Clever use of existing infrastructure to save costs - Tally Ho Stormwater Harvesting

Stormwater Victoria Conference

May 2017

Bringing engineering to **life**

Outline

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2.0 – Water Quality Assessment

3.0 – Hydraulic Configuration

4.0 – Water Balance Assessment

5.0 – Peak Flow Assessment

6.0 – Design

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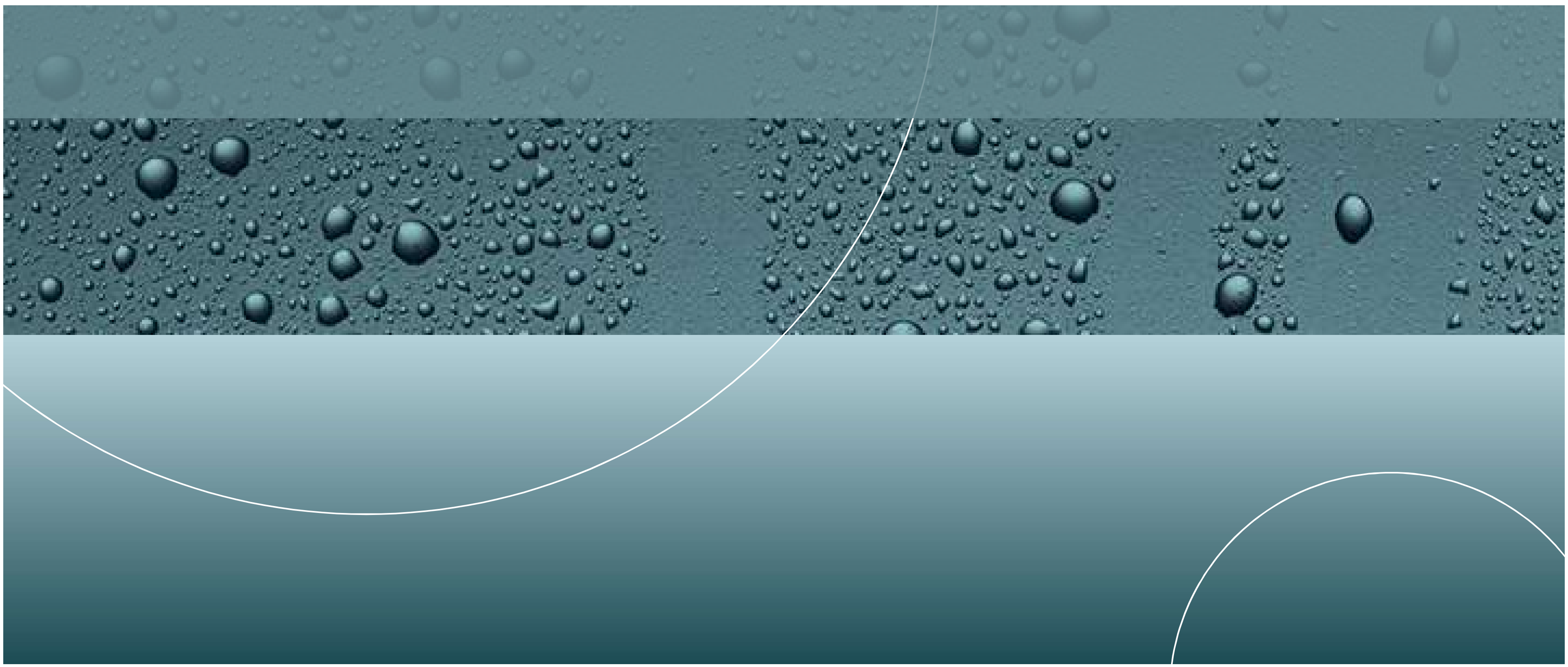
BACKGROUND AND OBJECTIVES



Background

- Council is seeking to harvest stormwater for irrigation purposes at Tally Ho Reserve.
- A nearby lake is a potential source referred herein as the Stormwater Pond (SP). It is a terminal point for stormwater at a nearby development to the north-west called Sienna Falls Estate.
  - Sienna Falls Estate catchment has an area of 7.41 Ha and is 50% impervious.
  - The only outflow for the SP is via pumping which discharges to Council's stormwater network, to the south east (north-west corner of Tally Ho Reserve).
  - A 225mm diameter pipe that has already been installed delivers this stormwater, with pumping based on pre-defined triggers of pond water levels.
- Investigation into the suitability of recovering this water for irrigation purposes with respect to water quality, peak flow analysis and hydraulic configuration.

Location


Stormwater Pond
Location of existing pumps
Existing 225mm rising main
Existing 38kL water tank
Sienna Falls Estate
Existing gravity stormwater
Highbury Rd
Cinnabar Ave
Bennett Ave
Pascall St
Walker Rd
Ormiston St
Tally Ho Tennis Club
Tally Ho Reserve
Pamay Rd

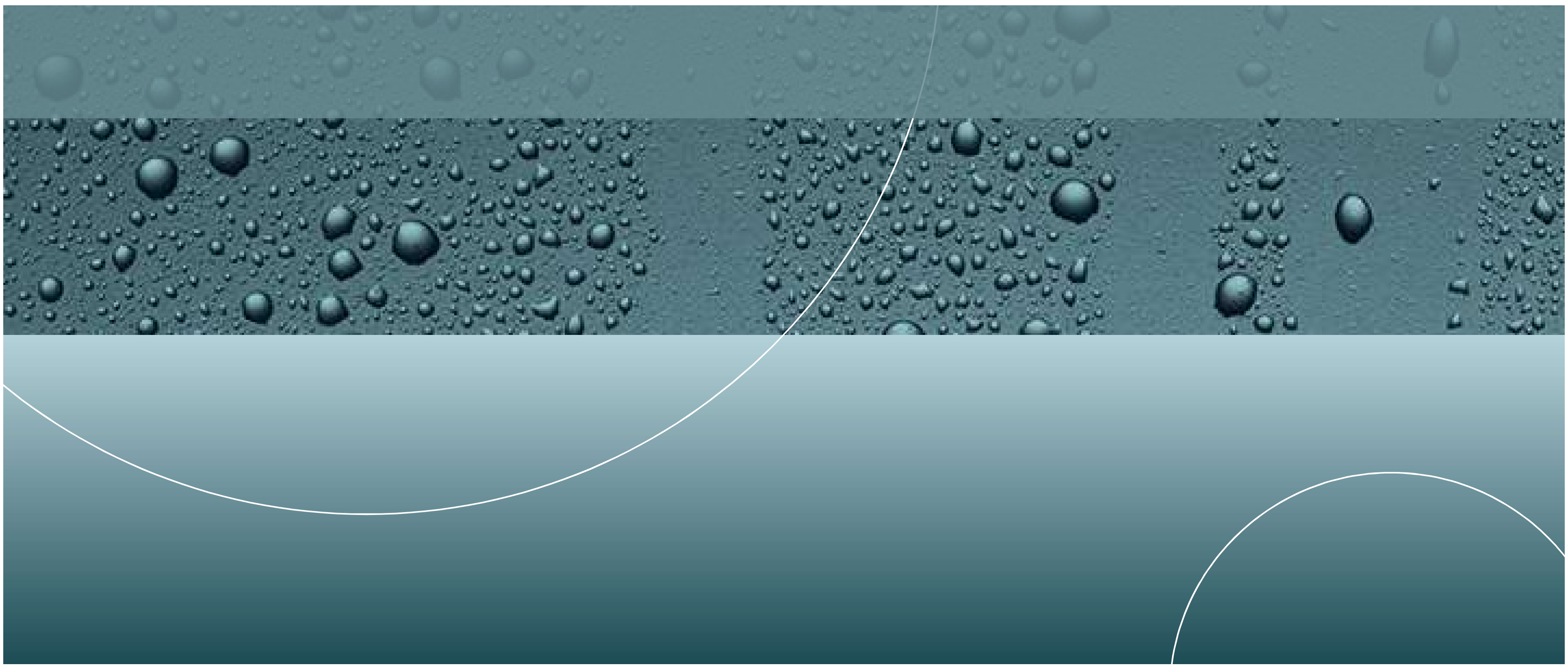
Objectives

Storm

- The overall objective of the project is to maximise the stormwater harvesting opportunity with consideration for flood mitigation of the Sienna Falls Estate and water quality limitations

- The objectives of this assessment are as follows:
  - Stormwater harvesting – water quality assessment, water balance optimisation to size storages and pump transfer rates to maintain reliability of irrigation supply
  - Flood mitigation (storage) - determine SP response to a 100 year ARI event

WATER QUALITY ASSESSMENT



Water Quality

- The lake water was observed to be very turbid instigating the need for further investigation.
- Council obtained laboratory testing and the samples have very similar properties.
- The key parameters tested and a summary of results is as follows:

Parameter	Comment
pH	Slightly high. Ideally it would not be used long term for irrigation
EC/Salinity	Slightly high and ideally not used in the long term for irrigation
Ca, Mg & Fe	These are within tolerable limits for irrigation, however, may cause some scaling on plumbing over the long term
E.coli	The counts are quite good for stormwater but can vary considerably. These levels can be experienced frequently in the Yarra during significant rainfall, however, the recommended limit for irrigation is still an order of magnitude less

Water Quality Management
- Turf Health

Water quality testing has identified there is some risk in affecting the health of the turf over the long term.

The primary recommendations were:

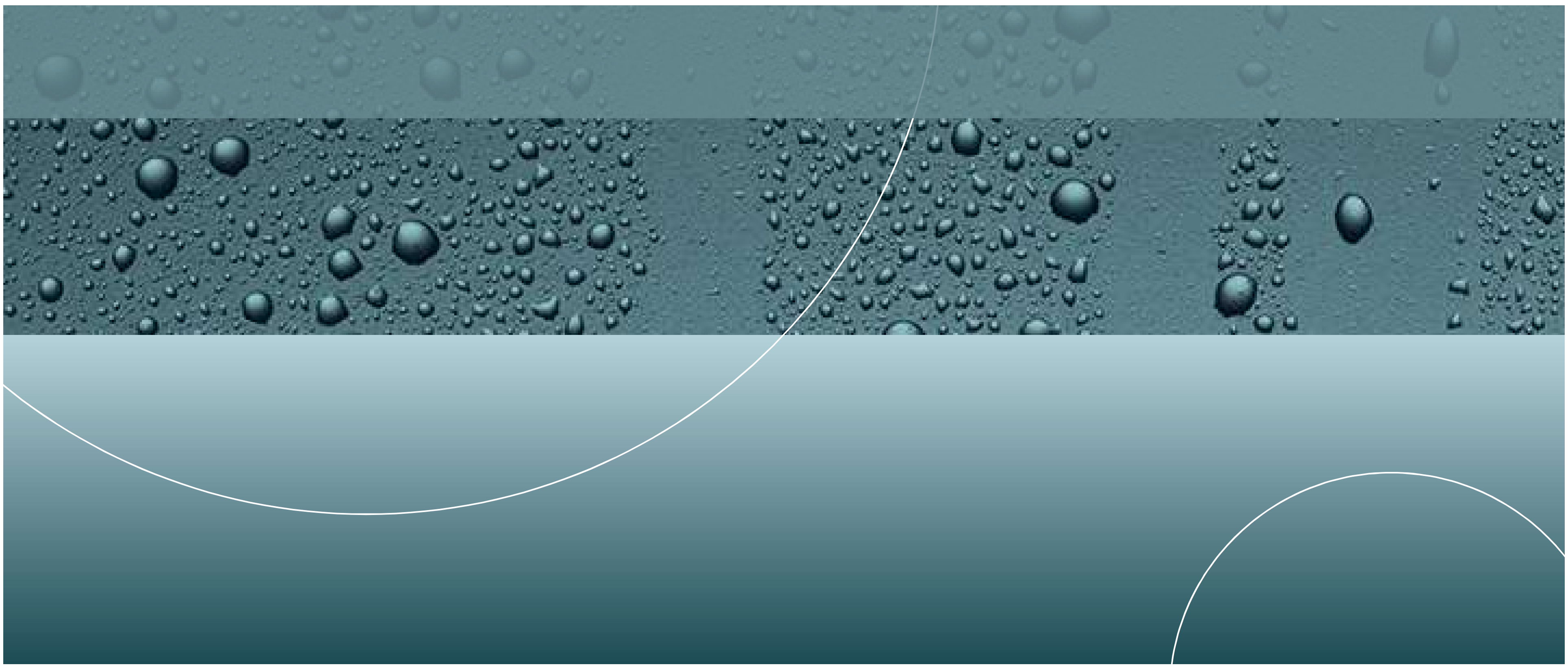
- To restrict poor water quality entering the tanks for irrigation
- To shandy the water with mains supply to reduce the concentrations of pollutants

Water Quality Management - Human Health

- Human health may be affected by exposure to stormwater in public areas. Of particular risk is pathogen exposure (represented by the E.coli indicator). Recommendations to be considered are as follows:

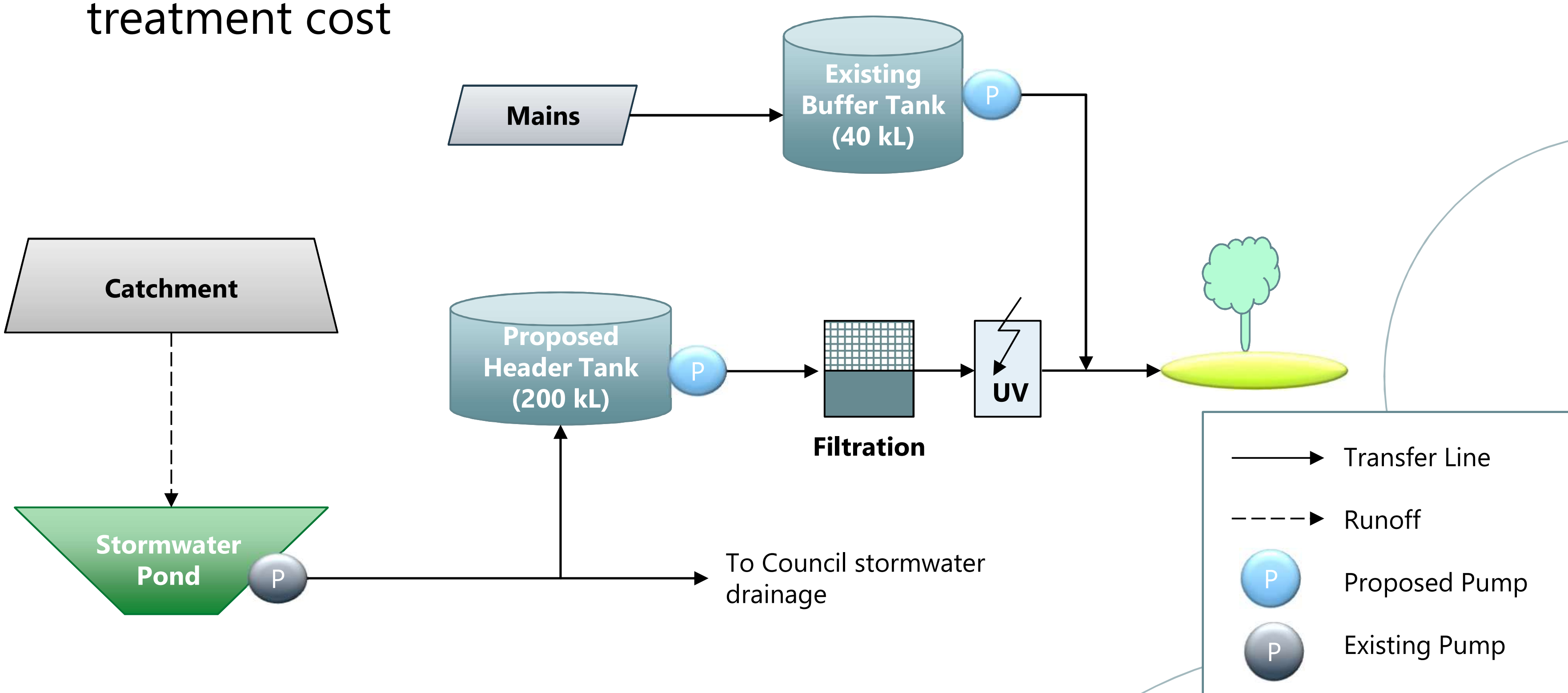
Measure	Comment
Move recirculation intake to southern side of pond to stimulate mixing and reduce the risk of algal blooms	This will be a key management task to reduce the risk of blooms
Disinfection is strongly recommended to minimise Council risk to public health on pathogen exposure	The typical method in this case would be UV however further water quality testing is required to confirm the effectiveness of this treatment
Filtration prior to disinfection is strongly recommended	This will improve UV performance and also help manage the potential for algae to be pumped to the header tank

HYDRAULIC CONFIGURATION



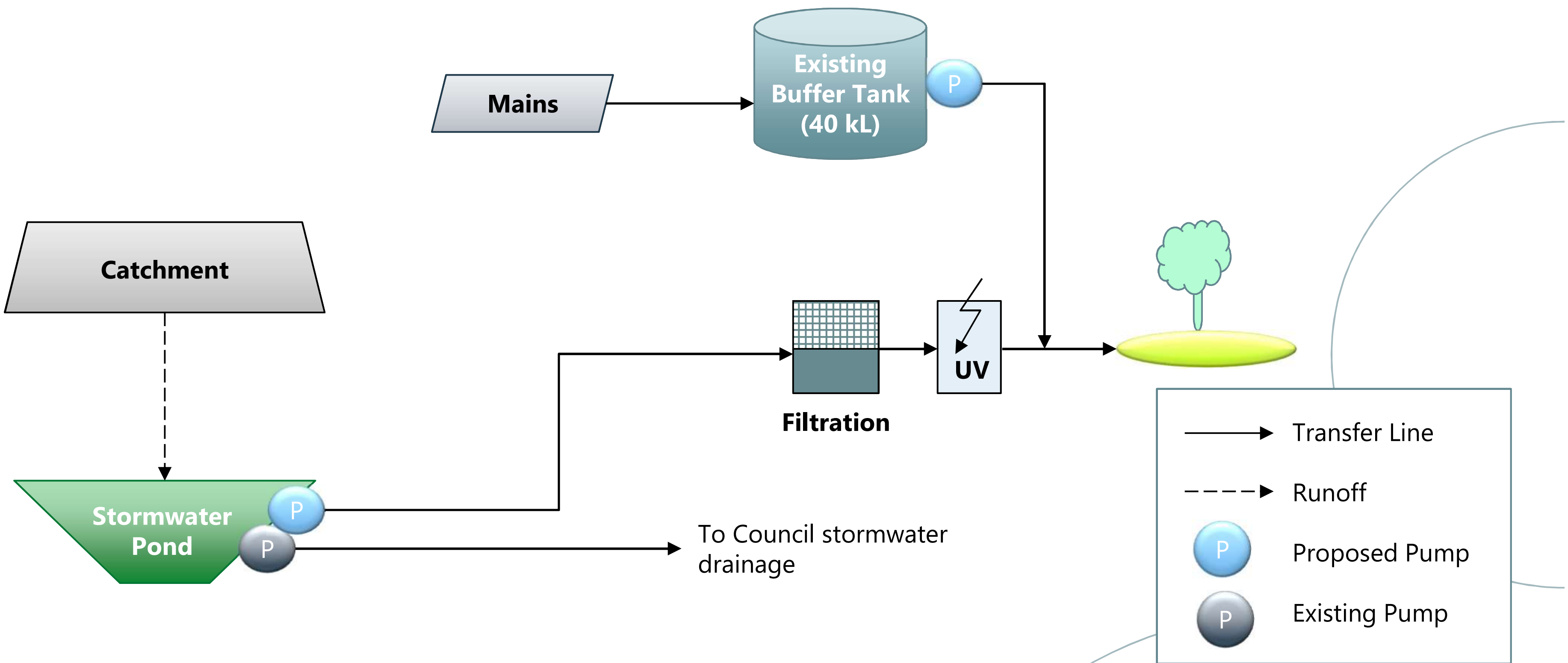
Option 1 – System Schematic

- As per initial strategy by others, however, with treatment prior to irrigation.
- A gravity offtake from the main line feeds an underground header tank
- The header tank allows a lower pump out rate to irrigation, reducing treatment cost



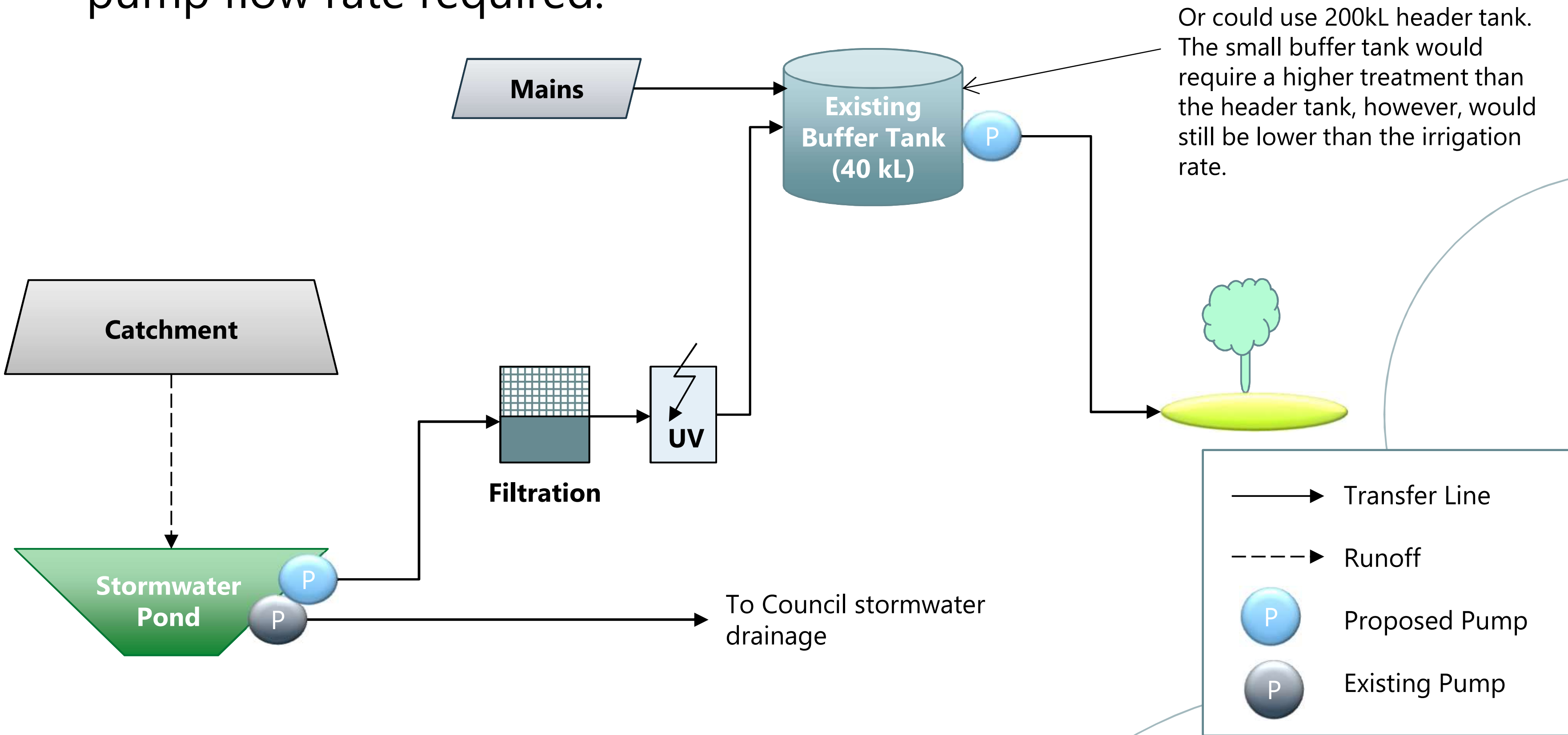
Option 2 – System Schematic

- Installation of low flow pump with irrigation directly from the lake, bypassing header or buffer tanks.
- The treatment rate would match the irrigation rate
- Make-up water still required from mains for when the lake is low, or shandying is required to manage water quality



Option 3 – System Schematic

- Install a low flow pump transferring at a lower rate to header or buffer tank
- Water is treated at a low rate (reducing treatment cost).
- The size of the header tank and irrigation rate would dictate the pump flow rate required.



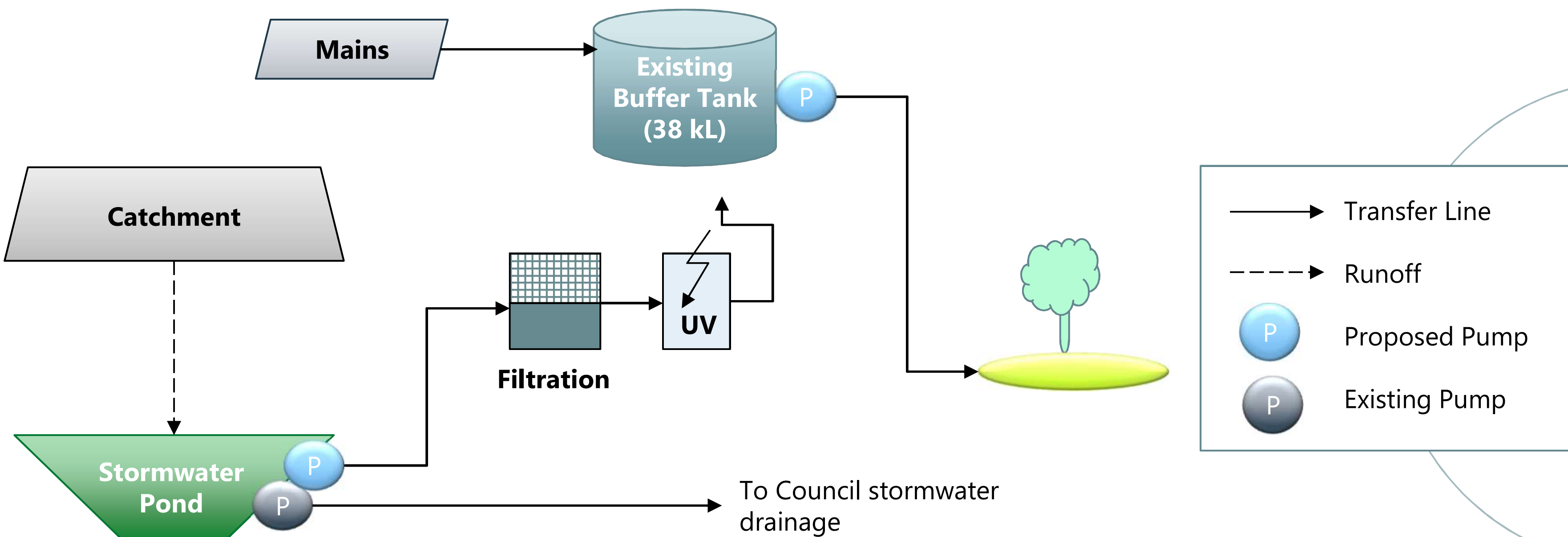
Options Summary

- A summary of the advantages and disadvantages of each of the options are as follows:

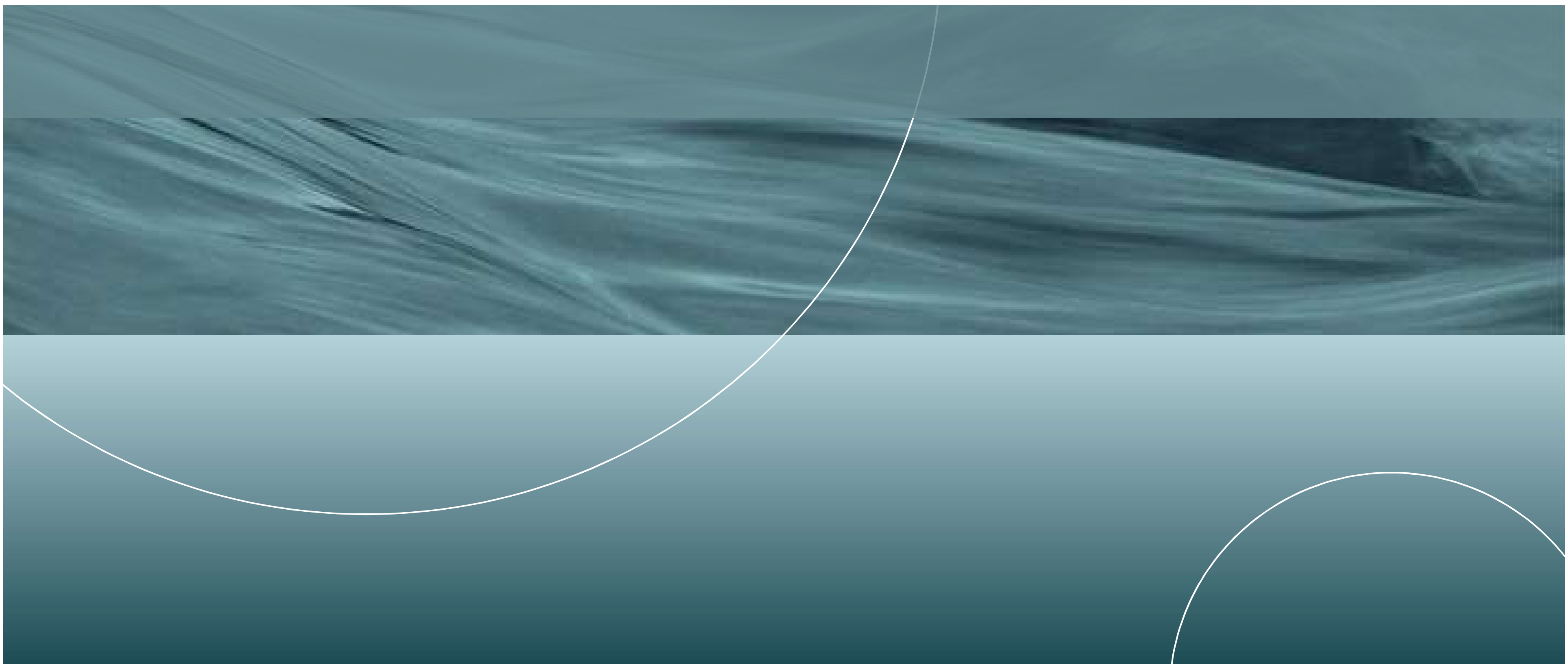
Element	Advantages	Disadvantages
Option 1 – Previous configuration (treatment added)	• The biggest advantage of this option is that existing infrastructure including rising main may be utilised to supply lake water. • This could utilise the small buffer tank and therefore run a smaller pump through treatment prior to the buffer tank and then through the existing pump and irrigation system, minimising costs associated with treatment of larger flows	• Operating 3 pumpsets to activate irrigation. Irrigating directly from the 200KL header tank would require only 2 pumpsets but treatment at the full irrigation rate would be required. • The 200 kL header tank is an underground installation and therefore attract significantly higher construction costs relative to above ground tanks
Option 2 – Direct irrigation from Pond	• Bypasses the need to install underground header tank •Treatment can be located at the lake or Tally Ho Reserve.	• Treatment rate would need to match the irrigation rate which would be higher than a transfer rate, and therefore higher treatment costs • The existing buffer tank would still be required to provide make up water if the lake is low • A low flow pump would need to be installed in the lake pump pit
Option 3 – Low flow pump and treatment	• Treatment occurs at a lower rate than irrigation (transfer rate) and therefore lowered cost • Can use existing infrastructure (above-ground buffer tank), without the need for installing underground infrastructure (depends on Council preference and water balance)	• The small buffer tank would require a higher treatment rate than the 200 kL (however, would still be lower than the irrigation rate) • A low flow pump would need to be installed in the lake pump pit

Preferred Option

Council selected Option 3 as their preferred stormwater harvesting arrangement which combines a lower treatment rate while utilising existing infrastructure.



WATER BALANCE ASSESSMENT



Water Balance Set-Up

- A 6-minute time-stepped water balance model was developed based on historical rainfall data for selected dry and mean years.
- The water balance aims to:
  - Replicate future performance using historical data
  - Determine the storage behaviour of the stormwater pond
  - Evaluate the sensitivity of the proposed system to varied buffer tank sizes and pump transfer rates
  - Determine the reliability of irrigation supply
  - Optimise performance of the harvesting scheme

Water Balance Inputs – Rainfall

Rainfall data for dry & mean rainfall years selected from BOM Station # 086071 (from August to July) based on:

- A range for dry years around the 10th percentile
- Quality of data for each year

Water Balance ID	1	2	3	4	5	**6**	**7**	**8**	**9**	**10**
Year	1996/97	1982/83	2003/04	1944/45	1966/67	2000/01	1965/66	1939/40	1980/81	1994/95
Rainfall (mm)	386	447	448	489	497	599	635	640	652	669
Period	Dry					Mean				

Water Balance Inputs – Irrigation Demands

- Irrigation demand calibration
  - Monash City Council provided proposed and actual irrigation use data for the Tally Ho Reserve between July 2012 – June 2013
  - Actual usage was 3620 kL while budgeted usage for the same period was 4260 kL
  - We calibrated our water balance model to match this usage
  - To achieve a calibrated model, we selected rainfall data from the 2000-2001 period which was a mean year by rainfall
- Modelled irrigation demand was based on:
  - Irrigation at night over a 6 hour period
  - Calibrated crop factors and irrigation deficit triggers, treating the soil profile as a storage
  - Evapo-transpiration for each time-step

Water Balance – Calibration

- The water balance was calibrated by adjusting the following parameters:
  - Crop factor
    - Was set to 0.6 based on the type of grass at the Tally Ho reserve as mentioned in the Reeds report.
  - Irrigation triggers
    - A number of 'triggers' were built into the water balance model. These controlled when the field required irrigation and whether harvested water was available.
  - Sprinkler flow rates
    - rates were sourced from Council's ground maintenance staff and totalled 3 L/s for the 41 sprinkler system.

Irrigation Demand

- Irrigation demands for a selected dry and mean year are shown below
- As would be expected, higher demand occurs during the dry year

Period	Oval
Irrigation Area	1.39 ha
Dry Year (1996/97)	5.76 ML/annum
Mean Year (2000/01)	4.65 ML/annum

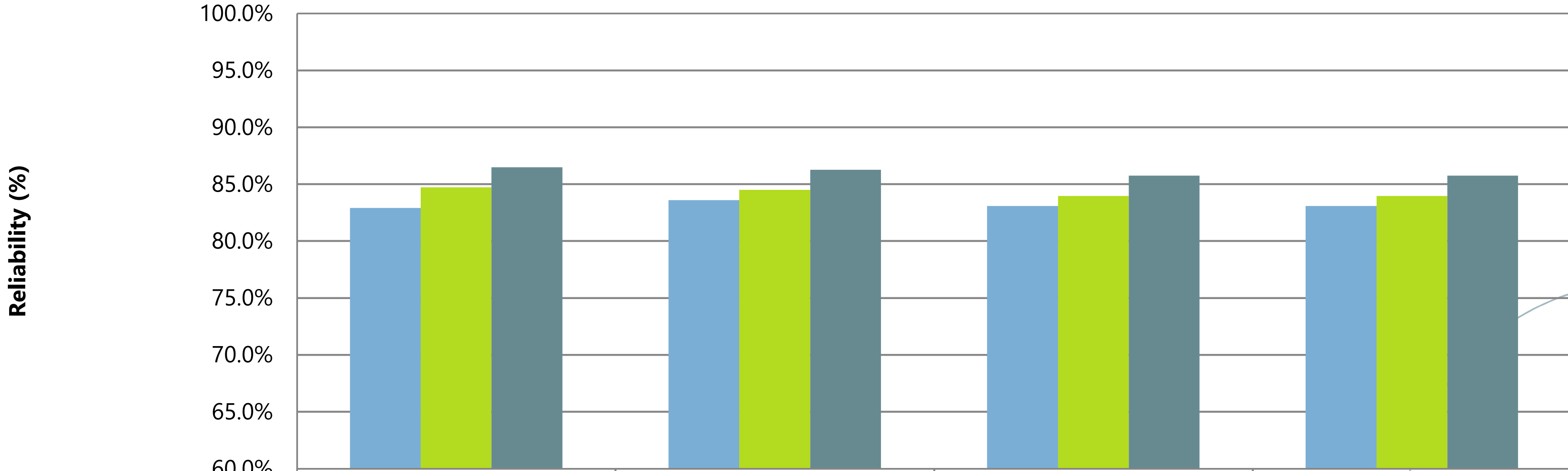
- These demands are considered conservative as they are larger than Council's budgeted usage

Stormwater Harvesting Optimisation

- Harvesting/Yield depends on:
  - Size of storage
  - Size and nature of catchment
  - Irrigation regime
    - How much water and when
    - Type of grass
  - Timing of rainfall events
    - Annual rainfall depth
    - When the rain falls
    - If the buffer tank has room to store runoff
- Sensitivity of yield has been investigated for all the 10 selected years
- We have utilised the first 500mm of the SP storage for harvesting (i.e. a drawdown of 500mm)
  - A range of drawdown levels were investigated with 500mm delivering the best balance between maintaining aesthetic SP levels and high harvesting yields (e.g. a 300mm drawdown provides 10% lower reliabilities)

Offtake Rates and Tank Size

- Selection of a mean year (Year 6 – 2000/01)
- A 500mm drawdown of the stormwater pond was selected

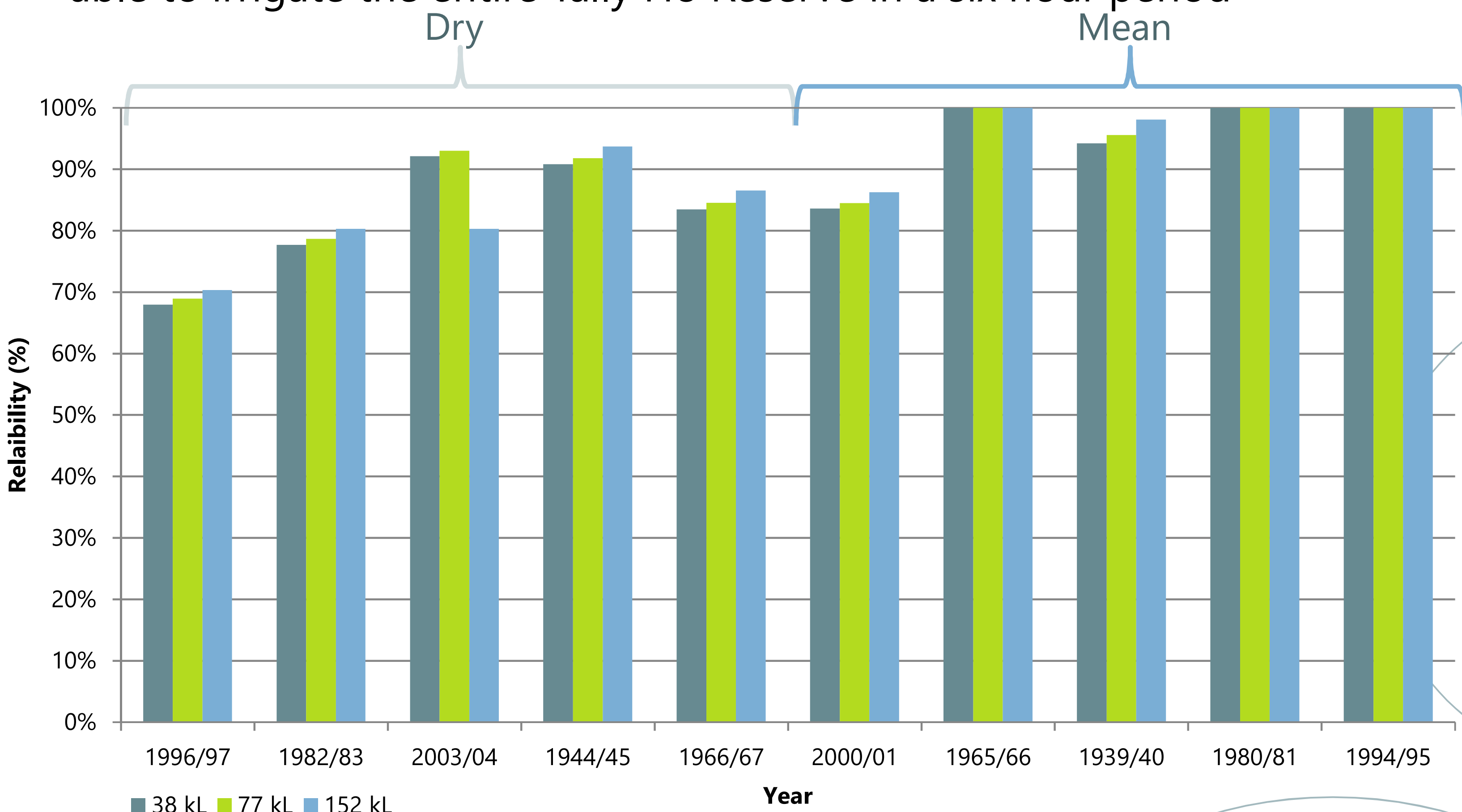


	Offtake Rate - 1 L/s	Offtake Rate - 2 L/s	Offtake Rate - 5 L/s	Offtake Rate - 10 L/s
Buffer Tank Size - 38 kL	82.9%	83.6%	83.1%	83.1%
Buffer Tank Size - 77 kL	84.7%	84.5%	84.0%	84.0%
Buffer Tank Size - 152 kL	86.5%	86.3%	85.7%	85.7%

- Above 80% reliability is achieved for all tank sizes and rates

Tank Size

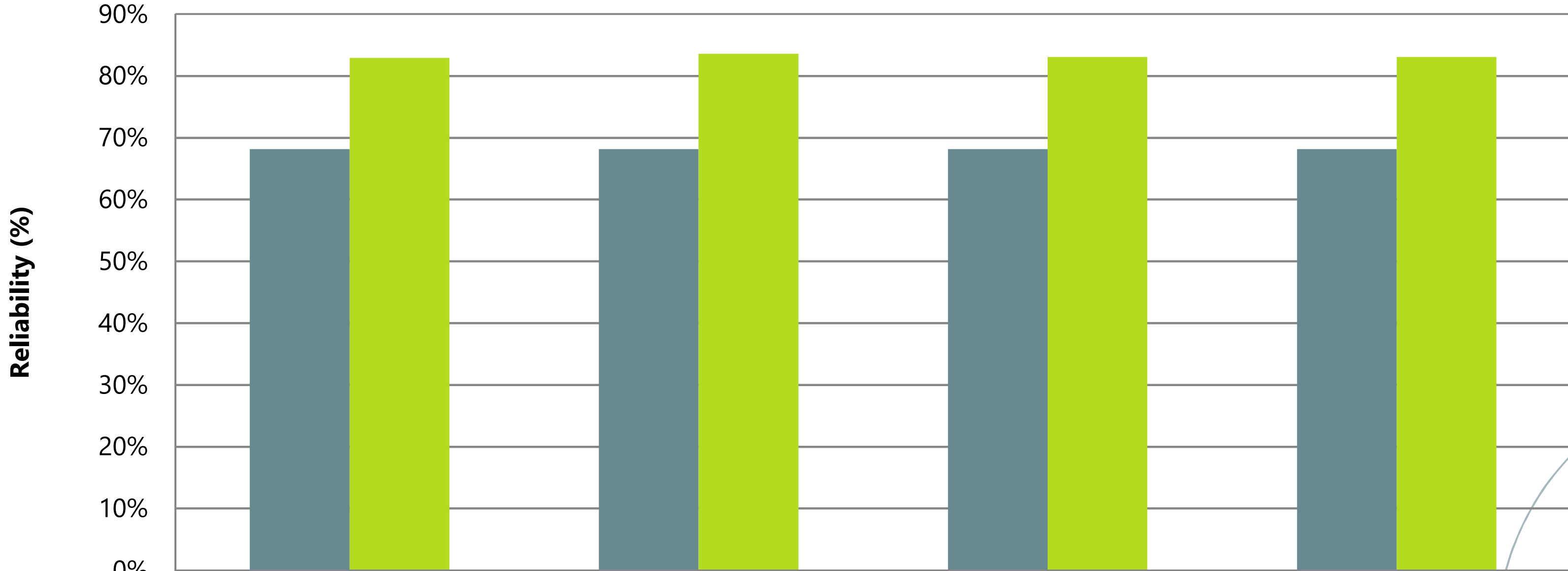
- The 38 kL, 77 kL and 152 kL tanks selected for further optimisation for all the selected years using a 500mm drawdown
- A 2 L/s offtake rate was selected as this was the minimum rate needed to be able to irrigate the entire Tally Ho Reserve in a six hour period



- The 38 kL has almost the same reliability as the much larger tanks

Offtake Rates

- The 38 kL tank was adopted for comparison with a dry year (1982/83)



	1 L/s	2 L/s	5 L/s	10 L/s
Dry Year	68%	68%	68%	68%
Mean Year	83%	84%	83%	83%

- The 2 L/s offtake is most applicable as it is the minimum offtake rate needed to irrigate Tally Ho Reserve in one irrigation cycle

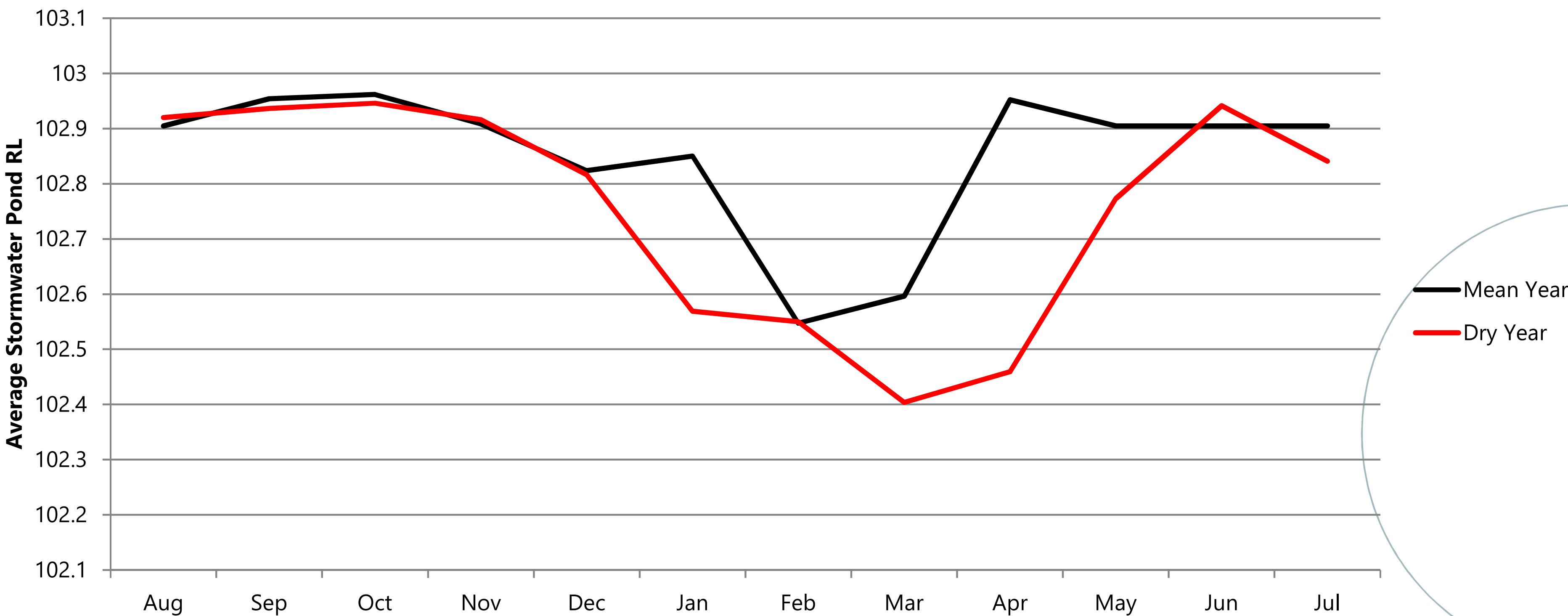
Reduction in Potable Supply

- Irrigation volumes, and therefore reduction in potable supply are shown below:

Scenario	Dry	Mean
Tally Ho Reserve (38 kL tank @ 2 L/s offtake)	3.83 - 5.58 ML (68 - 92% reliability)	1.97 - 4.18 ML (84 - 100% reliability)

Potential for Stormwater Pond to Dry Out

- Stormwater pump cut-in level: RL 103.15
- Stormwater pump cut-out level: RL 103.0



- Maximum level reached using data from 1994/95 (year 10) - RL103.2
- Minimum level reached using data from 1996/97 (Year 1) - RL102.4

Water Balance Results Summary

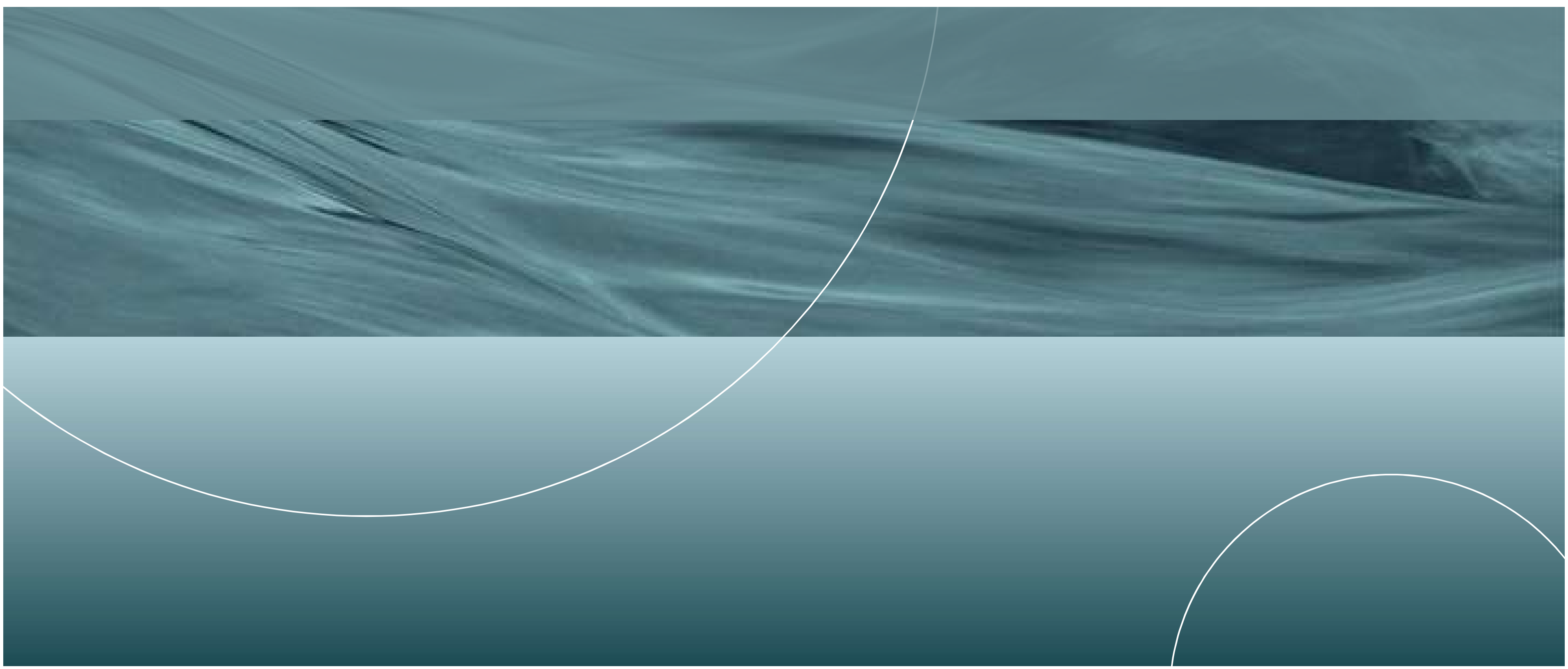
- Reliability stays constant when increasing offtake rates and tank sizes

- Mean years
  - Provides 84 - 100% reliability for all tested tank sizes and offtake rates

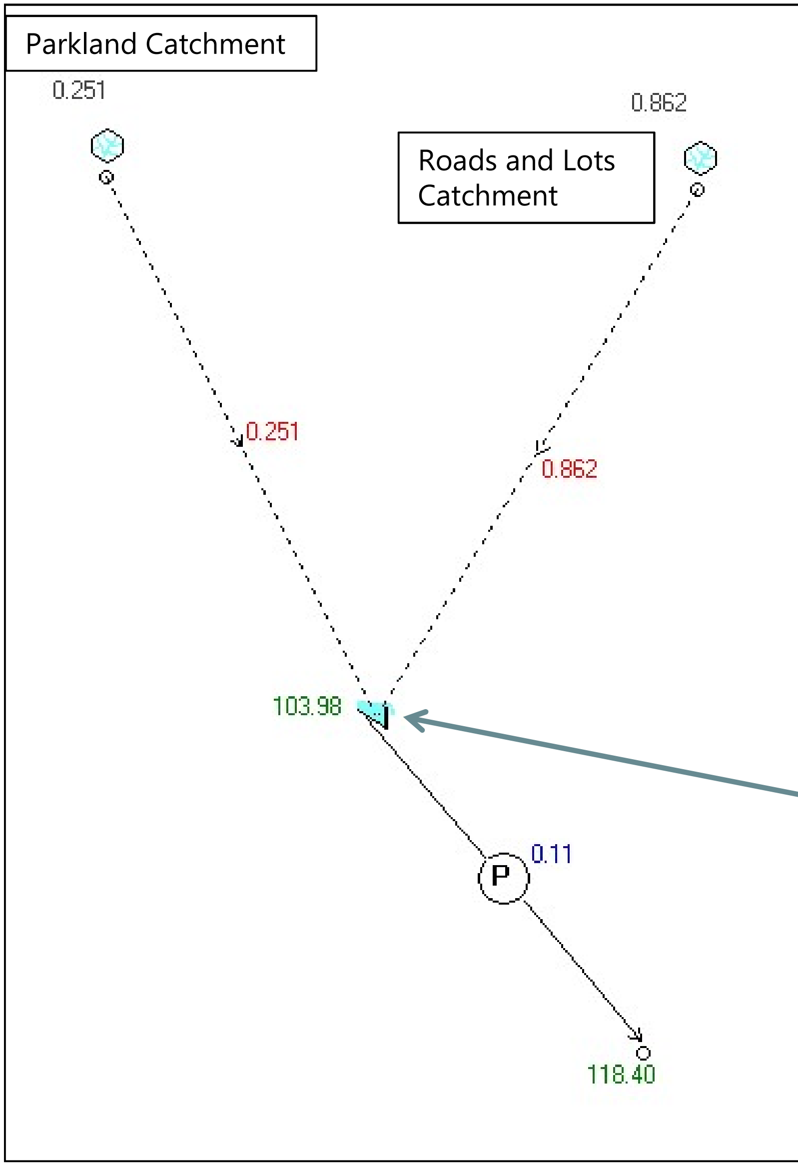
- Dry years
  - Around a 15% drop in reliability but still between 68 - 92%

- To manage the potable water top-up requirements, a second 38 kL tank should be installed next to the existing tank

PEAK FLOW ASSESSMENT



DRAINS Modelling - Results

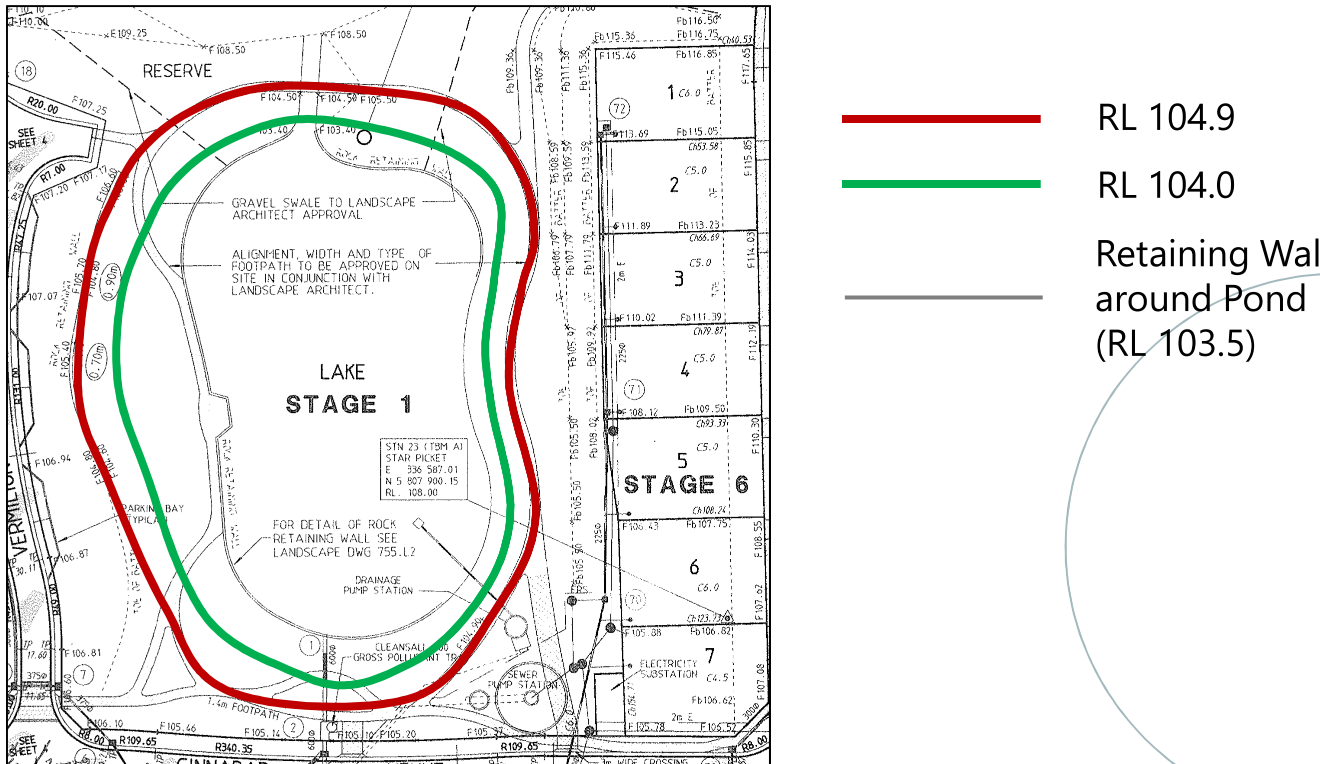


- Based on an initial water level of RL 103.2 and the stormwater drainage pump cutting in at RL 103.15 and cutting out at RL 103.0
- 100 Year ARI 3 hr storm event was the worst case scenario.
- This produced a peak pond RL of 103.98

A peak pond depth of RL 103.98

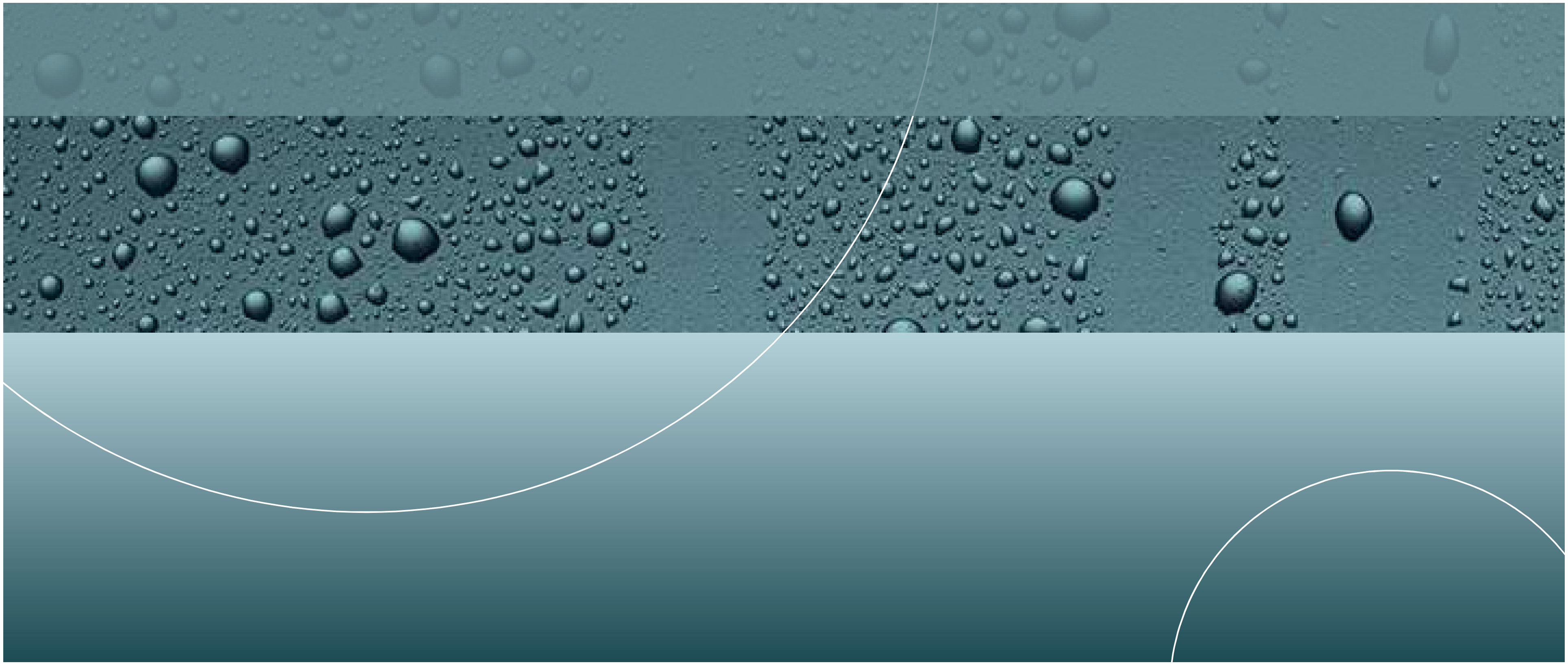
Drains Modelling - Results

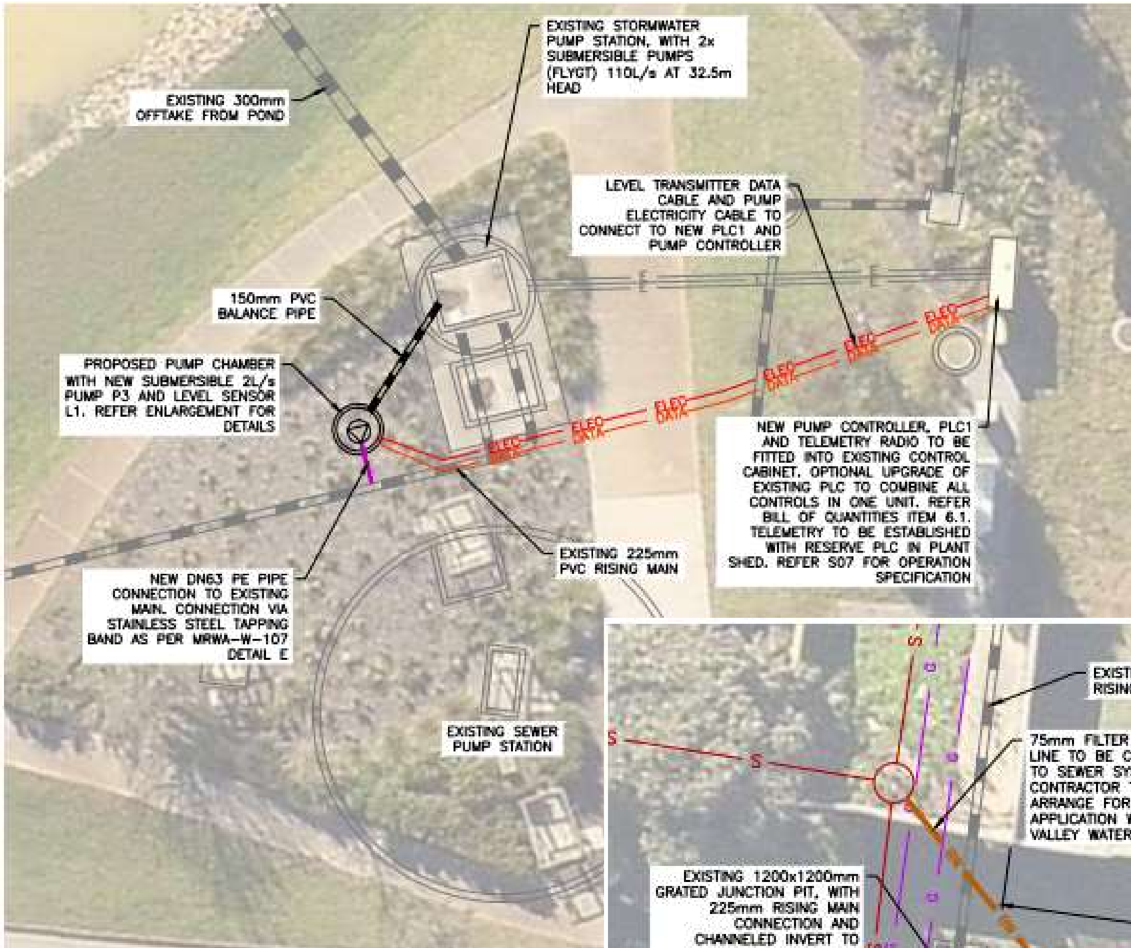
- A peak level of **RL 103.98** was reached during a 100 year, 3 hour storm event
- Based on the Sienna Falls Estate layout plan, this is well below the level of the footpath which runs around the perimeter of the pond at RL 104.9

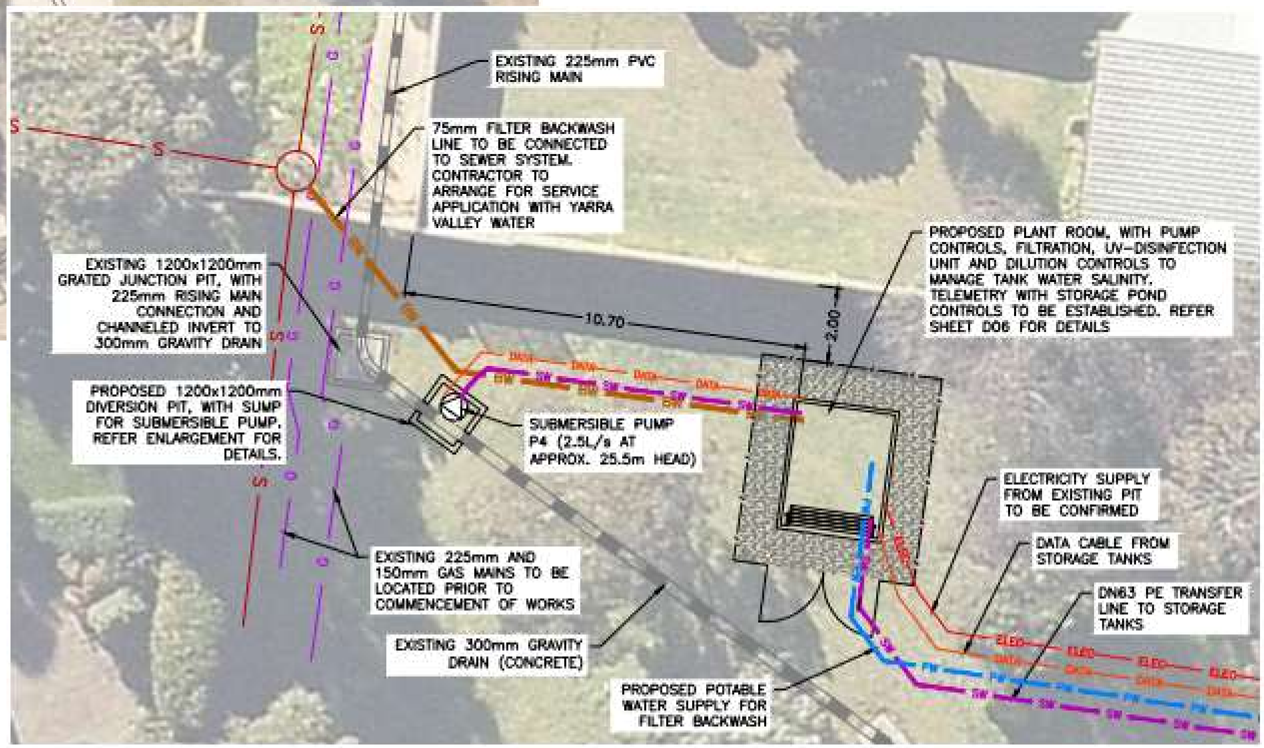


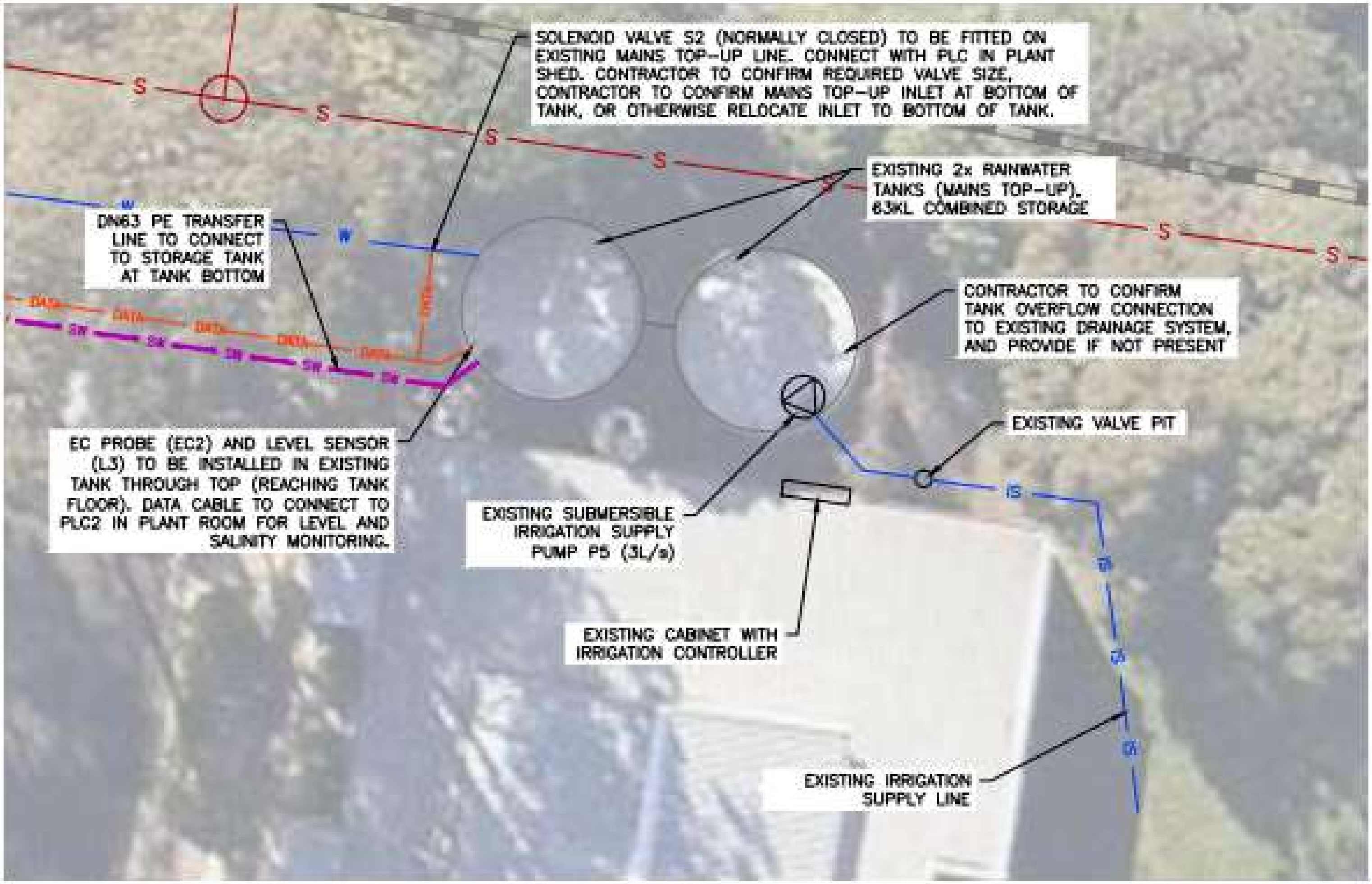
- The tested cut-in and cut-out levels provide enough capacity for flood storage while maintaining an aesthetically acceptable pond level

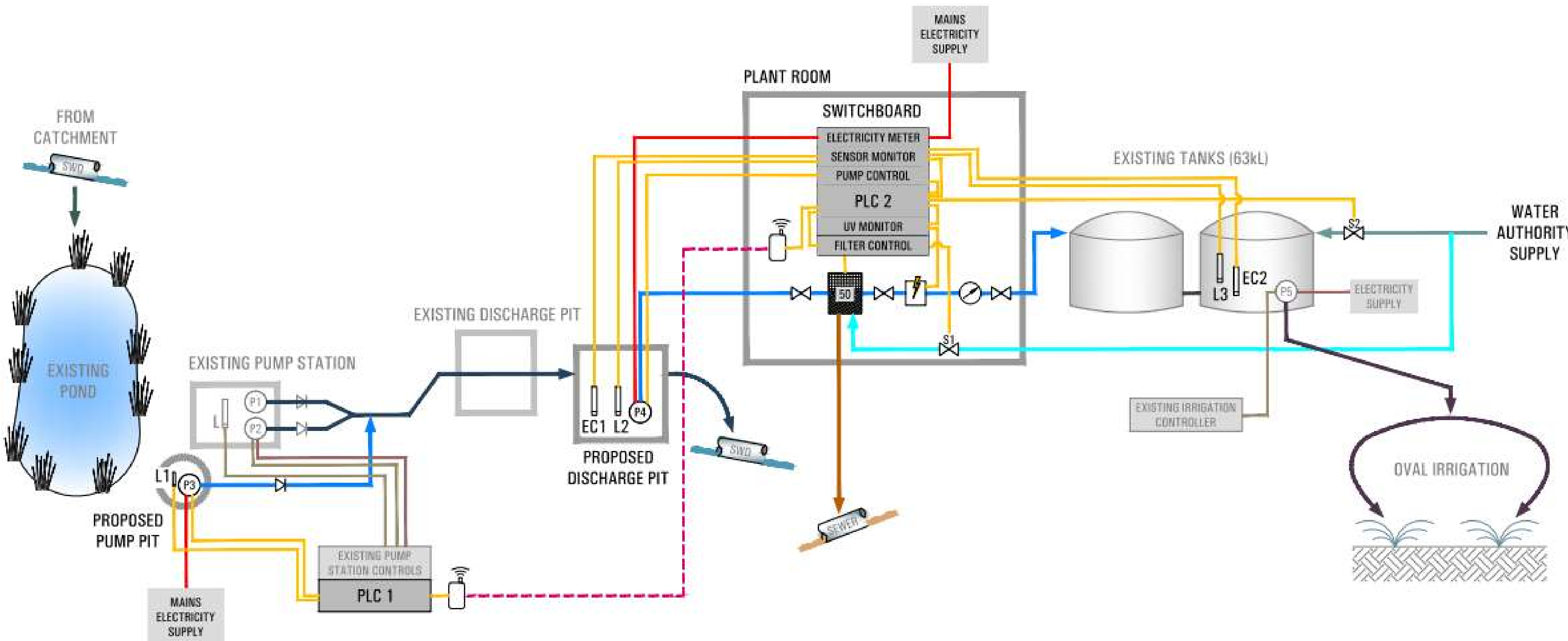
DESIGN




EXISTING STORMWATER PUMP STATION, WITH 2x SUBMERSIBLE PUMPS (FLYGT) 110L/s AT 32.5m HEAD
EXISTING 300mm OFFTAKE FROM POND
LEVEL TRANSMITTER DATA CABLE AND PUMP ELECTRICITY CABLE TO CONNECT TO NEW PLC1 AND PUMP CONTROLLER
150mm PVC BALANCE PIPE
PROPOSED PUMP CHAMBER WITH NEW SUBMERSIBLE 2L/s PUMP P3 AND LEVEL SENSOR L1. REFER ENLARGEMENT FOR DETAILS
NEW PUMP CONTROLLER, PLC1 AND TELEMETRY RADIO TO BE FITTED INTO EXISTING CONTROL CABINET. OPTIONAL UPGRADE OF EXISTING PLC TO COMBINE ALL CONTROLS IN ONE UNIT. REFER BILL OF QUANTITIES ITEM 6.1. TELEMETRY TO BE ESTABLISHED WITH RESERVE PLC IN PLANT SHED. REFER S07 FOR OPERATION SPECIFICATION
EXISTING 225mm PVC RISING MAIN
NEW DN63 PE PIPE CONNECTION TO EXISTING MAIN. CONNECTION VIA STAINLESS STEEL TAPPING BAND AS PER MRWA-W-107 DETAIL E
EXISTING SEWER PUMP STATION

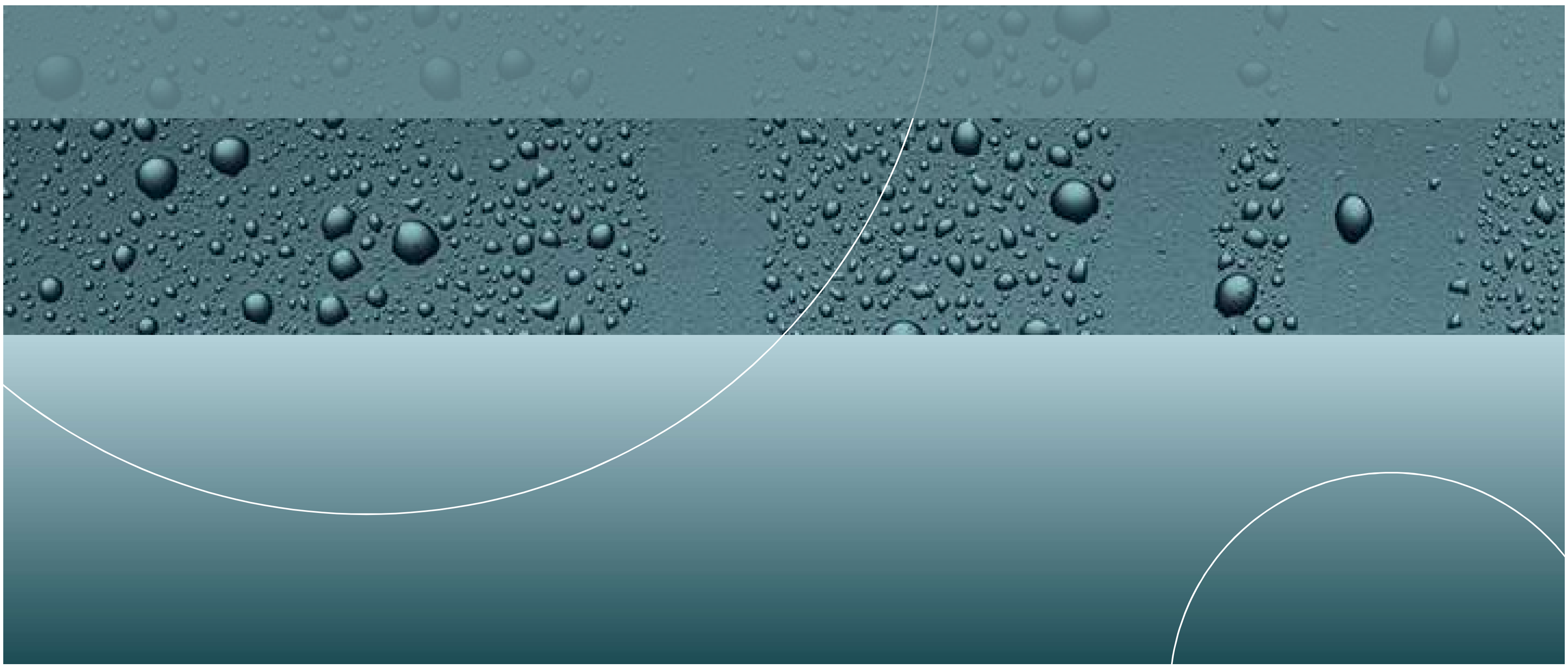

EXISTING 225mm PVC RISING MAIN
75mm FILTER BACKWASH LINE TO BE CONNECTED TO SEWER SYSTEM. CONTRACTOR TO ARRANGE FOR SERVICE APPLICATION WITH YARRA VALLEY WATER
PROPOSED PLANT ROOM, WITH PUMP CONTROLS, FILTRATION, UV-DISINFECTION UNIT AND DILUTION CONTROLS TO MANAGE TANK WATER SALINITY. TELEMETRY WITH STORAGE POND CONTROLS TO BE ESTABLISHED. REFER SHEET D06 FOR DETAILS
EXISTING 1200x1200mm GRATED JUNCTION PIT, WITH 225mm RISING MAIN CONNECTION AND CHANNELED INVERT TO 300mm GRAVITY DRAIN
10.70
2.00
PROPOSED 1200x1200mm DIVERSION PIT, WITH SUMP FOR SUBMERSIBLE PUMP. REFER ENLARGEMENT FOR DETAILS.
SUBMERSIBLE PUMP P4 (2.5L/s AT APPROX. 25.5m HEAD)
ELECTRICITY SUPPLY FROM EXISTING PIT TO BE CONFIRMED
DATA CABLE FROM STORAGE TANKS
DN63 PE TRANSFER LINE TO STORAGE TANKS
EXISTING 225mm AND 150mm GAS MAINS TO BE LOCATED PRIOR TO COMMENCEMENT OF WORKS
EXISTING 300mm GRAVITY DRAIN (CONCRETE)
PROPOSED POTABLE WATER SUPPLY FOR FILTER BACKWASH


SOLENOID VALVE S2 (NORMALLY CLOSED) TO BE FITTED ON EXISTING MAINS TOP-UP LINE. CONNECT WITH PLC IN PLANT SHED. CONTRACTOR TO CONFIRM REQUIRED VALVE SIZE. CONTRACTOR TO CONFIRM MAINS TOP-UP INLET AT BOTTOM OF TANK, OR OTHERWISE RELOCATE INLET TO BOTTOM OF TANK.
EXISTING 2x RAINWATER TANKS (MAINS TOP-UP). 63KL COMBINED STORAGE
DN63 PE TRANSFER LINE TO CONNECT TO STORAGE TANK AT TANK BOTTOM
CONTRACTOR TO CONFIRM TANK OVERFLOW CONNECTION TO EXISTING DRAINAGE SYSTEM, AND PROVIDE IF NOT PRESENT
EXISTING VALVE PIT
EC PROBE (EC2) AND LEVEL SENSOR (L3) TO BE INSTALLED IN EXISTING TANK THROUGH TOP (REACHING TANK FLOOR). DATA CABLE TO CONNECT TO PLC2 IN PLANT ROOM FOR LEVEL AND SALINITY MONITORING.
EXISTING SUBMERSIBLE IRRIGATION SUPPLY PUMP P5 (3L/s)
EXISTING CABINET WITH IRRIGATION CONTROLLER
EXISTING IRRIGATION SUPPLY LINE



MAINS ELECTRICITY SUPPLY
PLANT ROOM
SWITCHBOARD
ELECTRICITY METER
SENSOR MONITOR
PUMP CONTROL
PLC 2
UV MONITOR
FILTER CONTROL
EXISTING TANKS (63kL)
WATER AUTHORITY SUPPLY
FROM CATCHMENT
SWD
EXISTING POND
EXISTING PUMP STATION
P1
P2
L
EXISTING DISCHARGE PIT
EC1
L2
P4
PROPOSED DISCHARGE PIT
SWD
50
S1
S2
L3
EC2
P5
ELECTRICITY SUPPLY
EXISTING IRRIGATION CONTROLLER
OVAL IRRIGATION
SEWER
L1
P3
PROPOSED PUMP PIT
EXISTING PUMP STATION CONTROLS
PLC 1
MAINS ELECTRICITY SUPPLY

CONSTRUCTION



Plant Shed

Discharge Pit

Stormwater Pond and Offtake

Storm

Bringing engineering to **life**