WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Final Report

Avalon Corridor IWMP

City of Greater Geelong

20 March 2024

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Project Details

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ACKNOWLEDGEMENT OF COUNTRY

Water Technology proudly acknowledges the Wadawurrung People as the traditional owners and custodians of the waterways and lands on which this project is based. We pay our respects to their Elders past, present and emerging.

We recognise the connection of the Traditional Owners to Country and the value of their contribution to managing the land and water and acknowledge their ongoing contribution to improved and connected management of our waterways and floodplains. We embrace the spirit of reconciliation, working towards equity for Traditional Owners.

Artwork by Maurice Goolagong 2023. This piece was commissioned by Water Technology and visualises the important connections we have to water, and the cultural significance of journeys taken by traditional custodians of our land to meeting places, where communities connect with each other around waterways.

The symbolism in the artwork includes:

- *Seven circles representing each of the States and Territories in Australia where we do our work.*
- *Blue dots between each circle representing the waterways that connect us.*
- *The animals that rely on healthy waterways for their home.*
- *Black and white dots representing all the different communities that we visit in our work.*
- *Hands that are for the people we help on our journey.*

ABBREVIATIONS

ACS	-	Avalon Corridor Strategy
AEP	-	Annual Exceedance Probability
BW	-	Barwon Water
CASS	-	Coastal Acid Sulphate Soils
CCMA	-	Corangamite Catchment Management Authority
CGSWS	-	Central and Gippsland Sustainable Water Strategy
CMA	-	Catchment Management Authority
CoGG	-	City of Greater Geelong
DEECA	-	Department of Energy, Environment and Climate Action
DSS	-	Development Services Scheme
EPA	-	Environment Protection Authority
EPBC	-	Environment Protection and Biodiversity Conservation
FFG	-	Flora and Fauna Guarantee
GAEP	-	Greater Avalon Employment Precinct
GPT		Gross Pollutant Trap
IWM	-	Integrated Water Management
IWMP	-	Integrated Water Management Plan
LCA	-	Land Capability Assessment
MUSIC	-	Model for Urban Stormwater Improvement Conceptualisation
MWC	-	Melbourne Water Corporation
NASF	-	National Airport Safeguarding Framework
NWP	-	Northern Water Plant
NWGGA	-	Northern and Western Geelong Growth Area
PSP	-	Precinct Structure Plan
VPA	-	Victorian Planning Authority
WCC	-	Wyndham City Council
WRP	-	Water Reclamation Plant
WSUD	-	Water Sensitive Urban Design
WTOAC	-	Wadawurrung Traditional Owners Aboriginal Corporation
WTP	-	Western Treatment Plant
WWTP	-	Wastewater Treatment Plant

EXECUTIVE SUMMARY

The Avalon Corridor Strategy (ACS) is a strategic land use framework developed in collaboration between the City of Greater Geelong, the City of Wyndham, and the former Victorian Department of Environment, Land, Water and Planning (currently known as the Department of Energy, Environment and Climate Action) (CoGG and WCC, 2022). The Avalon Corridor covers an area of approximately 30,000 hectares and is located east of the township of Lara, between Melbourne and Geelong. The Greater Avalon Employment Precinct (GAEP) is a significant part of the ACS. The GAEP will be a State significant employment precinct centred around the Avalon Airport. This study focuses on the land within the City of Greater Geelong municipality and aims to develop an Integrated Water Management Plan (IWMP) for this area. The Avalon Corridor IWMP at regional level will inform a Precinct Structure Plan (PSP) for the GAEP by the Victorian Planning Authority (VPA) and other future planning projects in the area. The Avalon Corridor IWMP will:

- **Examine options for servicing** the future GAEP and nearby agricultural properties. The options will have a particular focus on secure and sustainable alternate water supplies.
- **Study options for managing potential stormwater runoff impacts** from industrial and commercial development on sensitive ecosystems, such as the adjacent Port Phillip Bay (Western Shoreline) RAMSAR wetland site.
- **Review opportunities to enhance environmental and cultural values** associated with local waterways and landscapes while investigating the delivery of cultural flows as the Wadawurrung Traditional Owners Aboriginal Corporation deem appropriate.
- **Align with relevant State Government frameworks and policies** related to IWM, including the Barwon Strategic Direction Statement.

The Avalon Corridor IWMP was prepared through a collaborative approach. The first phase of the project aimed to understand the key issues and opportunities related to IWM. The second phase of the project focused on IWM optioneering

Potential issues and constraints including topography, soils, environment, culture and heritage, flooding and drainage, climate change, groundwater, land ownership and operation (Avalon Airport) were considered. The key issues and drivers related to IWM were identified to be:

- **Ecologically and culturally significant environment**
  - One of the most critical drivers for IWM is to protect the ecologically and culturally sensitive environment from the adverse impacts of the uture industrial/commercial/airport developments.
  - At the same time, it is currently unknown what the acceptable change in hydrology and water quality would be that could minimise any adverse impact on the sensitive environment and enhance the ecological significance.
  - As such, this report takes a conservative approach until scientific information regarding the ecological and cultural tolerance of impacts is established.
- **Interface with Avalon Airport**
  - National Airport Safeguarding Framework (NASF) guidelines indicate that within 3 km of the airport boundary, mitigatory actions are needed for any existing wetland conservation areas and existing or new sewage/wastewater treatment facilities. In contrast, new wetland conservation areas are incompatible.
  - This is a significant constraint for creating new open water bodies such as wetlands and open water storages/basins within the GAEP. It is noted that the NASF provides a rigorous framework for consideration during more detailed drainage asset design investigations.

- **Flooding and drainage**
  - The extensive flooding limits the developable area and the footprint available for drainage infrastructure.
  - Due to the flat topography of the site, it would be challenging to connect future piped drainage outfalls to existing waterways and open channels/cut drains.
  - Environmental impacts of outfall construction and subsequent changes in hydrology and water quality would also need to be understood.
  - The shallow drainage pipes would lead to inefficiencies, including shallow retention basins with relatively large footprints. Alternatively, a pumped drainage management system would be required, significantly increasing the drainage network's capital and operational costs.
  - Existing outfalls at the bay are already tidally influenced, and the extent of this issue is expected to worsen with the climate change-induced sea level rise.
  - The design for the Avalon Airport in terms of development and stormwater volume, flow rates and water quality will be an important input into more detailed asset investigations.
  - When assessing the options and portfolio at detailed level, liaison with the City of Greater Geelong, as asset owner and manager must be undertaken. The City prefer to minimise the number of new treatment/detention assets, avoid streetscape assets where possible. Pumped drainage system is not desirable.
- **Shallow groundwater**
  - Constructability issue of drainage assets. Drainage assets will likely be limited to shallow assets with relatively large footprints, limiting the net developable area and impacting ecological and cultural values.
  - Limit the stormwater infiltration potential and increase groundwater contamination from urban stormwater. Therefore, water sensitive urban design assets will likely need to be lined in response to the shallow groundwater within this area.
- **Water supply and sewer**
  - Significant extension/upgrade to water and sewer infrastructure is expected.
  - Barwon Water are investigating the servicing options for the area, and the findings from this study will not be available in time for the current IWMP finalisation.
  - The flat terrain and other constraints would most likely limit any future sewer system to be a pressurised system while wastewater treatment plant capacity issues to be dealt with through system planning (e.g. pumping at low flow periods) or a new onsite treatment and reuse scheme.
    - It is noted that gravity sewer may still be a possibility even if it is localised to some sections. This is to be confirmed in future investigations.
- **Open space and interfaces**
  - Vegetation buffers or drainage assets could interface existing and future zones.
  - Opportunities to create open water bodies adjacent to open spaces are limited due to the increased risk of wildlife strike hazard.
- **Coastal Acid sulphate soils**
  - Future developments and infrastructure construction in areas with a high probability of CASS occurrence must consider the impacts on environment, surface/ground water, human health and

infrastructure at the early planning stage and provide appropriate risk management prior to and during the ground disturbance.

- **Uncertainty**
  - The IWMP was developed based on a set of assumptions, which need to be revisited when more information is available.
  - The IWMP needs to be revisited in future when complementary studies such as Barwon Waters' servicing investigation, Melbourne Water Development Services Scheme preparation, VPA's drainage and flooding strategy and Parks Victoria's Avalon Coastal Conservation Action Plan are completed.
  - Understanding the timeline for water management assets to be available/become active relative to the proposed development is critical.

The above key issues and drivers are proposed to be addressed through eight IWM objectives under three overarching themes.

- **Protect and enhance the health of receiving environments**
  - Protect and preserve natural waterways, mangrove country and saltmarsh country from pollution (stormwater quality)
  - Protect and preserve natural water flow regime (stormwater quantity)
  - Avoid wastewater discharges to the surrounding sensitive environment
  - Enhance habitat for migratory bird population
- **Provide secure and sustainable water services**
  - Reduce potable water consumption of future industrial/commercial developments through the use of fit-for-purpose water.
  - Maximise the availability and use available alternative water sources within the GAEP
- **Support the liveability of the places we live and work**
  - Enhance amenity and microclimate through the introduction of natural features
  - Minimise the impact of water management assets on existing and future users (e.g. land take, wildlife strike hazards impacting airport operations)

In total, 18 potential IWM options ranging from lot to regional scale were considered. In general, a greater reliance on external demands and larger asset footprints is required to meet stormwater volume reduction targets. Moreover, none of the proposed IWM options achieved consistently high benefits across the three IWM themes. As such, individual options addressing water cycle management at different scales were combined to create a set of promising IWM portfolios for further investigation. A total of five potential portfolios were identified, including:

- P1 – Stormwater treatment at three scales (lot scale, street scape and precinct) and reuse without creating new open water bodies combined with precinct-scale wastewater treatment and reuse
- P2 – Stormwater treatment at two scales (street scape and precinct) and reuse with new open water bodies combined with precinct-scale wastewater treatment and reuse
- P3 – Stormwater treatment at three scales (street scape, precinct and regional) and reuse with new open water bodies combined with regional-scale wastewater treatment and reuse
- P4 and P5 – Stormwater treatment at two scales (lot and precinct) and reuse with new open water bodies combined with precinct-scale wastewater treatment and reuse

The overall performance of shortlisted portfolios across broad IWM themes is summarised in Table E 1. If further investigations determine that new water bodies are incompatible around the airport, the P1 option would default to being the best overall performing portfolio to be further evaluated. However, in a scenario where new open water bodies can be created without impacting the airport operation, portfolios P3 and P5 are recommended for further evaluation.

Table E 1 IWM Portfolios Overall Performance Comparison

Portfolio ID	Overall IWM Theme Performance		
	Protect and enhance the health of receiving environments	Provide secure and sustainable water services	Support the liveability of the places we live and work
P1	Very High	Very High	High
P2	High	High	Medium
P3	Very High	High	Medium
P4	Very High	Very High	Low-medium
P5	Very High	Very High	Low-medium

It is critical to note that the current IWMP was developed based on a set of assumptions and these assumptions need to be tested. Therefore, there is a critical need to undertake the following additional investigations to test and validate these assumptions.

- Undertake an ecohydrological assessment to characterise baseline hydrology and water quality of the waterways and determine the acceptable level of change both in terms of hydrology and water quality.
- Liaise with the Avalon Airport to understand the feasibility of creating new open water bodies within the 3 km radius of the airport boundary without increasing and managing the wildlife strike hazard.
- Undertake a hydrological and groundwater assessment to test the feasibility of stormwater infiltration within the project area and incorporate stormwater infiltration options in subsequent IWMPs.
- Liaise with the Avalon Airport to seek an alignment in the IWM approach within the airport and the remainder of the GAEP where possible.
- Incorporate the latest climate change factors and undertake a flood study to understand the flooding issues and necessary mitigatory actions to facilitate development.
- Refresh the Avalon Corridor IWMP when complementary studies such as the GAEP PSP background investigations, Avalon Airport Master Plan, and Barwon Water's water and wastewater strategy are completed to confirm the current IWMP assumptions and estimates are still valid.
- Consider capital and operational issues, risks and costs of the options from each of the stakeholder perspectives[1].
- Consider the impact on the developable area of the proposed PSP and the cost of development and the feasibility for delivery by development proponents.

[1] It is noted that while capital and operational issues, risks and costs are usually considered during an IWM assessment, they are considered only at a high level by the VPA.

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1 INTRODUCTION

The Avalon Corridor Strategy (ACS) is a strategic land use framework developed in collaboration between the City of Greater Geelong (the City), the City of Wyndham, and the former Victorian Department of Environment, Land, Water and Planning (CoGG and WCC, 2022) (Figure 1-1). The strategy provides strategic guidance for future development within the precinct. It covers a range of key considerations, including environment, cultural heritage, movement and access, flooding and drainage, and economics and employment.

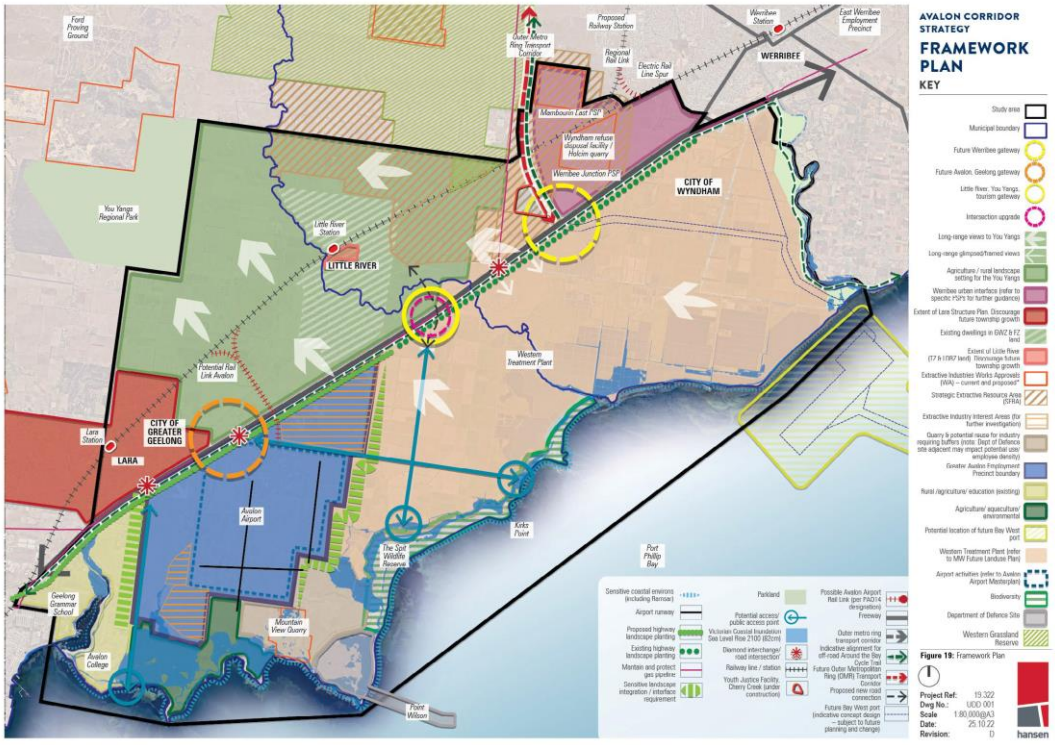

Figure 1-1 Avalon Corridor Strategy Framework (CoGG and WCC, 2022)

The Avalon Corridor covers an area of approximately 30,000 hectares and is located east of the township of Lara, between Melbourne and Geelong. Whilst the Avalon Corridor Strategy covers a broad area, the Integrated Water Management Plan (IWMP) will focus on the area located within the City of Greater Geelong municipality encompassing the Greater Avalon Employment Precinct (GAEP). The IWMP will:

- **Examine options for servicing** the future GAEP and nearby agricultural properties. The options will focus on secure and sustainable alternate water supplies.
- **Study options for managing potential stormwater runoff impacts** from industrial and commercial development on sensitive ecosystems, including Port Phillip Bay (Western Shoreline) RAMSAR wetlands.
  - It is noted that economic evaluation and cost allocation is not part of the scope.
- **Review opportunities to enhance environmental and cultural values** associated with local waterways and landscapes while investigating the delivery of cultural flows as the Wadawurrung Traditional Owners Aboriginal Corporation deem appropriate.
- **Align with relevant State Government frameworks and policies** related to Integrated Water Management (IWM), including the Barwon Strategic Direction Statement.

The IWM assessment will inform the preparation of a Precinct Structure Plan (PSP) for the GAEP by the VPA.

2 METHODOLOGY

The Avalon Corridor IWMP was prepared with a focus on collaboration. The overall methodology adopted is shown in Figure 2-1. The first phase of the project, situational analysis, involved a desktop review and stakeholder engagement to understand the key issues and opportunities related to IWM. The findings of the situation analysis have been presented in the interim project report "Situational Analysis Report" (Water Technology, 2023) (Appendix A).

The second phase of the project, IWM optioneering, was undertaken through a design sprint workshop to revisit key issues and drives related to IWM, discuss stakeholder vision for IWM and potential IWM options. This information was used to develop IWM objectives and potential long list of IWM options. IWM options were assessed against the key objectives/criteria to identify promising IWM options for further investigation.

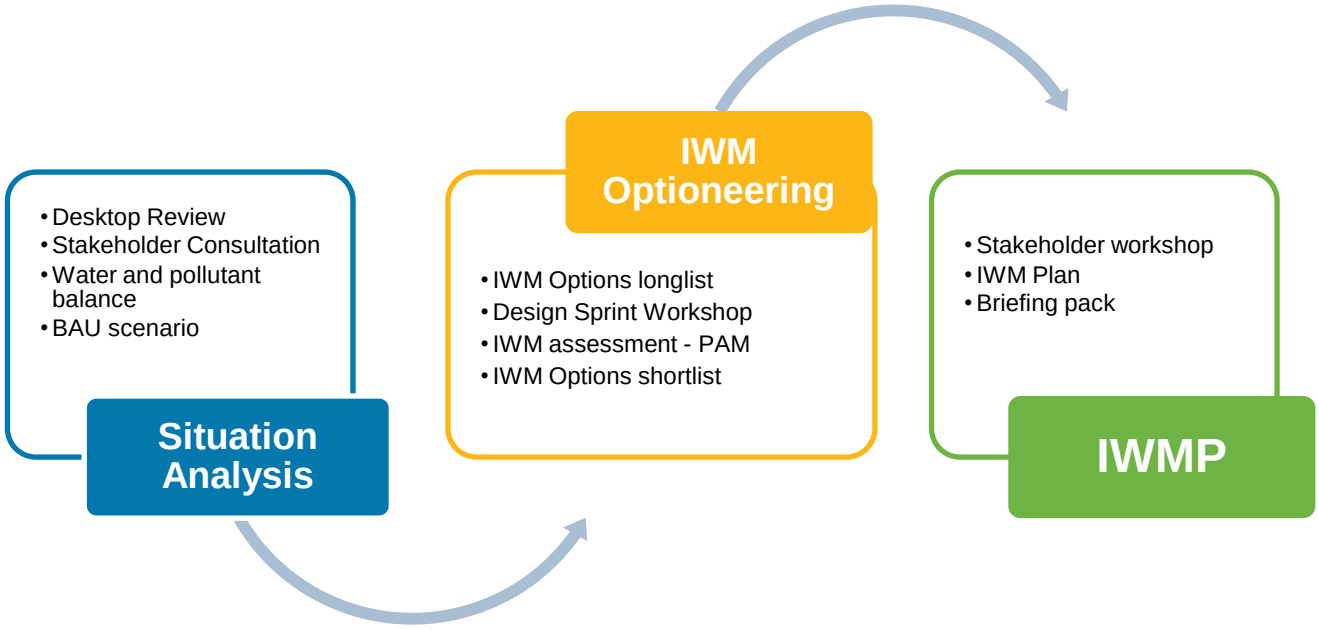

Figure 2-1 Methodology Overview

3 STUDY AREA

The study area is within the land of the Wadawurrung people. The boundary of the IWMP is the part of the ACS that falls within the City of Greater Geelong municipality (Figure 3-1), excluding the existing Lara residential development (township area). The area covered by the IWMP includes the GAEP, Avalon Airport itself, part of Western Treatment Plant (WTP) and a number of adjacent rural properties.

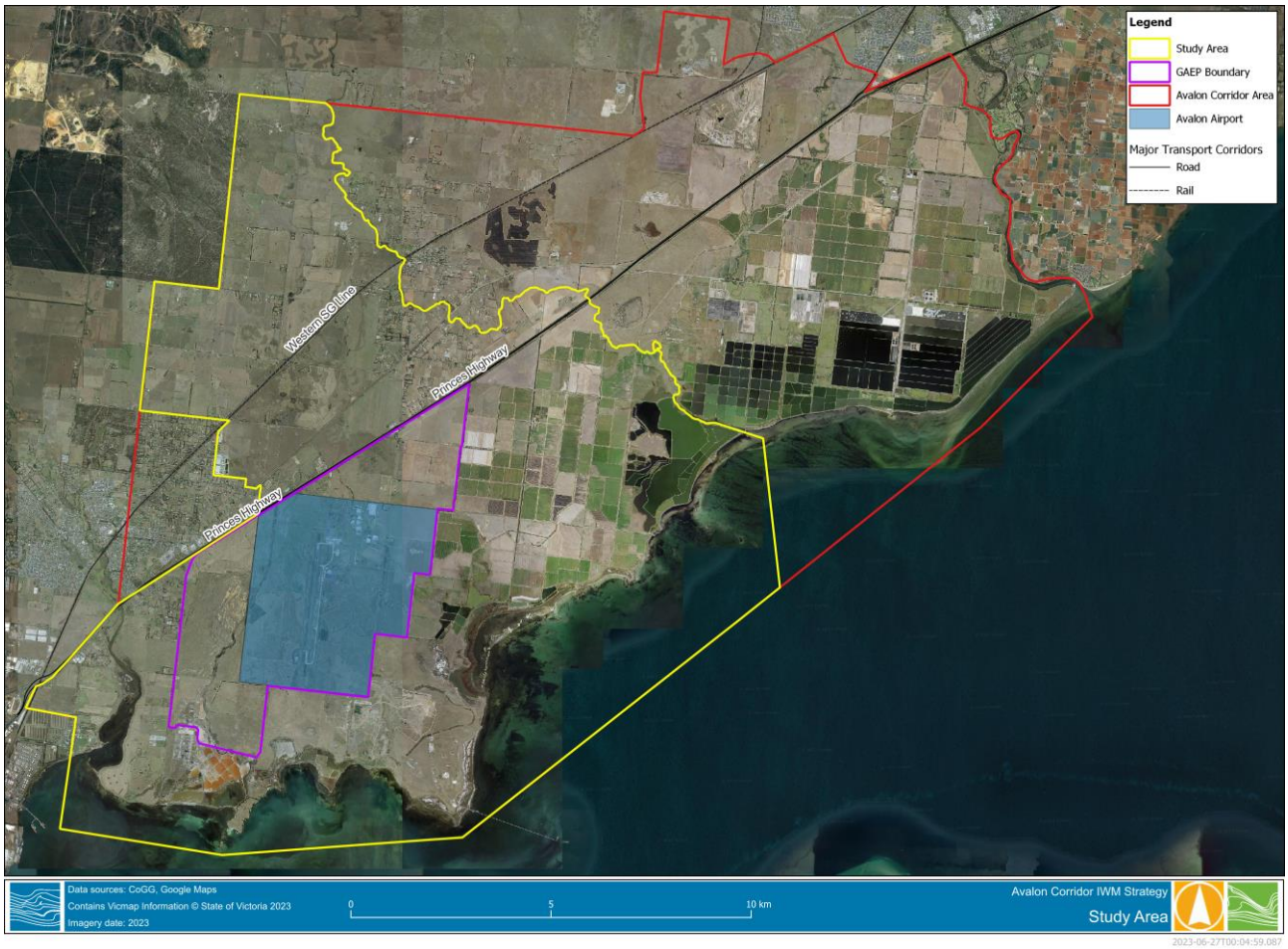

Figure 3-1 Study Area

3.1 Administration Boundaries

The study area encompasses several administrative boundaries (Figure 3-2). The Wadawurrung Traditional Owners Aboriginal Corporation (WTOAC) is the Registered Aboriginal Party of the study area. In terms of the water cycle management context, the area is managed by two Catchment Management Authorities (CMAs), namely Corangamite CMA and Melbourne Water Corporation. The City of Greater Geelong is the designated drainage authority (and along with Melbourne Water Corporation within MW's development service scheme areas), providing and maintaining drainage assets.Water and wastewater services are managed by Barwon Water, while Southern Rural Water is responsible for groundwater management, rural take and use licences within the area.

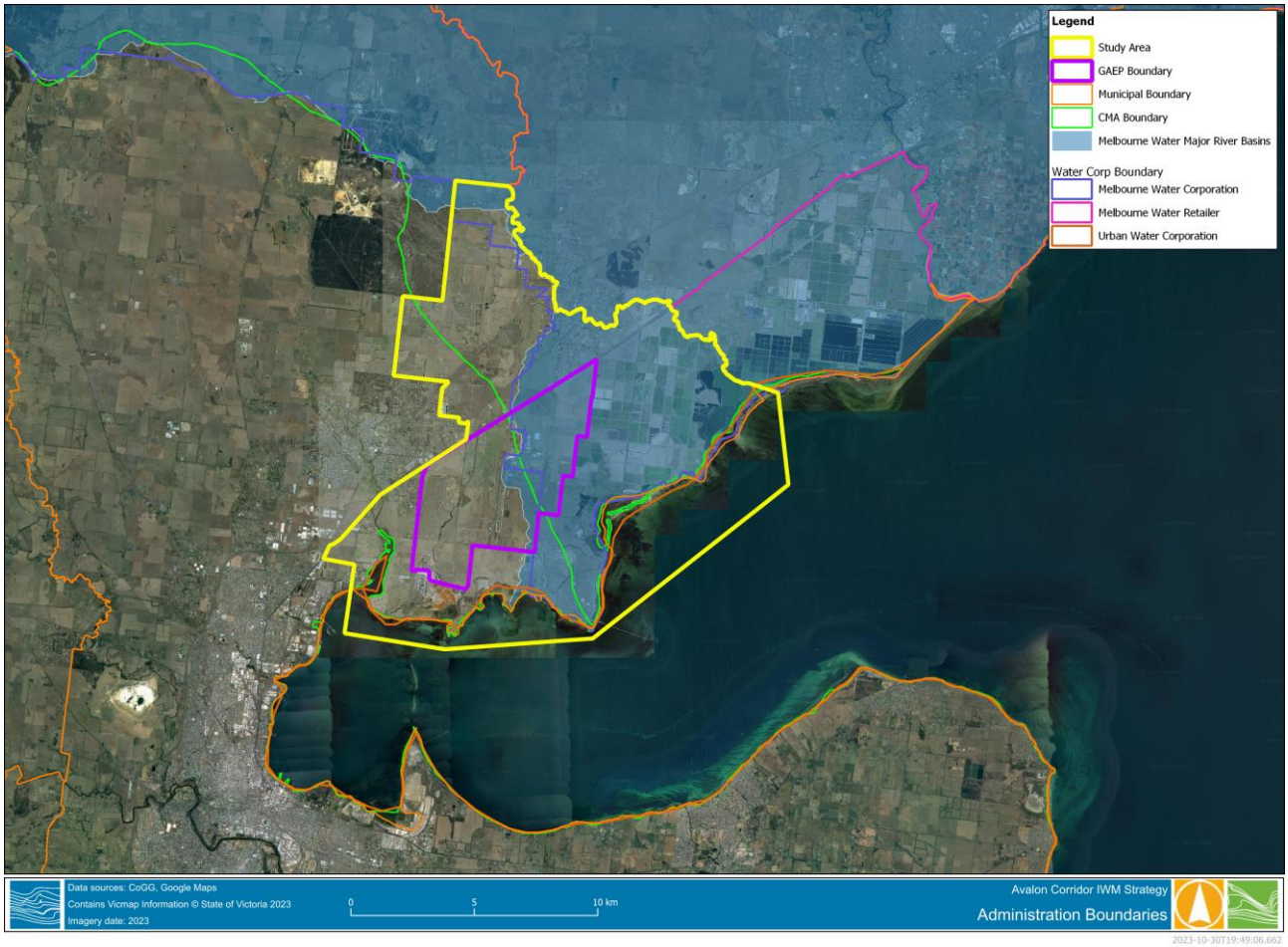

Figure 3-2 Administration Boundaries

3.1.1 Stakeholders

Key stakeholders identified during the project inception include:

- City of Greater Geelong (project owner)
- Victorian Planning Authority (VPA) (funding partner)
- Department of Energy, Environment and Climate Action (DEECA) (funding partner)
- Wadawurrung Traditional Owners Aboriginal Corporation (WTOAC)
- Barwon Water (BW) (funding partner)
- Melbourne Water Corporation (MWC)
- Corangamite Catchment Management Authority (CCMA)
- Parks Victoria
- Department of Defence (Point Wilson Pier)
- The Commonwealth Government (Land owner)
- Avalon Airport, including sub-tenants (i.e. Recharge Industries, Cotton On, Hanwha Defence, etc.)
- Other private landowners within the study area

3.2 Existing Landuse

A significant proportion of the land within the study area is currently being used as pasture/grassland, agricultural or wastewater treatment (WTP), and airport services land use (Figure 3-3). Additionally, the coastline is covered by a conservation area and protected landscape. Some scattered pockets of residential and industrial (quarries, manufacturing and industrial) land use are also present in the area. It should be noted that the farmland within the WTP is known to have contaminated soils resulting from legacy land/grass filtration (a historical method of wastewater treatment). The contaminant levels will likely impact the type of future land use adopted in the GAEP.

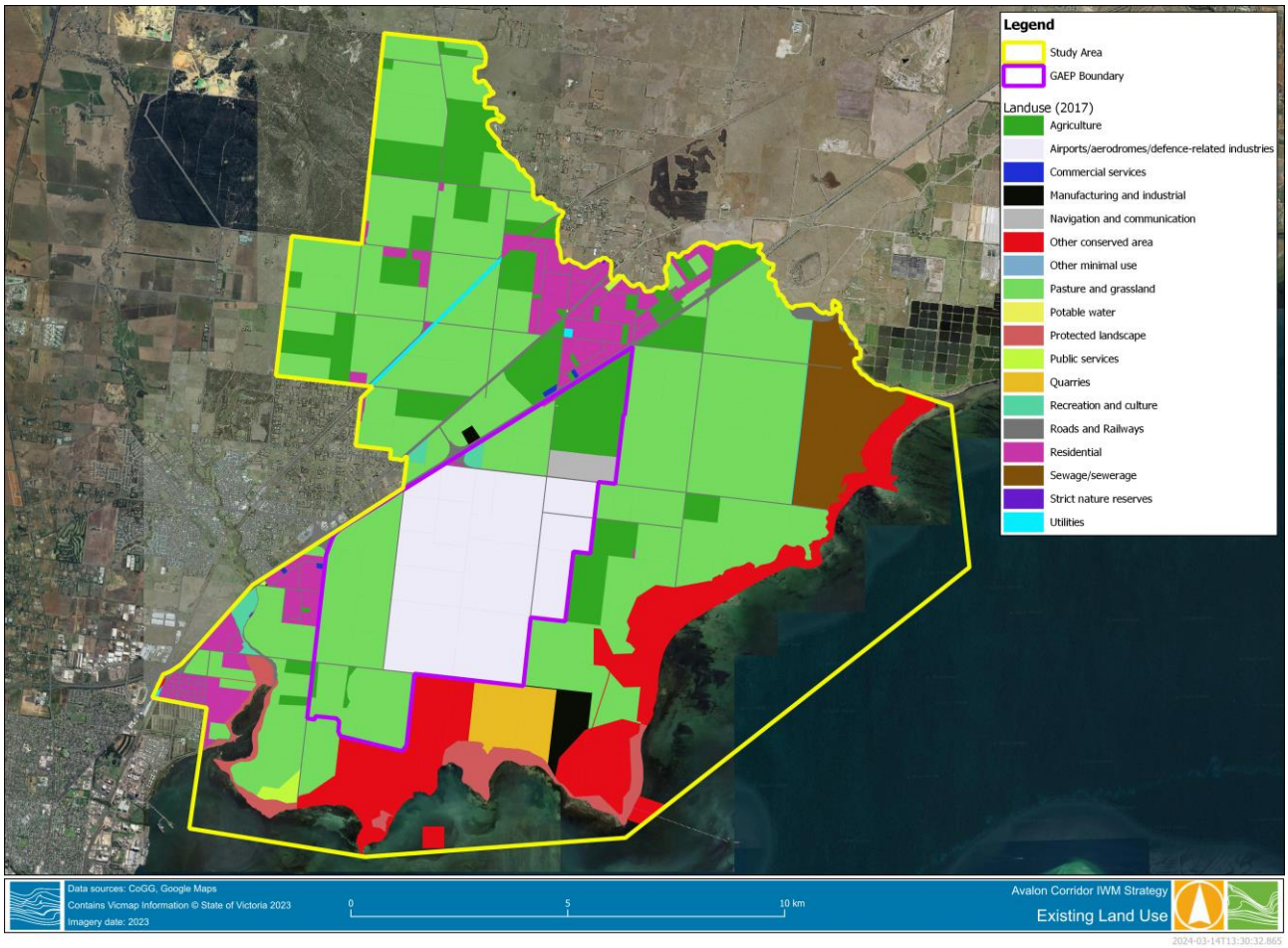

Figure 3-3 Existing Land Use

3.3 Proposed Development

ACS Vision
The Avalon Corridor will continue to provide a green break between Geelong (regional Victoria) and Werribee (metropolitan Melbourne), while protecting areas of recognised environmental, landscape, heritage, and cultural value.
It will limit residential growth while supporting the expanded operations of Avalon Airport as Victoria's second international airport and fostering new land use, development and employment opportunities on airport land and immediate surrounds (as appropriate).
It will protect operations of the Western Treatment Plant to ensure it can continue to provide low-cost sewage treatment, recycled water for irrigation and support broader biodiversity values in the region.

The ACS Framework Plan (Figure 1-1) guides future detailed land use and development in the Avalon Corridor up to 2050 (CoGG and WCC, 2022). The key guiding principles which underpin the Framework Plan include:

1. Maintain and reinforce a green break between Geelong (regional Victoria) and Werribee (metropolitan Melbourne).
2. Protect green wedge and rural landscapes, as well as cultural and environmental features of identified value.
3. Protect ongoing and future operations of the Western Treatment Plant.
4. Protect ongoing and future expanded functional operations of Avalon Airport as per Avalon Airport, Master Plan.
5. Focus on appropriate commercial and industrial development within and surrounding Avalon Airport, as per the Framework Plan.
6. Create economic development and employment opportunities in the northern part of Geelong.
7. Highlight the ongoing importance of the economic and transport connections between Werribee and Geelong.
8. Protect and enhance traffic movement on major roads (current and proposed) and rail corridors.
9. Avoid residential development within the Avalon Corridor.
10. Protect areas of acknowledged environmental value, including coastline and RAMSAR wetlands and grasslands.
11. Protect Wadawurrung cultural values and areas of known cultural heritage significance, as well as post-contact heritage sites (in addition to undertaking further investigations as part of specific land use change and development proposals).

Significant development is expected within the GAEP area of the study area. Sensitive landscape integration/interface requirements are proposed along the eastern and western edges of the GAEP, where it interfaces with the Western Treatment Plant (WTP), existing rural/agriculture and education near Limeburner's Bay. Other development areas include extractive industry in the form of existing quarry sites within the GAEP (Mountain View Quarry) and north of Princess Highway. Additionally, some agriculture/aquaculture operations exist to the south of GAEP. The remainder of the study area generally preserves existing land uses such as the agriculture/rural landscape upstream of Princess Highway, WTP land, rural/agriculture and education near Limeburner's Bay, biodiversity, and sensitive coastal areas (including the RAMSAR sites).

3.4 High-Level Pollutant and Water Balance

A combination of MUSIC (Model for Urban Stormwater Improvement Conceptualisation) modelling and high-level calculations of potable water and wastewater volumes was used to derive a high-level pollutant and water balance for the area. Please refer to the Situational Analysis Report (Water Technology, 2023) for detailed assumptions and calculations.

Figure 3-4 and Table 3-1 summarise the pollutant loading estimated under the existing and post-development (without any mitigation) scenarios. In general, an increase in sediment and nutrient loading is expected due to the significant increase in impervious surfaces within the overall GAEP area.

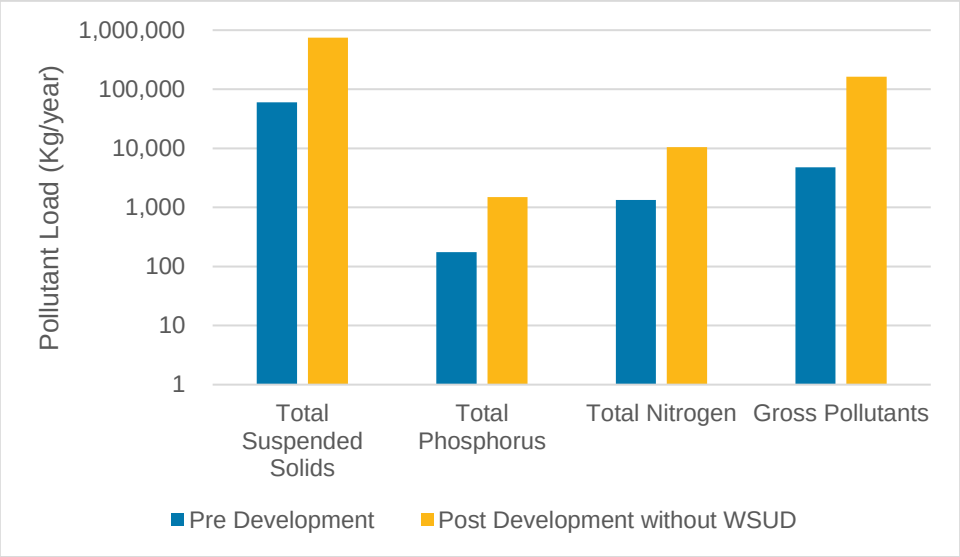

Figure 3-4 Stormwater Pollutant Comparison

Table 3-1 Pollutant Load Summary

Pollutants	Existing (kg/year)	PostDev without mitigation (kg/year)	Increase in pollutant loading
Total Suspended Solids	893,000	2,300,000	158%
Total Phosphorus	2,310	5,060	119%
Total Nitrogen	17,100	36,200	112%
Gross Pollutants	102,000	427,000	319%

Initial MUSIC modelling suggests the average annual stormwater runoff volume will increase from 5,490 ML to 12,900 ML with the proposed development (without any Water Sensitive Urban Design (WSUD) or volume management strategies).

Water demands and potential alternative water sources in the study area were also considered. Barwon Water note there is significant difficulty in estimating the water demand (potable and alternative) for the GAEP (including the Avalon Airport Masterplan), given the level of uncertainty around the development (Figure 3-5). Similarly, there is significant uncertainty in estimating reuse demands of the nearby agricultural land due to existing alternative supply availability. Therefore, the current water balance should be considered as only a high-level estimate. Refer to the Situational Analysis Report (Water Technology, 2023) for detailed assumptions for estimating these demands.

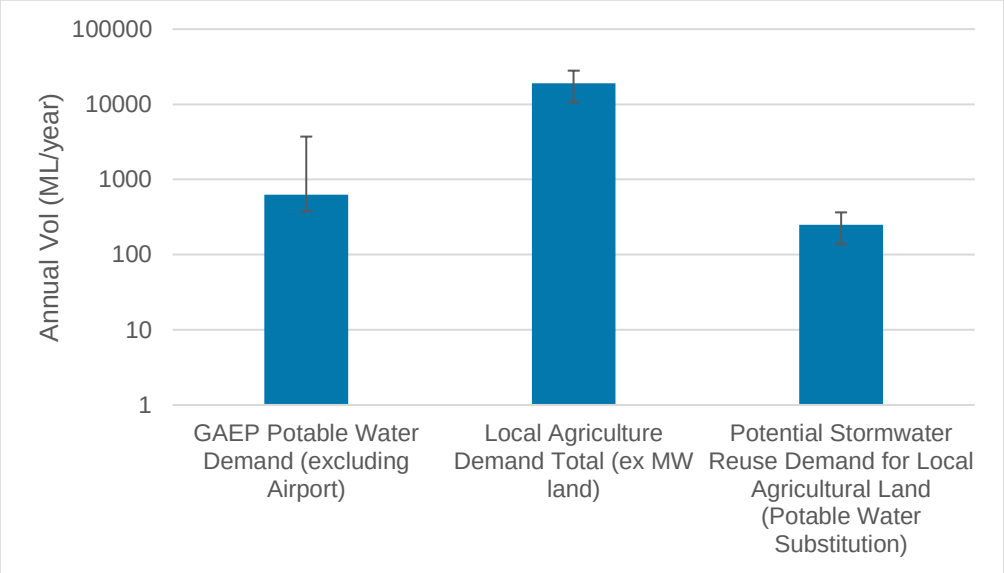

Figure 3-5 Uncertainty in Demand Estimates

Under an average water usage scenario, the total water demand for the study area was estimated to be ~37,500 ML/year, with 98% of the demand originating from agricultural irrigation (Figure 3-6). On the other hand, the total volume of alternative water sources available was estimated to be ~21,500 ML/year. On average, ~63% of the alternative water is comprised of recycled water (treated wastewater).

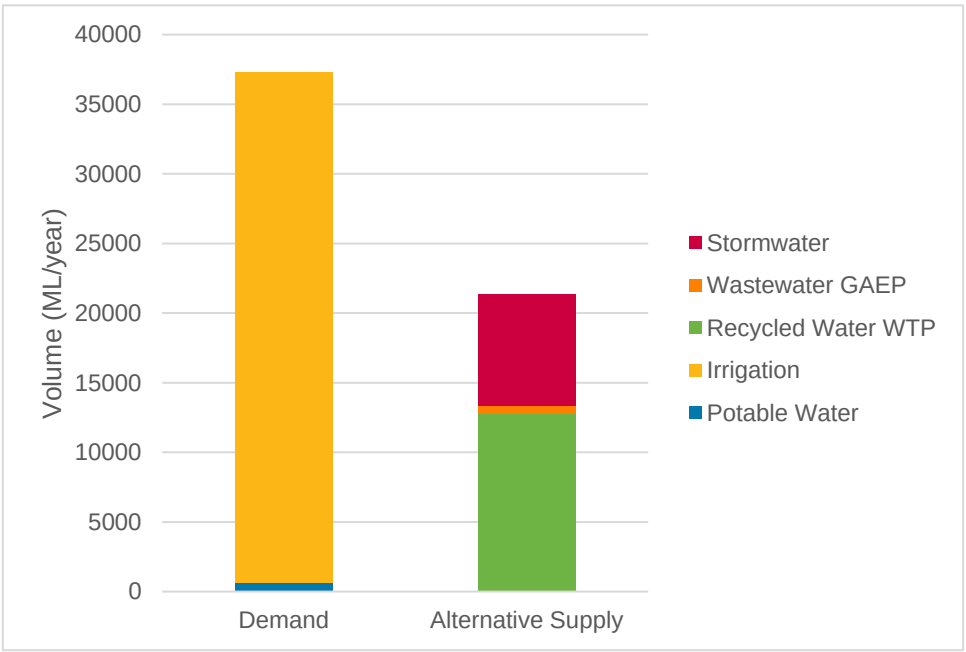

Figure 3-6 Future Water Demand and Potential Alternative Water Supply Options (Whole Study Area)

Since Melbourne Water WTP has its own recycled water supply and onsite irrigation. A separate analysis excluding Melbourne Water land was conducted (Figure 3-7). The total water demand was estimated to be ~19,900 ML/year, of which 96% was generated through agricultural irrigation. Similarly, the available alternative water volume decreased to 8,700 ML/year, of which only 8% comprise wastewater.

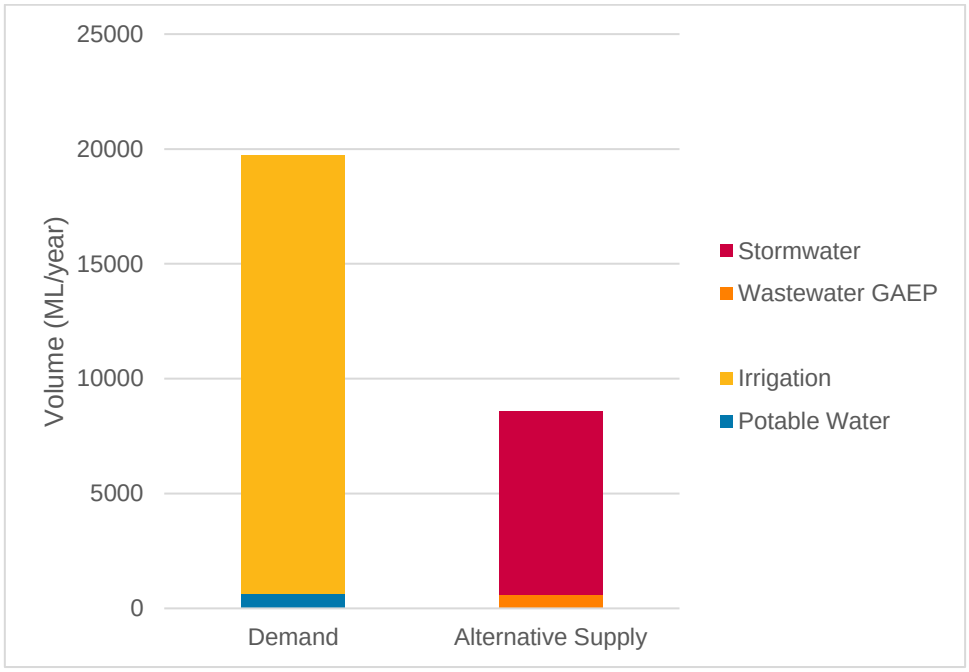

Figure 3-7 Future Water Demand and Potential Alternative Water Supply Options (Excluding WTP's onsite reuse)

The water balance indicates great potential to utilise alternative water sources for agriculture, which is one of the main aims of the IWMP (Section 1). However, the currently available data suggests that the majority of the nearby agricultural demands are already being supplied with recycled water from the WTP. Therefore, opportunities to reuse stormwater onsite for industrial uses or elsewhere may be required.

3.5 Water Cycle Management

The Situational Analysis Report (Water Technology, 2023) provides detailed information on the management of different water cycle components at present and potential options. A summary is provided below.

3.5.1 Potable Water, Wastewater and Recycled Water

The study area is within the Barwon Water Service area. There is limited water supply infrastructure within the area and no sewer or recycled water infrastructure currently servicing the site. It is understood that Barwon Water are currently undertaking their own servicing investigation to cater for the proposed development. Future service strategies are guided by the type of development expected in the area. In the absence of sufficient information on the development context, Barwon Water have provided some preliminary advice on potential service strategies. It is important to note that this is preliminary advice only and subject to change due to further investigations.

- **Water Supply:** Since the Avalon system is considered to be at its capacity, a new connection from Barwon Water's Lara/Lovely Bank supply network is expected to supply the proposed development
- **Wastewater:** Four potential options have been considered;
  - Direct untreated wastewater to Barwon Water system through Lara, where it could be transferred to the Geelong network or Northern and Western Geelong Growth Area (NWGGA) Water Reclamation Plant (WRP) in ~2033
  - Direct untreated wastewater to Northern Water Plant (NWP)

- Direct untreated wastewater to Melbourne Water network into WTP inlet.
- Construct a new onsite WRP and send recycled water to external customers, WTP lagoons.
  - WTOAC were not supportive of a large regional scale treatment facility servicing NWGGA being located at Avalon. Barwon Water have not consulted WTOAC on the prospect of a localised treatment facility servicing Avalon only. If pursed, further consultations with WTOAC would be essential.

- **Recycled water:** The recycled water service strategy largely depends on the wastewater servicing strategy (e.g. onsite WRP or connecting to existing recycled water network) and the stormwater strategy (e.g. availability of local stormwater harvesting and reuse).

3.5.2 Flooding and Drainage

The study area is subjected to extensive flooding. The relatively flat topography exacerbates the impact of flooding. It is understood that VPA are undertaking a flooding study for GAEP. The area has limited drainage pipes, and most of the flood outlet locations for the catchments exist at the bay interface and are tidally influenced. A significant upgrade to the Council drainage network will be required to service the proposed development. Flat terrain and climate change-induced sea level rise would make locating new drainage outfalls in the area challenging. Achieving an efficient gravity-fed drainage network design within this area will likely be difficult.

3.5.3 Groundwater

Shallow groundwater exists across most of the study area with an average depth of 2 m. Shallow groundwater will pose a risk for infrastructure, and especially WSUD assets will likely need to be lined in response to the shallow groundwater within this area. Furthermore, shallow groundwater will increase the exposure potential for groundwater to become contaminated from urban runoff and potentially disturbed CASS.

4 KEY ISSUES, DRIVERS, STAKEHOLDERS' VISION AND OBJECTIVES FOR IWM

This section summarises information gathered during situational analysis (Water Technology, 2023) and the Design Sprint Workshop (Appendix B) regarding key issues and drivers related to IWM and stakeholders' visions for IWM. This information was then used to formulate IWM objectives for the Avalon IWMP.

4.1 Key Issues and Drivers

4.1.1 Ecologically and Culturally Significant Environmental

There are numerous sensitive wetlands, native vegetation, and habitat sites for migratory birds in the study area (Figure 4-1). These environments are sensitive and important also for the Traditional Owners. One of the most critical drives for IWM is to protect this ecologically and culturally sensitive environment from the adverse impacts of the proposed development.

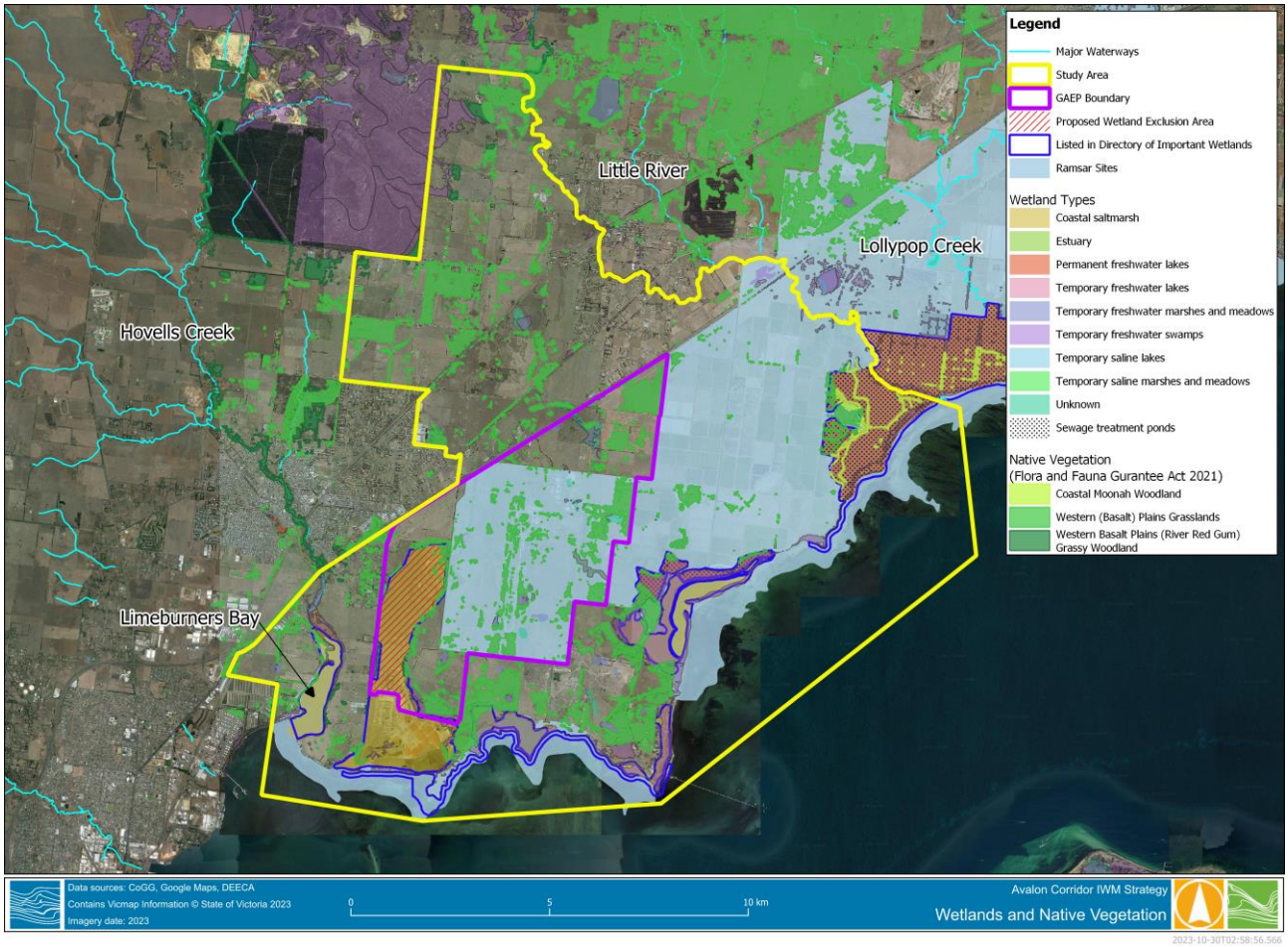

Figure 4-1 Sensitive Wetlands and Native Vegetation Extent

The increased stormwater runoff volume, changed runoff frequency, and increased water pollution will adversely impact ecological health. Conventional stormwater management approaches via Council-led Development Contribution Plans or Melbourne Water-led Development Services Scheme (DSS) do not normally target volume reduction. Therefore, volume reduction targets need to be incorporated through an IWM option. However, the final required volume reduction or frequency management target for the study area

has not yet been set. This will be determined by the VPA through the PSP process in consultation with stakeholders and future planning requirements may need to enforce these targets. While it is preferred to maintain the hydrology and water quality at the pre-development level to minimise adversely impacting the surrounding environment, it is acknowledged the costs associated with a "no net increase" strategy could be impractical or even cost prohibitive. Stakeholders are unaware of a site within Victoria where such a strategy was undertaken in stormwater management previously.

It is currently unknown what would be the acceptable change in hydrology and water quality that could minimise any adverse impact on the sensitive environment. An ecohydrological assessment (including a wetland monitoring program and aquatic habitat assessment) is needed to understand current conditions, the effects on the sensitive environment and associated mitigation actions to inform the future developments in the Avalon Corridor. Until such assessment is undertaken and reviewed by CoGG, VPA and DEECA, two scenarios will be considered for stormwater management targets.

- Current EPA stormwater management targets for priority areas (EPA, 2021)
- No net increase in volume and pollutant loading

4.1.2 Interface with Avalon Airport

Avalon Airport land occupies ~1,860 ha within the GAEP and comprises 54% of the GAEP area. A significant expansion of the airport's operations and establishment of non-aviation-related developments is planned for the airport. The airport development is not subject to the PSP process. It undergoes a separate approval process through the Department of Defence. Nonetheless, the Avalon Airport and its proposed development are integral to the GAEP. Therefore, it is critical to ensure there is consistency in future development layout as well as IWM throughout the whole GAEP area.

The airport's master plan is being renewed and won't be available for public comment until mid to late 2024. Therefore, there is some uncertainty regarding the type of development and the approach to water cycle management within the airport. For this IWMP development, it was assumed the same pollutant and volume reduction targets applicable to the remaining GAEP area also apply to the airport. It is acknowledged that there is a significant uncertainty associated with this assumption. However, in the absence of relevant information on future development plans for the airport, it was assumed that the current approach is adequate.

The other significant issue related to the interface of the airport is the wildlife strike hazard buffers. These buffers provide guidance on the land uses that present a risk of attracting wildlife and triggers (based on distance from an airport) for adopting active measures to mitigate that risk. Figure 4-2 shows the Avalon Airport's corresponding 3 km and 8 km buffer zones. Mitigatory actions are needed for the ongoing management of existing wetland conservation areas within the 13km buffer zone. New sensitive uses such as wetland and waterway conservation areas, open spaces and wastewater treatment facilities should undertake a risk assessment to address any incompatibility. This is a significant constraint for creating new open water bodies such as wetlands and open water storages within the GAEP. Nevertheless, the National Airports Safeguarding Framework (NASF) Guidelines[2] recommend considering necessary risk mitigation measures when local authorities seek to establish land uses that may increase the risk of wildlife strike near existing airports. It is noted that the NASF is not translated into the Victorian Planning Provisions and provides a rigorous framework for consideration during more detailed drainage asset design investigations. Further investigation for future planning projects e.g. the GAEP and collaboration with the airport and relevant

[2] It is also important to highlight that the NASF is currently a policy document under Clause 18.02-7S for consideration. However, the NASF principles and guidelines are not necessarily interpreted using Victorian planning language as they are not fully translated into the VPP as planning controls. Undertaking a risk assessment for mitigation/monitoring and developing a development assessment/referral pathway will be a practical approach to inform future land use planning in Avalon Corridor.

stakeholders esp. the RAMSAR land manager are required to understand the implications to the off-airport land uses. The required investigation includes:

- A review of requirements and best practice approaches to aviation safeguarding within the wildlife risk hazard context.
- A review of the Avalon Airport's current wildlife issues and strike risk profile (including those land uses surrounding the airport that have already been identified as a strike risk contributor).
- Identification of proposed strategic planning changes within 13km of the airport that are considered red flags in terms of wildlife attraction.
- The development of a wildlife hazard assessment mechanism on the off-airport lands that triggers more scrutiny for those proposed land use activities considered high risk, whilst allowing low risk activities to proceed relatively unimpeded.
- The development of a risk assessment process that aides in the above point to determine whether a land use is low or high risk.
- Identifying the roles of stakeholders (the planning/responsible/work authority, the land users, the airport etc).
- The preparation of guidance material around landscaping and a development assessment/referral pathway to reduce the wildlife attraction associated with things like stormwater/sewer infrastructure, agriculture, waste management etc.
- Planning projects in the area or future planning control could also consider developing acceptable solutions or performance outcomes etc, for adoption into the planning framework.

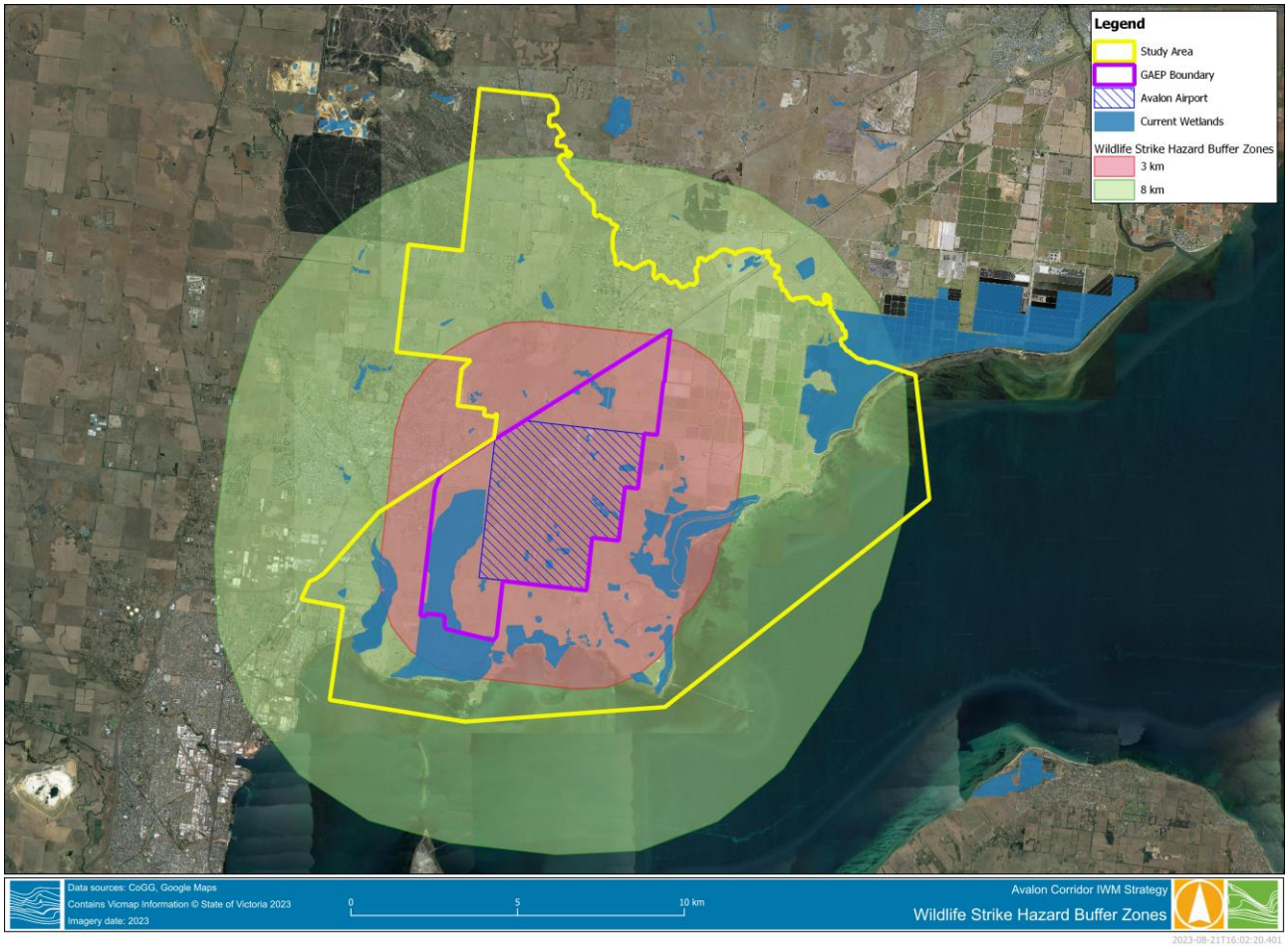

Figure 4-2 Wildlife Strike Hazard Buffers around the Avalon Airport

4.1.3 Flooding and Drainage

The study area is subject to extensive flooding (Figure 4-3), with the flooding extent exacerbated by the area's flat topography. The extensive flooding limits the developable area and the footprint available for drainage infrastructure. Most developable areas should avoid flood-affected land. However, some development/land uses (such as car parks) may utilise flood-affected areas through innovative design solutions. It is understood that VPA are planning to undertake a drainage and flooding study for the GAEP, in partnership with CoGG and MWC, to ensure a consistent approach is used to determine the existing and future flooding issues with CCMA and MWC administrative areas.

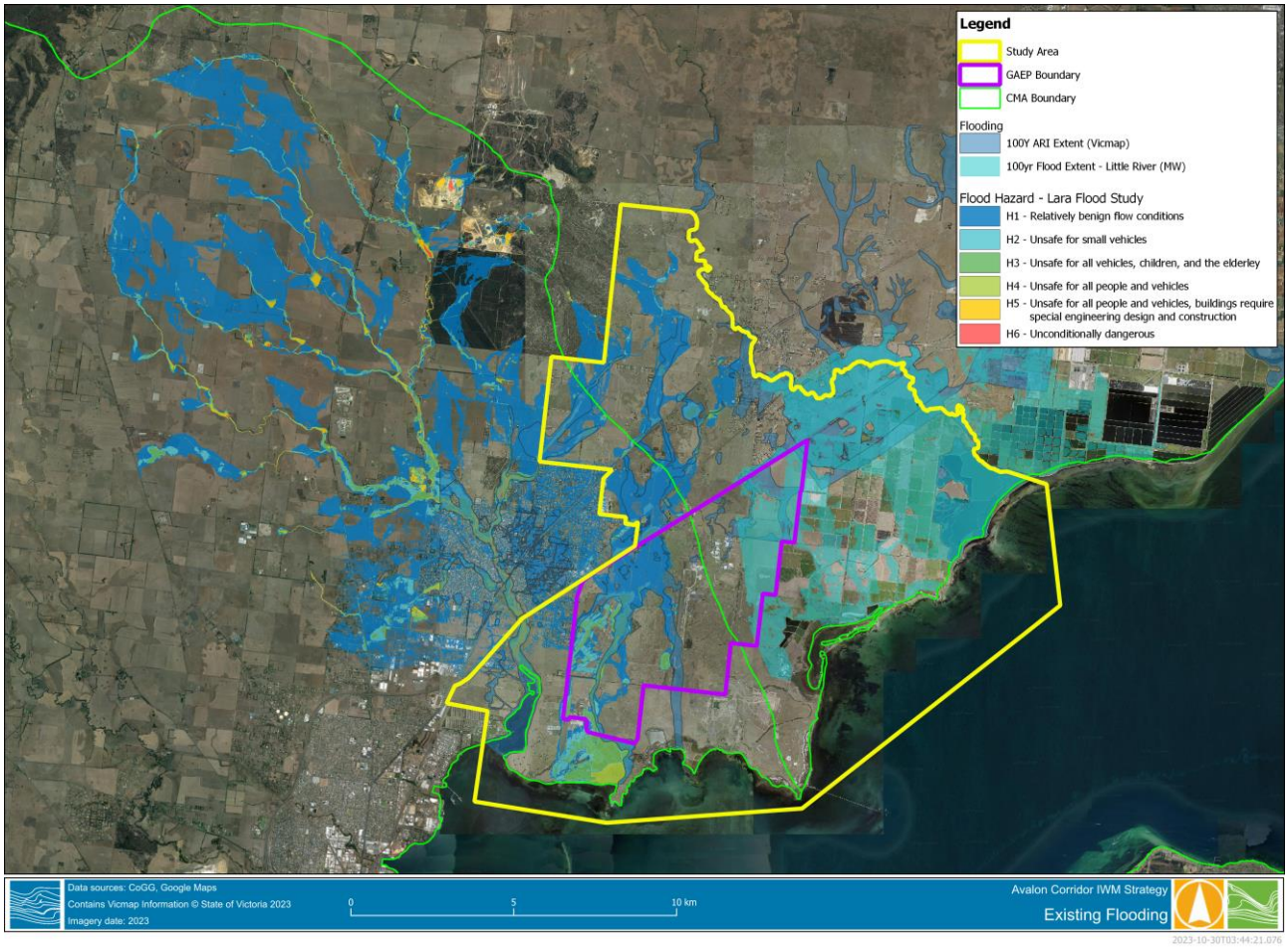

Figure 4-3 Existing Flooding

The extent of the existing council drainage network within the study area is minimal. Most drainage flow paths follow overland flow paths, existing waterways, and open channels (Figure 4-4). Due to flat topography, it would be challenging to connect future piped drainage outfalls to existing waterways and open channels/cut drains (for the catchment draining towards the WTP). Feasibility of new outfalls needs to be assessed on a case-by-case basis. Environmental impacts of any outfall construction would also need to be understood. Additionally, Melbourne Water have leased their land (to the west of GAEP) to agricultural users where the current WTP is. Cut drains within this area are identified to be of limited capacity. Any future drainage outfalls to this area also need to consider the capacity of existing drains and the potential impacts to agricultural users and existing habitats in the WTP. The potential environmental impacts from the runoff from the Avalon Airport into waterways, conservation areas and ecological habitats will need to be managed by the airport and the surrounding developments.

The shallow drainage pipes would lead to shallow retention basins with relatively large footprints. Alternatively, a pumped drainage management system would be required, significantly increasing the drainage network's capital and operational costs. Furthermore, existing outfalls at the bay are already tidally influenced. Moreover, climate change-induced sea-level rise is predicted to reduce the discharge capacity of existing catchments, leading to increased retention (GHD, 2021). The design for the Avalon Airport in terms of development and stormwater volume, flow rates and water quality will be an important input into more detailed asset investigations.

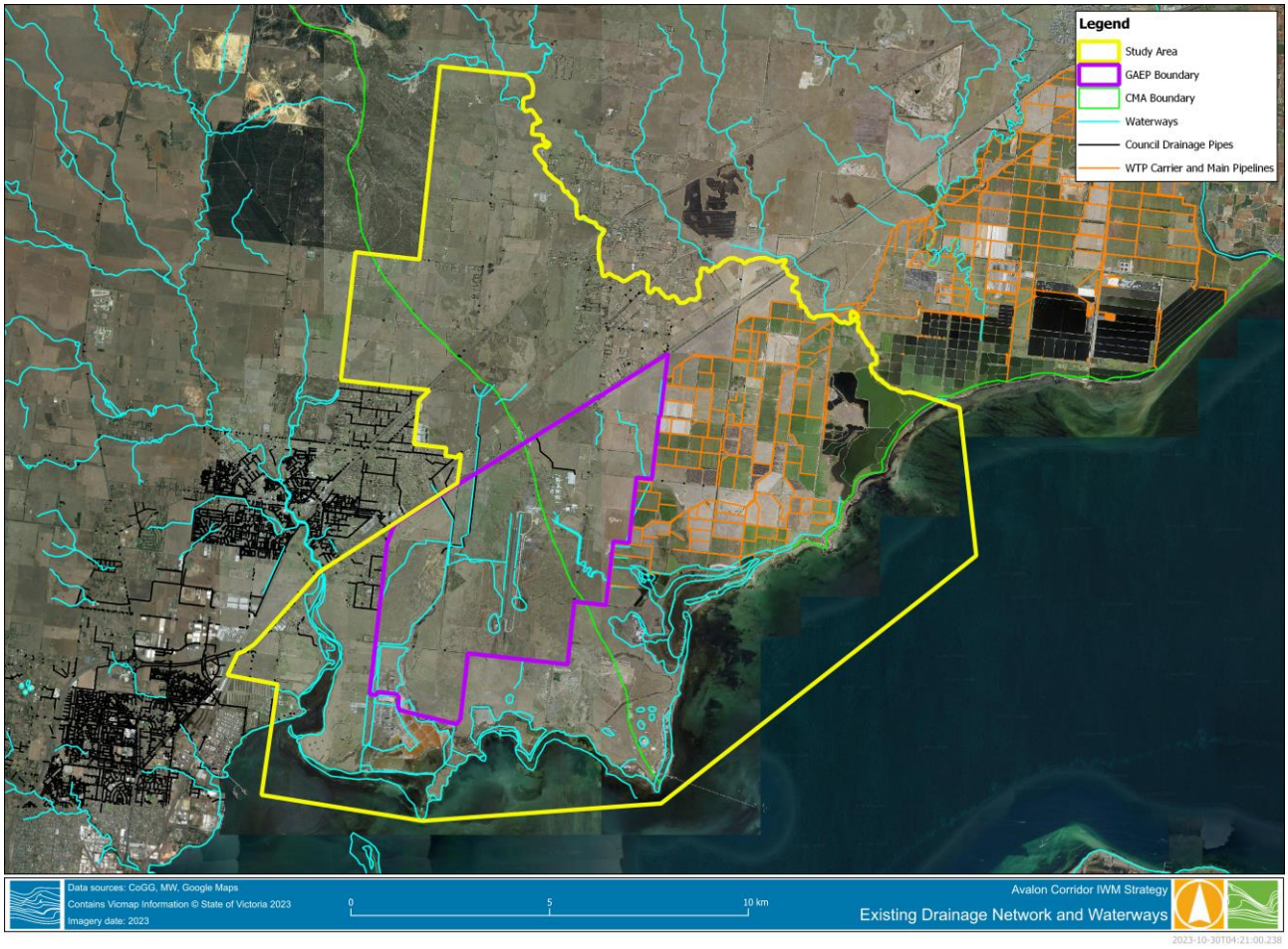

Figure 4-4 Existing Waterways and Drainage Network

4.1.4 Shallow Groundwater

Shallow groundwater exists across most of the study area (Figure 4-5). The average depth to groundwater in areas downstream of the Princess Highway varies from 0.1 m to 17.5 m, with and average depth of 2 m. Shallow groundwater will cause several issues:

- Constructability issue of drainage assets. Drainage assets will likely be limited to shallow assets with relatively large footprints, limiting the net developable area and impacting ecological and cultural values.
- Limit the stormwater infiltration potential and increase groundwater contamination from urban stormwater. Therefore, Water Sensitive Urban Design (WSUD) assets will likely need to be lined in response to the shallow groundwater within this area.
- Potential groundwater impacts must be considered as part of the riverine and coastal flood risk and the Coastal Acid Sulphate Soils (CASS) risk and should not be considered separately.

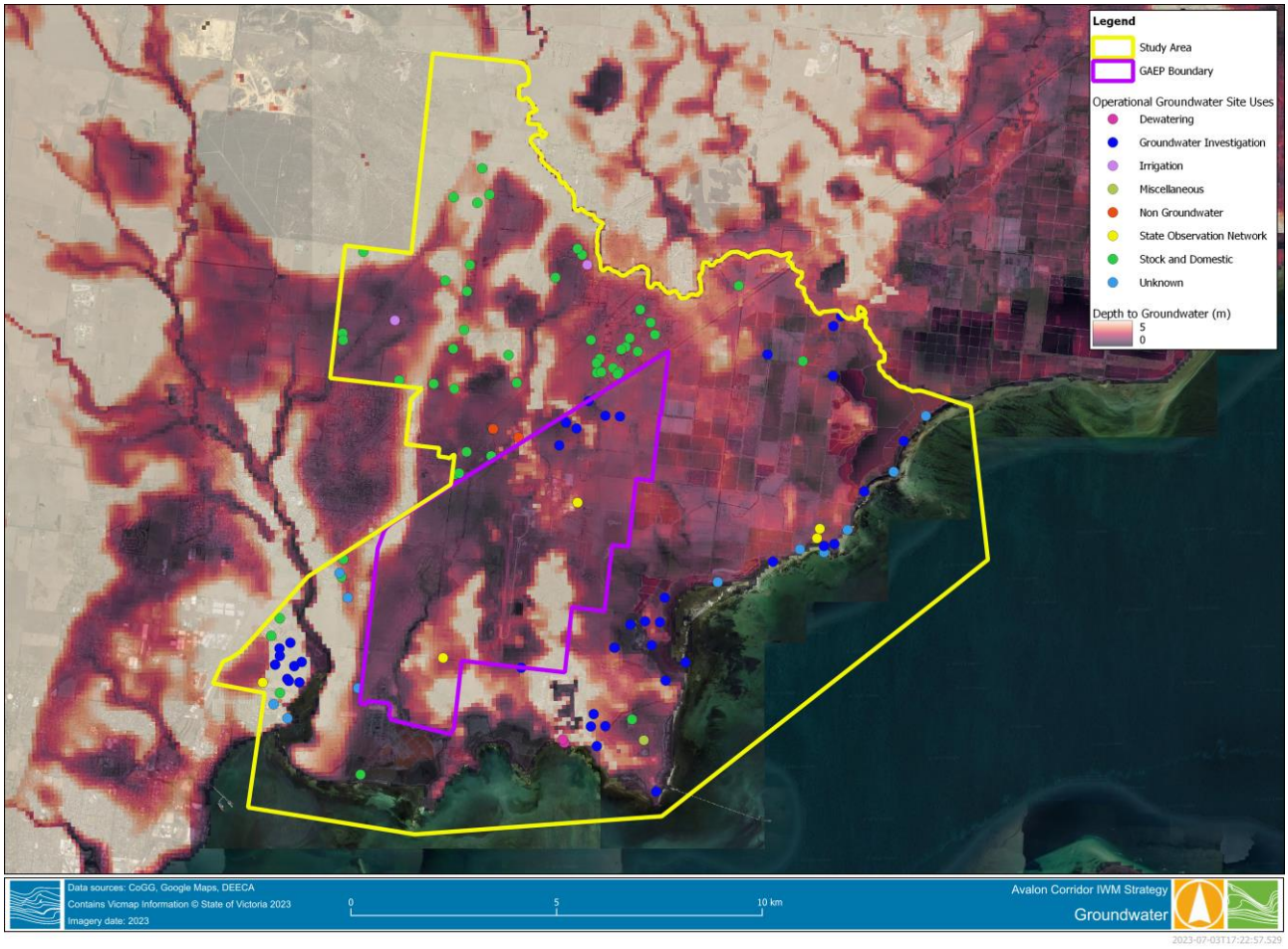

Figure 4-5 Depth to Groundwater and Operational Groundwater Sites

4.1.5 Water Supply and Sewer

GAEP was not identified as a potential precinct for strategic planning until recently. As such, the study area was considered to have no/minimal development potential (CoGG, 2020a) at the time Barwon Water were investigating its service strategy in previous years. As a result, water and sewer demands generated from Avalon were not considered in the NWGGA IWM Assessment (E2Design Lab, 2021). Furthermore, in a previous investigation, Barwon Water considered Avalon for creating a new wastewater treatment plant for servicing growth areas to the North and West of Geelong (prior to knowledge of the GAEP). However, this option was discarded due to the significant cultural heritage values of the area.

The need for a significant new investment in water, wastewater and recycled water infrastructure to service the nearby NWGGA has been identified by Barwon Water due to the capacity constraints within the existing water and sewer networks of Geelong, as well as the location, topography and size of the growth areas. Cost estimates arising from the initial concept level servicing strategies for NWGGA indicate Barwon Water will be required to invest in the order of $2B into new infrastructure over the next 40 years. This will include constructing new water, recycled water and wastewater pipelines, storages, pump stations and associated infrastructure, as well as an entirely new Advanced Water Recycling Facility. This however, does not factor in connecting servicing from the GAEP which would involve additional infrastructure upgrades and investment. Barwon Water are currently investigating the servicing options for the GAEP area, including an option exploring the additional infrastructure upgrades that would be associated with a potential connection of the GAEP to the proposed growth areas Advanced Water Recycling Facility. This investigation is expected to be completed in 2024.

The IWMP needs to be revisited once the Barwon Water's servicing options are determined. The GAEP are expected to be supplied with drinking water via an extension from the Lara/Lovely Bank supply network. The need for a recycled water supply is currently unknown. The presence of a recycled water network would compete with stormwater reuse. Since stormwater volume reduction is considered the highest priority, stormwater was assumed to be the preferred alternative water source for the GAEP area unless an extensive water user(s) who may benefit from a reliable alternative water supply is identified.

Sewer servicing options include treatment via the Barwon Water system, Melbourne Water WTP or a local treatment and reuse scheme. Two main constraints regarding the sewer servicing strategy identified are flat terrain and insufficient capacity at existing WWTPs. The flat terrain and other constraints might limit any future sewer system to be pressurised system while WWTP capacity issues to be dealt with through system planning (e.g. pumping at low flow periods) or a new onsite treatment and reuse scheme. However, gravity sewer may still be a possibility within some sections. This is to be confirmed in future investigations.

4.1.6 Open space and Interfaces

Interfaces between the airport, WTP and GAEP need to be considered. Some vegetation buffers or drainage assets could interface existing and future zones. The City and Victorian Government PSP guidelines would require open spaces to be incorporated into industrial development to improve amenity and liveability. Though a smaller footprint than a typical residential development, these open spaces could present opportunities to integrate with drainage infrastructure and stormwater reuse for irrigation. However, creating open space should consider the appropriate landscaping species and assess the risk of attracting wildlife around the airport.

4.1.7 Coastal Acid Sulphate Soils

Approximately 560 ha within the study area is identified to contain potential acid sulphate soils. Most of these areas are scattered throughout the low-lying areas adjacent to the coastal fringe, including Limeburners Bay, as shown in Figure 4-6. The recent land capability assessment conducted by VPA for the GAEP area (Jacobs, 2023) has identified a high probability of CASS occurrence coinciding with the locations of coastal lagoon deposits (the extent generally aligns with made land and prospective coastal acid sulphate soil extent in Figure 4-6). A detailed soil investigation[3] is proposed to be undertaken as the GAEP's PSP progresses further. Disturbing CASS will create the risks and impacts to the environment, surface/ground water, human health and infrastructure.The relevant guidelines, such as Assessing and Managing Coastal Acid Sulphate Soils[4] and EPA Publication 655.1: Acid Sulphate Soil and Rock[5], must be considered in GAEP's further investigation into CASS and future developments on lands subject to CASS. The construction of drainage assets in areas with a high probability of acid sulphate soil occurrence will require additional risk management measures during construction. Prior to the commencement of any works, a EPBC Act referral should be sought to determine the development extent due to the potential broad CASS impacts, and impacts associated with the RAMSAR wetlands, which is considered a matter of national environmental significance.

[3] It is understood VPA will undertaking a detailed assessment of sodic soils but exclude assessment of Acid Sulphate Soils
[4] https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0016/31237/CASS-BPMG-2010.pdf
[5] https://www.epa.vic.gov.au/about-epa/publications/655-1

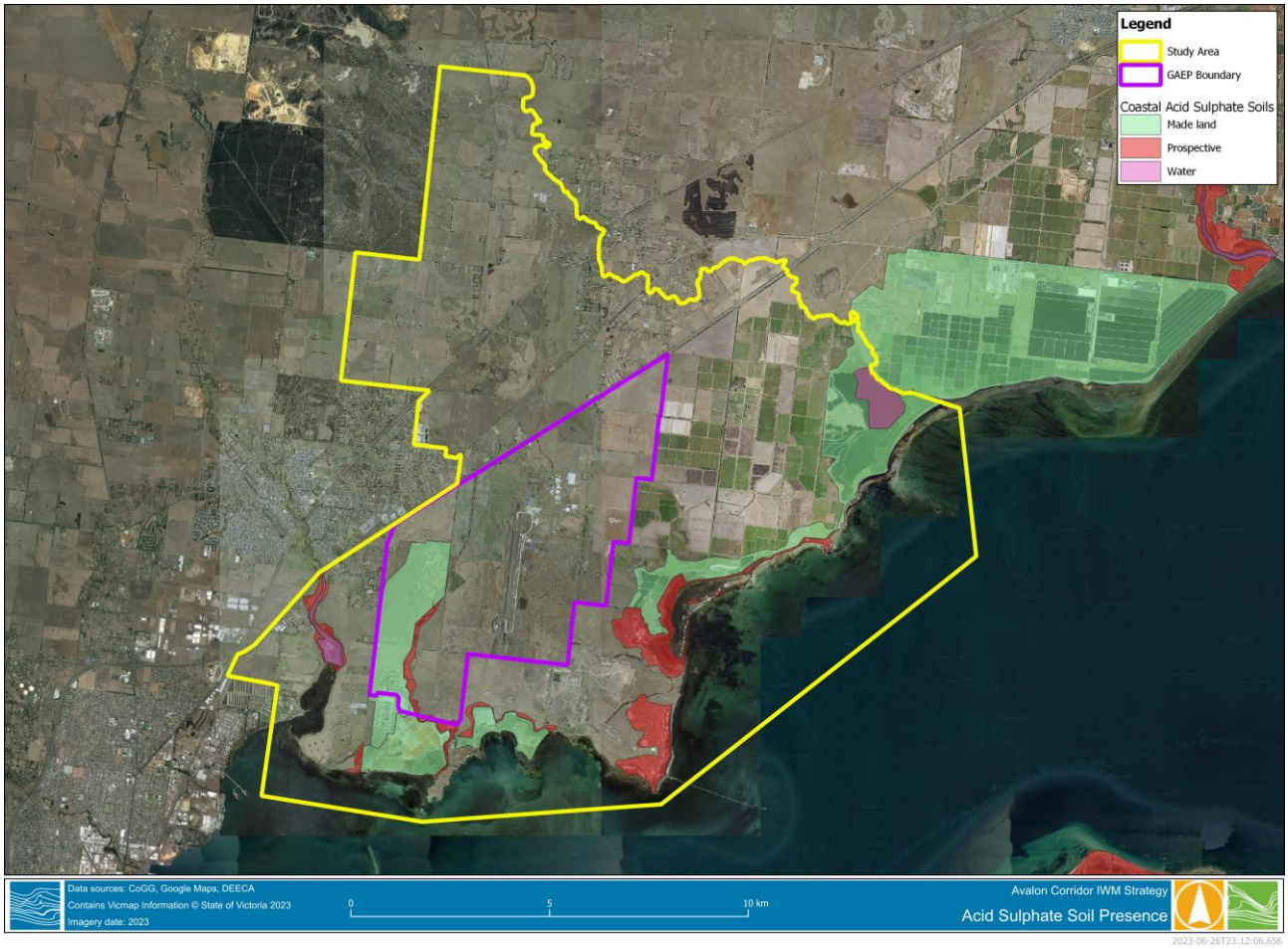

Figure 4-6 Acid Sulphate Soils Presence

4.1.8 Uncertainty

One of the main constraints in developing the IWMP is uncertainty. Since the PSP planning is still in the early stages, there are a lot of unknowns. For example, development layout, associated water demands, the Avalon Airport's new masterplan and its own IWM approach. Furthermore, another significant unknown is the acceptable change in stormwater volume and quality to protect the sensitive ecosystem within the study area. As such, the IWMP was developed based on a set of assumptions. These assumptions need to be revisited in the future when more information is available.

In addition, it is worth noting that current and future investigations, such as Barwon Waters' servicing investigation, Melbourne Water Development Services Scheme (DSS) development, VPA's precinct IWM and drainage assessment, and Parks Victoria's Avalon Coastal Conservation Actions Plan, that interact with the IWMP are in progress. Therefore, the IWMP needs to be revisited when these investigation outcomes are available.

Furthermore, it is critical to understand when water management assets will be available/become active relative to the proposed development. This will inform the selection of short-term to long-term IWM options for the GAEP and future infrastructure planning in the area.

Section 6.1 outlines the implications for subsequent IWM investigations which will guide the GAEP and future planning projects to achieve the certainty.

4.2 Stakeholder Vision for IWM

The overarching vision for water management within the study area (but not only the PSP) is based on the ecological needs of the waterways and surrounding environment. Hence, volume and water quality management are two of the most significant aspects of the Avalon Corridor IWMP. Stakeholders' expectations with regard to different water cycle management components consisted of:

- A consistent approach for water management throughout the GAEP area (within and outside the Avalon Airport)
- Adopt WSUD for the development and opportunities to serve environmental and cultural purposes (e.g. designing retention ponds as stormwater control measures as well as habitat for migratory bird populations)
- Ensure the land and waterways or the area are managed with respect of Paleert Tjaara Dja – Let's make Country good together 2020 – 2030, Wadawurrung Country Plan
- Keep stormwater within the landscape of irrigation, urban cooling and flood reduction
- Maximise stormwater harvesting opportunities and reduce stormwater discharge to waterways and sensitive environments
- Use of alternative water sources is desired with IWM options written into precinct planning documents and other planning project documents
- Alignment and agreement of IWM targets among stakeholders and commitment from stakeholders for subsequent implementation of the IWMP
- Consider climate change and adaptive planning pathways for proposed development from 2025 onwards.

In addition, stakeholders expressed interest in clear IWM targets to be stated in the IWMP and future precinct planning documents so that developers can work towards a consistent set of targets in future. It was also stressed that performance indicators for IWM targets should be identified to measure progress towards achieving the targets. Additionally, there was interest in understanding what is feasible to achieve different scales (lot, precinct and regional).

Since this IWMP is developed with a great deal of uncertainty in the development context, ecological needs for the waterways and water demands, it is unlikely the current Avalon Corridor IWMP will have set targets at regional level (e.g. exact stormwater runoff volume reduction target in terms of ML/year/ha or %). Instead, this IWMP will explore which strategies are broadly feasible at different scales in achieving IWM objectives and recommend further investigations. A subsequent IWMP proposed by VPA for GAEP PSP may strengthen the IWM objectives and verify the current IWM options' assumptions.

4.3 IWM Objectives

The key issues, drivers and stakeholder vision for IWM were formulated into eight IWM objectives under three overarching themes.

- **Protect and enhance the health of receiving environments**
  - Protect and preserve natural waterways, mangrove country and saltmarsh country from pollution (stormwater quality).
  - Protect and preserve natural water flow regime (stormwater quantity).
  - Avoid wastewater discharges to the surrounding sensitive environment (quantity and quality).
  - Enhance habitat for migratory bird population.

- **Provide secure and sustainable water services**
  - Reduce potable water consumption of future urban developments (including the GAEP) through the use of fit-for-purpose water.
  - Maximise the availability and use available alternative water sources for future urban developments (including the GAEP)
- **Support the liveability of the places we live and work**
  - Enhance amenity and microclimate through the introduction of natural features.
  - Minimise impact of water management assets on existing and future users (e.g. land take, wildlife strike hazard impacting the airport).

5 IWM BASE CASE, OPTION DEVELOPMENT AND ASSESSMENT

This section summarises the IWM base case, options development and assessment.

5.1 IWM Base case

An IWM base case is the reference scenario to which different IWM options will be compared. The base case is an option that usually represents the business-as-usual scenario. It consists of assumptions on guiding principles and key infrastructure requirements to manage the whole of the water cycle, such as water supply wastewater and stormwater management.

The proposed draft IWM base case of the study area is summarised below. It was informed by the stakeholder discussion and generally aligns with the current approach for stormwater management, water supply and wastewater management in typical developments, with additional requirements for volume management. It is acknowledged that due to the area's significant environmental and cultural sensitivities, additional measures are likely to be needed to manage potential risks.

Key assumptions related to development extent and water cycle management considerations are listed below:

- Development is limited to the industrial precinct identified within the GAEP and the proposed expansion of the Avalon Airport.
- No residential development within the study area is proposed
- Barwon Water will be the responsible authority for water supply and wastewater management.
  - Potable water supply will be through extensions and upgrades to the existing water supply infrastructure servicing the Lara area.
  - A new pressurised sewer system will be servicing the area. Wastewater will be sent to Barwon Water system through Lara and could be transferred to the Geelong network[6].
  - The area is not serviced by recycled water.
- The City of Greater Geelong is the designated drainage authority (along with MWC where lands are within MWC's administrative catchment) with the functions and responsibility for drainage specified by the Local Government Act 1989.
  - Stormwater will be treated to current best practice management targets unless a detailed assessment indicates that higher levels of treatment are required:
    - 80% reduction in post-development Total Suspended Solids
    - 45% reduction in post-development Total Phosphorus
    - 45% reduction in post-development Total Nitrogen
    - 70% reduction in post-development Gross Pollutants
  - Discharges for a 50% Annual Exceedance Probability (AEP) event should be maintained at pre-development levels for stormwater treatments.
  - Post-development annual runoff volume does not exceed the pre-development volume unless otherwise informed by a detailed environmental assessment.
- CCMA and MWC will be the responsible floodplain planning and management.

[6] It is noted that BW are currently investigating the sewer servicing options for GAEP and this may not be the preferred option. Gravity sewer is still possible, even if its in section. The assumption of pressure sewer to be revisited when BW service strategy investigation is finalised.

- The development will not worsen the existing flooding within the GAEP and the surrounding area
- Post-development peak-flow rates up to and including 1% AEP events will be kept at or below pre-development levels.

5.2 IWM Options Development

A range of IWM options were considered to achieve the IWM objectives set out in Section 4.3. However, the applicability of some IWM options was restricted by site-specific constraints. Therefore, the IWM options were developed taking the following assumptions/limitations into consideration.

- Without sufficient information on the Avalon Airport's proposed development and IWM approach, it was assumed that a separate IWM assessment would be conducted outside the current scope of works. Therefore, the proposed IWM options exclude the airport.
- Due to shallow groundwater, infiltration potential is likely to be very limited. Therefore, it was assumed stormwater infiltration would not be feasible.
- No groundwater harvesting is considered, and priority is given to stormwater harvesting and recycled water use.
- The preference is to avoid creating new water bodies within the 3 km radius of the airport. However, this may not be feasible as wetlands are typically best suited for treating larger catchments (> 10 ha) in flat terrain.

Since the overarching focus of the IWMP is to manage discharge volume and quality of future urban developments, IWM options that promote treatment and reuse of excess stormwater and wastewater volume generated from the GAEP were considered. A range of alternative water sources such as rainwater (RW), stormwater (SW), wastewater (WW) and mixed stormwater and wastewater (SW +WW) were explored. Reuse demands such as agricultural, open space irrigation, industrial/commercial (non-potable) and potable were considered. No residential demands were considered as urban residential growth is excluded in the study area and the nearby NWGGA IWMP already has put strategies for residential fit-for-purpose water use in place. In total, 18 options ranging from lot to regional scale were considered. Options typically focus on one aspect of water cycle and the remaining aspects of the water cycle were assumed to be managed as per the base case. Refer to Appendix C IWM options modelling assumptions.

5.2.1 Lot-scale Options

Lot scale options are focused on rainwater and stormwater treatment and reuse of industrial/commercial developments the GAEP. Two options considered were:

1. Mandatory rainwater harvesting for indoor non-potable uses (industrial/commercial) at each development lot
2. Each industrial/commercial lot has its own raingarden for stormwater treatment and onsite flood detention.

5.2.2 Streetscape Options

A single streetscape option for stormwater management was considered. This option is in line with the target T14 of the VPA's Precinct Structure Planning Guidelines: New Communities in Victoria: All streets containing canopy trees should use stormwater to service their watering needs. It also improves liveability of the precinct by enhancing canopy cover, aesthetics and a cooler climate.

3. Passive irrigation of street trees by stormwater

5.2.3 Precinct-scale Options

A total of ten precinct-scale options to manage stormwater and wastewater of the industrial/commercial developments within the GAEP were considered. Stormwater management options vary with the level of stormwater treatment (i.e. current Best Practice Environmental Management (BPEM), EPA priority area and no net increase), asset type (e.g. biofilters, wetlands, open storages, closed/underground storages) and reuse (i.e. none, agricultural, industrial/commercial) (Table 5-1).

Table 5-1 Precinct-scale Options Summary

Option ID	Source Water	SW Treatment Level	Treatment Asset Type	Reuse
4	SW	BPEM	Biofilters	n/a
5	SW	BPEM	Wetlands	n/a
6	SW	EPA Priority Area	Wetlands and open storages	Agricultural
7	SW	EPA Priority Area	Wetlands and closed storages	Industrial/commercial
8	SW	EPA Priority Area	Biofilters and closed storages	Industrial/commercial
9	SW	No net increase	Wetlands and open storages	Agricultural
10	SW	No net increase	Wetlands and closed storages	Industrial/commercial
11	SW	No net increase	Biofilters and closed storages	Industrial/commercial
12	SW	No net increase	Wetland and ocean outfall	n/a
13	WW	n/a	Local WRP	Industrial/commercial

The three levels of stormwater treatment aim to represent a range of infrastructure investments, even though the current BPEM achievement is most likely insufficient for protecting the sensitive environment surrounding the GAEP. The selection of asset types mainly aims to explore different options with and without creating new open water bodies within the 3 km wildlife hazard buffer. For instance, using biofilters for stormwater treatment will avoid the creation of new open-water bodies. Still, many biofilter assets would likely be needed compared to a treatment strategy using wetlands due to a smaller catchment area that can be treated by a single biofilter (≤10 ha). Wetlands, on the other hand, would be the preferred precinct scale treatment option for larger catchments (> 10 ha) in flat terrain and have the potential to create habitat for migratory birds. But wetlands increase the risk of bird strikes near the airport. Using closed/underground storage will reduce the risk of bird strikes near the airport. However, closed storages will require additional reuses to compensate for unrealised evaporation losses that can be achieved via open storages.

BPEM Options

4. Stormwater treatment to achieve BPEM targets by Gross Pollutant Traps (GPTs) and Biofilters (no reuse)

5. Stormwater treatment to achieve BPEM targets by sediment ponds and wetlands (no reuse)

EPA Priority Area Options

6. Stormwater treatment to achieve EPA harvest target by wetlands and agricultural reuse (with open storage)

7. Stormwater treatment to achieve EPA harvest target by wetlands and industrial/commercial reuse (with closed storage)

8. Stormwater treatment to achieve EPA harvest target by biofilters and industrial/commercial reuse (with closed storage)

No net Increase in pre-development volume Options

9. Stormwater treatment to achieve no net increase in volume target by wetlands and agricultural reuse (with open storage)
10. Stormwater treatment to achieve no net increase in volume target by wetlands and industrial/commercial reuse (with closed storage)
11. Stormwater treatment to achieve no net increase in volume target by biofilters and industrial/commercial reuse (with closed storage)
12. Stormwater treatment to achieve BPEM targets by wetlands and discharge excess stormwater runoff via an ocean outfall

Wastewater Treatment and Reuse Options

13. Local wastewater treatment and reuse for non-potable industrial/commercial uses

5.2.4 Regional Scale Options

Five regional scale IWM options were explored for SW, WW and SW+WW treatment and reuse. These options generally rely on existing regional infrastructure for full treatment of wastewater and management of excess stormwater (i.e. precinct scale solutions will still be in place for local stormwater treatment and discharge to maintain existing hydrology and water quality). Feasibility of these options rely on existing networks' capacity to accept additional flow or system planning to deal with existing capacity issues (refer to Section 4.1.5 for more details).

14. Stormwater treatment for potable reuse via Barwon Water network
15. Wastewater treatment and reuse via Barwon Water's existing recycled water network
16. Wastewater treatment and reuse via Melbourne Water's WTP
17. Mixed supply of treated stormwater and wastewater via Barwon Water's existing recycled water network
18. Mixed supply of treated stormwater and wastewater via Melbourne Water's WTP

5.2.5 Key Assumptions

Once the options were identified, options were characterised by preliminary sizing of required assets (WSUD, storages) and volume (discharges, reuse volumes, etc.) It should be noted that only a high-level characterisation was undertaken using MUSIC modelling, demand estimates extracted from the Situational Analysis Report (Water Technology, 2023), and some reference data extracted from other reports (E2Design Lab, 2015; E2Design Lab, 2021). Appendix C lists key assumptions based on which each option was modelled/characterised. A summary of key asset sizing, storage volumes, and reuse volumes is shown in Table 5-2. It should be noted that the asset sizing (surface area and volume) are only preliminary estimates derived using simplified modelling approaches.

Preliminary option characterisation provides some insights into potential future challenges associated with achieving high volume reduction targets. For example, it is likely that the GEAP will have to rely on significant external demands in terms of agricultural or non-potable demands[7] to achieve EPA volume reduction targets or "no net volume increase" target. This is because the desktop review suggested the agricultural lands in the Lara region is already being supplied with recycled water substantially and there is significant uncertainty in the non-potable water demand estimates within the GAEP itself. Furthermore, relatively larger WSUD assets than the conventional BPEM WSUD assets and larger storages will also be needed. This indicates more land take for accommodating these stormwater management assets compared to a typical development project Allowing some infiltration through assets will be able to reduce the reliance on external demands and asset footprint subject to site-specific groundwater and hydrological conditions. Still it may not be possible with shallow groundwater.

[7] There may be an opportunity to use excess stormwater to restore the former Salt Works site to a natural wetland under the Restoration Action Plan for Avalon Coastal Reserve (https://storymaps.arcgis.com/stories/f44a22f56d264d0ea6bbcc09f6d78c5d).

Table 5-2 IWM Options Asset and Volume Summary

Option ID	Short Description	WSUD Treatment Area (ha)[1]	Stormwater Storage Volume (ML)	Reuse Supplied (ML/Year)
1	Mandatory rainwater harvesting for indoor non-potable uses (industrial/commercial) at each development lot (60 kL average tank size)	-	16	270
2	Each industrial/commercial lot has its own raingarden for stormwater treatment	4	-	-
3	Passive irrigation of street trees by stormwater	-	-	318
4	Stormwater treatment to achieve BPEM targets by GPTs and Biofilters (no reuse)	2	-	-
5	Stormwater treatment to achieve BPEM targets by sediment ponds and wetlands (no reuse)	26	-	-
6	Stormwater Treatment to achieve EPA harvest target by wetlands and agricultural reuse (with open storage)	53[2]	600	1,725
7	Stormwater Treatment to achieve EPA harvest target by wetlands and industrial/commercial reuse (with closed storage)	50	750	2,094[3]
8	Stormwater Treatment to achieve EPA harvest target by biofilters and industrial/commercial reuse (with closed storage)	15	800	2,450[3]
9	Stormwater Treatment to achieve no net increase in volume target by wetlands and agricultural reuse (with open storage)	76[2]	800	1,780
10	Stormwater Treatment to achieve no net increase in volume target by wetlands and industrial/commercial reuse (with closed storage)	50	926	2,512[3]
11	Stormwater Treatment to achieve no net increase in volume target by biofilters and industrial/commercial reuse (with closed storage)	15	926	2,947[3]
12	Stormwater treatment to achieve BPEM targets by wetlands and discharge excess stormwater runoff via an ocean outfall	26	n/a	-
13	Local wastewater treatment and reuse for non-potable industrial/commercial uses	n/a	n/a	474
14	Stormwater treatment for potable reuse	26	n/a	316

Option ID	Short Description	WSUD Treatment Area (ha)[1]	Stormwater Storage Volume (ML)	Reuse Supplied (ML/Year)
15	Wastewater treatment and reuse via Barwon Water's existing recycled water network	n/a	n/a	59
16	Wastewater treatment and reuse via WTP	n/a	n/a	59
17	Mixed supply of treated stormwater and wastewater via Barwon Water's existing recycled water network	26	n/a	375
18	Mixed supply of treated stormwater and wastewater via WTP	26	n/a	375

Notes:

1. Treatment surface area only. Total asset footprint includes maintenance access, freeboard, batters. Provisions for these additional components are not provided.
2. Excludes evaporative storage pond surface area.
3. Exceeds GAEP potable water demand. Significant reliance on external water demands.

5.3 IWM Options Assessment

IWM options are rapidly assessed using the Preliminary Assessment Method (E2Design Lab, 2015). Each option was characterised against a selected set of performance indicators (Table 5-3), and the benefit against each indicator was ranked as low, medium or high based on defined ranges of performance thresholds (Table 5-4). A high-level cost and risk factors assessment including environmental risk assessment were also listed against each option. The option assessment matrix is presented in Appendix C.

Table 5-3 Performance Indicators

IWM Theme	Performance Indicator	Quantifiable
Protect and enhance the health of receiving environments	Reduction in stormwater discharge volume (ML/year)	Yes
	Stormwater sediment and nutrient load reduction	Yes
	Avoid wastewater discharge volume (ML/year)	Yes
	Habitat for migratory bird population/creation of new wetlands or open water bodies	No
Provide secure and sustainable water services	Reduction in potable water consumption (ML/year)	Yes
	No. of alternative water sources available locally	Yes
Support liveability of the places we live and work	Opportunity to integrate WSUD assets with public open spaces	No
	Passive irrigation of street trees and open spaces	No
	increased risk for airport operations through wildlife strike hazard	No
	Reduce flood risk	No

Table 5-4 Performance Thresholds

Performance Indicator	High Benefit	Medium Benefit	Low Benefit
Reduction in stormwater discharge volume (ML/year)	No net increase	Achieve at least 75%* volume reduction	Achieve <75%* volume reduction
Stormwater sediment and nutrient load reduction	No net increase	Meet BPEM targets	Does not meet BPEM targets, at least for a single pollutant
Avoid wastewater discharge volume (ML/year)	Local reuse	Regional reuse	No treated wastewater reuse
Habitat for migratory bird population/creation of new wetlands or open water bodies	Presence of new open water bodies with vegetation	n/a	Absence of new open water bodies with vegetation
Reduction in potable water consumption (ML/year)	>75% reduction	>40% reduction	<40% reduction
No. of alternative water sources available locally	More than one alternative water source	At least one alternative source	No alternative water supply

Performance Indicator	High Benefit	Medium Benefit	Low Benefit
Opportunity to integrate WSUD assets with public open spaces	Opportunities to integrate with vegetated WSUD assets	n/a	No opportunities to integrate with vegetated WSUD assets
Passive irrigation of street trees and open spaces	More than 80% of the spaces are supplied with an alternative water source	At least 50% of the spaces are supplied with an alternative water source	Potable water use for local irrigation needs
increased risk for airport operations through wildlife strike hazard	No new waterbodies within 3km radius of the airport	n/a	New waterbodies within 3km radius of the airport
Reduce flood risk	No net increase in flood risk	Some reduction in flood risk	Insignificant reduction in flood risk

Notes: * equivalent to EPA stormwater harvesting target for priority area in the 500 mm/year rainfall band.

5.4 IWM Options Shortlist

A review of benefit ranking across different performance indicators revealed that none of the proposed IWM options achieved consistently high or medium benefit across all indicators. Generally, some of the precinct and regional scale solutions seem to score relatively well under "protect and enhance the health of receiving environments" and "provide secure and sustainable water services" but indicated relatively low performance over "support liveability of the places we live and work". This is mainly because of some contradictory performance indicators across different themes. For instance, the creation of open water bodies is encouraged to support migratory birds. At the same time, attracting birds to new water bodies increases the risk of wildlife strike hazard and interferes with airport operations. Therefore, it is challenging to perform well for both indicators simultaneously.

As such, individual options were combined to create a set of promising IWM portfolios for further investigation. A total of five potential portfolios were identified. A short description of different options combined to create portfolios and their aims are presented in Table 5-5.

- Portfolio 1 (P1) was developed by combining IWM options that do not consist of creating any new open water bodies within the 3 km radius of the airport. Therefore, the treatment assets were limited to vegetated treatment assets such as biofilters and raingardens. Closed storage, such as rainwater tanks, was only considered. This portfolio would be able to satisfy no net increase in stormwater runoff volume and pollutant loading and, hence, is considered to be one of the best portfolios for protecting RAMSAR sites and other sensitive ecological systems from urban stormwater. However, a significantly large number of WSUD assets (rainwater tanks, raingardens and end-of-catchment biofilters), significantly large storage requirements (to compensate for the contribution of evaporation losses from open storages for harvest targets) and construction of a local WRP would likely increase capital and operation costs to the asset owners. Furthermore, the reliance on private owners for rainwater tank maintenance and management can also be another operational risk to consider.
- The remaining portfolios (P2 – P5) comprised new open water bodies for stormwater treatment and storage within the 3 km radius of the airport. The feasibility of these portfolios depends on the liaison with the Avalon Airport and the consideration of the NASF Guideline C to construct new water bodies within the airport buffer without increasing the risk of wildlife strike hazard that impacts airport operations.
    - Portfolio 2 (P2) relies on streetscape and precinct scale solutions for stormwater management and local WRP for wastewater management. While this portfolio would be able to satisfy no net increase

in stormwater runoff volume and pollutant loading (considered one of the best portfolios for RAMSAR site protection), one of the most significant uncertainties of P2 is reliance on agricultural users for stormwater reuse, with the current data suggesting that the nearby farms are already being supplied with recycled water substantially. The volume reduction targets would not be met if no sufficient local/regional agricultural demand can be found.

- Portfolio 3 (P3) is quite similar to P2 except for the reliance on Melbourne Water's WTP wastewater treatment and reuse. While this option will have relatively lower costs compared to P2 because of omitting the need for constructing a new WRP, the feasibility of this option needs to be further explored with Melbourne Water to confirm whether WTP has sufficient capacity to service the area and whether additional inflows from thr GAEP would have any adverse impact on the RAMSAR wetlands.
- Portfolios 4 & 5 (P4 and P5) rely on lot-scale and precinct-scale solutions for stormwater and wastewater management. Unlike other portfolios (P1 – P3), these two portfolios aim to achieve EPA stormwater volume reduction target (75% volume reduction). Therefore, these two options have slightly lower runoff volume reduction compared to other portfolios and may not be recommended as IWM options for RAMSAR site protection if it is found that the change in post-development hydrology is larger than the acceptable change threshold for ecological health. The precinct-scale stormwater storage and reuse strategy is the main factor differentiating P4 and P5. P4 was developed with an open water storage for local agricultural reuse. At the same time, P5 was created with a closed storage and non-potable industrial/commercial reuse. As mentioned previously, the uncertainty regarding the availability of local agricultural demand and future industrial/commercial demand within the GAEP for stormwater reuse should be investigated at detailed precinct/infrastructure planning stage. It is likely that stormwater reuse demands will be located and sourced externally to the study area, which will increase the cost of distribution networks. Similar to P1, both P4 and P5 rely on lot-scale rainwater reuse. The reliance on private owners for rainwater tank maintenance and management as an operational risk must be considered.

The performance of portfolios against the individual indicator is presented in Appendix C, with overall performance across broad IWM themes summarised in Table 5-6. Uncertainties around acceptable change in hydrology and water quality, local demand estimates, and compatibility of new open water bodies around the airport make it difficult to recommend a single portfolio for further evaluation. If further investigations determine that new water bodies around the airport are incompatible, then option P1 seems to provide the best overall performing portfolio to be evaluated. Alternately, if a scenario where new open water bodies can be created without impacting the airport operation is appropriate, portfolios P3 and P5 are recommended for further evaluation.

Table 5-5 IWM Portfolio Summary

Overarching Aim/Assumption	Portfolio ID	Soure Water	Treatment and Reuse Strategy			
			Lot-scale	Streetscape	Precinct-scale	Regional scale
Creation of new water bodies within 3km radius of the airport is not allowed	P1	RW SW WW	Rainwater harvesting for non-potable industrial/commercial uses	Passive irrigation of street trees	Stormwater treatment via biofilters and reuse for non-potable industrial/commercial uses Local recycle plant for wastewater reuse	n/a
Creation of new water bodies within the 3km radius of the airport or assets outside the 3km radius is allowed. (The airport employs an additional risk management strategy to manage off-airport wildlife strike hazard)	P2	SW WW	n/a	Passive irrigation of street trees	Stormwater treatment via wetland for agricultural reuse Local recycle plant for wastewater reuse	n/a
	P3	SW WW	n/a	Passive irrigation of street trees	Stormwater treatment via wetland for agricultural reuse	Wastewater treatment and reuse via WTP
	P4	RW SW WW	Rainwater harvesting for non-potable industrial/commercial uses	n/a	Stormwater treatment via wetland for agricultural reuse Local recycle plant for wastewater reuse	n/a

Overarching Aim/Assumption	Portfolio ID	Soure Water	Treatment and Reuse Strategy			
			Lot-scale	Streetscape	Precinct-scale	Regional scale
	P5	RW SW WW	Rainwater harvesting for non-potable industrial/commercial uses	n/a	Stormwater treatment via wetland for industrial reuse Local recycle plant for wastewater reuse	n/a

Table 5-6 IWM Portfolios Overall Performance Comparison

Portfolio ID	Options Combination	Overall IWM Theme Performance		
		Protect and enhance the health of receiving environments	Provide secure and sustainable water services	Support the liveability of the places we live and work
P1	1 + 3 + 11 + 13	Very High	Very High	High
P2	3 + 9 + 13	High	High	Medium
P3	3 + 9 + 16	Very High	High	Medium
P4	1 + 6 + 13	Very High	Very High	Low-medium
P5	1 + 7 + 13	Very High	Very High	Low-medium

5.4.1 Future Economic Evaluation of IWM Options

A preferred IWM solution must be developed and form part of the proposed urban form, open space and utility infrastructure design and provision (VPA, 2021). Timing, funding, and responsibility of key elements of the water system is typically identified in a precinct infrastructure plan (VPA, 2021). However, an IWM solution may lead to costs that would typically not have been incurred by the project partners through traditional water management strategies under current policy and regulations. In such instances, the DELWP cost allocation framework for IWM projects (DELWP, 2017) provides a framework (Figure 5-1) that can be used to guide decision and cost allocation for IWM projects. The short-listed IWM options need to be further assessed to allocate costs, and an economic evaluation is required.

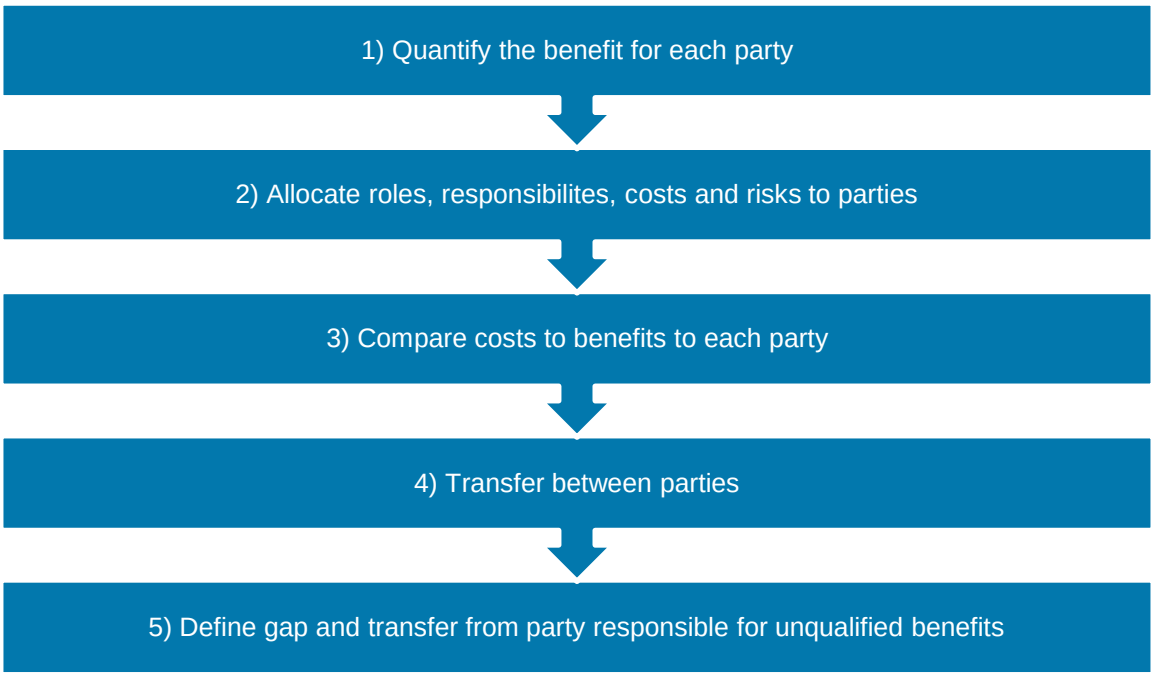

Figure 5-1 Cost Allocation Framework (DELWP, 2017)

6 SUMMARY AND RECOMMENDED FURTHER INVESTIGATIONS

The Avalon Corridor IWMP was prepared through desktop reviews and stakeholder engagement. The first phase of the project, "situational analysis' aimed to identify key information on the existing drainage and servicing situation as well as high-level opportunities and constraints influencing the IWMP. The findings from the situational analysis were tested with key stakeholders through a design sprint workshop aimed to confirm key issues and drivers related to IWM and stakeholders' visions for IWM. This information was used to develop IWM objectives and the potential long list of IWM options. IWM options were assessed against the key objectives/criteria to identify promising IWM options for further investigation.

A review of existing background reports and stakeholder interviews revealed limited infrastructure servicing the area. There is no Barwon Water-owned wastewater or recycled water infrastructure currently servicing the area and limited potable water supply infrastructure and council-managed drainage network servicing the area. This indicates that significant upgrades/extension to existing drainage, water supply and wastewater infrastructure is needed for servicing the growth of Avalon Corridor.

Additionally, a range of potential issues and constraints were considered, from topography, soils, environment, cultural and heritage, flooding and drainage, climate change, groundwater, land ownership to aviation safety. The key issues and drivers related to IWM were identified to be.

- **Ecologically and culturally significant environment**
  - One of the most critical drives for IWM is to protect the ecologically and culturally sensitive environment from the adverse impacts of the future industrial/commercial/airport developments.
  - At the same time, it is currently unknown what would be the acceptable change in hydrology and water quality that could minimise any adverse impact on the sensitive environment and enhance the ecological significance.
  - As such, this report takes a conservative approach until scientific information regarding the ecological and cultural tolerance of impacts is established.
- **Interface with Avalon Airport**
  - NASF guidelines indicate that within the 3 km of the airport boundary, mitigatory actions are needed for any existing wetland conservation areas. In contrast, the new wetland conservation areas are incompatible.
  - This is a significant constraint for creating new open water bodies such as wetlands and open water storages, including flood mitigation within the GAEP. It is noted that the NASF provides a rigorous framework for consideration during more detailed drainage asset design investigations.
- **Flooding and drainage**
  - The extensive flooding limits the developable area and the footprint available for drainage infrastructure.
  - Due to flat topography, connecting future piped drainage outfalls to existing waterways and open channels/cut drains would be challenging.
  - Environmental impacts of outfall construction and subsequent changes in hydrology and water quality would also need to be understood.
  - The shallow drainage pipes would lead to shallow retention basins with relatively large footprints. Alternatively, a pumped drainage management system would be required, significantly increasing the drainage network's capital and operational costs.
  - Existing outfalls at the bay are already tidally influenced, and the extent of this issue is expected to worsen with the climate change-induced sea level rise.

- The design for the Avalon Airport in terms of development and stormwater volume, flow rates and water quality will be an important input into more detailed asset investigations.
- When assessing the options and portfolio at detailed level, liaison with the City of Greater Geelong, as asset owner and manager must be undertaken. The City prefer to minimise the number of new treatment/detention assets, avoid streetscape assets where possible. Pumped drainage system is not desirable.

- **Shallow groundwater**
  - Constructability issue of drainage assets. Drainage assets will most likely be limited to shallow assets with relatively large footprints, limiting the net developable area.
  - Limit the stormwater infiltration potential and increase groundwater contamination from urban stormwater. Therefore, WSUD assets will likely need to be lined in response to the shallow groundwater within this area.
- **Water supply and sewer**
  - Significant extension/upgrade to water and sewer infrastructure is expected.
  - Barwon Water is investigating the servicing options for the area, with the findings from this study not available in time for the current IWMP finalisation.
  - The flat terrain and other constraints would limit any future sewer system to be a pressurised system, while WWTP capacity issues must be dealt with through system planning (e.g., pumping at low flow periods) or a new onsite treatment and reuse scheme.
    - Gravity sewer may still be a possibility even at some localised locations. This is to be confirmed in future investigations.
- **Open space and interfaces**
  - Some vegetation buffers or drainage assets could provide the interface between existing and future zones.
  - Opportunities to create open water bodies adjacent to open spaces are limited due to the increased risk of wildlife strike hazard.
- **Coastal Acid sulphate soils**
  - Future developments and infrastructure construction in areas with a high probability of CASS occurrence must consider the impacts on environment, surface/ground water, human health and infrastructure at the early planning stage and provide appropriate risk management prior to and during the ground disturbance.
- **Uncertainty**
  - One of the main constraints in developing the IWMP is uncertainty. Since the GAEP's precinct planing and the Avalon Airport's new masterplan are still at early stage, a lot of unknowns are yet to be investigated and addressed. For example, development layout, associated water demands, Avalon Airport development and its own IWM approach.
  - As such, the IWMP was developed based on a set of assumptions. These assumptions need to be revisited at precinct and infrastructure planning stage when more information is available.
  - The IWMP needs to be revisited when current and future investigations that impact IWMP, such as Barwon Waters' servicing investigation, Melbourne Water DSS development, VPA GAEP flood and drainage study, and Parks Victoria's Avalon Coastal Conservation Actions Plan, are completed.
  - Furthermore, it is critical to understand when water management assets will be available/become active relative to the delivery of urban growth in the Avalon Corridor.

The overarching stakeholder vision for water management within the Avalon Corridor was that it should be driven by the ecological needs of the waterways and surrounding sensitive environment. Hence, volume and water quality management were two of the most significant aspects of the Avalon Corridor IWMP. The key issues, drivers and stakeholders' vision for IWM were formulated into eight IWM objectives under three overarching themes.

- **Protect and enhance the health of receiving environments**
  - Protect and preserve natural waterways, mangrove country and saltmarsh country from pollution (stormwater quality)
  - Protect and preserve natural water flow regime (stormwater quantity)
  - Avoid wastewater discharges to the surrounding sensitive environment (quantity and quality)
  - Enhance habitat for migratory bird population
- **Provide secure and sustainable water services**
  - Reduce potable water consumption of future industrial/commercial developments through the use of fit-for-purpose water.
  - Maximise the availability and use available alternative water sources within the GAEP
- **Support the liveability of the places we live and work**
  - Enhance amenity and microclimate through the introduction of natural features
  - Minimise impact of water management assets on existing and future users (e.g. land take, wildlife strike hazard around the airport)

In total, 18 potential IWM options ranging from lot to regional scale were considered. It should be noted that the site-specific constraints led to the limitation of IWM options applicable to the study area. Nevertheless, a range of alternative water sources such as rainwater, stormwater, wastewater and mixed stormwater and wastewater and reuse demands such as agricultural, open space irrigation, industrial/commercial (non-potable) and potable were considered. Each option was characterised against a set of 10 performance indicators spanning the three IWM themes. In general, a greater reliance on external demands and larger asset footprints is required to meet stormwater volume reduction targets. None of the proposed IWM options achieved consistently high or medium benefits across all indicators. As such, individual options were combined to create a set of promising IWM portfolios for further investigation. A total of five potential portfolios were identified. A selection of preferred portfolio for further evaluation depends on clarifying the uncertainties around the acceptable change in hydrology and water quality, local demand estimates and the compatibility of new open water bodies around the airport.

6.1 Implications for subsequent IWM Investigations

It is critical to note that the current IWMP was developed based on assumptions that need to be tested. Therefore, there is a critical need to undertake the following additional investigations to test these assumptions.

It is also noted that even though the following investigations were recommended with respect to the GAEP and other strategic planning projects in the Avalon Corridor, these investigations are applicable for any developments within the region which eventually discharge to sensitive wetlands, impacting native vegetation and habitat sites for migratory birds in the study area.

- Undertake an ecohydrological assessment to characterise baseline hydrology and water quality of the waterways and determine the acceptable level of change in terms of hydrology and water quality.

- A similar assessment has been carried out for the Wianamatta-South Creek Catchment (NSW) to determine water quality and flow-related objectives for protecting and improving waterways, riparian vegetation communities, wetlands, and other water-dependent ecosystems (DPE, 2022).
- This type of assessment is expected to consist of the following scope items to be confirmed by an experienced and suitably qualified aquatic ecologist/biologist.
  - Catchment analysis including the identification of the existing and proposed drainage paths and outfalls.
  - Identification of areas directly or indirectly impacted by the proposed development. This will include the development area and any downstream areas along the existing overland flow paths and drainage outfalls.
  - Establish existing hydrology either through modelling or integrated catchment monitoring and modelling approaches.
  - Undertake baseline water quality monitoring of key waterways and wetlands.
  - Identify existing environmental values within the impact area using desktop assessment and field surveys.
  - Review of potential legislative implications, known threats and mitigation options associated with identified ecological values.

- Liaise with the Avalon Airport to understand the feasibility of creating new open water bodies within the 3 km radius of the airport boundary without increasing and managing the wildlife strike hazard.
- Liaise with the Avalon Airport to seek an alignment in the IWM approach within the airport and the remainder of the GAEP where possible.
- Undertake a hydrological and groundwater assessment to test the feasibility of stormwater infiltration within the project area and incorporate stormwater infiltration options in subsequent IWMPs.
- Incorporate the latest climate change factors and undertake a flood study to understand the flooding issues and necessary mitigatory actions.
- Reassess the validity of the original demand estimates and runoff volume estimates once further information on the GAEP's planning parameters is available.
- Refresh the Avalon Corridor IWMP when complementary studies such as GAEP PSP background investigations, Avalon Airport Master Plan, and Barwon Water's water and wastewater strategy are completed to confirm the current IWMP assumptions and estimates are still valid.

It is evident from the current study that the project area is complex and challenging due to a range of issues and constraints impacting regional-level IWM in the study area. Without a clear pathway for managing water in an integrated way, there is a risk of different water cycle components being managed separately by various agencies in the standard way. With multiple stakeholders undertaking various investigations at different timescales, strong coordination and collaboration between key stakeholders is needed to feed each investigation's findings/learnings at detailed precinct planning stage. Some of the critical processes to be integrated include:

- VPA – The GAEP's precinct planning and technical studies of biodiversity, land capability, drainage and flooding and the precinct-scale IWMP.
- Barwon Water - Servicing options report due mid-2024. This will feed into the GAEP's precinct planning process above.
- Melbourne Water – The preparation of DSS will feed into the GAEP precinct planning process.

- Parks Victoria – The preparation of Avalon Coastal Conservation Actions Plan is currently at finalisation stage. The findings will inform the GAEP precinct planning.
- WTOAC – The preparation of Cultural Values Assessment will feed into the GAEP precinct planning process.
- Avalon Airoport – The renewed masterplan is underway which will provide critical information for the GAEP's precinct planning and the investigations by Barwon Water and Melbourne Water.

6.2 Implications for Future Developments

Several knowledge gaps were identified in the first phase of the project which are applicable and impact not only IWM but also general development potential of the area. The following complementary investigations are recommended to inform any needs for new planning controls/policy and support individual developments and infrastructure assessments.

- Environment Impacts
  - The ecological assessment should collect sufficient information of existing condition of the receiving waterbodies, surface/ground water and native vegetation and identify the impacts on environment and any sensitive wetlands.
  - Where there are potential impacts on the national environment significance e.g. RAMSAR sites, a EPBC Act referral should be sought to determine the suitability and extent of the proposed developments.
  - Aquatic habitat assessment with wetland monitoring and assessment should be sought where the proposal is within or within a proximity to coastal reserves, sensitive wetlands and associated waterways and floodplains.
- Coastal Acid Sulphate Soils
  - Where the area is identified as ‘High/Medium Probability of Occurrence of Acid Sulphate Soil’, an Acid Sulphate Soil Hazard Assessment in accordance with the Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulphate Soil should be sought to determine the suitability and extent of the proposal. The Acid Sulphate Soil Hazard Assessment should conclude whether an Acid Sulphate Soil Management Plan is required if the high risk activity is allowed.
  - Acid Sulfate Soil Management Plan should be prepared in accordance with Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soil and EPA Publication 655.1 ‘Acid sulfate soil and rock’, to the satisfaction of the Responsible Authority.
- Drainage and Flooding Management
  - The Drainage and Flooding Management Plan is a site-specific assessment to understand the potential waterway stability/environmental/drainage/flooding problems and constraints arising from their development proposals (including upstream or downstream impacts on existing receiving environments, waterways, land uses and assets/works) and quantify and recommend what target is required to ensure compliance with the eight IWM objectives under this IMWP.
  - The management plan should also include the details on control over stormwater sediment loads and monitoring of same during estate construction works, and demonstrate how the works comply with best practice whilst addressing high construction-era sediment loads, potential acid sulphate soils and dispersive soils management issues.
- Climate Change Impacts

- Where the area is subject to coastal erosion and sea level rise, a Climate Change Impact Assessment should be sought to review the latest information available on climate change predictions/modelling relevant to the site to determine the potential areas prone/loss due to the coastal inundation and erosion.

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WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

APPENDIX A
SITUATIONAL ANALYSIS REPORT

Refer to the attached report.

WATER TECHNOLOGY
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APPENDIX B
DESIGN SPRINT WORKSHOP NOTES

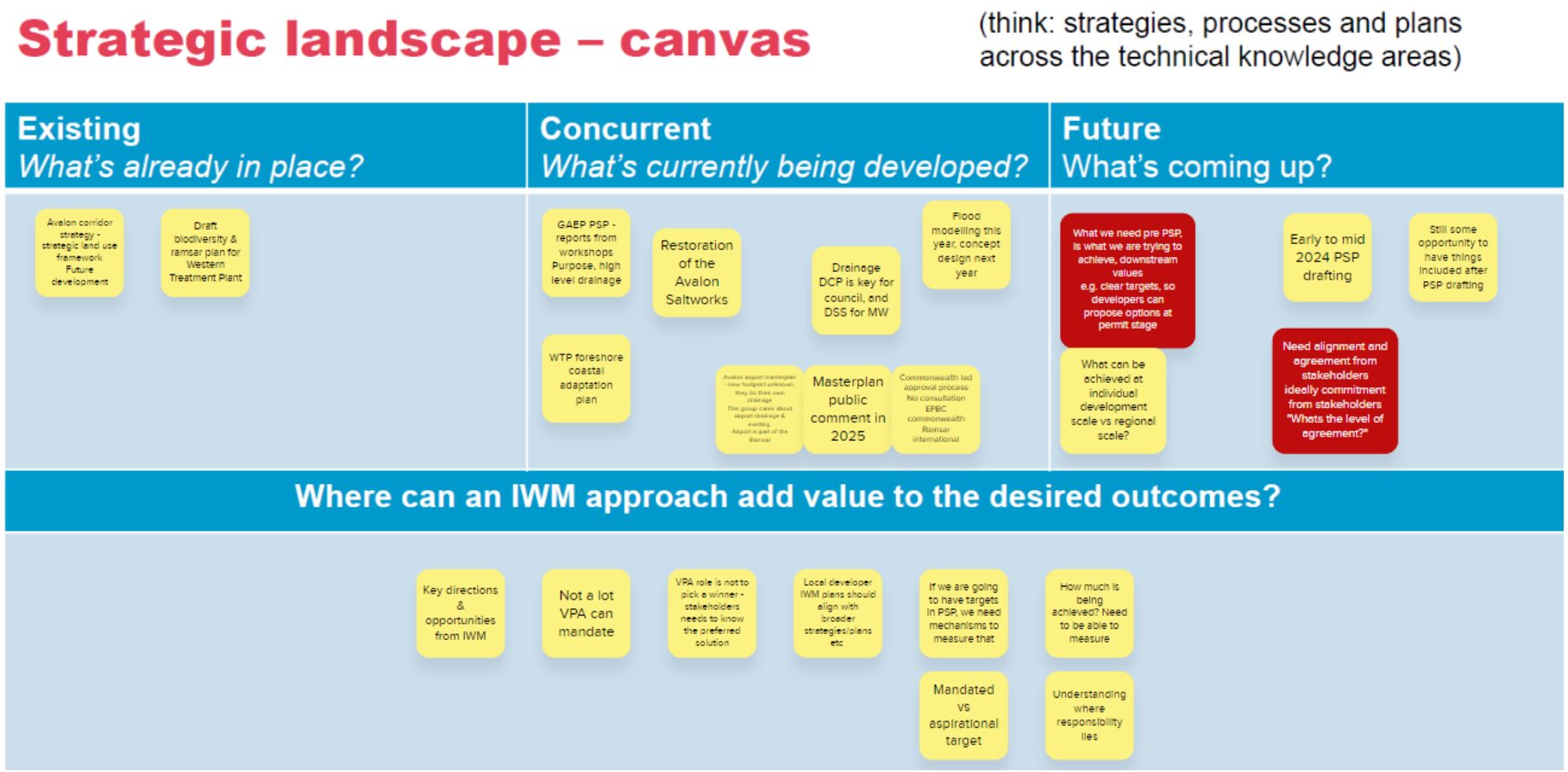
Avalon IWM Design Sprint
(notes from Mural Board)

10/08/2023

- 2.5 hr online design sprint workshop was facilitated by Casey Furlong (DEECA) on 10 August 2023.
- This workshop was attended by representatives from
  - CoGG, BW, CCMA, MW, VPA, DEECA, WT

  - Mural board was set up to capture stakeholder inputs. Mural board can be accessed from the link below.
  - https://teams.microsoft.com/l/message/19:meeting_N2YzMjZiOTAtNjliZi00NGM2LTlkNGQtNDVhNDE5ZDQ3Yzdi@thread.v2/1691630064105?context=%7B%22contextType%22%3A%22chat%22%7D

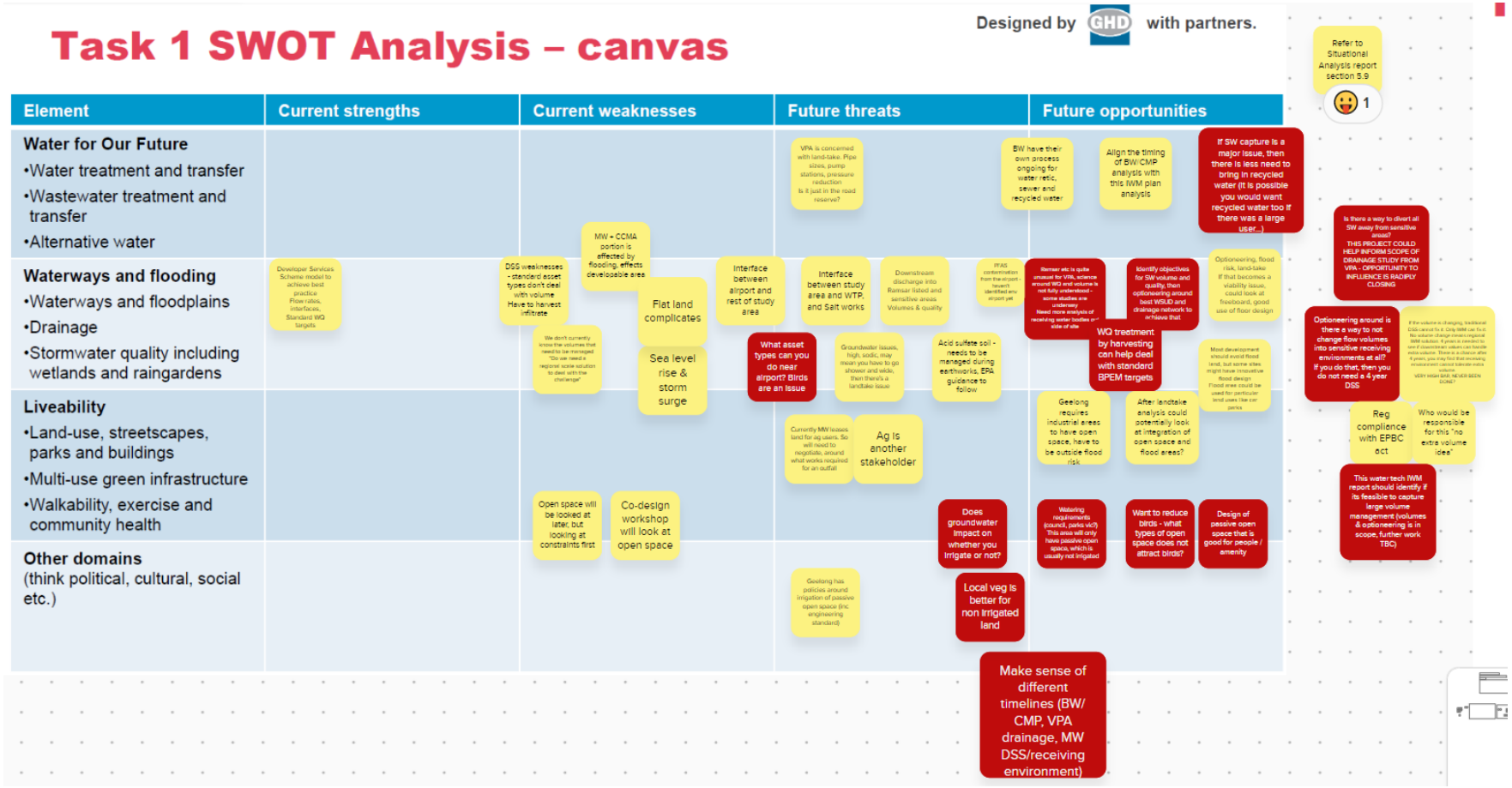
Strategic Landscape - Canvas



Strategic Landscape - Canvas

Existing What's already in place?	**Concurrent** What's currently being developed?	**Future** What's coming up?
Avalon corridor strategy - strategic land use framework Future development Draft biodiversity & ramsar plan for Western Treatment Plant	GAEP PSP - reports from workshops Purpose, high level drainage WTP foreshore coastal adaptation plan Restoration of the Avalon Saltworks Drainage DCP is key for council, and DSS for MW Flood modelling this year, concept design next year Masterplan public comment in 2025 Commonwealth led approval process No consultation EPBC commonwealth Ramsar international Avalon airport masterplan - new footprint unknown, they do their own drainage This group cares about airport drainage & existing Airport is part of the Ramsar	**What we need pre PSP, is what we are trying to achieve, downstream values** **e.g. clear targets, so developers can propose options at permit stage** **Need alignment and agreement from stakeholders ideally commitment from stakeholders** **"Whats the level of agreement?"** Early to mid 2024 PSP drafting Still some opportunity to have things included after PSP drafting What can be achieved at individual development scale vs regional scale?
Where can an IWM approach add value to the desired outcomes?		
Key directions & opportunities from IWM Not a lot VPA can mandate VPA role is not to pick a winner - stakeholders needs to know the preferred solution Local developer IWM plans should align with broader strategies/plans etc If we are going to have targets in PSP, we need mechanisms to measure that How much is being achieved? Need to be able to measure Mandated vs aspirational target Understanding where responsibility lies		

Task 1 SWOT Analysis - canvas



Task 1 SWOT Analysis - canvas

Element	Current strength	Current weaknesses	Future threats	Future opportunities
Water for our future • Water treatment and transfer • Wastewater treatment and transfer • Alternative water			VPA is concerned with land-take. Pipe sizes, pump stations, pressure reduction Is it just in the road reserve?	Refer to situational analysis report section 5.9 BW have their own process ongoing for water retic, sewer and recycled water Align the timing of BW/CMP analysis with this IWM plan analysis **If SW capture is a major issue, then there is less need to bring in recycled water (it is possible you would want recycled water too if there was a large user...)**

Task 1 SWOT Analysis - canvas

Element	Current strength	Current weaknesses	Future threats	Future opportunities
Waterways and flooding • Waterways and floodplains • Drainage • Stormwater quality including wetlands and raingardens	Developer Services Scheme model to achieve best practice Flow rates, interfaces, Standard WQ targets	DSS weaknesses - standard asset types don't deal with volume Have to harvest infiltrate We don't currently know the volumes that need to be managed "Do we need a regional scale solution to deal with the challenge" MW + CCMA portion is affected by flooding, effects developable area Flat land complicates Sea level rise & storm surge	Interface between airport and rest of study area Interface between study area and WTP, and Salt works **What asset types can you do near airport? Birds are an issue** Downstream discharge into Ramsar listed and sensitive areas Volumes & quality PFAS contamination from the airport - haven't identified env airport yet Acid sulfate soil - needs to be managed during earthworks, EPA guidance to follow Groundwater issues, high, sodic, may mean you have to go shower and wide, then there's a landtake issue	**Ramsar etc is quite unusual for VPA, science around WQ and volume is not fully understood - some studies are underway** **Need more analysis of receiving water bodies out side of site** **Identify objectives for SW volume and quality, then optioneering around best WSUD and drainage network to achieve that** **WQ treatment by harvesting can help deal with standard BPEM targets** **Is there a way to divert all SW away from sensitive areas?** **THIS PROJECT COULD HELP INFORM SCOPE OF DRAINAGE STUDY FROM VPA - OPPORTUNITY TO INFLUENCE IS RADIPLY CLOSING** **Optioneering around is there a way to not change flow volumes into sensitive receiving environments at all? If you do that, then you do not need a 4 year DSS**

Task 1 SWOT Analysis - canvas

Element	Current strength	Current weaknesses	Future threats	Future opportunities
Waterways and flooding • Waterways and floodplains • Drainage • Stormwater quality including wetlands and raingardens				**This water tech IWM report should identify if its feasible to capture large volume management (volumes & optioneering is in scope, further work TBC)** If the volume is changing, traditional DSS cannot fix it. Only IWM can fix it. No volume change means regional IWM solution. 4 years is needed to see if downstream values can handle extra volume. There is a chance after 4 years, you may find that receiving environment cannot tolerate extra volume. VERY HIGH BAR, NEVER BEEN DONE?

Task 1 SWOT Analysis - canvas

Element	Current strength	Current weaknesses	Future threats	Future opportunities
Waterways and flooding • Waterways and floodplains • Drainage • Stormwater quality including wetlands and raingardens				Optioneering, flood risk, land-take If that becomes a viability issue, could look at freeboard, good use of floor design Most development should avoid flood land, but some sites might have innovative flood design Flood area could be used for particular land uses like car parks Who would be responsible for this "no extra volume idea" Reg compliance with EPBC act

Task 1 SWOT Analysis - canvas

Element	Current strength	Current weaknesses	Future threats	Future opportunities
Liveability Land-use, streetscapes, parks and buildings Multi-use green infrastructure Walkability, exercise and community health	Co-design workshop will look at open space Open space will be looked at later, but looking at constraints first	Currently MW leases land for ag users. So will need to negotiate, around what works required for an outfall Ag is another stakeholder		Geelong requires industrial areas to have open space, have to be outside flood risk After landtake analysis could potentially look at integration of open space and flood areas?
Other domains • (think political, cultural and social etc.)	Geelong has policies around irrigation of passive open space (inc engineering standard)		**Does groundwater impact on whether you irrigate or not?** **Watering requirements (council, parks vic?)** **This area will only have passive open space, which is usually not irrigated** **Want to reduce birds - what types of open space does not attract birds?** **Make sense of different timelines (BW/CMP, VPA drainage, MW DSS/receiving environment)**	**Local veg is better for non irrigated land** **Design of passive open space that is good for people / amenity**

General – Salt works site

General

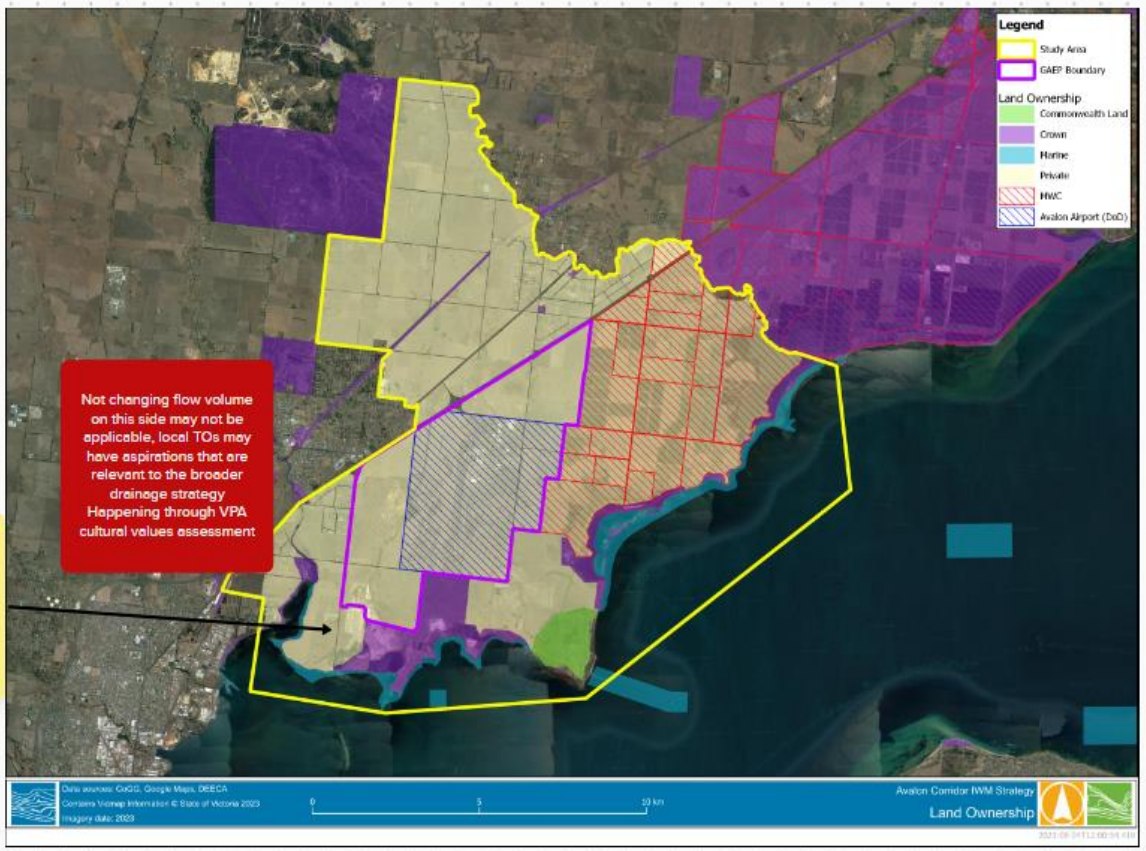
Water and river policy of Paleert Taara Djа: Wadawurrung Country Plan

Potential ASS identified by VPA LCA

Pre-1750 grassy woodland/ forest and downstream saltmarsh as natural and cultural heritage significance - restoration/recovery strategy for cultural values to be investigated

Wetland as a potential incompatible use with airport operations

Salt works in SW area of PSP



General – Salt works site

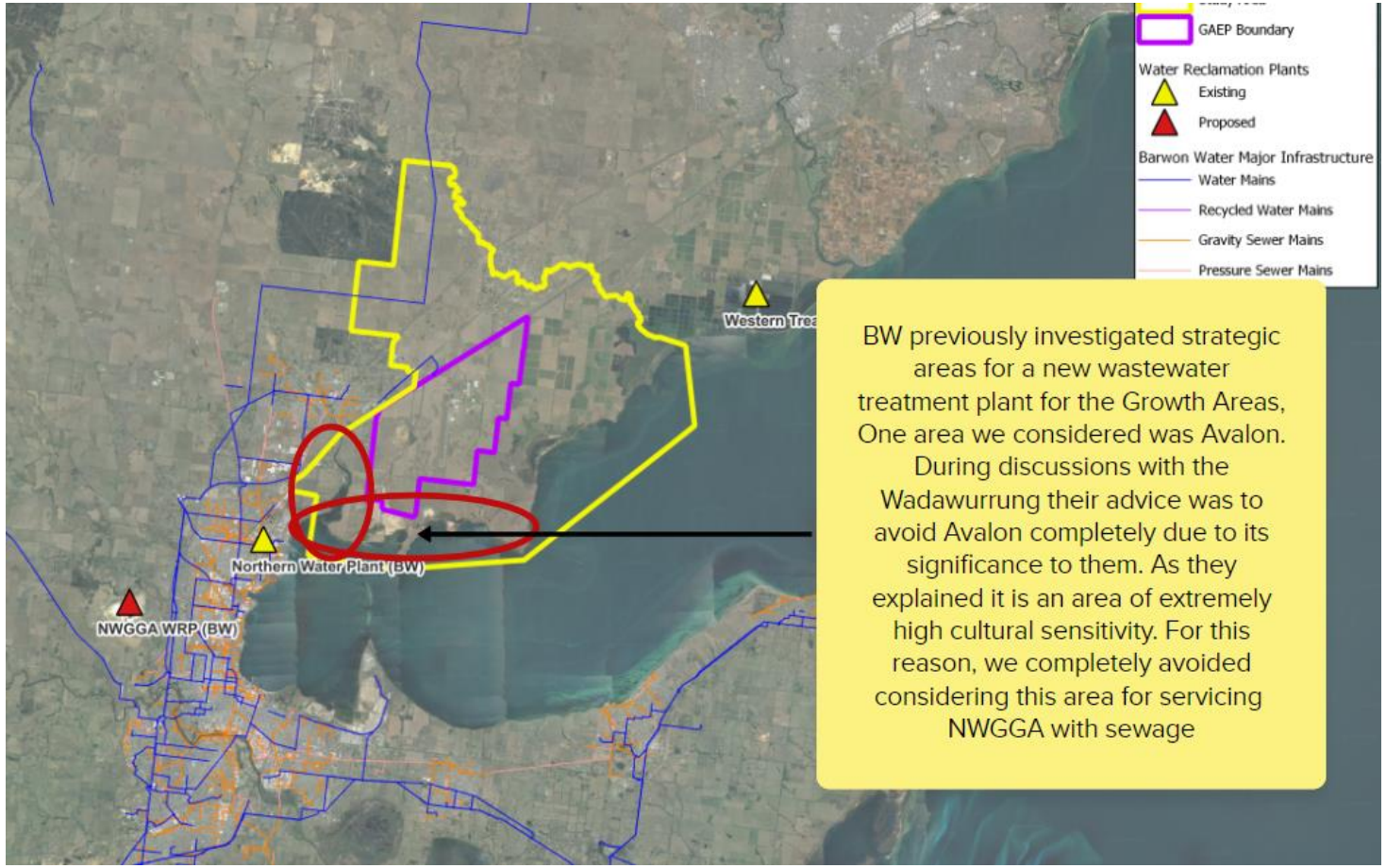
- Salt works in SW area of PSP
- **Not changing flow volume on this side may not be applicable, local TOs may have aspirations that are relevant to the broader drainage strategy**
- **Happening through VPA cultural values assessment**
- Pre-1750 grassy woodland/forest and downstream saltmarsh as natural and cultural heritage significance - restoration/recovery strategy for cultural values to be investigated
- Water and river policy of Paleert Taara Dja: Wadawurrung Country Plan
- Potential ASS identified by VPA LCA
- Wetland as a potential incompatible use with airport operations

General Notes

General Notes

- VPA is going to lead that work with MW - joint consulting brief
- Limited ability to do robust new drainage in leased ag land
- Bay outfall may require tougher approvals than to a river (DEECA approval)
- Biggest issue is the science around existing wetlands etc and what they can handle in terms of volume and WQ
- Science (eco hydrology) should inform next steps for IWM
- DSS is in early planning stages - this will have background investigations (DSS could be a 4 year project)
- Consultants are busy at the moment
- 4 year DSS could be a bit of an issue for PSP
- This study should include some key pointers, graphical representation of site constraints
- VPA need to do a scope for flood modelling, this IWM plan needs to give pointers for that

Water Supply



Water Supply

- BW previously investigated strategic areas for a new wastewater treatment plant for the Growth Areas, One area we considered was Avalon. During discussions with the Wadawurrung their advice was to avoid Avalon completely due to its significance to them. As they explained it is an area of extremely high cultural sensitivity. For this reason, we completely avoided considering this area for servicing NWGGA with sewage

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

APPENDIX C
IWM OPTION DETAILS

C-1 Key Assumptions

C-1-1 General

GAEP Water Demand Estimate

GAEP Industrial Non-potable Water Demand

Developable area	=	1026	ha
Proportion of high-demand users	=	0.25	
Proportion of low-demand users	=	0.75	
Usage Rate - High users	=	2.0	ML/ha/year (Equivalent to Highest water potable users in FY21)
Usage Rate - Low users	=	0.1	ML/ha/year (Equivalent to GREP usage)
Total Potable Water Demand	=	624	ML/year

GAEP Passive Open Space Irrigation Water Demand

Developable area	=	1026	ha
Proportion of Local Parks	=	0.02	
Passive Open space	=	20.5	ha
Open Space Irrigation rate	=	2	ML/ha/year
Open Space Irrigation Demand	=	41	ML/ha

GAEP Street Tree Irrigation Water Demand

Developable area	=	1026	ha
No. of Street Trees per ha	=	20	trees/ha
No. of Street Trees	=	20520	
Mature tree water demand	=	75	L/day/tree
Street Irrigation demand	=	562	ML/year

GAEP Water Demand Estimate	=	1,227	ML/year

C-1-2 Option-Specific

Table C-1 IWM Options – Modelling Assumptions

Option ID	Short Description	Key Assumptions
1	Mandatory rainwater harvesting for indoor non-potable uses (industrial/commercial) at each development lot	270 lots with an average lot size of 3.85 ha. Average tank size 60 kL 25% of the lot is covered with the roof and 100% of the roof is connected to the rainwater tank Reuse demand 624 ML/year (1026 ha developable area, 25% of the users would be high water users with 2 ML/year/ha and the remainder is low demand users (equivalent to GREP usage) 0.13 ML/year/ha) 50% of the industrial potable water demands can be substituted from an alternative water source
2	Each industrial/commercial lot has its own raingarden for stormwater treatment	270 lots with an average lot size of 3.85 ha. Average raingarden size 130 m^2/lot (treatment area equivalent to 0.3% of the lot area)
3	Passive irrigation of street trees by stormwater	2,000 trees per 100 ha of developable area (NWGGA IWMP) 15 ML/year of evapotranspiration losses and 16 ML/year of infiltration per 100 ha of developable area (NWGGA IWMP) Potable water substitution = ET loss + Infiltration Loss
4	Stormwater treatment to achieve BPEM targets by GPTs and Biofilters (no reuse)	Only developable areas are treated by WSUD GPT performance equivalent to HumeGard® GPT Biofilter treatment area equivalent to 0.2% of the developable area
5	Stormwater treatment to achieve BPEM targets by sediment ponds and wetlands (no reuse)	Only developable areas are treated by WSUD Sediment pond sized to achieve 1 in 5 year cleanout frequency Wetland and sediment pond treatment area equivalent to 3% of the developable area
6	Stormwater Treatment to achieve EPA Vic harvest target by wetlands and agricultural reuse (with open storage)	Only developable areas are treated by WSUD Sediment pond sized to achieve 1 in 5 year cleanout frequency Wetland and sediment pond treatment area equivalent to 5% of the developable area Evaporation pond is sized to 6% of the developable area 100% of the agricultural demand can be substituted from alternative water sources Agricultural demand occurs seasonally from Oct to Apr (Oct 1%, Nov 13%, Dec 24%, Jan 29%, Feb 19%, Mar 13%, Apr 1%)

Option ID	Short Description	Key Assumptions
7	Stormwater Treatment to achieve EPA Vic harvest target by wetlands and industrial/commercial reuse (with closed storage)	Only developable areas are treated by WSUD Sediment pond sized to achieve 1 in 5 year cleanout frequency Wetland and sediment pond treatment area equivalent to 5% of the developable area There is sufficient external demand for stormwater Industrial water demands are equally distributed over the year in contrast to seasonal irrigation demands High supply reliability (95%) for industrial water demands
8	Stormwater Treatment to achieve EPA Vic harvest target by biofilters and industrial/commercial reuse (with closed storage)	Only developable areas are treated by WSUD GPT performance equivalent to HumeGard® GPT Biofilter treatment area equivalent to 2% of the developable area There is sufficient external demand for stormwater Industrial water demands are equally distributed over the year in contrast to seasonal irrigation demands High supply reliability (95%) for industrial water demands
9	Stormwater Treatment to achieve no net increase in volume target by wetlands and agricultural reuse (with open storage)	Only developable areas are treated by WSUD Sediment pond sized to achieve 1 in 5 year cleanout frequency Wetland and sediment pond treatment area equivalent to 8% of the developable area Evaporation pond sized to 8% of the developable area Agricultural demand occurs seasonally from Oct to Apr (Oct 1%, Nov 13%, Dec 24%, Jan 29%, Feb 19%, Mar 13%, Apr 1%)
10	Stormwater Treatment to achieve no net increase in volume target by wetlands and industrial/commercial reuse (with closed storage)	Only developable areas are treated by WSUD Sediment pond sized to achieve 1 in 5 year cleanout frequency Wetland and sediment pond treatment area equivalent to 5% of the developable area There is sufficient external demand for stormwater Industrial water demands are equally distributed over the year in contrast to seasonal irrigation demands High supply reliability (95%) for industrial water demands
11	Stormwater Treatment to achieve no net increase in volume target by biofilters and industrial/commercial reuse (with closed storage)	Only developable areas are treated by WSUD GPT performance equivalent to HumeGard® GPT Biofilter treatment area equivalent to 2% of the developable area There is sufficient external demand for stormwater Industrial water demands are equally distributed over the year in contrast to seasonal irrigation demands High supply reliability (95%) for industrial water demands

Option ID	Short Description	Key Assumptions
12	Stormwater treatment to achieve BPEM targets by wetlands and discharge excess stormwater runoff via an ocean outfall	Stormwater is treated to BPEM targets before diverting to ocean outfall. Only excess stormwater volume will be transferred to ocean outfall.
13	Local wastewater treatment and reuse for non-potable industrial/commercial uses	80% of the wastewater will be available as recycled water
14	Stormwater treatment for potable reuse	Council drainage network has sufficient capacity to accept GAEP flows. Stormwater is treated to BPEM targets before diverting to regional treatment plant. Only excess stormwater volume will be transferred to regional treatment plant. 10% of the stormwater will be available as recycled water (based WTP wastewater inflow and recycled water volume from 2013-2019)
15	Wastewater treatment and reuse via Barwon Water's existing recycled water network	Regional treatment plant has sufficient capacity to accept GAEP flows. 10% of the wastewater will be available as recycled water (based WTP wastewater inflow and recycled water volume from 2013-2019)
16	Wastewater treatment and reuse via WTP	Regional treatment plant has sufficient capacity to accept GAEP flows. 10% of the wastewater will be available as recycled water (based WTP wastewater inflow and recycled water volume from 2013-2019)
17	Shandied supply of treated stormwater and wastewater via Barwon Water's existing recycled water network	Regional treatment plant has sufficient capacity to accept GAEP flows. Stormwater is treated to BPEM targets before diverting to regional treatment plant. Only excess stormwater volume will be transferred to regional treatment plant. 10% of the influent will be available as recycled water (based WTP wastewater inflow and recycled water volume from 2013-2019)
18	Shandied supply of treated stormwater and wastewater via WTP	Regional treatment plant has sufficient capacity to accept GAEP flows. Stormwater is treated to BPEM targets before diverting to regional treatment plant. Only excess stormwater volume will be transferred to regional treatment plant. 10% of the influent will be available as recycled water (based WTP wastewater inflow and recycled water volume from 2013-2019)

Table C-2 Option Matrix

ID	Source Water	Scale	Protect and enhance the health of receiving environments				Provide secure and sustainable water services		Support the liveability of the places we live and work				Cost Factors A: Advantage D: Disadvantage	Risks
			Reduce stormwater runoff volume (ML/year)	Improve stormwater runoff quality	Avoid wastewater discharge to the environment	Habitat for migratory bird population	Reduce potable water consumption (ML/year)	No. of alternative water supplies	Opportunity to integrate WSUD assets with public open spaces	Passive irrigation of street trees and open spaces	Reduce wildlife strike hazard around the airport	Flood risk (peak flow and volume)		
1	RW	Lot	270	L	L	L	270	M	L	L	H	M	A: downsize precinct WSUD; A: delay water supply augmentation	Planning permit conditions will be required Private asset Asset failure over time due to lack of maintenance WQ risks
2	SW	Lot	62	M	L	L	-	L	L	L	H	L	A: downsize precinct WSUD	Planning permit conditions will be required Private asset Asset failure over time due to lack of maintenance WQ risks
3	SW	Streetscape	318	L	L	L	318	M	M	H	H	L	A: downsize precinct WSUD A: delay water supply augmentation D: specialised kerb inlet and storage	Organisation capacity
4	SW	Precinct	30	M	L	L	-	L	H	L	H	L	D: proprietary GPTs D: distributed WSUD D: potential pumped outfalls	Insufficient hydraulic gradient Significantly large no. of assets/maintenance burden Well below the target volume reduction and WQ load reduction

ID	Source Water	Scale	Protect and enhance the health of receiving environments				Provide secure and sustainable water services		Support the liveability of the places we live and work				Cost Factors A: Advantage D: Disadvantage	Risks
			Reduce stormwater runoff volume (ML/year)	Improve stormwater runoff quality	Avoid wastewater discharge to the environment	Habitat for migratory bird population	Reduce potable water consumption (ML/year)	No. of alternative water supplies	Opportunity to integrate WSUD assets with public open spaces	Passive irrigation of street trees and open spaces	Reduce wildlife strike hazard around the airport	Flood risk (peak flow and volume)		
5	SW	Precinct	330	M	L	H	-	L	H	L	L	L	A: co-located retention and harvesting asset	WQ and public health risks Well below the target volume reduction and WQ load reduction
6	SW	Precinct	2,746	M	L	H	1,725	M	H	L	L	H	A: co-located retention and harvesting asset A: delay water supply augmentation D: pumped main to supply agricultural land north of Princess Highway D: significant asset footprint	Uncertain agricultural demand WQ risks Large asset footprint Potentially below the target volume reduction and WQ load reduction
7	SW	Precinct	2,748	M	L	M	2,094	M	H	L	L	H	A: local reuse A: delay water supply augmentation D: significant asset footprint D: potential pumped transfer to external users	Significant reliance on external demands WQ and public health risks Large asset footprint Potentially below the target volume reduction and WQ load reduction

ID	Source Water	Scale	Protect and enhance the health of receiving environments				Provide secure and sustainable water services		Support the liveability of the places we live and work				Cost Factors A: Advantage D: Disadvantage	Risks
			Reduce stormwater runoff volume (ML/year)	Improve stormwater runoff quality	Avoid wastewater discharge to the environment	Habitat for migratory bird population	Reduce potable water consumption (ML/year)	No. of alternative water supplies	Opportunity to integrate WSUD assets with public open spaces	Passive irrigation of street trees and open spaces	Reduce wildlife strike hazard around the airport	Flood risk (peak flow and volume)		
8	SW	Precinct	2,736	M	L	L	2,450	M	H	L	H	L	A: delay water supply augmentation D: distributed WSUD D: underground storage/shallow groundwater D: potential pumped transfer to external users	Reliability of stormwater supply could be an issue for industrial uses Large asset footprint Insufficient hydraulic gradient Significantly large no. of assets/maintenance burden Significant reliance on external demands Potentially below the target volume reduction and WQ load reduction
9	SW	Precinct	3,172	H	L	H	1,780	M	H	L	L	H	A: delay water supply augmentation A: co-located retention and harvesting asset D: pumped main to supply agricultural land north of Princess Highway D: significant asset footprint	Uncertain agricultural demand WQ risks Large asset footprint Organisation capacity and commitment (unprecedently high target)

ID	Source Water	Scale	Protect and enhance the health of receiving environments				Provide secure and sustainable water services		Support the liveability of the places we live and work				Cost Factors A: Advantage D: Disadvantage	Risks
			Reduce stormwater runoff volume (ML/year)	Improve stormwater runoff quality	Avoid wastewater discharge to the environment	Habitat for migratory bird population	Reduce potable water consumption (ML/year)	No. of alternative water supplies	Opportunity to integrate WSUD assets with public open spaces	Passive irrigation of street trees and open spaces	Reduce wildlife strike hazard around the airport	Flood risk (peak flow and volume)		
10	SW	Precinct	3,161	H	L	M	2,512	M	H	L	L	H	A: delay water supply augmentation D: underground storage/shallow groundwater D: potential pumped transfer to external users D: significant asset footprint	Reliability of stormwater supply could be an issue for industrial uses Large asset footprint Significant reliance on external demands Organisation capacity and commitment (unprecedently high target)
11	SW	Precinct	3,163	H	L	L	2,947	M	H	L	H	L	A: delay water supply augmentation D: underground storage/shallow groundwater D: potential pumped transfer to external users D: significant asset footprint D: distributed WSUD	Reliability of stormwater supply could be an issue for industrial uses Large asset footprint Insufficient hydraulic gradient Significantly large no. of assets/maintenance burden Significant reliance on external demands Organisation capacity and commitment (unprecedently high target)
12	SW	Precinct	3,161	M	L	M	-	L	H	L	H	L	D: approvals, shallow groundwater D: potential pumped outfall with additional storage	Environmental risks (disturbance to the sensitive downstream environment) Need for approval could delay the implementation

ID	Source Water	Scale	Protect and enhance the health of receiving environments				Provide secure and sustainable water services		Support the liveability of the places we live and work				Cost Factors A: Advantage D: Disadvantage	Risks
			Reduce stormwater runoff volume (ML/year)	Improve stormwater runoff quality	Avoid wastewater discharge to the environment	Habitat for migratory bird population	Reduce potable water consumption (ML/year)	No. of alternative water supplies	Opportunity to integrate WSUD assets with public open spaces	Passive irrigation of street trees and open spaces	Reduce wildlife strike hazard around the airport	Flood risk (peak flow and volume)		
13	WW	Precinct	-	L	H	L	474	M	L	L	H	L	A: delay water supply augmentation D: most likely a package-type treatment plant without open water storages	Uncertain local demand Organisation capacity WQ and public health risks
14	SW	Regional	3,161	H	L	L	316	M	L	L	H	L	D: pumped connection to existing network D: potential upgrades to the existing network	Current policies do not support this potable water augmentation
15	WW	Regional	-	L	H	L	59	M	L	L	H	L	A: delay water supply augmentation D: pressure sewer	Existing network may not have the capacity to convey Avalon flows
16	WW	Regional	-	L	M	H	59	M	L	L	H	L	A: delay water supply augmentation; A: WTP proximity D: approvals/shallow groundwater;	Environmental risks (WTP is a RAMSAR site). Additional assessment may be needed Need for agreement with MW Potential implementation delays
17	SW+ WW	Regional	3,161	H	H	L	375	H	L	L	H	L	A: WSUD downsize A: delay water supply augmentation D: pressure sewer D: existing network upgrade or additional local storage	Existing network may not have the capacity to convey Avalon flows

ID	Source Water	Scale	Protect and enhance the health of receiving environments				Provide secure and sustainable water services		Support the liveability of the places we live and work				Cost Factors A: Advantage D: Disadvantage	Risks
			Reduce stormwater runoff volume (ML/year)	Improve stormwater runoff quality	Avoid wastewater discharge to the environment	Habitat for migratory bird population	Reduce potable water consumption (ML/year)	No. of alternative water supplies	Opportunity to integrate WSUD assets with public open spaces	Passive irrigation of street trees and open spaces	Reduce wildlife strike hazard around the airport	Flood risk (peak flow and volume)		
18	SW+ WW	Regional	3,161	H	M	H	375	H	L	L	H	L	A: delay water supply augmentation A: WTP proximity A: WSUD downsize D: existing network upgrade or additional local storage	Environmental risks (WTP is a RAMSAR site). Additional assessment may be needed Need for agreement with MW Potential implementation delays

Table C-3 Environmental Risks and Impacts of IWM Options

Option ID	Short Description	Environmental Risks	Impact
1	Mandatory rainwater harvesting for indoor non-potable uses (industrial/commercial) at each development lot	Low risk, unless noxious contaminants mixed with non-potable water	Pollutants into RAMSAR impacting bird and marine life FFG/EPBC Act considerations
2	Each industrial/commercial lot has its own raingarden for stormwater treatment	Low risk, unless malfunction or blockage creates overflow into waterways.	Pollutant or sediment loads into RAMSAR, WTP, FFG/EPBC Act considerations
3	Passive irrigation of street trees by stormwater	Low risk, would reflect a common scenario. Surplus runoff into waterways.	Pollutant or sediment loads into RAMSAR, WTP, FFG/EPBC Act considerations
4	Stormwater treatment to achieve BPEM targets by GPTs and Biofilters (no reuse)	Low-moderate risk of CASS disturbance in identified areas during construction	Contamination of vegetation and surrounding wetlands/waterways
5	Stormwater treatment to achieve BPEM targets by sediment ponds and wetlands (no reuse)	Low-moderate risk of CASS disturbance in identified areas during construction	Contamination of vegetation and surrounding wetlands/waterways
6	Stormwater Treatment to achieve EPA Vic harvest target by wetlands and agricultural reuse (with open storage)	Low-moderate risk of CASS disturbance in identified areas during construction	Contamination of vegetation and surrounding wetlands/waterways
7	Stormwater Treatment to achieve EPA Vic harvest target by wetlands and industrial/commercial reuse (with closed storage)	Low-moderate risk of CASS disturbance in identified areas during construction	Contamination of vegetation and surrounding wetlands/waterways
8	Stormwater Treatment to achieve EPA Vic harvest target by biofilters and industrial/commercial reuse (with closed storage)	Low-moderate risk of CASS disturbance in identified areas during construction Low-moderate risk of threatened species colonising sediment ponds	Pollutant or sediment loads into RAMSAR, WTP, FFG/EPBC Act considerations
9	Stormwater Treatment to achieve no net increase in volume target by wetlands and agricultural reuse (with open storage)	Low-moderate risk of CASS disturbance in identified areas Low-moderate risk of threatened species colonising sediment ponds	Pollutant or sediment loads into RAMSAR, WTP, FFG/EPBC Act considerations
10	Stormwater Treatment to achieve no net increase in volume target by wetlands and industrial/commercial reuse (with closed storage)	low-moderate risk- failure of biofilter to capture contaminants.	Pollutant or sediment loads into RAMSAR, WTP, FFG/EPBC Act considerations
11	Stormwater Treatment to achieve no net increase in volume target by biofilters and industrial/commercial reuse (with closed storage)	Moderate risk - runoff into the bay (stormwater impacting marine environment)	Pollutant or sediment loads into RAMSAR, WTP, FFG/EPBC Act considerations
12	Stormwater treatment to achieve BPEM targets by wetlands and discharge excess stormwater runoff via an ocean outfall	Moderate risk- industrial/commercial reuse.	Pollutants, detergents chemicals into waterways
13	Local wastewater treatment and reuse for non-potable industrial/commercial uses	Moderate risk- industrial/commercial reuse.	Pollutants, detergents chemicals into waterways
14	Stormwater treatment for potable reuse	Wastewater treatment Moderate risk- increase of water into WTP site. Reuse- low risk, runoff from reused water or contamination of land from biosolids.	Pollutant, sediment and nutrient loads increased, may impact migratory bird, frog and fish habitat, nutrient loads increasing vegetation growth and increased nutrients from veg breakdown.
15	Wastewater treatment and reuse via Barwon Water's existing recycled water network	Low risk, unless increased capacity to existing facility creates surplus drainage into waterways	Pollutant, sediment and nutrient loads increased, may impact migratory bird, frog and fish habitat, nutrient loads increasing vegetation growth and increased nutrients from veg breakdown.
16	Wastewater treatment and reuse via WTP	Consider sea level rise -modelled rise considerations around low lying areas (e.g. WTP)	Hydrological changes to habitat
17	Shandied supply of treated stormwater and wastewater via Barwon Water's existing recycled water network	Low risk, unless noxious contaminants mixed with non-potable water	Pollutants into RAMSAR impacting bird and marine life FFG/EPBC Act considerations
18	Shandied supply of treated stormwater and wastewater via WTP	Low risk, unless malfunction or blockage creates overflow into waterways.	Pollutant or sediment loads into RAMSAR, WTP FFG/EPBC Act considerations

Table C-4 Portfolio Matrix

ID	Source Water	Scale	Protect and enhance the health of receiving environments				Provide secure and sustainable water services		Support the liveability of the places we live and work				Cost Factors	Risk Factors
			Reduce stormwater runoff volume (ML/year)	Improve stormwater runoff quality	Avoid wastewater discharge to the environment	Habitat for migratory bird population	Reduce potable water consumption (ML/year)	No. of alternative water supplies	Opportunity to integrate WSUD assets with public open spaces	Passive irrigation of street trees and open spaces	Reduce wildlife strike hazard around the airport	Flood risk (peak flow and volume)		
P1	RW+SW+WW	Lot+streetscape+precinct	3,225	H	H	H	3,691	H	H	H	H	M	Refer to Table C-2	Refer to Table C-2
P2	SW+WW	Streetscape+precinct	3,172	H	H	H	2,573	M	H	H	L	H	Refer to Table C-2	Refer to Table C-2
P3	SW+WW	Streetscape+precinct+regional	3,172	H	M	H	2,158	M	H	H	L	H	Refer to Table C-2	Refer to Table C-2
P4	RW+SW+WW	Lot+precinct	3,016	H	H	H	2,469	H	H	L	L	H	Refer to Table C-2	Refer to Table C-2
P5	RW+SW+WW	Lot+precinct	3,018	H	H	H	2,838	H	H	L	L	H	Refer to Table C-2	Refer to Table C-2

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