Cardinia Shire Council and South East Water

Pakenham East Growth Area Extension Whole of Water Cycle Assessment

Option 2 and 3 Further Assessment

July 2015

Executive summary

Pakenham East is a precinct located on the eastern edge of the South East growth corridor adjacent to the existing Pakenham Township and was part of the 2012 logical inclusions extension to Metropolitan Melbourne's Urban Growth Boundary. The precinct is approximately 635 hectares, with a developable area of approximately 413 ha providing land for approximately 6000 residential lots. A Precinct Structure Plan (PSP) is currently being developed by Council.

Council, South East Water and Melbourne Water all have an interest in the development of this area, due to the need to provide various water cycle services to support the development, and to minimise the impact on the environment. GHD were engaged to develop a Whole of Water Cycle management (WOWCM) plan for the precinct.

Following completion of that work, GHD were further engaged to undertake more detailed analysis into Options 2 (Pakenham WWTP recycled water) and 3 (Bald Hill stormwater harvesting with recycled water). The overall purpose of this further phase of work is to undertake further investigation to reduce these risks where possible so that a decision can be made on the way forward with more certainty. This report presents the findings of that further phase.

A description of Option 2 and 3 is as follows:

- **Option 2 Pakenham WWTP recycled water -** Dual pipe supply (from the existing Pakenham wastewater recycling plant), and otherwise as for the traditional approach.
- **Option 3 Bald Hill stormwater harvesting with recycled water -** Dual pipe supply (from a combination of recycled wastewater from the Pakenham facility and harvested stormwater), and an unconventional stormwater diversion to reduce retarding basin and wetland size. This option relies on altering the use of the existing Bald Hill basin, which is a SEW asset currently used to balance supply of Class C recycled water to irrigators.

Option 3 was further considered in two parts:

- Option 3a – Transfer of stormwater to Bald Hill Reservoir for the purpose of harvesting only and no flood mitigation function. This sub option would therefore not affect the size of the retarding basins within the PSP, but should reduce the required size of the wetlands or could provide additional water quality improvement above BPEM.
- Option 3b - Transfer of stormwater to BHR for the purpose of harvesting and also providing a flood mitigation function. This sub option would therefore potentially remove the need for some retarding basins within the PSP, as well as reducing the required size for the wetlands.

Analysis was undertaken of BHR using Class C consumption data provided by SEW. This analysis showed that in recent years (last 4) the basin has stayed relatively full, due to lower demand compared with the 4-year period before this. In the drought years of 2006 to 2010, however, the basin fell to a low level in the model during summer. This was due to the higher demand in those years.

Overall, this suggests that the basin may not have as much easily available 'spare' capacity as considered based on advice from more recent observations. This would indicate that BHR could not provide a flood retardation function, which would require spare capacity to be available, unless the Class C capacity was increased to enable the Class C irrigation demands to be met during the dry years. This would economically disadvantage the potential retardation element of Option 3. Based on that analysis, Option 3b was not considered further in this further phase or work.

A spreadsheet water balance model was setup to investigate each option under different scenarios. The purpose of these investigations was to understand the demand profiles and the behaviour of BHR for a range of climate conditions

NPV analysis was undertaken for Option 2 and 3A and the following observations were made:

- Using the base input factors, the Stormwater Harvesting Option appears to have an NPV which is around $2 million less than the Class A option. Taken at face value, this suggests this option is more attractive on a whole of community cost basis. However, this option is innovative, and will require a range of complex negotiations to determine how costs are reasonably distributed. So the stakeholders need to consider whether this quantum of benefit is worth pursuing (see Appendix L1 for output sheet).
- The cost of the pipeline to transfer the stormwater to Bald Hill is approximately the same as the cost of the wetlands. Conceptually, the pipeline substitutes for the wetlands, as it removes around half of the stormwater from the precinct, thus achieving a nutrient reduction equivalent to that achieved by the wetlands. In addition to removing pollutant loads, removing stormwater also provides some assistance with maintaining the existing flow regime (prior to development) within the receiving water. The question of the aesthetic value of the wetlands to the developer and the eventual residents is not directly accounted for in this comparison. However, using the base input factors (see Appendix L1), the NPV analysis has shown that there is approximately $2 million that could be used to provide a suitable substitute for the aesthetic value of the wetlands if required before Option 2 became more attractive on a whole of community cost basis.
- A further issue arises. As the water from the pipeline will then be used for supply, a question arises as to who should fund the pipeline, and under what mechanism. So while this element of cost comparison appears neutral on a whole of community cost basis, a number of other factors require consideration by the stakeholders.
- The result is sensitive to the ‘cost’ assigned to sending wastewater to ETP. Once this cost exceeds around $1500per ML, then the options become equivalent (see Appendix L2 for output sheet).
- The result is very sensitive to the cost of ongoing wetlands maintenance. The base input value is 5% of the capital value spent per year. If this is increased to 10% per year, then the stormwater harvesting option is $6 million more attractive on an NPV whole of community cost basis (see Appendix K3 for output sheet).
- A wide range of other sensitivity analysis were undertaken, and all keep the two options within the ranges of the sensitivities outlined above.

Overall, the analysis of these two options suggests that Stormwater harvesting is a viable innovative alternative. However, it is around neutral on a whole of community NPV basis. So pursuing this option will be a decision based on factors other than the NPV analysis, and will require negotiation between stakeholders.

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1. Introduction

1.1 Purpose of this report

This report presents further more detailed analysis into Options 2 (Pakenham WWTP recycled water) and 3 (Bald Hill stormwater harvesting with recycled water) as part of the Whole of Water Cycle Management (WoWCM) and Servicing Plan for the Pakenham East growth area extension.

It follows an initial phase of work that presented the costs and benefits of a range of short listed options and where the stakeholder group identified Options 2 and 3 as preferred options.

While significant work has already been undertaken to inform this decision and identify risks associated with these options as part of the initial phase of work, the overall purpose of this further phase of work is to undertake further investigation to reduce these risks where possible so that a decision can be made on the way forward with more certainty.

1.2 Background

GHD was engaged by Cardinia Shire Council and South East Water in 2014 to prepare a Whole of Water Cycle Management (WoWCM) and Servicing Plan for the Pakenham East growth area extension.

That whole of water cycle assessment provided the project stakeholders with a detailed understanding of the costs and benefits of a range of short listed options with the intention of enabling the selection of a strategy that delivers smart and economically efficient water services, protects the environment and existing beneficial uses and enhances the liveability of Pakenham East and surrounding communities.

1.3 Location

The Pakenham East precinct is located on the eastern edge of the South East growth corridor adjacent to the existing Pakenham Township as shown on the metropolitan and regional context plan. The precinct was part of the 2012 logical inclusions extension to Metropolitan Melbourne's Urban Growth Boundary, and is now the easternmost extent of the UGB.

The surrounding area is characterised by existing urban development to the west, and rural pastureland to the north, south and east. The rural town of Nar Nar Goon is located approximately 4 kilometres south east of the precinct.

2. Option description

2.1 Option 2 - Pakenham WWTP recycled water

Based on the initial phase of work, Option 2 would broadly involve:

- Potable water supplied from wider Melbourne system.
- Waste water sent to Pakenham Waste Water Treatment Plant (WWTP) and then excess onto ETP. Recycled Class A water supplied from Pakenham WWTP using existing class A infrastructure at Pakenham understood to be currently not used (available capacity 4ML/day, upgradeable to 8ML/day), although capacity will be required once growth occurs in Officer.
- Stormwater managed through conventional retarding basins and wetlands as outlined in the Pakenham East drainage strategy.

The schematic for Option 2 from the previous phase of work is presented in Appendix A. An updated layout plan, providing further details for Option 2 is presented in Figure 1.

2.2 Option 3 - Bald Hill stormwater harvesting with recycled water

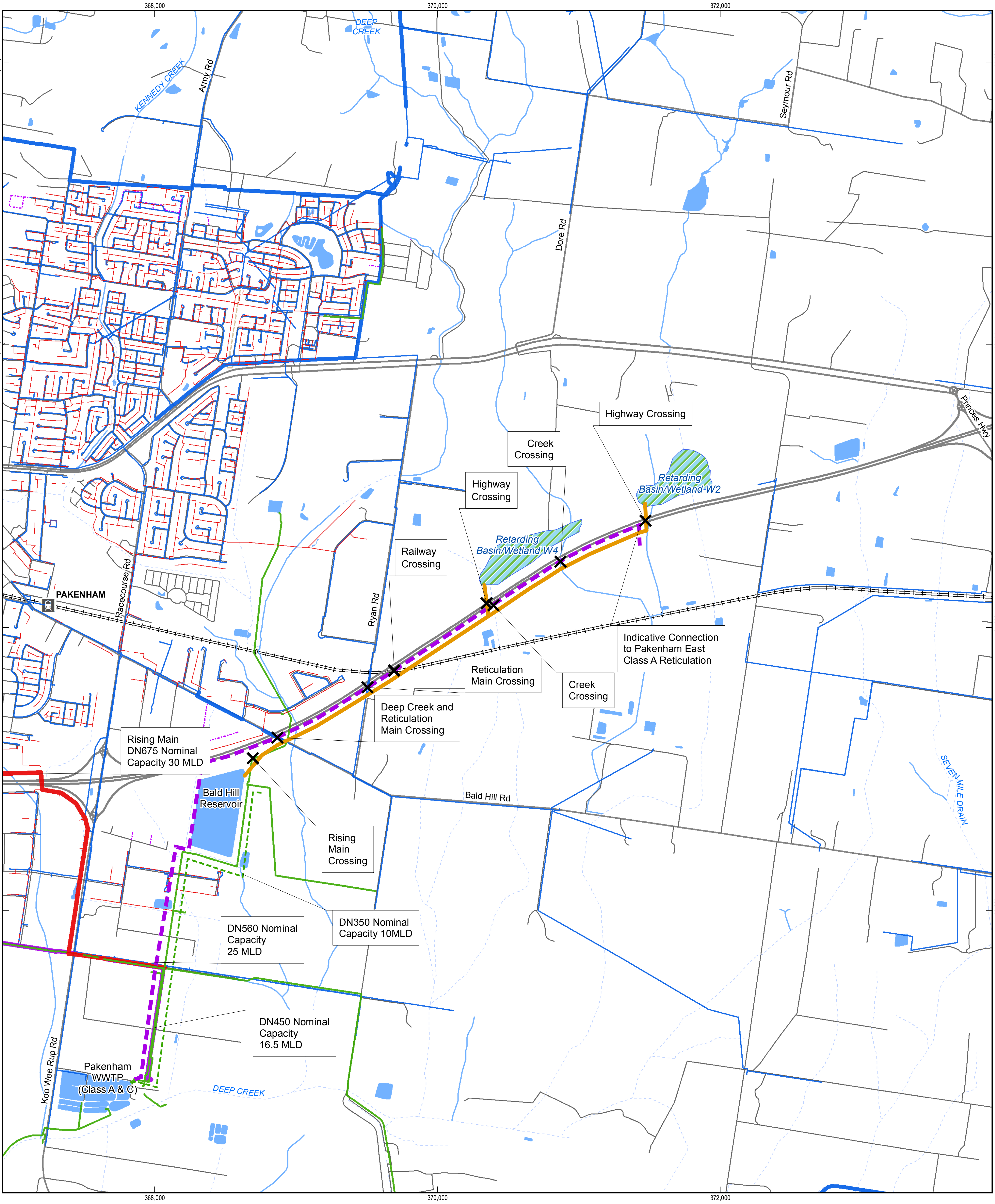
Based on the initial phase of work, Option 3 would broadly involve:

- Potable water supplied from wider Melbourne system.
- Waste water sent to Pakenham WWTP and then excess on to ETP.
- Stormwater managed through conventional retarding basins and wetlands as outlined in the Pakenham East drainage strategy, although their sizes may be reduced as a result of the stormwater harvesting. Stormwater harvested from proposed retarding basins and conveyed to Bald Hill reservoir where it would be stored. Treated to Class A standard using the Class A infrastructure at Pakenham WWTP understood to be currently not used (available capacity 4 ML/day, upgradeable to 8 ML/day) and existing pipe connections between Pakenham WWTP and Bald Hill before being supplied to households through a third pipe. Recycled Class C water supplied from Pakenham WWTP to Bald Hill reservoir would be used when there was insufficient stormwater available.

The schematic for Option 3 from the previous phase of work is presented in Appendix A. An updated layout plan, providing further details for Option 3 is presented in Figure 1.

Option 3 has been considered in two parts:

- Option 3a – Transfer of stormwater to BHR for the purpose of harvesting only and no flood mitigation function. This sub option would therefore not affect the size of the retarding basins within the PSP.
- Option 3b - Transfer of stormwater to BHR for the purpose of harvesting and also providing a flood mitigation function. This sub option would therefore potentially remove the need for retarding basins within the PSP.



LEGEND

Indicative Pipes	South East Water Pipes			
Class A - Recycled Main (New)	Sewer Main	Potable Transfer Main	Arterial	Drain/Channel/Other
Class C and Stormwater (New)	Class C - Recycled Main	Potable Reticulation Main	Collector	Waterbody
Stormwater (New)	Sewer Reticulation	Rail station	Proposed	Railway
	Class A - Recycled Main	Freeway	Tracks	Wetlands
		Highway	Stream	

Paper Size A3

0 250 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Cardinia City Council
Pakenham East Growth Corridor WoWCM Stage 2

Job Number 31-31322
Revision 0
Date 02 Jul 2015

South East Water Data Overview Schematic

Figure 1

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180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Data source: DELWP: VicMap, 2015; SEW, Water Data, 2014. GHD, Indicative Pipes, 2015. Created by:cagilbert

3. Pakenham WWTP

3.1 Overview

The Pakenham Wastewater Treatment Plant (WWTP) is located to the south of Pakenham on Kooweerup Road. It is owned and operated by South East Water (SEW). A general site arrangement for plant is provided in Appendix B.

A process overview of the existing Pakenham WWTP which shows the current operational philosophy is shown in Figure 2 below.

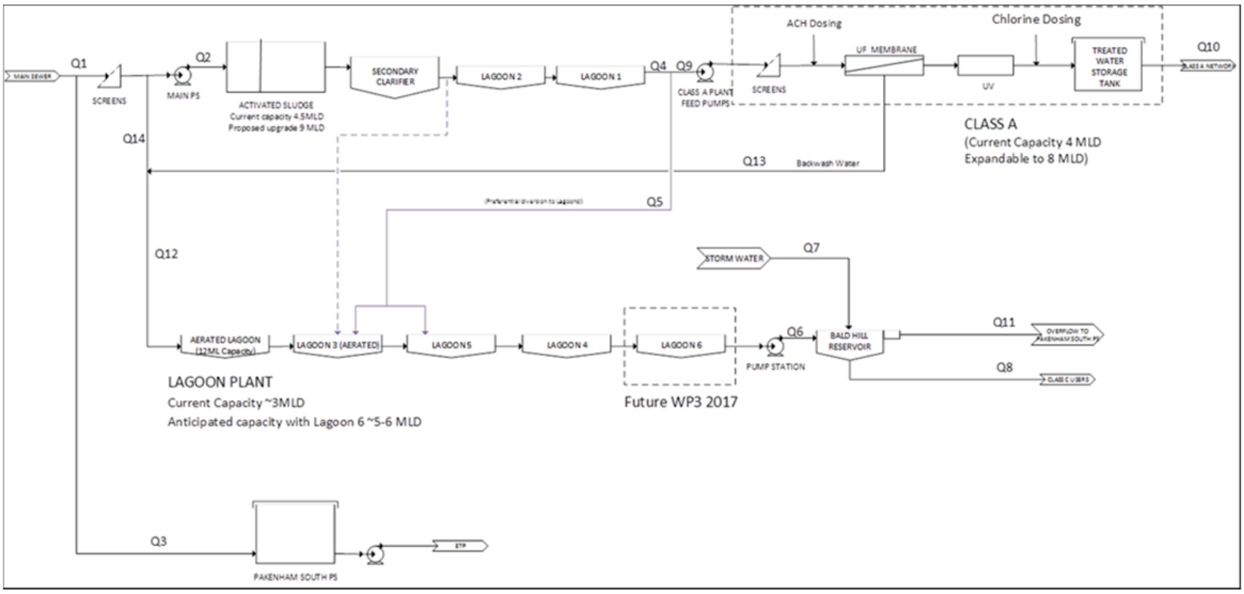


Figure 2 Process Flow Diagram for Pakenham WWTP

3.2 Activated Sludge WWTP (Class C WWTP)

The WWTP is currently comprised of the key process units:

- Raw sewage pumping
- Raw sewage screening
- 4.5MLD Activated Sludge Plant (ASP) – added in 1995
- 3 MLD Lagoon Plant - legacy plant in operation since 1975
- Chlorination
- Anaerobic digestion of primary and secondary sludge in sludge lagoons
- Sludge drying in drying pans.

Class C recycled water from the plant is pumped from Lagoon Number 4 to the Bald Hill Storage Reservoir (BHR). The flow to BHR is controlled by a high level in Lagoon Number 4 which initiates pumping to BHR.

3.3 Class C Plant Current Operation

Sewage from the Pakenham catchment is currently diverted to the Class C plant to meet recycled water demand requirements with excess flows directed to the Pakenham South Sewage Pump Station and transferred to the Eastern Treatment Plant (ETP).

Discussions with SEW have confirmed the following operational philosophy for the Pakenham WWTP:

- SEW currently preferentially meet reuse demand (either Class A or Class C) with the ASP.
- If Class A supply requires all the ASP flow SEW will meet Class C demand by increasing flow to the lagoon plant.
- If Class A supply on average exceeds the ASP capacity, SEW's current plan is to augment the activated sludge plant capacity with an additional clarifier and primary tank. This is planned for around 2024/25.
- The lagoon plant will receive wet weather flows which will be directed to the BHR. If the BHR becomes full then either pond 4 or reservoir water can be fed to Pakenham South pump station and pumped to ETP. This option is not favoured as SEW pay to treat the water twice under these conditions.

The effluent produced from the Class C plant is reported to be compliant with Class C requirements which are summarised in Appendix C.

3.4 Class A WRP

The Class A plant has a treated water design capacity of 4MLD with provision to expand to 8MLD in future.

The Class A Plant was constructed approximately 4.5 years ago to supply the South East Growth Corridor. The principal purpose of the Class A plant was to provide the third pipe recycled water scheme for the proposed development in Officer, with the secondary purpose to reduce the volume of effluent that will be transferred to ETP (*Pakenham Class A Facility – Concept Design Report, January 2009, Beca)*.

The Class A plant is comprised of the key process units:

- Feed pumps
- Pre-screen: coarse screening for removal of larger particulates
- Pre-treatment comprised of chlorination and coagulation using Aluminium Chlorohydrate (ACH)
- Ultrafiltration Membrane Train (Pall Microza) for removal of suspended solids and microorganisms (protozoa, virus)
- Ultraviolet (UV) Reactor for disinfection (protozoan inactivation) and
- Post disinfection via chlorine (sodium hypochlorite) (virus kill)
- 1.6ML Class A Chlorine Contact Tank
- Class A recycled water pump station.

Class A recycled water from the plant is pumped from three Class A recycled water pumps to the SEW Class A reticulation network which currently extends to the Officer South Residential Reuse requirements and Officer South.

3.5 Class A Plant Current Operation

Since being implemented, the Class A plant has been operated infrequently, with operational staff reporting that the plant has only operated for around 3 months to supply Class A water to the Officer South residential reuse and Officer South district. The current demand is reported to be typically around 0.2 MLD. This is significantly lower than the previously projected demands, which forecasted an average annual flow of 2.3 MLD up to a peak daily flow of 8.4MLD by 2015 (*Pakenham Class A Facility – Concept Design Report, January 2009, Beca*).

The low demand is understood to be associated with a number of factors including slower growth in Officer than anticipated, and possibly smaller lot sizes. Based on the growth forecast for Officer, the estimated population of Officer is projected to be around 34,000 people by 2035. The current population is 2,500. Refer Appendix D for details). The demand for Class A recycled water to service this growth requires consideration together with the Class A demands projected for the Pakenham East development. This is discussed further in the section below.

3.6 Class A Future Expansion

The Class A plant building has been designed with sufficient space to allow for future expansion to 8MLD capacity. As shown in the general arrangement provided in Appendix E, there is space for additional UF membrane train and associated infrastructure to be constructed within the existing building.

The plant is reportedly designed with sufficient electrical capacity for future expansion, however further detailed investigation is required to confirm this.

3.7 Current Performance Targets

The plant has recently passed performance testing and is reported to meet the product water quality requirements including the log removal targets (LRV) specified by the Department of Health (DoH). (Refer to Appendix C for details).

High colour in the Class A effluent (>15 Platinum Cobalt Units (PCU)) has previously been an issue for some Class A users, however this has reportedly improved since the waste from O'Connell's Abattoir's has been diverted to Pakenham South Pump Station. A colour of <15 PCU is reported to be achieved.

3.8 Impact of Stormwater

The blend of stormwater with the existing Class C effluent stored in the Bald Hill Reservoir (BHR) will potentially impact the water quality which is currently fed to the Class A plant.

Stormwater, typically low in total dissolved solids (TDS) and high in total suspended solids (TSS) are key considerations when evaluating the impact of the stormwater reuse option (Option 3) on the current system performance. The impact of stormwater on TDS concentration in BHR is reviewed in Section 6.5 below.

The low TDS of the stormwater will dilute the Class C effluent which will provide an additional benefit associated with Option 3. Increased solid and nutrient loading from the stormwater will, however, be fed to the BHR which may result in increased sludge accumulation and could also influence algal growth in the BHR. The Class A plant is not currently designed to deal with algae, therefore modification to the existing plant (ie: clarification process) could be required to manage this risk.

Intermittent desludging of the BHR may also be required to prevent sludge accumulation which may influence TSS exiting the BHR over time (ie: result in noncompliance with TSS requirement). This is discussed further in 6.6 below.

4. Bald Hill

4.1 Overview

The Bald Hill Reservoir (BHR) is located approximately 3km to the north of the Pakenham WWTP. A general arrangement drawing of the basin is provided in Appendix F. The BHR, which has a nominal capacity of 900ML typically provides between 600 to 1300 ML/year Class C recycled water. Class C water is pumped to the BHR upon activation of high level in Lagoon Number 4. The level is reported to be typically maintained at close to full level where possible. When BHR is full, excess flows are wasted to the ETP.

The management of Class C flows into the BHR and Class A plant is currently a manual process where SEW Operational staff undertake a water balance calculation to determine flows required through the WWTP plant to meet Class C recycled (and Class A) water demands.

The storage was constructed approximately 15 years ago to store Class C recycled water to meet downstream irrigation requirements. Class C recycled water is currently transferred from Lagoon Number 4 to the Bald Hill (BHR) Reservoir. The inlet to the basin is comprised of an open submerged inlet pipeline which is on the opposite side of the floating offtake. Class C water is pumped from the BHR to the downstream irrigators via transfer pumps which are housed in a pump station building opposite the basin.

4.2 Class C Demand Estimates

Based on Class C consumption data provided by SEW, the main Class C irrigators are the Bald Hill Farm, Evergreen Turf, Lilydale Instant Lawns and the Pakenham Golf Course. A number of other smaller users have historically used Class C water in the past however these users have not appeared over the past 4 years. It is not clear at present whether these users no longer require Class C water or whether they have just not required it during the generally wetter recent years (2010 to 2014). The majority of these users take water from the BHR outlet, however there are also a number of users on the inlet between the Class C plant and the BHR.

Monthly consumption data for Class C recycled water users was provided from SEW for the period 2007 to 2015. Based on that data the following was observed:

- The maximum demand over a 12 month period was 1317ML.
- The minimum demand over a 12 month period was 159ML.
- Class C irrigators typically require water from November to March each year however, during drought conditions irrigation can be required over a longer period (ie; 6 months).

A ‘user pays’ arrangement is currently in place for the Class C users. This allows the Class C irrigators to take water on an as required basis and only pay for the recycled water which they use. No advance notification to SEW operational staff is required under the current arrangement.

A water balance model was setup to examine the likely past performance of the BHR operating as an irrigation balancing supply. Using the historical demand data, and assuming that the Pakenham Class C plant was operating at 4.5ML/d continuously when the basin was less than 100% full, a timeline graph of basin level was developed, which is presented in Appendix G.

Appendix G shows that in recent years (last 4) the basin has stayed relatively full, due to lower demand compared with the 4-year period before this. In the drought years of 2006 to 2010, however, the basin fell to a low level in the model. This was due to the higher demand in those years.

Overall, this suggests that the basin may not have as much easily available 'spare' capacity as considered based on advice from more recent observations. This would indicate that BHR could not provide a flood retardation function, which would require spare capacity to be available, unless the Class C capacity was increased to enable the Class C irrigation demands to be met during the dry years. This would economically disadvantage the potential retardation element of Option 3.

Harvesting stormwater only (without the retardation function) would effectively replace the need to produce Class C water. This in turn would require more wastewater to be treated at ETP, but compared with the retardation function, would require a smaller stormwater transfer pipeline.

This analysis is particularly dependent on the following two points:

- The assumed operating regime of the Class C plant supplying water to BHR; and
- The reason for the reduction in Class C demand in the last 4-years during the wetter years.

4.2.1 Class C Water Quality

The recycled water quality from the BHR is reported by SEW to typically meet Class C quality requirements.

SEW Operational staff advised that algal growth has been an issue in the past however this has not impacted on Class C supply to irrigators. Notification is made to the irrigators during these events however no other rectification measures to remove or kill algae are currently undertaken.

The algae issue is thought to be attributed to previous plant operational practices which included discharge of waste from O’Connell’s abattoirs which resulted a higher nutrient load in the BHR (and better conditions for algal growth). With proposed changes to SEW current plant operations, the nutrient load will be lower and it anticipated that the algae issue will improve.

As noted above, the impact of algae on the Class A plant performance remains to be a risk which requires management through operational practices and control or addition of processes to the Class A plant to remove algae. This is discussed further in 6.6.1 below.

5. Water balance analysis

5.1 Dry, average & wet years

A spreadsheet water balance model was initially setup to investigate each option under three different scenarios:

- dry year;
- average year; and
- wet year.

Model Outputs for these scenarios are provided in Appendix K for Option 3 (Pakenham East supply only).

The purpose of these investigations was to understand the demand profiles and the behaviour of BHR for a range of climate conditions. The following assumptions were adopted:

- The demand for Class A non-potable water from development at both Pakenham East and Officer was included.
- Officer Precinct will be approximately three times as large as Pakenham East at ultimate growth.
- The Class A non-potable demand for Pakenham East was adopted from the IWM Toolkit, which was setup as part of the initial phase of work. The Class A non-potable demand for Officer was based on the East Pakenham estimate and pro-rated based on the relative size difference between Officer and Pakenham East.
- Class C irrigation demand was based on the historically available data from SEW.
- BHR was assumed to have an initial starting volume at 800ML, a minimum operating capacity of 200ML (considered a reasonable minimum operating volume to avoid sludge being drawn into the Class A WTP) and maximum operating capacity of 900ML.
- Stormwater was harvested from retarding basin W2 and retarding basin W4, which are located at the downstream boundary of the Pakenham East precinct and cover the two main catchments within the precinct.

5.2 Development from 2015 to 2034

The spreadsheet water balance model was further extended to investigate each option through the period covering the start of development (2015) to full development (2034). This model considered the growth rate in Pakenham East and Officer. The purpose of this investigation was to help identify the timing of when the capacity of Pakenham WWTP would need to be upgraded and what size the upgrades would need to be.

In addition to those listed in Section 5.1, the following assumptions were adopted:

- It was assumed that linear growth would occur in both the Pakenham East and Officer precincts from commencement of development (2015) to ultimate development (2034), after which no further growth was considered.
- Ultimate developments of precincts would occur in 20 years.
- Initial population of Pakenham East and Officer is assumed to be 1000 and 2551 persons (Cardinia Shire website).
- Class C irrigation demands were unchanged over time, i.e. Cardinia Shire has maintained their commitment to supply Class C recycled water for irrigation purposes. For the purpose of the water balance model, we have adopted the actual historical Class C irrigation demands (from 2007 to 2014), and continuously repeated over the period 2015 – 2034. The rainfall conditions corresponding to these years was similarly also repeated.

Outputs from the modelled Options are provided in Appendix J (Option 2) and Appendix K (Option 3).

6. Option development

6.1 Stormwater transfer pipeline

6.1.1 Function and alignment

For the purpose of transferring stormwater from the Pakenham East Precinct to Bald Hill, Option 3 requires a stormwater transfer pipeline.

As part of this option, this pipeline could be used and sized accordingly to transfer just stormwater flows for meeting harvesting requirements or for transferring flood flows up to the 100-yr ARI event to allow Bald Hill to achieve a flood flow retardation function as well as the harvesting function.

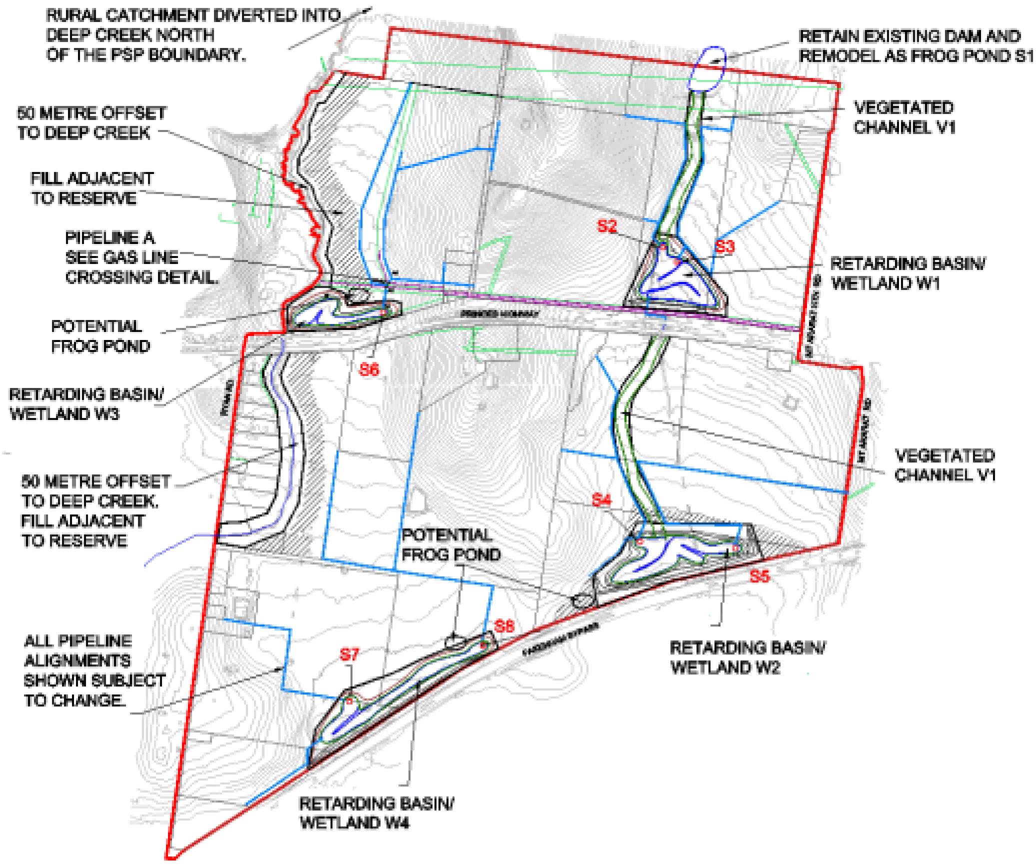


Figure 3 Proposed drainage strategy

(As presented for Option 1 in the drainage strategy report prepared by Stormy Water Solutions, 2014)

In addition to Deep Creek that runs along the western boundary of the precinct, there are two main drainage paths that run through the Pakenham East Precinct. Based on the drainage strategy, as presented in Figure 3, the majority of stormwater from the precinct will discharge into these two drainage paths, with some also discharging to Deep Creek. For the purpose of harvesting stormwater from the precinct, it has been considered that the transfer pipeline would connect to these two drainage paths at their outlets from the site at Retarding basin / wetlands W2 and W4.

If the transfer pipeline was to be used to only harvest stormwater from the precinct, it may only need to connect to one of these catchments. Alternatively, if the transfer pipeline was to be used to transfer the 100-yr ARI flood flow to provide a retardation function at BHR, it would need to connect directly to each RB site that it was replacing. If the transfer pipeline was connected to the outlet of the two catchments from the precinct it would have the potential to remove the need for retarding basin W2 and W4. However it would not remove the need for retarding basin W1 and W2, which are located further upstream and are required to attenuate the peak flood flows to enable them to pass through the existing culverts at the Princes HWY.

Unlike for the retarding basins, the stormwater harvesting options has the potential to remove the need for all four wetlands because the water quality targets need to be achieved leaving the precinct. The connection of the stormwater transfer pipe to retarding basin W2 and W4 could therefore potentially remove the need for wetlands at W1, W2, W3 and W4, because the harvesting will remove about 50% of the water overall, which is similar to the BEPM requirements to achieve 45% reduction of nutrients.

The proposed alignment for the transfer pipeline is presented in Figure 1, which indicates the major obstructions along the route including crossing a railway line, Deep Creek and the Princes FWY. The length of the route is approximately 3500m. A schematic showing the vertical alignment of the stormwater transfer pipeline is presented below in Figure 4. Based on the vertical alignment there is a fall of approximately 8 m between the proposed RB outlets within the precinct and the water surface at BHR. A low point is formed in the alignment where the pipe will have to pass beneath Deep Creek. The pipe will therefore have to flow under pressure to convey water from the RB outlets to BHR. Sediment basins will be located at the inlet s to the transfer pipeline to manage sediment loads carried within the pipe and the potential for siltation, particularly at the low point where the pipe passes beneath Deep Creek. Controls will also be required at the inlets to the transfer pipeline to prevent flow from entering the pipeline when BHR is at capacity. An overflow is located at BHR, but the preference will be for flow not to be transferred along the pipeline when BHR is at capacity.

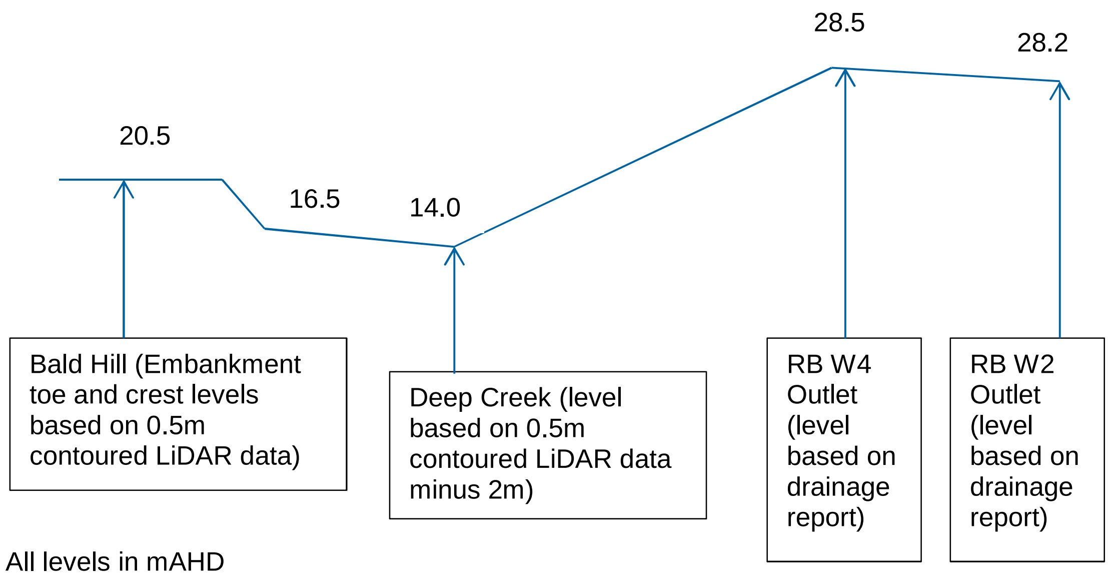


Figure 4 Schematic of the stormwater transfer pipeline vertical alignment showing key levels

6.1.2 Cost estimate

Indicative cost estimates for the stormwater transfer pipeline covering Options 3A and 3B have been prepared based on the following assumptions:

- Costs represent construction costs of the proposed works only and do not include specific allowances for:
  - Design, including design of associated works and/or service relocations;
  - Disposal of excess excavated material (including soil and/or removed drainage infrastructure);
  - Ongoing maintenance costs (expected to be relatively minor); and
  - Other investigative works or assessments (including but not limited to geotechnical, environmental or cultural heritage investigations and/or community consultation); and
  - Service relocations and associated works.
- Pipe rates include an allowance for excavating, pipe acquisition, pipe laying and backfilling (but currently exclude additional reinstatement costs) – the adopted pipe rates are outlined in Table 1;
- Pipe rates have been estimated based on a limited sample of data from three Melbourne Water Pipelines Alliance cost estimates (Sandgate Avenue Drain – Stage 3, Glass's Creek and Hawthorn Main Drain);
- Cost rate factors are based on those developed for previous Melbourne Water Redevelopment Services Scheme (RSS) studies and are currently used for Melbourne Water Development Services Schemes. These rates were developed from historical data and are likely to vary from site to site and over time It is understood that these factors indirectly incorporate a nominal allowance for reinstatement, traffic management, service relocation, and site constraints. The cost factors are presented in Table 2, are based on historical data and are likely to vary from site to site and over time; and
- Pit costs are assumed to be $50,000 per pit – this rate will overestimate some pits, but overall provides some allowance for larger pit structures, headwalls and outlets.
- Land costs for the easement have been assumed to be $50,000/ha, based on advice from Council for similar easements on VicRoads land.

These estimates are not intended to be accurate or reflect a total cost of developing and implementing this solution. They are intended to provide an indicative estimate for the cost of constructing this solution for comparison to other options and discussions regarding further development/refinement of this option. More reliable concept designs and cost estimates should be obtained prior to making decisions relating to strategic directions, particularly when the uncertainty in these estimates is relatively large compared to the differences between competing options.

Cost estimates for the stormwater transfer pipeline are presented in Table 1 for Options 3A and 3B. The cost estimates are based on:

Table 1 Assumed base pipe rates

Pipe Dia. (mm)	Cost ($/m)
600	1150
2100	3110

Table 2 General cost rate factors

Category	Median Factor
Greenfield	1
Reserve	1.2
Minor Road	1.4
Properties	1.8
Major Road	2.5
Pipe Jacking	4

Based on the above assumptions and approach, the Indicative cost estimates for the stormwater transfer pipeline covering Options 3A and 3B are presented in Table 3.

A breakdown of the estimate is provided in Appendix H.

Table 3 Stormwater transfer pipeline construction cost estimates

Option	Description	Construction cost estimate (excl prelims and contingency)
3A	Stormwater harvesting only (based on a 600mm pipeline diameter)	$6.4M
3B	Providing a retardation function (based on a 2100mm diameter pipeline)	$15.0M

Based on the previous phase of work, the potential cost for constructing the four wetlands was estimated to be $7.6M (excluding land costs).

6.2 Class A capacity

Estimates of the Class A peak demand for the Pakenham East and Officer precincts and their growth from the start of development (2015) to ultimate development (2035) are plotted in Appendix H. This shows:

- There is currently sufficient Class A capacity at Pakenham WWTP to supply Pakenham East only when fully developed.
- If Pakenham WWTP was providing Class A for both the Pakenham East and Officer precincts, its existing Class A capacity would be required to be upgraded by approximately 2020.

The above observations for Class A are independent of whether Option 2 or 3 is being considered.

While the plot in Appendix H indicates that there is sufficient Class A capacity at Pakenham WWTP to supply Pakenham East only (when fully developed), the Class C capacity would need to be upgraded because currently the existing Class C capacity is required to supply irrigators during dry years and therefore there is currently no spare capacity for supplying to Class A production.

6.3 Option 2 - Pakenham WWTP recycled water

The plot of demands and BHR volume through the period covering the start of development (2015) to full development (2034) are presented in Appendix I for Option 2.

Appendix I1 shows the results with the current Class C plant capacity, which based on BHR being emptied, confirms that there would be insufficient Class C capacity. The timing on the

Class C capacity upgrade would need to be as soon as Class A supply was provided because the current Class C capacity is all required to provide water to the irrigators.

Appendix I2 shows the results with the required Class C plant capacity upgrade to enable Class A and Class C demands to be met. For Option 2, the Class C capacity would need to be upgraded to 14ML/day.

In the case where the basin is not used, but Class A is supplied directly from the Pakenham plant [i.e. the case with no stormwater harvesting], there is a need to increase the amount of Class C produced from the plant to match the Class A demand from the dual pipe network. With no significant storage available, this additional Class C and Class A plant size will need to match each other, and be close to the peak demand for Class A.

6.4 Option 3 - Bald Hill stormwater harvesting with recycled water

The demands and BHR volume estimates are provided in Appendix J1 for Option 3 covering the dry, average and wet year scenarios. These results indicates an upgrade to the existing Class C capacity would be required in a 'dry' year, but for an 'average' and 'wet' year sufficient stormwater could be harvested to remove the need to upgrade the existing Class C capacity.

Basically shows that the existing capacity at Pakenham WWTP is not sufficient to meet ultimate demands at both Pakenham East and Officer for Option 3 in a dry year. However there is sufficient capacity in an average and wet year.

The plot of demands and BHR volume through the period covering the start of development (2015) to full development (2034) are presented in Appendix J2 and J3 for Option 3.

Appendix J2 shows the results with the current Class C plant capacity, which based on BHR being emptied on a few occasions, confirms that there would be insufficient Class C capacity.

Appendix J3 shows the results with the required Class C plant capacity upgrade to enable Class A and Class C demands to be met. For Option 3, the Class C capacity would need to be upgraded to 6.8ML/day. Alternatively potable water could be used to meet demands in the dry years.

Review of the results for the cases where stormwater is introduced into the basin shows that [as expected], dry years create a dual challenge to manage. Irrigation demand is increased, which draws the basin down more, and on the other hand, the inflow from stormwater is decreased, as it is dry, which does not fill the basin as much. So the design challenge is to identify the optimum sizing for the Class C plant, which provides certainty of supply, while avoiding overinvestment.

If the stormwater harvesting for flood mitigation is deemed too risky, there is still benefit in harvesting the stormwater, due to blending out of the elevated salinity, and due to the reduction [or even elimination] of the wetland area. This concept has reduced costs due to a smaller diameter pipe from the RBs to Bald Hill.

6.5 Option 3 Impact of Stormwater on SAR and TDS in Bald Hill Reservoir

Salt Adsorption Ration (SAR)

SEW have advised that the salt issue relating to the current treated effluent quality in BHR is due to the high Salt Adsorption Ratio (SAR). The SAR is a ratio defined by [Na]/SQRT (([Ca[+ [Mg]/2)).

Based on data provided by SEW, the SAR range is typically between 5 to 6.5. This is reported to be too high for the soils in Officer. The SEW proposed target (tbc) for SAR is 5.

The Na concentration of stormwater within the Pakenham East precinct is generally expected to be very low compared with the current treated effluent in BHR, although it can be very variable. Therefore as stormwater is added to the BHR, this will have the effect of reducing the sodium concentration of the Class C effluent and reducing the SAR of the effluent in the BHR over time.

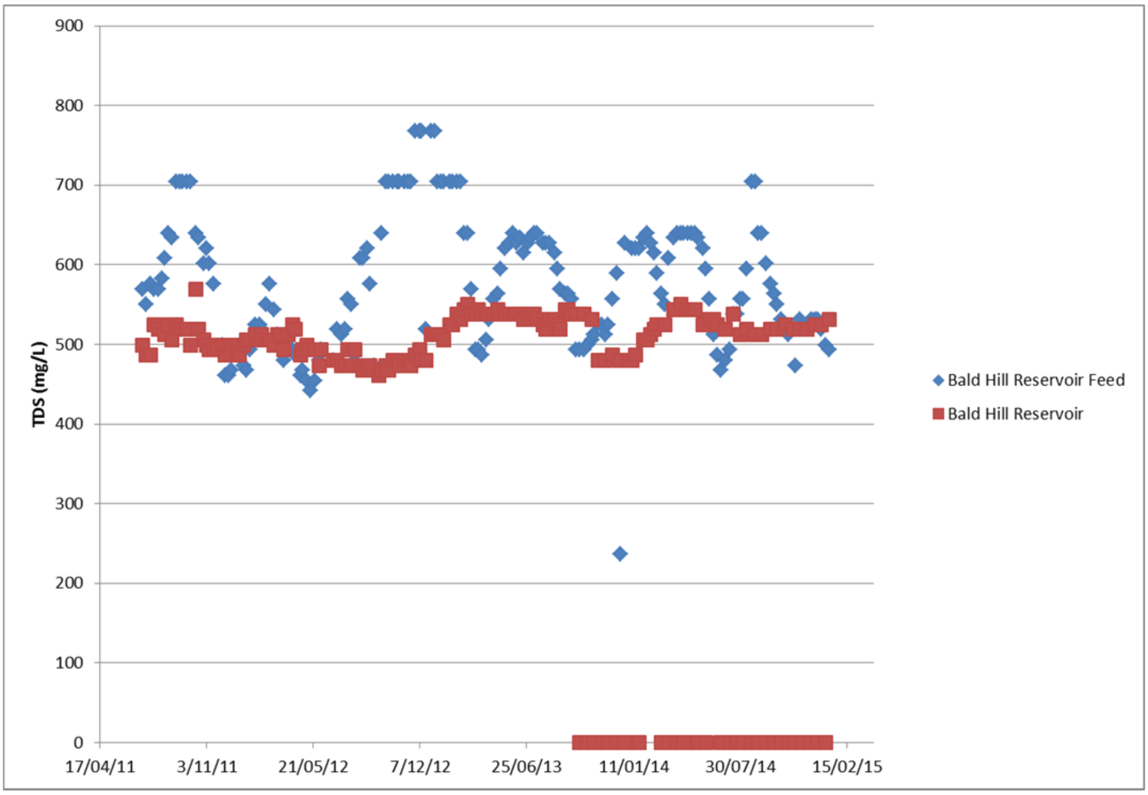
SEW have been considering the implementation of an RO plant to manage the SAR issue in BHR. Option 3 therefore offers the advantage of reducing the SAR via introduction of stormwater into the BHR which will offset the RO plant cost.

The CBA analysis undertaken in the latter section of this report, takes the cost of the RO plant required for Option 2 into account.

Total Dissolved Solids (TDS)

Electrical conductivity data obtained from SEW for the BHR was converted to TDS, the results of which are shown in Figure 5 below. The results demonstrate that the TDS currently typically fluctuates between 450mg/L to 770mg/L on the inlet and 460mg/L to 570mg/L on the outlet. Recycled water with a salinity of up to 500mg/L can generally be used without significant risk to crops, however recycled water with a TDS in excess of 500mg/L can be a risk to both soil and crops. The current TDS in BHR is a concern for SEW, therefore the dilution achieved via addition of stormwater to the BHR is a beneficial impact associated with Option 3.

To evaluate the impact of stormwater on the final TDS in the BHR, a salt balance was undertaken assuming the incoming Class C recycled water has a TDS of 800mg/L (assumed worst case), the initial TDS in the BHR is 600mg/L and the stormwater has a TDS of 20 mg/L.



Note: Assumed conversion for EC to TDS: 1000uS/cm = 640mg/L TDS.

Figure 5 Bald Hill Reservoir Total Dissolved Solids (TDS) 2011 to 2015 – Bald Hill Feed and Bald Hill Reservoir

The results of the analysis are shown in Appendix J3. The results indicate that the TDS in the BHR basin is reduced to around 400mg/L under the assumed conditions.

6.6 Option 3 Potential Water Quality Issues in Bald Hill Reservoir

A number of risks associated with the impact of stormwater introduction into BHR have been identified with Option 3. These risks and mitigation measures to manage the risks are summarised below:

6.6.1 Algae

Algae growth in the BHR has historically been an issue due to high nutrient loading associated with past plant operations, however SEW expect algae growth to be less of a problem in future with currently proposed changes to operation (lower incoming nutrient loads).

The incoming stormwater is anticipated to be typically lower in nutrients (phosphorus, nitrogen, nitrates) therefore it is expected that when combined with the Class C effluent the total nutrient load in the BHR will be reduced, which will be favourable to reduce the potential for algae growth.

The potential for algal growth in the BHR still poses a risk to the operation of the Class A plant as algae can potentially foul the UF membranes over time, resulting in a lower flux rate through the UF and reduction in capacity of the Class A plant.

A pre-treatment process ahead of the Class A plant, such as Dissolved Air Flotation (DAF) can be implemented to manage this risk. As part of the CBA for Option 3 a DAF plant has been included in the assessment.

The DAF plant would comprise DAF tanks, air saturator system, compressed air system, interconnecting pipework from BHR to the Class A plant and integration of the DAF plant with existing Class A plant controls and SCADA system. Waste sludge removed from the DAF plant would be directed to the existing Class C WWTP.

6.6.2 Total Suspended Solids (TSS)

Option 2

The existing Class C plant reportedly meets the Total Suspended Solids (TSS) target of < 30 mg/L. Assuming an average incoming TSS of around 15 mg/L from Class C effluent and an assumed flow of 2.6 ML/D to the BHR, the solids load into the BHR for Option 2 is around 14,000 kg/yr. The remaining 3.4 ML/D goes directly to the Class A plant and therefore not to BHR.

Option 3

The total suspended solids load from the stormwater will be managed via implementation of sediment basins at the inlets to the stormwater transfer pipeline at the retarding basin sites. The sediment basins will be designed to remove approximately 80% of the total suspended solids load from the stormwater prior to it entering the BHR.

Based on the assumptions below, the incoming loading to the BHR would be expected to be around 29,000 kg/yr.

Average annual harvested stormwater (ML/yr)	913
Average daily harvested stormwater (ML/day)	2.5
Typical urban total suspended solid concentration (mg/l)	158
Average annual total suspended solid load for harvested stormwater (kg/yr)	144,254
Sediment basin performance	80%
Calculated residual average annual total suspended solid load from harvested stormwater to BHR (kg/yr)	28,851

For Option 3, it was assumed that the average incoming TSS was around 10mg/L from Class C effluent (marginally less than Option 2 because ASP can provide the required demand of 3.4ML/D and therefore Option 3 does not have to rely on lagoon plant). A flow of 3.4ML/D to the BHR was assumed. This would equate to a solids load into the BHR for Option 3 of around 12,000 kg/yr.

Therefore the estimated additional TSS loading to BHR due to Option 3 is around 3 times more than Option 2 (29,000kg/yr + 12,000kg/yr = 41,000kg/yr).

This will result in increased sludge accumulation in BHR, which will bring forward any desludging as compared with Option 2. (SEW has not desludged the BHR in 15 years of operation).

This will also result in an increase in TSS load to the Class A Plant, which will result in more frequent backwashing and additional sludge production from the Class A plant. Given that allowance has been made for a DAF as a pretreatment to the Class A plant in the costings, the DAF plant will also help to remove some TSS ahead of the UF plant, and thereby reduce the additional TSS load to the UF.

6.7 Timing of stormwater harvesting

6.7.1 Council

In terms of the PSP process, decisions on the choice of option need to be made now that affect land take. Within the PSP boundary, the main difference between Option 2 and Option 3a would be with the wetlands and stormwater transfer pipeline as presented in Table 4.

Table 4 Infrastructure requirements within the PSP

Infrastructure	Option 2	Option 3A
Retarding basins (and associated pipe drainage)	Yes	Yes
Wetlands	Yes	No
Stormwater transfer pipeline	No	Yes
Third pipe network	Yes	Yes

The retarding basins are required for both Option 2 and Option 3A and the wetlands would be contained within the footprint of the retarding basins. Therefore there would be no change in the overall land take (encumbered land) for drainage infrastructure with or without the wetlands, unless the retarding basins were used for alternative uses such as open space which would then increase the residential net developable area.

The stormwater transfer pipeline is proposed to be located within the Princes FWY road corridor and would connect to the outlets of retarding basin W2 and W4 within the PSP, which are located at the boundary of the PSP with the Princes FWY corridor. The land take for the stormwater transfer pipeline within the PSP would therefore also not extend beyond the land required for the retarding basins.

As Options 2 and 3A do not change the total land take within the PSP beyond that which would be already encumbered by the retarding basins, it is understood that Council will proceed with a "standard" PSP delivery. It is understood that this will have consideration for wetlands but also include flexibility for different uses of the land within the retarding basin footprints.

6.7.2 South East Water

It is understood that South East Water would not have any particular time constraints on when it would need to implement a stormwater harvesting option, as Class A at the moment could be supplied through recycled wastewater.

6.7.3 Melbourne Water

Melbourne Water through the development services scheme would be responsible for the construction of the wetlands within the PSP. It is understood that under the normal delivery of the PSP, these would be constructed as development of the PSP occurs. The timing of this therefore presents a limit on how long a decision on stormwater harvesting can be deferred if the benefits of not having the wetlands are to be realised.

Stormwater harvesting could still be implemented following the construction of the wetlands, but then the cost saving benefits of not having the wetlands would clearly not be realised. This scenario could potentially also be used if increased storm water treatment performance was required after the construction of the wetlands.

6.8 Value of wetlands

A common set of hydraulic and environmental performance criteria are incorporated into the design of Melbourne Water's development services schemes. They are:

1. All new developments will be provided with 1-in-100 year flood protection consistent with ResCode requirement
2. The minor drainage system shall have a capacity to cater for a 1-in-5 year storm event
3. Water quality treatment to 'Best Practice'* (currently 45% reduction in total nitrogen and phosphorous, 80% reduction in total suspended solids)
4. Protection of the environmental, social (including heritage) and economic values of waterways.

Constructed wetlands are generally used in new developments in response to addressing criteria 3 and 4. However it is acknowledged that wetlands have further value to the community beyond these criteria. For example they provide amenity, a place for relaxation and enjoyment by the community, as well as being aesthetically pleasing.

Generally developers would prefer not to have to accommodate drainage infrastructure within their developments so that they can then maximise their number of lots. However in the case where retarding basins are required, developers then typically prefer to have wetlands incorporated within the footprints of the retarding basins because of the extra value the wetlands provide to the otherwise encumbered land. It is understood that this extra value is reflected in the price of the lots that the developers can sell adjacent to these locations.

The removal of the wetlands from the retarding basins would therefore potentially create a reduction in the value of the land to the developer.

The four wetlands within the Pakenham East precinct cover a large area (in total 14.6ha). One option that is considered would provide a financial cost saving for Option 3A while still providing value to developers is to construct smaller wetlands or more ornamental lakes. It is not clear at this stage to what size the wetlands could be reduced from a developer's perspective.

An alternative to constructing wetlands within the footprint of retarding basins, would be to consider facilities such as sports ovals, which are relatively tolerant to flooding. A typical cost for an irrigated sports oval would be approximately $0.5M. This would probably need to be discussed with developers to better understand the value of this approach compared with wetlands. This approach may offer more land within the PSP, if Council was prepared to consider that an oval within a defined retarding basin site was an acceptable replacement for an oval otherwise elsewhere.

7. Cost benefit analysis

7.1 Key considerations

The analysis presented in Section 4.2 showed that there are times when the full BHR depth is utilised [in dry years when there is maximum demand], and therefore the opportunity to use the basin to manage floodwater flows is limited. In addition, risk assessment showed that using the basin to manage flooding had the highest risk and complexity. As a result, Option 3b was eliminated from further consideration. Options 2 and 3A were therefore left for comparison.

In the CBA analysis presented in this section, Option 2 refers to Class A supply to a dual pipe network and Option 3A refers to stormwater harvesting in Bald Hill. Through analysis, discussion with stakeholders, site visits and risk assessment, a range of issues, risks and opportunities were developed.

The estimates presented in this net present value assessment have been developed for the purpose of option comparison. They are not suitable as a basis for setting budgets. The accuracy of the cost estimates are expected to be within ±30%.

The following list explains a number of the key considerations, and then the following table provides a summary of how the options have been compared, taking these considerations into account.

1. **Wastewater treatment.** In the stormwater harvesting option, more wastewater is sent to ETP, as the need to treat it locally to produce Class A water is reduced. This has been considered by assigning a ‘cost’ to sending wastewater to ETP.
2. **Potable water backup for Class A production.** Various sizings for Class A are possible, ranging from 100% of peak alternative demand down. Lower levels require increasing amounts of potable backup. In this comparison, these are kept constant between the options, so each requires the same amount of potable backup.
3. **Algae.** The proposed configuration of the stormwater harvesting option includes supply of a blend of Class C and stormwater from Bald Hill to the Class A plant for further filtration and then supply. Bald Hill may contain algae from time to time, which could affect the treatment plant. This has been considered by adding a DAF plant prior to the treatment plant.
4. **Elevated Sodium Absorption Ratio (SAR).** The current Class C water contains elevated levels of Na which increase TDS and SAR and are not desirable for customers. This risk is reduced in the case where stormwater is harvested, as the Na content of stormwater is very low. A partial RO plant is included for Option 2 to manage this risk.
5. **Sediments.** The stormwater will include sediments. These have been considered by including a settling basin prior to the pipeline heading to the plant. This will remove around 80% of the sediments. Note that the remaining 20% will still enter Bald Hill. However, the current Class C water also includes suspended solids, so there is some build up occurring in any case.
6. **Provision of sufficient Class C water.** The existing plant has two trains which can be operated in parallel. It has been assumed that around 7.5 ML/d can be treated without significant upgrades based on advice from SEW.

7. **Pipeline to harvest stormwater.** This option includes a pipeline from the East Pakenham development to Bald Hill basin. This pipeline has to cross major roads and across private land. Allowance for crossings etc has been included in the cost estimate, but further work is required to determine how easements and crossing approvals etc would be managed before this option could be adopted with confidence.

8. **Effects on the Development.** In both options, the development is serviced with Dual pipe. The key difference is that in the case of the stormwater harvesting, no wetlands are required. This will change the aesthetics of the retarding basins. It provides an opportunity for alternative landscaping approaches, or other uses such as playing fields.

Table 5 Option comparison

Consideration, Risk, Opportunity	Class A Option	Stormwater Harvesting Option
Wastewater Treatment	Less Goes to ETP. Included in NPV.	More goes to ETP. Included in NPV.
Potable Backup	Same for both Options.	
Algae impact on Class A Filtration Plant	Not applicable.	DAF Plant included as pre-treatment ahead of Class A plant
Elevated SAR	Partial RO to reduce.	Reduced through SW addition.
Sediments into Bald Hill	As per current loading from Class C TSS.	80% reduction of SW TSS prior to Bald Hill. Residual risk related to 20%.
Increased Class C capacity.	Up to 7.5 ML/d available from existing facility.	Not required as SW provides resource.
Pipeline for SW to Bald Hill	Not required.	Costed on basis of route. Risk related to getting easements, crossing approvals etc.
Development Aesthetics	Wetlands in RBs.	No wetlands, but an opportunity to landscape, not currently costed.

7.2 Observations from the NPV Analysis

NPV analysis was undertaken for Option 2 and 3A and the following observations were made:

- The cost of the pipeline to transfer the stormwater to Bald Hill is approximately the same as the cost of the wetlands. Conceptually, the pipeline substitutes for the wetlands, as it removes around half of the stormwater from the precinct, thus achieving a nutrient reduction equivalent to that achieved by the wetlands. The question of the aesthetic value of the wetlands to the developer and the eventual residents is not accounted for in this comparison. A further issue arises. As the water from the pipeline will then be used for supply, a question arises as to who should fund the pipeline, and under what mechanism. So while this element of cost comparison appears neutral on a whole of community cost basis, a number of other factors require consideration by the stakeholders.

- Using the base input factors, the Stormwater Harvesting Option appears to have an NPV which is around $2 million less than the Class A option. Taken at face value, this suggests this option is more attractive on a whole of community cost basis. However, this option is innovative, and will require a range of complex negotiations to determine how costs are reasonably distributed. So the stakeholders need to consider whether this quantum of benefit is worth pursuing (see Appendix K1 for output sheet).

- The result is sensitive to the ‘cost’ assigned to sending wastewater to ETP. Once this cost exceeds around $1500per ML, then the options become equivalent (see Appendix K2 for output sheet).

- The result is very sensitive to the cost of ongoing wetlands maintenance. The base input value is 5% of the capital value spent per year. If this is increased to 10% per year, then the stormwater harvesting option is $6 million more attractive on an NPV whole of community cost basis (see Appendix K3 for output sheet).
- A wide range of other sensitivity analysis were undertaken, and all keep the two options within the ranges of the sensitivities outlined above.

Overall, the analysis of these two options suggests that Stormwater harvesting is a viable innovative alternative. However, it is around neutral on a whole of community NPV basis. So pursuing this option will be a decision based on factors other than the NPV analysis, and will require negotiation between stakeholders.

7.3 Distributional analysis

7.3.1 General

A preliminary analysis has been completed to consider how the overall cost for each option is divided between the following stakeholders:

- Melbourne Water (responsible for bulk water, bulk wastewater and drainage).
- South East Water (water and wastewater service retailer, including recycled water).
- Council (responsible for local drainage and public spaces).
- The developer (builds much of the infrastructure that is subsequently transferred to other stakeholders).
- Households (residents of the precinct).

The analysis has considered a simple split of the overall net present values for the options using the matrix for CAPEX shown in Table 6 and for OPEX shown in Table 7.

The analytical tool underlying this has been developed so that the weightings in this table can be easily modified to change how the costs are divided. It is recognised in this analysis that some assets are transferred (for example the reticulation) and that costs will be passed on through billing mechanisms to other parties and ultimately the households. This analysis does not include these transfers in any detail.

Table 6 CAPEX Cost Distribution Matrix

Component	MW	SEW	Council	Developer	Household
Reticulation (pipework within precinct)					
Potable Reticulation				1	
WW reticulation				1	
Drainage System				1	
Dual Pipe Reticulation				1	
Pipelines (connections to existing network or treatment plants)					
Supply Pipe from Regional Potable Network		1			
Class A TP at Pakenham WWTP to Class A Network Pipeline		1			
Bald Hill to Class A TP Feed at Pakenham WWTP Pipeline		1			
Storm Water Harvest from RB to Bald Hill		0.5		0.5	
Treatment Plants					
Expansion of Pakenham WWTP		1			
Expansion of Class A TP at Pakenham WWTP		1			
Pumpstations					
Class A TP to Purple Network Pumpstation		1			
Bald Hill to Class A TP Feed at Pakenham WWTP Pumpstation		1			
Storm Water Harvest from RB to Bald Hill Pumpstation		0.5		0.5	
Waste water pump station		1			
Collection and Storage					
Potable Network Storage Tank		1			
Class A Network Storage Tank		1			
Bald Hill Stormwater Inflow Works		1			
Retarding Basins				1	
Wetlands				1	
Other Capital Costs/Benefits					
Land Take				1	

Table 7 OPEX Cost Distribution Matrix

	MW	SEW	Council	Developer	Household
Pumping costs		1			
Mains Water Use (Potable water top-up to Class A TP)	0.5	0.5			
WW To ETP	0.9	0.1			
WW Treatment (Local)		1			
Class A Treatment in Class A WTP		1			
Extra Operation to manage floods at Bald Hill	0.2		0.8		
Wetlands Maintenance Cost	0.2		0.8		
Cost of WW contaminant loads to WWTP					

The cost of elements has been shared between parties where there is either some shared responsibility (e.g. for potable water Melbourne Water provide the bulk water and trunk mains, while SEW provide the supply mains and act as the retailer) or assets are delivered by one entity for another (e.g. the reticulation is built by the developer, who in turn transfers ownership to SEW). It is recognised that some of the cost distributions present above will require further negotiation between the various parties before they are agreed.

The distribution in the above matrices provides overall costs (as net present values in $M) for each of the above described stakeholders for CAPEX, OPEX and the total of CAPEX and OPEX in Table 8, Table 9 and Table 10 respectively.

Table 8 CAPEX costs by Stakeholder (based on Distribution Matrix)

	MW	SEW	Council	Developer	Household	Total
Option 2	$ -	$16,666,576	$ -	$66,979,681	$ -	$ 83,646,257
Option 3A	$ -	$19,459,987	$ -	$62,456,889	$ -	$ 81,916,876

Table 9 OPEX costs by Stakeholder (based on Distribution Matrix)

	MW	SEW	Council	Developer	Household	Total
Option 2	$1,694,582	$7,771,199	$ 3,085,440	$ -	$ -	$ 12,551,221
Option 3A	$7,258,016	$5,222,489	$ -	$ -	$ -	$ 12,480,505

Table 10 CAPEX and OPEX Costs by Stakeholder (based on Distribution Matrix)

	MW	SEW	Council	Developer	Household	Total
Option 2	$1,694,582	$ 24,437,774	$ 3,085,440	$66,979,681	$ -	$ 96,197,477
Option 3A	$7,258,016	$ 24,682,476	$ -	$62,456,889	$ -	$ 94,397,381

7.4 Development Services Schemes

Melbourne Water schemes comprise of a catchment-based drainage strategy that outlines the functional designs of the relevant infrastructure required to service urban growth, and a pricing arrangement that details how Melbourne Water will recoup the infrastructure costs through financial contributions paid by developers.

Each scheme consists of a strategy for proposed Melbourne Water (regional) assets, and some assets which may become local council assets, consisting of conceptual designs for works such as pipelines, overland flow paths, retarding basins, wetlands, floodways and other drainage and water quality treatment measures.

The strategy ensures that planning for urban development is conducted on a catchment basis, and meets appropriate standards for flood protection and environmental performance, including protection and enhancement of waterway and biodiversity values.

The strategy is funded by financial contributions paid when development occurs. All developable properties pay a drainage contribution on the basis of the development size and the development type. Contributions will include a hydraulic component which funds the flood protection works, and a water quality component which funds the water quality treatment works. The water quality component may be able to be reduced or negated by the developer undertaking their own on-site water quality treatment.

A common set of hydraulic and environmental performance criteria are incorporated into the design of development services schemes as follows:

- All new developments will be provided with 1-in-100 year flood protection consistent with ResCode requirement.

- The minor drainage system shall have a capacity to cater for a 1-in-5 year storm event.
- Water quality treatment to 'Best Practice'* (currently 45% reduction in total nitrogen and phosphorous, 80% reduction in total suspended solids).
- Protection of the environmental, social (including heritage) and economic values of waterways.

Melbourne Water follows 16 core principles for creating and funding schemes, which are outlined in their Principles for Provision of Waterway and Drainage Services for Urban Growth. Principle 4 states that schemes should propose infrastructure to service development that is optimal in terms of cost and performance.

The above design criteria outline what development services schemes need to achieve and that criteria does not include a need to provide stormwater harvesting. Principle 4 effectively states that Melbourne Water cannot add anything into a scheme that is not required to achieve the design criteria (in an optimum way). The assessment of Option 2 and 3A has been based on the overall costs to the community. However, one reading of these requirements suggests that if developer contributions as part of a DSS are used to fund either of the options, the overall costs for the infrastructure must be no more than the costs needed with an optimal traditional approach.

Funds could be transferred out of a scheme if infrastructure was needed to be constructed by organisations other than Melbourne Water or the developer.

At present the cost of constructing the wetlands approximately balance the costs of constructing the stormwater transfer pipeline. The function of the wetlands in providing stormwater treatment is effectively covered by the stormwater transfer pipeline. Therefore in theory developer contributions from the DSS could fund the stormwater pipeline.

The funding of water servicing infrastructure whether or not covered within the DSS should be agreed between the various funding parties, which include MW and SEW and most likely will also include the developers.

7.5 Wetland maintenance costs

The maintenance costs of the wetlands would be covered by the River Health team at Melbourne Water. The removal of the wetlands and thus the maintenance costs would therefore provide Melbourne Water with a cost saving.

8. Risk and issues management register

A number of risks and issues have been identified for Option 3 which needs to be addressed to adequately evaluate this option. The impact of and suggested actions to manage the risks are summarised in Table 11 below. Stakeholders responsible for managing the risks have also been identified (note: this is for further discussion). The intention is that all risks and issues identified throughout the project are captured and managed progressively and are mitigated or eliminated where possible.

Table 11 Summary of Key Risks and Issues – Option 3

Category	Risk/Issue	Impact	Status/Actions	Responsibility for Managing
Technical	Condition of current inlet works Inadequate mixing of stormwater and Class C effluent	Insufficient mixing results in short circuiting and deterioration in raw water quality to Pakenham WWTP Class A facility.	• Inlet works comprise only a inlet pipe • Design to allow for mixing in Bald Hill (baffles/inlet location)	SEW/GHD
Technical	Can Bald Hill operate with sufficient storage volume available to accommodate a flood?	Insufficient capacity to accommodate flood event leading to overflow from Bald Hill and discharge to environment (Deep Creek?)	• Water balance developed to assess scenarios. • Confirm design basis: (e.g. flood volumes for 1 in 10 yr event, 1 in 50 yr event?)	SEW/GHD/MW
Technical	Water Quality issues in Bald Hill: • Algae • Total Suspended Solids (TSS) • Salinity • Bird life (high faecal contamination) • Sludge accumulation [Bald Hill has never been desludged] • Colour • Consistency in meeting Class C quality requirements	Feedwater quality to Class A plant not within design envelope Algae detrimentally impact on Class A plant performance (currently no treatment for algae) (how is this currently managed in existing plant?) TSS increase loading on Class A plant and sludge production Salinity reduction due to dilution with stormwater	• Modify Class A plant to include pre-treatment steps for removal of algae/increased solids? [cost] • Algae data required to confirm frequency and severity of impact of algae bloom • Salinity data required to confirm dilution and impact	SEW (data input) GHD (concept design)
Technical	Available power for new/modified WTP		• Confirm power supply capacity/availability for Class A plant extension	SEW
Technical	Space allowance for new/modified WTP	Insufficient space for modifications/new plant	• Site visit confirmed there is sufficient space available for future upgrade of Class A plant when required [as growth and Class A demand increases]	SEW
Technical	Waste disposal from new/modified WTP (chemicals, sludge, brine)	Overflow of existing sludge lagoons/impact on performance of existing sludge lagoons	• Confirm available /spare capacity existing sludge lagoons.	SEW
Technical	Allowable downtime in Pakenham Class A plant for cut-ins/connections for the new scheme.	Unable to supply Class A demands during cutover periods	• Not considered a major issue: Class A storage tank on site • Class A is currently not operated at capacity (typically around 0.2MLD)	

Category	Risk/Issue	Impact	Status/Actions	Responsibility for Managing
Technical	Future Demand for Class C: -Number of users increase/decrease? -Seasonal nature of demands and variability	If Class C demand was to increase then this impacts on the storage level in Bald Hill and less is available for Class A use (this must be substituted by more Class C flow through WWTP – ie: increased capacity) If demand is spread out over a longer period this impacts on Bald Hill level, and thus on any upgrade required at Class C plant (ie: because can accept more stormwater)	• SEW to confirm long terms plans for Class C users • Can the usage be controlled/regulated so not as flexible (to help manage demand)?	SEW
Technical	Timing of development of Officer and requirement for Class A water (versus Pakenham East) Current projections show a substantial increase in growth of 2015-2036.	Current Plant allows for future Class A requirements for Officer (design basis) New demand from Pakenham East will potentially bring forward Upgrade of Class C WWTP and Class A WWTP	• Confirm growth projections for Officer	Council/SEW
O&M	Allowable downtime in Bald Hill for cutovers etc.	Class C users may not receive sufficient supply.	• Undertake cutovers etc. during wet period when Bald Hill is full	SEW
O&M	Effect on operations of Pakenham WWTP ie: how the system must be managed due to impact of stormwater into Bald Hill [eg: increased diversion of waste to sewer & cost, and lower demand on Class C WWTP]	Poor performance of existing Class C WWTP Bald Hill Storage water quality & storage levels Costs for diversion of wastewater to ETP	• Undertake various water balance model scenarios to understand impact on performance of assets (flows, quality)	GHD/SEW
Environment	Management of stormwater at Bald Hill during flood (including consideration of water quality)?	Excessive stormwater run-off detrimentally impacting on receiving environment	• Identify quantity and quality of overflow via Water Balance/model • Confirm acceptable environmental discharge	GHD/SEW/MW
Approvals	Additional validation requirements for Class A plant (with altered feed water quality due to stormwater)	DoH may require repeat validation of Class A plant	• Initiate discussion with relevant authorities	SEW/GHD
Approvals	Planning approvals of new/modified scheme • RBs to Bald Hill pipeline alignment • Modifications to Class A plant?	Delay in commencement of construction works.	• Identify relevant approvals & lead time	SEW/GHD

Category	Risk/Issue	Impact	Status/Actions	Responsibility for Managing
Approvals	Works approvals of new/modified WTP (if required?)	Delay in commencement of construction works.	• Identify relevant approvals & lead time	SEW/Council/MWC
Approvals	RBs to Bald Hill pipeline alignment (environmental approvals)	Delay in commencement of construction works.	• Identify relevant approvals & lead time	SEW/Council
Approvals	RBs to Bald Hill pipeline alignment (VicRoads approvals)	Delay in commencement of construction works.	• Identify relevant approvals & lead time	SEW/Council
Commercial	Impact on current supply agreement/contracts with Class C users	Class C users may not receive sufficient supply	• Review existing/contract agreements with consumers.	SEW/Council/MWC

9. Conclusions and next steps

9.1 Bald Hill

Analysis was undertaken of BHR using Class C consumption data provided by SEW. This analysis showed that in recent years (last 4) the basin has stayed relatively full, due to lower demand compared with the 4-year period before this. In the drought years of 2006 to 2010, however, the basin fell to a low level in the model during summer. This was due to the higher demand in those years.

Overall, this suggests that the basin may not have as much easily available 'spare' capacity as considered based on advice from more recent observations. This would indicate that BHR could not provide a flood retardation function, which would require spare capacity to be available, unless the Class C capacity was increased to enable the Class C irrigation demands to be met during the dry years. This would economically disadvantage the potential retardation element of Option 3. Based on that analysis, Option 3b was not considered further in this further phase or work.

9.2 Net Present Value

A spreadsheet water balance model was setup to investigate each option under different scenarios. The purpose of these investigations was to understand the demand profiles and the behaviour of BHR for a range of climate conditions

NPV analysis was undertaken for Option 2 and 3A and the following observations were made:

- The cost of the pipeline to transfer the stormwater to Bald Hill is approximately the same as the cost of the wetlands. Conceptually, the pipeline substitutes for the wetlands, as it removes around half of the stormwater from the precinct, thus achieving a nutrient reduction equivalent to that achieved by the wetlands. The question of the aesthetic value of the wetlands to the developer and the eventual residents is not accounted for in this comparison. A further issue arises. As the water from the pipeline will then be used for supply, a question arises as to who should fund the pipeline, and under what mechanism. So while this element of cost comparison appears neutral on a whole of community cost basis, a number of other factors require consideration by the stakeholders.
- Using the base input factors, the Stormwater Harvesting Option appears to have an NPV which is around $2 million less than the Class A option. Taken at face value, this suggests this option is more attractive on a whole of community cost basis. However, this option is innovative, and will require a range of complex negotiations to determine how costs are reasonably distributed. So the stakeholders need to consider whether this quantum of benefit is worth pursuing (see Appendix K1 for output sheet).
- The result is sensitive to the ‘cost’ assigned to sending wastewater to ETP. Once this cost exceeds around $1500per ML, then the options become equivalent (see Appendix K2 for output sheet).
- The result is very sensitive to the cost of ongoing wetlands maintenance. The base input value is 5% of the capital value spent per year. If this is increased to 10% per year, then the stormwater harvesting option is $6 million more attractive on an NPV whole of community cost basis (see Appendix K3 for output sheet).
- A wide range of other sensitivity analysis were undertaken, and all keep the two options within the ranges of the sensitivities outlined above.

Overall, the analysis of these two options suggests that Stormwater harvesting is a viable innovative alternative. However, it is around neutral on a whole of community NPV basis. So pursuing this option will be a decision based on factors other than the NPV analysis, and will require negotiation between stakeholders.

9.3 Cardinia Shire Council

Council is supportive of the Integrated Water Management approach in the development of the Pakenham East PSP, and will aid where appropriate in the delivery of the infrastructure. Council's primary role in this delivery will be in the formation of the PSP and the mechanism's around its delivery. As the preferred options 3a and 2 do not impinge on the land take in the PSP, or the timing of their delivery, at this stage Council will proceed with a "standard" PSP delivery. It is envisaged that the option 3a will be incorporated into the Drainage Services Scheme and primarily be a collaboration between SEW and MW with Councils support.

The proposed drainage strategy as shown on the current Future Urban Structure will be implemented through the PSP process. To allow the PSP to be progressed without removing the future viability of implementing 3a of this report, a degree of flexibility should be built into the PSP. If Option 3a of this report is implemented and results in land no longer being required for a sediment pond or wetland on any of the reserves encumbered by drainage infrastructure, then it may be possible for this land to form part of active open space (Recreation Reserve). The open space will be designed to allow for a 600 mm freeboard above a 100 year ARI event for all permanent structures in the reserve and will be to the satisfaction of the Responsible Authority and Melbourne Water. If a waterway drainage line traverses the land, the existing waterway corridor requirements will apply. Any proposed variations will be to the satisfaction of the Responsible Authority and Melbourne Water.

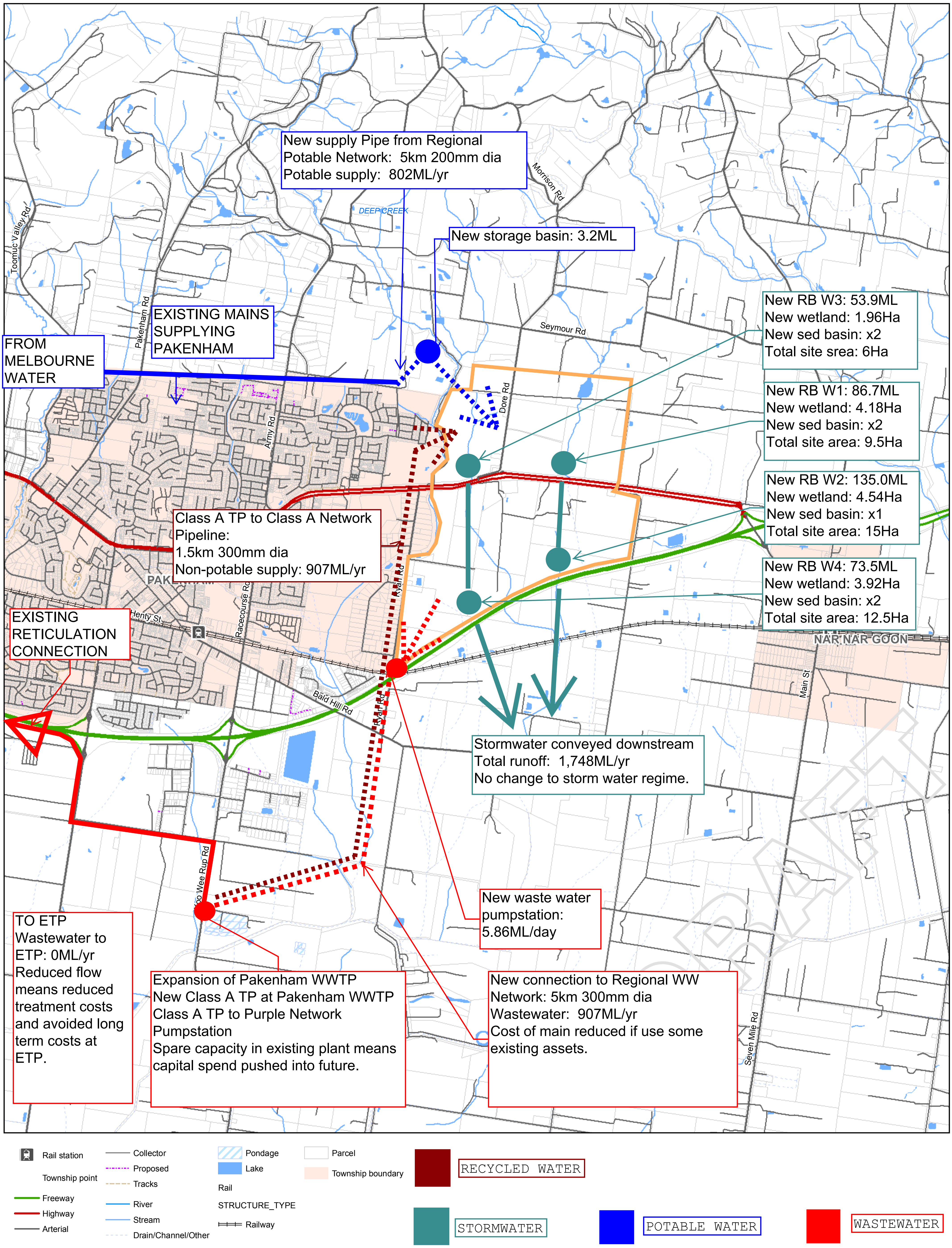
9.4 Next steps:

Based on the findings of this report, the next steps should be as follows:

- The working group should agree on which option to move forward with and how it should be implemented.
- After agreeing on which option is the preferred option, the working group should agree on how the preferred option will be funded and how the costs should be shared.
- Further work will be required on how the agreed preferred option will be implemented, in particular on how the risks and issues identified in Section 8 will be addressed.

Appendices

Appendix A – Option 2 and Option 3 Schematics



Paper Size A3

0 195 390 780 1,170 1,560

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

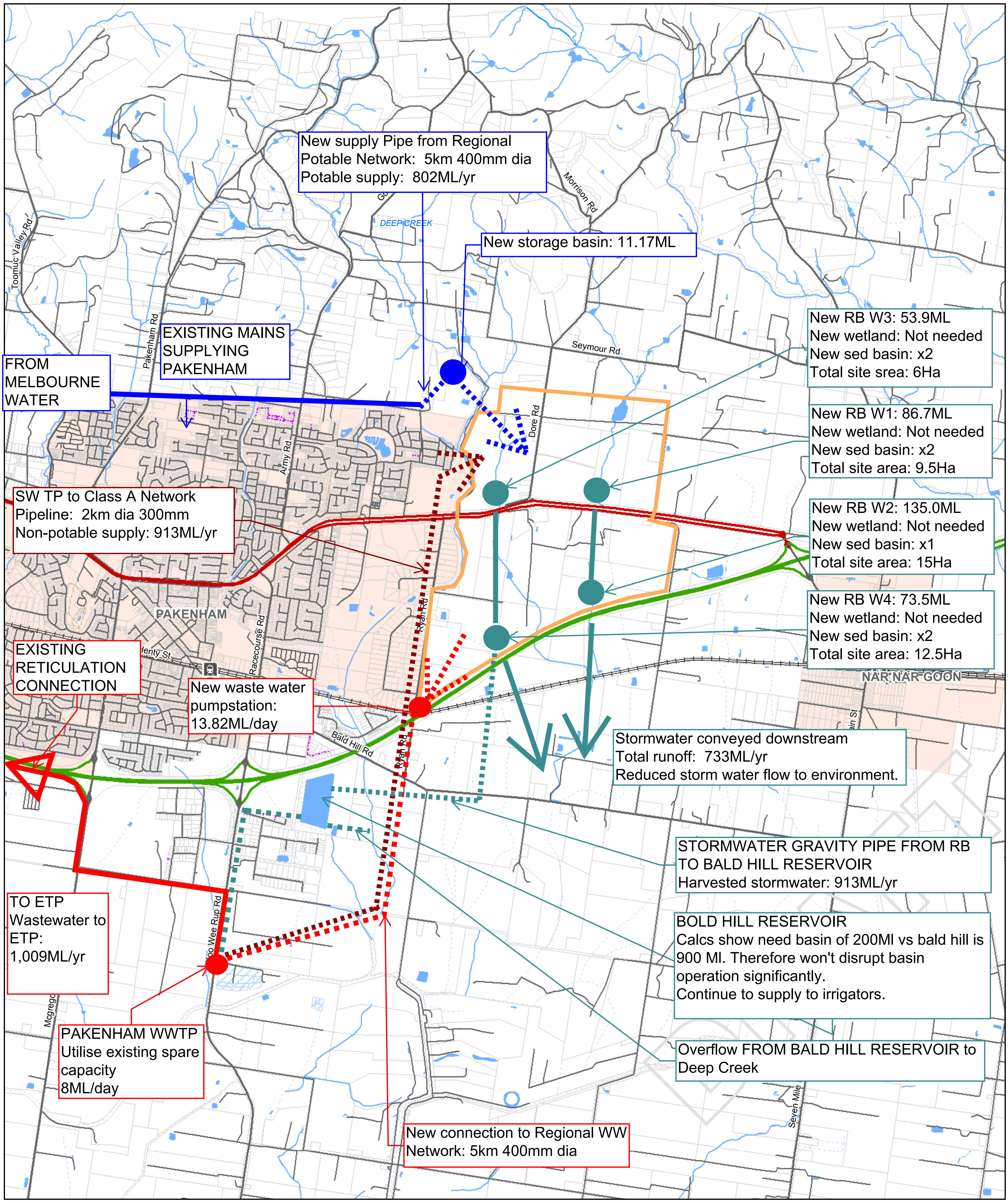
GHD

Option 2 - Pakenham WWTP recycled water

G:\31\31322\GIS\Maps\Working\31322_005_WiderArea_A3P.mxd

Hazelwood Drive (cnr Lignite Court) Morwell VIC 3840 Australia **T** 61 3 5136 5800 **F** 61 3 5136 5888 **E** mwlmail@ghd.com **W** www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:cillingworth



Rail station
Township point
Freeway
Highway
Arterial
Collector
Proposed
Tracks
River
Stream
Drain/Channel/Other
Pondage
Lake
Rail
STRUCTURE_TYPE
Railway
Parcel
Township boundary

RECYCLED WATER
STORMWATER
POTABLE WATER
WASTEWATER

Paper Size A3
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Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

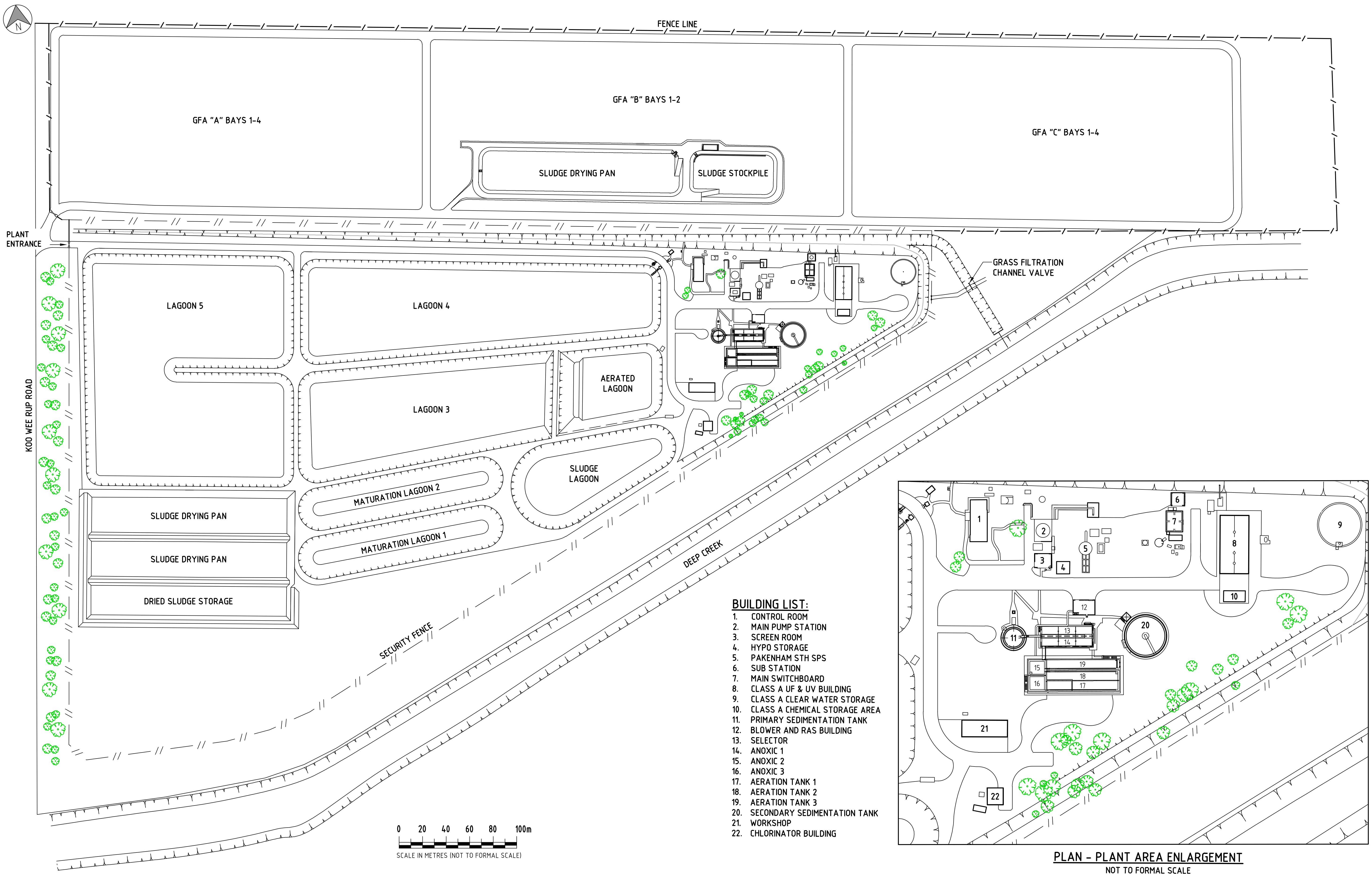
Option 3 - Bald Hill stormwater harvesting and recycled water

G:\31\31322\GIS\Maps\Working\31322_005_WiderArea_A3P.mxd

Hazelwood Drive (cnr Lignite Court) Morwell VIC 3840 Australia **T** 61 3 5136 5800 **F** 61 3 5136 5888 **E** mwlmail@ghd.com **W** www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:cillingworth

Appendix B – Pakenham WWTP General Site Layout



BUILDING LIST:

1. CONTROL ROOM
2. MAIN PUMP STATION
3. SCREEN ROOM
4. HYPO STORAGE
5. PAKENHAM STH SPS
6. SUB STATION
7. MAIN SWITCHBOARD
8. CLASS A UF & UV BUILDING
9. CLASS A CLEAR WATER STORAGE
10. CLASS A CHEMICAL STORAGE AREA
11. PRIMARY SEDIMENTATION TANK
12. BLOWER AND RAS BUILDING
13. SELECTOR
14. ANOXIC 1
15. ANOXIC 2
16. ANOXIC 3
17. AERATION TANK 1
18. AERATION TANK 2
19. AERATION TANK 3
20. SECONDARY SEDIMENTATION TANK
21. WORKSHOP
22. CHLORINATOR BUILDING

PLAN - PLANT AREA ENLARGEMENT

NOT TO FORMAL SCALE

REV.	ZONE	REVISION	DATE	APP'D
A		Initial Preparation	10/11/14	GJC

DESIGNED: G. CHALMERS 10/11/14
DRAWN: D. LANSDOWN 10/11/14
SEWL PROJECT MGR.: PETER UREN
DESIGN CHECK
DRAFT CHECK
MANAGER STPAM: SUSAN CROSHER
APPROVED

South East Water

ABN 89066902547
20 Corporate Drive
Moorabbin 3189

PAKENHAM STP
GENERAL LAYOUT PLAN
SHEET 1 OF 1

DO NOT SCALE
SCALE: AS SHOWN
DRAWING NUMBER
STP533/000/G/001 — REV A

Appendix C – Class A and Class C Water Quality Objectives

Class C Recycled Water Effluent Quality Requirements

Recycled water must be fit for purpose and treated according to the Environment Protection Authority's Guidelines for Environmental Management – Use of Reclaimed Water 2003.

Table 1 Class C Recycled Water standards for biological treatment and pathogen reduction

Parameter	Water Quality Objectives (median unless otherwise specified over 12months)[1]	Comment
E.coli	<1000 organisms/100mL	
pH	6-9	90th percentile. Higher limit for lagoon based systems with algal growth may be appropriate provided it will not be detrimental to receiving soils and disinfection efficacy is maintained
Biochemical Oxygen Demand (BOD)	<20mg/L	
Suspended Solids (SS)	<30mg/L	

Notes:

1. Refer to EPA Publication 464.2 Guidelines for Environmental Management; Use of Reclaimed Water, 2003 for further information on management requirements.

Pakenham Recycled Water Treatment Plant Design Envelope

The design basis for the influent water quality to the Class A plant is provided in the table below.

Table 2 Pakenham Class A Influent Water Quality – Sourced from Lagoon 2[1]

Table 1 Lagoon 2 effluent water quality

Lagoon No. 2 - Effluent	Unit	Data period	No. of samples	10th Percentile	Median	90th Percentile
TSS	mg/L	10/10/07-4/12/09	92	2	4	8
Colour	Pt/Co unit	10/10/07-4/12/09	29	40	50	60
UV transmissivity (filtered)	%	10/10/07-11/9/08	27	55	59	61
pH		12/10/07-4/12/09	64	7.4	7.7	8.1

Source: Data supplied by SE Water Steeple data compiled 6 Jan 2010

Note 1. Extracted from 'Functional Scope and Technical Requirements for the Pakenham Recycled Water Treatment Plant', South East Recycled Water Alliance, December 2009.

With the proposed changes to the current operation of the Pakenham WWTP, SEW anticipate that the influent water quality fed to the Class A plant will improve.

The design basis product water quality requirements for the Pakenham Class A WTP are summarised below.

Table 3 Pakenham Class A Plant Pathogen Log Removal Targets[1]

Process	Viruses	Protozoa
UF Membrane	4-log	4-log
UV Disinfection		2-log
Chlorination	3-log	
RWTP Total	**7-log**	**6-log**
Class A – Median	7-log	6-log
Class A – Critical limit	6-log	5-log

Note 1. Extracted from 'Functional Scope and Technical Requirements for the Pakenham Recycled Water Treatment Plant', South East Recycled Water Alliance, December 2009.

Appendix D – Projected Growth - Officer

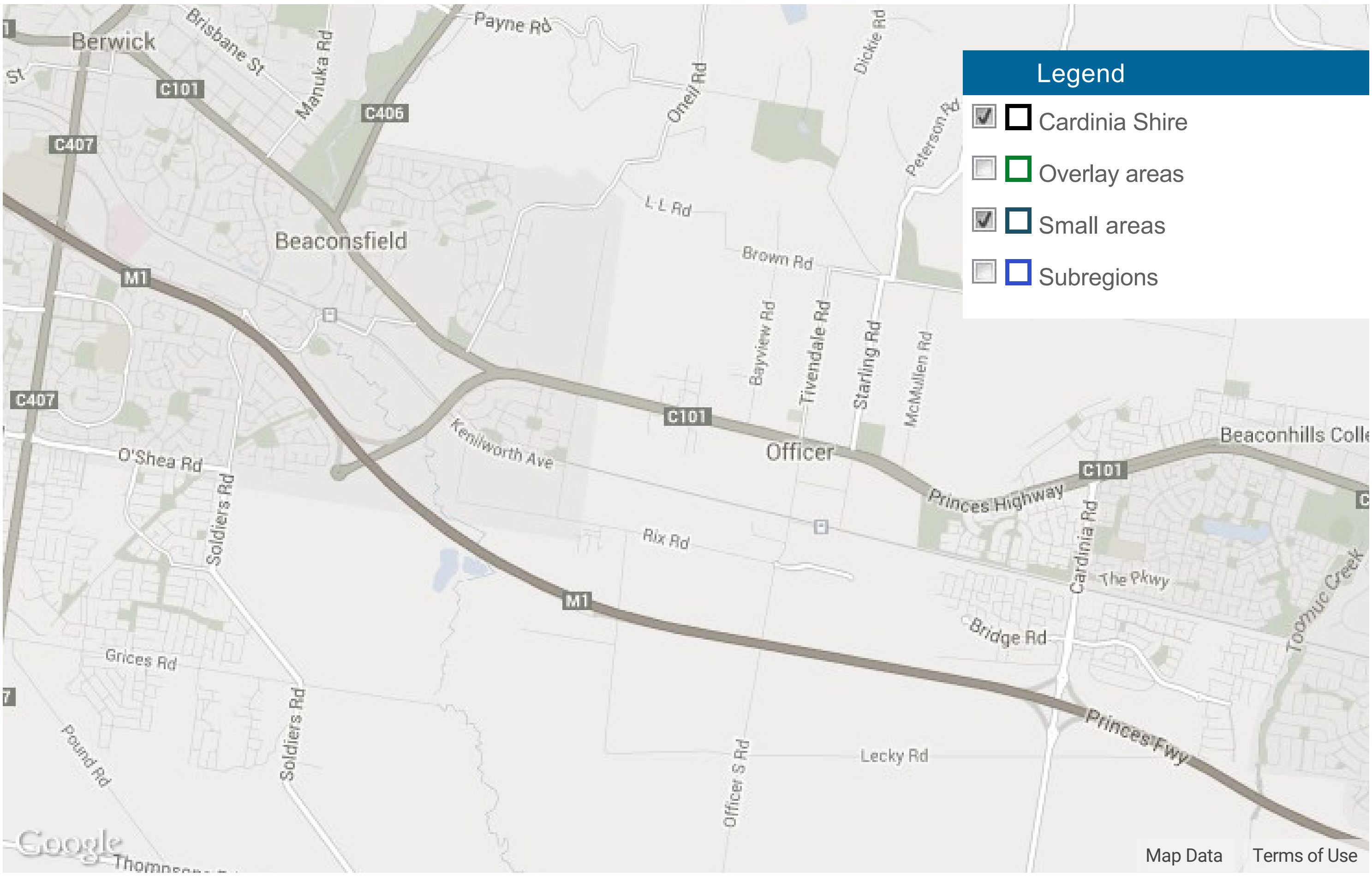
About the forecast areas

Officer Precinct is bounded by the transmission line and Brown Road in the north, the Gum Scrub Creek and its western tributary in the east, Princes Freeway in the south and the Cardinia Creek, Princes Highway and May Road in the west. This area comprises parts of the localities of Officer and Beaconsfield.

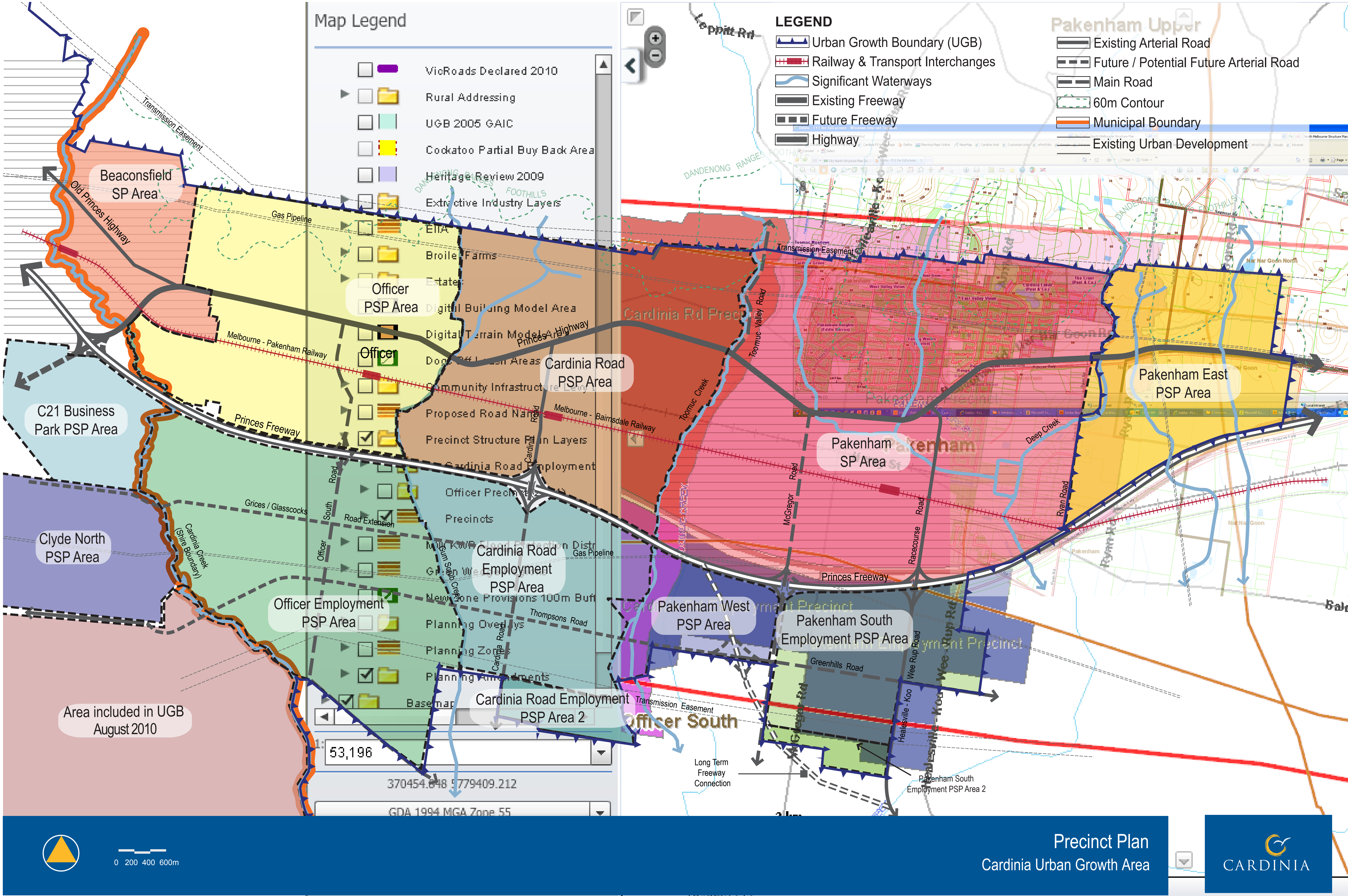
Important Statistics	Population 2015	Population 2036	Change 2015-36
	2,551	33,471	1211.82%

Forecast areas

Officer Precinct

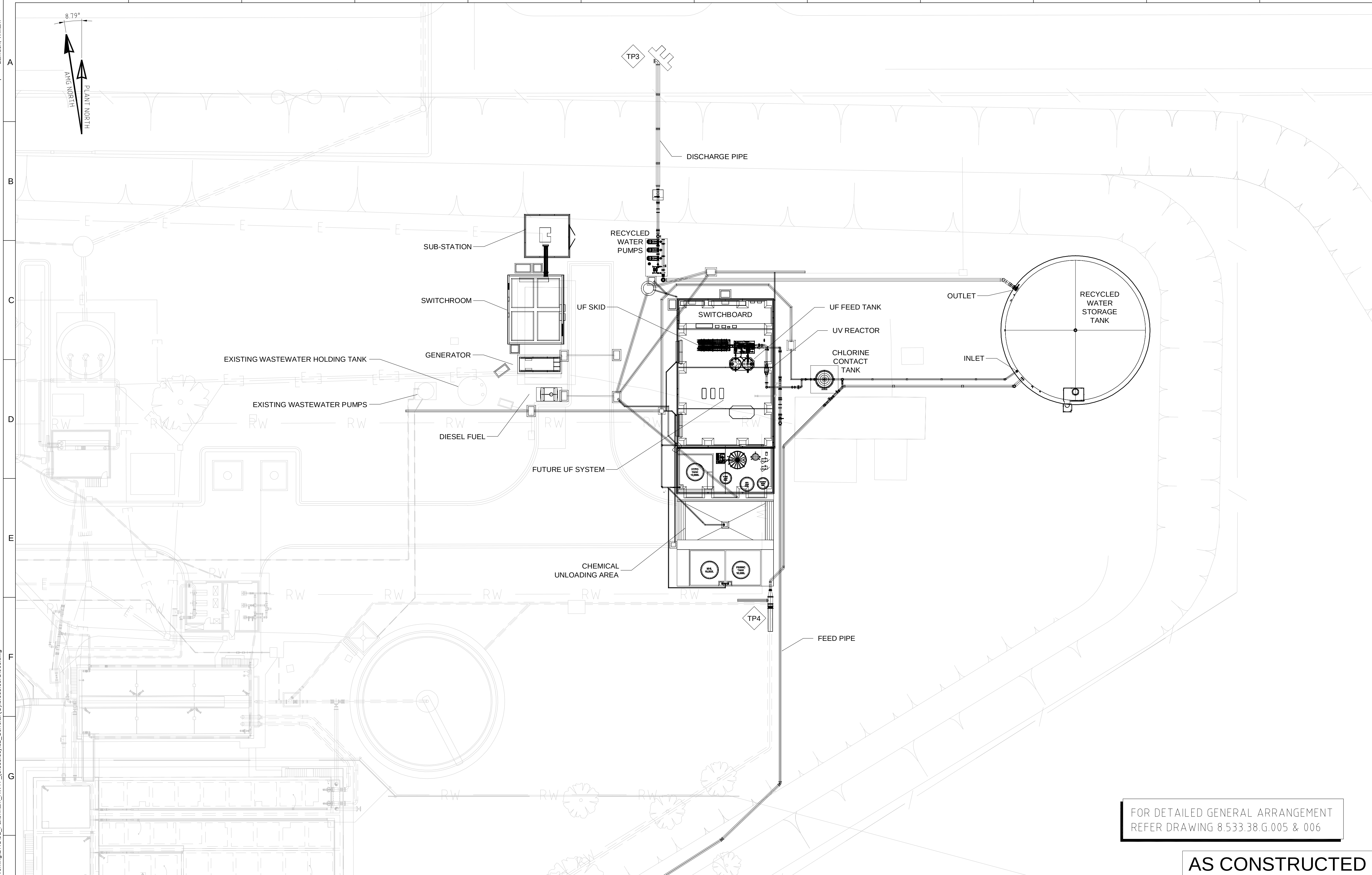


Source: Population and household forecasts, 2011 to 2036, prepared by .id, the population experts, February 2015.



ref.: SMEC3410344U
date: 18 Feb 2013

Appendix E – Class A Recycled Water Plant General Layout



FOR DETAILED GENERAL ARRANGEMENT
REFER DRAWING 8.533.38.G.005 & 006

AS CONSTRUCTED

REV.	ZONE	REVISION	DATE	APP'D
AC		AS CONSTRUCTED	20.09.11	TS
C	-	GENERAL REVISION UPDATE	30.07.10	GS
B	-	PRELIMINARY ISSUE	17.02.10	TS
A	-	CONCEPT DESIGN	10/11/09	

SCALE BAR

SCALE : 1 : 250 AT A1

SCALE : 1 : 500 AT A3

serwa
SOUTH EAST
RECYCLED WATER ALLIANCE
SOUTH EAST WATER | AECOM | TRANSFIELD SERVICES
creating a new future in recycled water

DESIGNED AB 30.07.10	DRAWN LAO 30.07.10	SERWA
DESIGN CHECK GS 30.07.10	DRAFT CHECK AB 30.07.10	SE WATER
APPROVED GS 30.07.10		

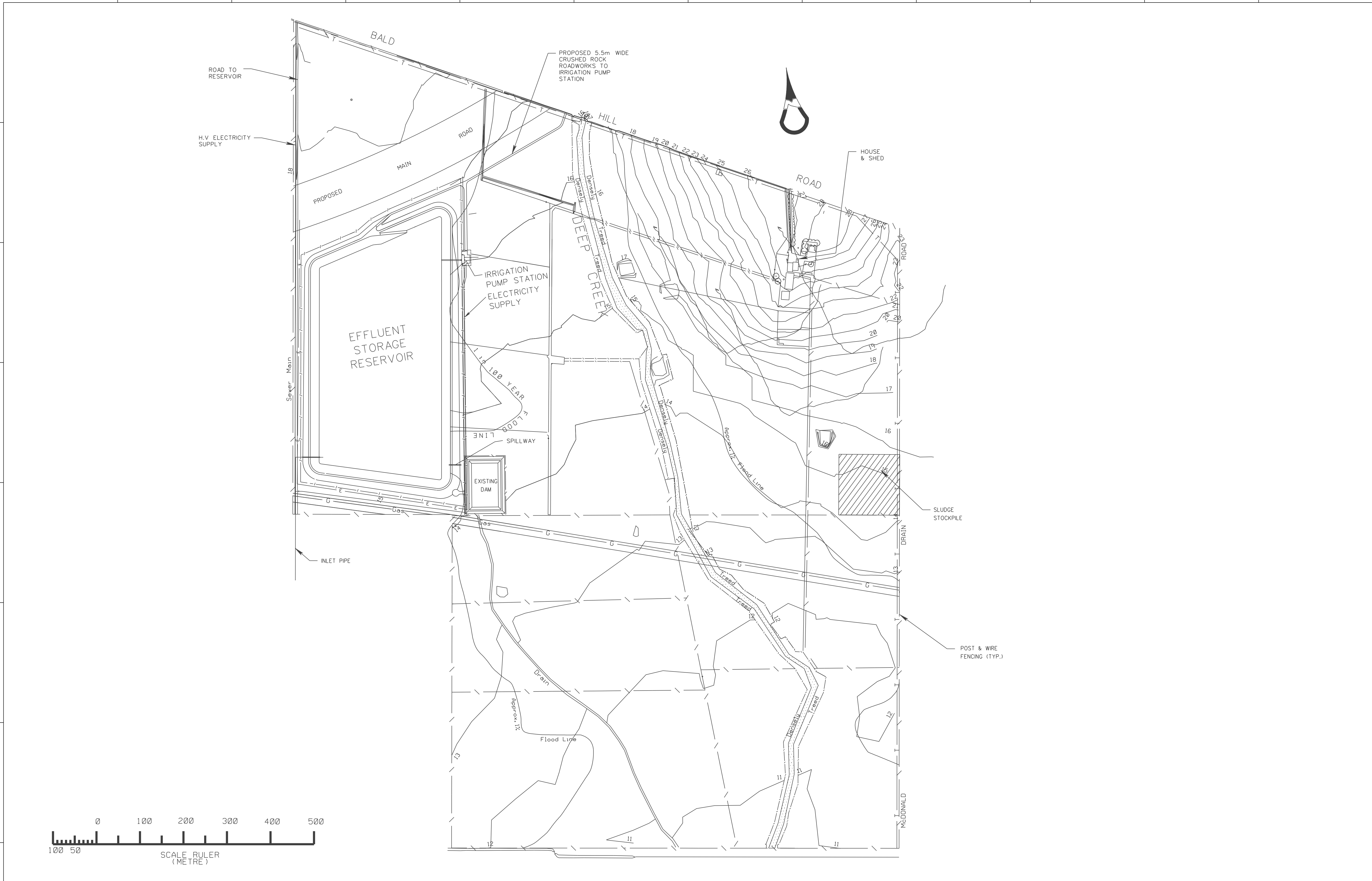
SOUTH EAST WATER
ABN 89 066 902 547
20 Corporate Drive
Moorabbin 3189

PAKENHAM SEWAGE TREATMENT PLANT
RECYCLED WATER TREATMENT PLANT
GENERAL ARRANGEMENT
SITE PLAN BASIC

DO NOT SCALE
SCALE:
DRAWING NUMBER
8.533.38.G.003 | AC
NUMERAL | REV

20-Sep-11 Lamden, William
R:\Shared\Aecom\5_CADD\5.3_Working\DRG\02_Pakenham_RWTP_(8.533.38)\02_General (G)\8.533.38.G.003.dwg
A1

Appendix F – Bald Hill Reservoir General Arrangement



REV	ZONE	DESCRIPTION	DATE	APP'D

DESIGNED | DRAWN | SEWL PROJECT MGR.

DESIGN CHECK | DRAFT CHECK | MANAGER STPAM

APPROVED

SOUTH EAST WATER
47 - 51 LAWSON AVE
FRANKSTON 3199

PAKENHAM SEWAGE TREATMENT PLANT
BALD HILL FARM
GENERAL ARRANGEMENT

DO NOT SCALE
SCALE:
DRAWING NUMBER
8.533.90.G.003
NUMERAL | REV

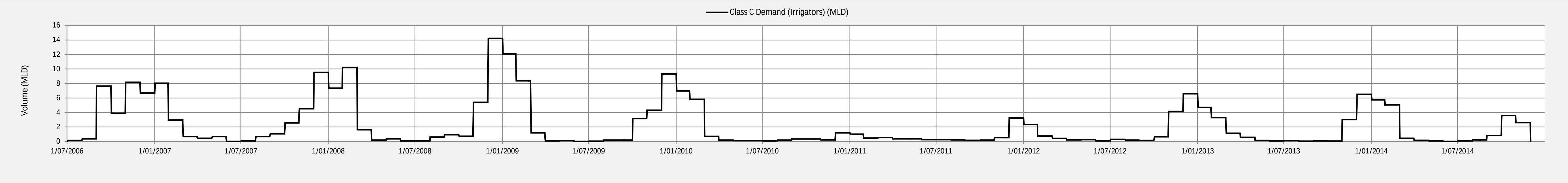
THE ORIGINAL DRAWING WAS HAND SIGNED BY THE PERSON WHOSE NAME OR INITIALS APPEAR PRINTED AND MARKED THUS (*) IN THE SIGNATURE BLOCKS.

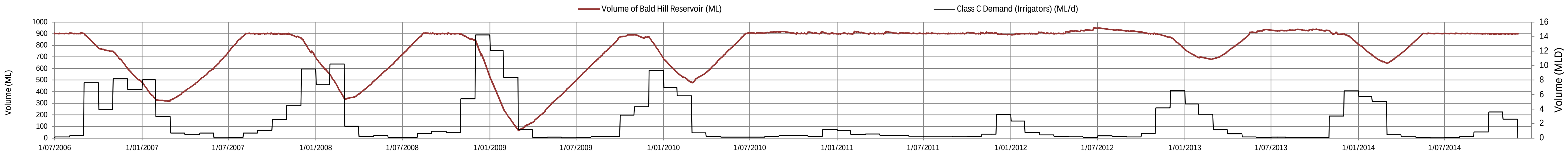
SEWL FILENAME: PAKENHAM\853390G003R0.DGN

A1

Appendix G – Modelled performance of Bald Hill Reservoir

Current Practice to Supply Irrigation Demands





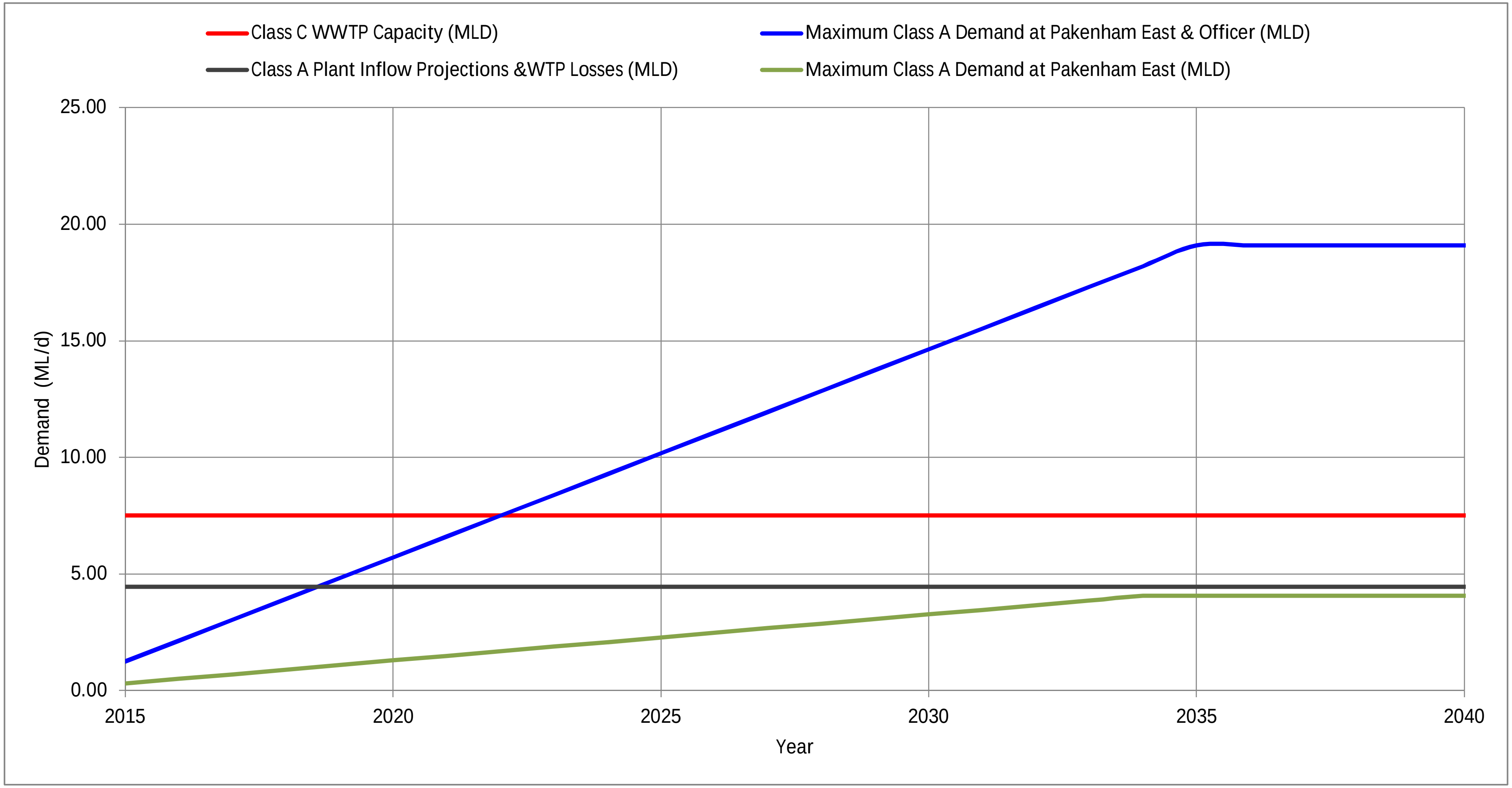
Appendix H - Stormwater transfer pipe cost breakdown

From W2 and W4 to Bald Hill

Pipe diameter (mm)	600	$	1,150			
Item	**Description**	**Rate**		**Length/number**	**Cost estimate**	
Inlet	Retarding basin/wetland W2	$	100,000	1	$	100,000
Pipe	Pipe jacking beneath HWY	$	4,600	100	$	460,000
Overflow	Retarding basin/wetland W2	$	100,000	1	$	100,000
Pipe	Across greenfield	$	1,150	600	$	690,000
Pipe	Pipe jacking beneath creek crossing	$	4,600	30	$	138,000
Pipe	Across greenfield	$	1,150	500	$	575,000
Pipe	Pipe jacking beneath creek crossing	$	4,600	30	$	138,000
Inlet	Retarding basin/wetland W4	$	100,000	1	$	100,000
Pipe	Pipe jacking beneath HWY	$	4,600	100	$	460,000
Overflow	Retarding basin/wetland W4	$	100,000	1	$	100,000
Pipe	Across greenfield	$	1,150	700	$	805,000
Pipe	Pipe jacking beneath railway line	$	4,600	50	$	230,000
Pipe	Across greenfield	$	1,150	1000	$	1,150,000
Pipe	Pipe jacking beneath Deep Creek	$	4,600	50	$	230,000
Pipe	Across greenfield	$	1,150	400	$	460,000
Outlet	Bald Hill	$	200,000	1	$	200,000
Land	Easement ($/ha)	$	50,000	2.139	$	106,950
Sediment basin	At inlets	$	200,000	2	$	400,000
Total				3565	**$**	**6,442,950**
Preliminaries			20%		$	1,288,590
Contingency			20%		$	1,288,590
Total					**$**	**9,020,130**

Appendix I – Projected Growth of Class A demands for Pakenham East and Officer

Growth of Pakenham East and Officer Non-Potable Maximum Demand over 2015 to 2040



Appendix J – Option 2 model outputs

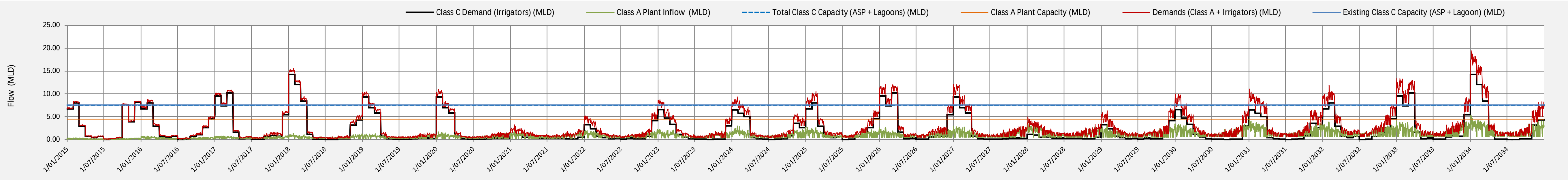
J1 - Option 2A Pakenham WWTP Recycled water (Pakenham East) (2015-2034) - At Current Plant Capacity

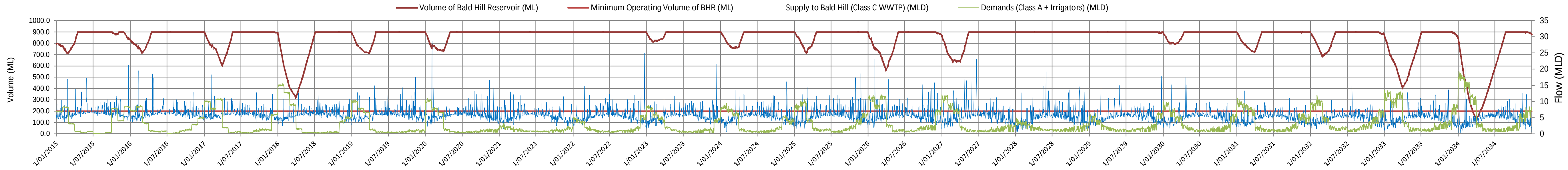
J2 - Option 2A Pakenham WWTP Recycled water (Pakenham East) (2015-2034) - At Upgraded Plant Capacity

J3 – Option 2B Pakenham WWTP Recycled water (Pakenham East + Officer) (2015-2034) - At Current Plant Capacity

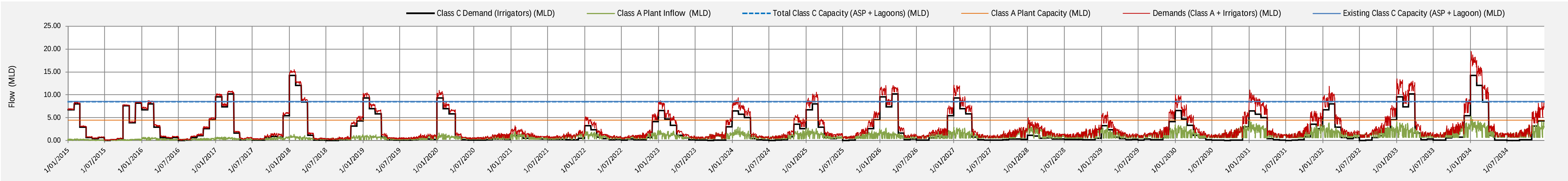
J4 – Option 2B Pakenham WWTP Recycled water (Pakenham East + Officer) (2015-2034) - At Upgraded Plant Capacity

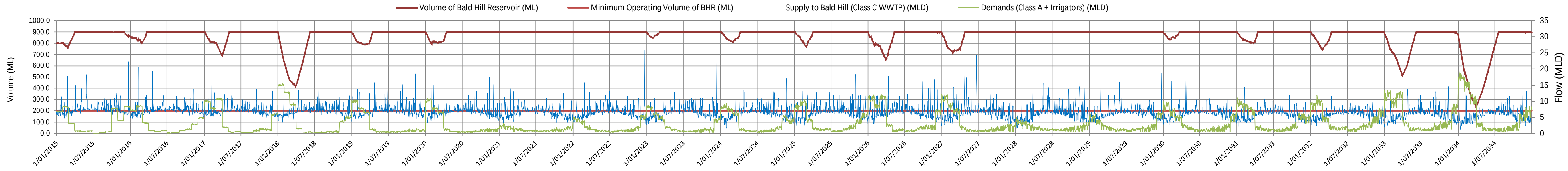
Option 2 Pakenham WWTP Recycled water (Pakenham East) (2015-2034) - At Current Plant Capacity



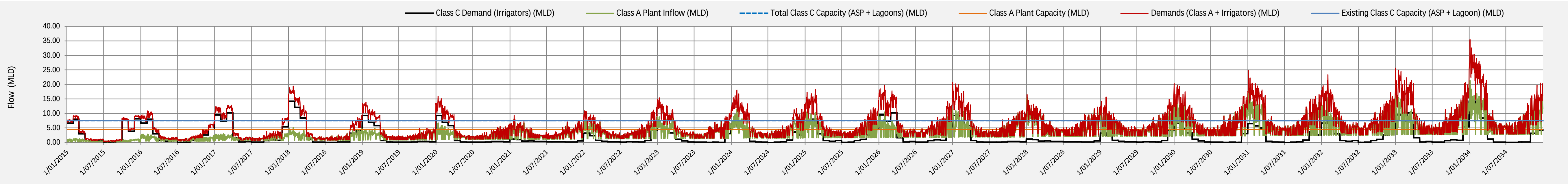


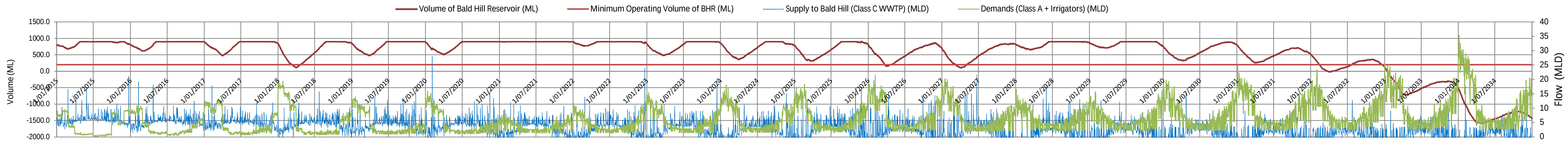
Option 2 Pakenham WWTP Recycled water (Pakenham East) (2015-2034) - At Upgraded Plant Capacity



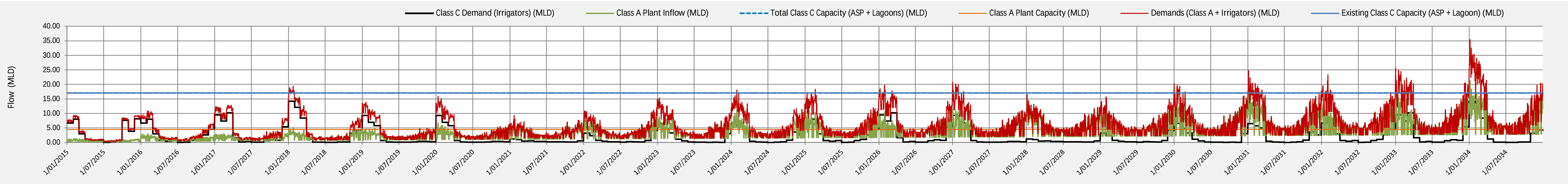


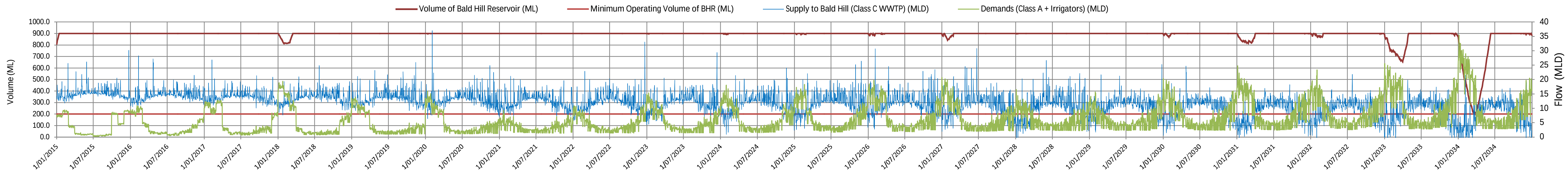
Option 2 Pakenham WWTP Recycled water (Pakenham East + Officer) (2015-2034) - At Current Plant Capacity





Option 2 Pakenham WWTP Recycled water (Pakenham East + Officer) (2015-2034) - At Upgraded Plant Capacity





Appendix K – Option 3 model outputs

K1 – Option 3A_Bald Hill Stormwater harvesting with recycled water (Pakenham East) -At Current Plant Capacity: Dry Year, Average Year and Wet Year.

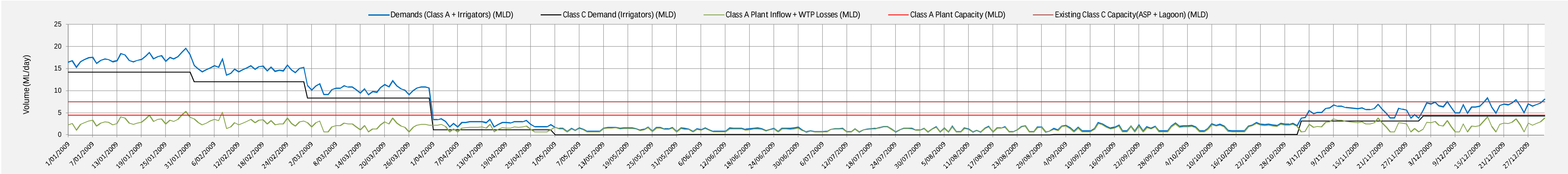
K2 – Option 3A_Bald Hill Stormwater harvesting with recycled water (Pakenham East) (2015-2034) -At Current Plant Capacity

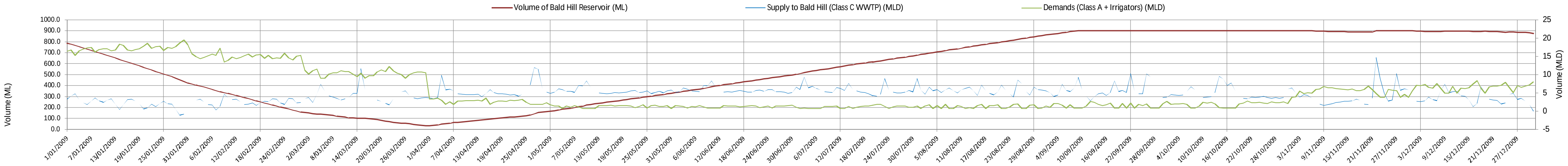
K3 – Option 3B_Bald Hill Stormwater harvesting with recycled water (Pakenham East + Officer) (2015-2034) -At Upgraded Plant Capacity

K4 – Modelled Impact of Stormwater Inflow on TDS in Bald Hill Reservoir over time

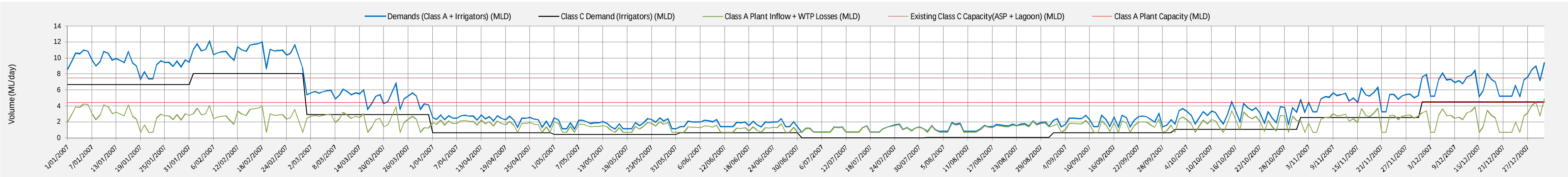
Option 3A Pakenham WWTP Recycled water (Pakenham East) - At Current Plant Capacity

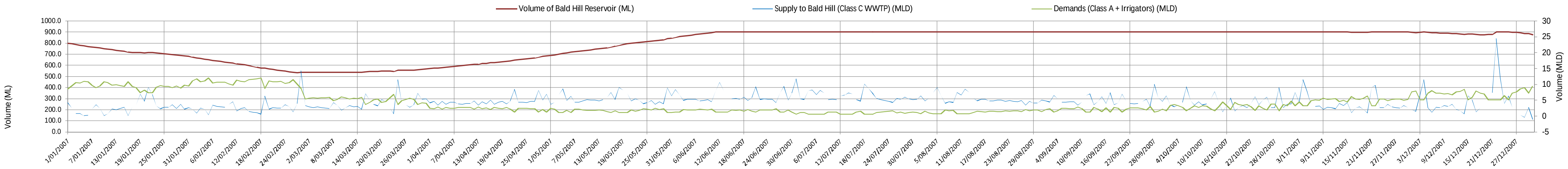
DRY YEAR (2009)



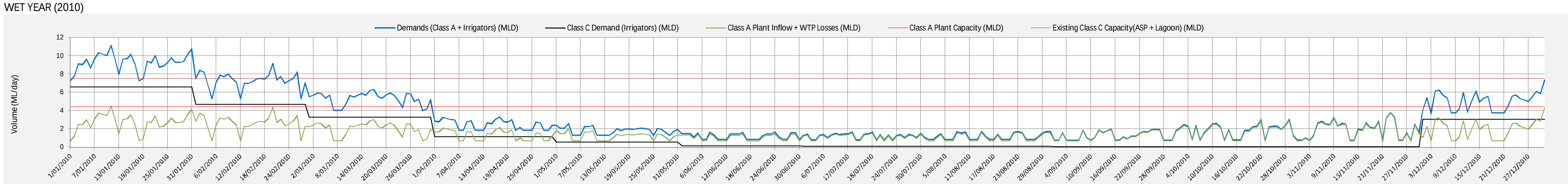


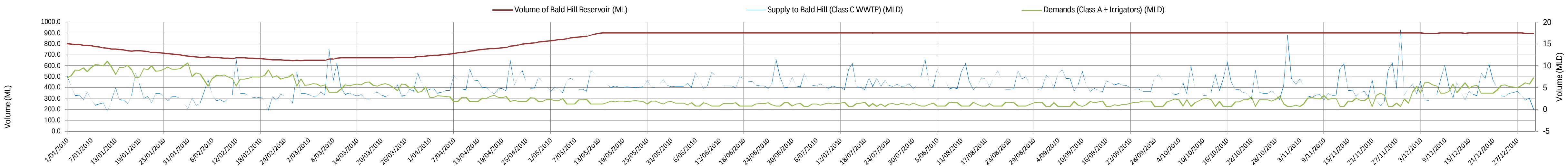
AVERAGE YEAR (2007)



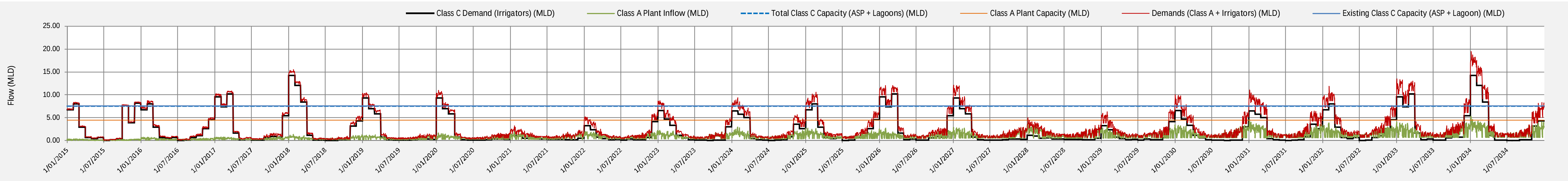


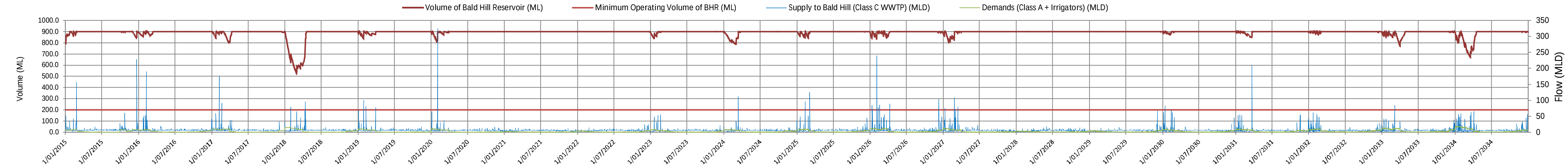
WET YEAR (2010)



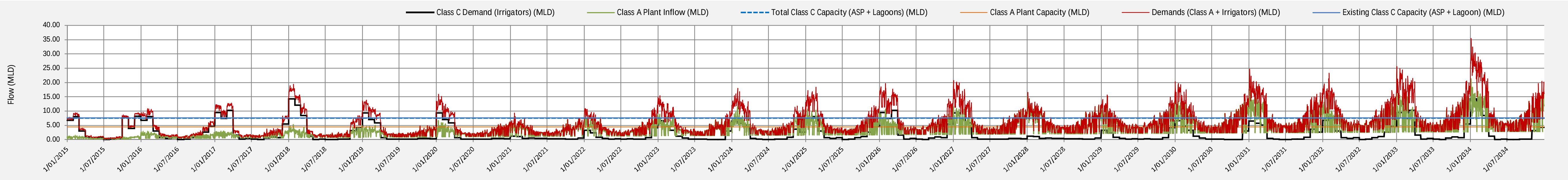


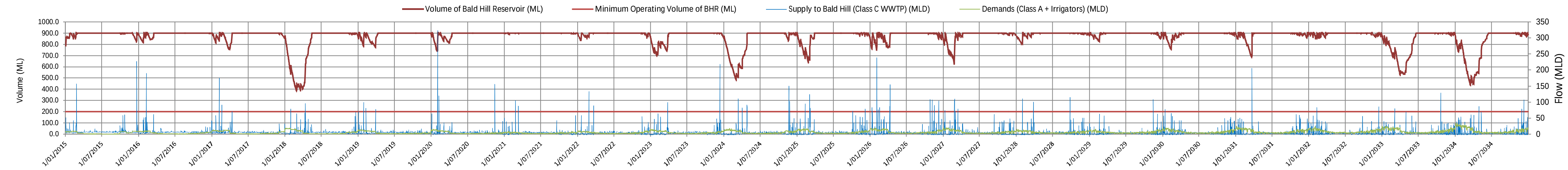
Option 3 Pakenham WWTP Recycled water (Pakenham East) (2015-2034) - At Current Plant Capacity





Option 3 Pakenham WWTP Recycled water (Pakenham East + Officer) (2015-2034)





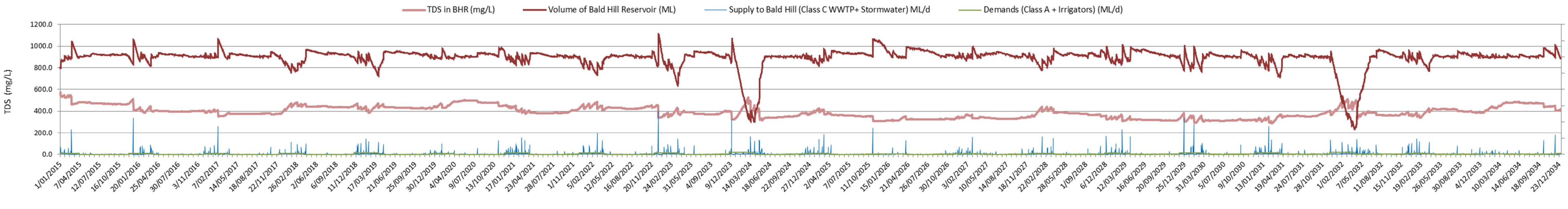


Figure G3: Impact of Stormwater Inflow on TDS in Bald Hill Reservoir over time (Option 3)

Appendix L – CBA Outputs

L1 – East Pakenham Two Final Options NPV Comparison Base Inputs

L2 – East Pakenham Two Final Options NPV Comparison Higher ETP Costs

L3 – East Pakenham Two Final Options NPV Comparison Higher Wetlands Maintenance Cost

L1 – East Pakenham Two Final Options NPV Comparison Base Inputs

	Units	OPTION 2 - Pakenham WWTP Recycled Water	OPTION 3A - Bald Hill Stormwater Harvesting with Recycled Water
CAPEX			
Ann Avg Class A Non-Potable Demand	ML/d	1.6	1.6
Class A Peak Day Non-Potable Demand	ML/d	3.4	3.4
Class A Existing Size	ML/d	4.8	4.8
Class A Total Treatment Size Required	ML/d	3.4	3.4
Class C Existing Size	ML/d	7.5	7.5
Class C Total Plant Size Required	ML/d	6	2.5
Avg Potable Water Demand (without Top-up)	ML/d	2.13	2.13
Stormwater Harvest	Y/N	0	1
Annual Average Stormwater Harvest	ML/d	0	4
Storm Water Harvest from RB to Bald Hill Pipeline Size	mm dia	0	600
Storm Water Harvest from RB to Bald Hill Pipeline Length	km	0	3.5
Stormwater Runoff	ML/d	4.8	0.8
Wetland	Y/N	1	0
Cost to Establish Full Wetland Area	$/unit	$ 8,000,000.00	$ 8,000,000.00
Bald Hill Stormwater Inflow Works	Y/N	0	0.5
Unit cost of Bald Hill Inflow Works	$/unit	$ 250,000.00	
DAF to Manage Algae	ML/d		3.36
RO to Manage SAR	ML/d	0.5	
OPEX			
Volume of Potable Used to Backup Class A Non Potable	ML/yr	100	100
Volume of Class C treated (at Pakenham WWTP)	ML/yr	1411	619
Volume of Class A treated	ML/yr	584	584
Volume of WW from East Pakenham sent to ETP	ML/yr	80	810
Total WW Volume created in East Pakenham		907	907
Class C treated to make irrigation		504	504
Total Class C needing treatment		1411	619

'Case' Where ignoring Officer

Sensitivity Inputs

Discount Rate		5%
Cost of Potable Water	$/ML	$ 475.00
Cost of WW sent to ETP	$/ML	$ 1,000.00
Operating Costs of Class A Plant	$/ML	$ 400.00
Operating Costs of Class C Plant	$/ML	$ 400.00
Wetland Maintenance Costs	% of Cap per yr	5%
Operating Costs of RO	$/ML	$ 800.00
Net (with RO) Class A Operating Cost		640

L1 – East Pakenham Two Final Options NPV Comparison Base Inputs

NPV of CAPEX	OPTION 2 - Pakenham WWTP Recycled Water	OPTION 3A - Bald Hill Stormwater Harvesting with Recycled Water	Savings for Option 3A versus Option 2
250000			
Reticulation			-
Potable Reticulation	$ 10,322,671	$ 10,322,671	$ -
WW Reticulation	$ 16,439,809	$ 16,439,809	$ -
Drainage system	$ 15,675,167	$ 15,675,167	$ -
Dual Pipe Reticulation	$ 5,734,817	$ 5,734,817	$ -
Supply Pipe from Regional Potable Network	$ 3,323,837	$ 3,323,837	$ -
Class A TP to Class A Network Pipeline	$ 5,819,088	$ 5,819,088	$ -
BHR to Class A TP at Pakenham WWTP Pipeline	$ -	$ -	$ -
RB to Bald Hill Reservoir Stormwater Harvest Pipeline	$ -	$ 6,149,098	-$ 6,149,098
Treatment Plants			-
Expansion of Pakenham WWTP	$ 308,323	$ 308,323	$ -
Expansion of Class A TP	$ 1,793,568	$ 1,167,173	$ 626,395
Pumpstations			-
Class A TP to Purple Network Pumpstation	$ 568,672	$ 568,672	$ -
Bald Hill to Class A TP Feed at Pakenham WWTP Pumpstation	$ -	$ 429,426	-$ 429,426
Storm Water Harvest from RB to Bald Hill Pumpstation	$ -	$ -	$ -
Waste water pumpstation	$ 682,147	$ 479,270	$ 202,877
Collection & Storage & Wetlands			-
Potable Network Storage Tank	$ 1,618,234	$ 1,618,234	$ -
Class A Network Storage Tank	$ 2,552,707	$ 2,552,707	$ -
Bald Hill Stormwater Inflow Works	$ -	$ 118,708	-$ 118,708
Retarding Basins	$ 1,000,950	$ 1,000,950	$ -
Wetlands	$ 7,597,341	$ -	$ 7,597,341
Other Capital Costs/Benefits			-
Land Take	$ 10,208,927	$ 10,208,927	$ -
Sum of NPV of Capex	$ 83,646,257	$ 81,916,876	$ 1,729,381
NPV of OPEX			
Pumping costs	$ 1,493,967	$ 1,296,169	$ 197,797
Mains Water Use (Potable water top-up to Class A TP)	$ 457,995	$ 457,995	$ -
WW Sent To ETP	$ 771,360	$ 7,810,021	-$ 7,038,661
WW Treatment (Local at Pakenham WWTP)	$ 5,971,098	$ 2,916,320	$ 3,054,779
Class A Treatment in Class A WTP	$ -	$ -	$ -
Extra Operation to manage floods at Bald Hill	$ -	$ -	$ -
Wetlands Maintenance Cost	$ 3,856,800	$ -	$ 3,856,800
Cost of WW contaminant loads to WWTP	$ -	$ -	$ -
Cost of SW contaminant loads to Environment	$ -	$ -	$ -
Sum of NPV of Opex	$ 12,551,221	$ 12,480,505	$ 70,716
			0
Total NPC	$ 96,197,477	$ 94,397,381	$ 1,800,096

L2 – East Pakenham Two Final Options NPV Comparison Higher ETP Costs

	Units	OPTION 2 - Pakenham WWTP Recycled Water	OPTION 3A - Bald Hill Stormwater Harvesting with Recycled Water
CAPEX			
Ann Avg Class A Non-Potable Demand	ML/d	1.6	1.6
Class A Peak Day Non-Potable Demand	ML/d	3.4	3.4
Class A Existing Size	ML/d	4.8	4.8
Class A Total Treatment Size Required	ML/d	3.4	3.4
Class C Existing Size	ML/d	7.5	7.5
Class C Total Plant Size Required	ML/d	6	2.5
Avg Potable Water Demand (without Top-up)	ML/d	2.13	2.13
Stormwater Harvest	Y/N	0	1
Annual Average Stormwater Harvest	ML/d	0	4
Storm Water Harvest from RB to Bald Hill Pipeline Size	mm dia	0	600
Storm Water Harvest from RB to Bald Hill Pipeline Length	km	0	3.5
Stormwater Runoff	ML/d	4.8	0.8
Wetland	Y/N	1	0
Cost to Establish Full Wetland Area	$/unit	$ 8,000,000.00	$ 8,000,000.00
Bald Hill Stormwater Inflow Works	Y/N	0	0.5
Unit cost of Bald Hill Inflow Works	$/unit	$ 250,000.00	
DAF to Manage Algae	ML/d		3.36
RO to Manage SAR	ML/d	0.5	
OPEX			
Volume of Potable Used to Backup Class A Non Potable	ML/yr	100	100
Volume of Class C treated (at Pakenham WWTP)	ML/yr	1411	619
Volume of Class A treated	ML/yr	584	584
Volume of WW from East Pakenham sent to ETP	ML/yr	80	810
Total WW Volume created in East Pakenham		907	907
Class C treated to make irrigation		504	504
Total Class C needing treatment		1411	619

'Case' Where ignoring Officer

Sensitivity Inputs		
Discount Rate		5%
Cost of Potable Water	$/ML	$ 475.00
Cost of WW sent to ETP	$/ML	$ 1,500.00
Operating Costs of Class A Plant	$/ML	$ 400.00
Operating Costs of Class C Plant	$/ML	$ 400.00
Wetland Maintenance Costs	% of Cap per yr	5%
Operating Costs of RO	$/ML	$ 800.00
Net (with RO) Class A Operating Cost		640

L2 – East Pakenham Two Final Options NPV Comparison Higher ETP Costs

NPV of CAPEX	OPTION 2 - Pakenham WWTP Recycled Water	OPTION 3A - Bald Hill Stormwater Harvesting with Recycled Water	Savings for Option 3A versus Option 2
250000			
Reticulation			-
Potable Reticulation	$ 10,322,671	$ 10,322,671	$ -
WW Reticulation	$ 16,439,809	$ 16,439,809	$ -
Drainage system	$ 15,675,167	$ 15,675,167	$ -
Dual Pipe Reticulation	$ 5,734,817	$ 5,734,817	$ -
Supply Pipe from Regional Potable Network	$ 3,323,837	$ 3,323,837	$ -
Class A TP to Class A Network Pipeline	$ 5,819,088	$ 5,819,088	$ -
BHR to Class A TP at Pakenham WWTP Pipeline	$ -	$ -	$ -
RB to Bald Hill Reservoir Stormwater Harvest Pipeline	$ -	$ 6,149,098	-$ 6,149,098
Treatment Plants			-
Expansion of Pakenham WWTP	$ 308,323	$ 308,323	$ -
Expansion of Class A TP	$ 1,793,568	$ 1,167,173	$ 626,395
Pumpstations			-
Class A TP to Purple Network Pumpstation	$ 568,672	$ 568,672	$ -
Bald Hill to Class A TP Feed at Pakenham WWTP Pumpstation	$ -	$ 429,426	-$ 429,426
Storm Water Harvest from RB to Bald Hill Pumpstation	$ -	$ -	$ -
Waste water pumpstation	$ 682,147	$ 479,270	$ 202,877
Collection & Storage & Wetlands			-
Potable Network Storage Tank	$ 1,618,234	$ 1,618,234	$ -
Class A Network Storage Tank	$ 2,552,707	$ 2,552,707	$ -
Bald Hill Stormwater Inflow Works	$ -	$ 118,708	-$ 118,708
Retarding Basins	$ 1,000,950	$ 1,000,950	$ -
Wetlands	$ 7,597,341	$ -	$ 7,597,341
Other Capital Costs/Benefits			-
Land Take	$ 10,208,927	$ 10,208,927	$ -
Sum of NPV of Capex	$ 83,646,257	$ 81,916,876	$ 1,729,381
NPV of OPEX			
Pumping costs	$ 1,493,967	$ 1,296,169	$ 197,797
Mains Water Use (Potable water top-up to Class A TP)	$ 457,995	$ 457,995	$ -
WW Sent To ETP	$ 1,157,040	$ 11,715,031	-$ 10,557,991
WW Treatment (Local at Pakenham WWTP)	$ 5,971,098	$ 2,916,320	$ 3,054,779
Class A Treatment in Class A WTP	$ -	$ -	$ -
Extra Operation to manage floods at Bald Hill	$ -	$ -	$ -
Wetlands Maintenance Cost	$ 3,856,800	$ -	$ 3,856,800
Cost of WW contaminant loads to WWTP	$ -	$ -	$ -
Cost of SW contaminant loads to Environment	$ -	$ -	$ -
Sum of NPV of Opex	$ 12,936,901	$ 16,385,515	-$ 3,448,615
			0
Total NPC	$ 96,583,157	$ 98,302,391	-$ 1,719,234

L3 – East Pakenham Two Final Options NPV Comparison Higher Wetlands Maintenance Cost

	Units	OPTION 2 - Pakenham WWTP Recycled Water	OPTION 3A - Bald Hill Stormwater Harvesting with Recycled Water
CAPEX			
Ann Avg Class A Non-Potable Demand	ML/d	1.6	1.6
Class A Peak Day Non-Potable Demand	ML/d	3.4	3.4
Class A Existing Size	ML/d	4.8	4.8
Class A Total Treatment Size Required	ML/d	3.4	3.4
Class C Existing Size	ML/d	7.5	7.5
Class C Total Plant Size Required	ML/d	6	2.5
Avg Potable Water Demand (without Top-up)	ML/d	2.13	2.13
Stormwater Harvest	Y/N	0	1
Annual Average Stormwater Harvest	ML/d	0	4
Storm Water Harvest from RB to Bald Hill Pipeline Size	mm dia	0	600
Storm Water Harvest from RB to Bald Hill Pipeline Length	km	0	3.5
Stormwater Runoff	ML/d	4.8	0.8
Wetland	Y/N	1	0
Cost to Establish Full Wetland Area	$/unit	$ 8,000,000.00	$ 8,000,000.00
Bald Hill Stormwater Inflow Works	Y/N	0	0.5
Unit cost of Bald Hill Inflow Works	$/unit	$ 250,000.00	
DAF to Manage Algae	ML/d		3.36
RO to Manage SAR	ML/d	0.5	
OPEX			
Volume of Potable Used to Backup Class A Non Potable	ML/yr	100	100
Volume of Class C treated (at Pakenham WWTP)	ML/yr	1411	619
Volume of Class A treated	ML/yr	584	584
Volume of WW from East Pakenham sent to ETP	ML/yr	80	810
Total WW Volume created in East Pakenham		907	907
Class C treated to make irrigation		504	504
Total Class C needing treatment		1411	619

'Case' Where ignoring Officer

Sensitivity Inputs		
Discount Rate		5%
Cost of Potable Water	$/ML	$ 475.00
Cost of WW sent to ETP	$/ML	$ 1,000.00
Operating Costs of Class A Plant	$/ML	$ 400.00
Operating Costs of Class C Plant	$/ML	$ 400.00
Wetland Maintenance Costs	% of Cap per yr	10%
Operating Costs of RO	$/ML	$ 800.00
Net (with RO) Class A Operating Cost		640

L3 – East Pakenham Two Final Options NPV Comparison Higher Wetlands Maintenance Cost

NPV of CAPEX	OPTION 2 - Pakenham WWTP Recycled Water	OPTION 3A - Bald Hill Stormwater Harvesting with Recycled Water	Savings for Option 3A versus Option 2
250000			
Reticulation			-
Potable Reticulation	$ 10,322,671	$ 10,322,671	$ -
WW Reticulation	$ 16,439,809	$ 16,439,809	$ -
Drainage system	$ 15,675,167	$ 15,675,167	$ -
Dual Pipe Reticulation	$ 5,734,817	$ 5,734,817	$ -
Supply Pipe from Regional Potable Network	$ 3,323,837	$ 3,323,837	$ -
Class A TP to Class A Network Pipeline	$ 5,819,088	$ 5,819,088	$ -
BHR to Class A TP at Pakenham WWTP Pipeline	$ -	$ -	$ -
RB to Bald Hill Reservoir Stormwater Harvest Pipeline	$ -	$ 6,149,098	-$ 6,149,098
Treatment Plants			-
Expansion of Pakenham WWTP	$ 308,323	$ 308,323	$ -
Expansion of Class A TP	$ 1,793,568	$ 1,167,173	$ 626,395
Pumpstations			-
Class A TP to Purple Network Pumpstation	$ 568,672	$ 568,672	$ -
Bald Hill to Class A TP Feed at Pakenham WWTP Pumpstation	$ -	$ 429,426	-$ 429,426
Storm Water Harvest from RB to Bald Hill Pumpstation	$ -	$ -	$ -
Waste water pumpstation	$ 682,147	$ 479,270	$ 202,877
Collection & Storage & Wetlands			-
Potable Network Storage Tank	$ 1,618,234	$ 1,618,234	$ -
Class A Network Storage Tank	$ 2,552,707	$ 2,552,707	$ -
Bald Hill Stormwater Inflow Works	$ -	$ 118,708	-$ 118,708
Retarding Basins	$ 1,000,950	$ 1,000,950	$ -
Wetlands	$ 7,597,341	$ -	$ 7,597,341
Other Capital Costs/Benefits			-
Land Take	$ 10,208,927	$ 10,208,927	$ -
Sum of NPV of Capex	$ 83,646,257	$ 81,916,876	$ 1,729,381
NPV of OPEX			
Pumping costs	$ 1,493,967	$ 1,296,169	$ 197,797
Mains Water Use (Potable water top-up to Class A TP)	$ 457,995	$ 457,995	$ -
WW Sent To ETP	$ 771,360	$ 7,810,021	-$ 7,038,661
WW Treatment (Local at Pakenham WWTP)	$ 5,971,098	$ 2,916,320	$ 3,054,779
Class A Treatment in Class A WTP	$ -	$ -	$ -
Extra Operation to manage floods at Bald Hill	$ -	$ -	$ -
Wetlands Maintenance Cost	$ 7,713,601	$ -	$ 7,713,601
Cost of WW contaminant loads to WWTP	$ -	$ -	$ -
Cost of SW contaminant loads to Environment	$ -	$ -	$ -
Sum of NPV of Opex	$ 16,408,021	$ 12,480,505	$ 3,927,516
			0
Total NPC	$ 100,054,278	$ 94,397,381	$ 5,656,897

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A						05/03/2015
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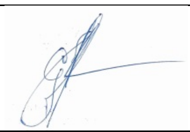
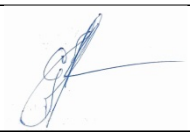
	P Joyce D Anderson	G Finlayson		G Finlayson		02/07/2015

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