance taking place. A typical MLV site comprises of 10 m x 10 m fenced compound.
- Cathodic protection (CP) is to be provided via a combination of crossbonds to existing CP system and the installation of an impressed current system at either of the MLVs which will be determined during detailed design. The pipeline primary corrosion protection system shall be its external coating.

The Crib Point Pakenham Pipeline has a design life of 60 years. The design life of other pipeline equipment and sub-systems ranges from 15 to 25 years, but with ongoing integrity management, and subject to appropriate commercial drivers, the operational life is expected to be longer[1].

[1] APA Design Basis Manual General: Crib Point to Pakenham Pipeline Project. 29 March 2018, CPT. 2373

1.2.2 Pipeline Route

The preferred pipeline route has been selected after more than 6 months of consultation with affected landowners and Government Stakeholders, and the completion of detailed environmental investigations that inform the construction methodology for avoidance and minimisation of impacts. A map showing the preferred route is presented in **Figure 1**.

The key sections of the route are as follows:

- APA Crib Point Receiving Facility to Graydens Road (KP00 to KP10):
  - From the APA Crib Point Receiving Facility immediately north of the existing jetty facilities (KP0), the pipeline generally follows existing oil and gas pipeline infrastructure corridors to the south of Hastings.
  - These infrastructure corridors are followed for the first 5km of the pipeline route to Reid Parade, Hastings including a 1.7km crossing of Warringine Park, a local conservation reserve managed by the Mornington Peninsula Shire Council.
  - Through Hastings, the pipeline route generally follows Frankston-Flinders Road, with the exception of where the Stony Point Rail Line corridor is wide enough to accommodate the pipeline for approximately 500m. Within Hastings where the pipeline is co-located with Frankston-Flinders Road, the pipeline route has been located within the adjacent service road of the main carriageway where possible.
- Graydens Road to the north of Hastings (KP10 to KP25):
  - From Graydens Road the pipeline is generally located within private property following the crossing of the Stony Point Rail Line and Frankston-Flinders Road (KP9.8).
  - Between KP10.1 and KP29.9 the pipeline is generally co-located adjacent to the Esso Australia oil and gas pipeline corridor. In a number of instances, the pipeline route diverges from this existing linear infrastructure corridor to avoid social and environmental constraints or to facilitate the proposed construction methodology. The pipeline route is located to the south of the Western Port Highway and the townships of Tyabb and Pearcedale, with the crossing of Baxter-Tooradin Road at KP25.3. Through the area between KP13 to 25, the pipeline route is close to Westernport and the associated Ramsar Wetland and the Yaringa Marine National Park.
- Hastings to Pakenham South (KP25 to KP42):
  - Following the crossing of Baxter-Tooradin Road (KP25.1), the pipeline is generally located in more open agricultural land and the pipeline diverges from the Esso Australia oil and gas pipeline corridor prior to the crossing of the South Gippsland Highway (KP30.4) to take a more direct route to the east of Pakenham. The pipeline crosses the dis-used Leongatha Rail Line at KP33.7.
  - Between the South Gippsland Highway (KP30.4) and Pakenham South (approximately KP50), the pipeline traverses the low lying Koo Wee Rup swamp area and a number of significant drainage features that are maintained by Melbourne Water. Western Contour Drain (KP31), Cardinia Creek (KP40.2), Deep and Toomuc Creeks (KP41.5) are three of the most significant drainage features that the pipeline crosses in between South Gippsland Highway and Pakenham South.
- Pakenham to Longford-Dandenong Pipeline (KP42 to KP55.9):
  - Towards Pakenham, the pipeline crosses the Gippsland Rail Line (KP54.2), prior to reaching the proposed Pakenham Delivery Facility.
  - From the Pakenham Delivery Facility, the pipeline then follows Oakview Lane and Mt Ararat Road to reach the terminal point on the Longford-Dandenong Pipeline on the northern side of the Princes Highway. In order for this to occur there are two significant road crossings of both the Princes Freeway (KP54.9) and the Princes Highway (KP55.9).

1.2.3 Pipeline Right of Way

The construction footprint will comprise a 30 m wide pipeline construction Right of Way (ROW), and extra work spaces for temporary facilities to support construction. Extra work space and temporary facilities will include:

- Access tracks (upgrade of existing and construction of new);
- Additional work areas (turn-around points, additional work space for crossings, Horizontal Directional Drilling (HDD) rig set up and, if required storage areas); and
- Water supply tanks and temporary dams for storing water required for dust suppression and hydrostatic testing (pressure testing) of the pipeline.

The width of the ROW may be reduced in areas such as sensitive environments and/or water courses. In some cases due to the presence of high conservation value ecosystems or agricultural land, APA will implement a construction methodology such as Horizontal Directional Drilling (HDD) that will negate the need for a construction ROW.

The construction ROW and all temporary facilities, temporary access tracks and extra work areas will be progressively decommissioned and reinstated on completion of the construction phase.

Following construction of the pipeline, landowners will be able to resume use of the land.

Excavating or erecting permanent structures or buildings over the buried pipeline will be prohibited in accordance with the requirements under the relevant legislation and pursuant to agreements with the landowners. Pipeline markers will be provided at fences, road crossings and other locations as required by Australian Standard 2885 Pipelines - Gas and Liquid Petroleum (AS 2885).

1.3 Purpose of this Report

The purpose of this report is to summarise the hydrogeological and hydrological setting of the APA Project in a form which allows an assessment of the potential environmental impacts and provides a justification for the management and mitigation strategies being proposed for construction and operational phases.

Specifically, this reports aims to outline the following associated with the APA Project:

- relevant hydrological and hydrogeological catchment(s) and sub-catchments;
- relevant aquifers (groundwater units) potentially effected;
- surface water and groundwater receptors (including GDEs);
- potential impacts and their significance to those receptors associated with the construction and/or operational phase;
- general mitigation strategies; and
- key areas of uncertainty (if any).

1.4 Exclusions/Limitations

This report is a desktop assessment only. Findings are based on a review of existing project specific studies, together with review and interpretation of publicly available datasets. No field investigations were undertaken.

Potential impacts are considered only for the APA Crib Point Pakenham Pipeline project. This report does not consider potential impacts from the AGL Gas Import Jetty Project at Crib Point.

2.0 Existing Environment

2.1 Data Sources

The publically available data sources used in the preparation of this report include the following:

Table 1 Data Sources

Data	Source
Hydrology	Melbourne Water: https://www.melbournewater.com.au/water/health-and-monitoring/river-health-and-monitoring/westernport-catchment *Waterway Crossing Assessment* prepared by Alluvium Consulting Australia (Coffey, 2018)
Soil types	Australian Soil Resource Information System (ASRIS): (www.clw.csiro.au/aclep). Sargeant and Inhof et al (1996)
Acid sulfate soils	Australian Soil Resource Information System (ASRIS): (www.clw.csiro.au/aclep). DELWP (2015) Coastal Acid Sulfate Soils Distribution: http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/soil-home
Aquifer units	SRW Port Phillip and Western Port Atlas (SRW, 2014b) Victorian Aquifer Framework[2]
Groundwater levels	DELWP Water Management Information System: http://data.water.vic.gov.au/monitoring.htm *Crib Point to Pakenham Pipeline Project Desktop Geotechnical and Hydrology Study* (Coffey,(2018) Department of Environment, Land, Water and Planning (DELWP) database
Groundwater management	SRW *Koo Wee Rup WSPA* (SRW, 2010)
Groundwater salinity	Department of Environment, Land, Water and Planning (DELWP) database
Groundwater users	DELWP Water Management Information System: http://data.water.vic.gov.au/monitoring.htm
Groundwater Dependent Ecosystems (GDEs)	Bureau of Meteorology: GDE Groundwater Dependent Ecosystem Atlas: http://www.bom.gov.au/water/groundwater/gde/map.shtml
Contaminated Land	Visualising Victoria's Groundwater: http://www.vvg.org.au/ Department of Environment, Land, Water and Planning, Planning Maps Online: http://services.land.vic.gov.au/maps/pmo.jsp *Crib Point to Pakenham Pipeline Project Desktop Geotechnical and Hydrology Study* (Coffey,(2018)

[2] Victorian Aquifer Framework - developed by DSE (now DELWP). May 2012

2.2 Regional Catchment Setting

The APA pipeline Project is solely located in the Western Port catchment.

The Western Port catchment varies from the hilly regions near the Bunyip State Park and Strzelecki Ranges to the low lying, flat to undulating terrain of the former Koo Wee Rup swamp, with surface water draining from these topographic highs to Western Port (refer to **Figure 1**).

The catchment has an area of around 3,700 square kilometres and contains over 2,200 kilometres of rivers and creeks. Seventeen waterways enter Western Port, including major rivers and creeks such as Bunyip, Tarago, Cardinia, Yallock , Lang Lang and Bass River networks; all of which discharge directly into the Western Port Ramsar Wetland.

Much of the catchment has been modified to support rural and green wedge land use. Historically the Koo Wee Rup swamp covered large areas in the Western Port hinterland but was drained for development and has resulted in a number of watercourses in the lower catchment becoming channelised drains. Although the area contains a mixture of land uses, the predominant land use is agricultural consisting of dairying, grazing and horticulture.

The pipeline Project traverses coastal floodplains in the lower reaches of the catchment where the relief is mostly low lying and generally flat to gently undulating. The ground surface elevation ranges from approximately 1-2 mAHD in the southern portion to 10-25 mAHD over the northern portion, where the gently sloping topography grades up to the north.

2.3 Hydrology

2.3.1 Surface Water Flows

The Western Port catchment contains five sub-catchments, three of which are intersected by the proposed pipeline route (refer to **Figure 1**):

- Mornington Peninsula system;
- Cardinia system; and
- Lower Bunyip, Lang Lang and Bass system.

In the Mornington Peninsula system most waterways are small creeks flowing into Western Port, Port Phillip Bay or Bass Strait; the exception being the more significant Watsons Creek that flows through the project area. The system also supports a number of significant wetlands and creek estuaries.

The major waterways of the Cardinia system historically did not exist or were disconnected from Western Port by the former Koo Wee Rup swamp. Estuaries like Cardinia Creek support wetland habitat, and are used for flood mitigation and recreational use, as well as supporting animals such as platypus and growling grass frogs. More specifically, the Melbourne Water Healthy Waterways Strategy[3] states that the platypus is known to occur in the north eastern parts of the Western Port catchment (outside of the project area), including rivers and creeks in the Bunyip, Tarago and Lang Lang river systems. However, although there was a reintroduced population in Cardinia Creek (between 2004 and 2007) platypus are thought to be absent on the Mornington Peninsula and Phillip and French Islands.

In the Lower Bunyip, Lang Lang and Bass system the waterways are mainly rural, and used for water supply, flood mitigation and townships. Together with estuaries and waterways they also support a variety of plant and animal species.

The proposed pipeline is considered broadly to occur across two zones with respect to the surface water setting (Appendix B, Coffey 2018). The first being from Crib Point to immediately east of Pearcedale (approximately 22 km reach) which is dominated by waterways with largely intact physical form and vegetation. The second zone extends from near Pearcedale to Pakenham. This reach traverses multiple waterways subject to significant clearing and drainage works, including a number that were included in the Koo Wee Rup swamp drainage program. Although largely successful, the

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[3] https://yoursay.melbournewater.com.au/healthy-waterways/platypus

drains have been subject to ongoing instability with channel deepening (incision) and associated widening.

A preliminary waterway crossing risk assessment was carried out by Alluvium Consulting Australia Pty Ltd (Alluvium) on behalf of APA (included as Appendix B to Coffey, 2018), were eight main watercourse crossings were identified:

- Warringine Creek;
- Rutherford Creek;
- Tributary of Rutherford Creek;
- Watsons Creek;
- Western Outfall Drain;
- Cardinia Creek;
- Gum Scrub Creek; and
- Toomuc Creek.

In addition, the pipeline crosses 58 unnamed channels/drains or unnamed waterways (Appendix A of Coffey 2018). It is inferred that the majority of these are likely to be ephemeral, with some channels observed by Coffey (2018) to be dry during a site visit in February 2018 as part a preliminary desktop geotechnical study.

Analysis of data for ten streamflow gauges in the vicinity of the proposed pipeline route identified relatively low flow rates, commensurate with small, low relief catchments (Appendix B of Coffey, 2014).

A summary of flood frequencies for the ten streamflow gauges showed flow rates generally ranged from 7.6 to 36 m^3/sec for 10 year ARI[4], and 10.7 to 75 m^3/sec for 100 yr API. The exception being on the Bunyip River at Koo Wee Rup where the 10 year API was 107 m^3/sec, and the 100 year ARI was 255 m^3/sec.

The preliminary risk assessment by Alluvium (Appendix B, Coffey 2018) concluded that 21 of the 66 crossings should be visited and additional site specific investigations completed to confirm risks from flooding and scouring and that current design is appropriate. Based on the level of rigour and transparency evident in the risk assessment methodology, it is considered appropriate to carry forward the recommendations to inform detailed pipeline design.

2.3.2 Surface Water Quality and Beneficial Uses

An annual ‘Report Card’ is available at the Yarra and Bay website[5] that describes the surface water quality across the Western Port catchment for the period 1 July to 30 June. This is based on data from 33 monitoring sites using the water quality parameters: nutrients, water clarity (total suspended solids), dissolved oxygen, salinity (conductivity), pH (acidity/alkalinity) and metals. The 33 monitoring sites collect information for approximately 60% of the Western Port catchment. The remaining catchment area is mostly rural and would generally score as ‘Poor’ in the region.

The most recent report card publicly available (2016 – 2017) described the overall surface water quality for Western Port catchment as being ‘poor’ (i.e. under considerable stress), which is consistent with historical water quality index results that have designated the water quality to be ’Poor’ since 2000-2001.

The pattern of water quality across the Western Port catchment reflects the impacts of climate and land uses (including natural forests, agriculture, industrial centres and urban environments). In the upper catchment, the near-natural areas usually have ‘Good’ water quality, while rural streams in mid-catchment typically score ‘Fair’. Water quality declines further as waterways flow into the lower catchments of the former Koo Wee Rup swamp, with runoff carrying sediments, nutrients and other pollutants (including metals) results in ‘Poor’ to ‘Very Poor’ water quality.

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[4] ARI – Average Recurrence Interval
[5] (https://yarraandbay.vic.gov.au/report-card/report-card-2017/western-port-and-catchment/western-port-catchment)

Results for the five monitoring locations most relevant to the proposed pipeline alignment show the water quality as poor (Olivers Creek and Toomuc Creek) and very poor (Watsons Creek, Wylies Drain and Lower Gum Scrub Creek). These water quality scores were driven by the water quality parameters dissolved oxygen, salinity, nutrients and metals.

The State Environment Protection Policy (Waters of Victoria) (SEPP [*WoV*]) provides the framework to set beneficial uses and environmental values of surface water with the aim of achieving sustainable waters throughout Victoria.

The project area falls with Schedule F8: Waters of Western Port and Catchment, and transects three of its segments; Peninsula, Lowlands and Phillip Island, and South Eastern Rural.

Values are provided for in-stream environmental quality indicators and objectives for a number of constituents - including physio chemical parameters and nutrients. For other toxicants SEPP (*WoV*) directs the reader to the ANZECC Guidelines for Fresh and Marine Waters[6] - where the level of species protection would be determined based on the level to which the aquatic ecosystem has been modified.

2.3.3 Western Port Ramsar

Designated as a wetland of international significance in 1982, the Western Port Ramsar site covers 59,950 hectares (ha) of Western Port. The environmental, social and economic worth of Western Port is recognised further through the declaration of Western Port as a UNESCO Biosphere reserve and the presence of three Marine National Parks within it (Churchill Island, French Island and Yaringa).

It comprises vast intertidal mudflats with saltmarsh, seagrass and mangrove habitats as well as steep subtidal sloping banks with seagrass and deep channels that connect the north of the bay with the oceanic waters of Bass Strait in the south. Many of the animal and plant species are not specifically protected or listed for conservation value, but the combination of mangroves and seagrasses, saltmarsh, fish, birds, crustaceans, worms and other invertebrates all form the Western Port marine ecosystem.

The proposed pipeline route abuts the Ramsar boundary from Crib Point (KP00) to Warringine Park (KP4.5), and horizontal directional drilling (HDD) is proposed to a depth of 14.5 m beneath the Ramsar site at Warringine Park (KP04 – KP05).

The pipeline is typically more than 700 m from the Ramsar boundary between the north-side of Warringine Park (KP05) to south of Watsons Creek (KP20). From Watsons Creek to Langwarrin Creek (KP23) the pipeline is within 200 m of the Ramsar boundary. HDD is proposed for the majority of this section of pipeline.

The pipeline project crosses four named creeks within 1 km of the Ramsar boundary. These are Warringine Creek, Watson Creek (identified as major watercourses in the preliminary waterway crossing risk assessment; refer to Section 2.3.1), Kings Creek and Langwarrin Creek. Of these only the Langwarrin Creek crossing is proposed to be open trenched, with HDD proposed at the remaining three locations.

2.4 Soils

The soils of the area are dominated by brown podsol soil types, although along the entire pipeline length a wide range in soil types can be found and have been mapped[7].

The brown podsol soil types are characterised as having relatively low permeability, tend to have an acidic pH level and are high in organic matter. The risks with these soil types can be summarised as follows:

- Moderately reactive, high plastic subsoil; and
- Poor soil drainage, with seasonal water logging.

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[6] Australian and New Zealand Environment and Conservation Council (ANZECC), Australian Water Quality Guidelines for Fresh and Marine Waters (1992), dated October 2000.
[7] Major Agricultural Soils of the Cranbourne and Koo-Wee-Rup Region (Sargeant and Imhof et al, 1996).

2.4.1 Material Properties

A desktop study of the material properties likely to be encountered during the excavation of the pipeline is provided by Coffey (2018), with the key outcome being the wide range of material types that will be encountered, ranging from loose, wet (unconsolidated) clays and silts to sandy silts that are consolidated dry and stiff to soft/hard rock;

Further geotechnical investigation will be required to assess the subsurface conditions to allow detailed design and in the preparation of the Construction Environment Management Plan (CEMP).

2.4.2 Acid Sulfate Soils

Based on CSIRO's Australian Soil Resource Information System (CSIRO, 2014) the likelihood of acid sulfate soil being present in the project area is inferred to be:

- *Low to extremely low probability, very low confidence* - southern portion of the project area (i.e. Crib Point to Tooradin KP0 to KP26.6.), based on mapped soil types and geological formations but little supporting data.
- *High probability, low to high confidence* – northern portion of the project area (i.e. Tooradin to Officer South KP26.6 to KP48), based on mapped soil types, geological formations and supporting data.

To better define the risks, an acid sulfate soil assessment was carried out by (Monarc, 2018) that included desktop review and soil sampling along the pipeline alignment.

Soil sampling was undertaken at ten locations along the pipeline route targeting areas where acidogenic soils were considered most likely to be present. Samples were collected at 0.5 m intervals to a depth of 3.5 m. A total of 13 samples were analysed, with at least one from each location.

Results of the soil sampling indicated that only the two locations at Crib Point presented positive indicators of acid sulfate soil. None of the other soils analysed were classified as acid sulfate soil. It was also noted that the buffering capacity of the samples analysed was high, including those locations at Crib Point.

It was concluded that there is a possibility that exposure of soils at the Crib Point locations to air could ultimately lead to acidification of surface and groundwater adjacent to the route.

It should be noted however that this statement does not consider management and mitigation measures that can be put in place to address the risks associated with encountering acid sulfate soils.

Although mapping by CSIRO indicates a high probability of acid sulfate soils being present across some portion of project area (with low to high confidence), the site specific assessment undertaken in June/July 2018 (Monarc, 2018) only found acid sulfate soils at the Crib Point sample locations.

2.5 Hydrogeology

2.5.1 Groundwater Occurrence

The site is located within the Western Port Basin (the Basin) which is a relatively shallow, structurally controlled sedimentary basin consisting of sediments and volcanic flows. The western side of the Basin coincides with the Clyde Monocline-Tyabb Fault System, and the eastern extent is controlled by the Heath Hill Fault. Basin sediments pinch out to the north against uplifted basement (SRW, 2010), and extend offshore to the south.

The sediments and volcanic flows of the basin form a multilayered aquifer system, which is dominated by a Tertiary Age sedimentary sequence that thickens to approximately 200m in the Koo Wee Rup area, and pinches out along Basin margins.

The Tertiary Age sediments are overlain by a relatively thin veneer of Quaternary sediments, including coastal and inland dune deposits, swamp and lake deposits and alluvial deposits; although these sediments thicken to between 10 m and 50 m in the Koo Wee Rup area.

A summary of the Basin's geology and hydrostratigraphy is provided in Table 2, with the following considered relevant to the project based on the proposed pipeline alignment and construction methodologies:

- thin outcropping Quaternary age sediments of the unconfined Upper Aquifer (QA), and
- outcropping to sub-cropping Tertiary age sediments of the semi-confined to confined Middle Aquifer (UTAF and UMTA).

The water table across the Basin will generally be a subdued version of topography, with the depth to groundwater increasing beneath topographical highs and shallow groundwater in the lower reaches of the Basin. Regional groundwater flow will be from Basin margins towards Western Port Bay. The presence of shallow aquitards, surface water features and groundwater extraction will locally affect depths to groundwater.

The depth to groundwater across much of the project area (approximately 75% of the pipeline) is inferred to be less than 5m (refer to **Figures F4a to 4e**), including along low lying reaches close to the coast and watercourses. Depth to groundwater is inferred to increase to between 5 and 20m in some parts of the central and northern portions of the project area.

Depths to groundwater in the UTAF and UMTA also increase during the irrigation season in areas where groundwater use is concentrated and cones of depression are set up. The influence on groundwater levels in the overlying QA is not well understood (SRW, 2014b).

Groundwater levels of less than 1 m below ground surface (mbgs) have been measured in shallow soil bores/monitoring wells in the southern portion of the project area (KP00 – KP30), and 1.75 to 2.5 mbgs in the northern portion of the project area (KP30 onwards).

In the southern portion of the project area the geology is predominantly coastal and inland dune deposits, and outcropping Red Bluff sandstone. Groundwater is likely to be limited in lateral and vertical extent within the Quaternary sediments; associated with nearby water courses or locally thicker dunal sands. Where Quaternary sediments thin the water table aquifer will be formed by the outcropping to sub-cropping weathered Upper Tertiary Red Bluff sandstone.

Further north (from approximately KP30) the pipeline turns inland towards Pakenham, and the project area is underlain by a thicker sequence of Quaternary swamp and lake sediments associated with floodplains in the Koo Wee Rup area. Here sediments are thought to be between 10m to 50m thick, comprising silty clay, silts and clay lenses. Where saturated they are likely to be low yielding and have higher salinity groundwater (SRW, 2014b).

The final 2 km or so of the pipeline (from KP53.6) is inferred to be underlain by outcropping basalts of the Older Volcanics Lower Tertiary Basalts (LTB) aquifer, where groundwater levels are inferred to be from 10 m to greater than 20 m below ground surface.

Table 2 Western Port Basin Geological and Hydrogeological Summary

Geological Unit	Main Occurrence	Approximate Portion of Alignment[8]	Depth to Aquifer Unit	Thickness	Lithology	Aquifer Layer	Hydrogeological Layers	Hydrogeological Unit
Dune Deposits	Small occurrences; Cranbourne and Lang Lang areas	15%	Outcropping	Thin, mostly less that 6m	Sand, medium to coarse quartz	Upper	QA Quaternary	Undifferentiated recent sediments
Alluvial Deposits	Longwarry to Dalmore	55%	Outcropping	Less than 7m	Clay, sand and gravel			
Western Port Group	Throughout	20%	Outcrop to subcrop for most of east area. Up to 75m clay cover in west	20 to 175m	Sand, gravel, limestone, clay, silt and lignite	Middle	UTAF Upper Tertiary Aquifer (Fluvial)	Baxter Sandstone (Red Bluff Sandstone)
							UMTA Upper Mid Tertiary Aquifer	Sherwood & Yallock Formation
Older Volcanics	Throughout	10%	Outcrop in Cranbourne and along Heath Hill Fault. Up to 250m cover in central Basin.	10 to 75m	Basalt, basaltic clay	Lower	LTB Lower Tertiary Basalts	Older Volcanics
Childers Formation	Main occurrence: Yallock-Yannathan-Lang Lang area		10 to 75m	5 to 50m	Sand and gravel with lignite beds		LTA Lower Tertiary Aquifer	Childers Formation
Basement	Throughout		Outcrop at Basin margins. >400 m in central Basin	-	Siltstone, sandstone, claystone and granite.		BSE Mesozoic an d Palaeozoic bedrock	Permian glacial sediments, all Palaeozoic basement rock

Note: highlighted rows indicate key geological units considered relevant to the project.

[8] Coffey Services Pty Ltd (2018). Desktop Geotechnical Study.

2.5.2 Groundwater Management

There are two Local Groundwater Management Areas within the Western Port Basin:

- Koo Wee Rup Water Supply Protection Area (KWR WSPA); and
- Corinella Groundwater Management Area (Corinella GMA).

The pipeline crosses into the KWR WSPA, with the remainder located within the general Unincorporated Area (refer **to Figure F3**).

The KWR WSPA consists of seven sub zones and includes a Coastal Buffer area. Although no vertical limit has been placed on the depth of the WSPA, it is predominantly applied to the groundwater resource in the Western Port Group (i.e. Upper Tertiary Aquifer [Fluvial] and Upper Mid-Tertiary Aquifer), neither of which will be intersected by construction of the pipeline.

The KWR WSPA is managed via a Groundwater Management Plan (SRW, 2010) which documents all local management rules including rules on trade, metering, groundwater monitoring, licenses and consultation. A Permissible Consumptive Volume (PCV) of 12,915 ML/year currently applies to the WSPA. While no restrictions are placed on current licence holders, no new licences will be issued[9].

Areas outside of the Corinella GMA and Koo Wee Rup WSPA are grouped into the Unincorporated Area, which has no groundwater management plans or local restrictions.

In terms of the APA Project, although dewatering activities may require an extraction licence(s), it is considered unlikely given the anticipated limited depth and duration of dewatering works. This will need to be confirmed with Southern Rural Water (SRW).

2.5.3 Groundwater Quality, Yields and Beneficial Uses

The yield and salinity[10] of groundwater in the Quaternary sediments of the Upper Aquifer is highly variable due to the heterogeneity of the soil type (including clay, silts, shoe string sands and dune sands), aquifer thickness and depth to groundwater. The yield is typically higher and the salinity lower in sandy and gravelly soils. Conversely, in clay soils the yield is low and the salinity higher such as in sediments forming the previously drained Koo Wee Rup Swamp.

Across the Basin, salinity ranges from less than 500 mg/L and up to 3,500 to 7,000 mg/L in the Upper Aquifer, and yields vary from less than 1 L/s and up to 10 - 50 L/s (southeast of Koo Wee Rup where sediments are thicker, and sandy and gravelly) (SRW, 2014b).

In the underlying Tertiary sediments of the Middle Aquifer (UTAF and UMTA) the salinity is typically between 1,000 and 3,500 mg/L across much of the Basin, with isolated pockets of lower or higher salinities. The yield is generally between less than 1 to 5 L/s, increasing to 10 - 50 L/s in the Koo Wee Rup area (southeast of the project area).

The salinity of groundwater in the water table aquifer along the proposed pipeline alignment is inferred to vary from less than 1,000 mg/L (9% of pipeline), 1,000 to 3,000 mg/L (60% of pipeline) and 3,000 to 7,000 mg/L (31% of pipeline); refer to **Figure F5**.

The State Environment Protection Policy Groundwaters of Victoria [SEPP (GoV)], provides a framework to '*maintain and where necessary improve groundwater quality to protect existing and potential beneficial uses of groundwater across Victoria'*. Groundwater segments are classified based on background total dissolved solids (TDS). Protected beneficial uses are provided for each segment, and groundwater quality indicators and objectives are established to protect each beneficial use.

It would be reasonable to consider groundwater across the project area to be Segment B (1,001 to 3,500 mg/L) based on regional data. The Segment B beneficial uses to be protected include:

- Maintenance of ecosystems
- Potable mineral water supply
- Agriculture, parks and gardens

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[9] With the exception of those specified in prescription of the Plan
[10] Salinity generally measured as Total Dissolved Solids in mg/L

- Stock watering
- Industrial water use
- Primary contact recreation
- Buildings and structures

2.5.4 Groundwater Users

A total of 304 registered groundwater bores, with the status ‘used’, were identified within 1 km of the proposed pipeline route using DELWP’s WMIS[11] (accessed online 7 August 2018; http://data.water.vic.gov.au/monitoring.htm)

The nominated bore uses are summarised below and locations provided on **Figures F6a – 6i**:

- 205 - stock, domestic or stock and domestic (D&S)
- 49 - groundwater investigation or groundwater observation
- 31 - irrigation or stock, domestic and irrigation
- 12 - not known
- 3 - commercial
- 2 - stock, domestic and dairy
- 2 - stock, domestic and miscellaneous

A further 59 bores were nominated as ‘non-groundwater’, seven ‘not used’ and three ‘decommissioned’.

Bore search results for the project area are consistent with the rest of the region where most bores are used for domestic and stock (D & S) or agribusiness (SRW, 2014b). The majority of D&S bores in the Western Port Basin are thought to be installed in the Middle or Lower Aquifers (SRW, 2014b).

2.5.5 Groundwater Dependent Ecosystems

The Groundwater Dependent Ecosystems Atlas (GDE Atlas) was developed as a national dataset of Australian GDEs (http://www.bom.gov.au/water/groundwater/gde/map.shtml).

The Atlas contains information about:

- **Aquatic** ecosystems: reliant on the surface expression of groundwater and includes surface water systems (freshwater only) which may have a groundwater component (i.e. rivers, springs and wetlands)
- **Terrestrial** ecosystems: reliant on the subsurface presence of groundwater, and includes all vegetation ecosystems
- **Subterranean** ecosystems: such as caves and aquifer ecosystems

It is important to note that the Atlas GDE mapping is from two broad sources:

- National assessment – national scale assessment based on a set of rules that describe potential for groundwater/ecosystem interaction and available GIS data
- Regional studies – more detailed assessment by States and/or regional agencies using approaches included field work, analysis of satellite imagery and application of rules/conceptual models.

The identification of potential GDEs in the Atlas therefore does not confirm that a particularly ecosystem is groundwater dependent.

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[11] Department of Environment, Land , Water and Planning – Water Measurement Information System

Aquatic GDEs

The proposed pipeline intersects 11 watercourses designated as high potential GDE (national assessment): Warringine Creek, Olivers Creek, Kings Creek, Watson Creek, Langwarrin Creek, Rutherford Creek, Western Outfall Creek, Cardinia Creek, Lower Gum Scrub Creek, Deep Creek and Toomuk Creek.

Between Crib Point (KP01) and the Pearcedale area (KP30) the proposed pipeline is in the vicinity coastal wetlands described as semi-permanent saline, salt meadow wetlands that are classified as known GDEs (regional study). A number of high to moderate potential GDEs (regional study) described as coastal wetlands/saltmarsh are also in close proximity to the proposed pipeline route.

Beyond the Pearcedale Area the proposed pipeline alignment turns northeast away from coastal GDEs and towards Pakenham.

Terrestrial GDEs

There are numerous moderate to high potential (national assessment) terrestrial GDEs intersected by the proposed pipeline, particularly in the southern portion of the project area (between Crib Point and the Pearcedale area). These include woodland, coastal saltmarsh, swamp scrub and salt meadow.

The location of GDEs and proposed pipeline route are provided in **Figures F7a to F7i**.

2.5.6 Contamination

There is the potential for shallow groundwater quality to be impacted along the pipeline alignment where it is adjacent to land uses that are sources of contamination, for example in areas of commercial/industrial land use.

Sites that have undergone Environmental Audit, appear on EPA's Priority Sites Register and/or have an Environmental Audit Overlay (EAO) applied to them are also indicators that contamination of groundwater may have occurred.

Based on a review of VVG[12], DELWP's online planning maps[13] and Coffey (2018) the following areas are highlighted as potential sources of impact on groundwater quality:

- Crib Point Terminal;
- Industrial land use corridor through Hastings;
- Railway line Hastings;
- Service Stations along the pipeline route;
- Tyabb, former landfill – 53V Audit and Priority Sites Register;
- Tyabb market gardens; and
- Agricultural practices - along majority of pipeline route.

In cases where impacted groundwater and/or soil are intersected the material would need to be appropriately assessed and managed to minimise potential impact to the environment.

[12] Visualising Victoria's Groundwater: http://www.vvg.org.au/
[13] Department of Environment, Land, Water and Planning, Planning Maps Online: http://services.land.vic.gov.au/maps/pmo.jsp

3.0 Impact Assessment

3.1 Construction Methodology

It is proposed that approximately 48km of the 56 km pipeline alignment will be open trenched, with trenchless installation in a number of areas due to high conservation value ecosystems, water courses, agricultural land, roads and rail lines. The number, length and location of trenchless systems may be modified during detailed design to accommodate an increased understanding of landowner issues, material types and groundwater levels.

The general construction and key assumptions for each method are provided in Table 3, and the type of pipeline construction indicated in **Figures 1 to 7**.

Table 3 Construction Methods

Method	Description	Assumptions
Trenching	Open trench excavation using excavator or trenching machine, with battered sides if risk of collapse. Pipe placement including packing sand and at least 1.2 m cover.	Excavation depth generally 2.1 m; increasing to 2.7 m at watercourses and open cut roads Multiple sections open at any one time. Open 3 to 6 weeks average If dewatering required then discharge to ground – either direct or via sump(s) to settle
Trenchless - Horizontal Directional Drilling (HDD)	Angled pilot hole drilled from surface to depth, returning to surface on opposite side of the specified area. Pilot hole is reamed out to the required diameter, and the pipe is pulled back through the drilled hole as the drill string is withdrawn.	No dewatering required. Use of biodegradable drilling fluids and additives during installation process.
Trenchless - Thrust Boring	This jack and bore method requires the construction of an entry and exit pit/shaft to accommodate steel pipe and boring machine. Hole typically drilled with auger to allow a steel pipe to be jacked into place. At the end of the run the auger and cutting bit assembly is removed and the pipe is installed through the casing. Annulus is pressure grouted and pits/shafts are backfilled following pipework connection.	Maximum pit/shaft depth of 4 metres Shafts open for up to 60 days Dewatering required during thrust bore operation when groundwater is present and shafts open (up to 2 months). No preferential pathway for groundwater due to grouting of annulus.

3.1.1 Trenchless Sections

Fifteen HDD locations and seven thrust boring locations are currently nominated across the proposed route alignment as summarised in Table 4 and Table 5, respectively.

A number of additional, shallow (<4m) HDD may also be used along sections of the pipeline route as part of final design assessments.

Table 4 Summary of Trenchless HDD Sections

KP	Location of HDD	Feature Description	Max. Depth (m)
4.0 - 4.4	Warringine Park	HDD to avoid significant flora	14.5
4.6 – 5.0	Warringine Creek	HDD under Warringine Creek	12
7.25 - 7.75	Kings Creek	HDD under Kings Creek and Hastings Leisure Centre Reserve – vegetation avoidance	8.5
8.9 – 9.0	Craydens Road	HDD under Craydens Road to avoid essential services	6
9.9 - 10.4	BlueScope Properties	HDD under Bluescope Properties to avoid ESSO underground pipelines	11
14.6 - 15.2	Significant Flora	HDD under Significant habitat and vegetation	12.5
17.1 - 17.4	Whitneys Road	HDD under Whitneys Road and avoid private infrastructure	10
18.7 - 19.6	Watsons Creek	HDD under Ramsar Wetland	14
22.7 - 23.1	Vowell Road Wetland	HDD under significant aquatic habitat	14
26.8 - 27.3	Fisheries Road crossing	HDD under Fisheries Road and avoid of large trees	6
29.7 - 30.3	South Gippsland Hwy and agricultural land	HDD to avoid high value farmland and under South Gippsland Hwy dual carriage.	16
40 - 40.3	Cardinia Creek	HDD under significant ecosystem	17
41.45 - 41.9	Toomuc Creek – Ballarto Road	HDD under Melbourne Water asset and significant aquatic habitat	16
54.4 - 54.7	Princes Fwy Crossing	HDD under Princes Fwy dual carriage	14
55.1 - 55.4	Princes Hwy Crossing	HDD under Princes Hwy dual carriage	12

Table 5 Summary of Trenchless Thrust Boring Sections

KP	Location of Thrust Boring	Feature Description	Assumed Max. Shaft Depth (m)
0.1 – 0.15	The Esplanade	Under road	4
1.9 – 1.95	Woolleys Road	Under road	4
9.8 – 9.9	Frankston-Crib Point Rail line	Under rail line	4
21.1 – 21.2	Near Pearcedale Conservation Park	Under significant ecosystem	4

KP	Location of Thrust Boring	Feature Description	Assumed Max. Shaft Depth (m)
24.5 – 24.56	Private access road off C781	Under road	4
50.9 – 50.95	Bald Hills Road	Under road	4
53.6 – 54.0	Pakenham Rail Line	Under rail line	4

3.2 Pipeline Design

The 600 mm diameter gas pipe will be installed using open trench methods over approximately 48 km of the route, HDD at 15 locations and 7 thrust boring locations.

Trenched sections will generally be to a maximum depth of 2.1 m and consist of packing sands around the pipe, and a minimum cover of 1.2 m to surface.

HDD will be used to install to depths of up to 17 m beneath a number of significant features (including flora, creeks, roads and underground services), and thrust boring used at additional road and rail line crossings using entry and exit pits to a maximum depth of 4 m.

3.3 Potential Impacts

3.3.1 Hydrology

The design of the pipeline is such that its alignment and depth will not impact on the hydrology of the catchment. The remaining risks are limited to the construction phase, thus will be at a local scale and temporarily limited.

The pipeline alignment results in eight main water crossings and 58 unnamed waterways crossings (Coffey, 2018). Although only four named creeks are cross within 1 km of the Ramsar boundary. The unnamed water ways are anticipated to be ephemeral, with the relevant named creeks either ephemeral or having significantly reduced flow during dryer months. The creeks and waterways in the catchment have been reported to have relatively significant levels of degradation, with the overall assessment of the catchment as Poor or Very Poor.

Open cut trenching is proposed for the majority of waterway crossings as these are expected to be dry, or have very low flow at certain times of the year. Timing construction to coincide with the times of the year where these waterways at the crossing points are dry, or have very low flows, will be expected to result in minimal environmental impact during construction.

The four named creeks within 1 km of the Ramsar boundary that will be cross are Warringine Creek, Watson Creek (identified as major watercourses in the preliminary waterway crossing risk assessment; refer to Section 2.3.1), Kings Creek and Langwarrin Creek. Of these only the Langwarrin Creek crossing is proposed to be open trenched.

3.3.2 Hydrogeology

Trench Sections

Approximately 48km of the 56km pipeline alignment will be installed in open trench. However, approximately 14.5km (around 26%) is anticipated to be intersecting the local groundwater table and less than 2km (about 4%) of the trenched excavation is likely to be 1.5m or more below water table.

Where the published groundwater level map suggests the trench excavation will be between 1 and 2m below water table, highly localised response to the water table are possible, but impact on the resource is not envisaged given drawdown will be limited in duration (<1 month) and extent (less than 0.1m at 10m from excavation) given works will occur during the drier periods of the year and the clayey nature of the soils.

In summary it is not anticipated there will be any unacceptable risks to registered bores or GDEs from the trenched excavation sections of the proposed pipeline.

Trenchless Sections

Groundwater impacts from the HDD sections are limited to quality risks from the water based additives. Dewatering is not required as part of HDD works.

At locations where thrust boring is planned, the entry shaft will require temporary dewatering to a maximum depth of 4m below ground. The potential impact on groundwater in these areas is as follows:

- Lowering of water table: considered to be negligible to low potential to cause significant impact given limited lateral extent of drawdown (based on low permeability sediments, temporary dewatering and depth of excavation). The maximum drawdown likely to be less than 0.5 m at 50 m from excavation[14] for a period of less than 2 months.
- Reduction in base flow of creeks: considered to be negligible to low potential to cause significant impact given and temporary dewatering and limited inflow rates anticipated (based on low permeability sediments and depth of excavation).
- Settlement in areas of compressible (i.e. unconsolidated) sediments: considered low potential to cause significant impact given limited lateral extent of drawdown and appropriate site specific geotechnical investigations.

Operation

The key potential impacts during operation are identified to be:

- *Preferential pathway(s) along the trenched sections of pipeline due to use of packing sands*: considered low potential to significantly impact groundwater flow regime and/or groundwater levels through appropriate design and construction methods (e.g. collar cut-offs/trench breakers); and
- *Groundwater contamination from fixed plant and fuel storage*: considered low potential to significantly impact groundwater and surface water with implementation of an Operational Environment Management Plan

3.4 Mitigation Strategies

The design basis of the pipeline is to avoid risk to hydrology and hydrogeology of the Western Port catchments, and the primary mitigation strategy.

The remaining mitigation strategies are focused on the temporal construction risks to the environment and project, and include the following:

- Early liaison with stakeholders (including Southern Rural Water, Port Phillip Bay and Westernport CMA, Melbourne Water and EPA Victoria) to ensure expectations and license/permit requirements are addressed;
- Construction during drier months (where possible), particularly for open trenching sections of the pipeline at watercourses;
- Development and implementation of a detailed Construction Environment Management Plan (CEMP) - as required under the *Pipelines Act 2005* prior to construction, with matters to be included set out in the Pipeline Regulations 2017; and
- Undertake works in accordance with Industry and Regulatory policies, practices and guidelines.

Table 6 outlines the specific construction phase strategies for key sections of the pipeline alignment.

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[14] Preliminary estimate using Theis approximation: with 4m drawdown at shaft, hydraulic conductivity of 1 m/d and storage coefficient of 0.1 (unconfined aquifer)

Table 6 Potential Impacts and Mitigation Measures

Activity	Potential Effect	Comment	Possible Project Areas to Consider	Potential Specific Mitigation Measures (in addition to those listed in Section 3.4)
Construction Phase				
Dewatering (during trenching and thrust-boring works)	Reduced groundwater levels at registered groundwater bores	51 bores (within 1 km of pipeline) with consumptive use had depths less than or equal to 15m (including 12 erroneously stated as 0 m) from WMIS database. Less potential for deeper bores to be affected. Majority of bores abstract from UTAF and UMTA (SRW, 2014b); i.e. below the Quaternary sediments. Majority of pipeline intersects Quaternary sediments, with only uppermost part of Tertiary sediments intersected (southern section). In central and northern sections Quaternary sediments associated with Koo Wee Rup swamp and typically clayey, silty clays - likely limited yields and radius of influence (i.e. less than 0.5 m drawdown at 50 m)	Where shallow (<15 m deep), consumptive use bores within 1 km (to be conservative) of trenching or thrust boring: KP05 (bore 97216) KP17 - KP18 (bore 97291) KP20 - KP21 (7 bores) KP24 - KP39 (multiple bores) KP44 - KP45 (84110 & 84108) KP53 (84118)	• In areas where groundwater <5m below ground: - Site specific assessment of drawdown at shallow bores along the pipeline • **Construction Environment Management Plan (under Pipelines Act 2005)** - As part of the CEMP develop and implement strategies to minimise groundwater drawdown impacts based on site specific assessments.
	Reduced groundwater levels and flow at GDEs and/or watercourses	A number of estuarine/coastal saltmarsh areas designated known or high to moderate potential aquatic GDEs between KP00 and KP25. Potential effect where pipeline close to coastline. 11 watercourses designated as high potential GDE (national assessment). HDD nominated to install under majority of these. Trenching across or close to four (included in list at right). Numerous moderate to high potential (national assessment) terrestrial GDEs intersected or close to proposed pipeline (esp. southern portion).	KP00 - KP20: potential terrestrial GDEs KP02 - KP06; KP12 - KP15; KP18 - KP21: potential or known aquatic GDE (coastal) KP40.3 - KP41.5: trenching alongside Lower Gum Scrub Creek, Deep Creek and Toomuk Creek	• **Construction Environment Management Plan (under Pipelines Act 2005)** - as part of the CEMP develop and implement strategies to minimise groundwater drawdown impacts based on site specific assessments
	Reduced groundwater levels causing saline intrusion	Potential in low lying areas close to the coast (say <100m); where base of trenching or thrust boring at or below Mean Sea Level.	Consider KP00 - KP05	• **Construction Environment Management Plan (under Pipelines Act 2005)** - as part of the CEMP develop and implement strategies to manage saline water potentially collected in trenched sections.
	Settlement of buildings and structures	Drawdown due to dewatering may cause settlement of compressible materials, and potential damage to buildings or other structures. Dewatering activities likely to be limited in scale and temporary in nature, with radius of drawdown likely to be limited in extent (less than 0.5 m at 50 m). Potential where groundwater is shallow, soils are compressible, buildings/structures in close proximity; and trenching or thrust boring used.	KP06 - KP09 (Hastings) Road and rail crossings where thrust boring used.	• Ensure geotechnical assessment includes potential for settlement from temporary dewatering works where there is the potential for compressible soils/sediments. • **Construction Environment Management Plan (under Pipelines Act 2005)** - as part of the CEMP develop and implement strategies to manage settlement
	Surface water quality affected by discharge of dewatering	Poorly managed stormwater runoff from disturbed ground (i.e. work areas) and/or inadequate treatment of high turbidity water from excavations can lead to discharge into nearby water features. Likelihood is considered low with adequate management in place.	Areas within 100 m of surface water bodies and watercourses	• Discharge to ground and/or via sediment controls • Control stormwater runoff to avoid sediment and runoff to trench • Consider alternative discharge option if required • **Construction Environment Management Plan (under Pipelines Act 2005)** - as part of the CEMP develop and implement strategies to minimise impacts to surface water from dewatering discharges

Activity	Potential Effect	Comment	Possible Project Areas to Consider	Potential Specific Mitigation Measures (in addition to those listed in Section 3.4)
	Generation of acid sulfate soils through oxidation affecting surface water and/or groundwater quality	Likelihood of ASS *Low to extremely low probability, very low confidence* in southern half of route. *High probability, low to high confidence* in northern half of route. Monarc (2018) tested likely locations along route. Only two locations (at Crib Point) presented positive indicators of acid sulfate soil. In northern section soils are inferred to be predominantly clayey, silty clay. Dewatering influence likely to be limited in lateral extent. Assume potential effect only where ASS encountered during excavation.	Only where Acid Sulfate Soil encountered during trenching or thrust boring.	• **Construction Environment Management Plan (under Pipelines Act 2005)** - as part of the CEMP develop and implement strategies to minimise potential for acid sulfate soils to impact the environment
	Contaminated groundwater intersected and/or mobilisation of contaminant plumes	Possibility where adjacent to current/former land uses with potential to contaminate groundwater (and soils). Majority of pipeline route through green wedge and special use (due to high agricultural value) zoning. Potential diffuse pollution from agricultural practices not considered further. Discharge to ground of such shallow groundwater not considered to be low potential to significantly alter background groundwater or surface water quality.	Key areas include: KP00 - KP01: Crib Point Terminal area KP06 - KP10: Hasting industrial zoning KP13: Former landfill	• Monitor for visual or olfactory evidence of gross pollution (particularly in areas of potential concern) • Appropriate assessment and management /disposal of contamination if intersected. • **Construction Environment Management Plan (under Pipelines Act 2005)** - as part of the CEMP develop and implement strategies to minimise potential for contaminated groundwater (and soils) to impact the environment
Trenchless installation	Introduction of drilling muds affecting groundwater quality	Considered low potential to be material impact due to the nature of drilling muds used and potential extent of impacts.	All trenchless sections	• Typically limited ingress of drilling muds into expected formations • Use of biodegradable drilling fluids and additives
Open trenching	Encountering acid sulfate soils during excavation, drilling, tunnelling etc.	Likelihood of ASS *Low to extremely low probability, very low confidence* in southern half of route. *High probability, low to high confidence* in northern half of route. Monarc (2018) tested likely locations along route. Only two locations (at Crib Point) presented positive indicators of acid sulfate soil. Overall, considered low potential of encountering and with management, low potential to impact environment.	KP00 - KP01: Crib Point Area KP18 - KP21 KP27 - KP49	• **Construction Environment Management Plan (under Pipelines Act 2005)** - as part of the CEMP develop and implement strategies to minimise potential for acid sulfate soils to impact the environment
Open trenching	Working at or in waterways effecting flow and water quality	Numerous crossings at minor and/or ephemeral streams. Also nominated crossings at several major watercourses and four watercourses described as high potential aquatic GDEs.	Key watercourse crossings: KP06: Olivers Creek KP21: Langwarrin Creek KP27: Rutherford Creek KP31: Western Outfall Creek	• Consider - Alternative construction method - Stage construction for drier time of year (e.g. Dec - Mar) - Pre-clearance of aquatic fauna - Minimise sediment transport during construction using erosion, sediment and stockpile management controls - Reinstate works area and re-establish vegetation as soon as possible • **Construction Environment Management Plans (under Pipelines Act 2005)** - As part of the CEMP develop and implement strategies to minimise potential for impacts to surface water quality

Activity	Potential Effect	Comment	Possible Project Areas to Consider	Potential Specific Mitigation Measures (in addition to those listed in Section 3.4)
Fixed and mobile machinery/plant, fuel and chemical storage etc.	Leaks or spillages reach groundwater or surface water		All	• To be sited at suitable distances from waterways • Appropriate bunding • Emergency response plan • **Construction Environment Management Plan (under Pipelines Act 2005)** - as part of the CEMP develop and implement strategies to minimise potential for contaminated materials entering the environment
Operational Phase				
Trench construction	Preferential flowpaths changing groundwater flow patterns and/or levels	Trenchless methods not considered to create preferential pathways. Trench construction may provide preferential pathway for shallow groundwater along packing sands.	All trenched sections.	• Ensure construction design and installation minimises potential for preferential pathways (i.e. collar cut-offs/trench breakers)
Fixed machinery/plant, fuel and chemical storage etc.	Leaks or spillages reach groundwater or surface water		Crib Point Terminal Victorian Transmission System near Pakenham)	• Appropriate bunding, monitoring and management • Emergency response plan • **Operational Environmental Management Plan** - as part of the OEMP develop and implement strategies to minimise potential for contaminated materials entering the environment

3.5 Uncertainties

The uncertainties outlined in Table 7 are listed as relevant in the development of the CEMP and those local and temporal risks associated with the construction phase of the APA Project.

Table 7 Key Uncertainties

Uncertainty	Management
Depth to groundwater.	Targeted site investigations in areas with potential depth to groundwater <5m to inform dewatering strategy
Radius of influence due to dewatering activities.	Targeted desktop and site investigations to inform dewatering strategy and drawdown estimates in areas where potential for impacts to groundwater users/receptors.
Requirements for licensing of dewatering activities.	Early liaison with Southern Rural Water.
Extent of settlement due to dewatering activities.	Geotechnical assessment to include potential for settlement from temporary dewatering works where there is the potential for compressible soils/sediments.
Risk of flooding and scouring	Final construction schedule to take into account risks from certain waterways.

4.0 Relevant Referral Criteria

Relevant referral criteria (DSE, 2006) and comments regarding the potential for them to occur are provided in Table 8:

Table 8 Relevant Referral Criteria

Type	Description	Comment
Single	Potential long-term change to the ecological character of a wetland listed under the Ramsar Convention or in 'A Directory of Important Wetlands in Australia'	No changes anticipated based on the small scale temporary nature of dewatering activities, use of HDD construction in sensitive areas and implementation of CEMP.
Combination	Potential extensive or major effects on land stability, acid sulfate soils or highly erodible soils over short or long term	Dewatering activities likely to be limited in scale and temporary in nature, with effects of settlement anticipated to be limited in extent. Also, pipeline only close to buildings or other structures over small portion(s) of alignment. Acid sulfate soils potential is generally low based on publicly available databases, and site assessment (Monarc, 2018). If intersected then management measures would mitigate potential effects.
	Potential extensive or major effects on beneficial uses of waterbodies over the long term due to changes in water quality, streamflow or regional groundwater levels	Dewatering activities are likely to be limited in scale. Although groundwater levels are expected to decline during dewatering of some sections of the pipeline, these effects are anticipated to be localised and temporary only, with no significant effects on beneficial uses anticipated. The potential for water quality to be impacted is not considered to be significant based on the proposed construction techniques and implementation of CEMP.

5.0 References

Coffey Services Australia Pty Ltd, 2018, *Crib Point to Pakenham Pipeline Project Desktop Geotechnical and Hydrology Study*. Report for APA Group. 6 April 2018.

CSIRO 2014. *Australian Resource Information System (ASRIS)*. CSIRO Australia. http://www.asris.csiro.au

Environment Protection Authority, 1999, *Industrial Waste Management Policy (Waste Acid Sulfate Soils)*. 17 August 1999.

Kellog, Brown and Root, 2010, *Western Port Ramsar Wetland Ecological Character Description*. Report for Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Monarc Environmental. 2018. *Acid Sulfate Soil Assessment for Crib Point to Pakenham Pipeline*. Prepared for APA Group, dated 19 July 2018.

Southern Rural Water, (SRW) 2010, *Groundwater Management Plan Koo Wee Rup Water Supply Protection Area*. 4 August 2010.

Southern Rural Water, (SRW) 2014a, *Westernport Groundwater Catchment Statement*. January 2014

Southern Rural Water, (SRW) 2014b, *Port Phillip and Western Port Groundwater Atlas*. July 2014

6.0 Standard Limitations

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Figures

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Coordinate System: GDA 1994 MGA Zone 55
0 1,800 3,600 7,200
metres
1:200,000 (when printed at A3)

LEGEND
- Trench
- Trenchless
- Bairnsdale-Melbourne Railway
- Watercourses

Western Port Sub-Catchment
- Cardinia
- Mornington Peninsula
- French and Phillip Islands
- Upper Bunyip and Tarago
- Lower Bunyip, Lang Lang and Bass

Project Location

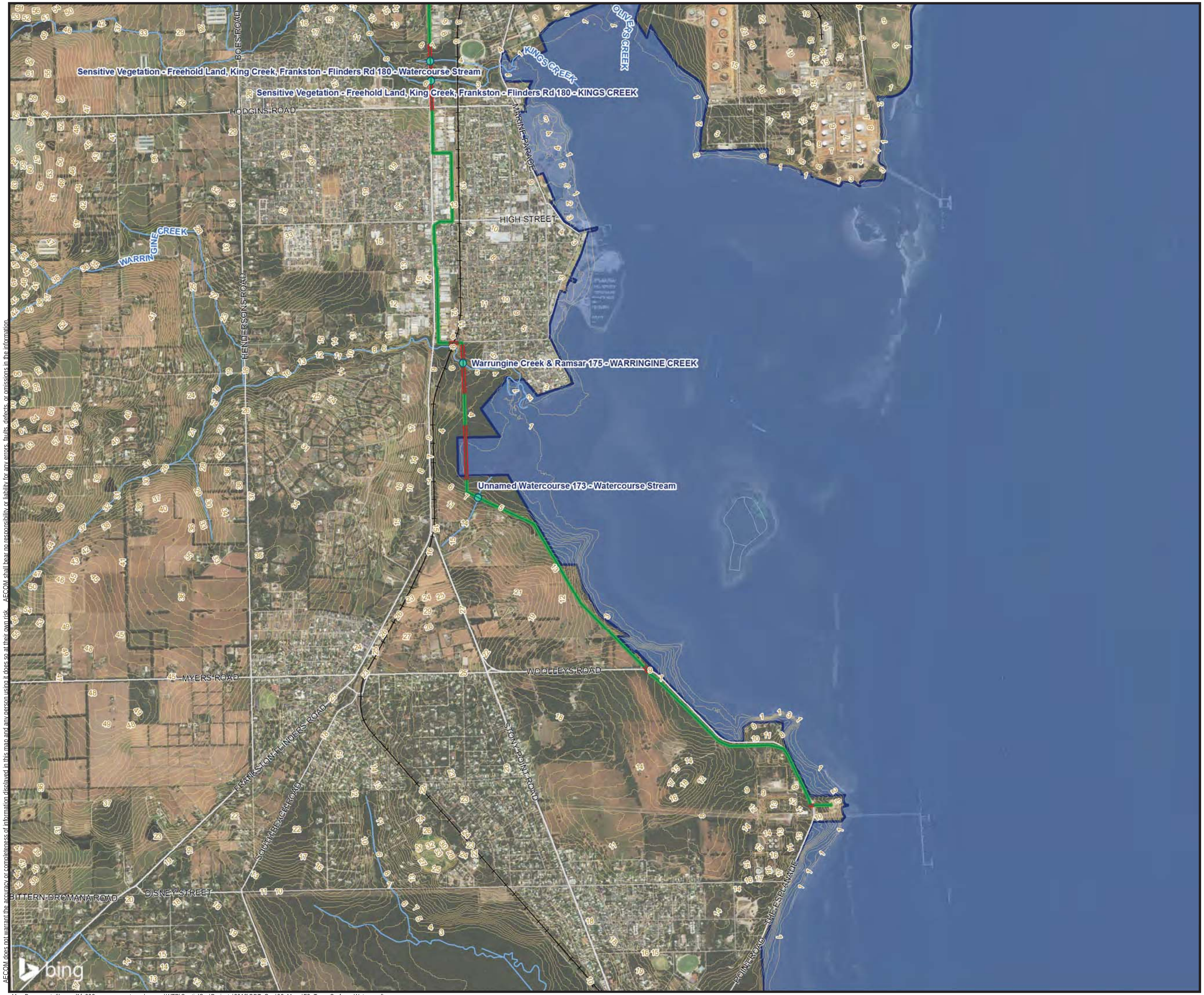
APA Group

Hydrological and Hydrogeological Assessment – Crib Point to Pakenham Pipeline Project

Westerport, VIC

Figure
F1

Map Document: (\\aumel1fp003.au.aecomnet.com\groups\WTR\SpatialSys\Projects\2018\CPT_Geo\02_Maps\F1_Site_Location.mxd)



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Coordinate System: GDA 1994 MGA Zone 55

0 240 480 960

metres

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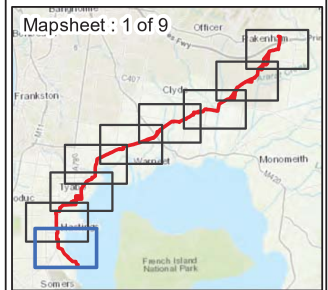
LEGEND

- Trench
- Trenchless
- Drain / Watercourse Intersection
- Bairnsdale-Melbourne Railway
- Watercourses
- Contours (1m)

Ramsar wetlands

- Western Port



Surface Water Features

APA Group

Hydrological and Hydrogeological Assessment – Crib Point to Pakenham Pipeline Project

Westerport, VIC

Figure

F2a

Map Document: (\\aumel1fp003.au.aecomnet.com\groups\WTR\SpatialSys\Projects\2018\CPT_Geo\02_Maps\F2_Topo_Surface_Water.mxd)

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metres
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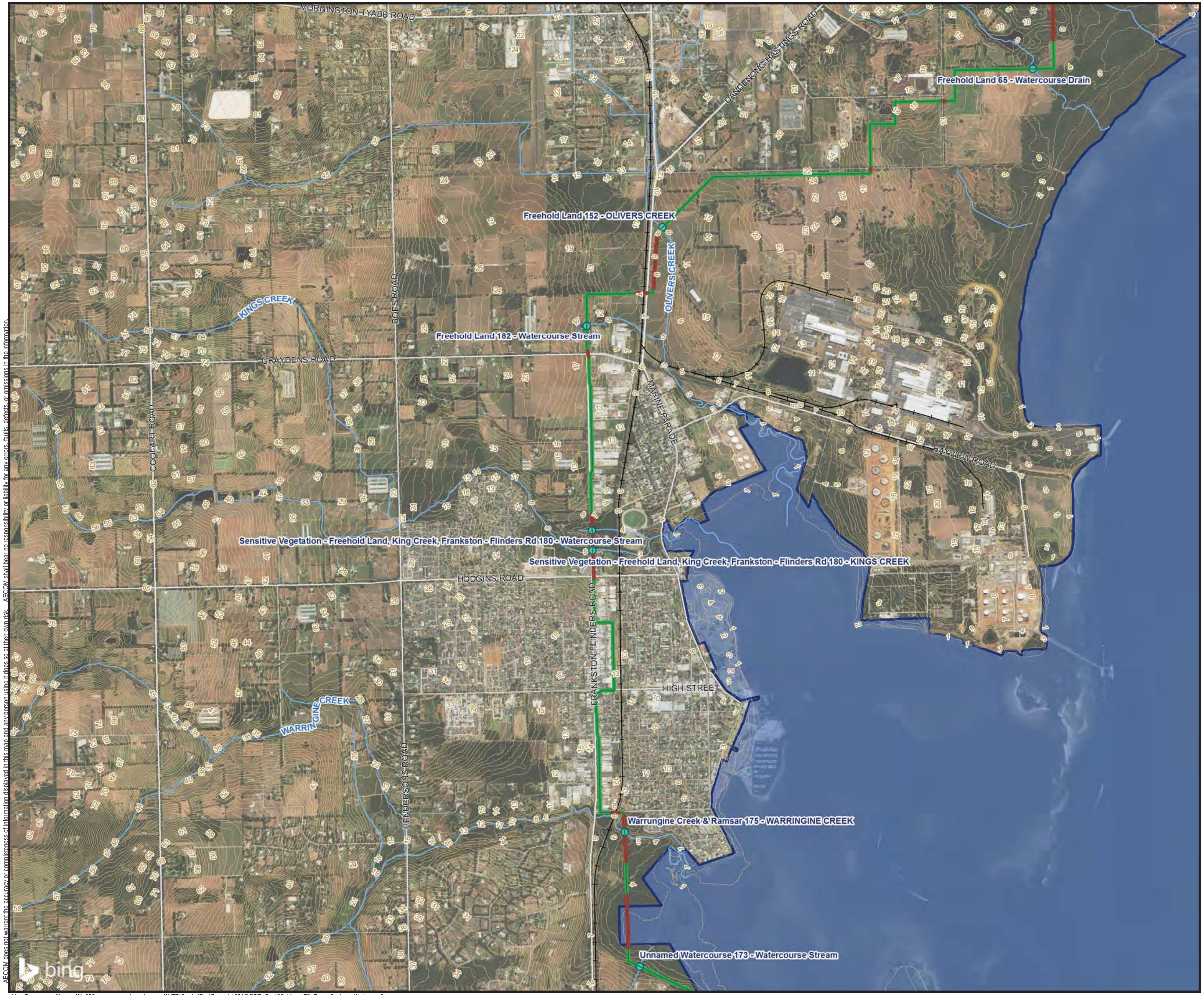
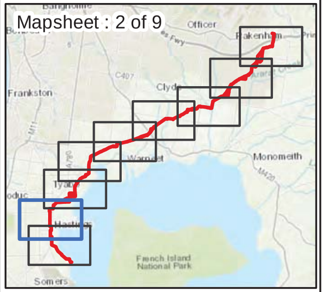
LEGEND

- Trench
- Trenchless
- Drain / Watercourse Intersection
- Bairnsdale-Melbourne Railway
- Watercourses
- Contours (1m)

Ramsar wetlands

- Western Port





Surface Water Features

APA Group

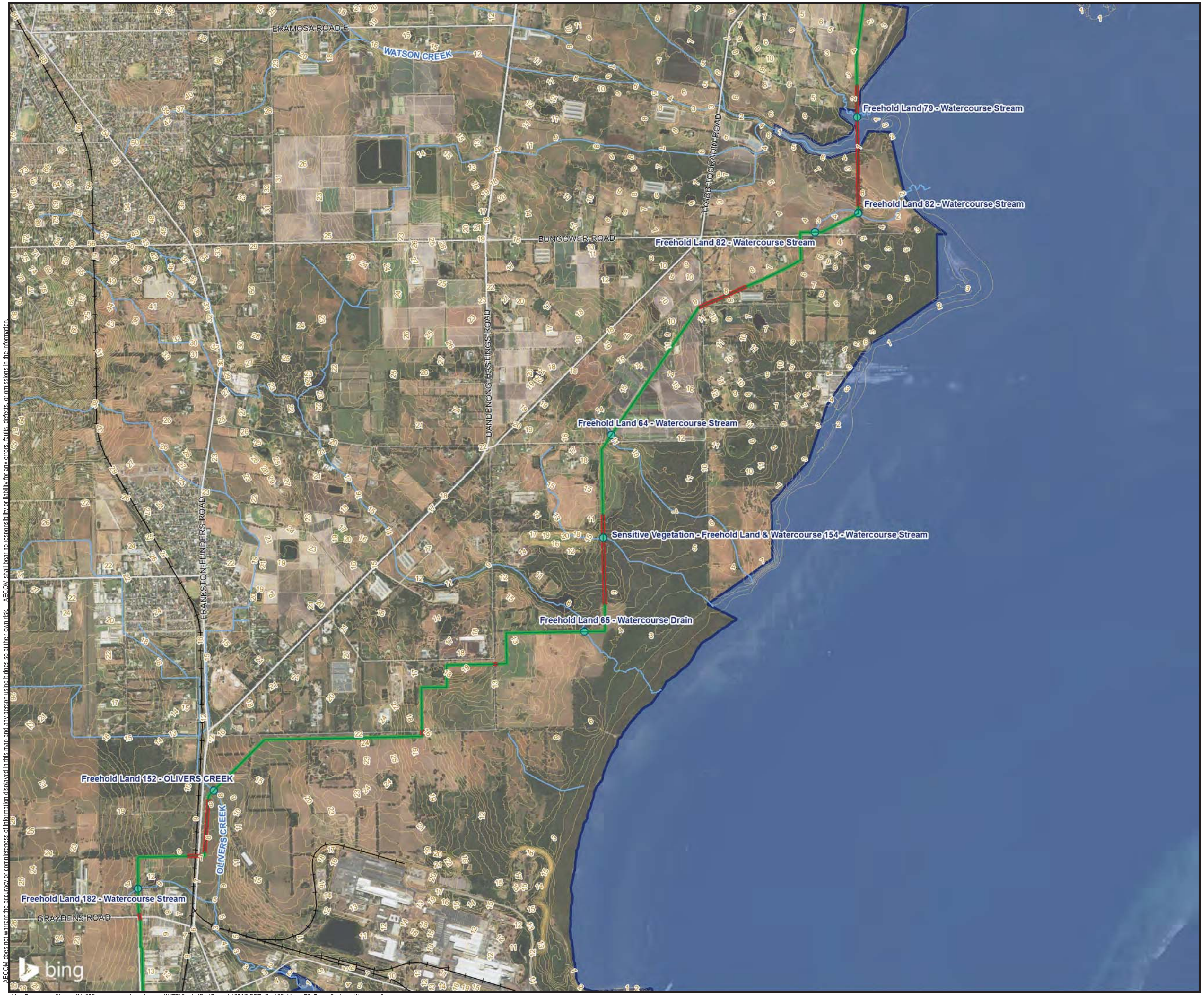
Hydrological and Hydrogeological Assessment – Crib Point to Pakenham Pipeline Project

Westerport, VIC

Figure

F2b

Map Document: (\\aumel1fp003.au.aecomnet.com\groups\WTR\SpatialSys\Projects\2018\CPT_Geo\02_Maps\F2_Topo_Surface_Water.mxd)



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Coordinate System: GDA 1994 MGA Zone 55
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metres
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LEGEND

- Trench
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Ramsar wetlands

- Western Port

Mapsheet : 3 of 9

Surface Water Features

APA Group

Hydrological and Hydrogeological Assessment – Crib Point to Pakenham Pipeline Project

Westerport, VIC

Figure

F2c

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LEGEND

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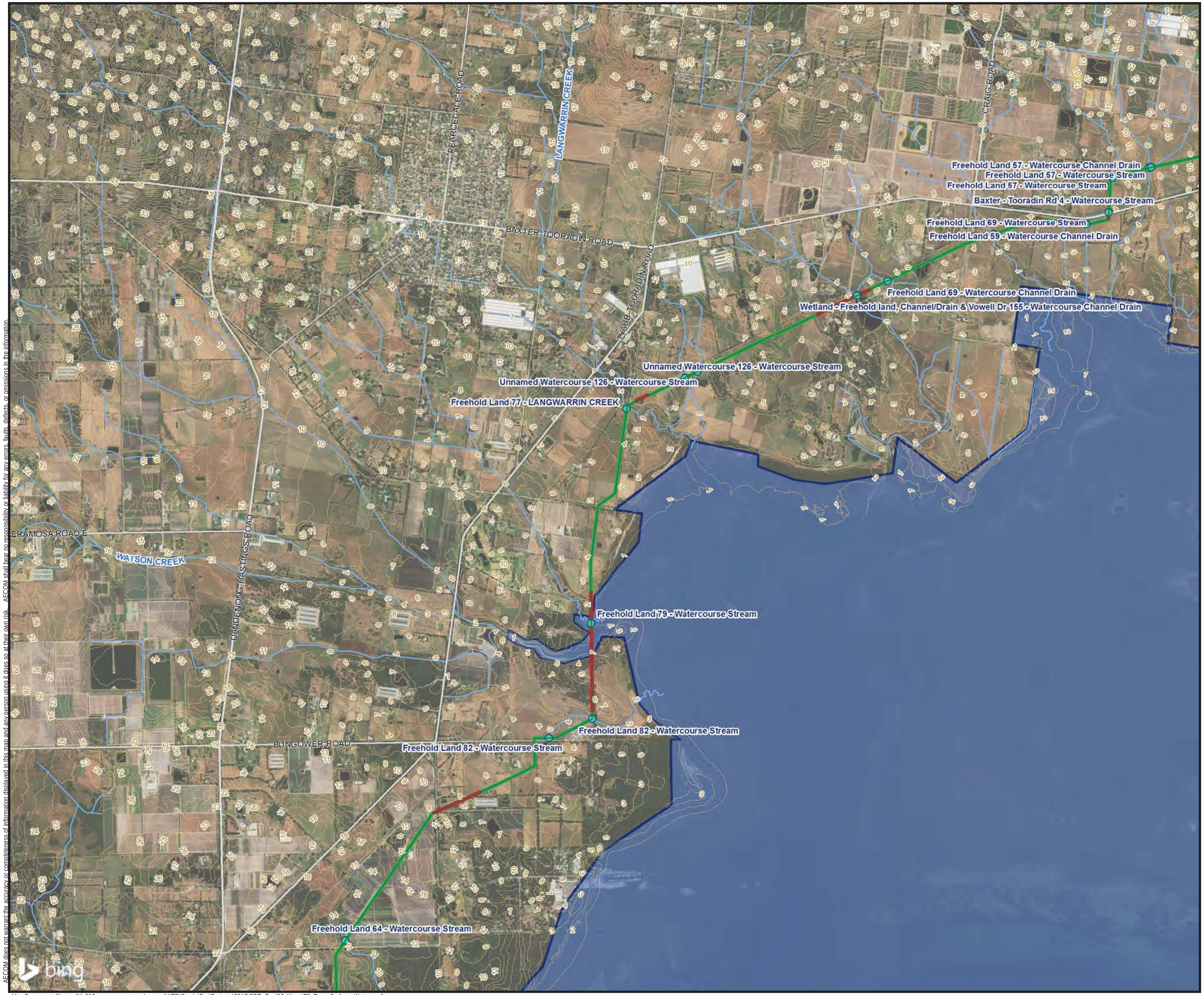
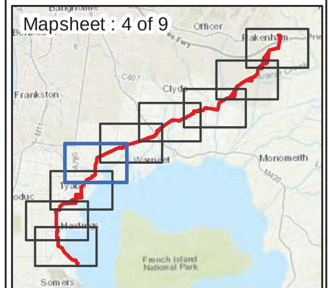




Surface Water Features

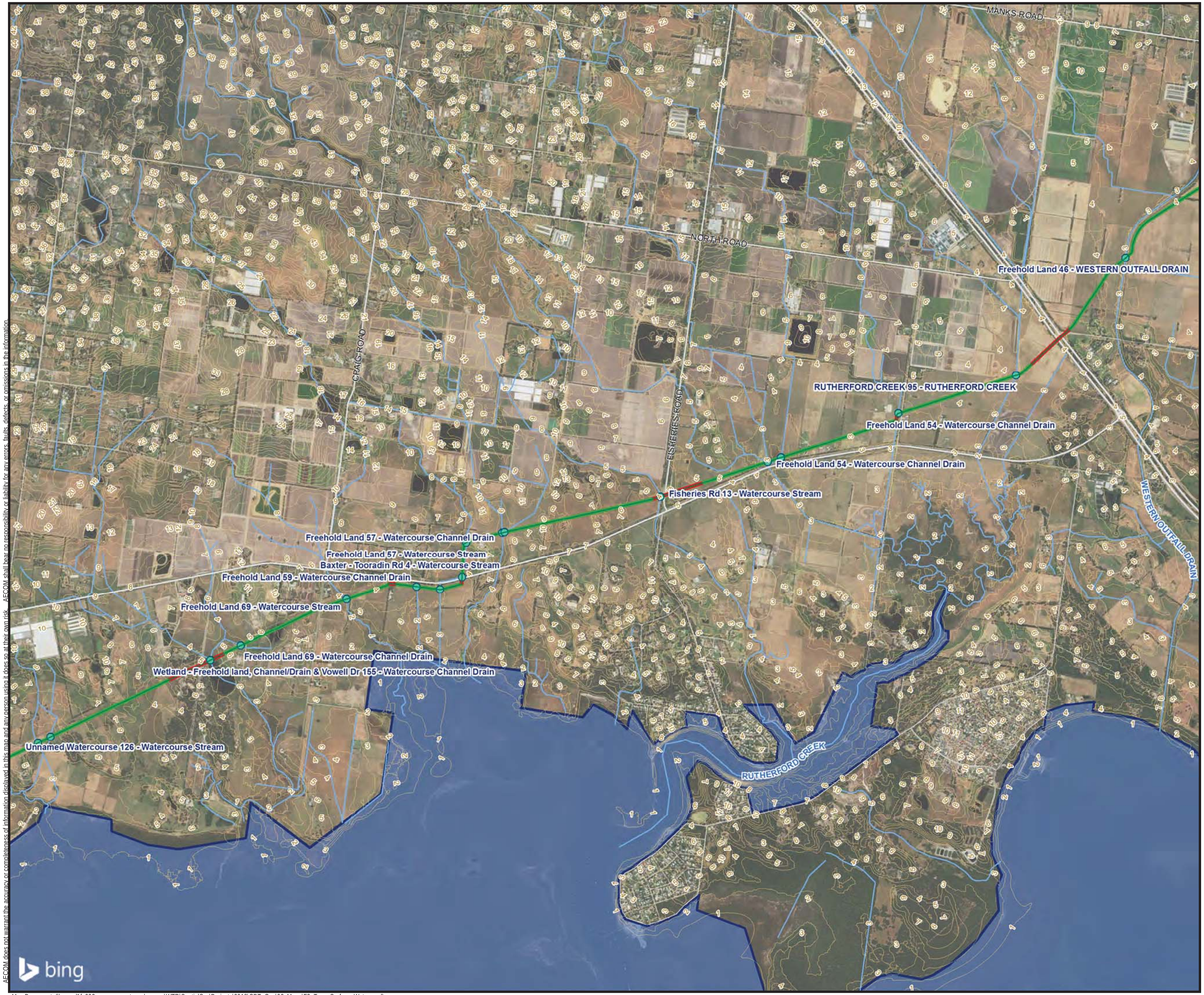
APA Group

Hydrological and Hydrogeological Assessment – Crib Point to Pakenham Pipeline Project

Westerport, VIC

Figure F2d

Map Document: (\\aumel1fp003.au.aecomnet.com\groups\WTR\SpatialSys\Projects\2018\CPT_Geo\02_Maps\F2_Topo_Surface_Water.mxd)



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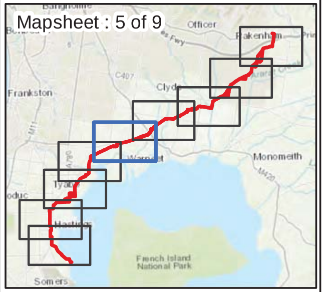

Surface Water Features

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Westerport, VIC

Figure

F2e