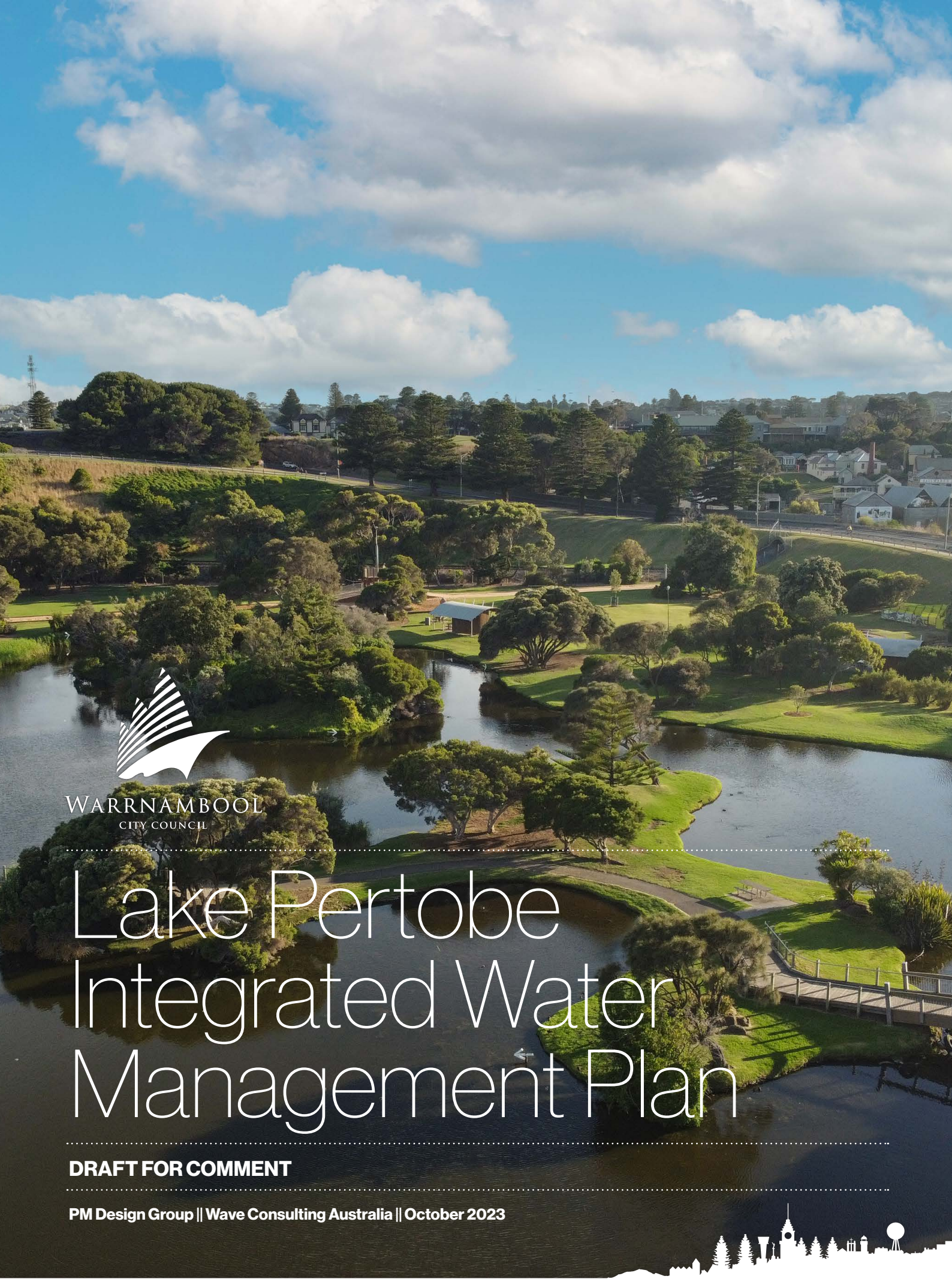


WARRNAMBOOL
CITY COUNCIL

Lake Pertobe Integrated Water Management Plan

DRAFT FOR COMMENT

PM Design Group || Wave Consulting Australia || October 2023

Pareeyt Poondee-teeyt.
Water is Life.
Dhauwurd Wurrung language group

Pa poonteeyt paman paman.
And life is sacred.
Keerray Wurrung language group

Integrated Water Management is a collaborative approach to water planning and management that brings together organisations with an interest in all aspects of the water cycle.

It has the potential to provide greater value to our communities by identifying and leveraging opportunities to optimise outcomes.

Source: Great South Coast Strategic Directions Statement October 2019

Acknowledgements

Lake Pertobe is situated on the lands of the Traditional Owners, the Eastern Maar People and Aboriginal communities of the Maar Nation.

This project was supported by the Victorian Government.

The Working Group included:
Warrnambool City Council (WCC)
Wannon Water (WW)
Eastern Maar Aboriginal Corporation (EMAC)
Department Energy, Environment and Climate Action (DEECA)
Southern Rural Water (SRW)
Glenelg Hopkins Catchment Management Authority (GHCMA)

Version: 1.4
Distributed: 6 November 2023
All photos and images by PM Design and Wave Consulting unless otherwise stated.

Executive Summary

The Lake Pertobe precinct in Warrnambool holds significant potential for Integrated Water Management (IWM) within its highly regarded open space.

The IWM process, involving stakeholder engagement and community consultation, has highlighted key aspects of Lake Pertobe, specifically its low-lying lakes and land, the substantial influx of over 1000 ML of stormwater per year, and the utilization of potable water for irrigation. Notably, recent weather patterns, characterized by two years of relatively cool conditions and above-average rainfall (in 2021 and 2022), have shifted the community's focus towards flooding and drainage issues, with water security and scarcity taking a backseat. It is worth noting that the path between the Mill and Main Lakes was temporarily closed during the development of this IWM Plan due to these concerns.

Key opportunities for Lake Pertobe's IWM strategy include enhancements in treatment, storage, and flow control within the lakes, as well as harnessing stormwater resources. Furthermore, the plan identifies prospects for education and recreation and introduces initiatives in the catchment area to promote rainwater infiltration, thereby restoring a more natural, predevelopment water cycle.

To effectively address these opportunities, it is essential to bridge knowledge gaps, which include the direct measurement of stormwater flows, monitoring changes in lake and groundwater levels over time, and assessing water and sediment quality. The acquisition of improved data and information will not only support the management of water resources in Lake Pertobe but will also facilitate more comprehensive planning of identified initiatives, including the construction of a new water basin, enhancements to lake connectivity and levels, improved public access to recreational water activities, and community education on the intrinsic value of water.

IWM for future generations

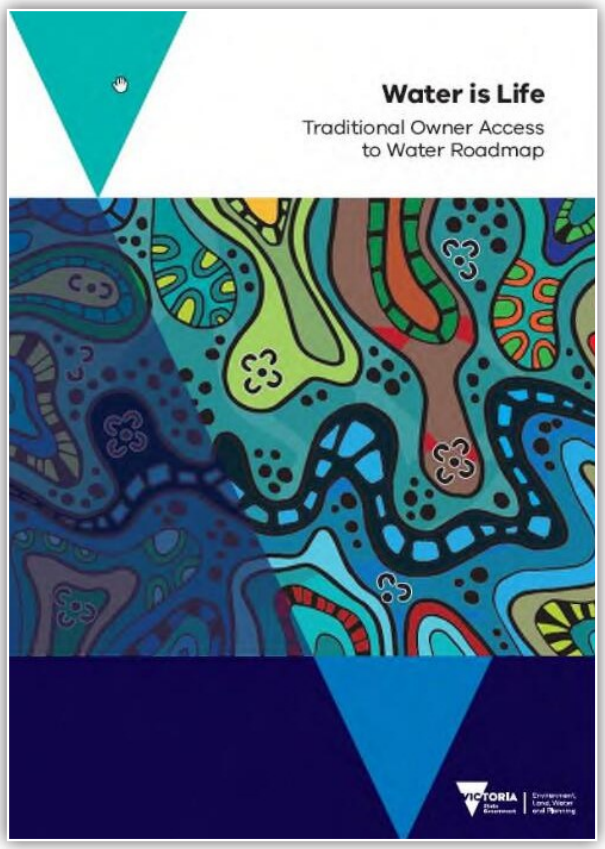
Parreeyt (Water)

Water is Life is a pathway to genuine, meaningful outcomes for Traditional Owners. Water is Life recognises the central importance of the relationship between people and Country, embodied in the cultural water paradigm. Cultural water means water entitlements controlled or held by Traditional Owner Nations to benefit a range of outcomes as determined by each Traditional Owner group. Caring for Country and water can deliver thriving cultural economies and benefits for Traditional Owners, existing entitlement holders, and all Victorians.

Summary from Water is life: Traditional owner access to water Roadmap

Parreeyt is our lifeblood and as Maar people have always had a strong spiritual connection to it. For us, we continue to remain resilient to fight and care for these waters today. Let's hope we can all work together to fix the land and water issues of the past, for our future' generations to enjoy.

Eastern Maar Traditional Owner.



1. Introduction

The Warrnambool Lake Pertobe precinct is described as a highly valued open space.

Following the successful completion of the Albert Park precinct Integrated Water Management Plan in 2019, Lake Pertobe was identified to have great potential for integrated water management (IWM) in 2022, given its characteristics including;

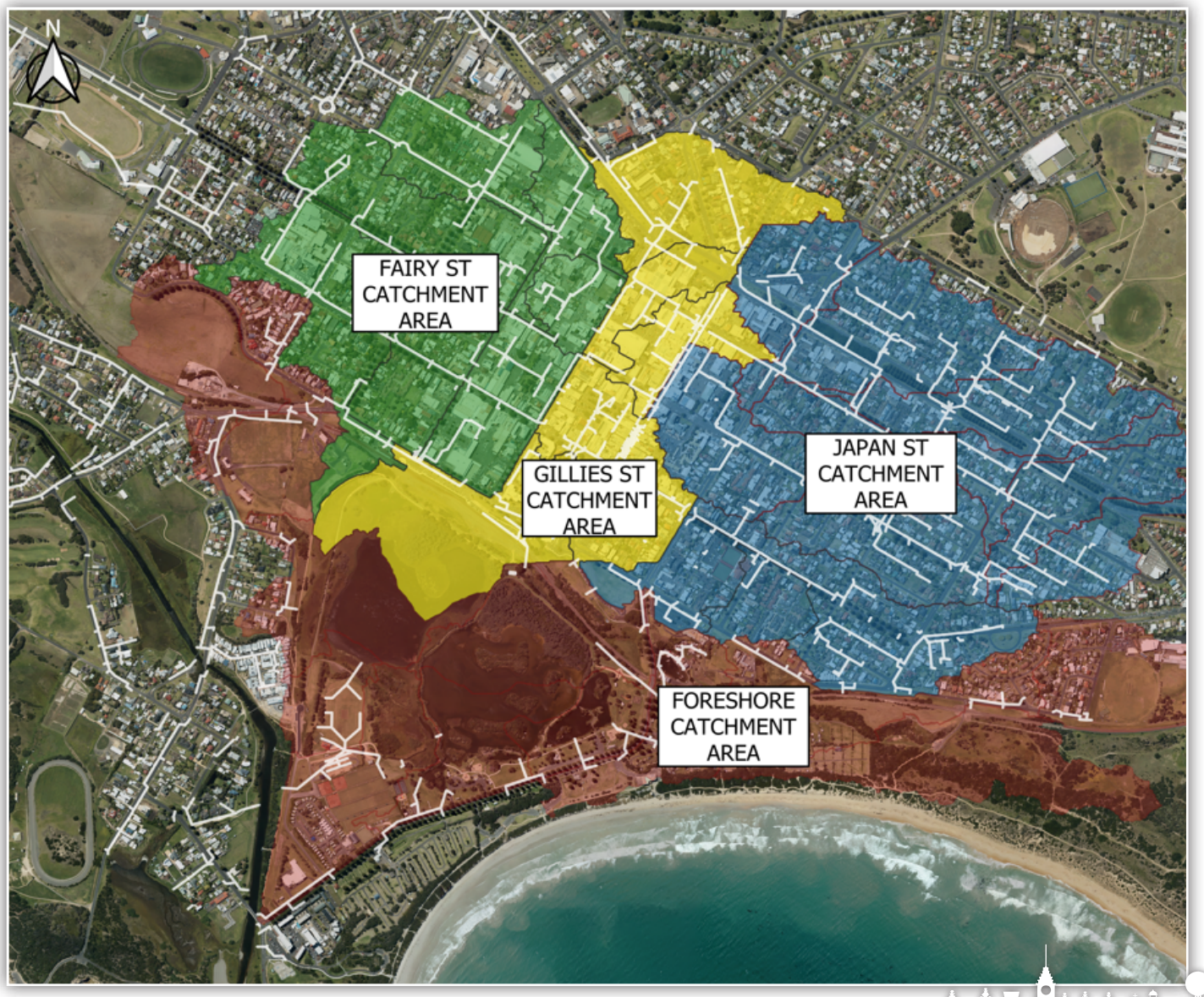
- receiving significant volumes of stormwater,
- providing natural treatment of stormwater prior to water flowing into the Merri River Estuary,
- using significant volumes of reticulated potable water for irrigation and toilet flushing,
- using significant volumes of groundwater for irrigation and suppling park water features,
- the area's proneness to drainage and flooding issues, and
- the area's current and potential for tourism, recreation, environmental and cultural values.

The highly valued Lake Pertobe has opportunities for all outcomes and objectives of IWM to be investigated, from safe, secure and affordable water supplies to economic benefits and innovation.

Lake Pertobe Catchments

Small white lines indicated the stormwater pipe network.

The Fairy, Gillies, and Japan St catchments at over 100 Ha of urban area generate the vast majority of stormwater entering Lake Pertobe.



Integrated Water Management - what is it?

The Department of Energy, Environment and Climate Action define IWM as:

"Integrated Water Management (IWM) is a collaborative approach to the way we plan for and manage all elements of the water cycle. IWM considers how the delivery of water, wastewater and stormwater services can contribute to water security, public and environmental health and urban amenity. It fundamentally shifts the way water, land use planning and urban development opportunities are understood and undertaken in Victoria."

Lake Pertobe is a good location to consider IWM issues and solutions, as several different water issues are impacting the site and several opportunities for water solutions that involve multiple parts of the water cycle exist.

A demonstration precinct, park, or building that incorporate IWM could;

- use rainwater, or treated stormwater / wastewater to offset the use of potable drinking water,
- incorporate water efficiency methods (i.e. appliances and water oval at night) and messaging
- stormwater retention and treatment reducing downstream flooding and pollution
- improve the ecology and biodiversity
- IWM at Lake Pertobe is designed to deliver several outcomes, outlined below, and ideally change the landscape and experience for the users through creative and recreational opportunities.

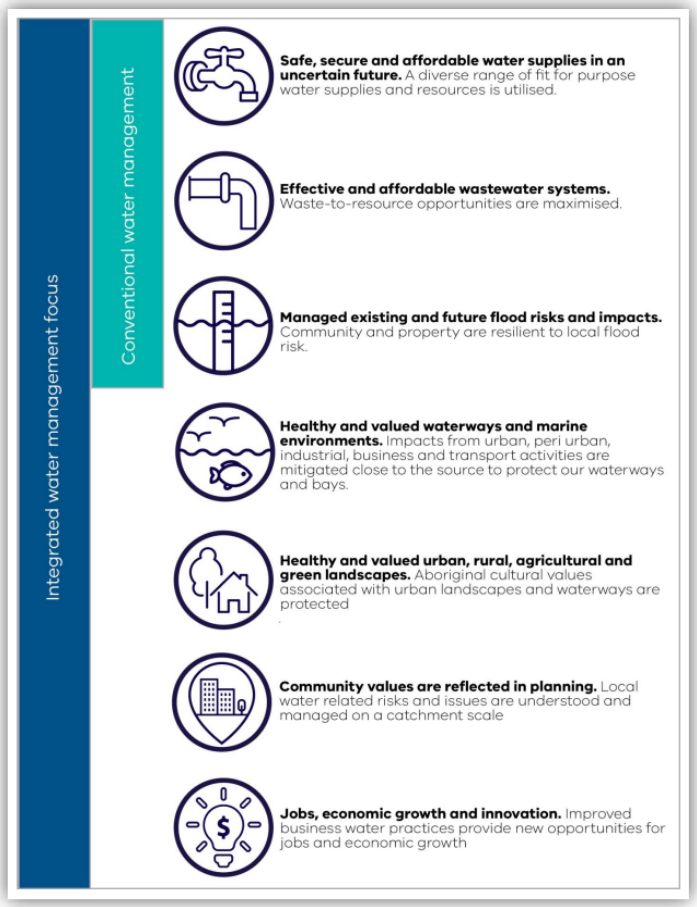
Integrated Water Management Outcomes

Under the DEECA Integrated Water Forums and the Great South Coast Strategic Directions Statement (2019), the IWM Program aims to deliver on the seven specific outcome areas illustrated in the adjacent graphic.

These outcomes are at the forefront for prioritising IWM opportunities (projects), alongside a process that engages the community and stakeholders.

IWM projects from the Albert Park IWM Plan 2019, such as the 'Warrnambool Roof Water Harvesting Initiative' and raingardens in the city of Warrnambool, illustrate projects that can eventuate from IWM plans.

This plan focuses on IWM in the Lake Pertobe precinct, with projects delivering on one or more of the seven outcome areas and thus supporting a more liveable, sustainable, and prosperous region.



Water play space at Lake Pertobe

2. Lake Pertobe

As stated in the 2018 Master Plan, Lake Pertobe – whose name originates from the local Gunditjmara/Dhauwurd Wurrung language, where "pirtup" means "small sandpiper" – spans 58 hectares.

It is situated between the city's central business district (CBD) and the beachfront. Evolving from ephemeral wetlands in the 1970s, it has transformed into a popular attraction with recreational lakes and an adventure playground and is known for its diverse play options and extensive social spaces. Over the past four decades, Lake Pertobe has emerged as Warrnambool's most prominent visitor destination.

Lake Pertobe is at the end of the terrestrial (land) portion of the water cycle, situated just a meter above sea level, adjacent to the saline southern ocean. It is comprised of three lakes - Mill, Main, and Kids Lakes - with relatively shallow depths and fringed with a diverse array of vegetation, including indigenous, native, and noxious species.

Stormwater from upstream catchments, including the Warrnambool CBD, is the largest flow of water into the lakes, namely at the Fairy, Gillies and Japan Street outfalls. Direct rainfall and runoff from park grounds also contribute to the lakes' water inputs. Groundwater lies at a depth of approximately 1-2 meters below the current surface level, and the prevailing notion is that the lakes sit above the groundwater table. This is evident during hot, dry periods, such as the summer months, when the lakes exhibit signs of drying out. Groundwater serves a year-round role, supplying water for features like splash pools and water play areas, and is used to maintain adequate water levels in the lakes throughout the summer months.

Flowing out into the Merri River, the lakes discharge at the southern edge of Mill Lake. During periods of elevated water levels in the Merri River estuary, water may reverse its course and flow back into the Lake Pertobe system. Drainage and flooding issues typically arise during the winter season, characterized by extended periods of rain that saturate the ground.

Key IWM related features at Lake Pertobe

3. Visions

Lake Pertobe IWM Plan Vision

Lake Pertobe is Warrnambool's most iconic thriving open space precinct.

Integrated water management enables Lake Pertobe to be more liveable, resilient, sustainable, ecologically diverse, and prosperous. Lake Pertobe inspires Warrnambool's residents and visitors to gather, play and enjoy the lake and surrounds.

Challenges by our changing climate include resilience and sustainability of community assets

4. Objectives

The Lake Pertobe IWM Plan has eight key objectives;

1. Engage and support the land and water managers in the precinct in more sustainable water use.
2. Identify opportunities to reduce demand on potable supply.
3. Identify opportunities to improve the quality of stormwater discharge to the Merri River
4. Identify opportunities to reduce stormwater and ground water pollution.
5. Identify opportunities for integrated water management to improve the open space and other community amenities of the precinct.
6. Identify opportunities to value the ecological and hydrological characteristics of the precinct.
7. Identify opportunities to value the bio-cultural landscape that Lake Pertobe is a part of.
8. Identify opportunities for this highly utilised site to support broader community awareness and education about where our water comes from and associated impacts.

These objectives have been taken into account by the project control group when developing the IWM options for Lake Pertobe. IWM options typically try to meet one or more of the objectives.

Opportunity to reduce pollution

Rubbish, such as beverage containers, is common at stormwater outfalls into Lake Pertobe. Opportunities to reduce pollutants entering the lakes are addressed in the IWM Plan.

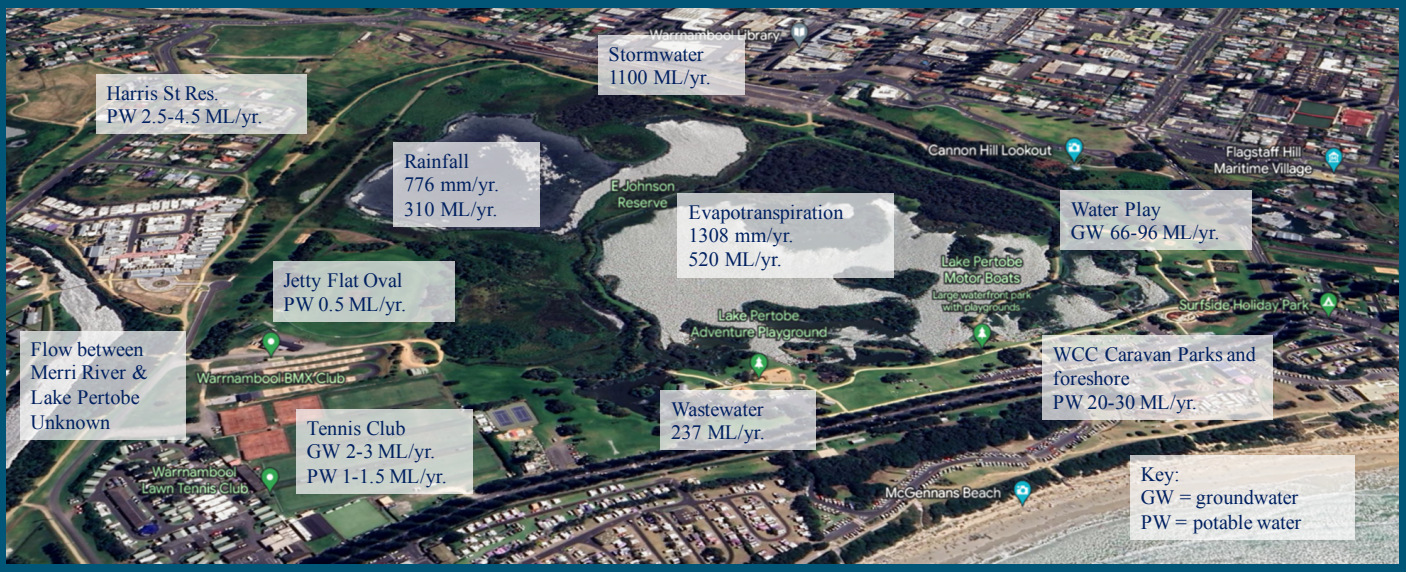
5. Water and pollutant balance

The Lake Pertobe precinct is in an interesting hydrological setting, given its location between the township and the ocean, being adjacent to the Merri River and its current uses.

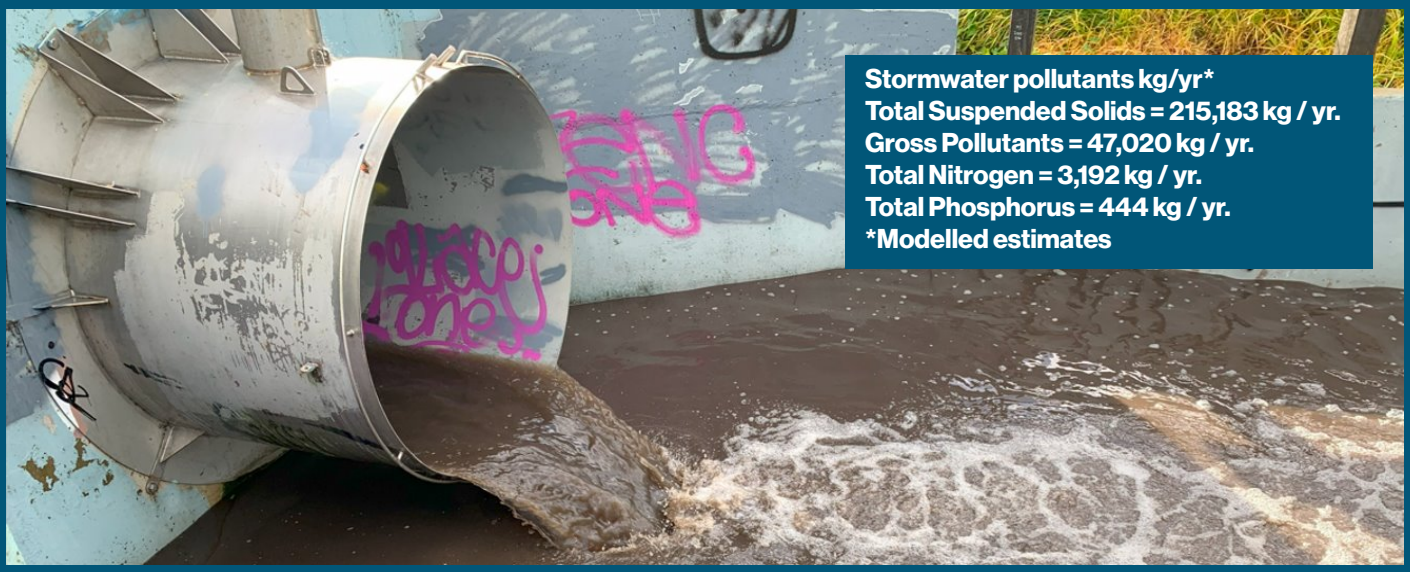
An annual water balance has been developed using available data, noting that IWM should consider the impacts of climate change, including more variable rainfall. Water components used in the water balance are:

- Direct rainfall = 776 mm/yr (averaged over 50 years data BOM*).
- Evapotranspiration = 1308 mm/yr (averaged over 50 years data BOM).
- Stormwater inflows = 1133 ML/yr (averaged over 50 years data, modelled & BOM).
- Groundwater use = Tennis Club (license for 9 ML) 2-3 ML/yr, WCC Staff shed bore 50-60 ML/yr, WCC Playground bore 16-36 ML/yr. (SRW data)
- Potable water use = 37-52 ML/yr Major users include, the Harris St Reserve, WCC and Commercial caravan parks, and Lawn Tennis Club. (WW - Warrnambool's recent average potable water use is 3450 ML/yr, i.e. major users consume 1-2 % of Warrnambool's annual demand).
- Wastewater* to sewer = 237 ML/yr (WW)
- Lake Pertobe and Merri River estuary connection flows = unknown (as no measurements are made).

(BOM = Bureau of Meteorology, *some of this is likely to be stormwater / groundwater infiltration to sewer)



Water use, inflows and outflows at Lake Pertobe



Stormwater pollutants kg/yr*
Total Suspended Solids = 215,183 kg / yr.
Gross Pollutants = 47,020 kg / yr.
Total Nitrogen = 3,192 kg / yr.
Total Phosphorus = 444 kg / yr.
***Modelled estimates**

Stormwater and sediment entering Lake Pertobe

Are the lakes getting smaller from pollution?

Lake Pertobe is continually accumulating sediment derived from stormwater inflows and from aquatic primary production, e.g. algal blooms. Models estimate that over 100 cubic meters of sediment enters the system every year from stormwater alone.

6. Knowledge gaps

Through the development of the IWM Plan, several knowledge gaps have been identified, as well as areas where improved data and information may be beneficial for future projects and longer-term management.

Some of the gaps may be addressed by the IWM opportunities developed in this plan. Gaps where more information could be gathered include:

- **Water levels –** lake water heights are observed to fluctuate; however, no actual recording of the lake water heights have been made. This information, combined with rainfall and tide data, could assist with longer term drainage and flood management.
- **Water volumes –** some water inputs are measured, such as pumped groundwater inputs; however, the largest inflow stormwater, volumes are unknown. Computer modelling has estimated inflows (approx. 1100 ML/yr.); more accurate inflow information could be gathered if required in the future.
- **Groundwater heights and quality –** groundwater heights and quality around Lake Pertobe are somewhat unknown. As an example, the tennis club uses groundwater for irrigation then reverts to potable town water once the groundwater becomes too salty, noting that the bore is near the ocean.
- **Function of Lake Pertobe –** the various roles / functions of Lake Pertobe were discussed, from stormwater basin to valuable ecological habitat to human activity centre. Deliberations on how to balance its various functions are ongoing.
- **Water quality and sediment accumulation –** data on stormwater or lake water quality is limited. It is likely the lakes are filling up with sediment; however, the rate and type of contaminants (e.g. lead) in the sediment is not well understood.

Kids Lake Jetty in January and June 2023, example of fluctuating water levels in the lakes

Knowledge gaps identified through the IWM include water levels over time in the lakes. Such information combined with rainfall and other data could be used to help plan and design future developments.

7. Community values

The 2018 Lake Pertobe Master Plan lists the top five things loved and valued by the community, being:

- The variety of play equipment and barbecue facilities
- Its spaciousness and size
- Open, grassed areas
- The wildlife and environment
- Walking tracks and accessibility.

Additionally, it lists the top five things that people would like to see changed or improved, being;

- Add and update play areas (including shade and water elements)
- Update and link paths and trails
- More native plants and wildlife
- Signage and wayfinding
- Better access for all (Refer to Master Plan for more details).

A summary of 2023 IWMP community engagement and feedback is listed below.

Early phase

- Flooding, drainage and lake water heights
- Maximising visitation and experience

Formal Consultation Phase

- To be completed following formal consultation of the "draft for consultation Lake Pertobe IWM Plan.

Variable conditions can impact values

Lake water heights and the impact on visitor experience were voiced by some of the community in the consultation phase of preparing the IWM Plan. Photos taken in April and June 2023 show how water levels can fluctuate.

8. IWM opportunities at Lake Pertobe & the CBD

Several IWM opportunities were identified by the Working Group based on Lake Pertobe's characteristics and features, the shared vision for Lake Pertobe, and objectives of IWM. They are listed on the below image and their approximate location at Lake Pertobe shown. The opportunities listed are not ranked in preference. Each opportunity is explored outlining benefits, risks and further analysis (GPT = gross pollutant trap).

8.1 Water quality improvement

The three main stormwater inflows along the north of Lake Pertobe have the opportunity for improved stormwater treatment.

Stormwater carries a range of pollutants that can adversely affect the values of Lake Pertobe from visual amenity to human and animal health risks. Previous engineering efforts to reduce gross pollutants (litter and large organic matter) entering Lake Pertobe were not successful due to a numbers of reasons including resources to clean and maintain the pollutant traps.

To ensure effective ongoing water quality improvement critical consideration to cleaning & maintenance requirements for both pollutant traps and sediment accumulation zones is needed. Weed control, such as deciduous trees is also critical to reduce organic and nutrient inputs into the lakes. Additionally, preventive efforts such as community education, street cleaning and the newly started Victorian container deposit scheme will also contribute to managing stormwater pollution. This option also aligns with Lake Pertobe Master Plan recommendations 6.7.5, improve the reserves habitat values through weed control and works to improve water quality.

Foreseen benefits:

- Reduced gross pollutants – litter, rubbish and large organics such as leaves and fronds
- Reduced nutrients and sediments
- Improved water quality in general

Drink containers pooling below Gilles St stormwater outfall.

Potential risks:

- Capital and operation costs
- Lack of maintenance will result in minimal water quality improvement

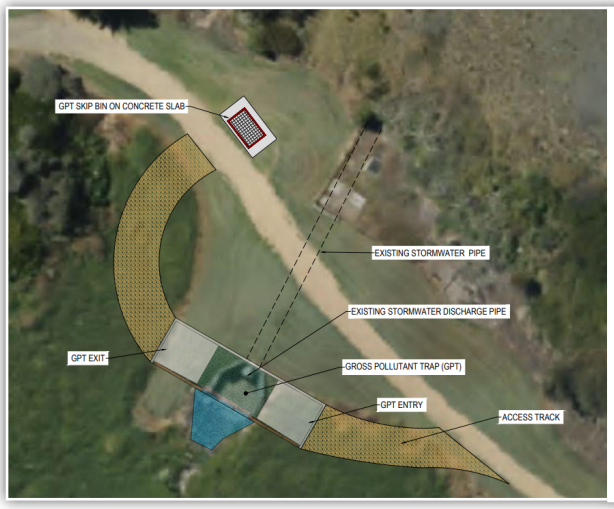
Further analysis

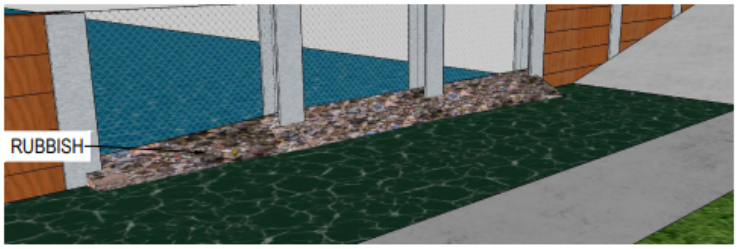
- Design of purpose-built gross pollutant traps,
- Consider upstream interventions and size treatment accordingly.

8.1 Water quality improvement – concept.

The stormwater inflows to Lake Pertobe create some specific challenges for gross pollutant traps (GPTs) functioning effectively, including location, accessibility and peak hydraulic flows. Opportunity exists to improve utilization of on ground resources, staff and tractor at Lake Pertobe to better manage gross pollutants.

It is proposed to design and install purpose built GPTs for Fairy St and Giles St stormwater outfalls. Drawing on design concepts from weeping wall dairy effluent treatments systems (cleaned by tractors), a drive through i.e. two-way GPT, with a filter wall system with removeable / changeable aperture (various sizes could be trialed) screen panels. Operation would entail WCC staff cleaning the GPT as needed, i.e. in autumn it may need daily cleaning, and or on a regular a basis. Pollutants removed would be placed into a nearby bund or container skip and this would be emptied as required. High flows however, would most likely overload the GPTs and spill over and around the screens. Images below show an indicative layout plan and sketch of the drive through concept for the Fairy St outlet.





8.2 Multi benefit basin

The large area between the Fairy St stormwater outfall and the north edge of Mill Lake has scope for a new multi purpose / benefit water basin to be constructed.

The new water body functions would include; stormwater treatment improving water quality entering the existing lakes, water storage for later use in summer for irrigating Harris St reserve and other possible uses, excess stormwater diversion directly to the Merri River, and simply creating more aquatic habitat for further ecological enhancement of Lake Pertobe. This option also relates to numerous Lake Pertobe Master Plan recommendations and values of the community. Images Adjacent show the LiDAR (Light detection and ranging) height data indicates there is likely enough fall 2-3 m from the Fairy St Stormwater outfall to the Merri River for a gravity diversion (via approx. 1.3 km pipe) of excess stormwater from a new basin.

Foreseen benefits:

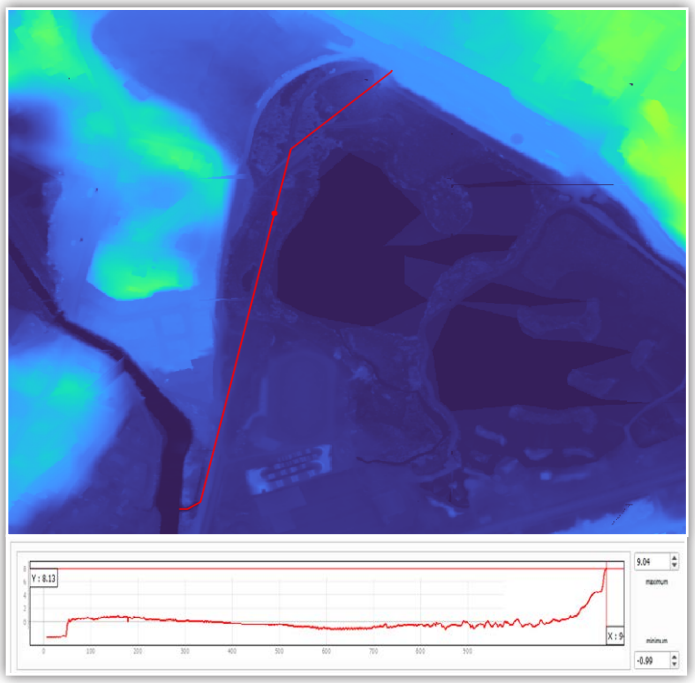
- Improved water quality for Lake Pertobe, reduced sediment, nutrients and pathogens
- Alternate water supply for Harris St irrigation (reduced potable water consumption)
- High / excess stormwater flow bypass has the potential to alleviate flooding
- More water in the landscape has community and ecological value.

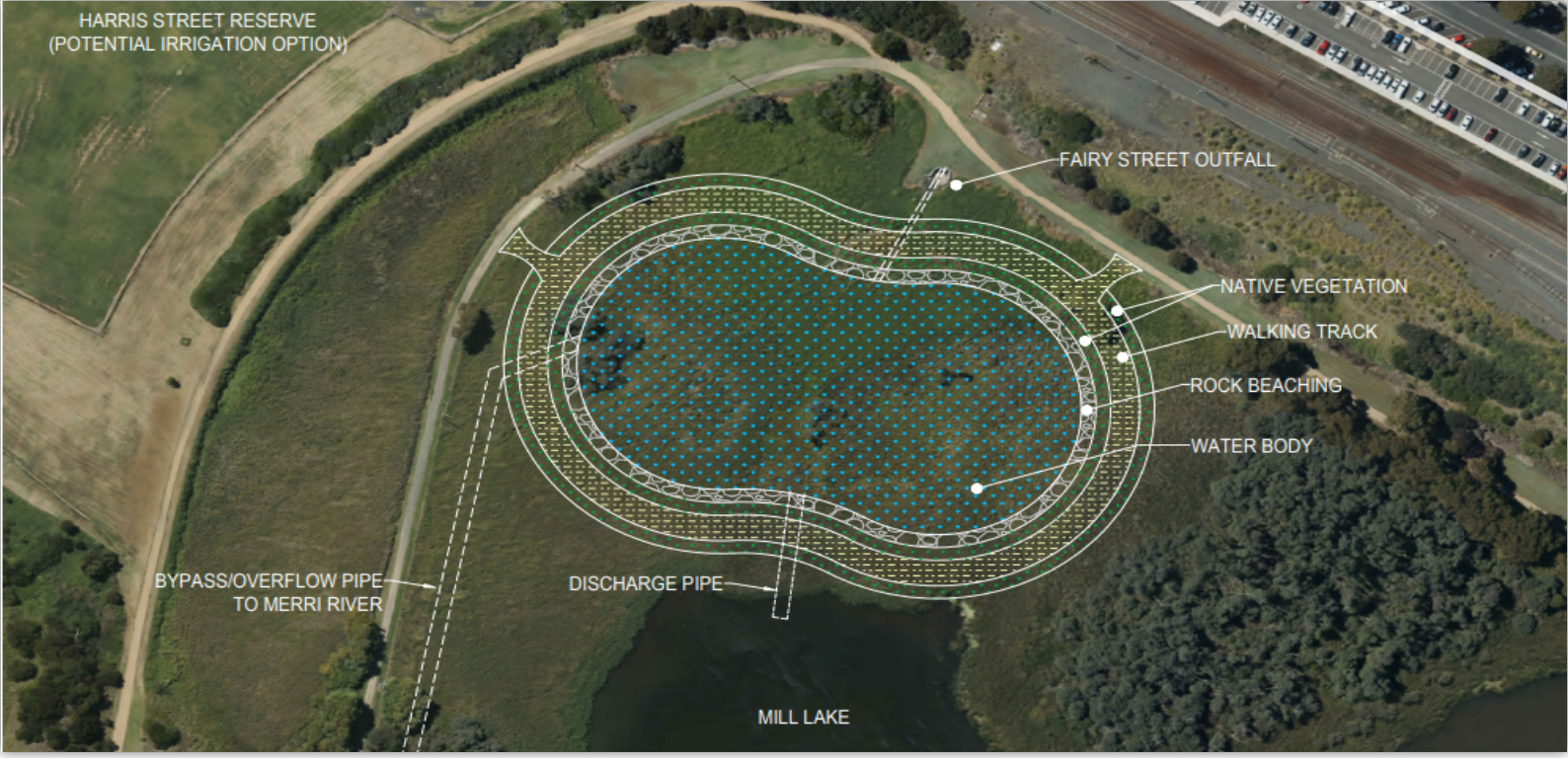
Potential risks:

- Capital costs
- Maintenance requirements / costs

Further analysis:

- Feasibility study due to likely significant capital costs
- Stakeholder engagement to consider relative costs and benefits for each stakeholder





8.2 Multi benefit basin - proposal

The concept of the new basin will enable multiple functions to be performed including sediment trap, water treatment and storage, and water diversion (conveying water via a new pipe to the Merri River).

Initial estimates suggest a basin size of potentially 10,000 m2 by 2 m deep (working volume), thus storing 20,000 kL or 20 ML of water. Concept design sketches are shown in the above image. Disturbance of contaminated sediment (identified by the working group) may complicate the project, and sediment quality will need to be determined at the next planning stage. This will inform the options for sediment use or disposal.

8.3 – Lakes links and levels

Currently water levels in the three lakes are marginally managed, more so the lake levels fluctuate due to water inflows (bore and stormwater), water outflows (limited by pipe size), and Merri River heights (i.e. impeding outflow and at times back flow may occur from the estuary).

Water levels can somewhat be controlled using existing drop board structures, however the effectiveness of the method is uncertain. Potentially the lakes could be openly connected with passageways (that could be shut if required, i.e., to isolate a lake) large enough for watercraft, i.e. canoes, that would result is having only one lake water height to manage rather than three. Feedback from community consultation highlighted drainage and inundation as key concerns and this may be alleviated by improved capacity for outflow/discharge to the Merri River and water level control. Additionally, given the ability to control water levels may facilitate the use of lake water for irrigation or other uses. The option also links with Master Plan recommendation 6.10.1 Develop and implement a drainage maintenance program to ensures that the lakes important drainage function is sustained.

Foreseen benefits:

- Reduction of poor drainage and inundations of areas
- Prevention of backflow of water from a flooded Merri River and flooding of Lake Pertobe
- Reduced groundwater pumping to maintain water levels in the Kids and Main Lakes
- Potential to use the Lakes as a storage reservoir for irrigation water over summer.

Potential risks:

- Management challenges if Lake Pertobe is underwater (and infrastructure flooded)

Further analysis:

- Consider options for water removal while estuary is high and lake in flood to reduce time of inundation
- Modelling to understand and optimisation management of system

8.3 Lakes links and levels - proposal

This option has a scope that ranges from simple to complex, from creating channel connections that could allow canoe passage, to replacing pipe culverts and upgrading to a box culvert (larger area and improved hydraulic and ecological connection) to advanced computer modelling, sizing of automated gate systems, and potentially installation of a pump station to remove excess floodwater.

Alternatively, a more intermediate measure could be to upgrade current hydraulic control structures with more modern equivalents, as outlined.

Main Lake - Mill Lake connection (refer to adjacent photos*)

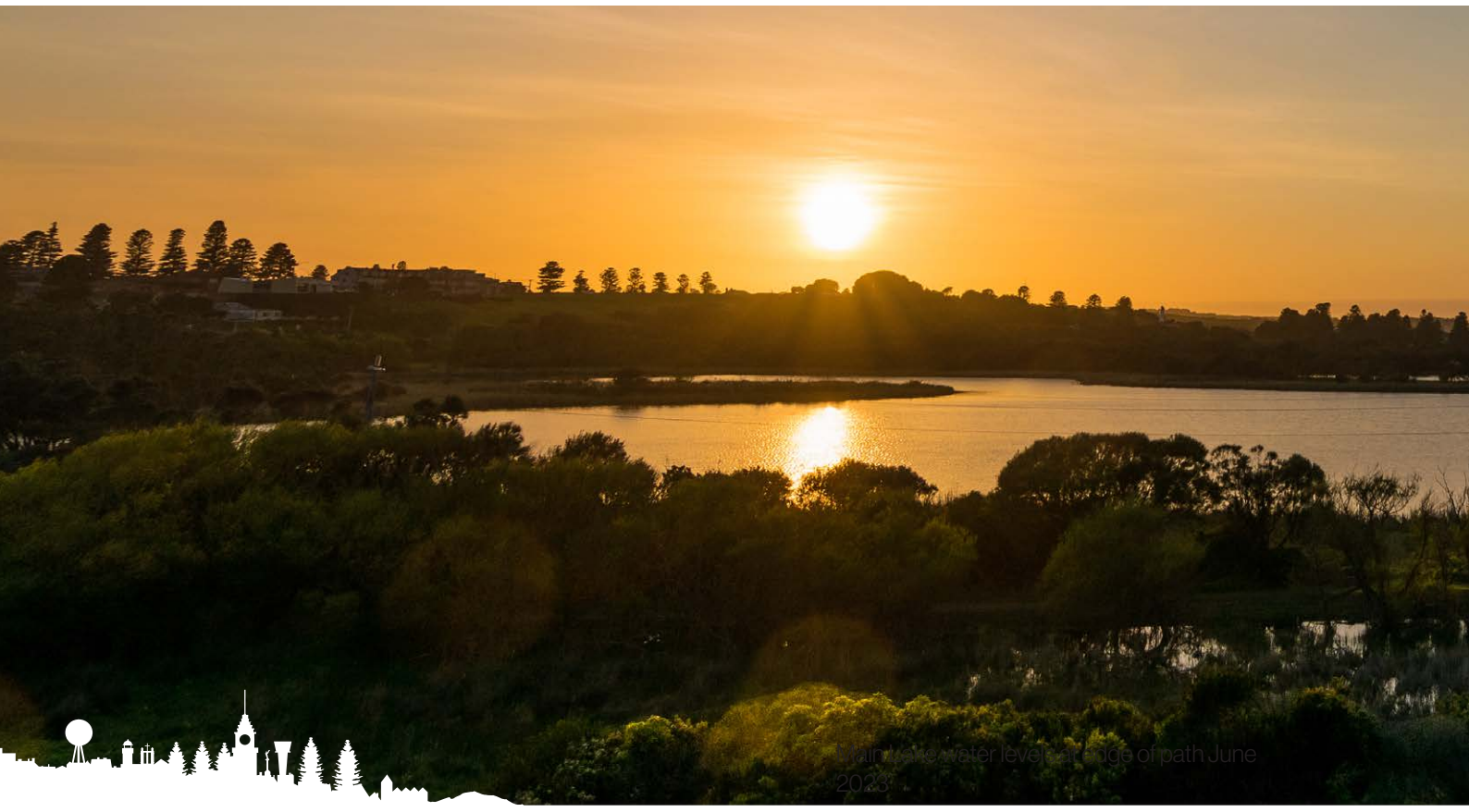
- Current: Wooden drop boards / stop logs – age unknown, usability unknown.
- Upgrade: Segmented Stopboards – marine grade aluminum stopboards in stainless steel frame
- Benefits user friendly, control the flow between Mill and Main Lakes.

Mill Lake Outlet (refer to adjacent photos*)

- Current: Bluestone headwall concrete weir with wooden drop boards / stoplogs
- Upgrade: Down opening penstock decant gate – stainless steel, manual handwheel operation
- Benefits user friendly, can set minimum water level in Mill Lake, excess water overtops gate

Merri River Outlet (refer to adjacent photos*)

- Current: 600 mm pipe open (flap valve previously installed)
- Upgrade: Up lift penstock gate – stainless steel, new head wall and manual handwheel operation
- Benefits user friendly and installed to prevent Merri River floods backflowing into the Lake Pertobe system. (*Aluminium gate photos sourced from; https://www.awmawatercontrol.com.au/)



Main lake water level at edge of path June 2023

8.4 Stormwater irrigation

As outlined in the previous section, given the size of Lake Pertobe there is opportunity to use the Lake/s as a storage reservoir for water that then can be drawn down to irrigate nearby sports facilities and other possible uses such as toilet flushing.

Based on preliminary calculations if Mill Lake had a 30cm water depth allocation for irrigation approximately 25 ML of water could be available, i.e. a summers irrigation requirements. Additionally, the construction of an additional Basin (Option 2) directly below the Fairy St stormwater outfall could be considered. Design concepts estimated a new basin could have a capacity of 20 ML that would likely to be able to supply sports fields irrigation requirements most years. It should be noted that in both scenarios further treatment of the stormwater is likely to be required prior to use, this should be determined following discussion with Authorities. The option also links with Master Plan recommendation 6.10.2 Explore alternate for potable water use for irrigation.

Foreseen benefits:

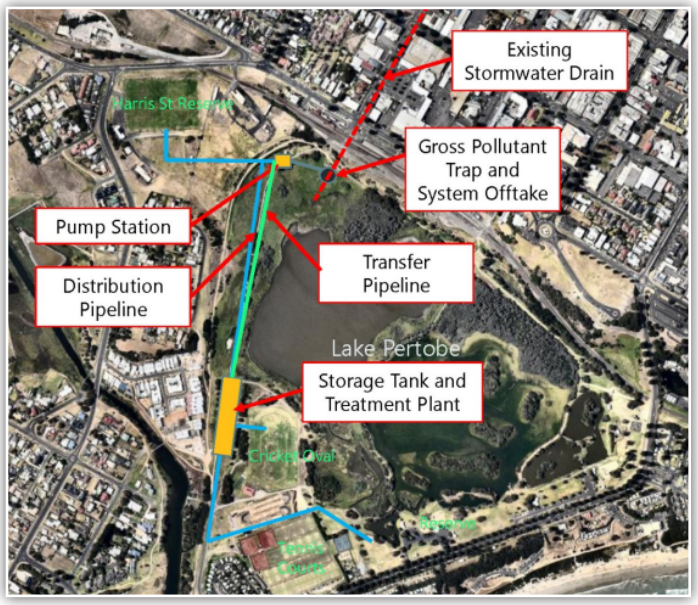
- Reduce potable water demand and drought resilience contingency
- Use of a fit for purpose water to meet community needs
- Possible creation of a new water basin (Option 2)
- Improved water quality for Mill Lake
- Nutrient diversion for beneficial use i.e. irrigation of grass fields

Potential risks include:

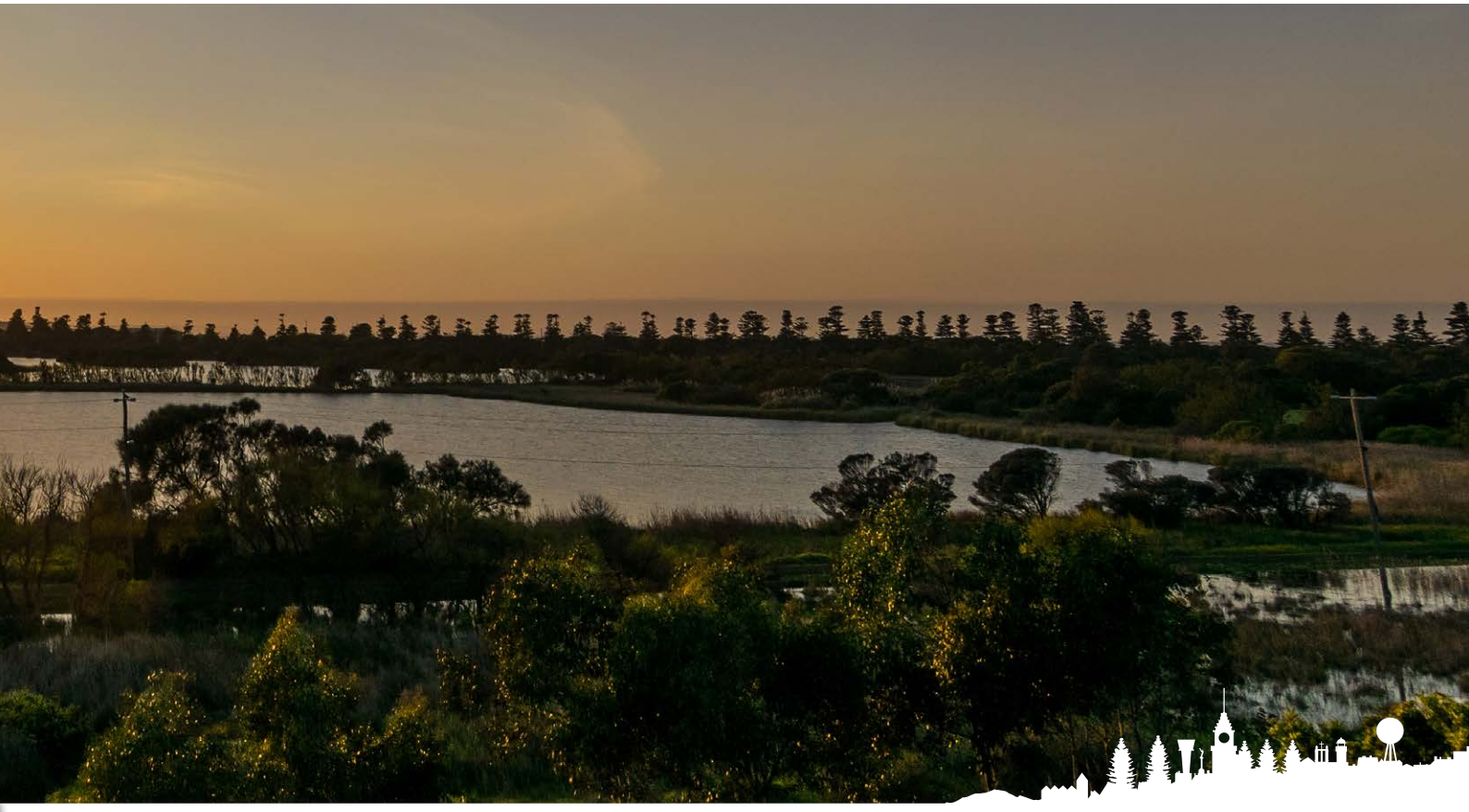
- Dry hot years may limit stormwater availability and hence limit irrigation volumes
- Costs, the unit costs, i.e. $/KL of stormwater irrigated may be high

Further analysis:

- Verify opportunities for potable water offsets and demands in precinct
- to maximise the potential alternate water scheme, potentially reducing unit costs.



Schematic of a potential stormwater irrigation scheme proposed in 2018 Lake Pertobe Master Plan (Source; 2018 Lake Pertobe Master Plan)



8.4 Stormwater irrigation – case comparison

As detailed in the State Government IWM Progress Report March 2022, a sports field irrigation project using stormwater is being constructed in the Baw Baw Shire. The project has many similarities with the opportunity proposed at Lake Pertobe as outlined in the table below.

Baw Baw Shire – Western Park Ovals	Warrnambool City Council – Harris St Reserve and Jetty Flat Oval
Irrigation of ovals used 600,000 L/week (600 kl) forecast to increase with a hotter drier Climate, annual volume use not stated.	Data indicates usage between 400,000 to 500,000 L/week (500 kl) in summer (12 weeks).Annual volume use approximately 5 ML / yr.
Dichotomy between water conservation and maintaining the ovals.	Comparable circumstances – conservation vs use.
2.5 Ha wetland adjacent to ovals, capturing and treating stormwater from upstream residential development.	Approx 20 Ha of water surface at Lake Pertobe – volume of lakes unknown, stormwater from commercial and residential catchments.
Plan developed to divert a portion of stormwater to irrigate sporting ovals, involving; an off-take pump station, inline sediment filter, UV filtration system and a 600,000 L underground storage tank.	Similar concepts plans developed in Lake Pertobe Master Plan.
Projected to save 20 million litres of drinking water every year.	Unknown, Warrnambool climate does not require irrigation year-round.
Decrease pollution entering the creek downstream of the wetland.	Comparable circumstances. Lake Pertobe impact on Merri River compared to the greater Catchment (900 km2 approx.) issues, is likely to be relatively small.
Drought proof a valuable community space.	Comparable circumstances – likelihood of water restrictions low in the short term.
Funding Victorian Government IWM Program ($425,000), Baw Baw Shire($195,000) and Gippsland Water ($10,090).	Master Plan concept costing in the order of $1.5 - $2 million dollars.

8.5 Education and value of water

Education, awareness and appreciation of the water cycle is an ongoing exercise in working towards a sustainable water use.

The project team with reference to Master Plan Arts and Culture Recommendations "6.1.11 Develop an App to increase engagement and enjoyment..." and 6.5.1 "Include and share stories about Lake Pertobe's heritage, Indigenous culture, stormwater and drainage function and environment" and propose a digital self-guided tour app be developed for Lake Pertobe. The tour would utilise and build on current wayfinding and signage at Lake Pertobe and could also link with the Pirtup Meeting Place Project that is currently underway and Wannon Water summer water saving campaigns. Other education opportunities include; signage at any new infrastructure that built such as passageways between the lakes and ensuring schools are aware of and utilise the digital tour once developed.

Foreseen benefits:

- Overall community awareness of the water cycle and Lake Pertobe role in the cycle
- Promotion of the value of water and the "water is life" vision.

Potential risks:

- Vandalism of signs
- Digital self-guided tour app not utilized, app becoming dated

Further analysis:

- Test user experience and messaging to ensure education is targeted and uses the right terminology
- Consider options to increase and maximise uptake of app, i.e. launch campaign, permanent signage, etc.

8.6 Water recreation

Current water-based recreation at Lake Pertobe consist of two hires operations and informal public use, i.e. school camps may use the lake for a raft building activity, canoeing etc.

The hire businesses, a small petrol driven engine boat and a paddle boat and canoe hire have been operating at Lake Pertobe for decades and typically only open in peak tourist times. Given the abundance of personal watercraft such as kayaks (including the recreational fishing type) and paddle boards, the relatively "safe" environment of Lake Pertobe provides great opportunity for increased public and access use. Additionally, stand up paddle board businesses have expressed interest in being able to run classes on the lake.

Improved access could range from simply a turning circle with "boat / craft drop off and pick zone" in proximity of the Lake to an actual boat ramp where craft could directly launch into water with a more accessible canoe launcher. This option would also benefit from improved lake connectivity, i.e. channels between lakes, however in the short term "portage" sites could be established for watercraft to be carried from one lake to the other. Master Plan link include 6.1.2 Provide access to the water, and 6.3.1 Accessible destination points.

Foreseen benefits:
- Greater use and appreciation of the lake
- Healthier community (physical, mental, etc.)

Potential risks:
- Expensive asset if not well utilised

Further analysis:
- Optimisation of preferred location
- Scoping the appropriate type and size of facility

8.7 Roof water to aquifer recharge

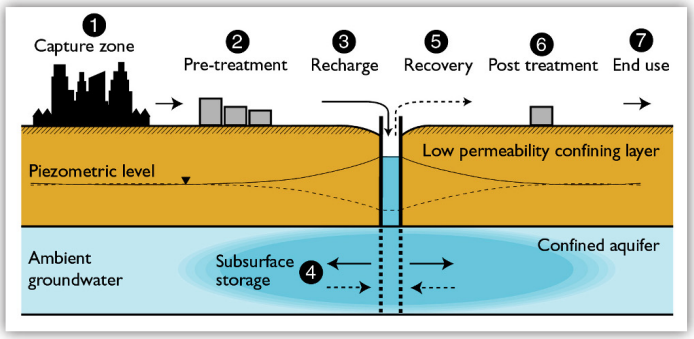
Building on the success of previous roof water harvesting initiatives in Warrnambool, it is proposed to extend and adapt this practice to facilitate managed aquifer recharge.

The concept is to divert rainwater collected from rooftops in Warrnambool's CBD to recharge the shallow sandstone groundwater aquifer. It is important to emphasize that only roof water is intended for this aquifer recharge, a measure taken to safeguard groundwater quality. Warrnambool sandstone is very porous, making it exceptionally well-suited for aquifer recharge. The aquifer overlies the extensive regional Port Campbell Limestone aquifer; therefore, the two units have the capacity to store a considerable volume of water.
This approach has the potential to be expanded or replicated over time, allowing for the construction of multiple recharge systems. Approximately 15,000 square meters of roof area, roughly equivalent to the rooftop space in a typical Warrnambool CBD block, could generate an annual yield of 10 megaliters for recharge. This recharged water would, in turn, help offset the water extracted from the existing bores at Lake Pertobe. Furthermore, this initiative aligns with Master Plan objective 6.10.2, which seeks to explore alternatives to potable water for irrigation.

Foreseen benefits:
- Recreating a more natural water cycle (i.e. when more water infiltrated into the land).
- Reducing hydraulic load on the stormwater system
- Aquifers have very large potential storage volumes
- Recharging the aquifer balances extracted water .

Potential risks:
- Dry years will reduce recharge volumes when demand is likely to increase
- Poor performance or contamination concerns if the system is not maintained.
- Retrofitting costs

Further analysis:
- Review regulatory requirements and approval process



Concept diagram of how roof water can be harvested and used for aquifer recharge. (Source: https://www.csiro.au/en/news/all/articles/2016/october/managed-aquifer-recharge)

8.8 – Catchment permeability

Another option for increasing recharge of the groundwater aquifer, like roof water aquifer recharge (Section 8.7), is to focus on nearby surrounds, i.e. the Warrnambool CBD, and aim to significantly increase urban permeability using infiltration trenches, passively watered trees, bioretention systems, and permeable pavements.

The filtered water recharges the local shallow upper aquifer and can be then extracted from the aquifer to effectively balance bore water use in the Lake Pertobe Precinct, i.e. the play space bore. This options links with the Master Plan 6.10.2 Explore alternative to potable water for irrigation.

Forecast benefits:

- Reducing hydraulic load on the stormwater system
- Recreating a more natural water cycle (i.e. when more water infiltrated into the land).
- Recharging the aquifer that then can be drawn upon (pumped) when needed, i.e. over summer.
- Aquifers have very large potential storage volumes

Potential risks:

- Maintenance of local WSUD assets
- Monitoring of volumes of water that recharge the aquifer

Further Analysis:

- Review associated risks of large-scale catchment permeability

Permeable gravel allows water to soak into the ground Koroit St Warrnambool

9. Prioritisation and assessment (Which way to swim?)

9.1 Prioritisation by IWM outcomes

To help prioritise Lake Pertobe IWM opportunities, assessment using a low (1), medium (2) and high (3) score i.e. relative contribution towards IWM outcome areas, is shown in the table below.

Total scores (colored to highlight the different scores) show that based on this assessment the Multi Benefit Basin is the highest ranked project (scoring a 3 + 1 + 3 + 3 + 3 + 2 + 2 = 17), followed by the Lakes links and levels and Stormwater Irrigation opportunities. The assessment is indicative only with scores differing by four points from highest to lowest.

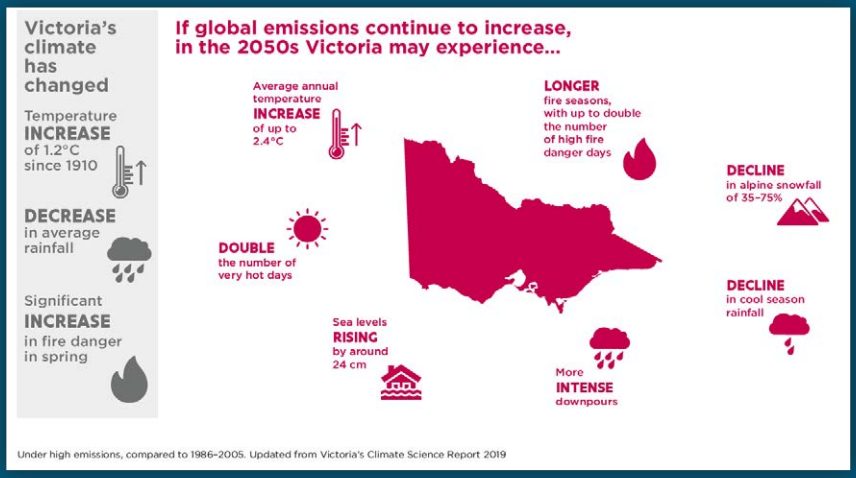
	IWM outcomes								
	Opportunity	Safe secure water supplies	Effective and affordable wastewater	Manage existing and future flooding	Healthy and valued waterways	Heathy and valued green landscapes	Community values	Jobs, economic growth and innovation	Total score
8.1	Water Quality Improvement	Low	Low	Medium	High	High	High	Low	14
8.2	Multi Benefit Basin	High	Low	High	High	High	Medium	Medium	17
8.3	Lakes Links and Levels	Medium	Low	High	Medium	Medium	High	Medium	15
8.4	Stormwater Irrigation	High	Low	Medium	Low	High	High	Medium	15
8.5	Education and value of water	Medium	Low	Low	Medium	Medium	High	Medium	13
8.6	Water Recreation	Low	Low	Low	High	Medium	High	High	14
8.7	Roof Water to Aquifer Recharge	High	Low	Medium	Medium	Medium	Medium	Medium	14
8.8	Catchment Permeability	Medium	Low	Medium	High	Medium	Medium	Low	13

9.2 Climate change considerations

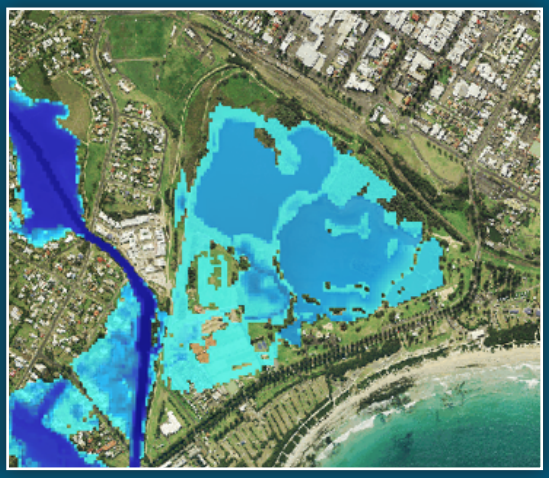
In preparation of this IWM Plan, the control group discussed climate change, sea level rise and Lake Pertobe's exposure to future changes.

The GHCMA is working on an updated South Warrnambool flood study at the time of developing this IWM Plan. Existing flood modelling (see image below) incorporating a 0.8 m sea level rise does show Lake Pertobe impacted by flooding in a 1% AEP Riverine Flooding event, i.e. a flood of this magnitude has a 1% chance of occurring in any given year. The potential for more regular estuarine / seawater incursion into the current freshwater system was also considered in this IWM Plan.

Thinking of current and future generations, IMW opportunities that minimize or reduce greenhouse emissions will be favored and pursued. The infographic shows predicted changes to Victorias climate in 2050s.



(Source: https://www.climatechange.vic.gov.au/victorias-changing-climate)

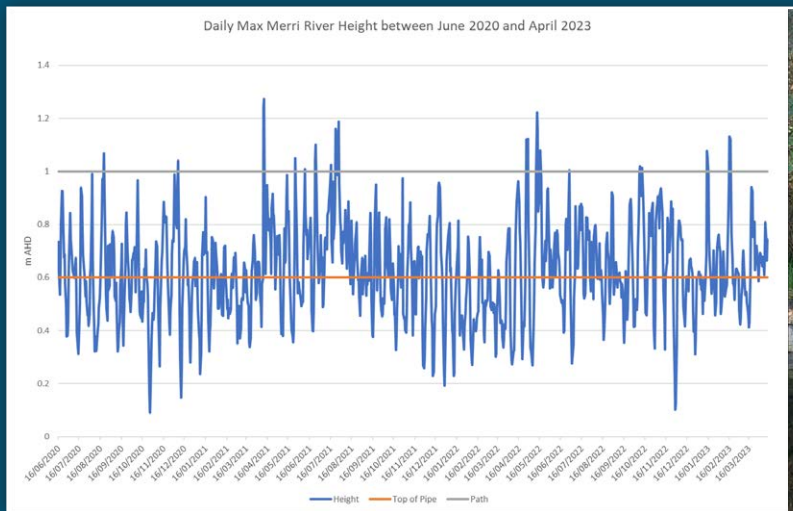


(Source: https://flood.ghcma.vic.gov.au)

Merri River water heights and Lake Pertobe

The graph below displays maximum Merri River heights from June 2020 to April 2023.

The orange line at 0.6 m indicates the top of the pipe connecting Lake Pertobe to the Merri River and the grey line is the height of the retaining wall (right photo) at the Main Lake – Mill Lake connection. Merri River water levels strongly influence the flow of water in or out of Lake Pertobe, noting the outlet pipe diameter also dictates flow rates in and out. As outlined on the previous page, climate change and predicted sea level rise will have a flow on effect, also likely increasing Merri River heights and therefore impacting flow of water in and out of Lake Pertobe.



9.3 Prioritisation by local and climate outcomes

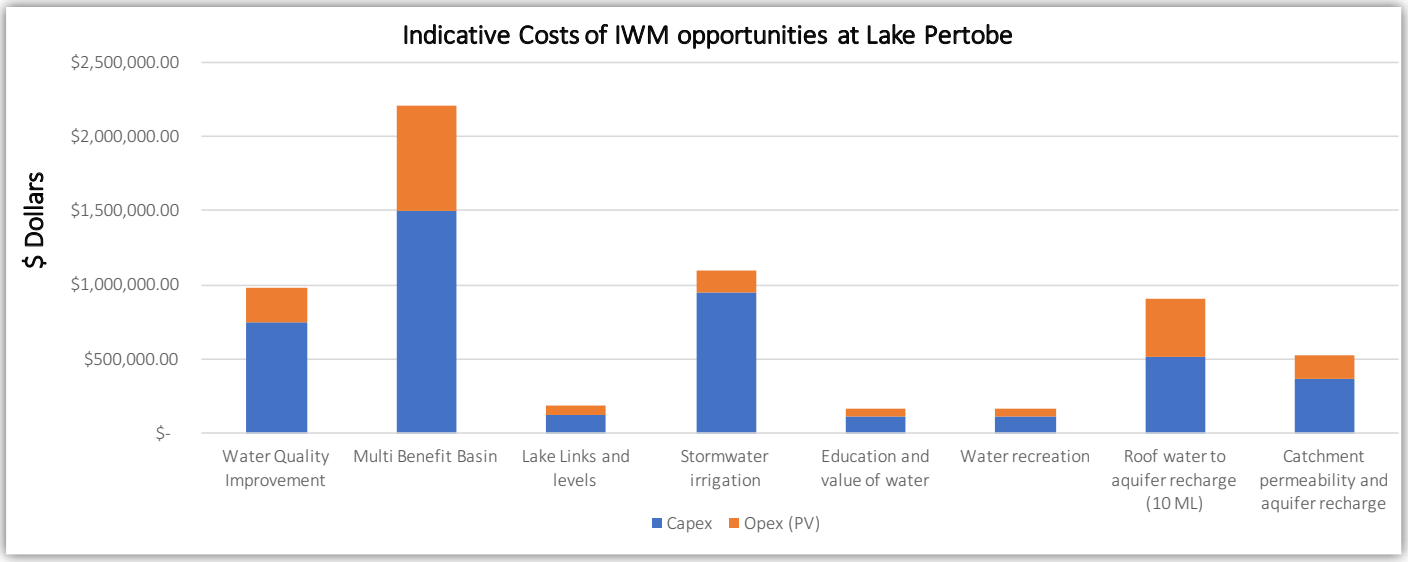
To help prioritise Lake Pertobe IWM opportunities, assessment using a low (1), medium (2) and high (3) score relative contribution to Lake Pertobe IWM objectives, Lake Pertobe Master Plan alignment and Climate Change benefit is shown in the table below.

Total scores (colored to highlight the different scores) show that based on this assessment stormwater irrigation is the highest ranked opportunity (scoring a 3 +3 +1 +3 + 3 + 2 + 1 + 3 + 1 + 2 = 19), followed by the Multi benefit Basin and Education and the value of water. The lowest ranked options are water quality improvement and water recreation.

		LP IWM objective							Master Plan	Climate		
	Opportunity	Engage and support the land and water managers in the precinct in more sustainable water use	Reduce demand on potable supply	Improve the quality of stormwater discharge to the Merri River	Reduce stormwater and ground water pollution	Improve the open space and other community amenities of the precinct	Value the cultural, ecological and local aboriginal characteristics of the precinct	Support broader community awareness and education about where our water comes from and associated impacts	Aligns with Master Plan Recommendations	Sea Level Rise resilient?	Climate change (CO_2) benefit	Total score
8.1	Water Quality Improvement	Low	Low	Medium	Medium	Low	Medium	Low	High	High	Low	13
8.2	Multi Benefit Basin	High	High	High	High	Medium	High	Medium	High	High	Medium	17
8.3	Lakes Links and Levels	Medium	Low	Medium	Medium	Medium	Medium	Low	High	Low	Low	15
8.4	Stormwater Irrigation	High	High	Low	High	High	Medium	Low	High	Low	Medium	19
8.5	Education and value of water	Low	Low	Low	Low	High	High	High	High	Medium	Medium	16
8.6	Water Recreation	Low	Low	Low	Low	High	Medium	Low	High	Low	Low	13
8.7	Roof Water to Aquifer Recharge	High	High	Medium	High	Low	Low	Low	Low	High	Medium	15
8.8	Catchment Permeability	High	High	Medium	High	Low	Low	Low	Low	High	Medium	15

9.4. Cost projections

Indicative costs for the opportunities are presented in the graph below and show a large range in costs from the Lake links and levels (approx. $200k) up to the Multi Benefit Basin (approx. $2.2M). Capital Expenditure (Capex) i.e. the initial costs and the Operational Expenditures (Opex) i.e. the estimated running costs over 25 years (shown in present value), noting they are indicative only (costs could vary by plus or minus 50%).



9.5 IWM Holistic Assessment

The holistic assessment aims to capture both tangible and intangible economics of the options and also include the prioritisation tables that consider opportunities to other factors, such as sensitivity to climate change.

The eight opportunities are presented in the table on the following page with their associated assessments.

An effort was made to assign an economic value to all major benefits, including intangible benefits (e.g. improved community health and well-being). See the Appendix for further definition of each benefit, calculations, assumptions, and references. Costs listed are combined capital and operating costs (estimate of dollar costs).

Benefit Cost Ratio is calculated by dividing the benefits dollars value by the costs dollar value to create a ratio number. The number can be used as an indicator of value for money, for example if Option A benefits were $100 and Costs were $50 the ratio = $100/$50 = 2. Comparatively if Options B ratio was $50/$100 = 0.5 the assessment would conclude that 2 is higher than 0.5 indicating Option A is better value for money. Prioritisation Combined simply combines the scores from both prioritisation tables, IWM outcomes, local objectives and climate change factors.

Main Beneficiary is the organisation or person (people) who will benefit most from the option. The owner is usually the main beneficiary and is typically the principal funder of the project. Other parties may also contribute funds to the projects, for example, water recreation; a canoe launching asset may be primarily WCC asset however other stakeholders may contribute such as the GHCMA.

Holistic Rank is an intuitive ranking based on the information presented. It considers both the Prioritisation Combined and the Benefit Cost Ratio. The opportunities are ranked top down from 1 down to 5 with some options receiving the same rank.

9.5 IWM Holistic Assessment*

Opportunity	Main beneficiary (Owner = bold)	Quantifiable benefits	Prioritisation Combined	Benefit Cost Ratio (PV)	Holistic Rank (Intuitive)
8.1- Water Quality Improvement	WCC Community Environment	Nutrient reduction (TSS) Improved water clarity due to reduction of gross pollutants and TSS	27	Cost = $984,000 Benefit = $32,586,000 Ratio = 33	4
8.2- Multi Benefit Basin	WCC Community Environment Economic	Flood & drainage management Nutrient reduction (Total Nitrogen) Improved water clarity due to reduction of gross pollutants and TSS	34	Cost = $2,203,000 Benefit = $58,610,000 Ratio = 27	1
8.3- Lakes links and levels	WCC Community	Flood & drainage management	30	Cost = $181,000 Benefit = $16,403,000 Ratio = 91	2
8.4- SW harvesting and irrigation (Harris St and other demands)	WCC WW	Avoided potable water use for irrigation over summer Nutrient reduction (Total Nitrogen)	34	Cost = $1,093,000 Benefit = $681,730 Ratio = 0.62	4
8.5- Education and value of water	WCC Community	Increased community awareness and education Improved community health and well-being due to increased visitation	29	Cost = $165,000 Benefit = $909,000 Ratio = 6	4
8.6- Water Recreation	WCC Community	Improved community health and well-being Increased visitation / Additional boat and paddle board hire	27	Cost = $165,000 Benefit = $42,961,000 Ratio = 260	3
8.7- Roof water to Aquifer Recharge	WCC / SRW / WW Environment	Offset of potable water use Offset of stormwater upgrades	29	Cost = $908,000 Benefit = $544,000 Ratio = 0.60	5
8.8- Catchment permeability and aquifer recharge	WCC Environment	Offset of potable water use Offset of stormwater upgrades	28	Cost = $529,000 Benefit =$544,000 Ratio = 1	5

10. Water and pollutant balance (pre and post plan implementation)

Of the opportunities for IWM at Lake Pertobe some have readily quantifiable outcomes such as potable water substitution with stormwater and installation of pollutant treatment traps and basins.

Others such as water education and recreation have more intangible benefits i.e. harder to quantify. The table below outlines changes in the water volumes and pollutant loads, from pre (current situation) to post IWM opportunities i.e. all opportunities implemented.

Water	Pre	Post	% Change
Potable Water (ML)	36	30	17
Groundwater (ML)	99	99 +	Increased recharge Scale dependent.
Stormwater	1100	902	18
Wastewater	237	237	0
Pollutants (kg/yr)			
Total Suspended Solids	213,000	19,000	91
Gross Pollutants	47,000	0	100
Total Nitrogen	3,200	1750	45
Total Phosphorous	447	122	73

11. Recommendations

Considering the vision for Lake Pertobe, the holistic assessment, and community feedback, the IWM Plan recommends the following actions:

Address knowledge gaps. It is recommended that all agencies work together to better monitor and understand the water cycle at Lake Pertobe. Improved data (specifically monitoring data of stormwater inflows and local rainfall pluvio data) would enable improved quantification of the design of new infrastructure and provide more confidence in delivering resilient and long-lasting assets through improved hydraulic modelling, in particular for the option of the multi-benefit basins or lake connection and level control.

Implement the Multi Benefit Basin (8.2). This is a priority project to be considered for further design work and implementation. This project addresses many issues and opportunities and would result in a large array of potential benefits to several user groups and stakeholders. Benefits include improving water quality, reducing flooding via a high flow bypass, and offers the potential for stormwater to replace potable water for sport fields irrigation. As it is a relatively large project, it is recommended that all stakeholders consider how best to seek external grant funding.

Consider changes to lake levels and connectivity (8.3). The Lake Pertobe vision is compromised when water levels are high, creating soggy and unusable areas and paths and negatively impacting lake users. Therefore, improved lake level control is recommended with the intent to reduce the risk of adverse highwater conditions. Conversely in dry times, the system could capture stormwater for reuse as a substitution for irrigation on local nearby ovals.

Improve water recreation (8.6). A key recommendation with significant community benefits is a focus on opportunities for everyone to be "on water." This recommendation also links to education and the value of water, as well as having several other benefits, including health in well-being of residents and visitors.

Implement education and value of water project (8.5). Community awareness of the water cycle and Lake Pertobe role in the water cycle is important to help the whole community understand their responsibility for good water outcomes, i.e. water conservation, pollution prevention, etc.

Lastly, it is recommended to revisit four of the lower priority options in 5 years, to consider their relative priority and potential benefit. These actions are the Water quality Improvement (8.1), Stormwater harvesting and irrigation (8.4), Roof water to aquifer recharge (8.7) and Catchment permeability and aquifer recharge (8.8).

12. Implementation

Actions, lead agency for project management, indicative time frames, and budgets are shown below for the IWM opportunities.

Some of the opportunities, such as aquifer recharge, will require further consideration of legal requirements; others will require further modelling and design, geotechnical, environmental, flora and fauna considerations. External funding and partnerships with stakeholders will be needed to implement many of the opportunities.

#	Opportunity	Action	Who	Implementation Time (yr)	Feasibility / design budget ($ 000's)
8.1	Water quality improvement	Design specific gross pollutant traps for outlets	WCC	1 to 2	30
8.2	Multi benefit basin	Feasibility study and preliminary design	Multi Agency	3 to 5	60
8.3	Lakes links and levels	Preliminary design	WCC/GHCMA	1 to 2	40
8.4	Stormwater irrigation	Feasibility study and preliminary design	WCC/Wannon Water	3 to 5	30
8.5	Education and value of water	Tour and education app development	WCC/GHCMA	1 to 3	50
8.6	Water recreation	Preliminary design	WCC/GHCMA	1 to 2	10
8.7	Roof water to aquifer recharge	Feasibility study and preliminary design	Multi Agency	3 to 5	50
8.8	Catchment permeability and aquifer recharge	Ongoing by WCC	WCC	Ongoing	n/a

13. Appendix

List of key documents referenced in the IWM Plan:

Lake Pertobe Master Plan – Warrnambool City Council 2018
Great South Coast Strategic Directions Statement - Department of Environment, Land, Water and Planning, October 2019
Water is Life, Traditional Owner Access to Water Roadmap – Department of Environment, Land, Water and Planning 2022
Albert Park Integrated Water Management Plan – Warrnambool City Council 2019
Integrated Water Management Progress Report – Department of Environment, Land, Water and Planning, March 2022

Benefit Calculations, References, and Assumptions Table

Opportunity	Quantifiable benefits	Unit	Rate	Value	Total (PV)	Reference	Assumptions
1- Water Quality Improvement	Nutrient reduction (TSS)	$/kg TSS	$43.50/kg TSS	20 kg/yr	$ 13,591	City of Ipswich (2023). Voluntary Stormwater Quality Offset Program. Ipswich, QLD: Ipswich City Council. https://www.ipswich.qld.gov.au/__data/assets/pdf_file/0004/239845/Stormwater-quality-offsets-report-2021-2022.pdf	Ipswich found the cost-benefit per kg TSS removed to range from $5 to $82 per kg TSS removed. Average of $43.50/kg is assumed.
	Improved water clarity (willingness to pay)	$/person/ year	$4.17/person/year	500,000 people / year	$ 32,572,037	Gunawardena, A., Zhang, F., Fogarty, J., Iftekhar, M. S., (2017). Review of non-market values of water sensitive systems and practices: An update. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.	People's WTP for increased water clarity in the Karapiro catchment, New Zealand: mean annual WTP per household for water clarity from the current clarity (around 1 m) to: see up to 1.5, 2.0, and 4.0 m underwater were, respectively $4.17, $21.03, and $65.82. Assumed reduction of TSS and GPP will increase clarity up to 1.5m at a value of $4.17 per visitor
2- Multi Benefit Basin	Flood & drainage management	$/day	$70,000/day	15 days	$ 16,403,184	Tourism Australia (2018), Key Tourism Metrics for Warrnambool, 2014-2017 and Lake Pertobe Master Plan 2018.	Assumed 15 days of recreation lost per year due to flooding. Assumed visitors to Lake Petrobe spend $50/day in Warrambool and there are 1,400 visitors per day on average (500,000 people/year divided by 365 to equal on average daily visitors) to equal $70,000 per day
	Nutrient reduction (TN)	$/kg TN	$6,645/kg TN	1450 kg	$ 9,635,250	Melbourne Water, "Stormwater offsets explained" https://www.melbournewater.com.au/building-and-works/developer-guides-and-resources/drainage-schemes-and-contribution-rates-2-0	Offset rate is $6,645/kg TN. Nitrogen is measured for the Stormwater Offsets Program. If nitrogen (the limiting pollutant) targets are achieved, then phosphorus and suspended solid targets are also achieved. Offsets are paid once and are not an annual value.
	Improved water clarity (willingness to pay)	$/person	$4.17/person	500,000 people / year	$ 32,572,037	Gunawardena, A., Zhang, F., Fogarty, J., Iftekhar, M. S., (2017). Review of non-market values of water sensitive systems and practices: An update. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.	Willingess to pay (WTP) for increased water clarity in the Karapiro catchment, New Zealand: mean annual WTP per household for water clarity from the current clarity (around 1 m) to: see up to 1.5, 2.0, and 4.0 m underwater were, respectively $4.17, $21.03, and $65.82. Assumed reduction of TSS and GPP will increase clarity up to 1.5m at a value of $4.17 per visitor.
3- Lakes links and levels	Flood & drainage management	$/day	$70,000/day	15 days	$ 16,403,184	Tourism Australia (2018), Key Tourism Metrics for Warrnambool, 2014-2017 and Lake Pertobe Master Plan 2018.	Assumed 15 days of recreation lost per year due to flooding. Assumed visitors to Lake Petrobe spend $50/day in Warrambool and there are 1,400 visitors per day on average (500,000 people/year divided by 365 to equal on average daily visitors) to equal $70,000 per day.
4- SW harvesting and irrigation (Harris St and other demands)	Avoided potable water use ($/kL). Irrigation water use over summer.	$/kL	$2.24/kL	6000 kL / year	$ 266,418	Wannon Water, Price Submission 2023-28 - https://www.wannonwater.com.au/media/113418/final-wannon-water-price-submission-2023-2028.pdf	Current retail price is $2.24/kL. Retail price of water is assumed to grow at 2.1% each year.
	Nutrient reduction (TN)	$/kg TN	$6,645/kg TN	62.5 kg	$ 415,313	Melbourne Water, "Stormwater offsets explained" https://www.melbournewater.com.au/building-and-works/developer-guides-and-resources/drainage-schemes-and-contribution-rates-2-0	Offset rate is $6,645/kg TN. Nitrogen is measured for the Stormwater Offsets Program. If nitrogen (the limiting pollutant) targets are achieved, then phosphorus and suspended solid targets are also achieved. Offsets are paid once and are not an annual value. Assumes 25 ML of stormwater contains 62.5 Kg of TN, based on eWater MUSIC Guidelines and modelling of Option 2.
5- Education and value of water	Increased community awareness and education	$/person	$1.20/person	5,000 people / year	$ 93,732	Australian Bureau of Statistics (2016 Census) and Statista "Average prices for apps in the Apple App Store as of May 2023 (in U.S. dollars)"	Average purchase price of an app in the Apple App store (May 2023) was $1.20 AUD. This is used as a proxy for willingness to pay for an app. Assumed all school age kids in district (estimated 5000) have app.
	Improved community health and well-being due to increased visitation	$/person	$4.54/person	11,500 people / year	$ 815,629	Henderson-Wilson, Claire, Sia, Kah-Ling, Veitch, Jenny, Staiger, Petra K., Davidson, Penny and Nicholls, Peter 2017, Perceived health benefits and willingness to pay for parks by park users: quantitative and qualitative research, International journal of environmental research and public health, vol. 14, no. 5, Article number: 529, pp. 1-18.	Assumed app would increase lake interest by 10% for those using the app and their families (assume 11,500 people). In reference study, park users were willing to pay $45.40 per year for park. Assumed Lake Pertobe users would be willing to pay 10% of $45.40 based on app use.
6-Water Recreation	Improved community health and well-being	$/person	$4.54/person	500,000 people / year	$ 35,462,121	Henderson-Wilson, Claire, Sia, Kah-Ling, Veitch, Jenny, Staiger, Petra K., Davidson, Penny and Nicholls, Peter 2017, Perceived health benefits and willingness to pay for parks by park users: quantitative and qualitative research, International journal of environmental research and public health, vol. 14, no. 5, Article number: 529, pp. 1-18.	Assumed improved access would increase lake amenity by 10%. In study, park users were willing to pay $45.40 per year for park. Assumed users would be willing to pay 10% of $45.40 for improvement. Assumed Lake Pertobe has 500,000 visitors per year.
	Increased visitation (additional boat and paddle board hire)	$/person	$48/person	10,000 visitor / year	$ 7,498,598	Visit Victoria "Lake Pertobe Motor Boats Hire" https://www.visitvictoria.com/regions/great-ocean-road/see-and-do/outdoor-and-adventure/boating-and-kayaking/lake-pertobe-motor-boats-hire Go Surf School "Stand-Up Paddleboard Lessons" https://gosurf.com.au/lessons-hire/	Based on references, SUP lesson is $45 - $65 per person; boat hire is $30/30 minutes. Assumed average of $48 per person. Also assumed 100 days of use at 100 persons/day
7 - Roof water to Aquifer Recharge	Recharging groundwater assumes offsetting potable water use	$/kL	$2.24/kL	10,000 kL/ year	$ 444,030	Wannon Water, Price Submission 2023-28 - https://www.wannonwater.com.au/media/113418/final-wannon-water-price-submission-2023-2028.pdf	Current retail price is $2.24/kL. Retail price of water is assumed to grow at 2.1% each year.
	Offsetting stormwater upgrades	$/ha	$20k/ha	5 Ha	$ 100,000	Colac Stormwater Strategy 2019 - Colac Otway Shire.	Development fees range from $70 -100 K per Ha. Assumed will offset stormwater upgrades at 25% of new development rate of $80k/ha. Warrnambool CBD block is approx 5 Ha. Development fees are paid once and are not an annual value.
8- Catchment permeability and aquifer recharge	Recharging groundwater assumes offsetting potable water use	$/kL	$2.24/kL	10,000 kL/ year	$ 444,030	Wannon Water, Price Submission 2023-28 - https://www.wannonwater.com.au/media/113418/final-wannon-water-price-submission-2023-2028.pdf	Current retail price is $2.24/kL. Retail price of water is assumed to grow at 2.1% each year.
	Offsetting stormwater upgrades	$/ha	$20k/ha	5 Ha	$ 100,000	Colac Stormwater Strategy 2019 - Colac Otway Shire.	Development fees range from $70 -100 K per Ha. Assumed will offset stormwater upgrades at 25% of new development rate of $80k/ha. Warrnambool CBD block is approx 5 Ha. Development fees are paid once and are not an annual value.