



St Helena  
Government

# **Appendices: Water Resource Management Plan** **(Draft for Consultation)**

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# Report Details

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# Contents

<b>A</b>	<b>Supply-Demand Balance Assessment</b>	<b>A-1</b>
	A.1 Summary	A-1
	A.2 Introduction	A-3
	A.3 Supply assessment	A-4
	A.4 Demand modelling	A-21
	A.5 Base Water Resources Modelling	A-29
	A.6 Base Yield and Deployable Output	A-47
	A.7 Sensitivity to climate change	A-50
	A.8 Baseline Supply Demand Balance	A-57
	A.9 Conclusions and recommendations	A-59
<b>B</b>	<b>Options appraisal and best value planning</b>	<b>B-1</b>
	B.1 Summary	B-1
	B.2 Purpose	B-1
	B.3 The process of options appraisal	B-1
	B.4 Best value planning	B-2
	B.5 Options identification and long list screening	B-3
	B.6 Further refinement of the options list	B-9
	B.7 Feedback on options screening	B-10
	B.8 Options shortlist	B-10
	B.9 Options Appraisal	B-17
	B.10 Options shortlist ranking	B-24
	B.11 Phasing of options	B-25
	B.12 Cost assessment	B-26
	B.13 Low regret or enabling actions additional costing	B-33
	B.14 Summary and conclusions	B-37
<b>C</b>	<b>Institutional, legal and regulatory adjustments required</b>	<b>C-1</b>
	C.1 Evidence base and sources reviewed	C-1
	C.2 Rainwater harvesting	C-2
	C.3 Recycled and non-potable water	C-2
	C.4 Abstraction control	C-3
	C.5 Water quality	C-3
	C.6 Agricultural water	C-4
	C.7 WRMP implementation, review and governance	C-5



**D Environmental Assessment**

**D-1**

D.1 Purpose and context

D-1

D.2 Environmental baseline and sensitivity context

D-1

D.3 Environmental screening of options

D-5

D.4 Screening approach

D-6

D.5 Summary of screening outcomes

D-6

**E Public Consultation**

**E-1**

E.1 Purpose

E-1

E.2 Consultation activities undertaken

E-1

E.3 Survey results

E-1

E.4 How consultation influenced the WRMP

E-3

# A Supply-Demand Balance Assessment

## A.1 Summary

This appendix presents the supply-demand balance assessment undertaken to support the St Helena Water Resources Management Plan (WRMP). Its purpose is to demonstrate that a robust, proportionate and transparent process has been applied to estimate the deployable output (DO) of the island's water supply system at an agreed 1 in 100-year level of service, and to identify when future supply-demand deficits may arise.

To quantify water availability, a hydrological modelling framework was developed to represent long-term inflows from surface water and spring-fed catchments using GR6J modelling to define model inflows. Input from groundwater has been quantified based on the data available

A system-wide water resources model was developed in Aquator XV to represent the operation of St Helena's supply system, including surface water abstractions, groundwater boreholes, reservoirs, storage tanks, treatment works and demand centres. The model was benchmarked against observed abstraction and storage data for the period 2016-2024 and was found to replicate seasonal patterns, drought drawdown and recovery behaviour satisfactorily. The model is therefore considered fit for purpose for strategic water resources planning.

Using this framework, the baseline deployable output of the St Helena supply system was estimated at approximately 1,659 m<sup>3</sup>/day for a 1 in 100-year return period under historical climate conditions. Inclusion of storage tanks within the model increases the effective deployable output to approximately 1,930 m<sup>3</sup>/day, indicating that tanks provide around 15% additional system resilience, particularly in zones with limited natural storage such as Jamestown.

Zone-level analysis highlights marked spatial variability in water resource availability. The eastern supply zones, particularly Hutts Gate and Levelwood, exhibit higher yields due to the availability of groundwater sources that provide increased drought resilience. In contrast, Redhill and Jamestown are more vulnerable to supply shortfalls as they rely predominantly on spring and surface water sources that are highly sensitive to rainfall variability. This imbalance, combined with the concentration of demand in the western part of the island, underlines the critical role of inter-zone transfers in maintaining system resilience.

Future pressures were assessed through demand growth scenarios and climate change sensitivity testing. Climate change is projected to reduce deployable output by approximately 10-20% by the 2060s, depending on emissions pathway and storage assumptions. For planning purposes, a conservative "no tanks" supply forecast was adopted to reflect outage risk and infrastructure vulnerability. When combined with demand projections, the analysis indicates that while the system is currently in surplus, a supply-demand deficit emerges under moderate and high impact scenarios, with deficits arising from the mid-2030s onwards in the higher growth case.



Overall, the assessment demonstrates that St Helena's water supply system can meet current demand but is increasingly exposed to future risks arising from climate change, demand growth, limited storage and operational constraints. The results provide a robust baseline for the WRMP, identifying when intervention may be required and informing the development and appraisal of supply-side and demand-side options in subsequent stages of the plan. As monitoring improves and further data become available, this assessment can be refined in future WRMP cycles.

## A.2 Introduction

This section sets out the technical assessment underpinning the St Helena Water Resources Management Plan (WRMP). Its purpose is to establish a robust and transparent evidence base on the availability of water resources, current and future demand, and the long-term balance between supply and demand on the island.

St Helena faces a distinctive set of water management challenges. The island has limited natural freshwater resources, highly variable rainfall, steep topography, small and responsive catchments, and a water supply system that relies on a combination of springs, surface water, groundwater and relatively small storage assets. Climate variability, ageing infrastructure, leakage and operational constraints further influence system resilience. At the same time, future pressures may arise from population change, economic development, agricultural demand and the impacts of climate change.

In this context, long-term water resources planning is essential to ensure that St Helena continues to provide secure, safe and affordable water supplies for households, businesses, agriculture and public services. The WRMP provides a structured framework to assess risks to supply, define appropriate levels of service, and identify proportionate, cost-effective and adaptive interventions over the planning horizon.

The approach adopted in this assessment is consistent with UK water company WRMP processes and guidance (including Environment Agency and UKWIR methodologies), while being applied in a proportionate manner reflecting the scale, data availability and operational realities of St Helena. In line with UK practice, the WRMP:

- establishes a clear baseline of deployable output at an agreed level of service;
- develops demand forecasts using measured consumption data and scenario-based population projections;
- assesses the impacts of climate change on long-term water availability;
- applies headroom to reflect residual uncertainty; and
- uses supply-demand balance analysis to identify when intervention may be required.

This appendix presents the baseline supply-demand balance assessment, including:

- quantification of available water resources through hydrological and groundwater analysis;
- development of a system-wide water resources model representing abstraction, storage, treatment and distribution assets;
- forecasting of household, non-household, agricultural and leakage demand under multiple future scenarios;
- estimation of system deployable output at a defined level of service;
- assessment of climate change impacts on water availability; and
- identification of when future supply-demand deficits may arise.

While the methods applied align with established UK WRMP best practice, they have been adapted pragmatically to reflect local data constraints and the operational characteristics of the St Helena system.

The outputs of this section provide the technical foundation for the subsequent options appraisal, phasing and preferred programme development stages of the WRMP.

### **A.3 Supply assessment**

#### **A.3.1 Introduction and modelling framework**

A key first step in water resources system modelling is to understand and quantify the inflows to the system, which define the volume of water available for supply. On St Helena, these inflows comprise surface water sources (streams and springs) and groundwater sources (boreholes). Together, these flows provide the primary inputs to the island's reservoirs, and their variability over time constrains the water available for abstraction and supply.

To assess water availability, it is important to consider inflows over a long period of record, in order to capture the full range of climatic conditions, including dry and drought years, wet years and average conditions. On St Helena, however, the period of observed flow data is limited, and many locations within the system are ungauged. As a result, hydrological modelling has been required to estimate surface water inflows, while available observations and local knowledge have been used to characterise groundwater contributions.

The hydrology of St Helena is inherently complex and highly variable, influenced by steep topography, small and responsive catchments, mist interception, and a strong interaction between surface water, springs and groundwater. Despite this complexity, the data available to explicitly represent all underlying hydrological processes are limited.

The guiding principle for the hydrological assessment has therefore been to adopt a proportionate, staged approach, starting with a relatively simple representation of system inflows and introducing additional complexity only where necessary to achieve an acceptable match to observed behaviour. This approach reduces reliance on poorly constrained assumptions about processes such as mist capture or groundwater flow paths, for which direct evidence is limited.

Estimated inflows have been subject to a two-stage validation process. First, modelled flows were compared against the limited observed flow records available at specific watercourses. Second, the derived inflows were tested within the water resources system model to assess whether resulting reservoir volumes and system behaviour were consistent with operational experience. Validation against both observed data and system performance provides increased confidence in the estimated inflows, helping to reduce uncertainty and ensure that modelled supplies are as representative as possible.

### A.3.2 Hydrological modelling

#### Selection of hydrological model

Following a literature review and testing the GR6J rainfall runoff model was identified as a model suitable for application in St Helena. The GR6J model is a lumped conceptual rainfall-runoff model used to simulate daily stream flows based on inputs of precipitation and potential evapotranspiration. The model has six parameters that dictate how rainfall is converted to runoff. These govern how water is stored, routed, exchanged, and lost through evaporation within the catchment. This model is therefore relatively simple and easy to calibrate. It also has enhanced representation of low flows and is therefore well suited for application in water resources studies. In addition, the model can simulate baseflow dominated catchments with ephemeral<sup>1</sup> flows (albeit in a limited way), like those seen in St Helena. HEC-HMS was also identified as a suitable candidate model; however, this model is more complex, has more parameters, and requires more detailed spatial information to be set up. GR6J was found to replicate the observed flows on the island reasonably well and carried forward for use in deriving the hydrological inflows for the modelling.

#### Model inputs

Figure gives the inputs and outputs required for the GR6J modelling process. The model requires rainfall, potential evapotranspiration and observed flow to run and calibrate the model over a defined time period, known as the calibration period. The model then uses these inputs to simulate flows. The model set-up, calibration and run process for St Helena is outlined in the below sections.

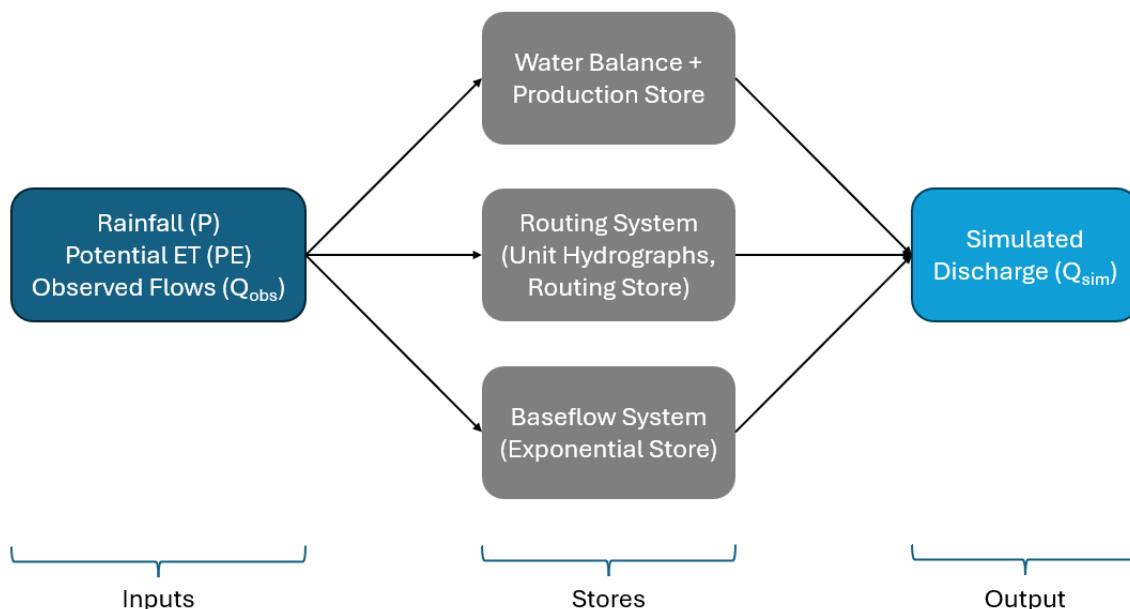


Figure A-1: Inputs and outputs of the GR6J modelling process

<sup>1</sup> Watercourses that flow intermittently, like those on St Helena.

## Model inputs - flow

As a first step, the observed flow records were examined to identify (1) those with the longest periods of observation and (2) those with suitable data quality for model calibration. The majority of gauging on St Helena has been undertaken through the Cloud Forest Project. There is some additional flow monitoring is carried out by Connect Saint Helena Ltd (CSH) at their abstraction locations. Locations of the cloud forest project gauges are given in Figure .

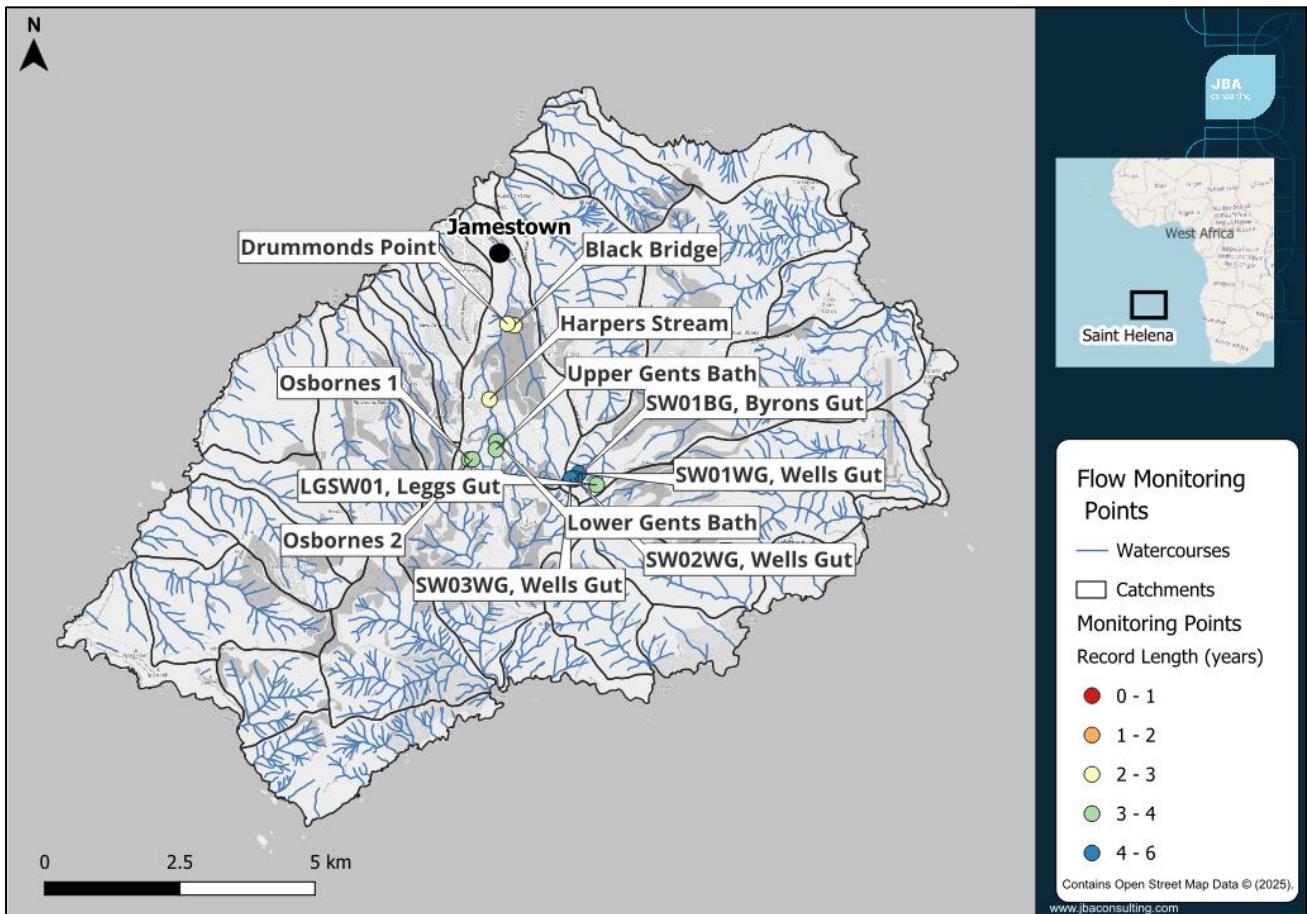


Figure A-2: River level and flow monitoring points

A review of gauge locations installed as part of the Cloud Forest Project indicated that most are situated at CSH abstraction weirs. Level gauges have been installed at these locations and converted to flow measurements when water levels exceed the height of the outlet weir. A comparison of observed flows at these gauges with those recorded at CSH's abstraction points showed limited or no similarity in flow volumes. This discrepancy is likely due to abstraction, which removes a component of the total flow before it reaches the gauge. Most of the records are intermittent and flows are only recorded when the weirs are overtopping. This raised concerns about data completeness, and therefore only flow records showing continuous or near-continuous flow would be used for model calibration to reduce the risk of missing volumes.

Most of the observed flow records are relatively short, typically less than two years in length. While calibration to a short record is possible, it is not ideal, as it limits the

opportunity to test model parameters under a wide range of antecedent conditions. In addition, a number of gauges were found to contain suspect values, such as step changes in flow or abrupt shifts in flow behaviour, as illustrated in Figure A-3.

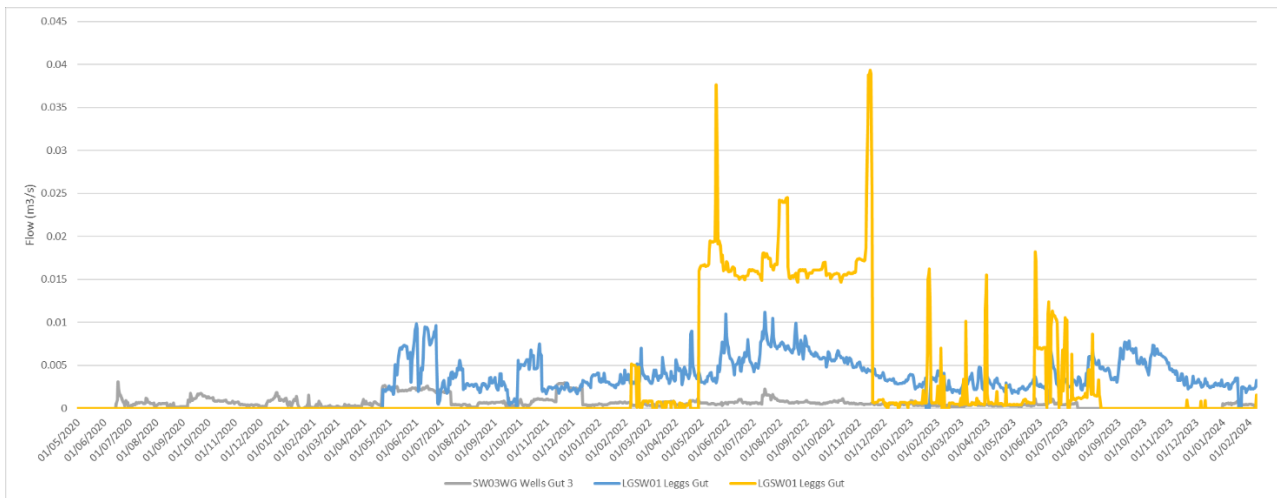


Figure A-3: Example plot of flow timeseries from Cloud Forest gauges

As previously noted, CSH also monitors flows at a number of their spring abstractions which is available from 2016 onwards. At some of these locations, it appears that nearly all of the inflow is abstracted as which was demonstrated in the earlier comparison between Cloud Forest Project and CSH data. This suggests that these records represent the total inflow into these abstraction points. It is worth noting that high-flow conditions are likely not captured in this dataset but given the very limited surface water component of the spring catchments this was considered acceptable given the modelling focus on low-flow conditions.

To select locations for calibration of the rainfall runoff model, the available gauges were then assessed against three criteria: (1) record length, (2) data quality, and (3) hydrological characteristics. Given the reliance on springs within the water supply system on St Helena, it was considered important to have one rainfall runoff model that well represented the flows from these sources. However, Jamestown for example is more reliant on both spring and surface water inputs so a gauge that captures this flow regime type was also of interest. With this in mind, two gauges with the two identified hydrological characteristics were selected for model calibration:

- Osbourne's Abstraction - spring flow monitoring point managed by CSH. While the record includes some missing or suspect data, it is generally of good quality and spans from 2016 to 2024.
- Black Bridge - A location monitoring both spring and surface water flows. CSH data indicate this site is not regularly used for abstraction, meaning there is a lower risk of missing flow volumes.

Both gauges are located within the James Valley catchment and are considered the most appropriate for use in model calibration, with a balance between data quality, record length, and representation of differing hydrological conditions across the catchment.

### Model inputs - rainfall

Rainfall data of varying lengths and resolution has been provided for use in this project by different project partners. Key sources were from monitoring installed during the cloud forest projects (DPLUS051 and DPLUS103) and the long-term monitoring from the ENRP. These data sources are summarised below in Table A-1.

Table A-1: Summary of provided rainfall data

Data Source	Number of rain gauges	Period of record
Cloud forest (DPLUS051)	2	2016-2018
Cloud forest (DPLUS103)	6	2021-2024
Met Office/ENRP	57	1986-2024 (varying record length, most gauges do not have data for full period of record)

Point rainfall is generally not preferred for hydrological modelling, as it reflects conditions at the specific location of the gauge and may not represent the wider rainfall distribution across a catchment. This limitation is particularly relevant in catchments with steep gradients and varied topography, such as those found on St Helena. To address this, a combined rainfall record for the catchment was derived using multiple gauges, weighted through a Thiessen polygon approach. A Thiessen polygon defines a region around each rain gauge such that any point within the polygon is closer to that gauge than to any other. The area of each gauge's polygon within the catchment is calculated and used to determine the weight assigned to each gauge in the combined rainfall record. This method provides an estimate of catchment-mean rainfall.

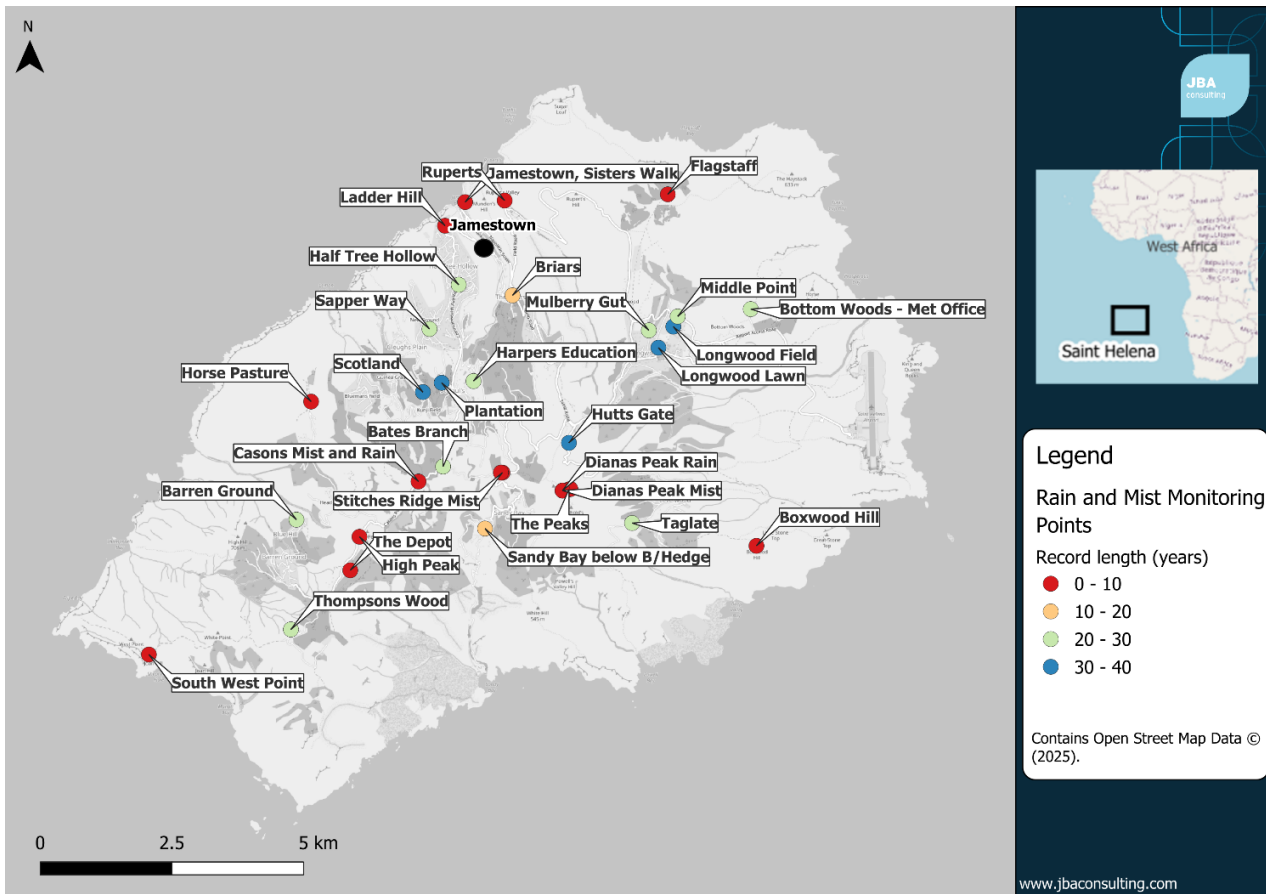


Figure A-4: Rain and mist monitoring stations on St Helena

Available rain gauges were first filtered to include only those with more than 25 years of data, which informed the selection of suitable gauges for use in the hydrological modelling. Rainfall estimation was initially carried out for the James Valley catchment, which has the largest volume of observed flow data. Catchment rainfall was calculated using a weighted mean of the Hutts Gate and Harper Education gauges, with weights of 56% and 44%, respectively. A review of these two records identified periods of missing or suspect data. Where one gauge had unreliable or missing data, infilling was carried out using the other gauge. This was done by examining the relationship between the two gauges and applying a scaling factor based on the ratio of their mean annual rainfall. If both gauges had missing data, the Plantation rain gauge was used to fill the gap.

The daily data from the available rain gauges only cover the period 1986-2024. However, ideally a longer data period would be used within the water resources system modelling to estimate the system yield in different return period events with a higher degree of confidence. Monthly rainfall data were available from Brown (1982) for 26 rain gauges, covering the period 1812-1979, although most of these records were incomplete or fragmented. Hutts Gate was the only gauge with a complete monthly record over the period 1926-1979. Additional monthly rainfall data were sourced from Mathieson (1988) for four gauges between 1952 and 1988, with Hutts Gate again providing coverage from 1963-1988. Hutts Gate therefore had the longest continuous rainfall record (1926-2024) and, as

this gauge had previously been used to derive the daily time series, it was ideal for estimating catchment rainfall over a longer historical period.

GR6J requires a daily time series, the monthly rainfall data for Hutts Gate from 1926-1985 were disaggregated into a daily format using the following method:

1. Annual total rainfall was calculated for each year in both the monthly (1926-1985) and daily (1986-2024) time series.
2. For each annual total in the monthly dataset, the most similar annual total in the daily dataset was identified. These were used as substitute years.
3. Monthly totals were calculated from the daily dataset. Each daily value was then divided by its corresponding monthly total to produce daily proportions.
4. A daily time series from 1926-1985 was created using the observed monthly totals. Daily proportions from the substitute year were applied to disaggregate these monthly totals into estimated daily values.
5. Annual totals derived from the estimated daily time series were compared with the original monthly annual totals to verify consistency and ensure an acceptable level of similarity.

The estimated daily time series combined with the observed daily time series produced an extended complete daily time series from 1926 to 2024 for the catchment. This has been done with the acknowledgement that over a daily timestep the extended rainfall is limited in its accuracy but over the longer-term monthly and seasonal durations which are more critical for water resources these totals are representative of actual historical conditions. The extended rainfall been used as input to the GR6J model to derive long term inflows for use in water resources modelling.

### **Model inputs - potential evapotranspiration**

There are several monitoring points for Potential Evapotranspiration (PET) across the island, located in different climatic zones (Figure A-5).

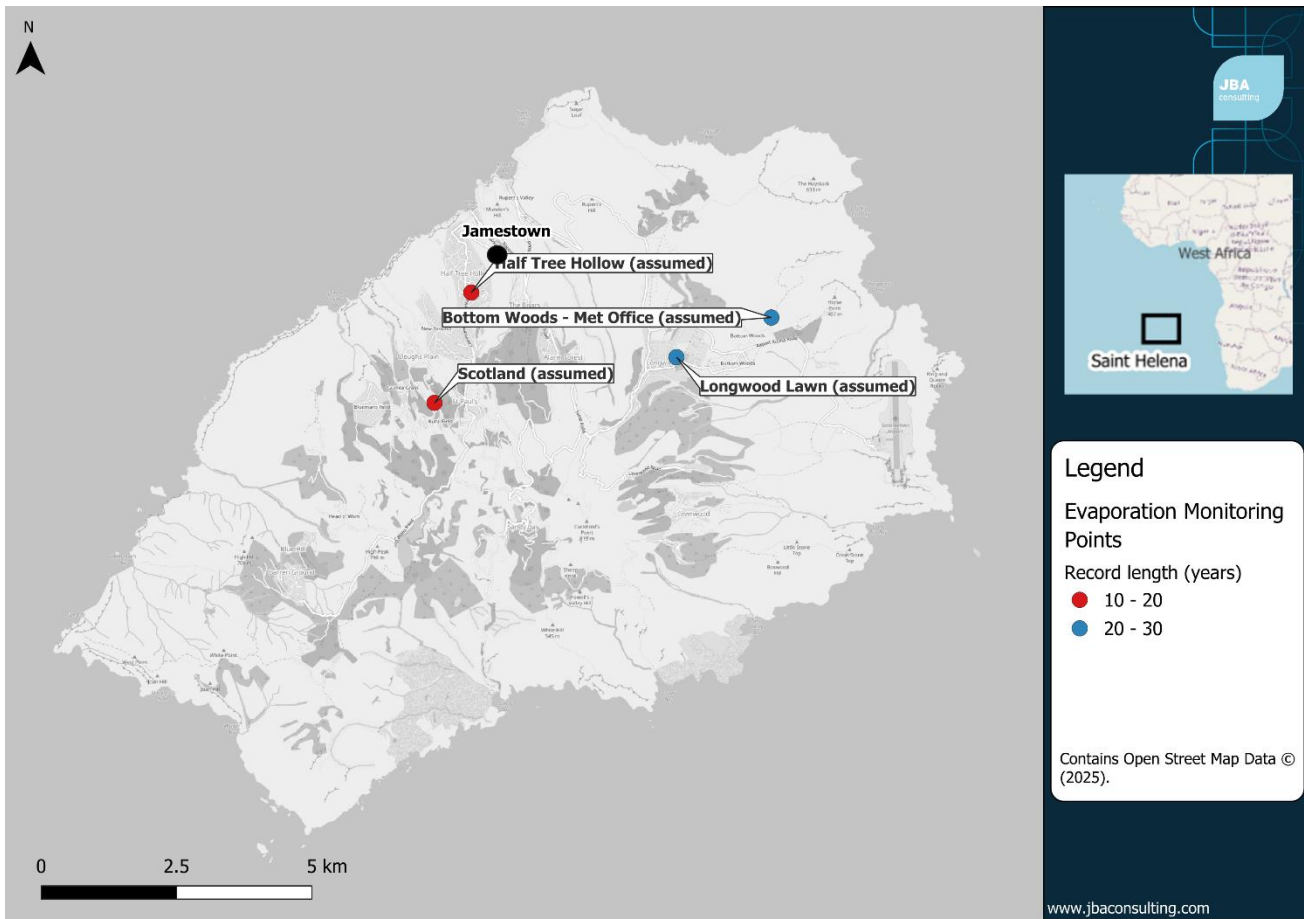


Figure A-5: Evaporation monitoring stations on St Helena

These monitoring stations have varying record lengths, and no gauge covers the entire period required for modelling. An annually repeating evaporation profile was therefore developed based on the observed data. For each gauge, the median daily evaporation was calculated for each day of the year, using the available record. Other techniques for estimating PET from observed temperature data are available, however, using observed data is more likely to give representative values.

Estimating PET from a single location is not preferred. Consequently, a Thiessen polygon approach was applied to estimate PET for the James Valley catchment. Catchment PET was calculated using a weighted mean from the Longwood, Scotland, and Half Tree Hollow gauges, with respective weights of 16%, 59%, and 25%. The resulting profile, which was used as input for the GR6J model, is shown below in Figure A-6.

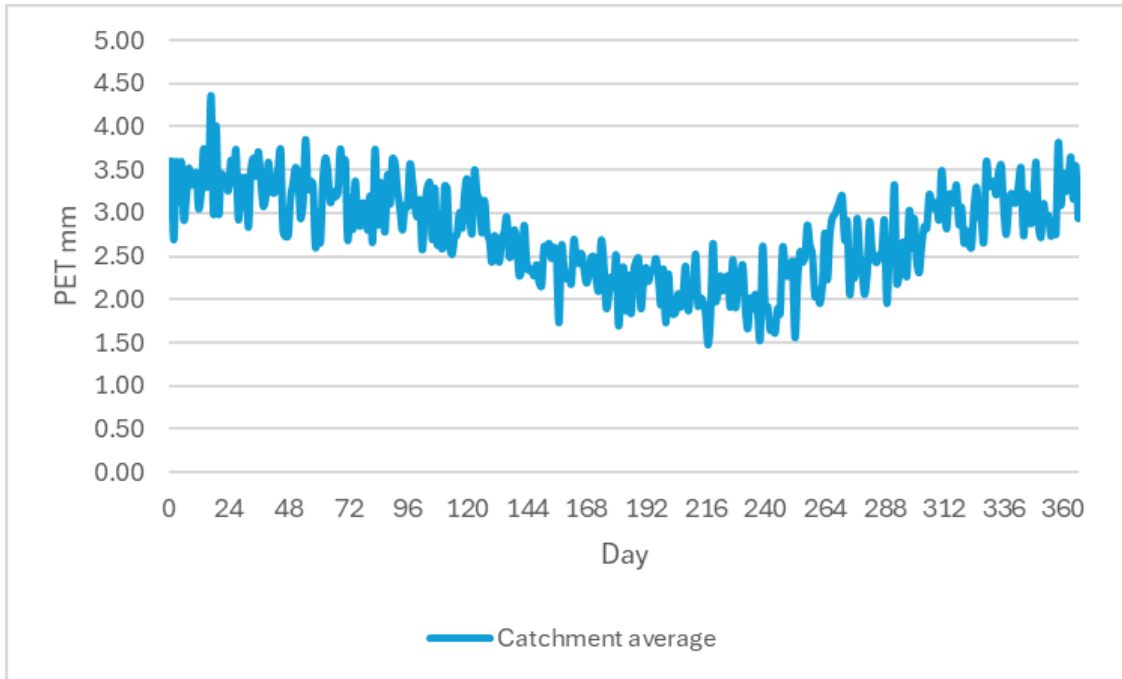


Figure A-6: Annual weighted mean daily PET profile from Longwood, Scotland and Half Tree Hollow gauges

### Model calibration

The GR6J model, like other conceptual rainfall-runoff models, represents the hydrological cycle using a simplified system of interconnected stores and flow pathways. Rainfall is routed through these stores, each representing different parts of the catchment's water balance, before eventually being used to estimate river flow at the catchment outlet.

The model structure consists of a production store (representing soil moisture and evapotranspiration losses), a routing store (which delays and attenuates surface and quick flows), and an exponential store (to simulate slower, baseflow-like responses). Rainfall is partitioned between these components depending on the current saturation state of the catchment. Water entering the production store can be lost to evapotranspiration, percolate to deeper layers, or contribute to runoff depending on soil moisture status. The behaviour of these stores is governed by a set of parameters that are optimised during model calibration. These parameters allow for key physical characteristics of the catchment, such as storage capacity, infiltration rates, and baseflow contributions, to be reflected in the model's structure and response.

In this study, the GR6J model has been used to simulate system inflows based on the available rainfall and potential evapotranspiration data, as detailed in the section above. GR6J model has six key parameters, which have been calibrated against observed flow data at Osbournes and Blackbridge abstraction points. The calibration has focused particularly on capturing low summer baseflows, which are important for assessing water availability, while also ensuring realistic responses to peak rainfall events to allow for realistic reservoir refill.

## Model calibration - Osbournes model performance

The model has been set up to calibrate to observed flow data from the CSH gauge at the Osbournes abstraction point over the period 2016-2023, using a 10-year model warm-up. This period covers two recent droughts and is therefore ideal. The final calibrated parameters are given in Table .

Table A-2: Parameter values used in the final calibrated Osbournes model

Parameter	Value	Definition	Unit
X <sub>1</sub>	36.6	Production store capacity	mm
X <sub>2</sub>	3.0	Intercatchment exchange coefficient	mm/d
X <sub>3</sub>	288.2	Routing store capacity	mm
X <sub>4</sub>	2.9	Unit Hydrograph time constant	d
X <sub>5</sub>	0.3	Inter catchment exchange threshold	-
X <sub>6</sub>	4	Coefficient for emptying exponential store	mm

Model performance against the observed is summarised in Figure A-7. The modelled flows were considered a reasonable representation of the observed and are suitable for use in Aquator modelling. The flow duration curve comparisons and the flow signature pattern for monthly flow estimates compare well, particularly within the context of the uncertainty within the observed data. Flows respond seasonally in line with observed flows and are volumetrically similar (where data is reliable). Model performance statistics are within an acceptable range.

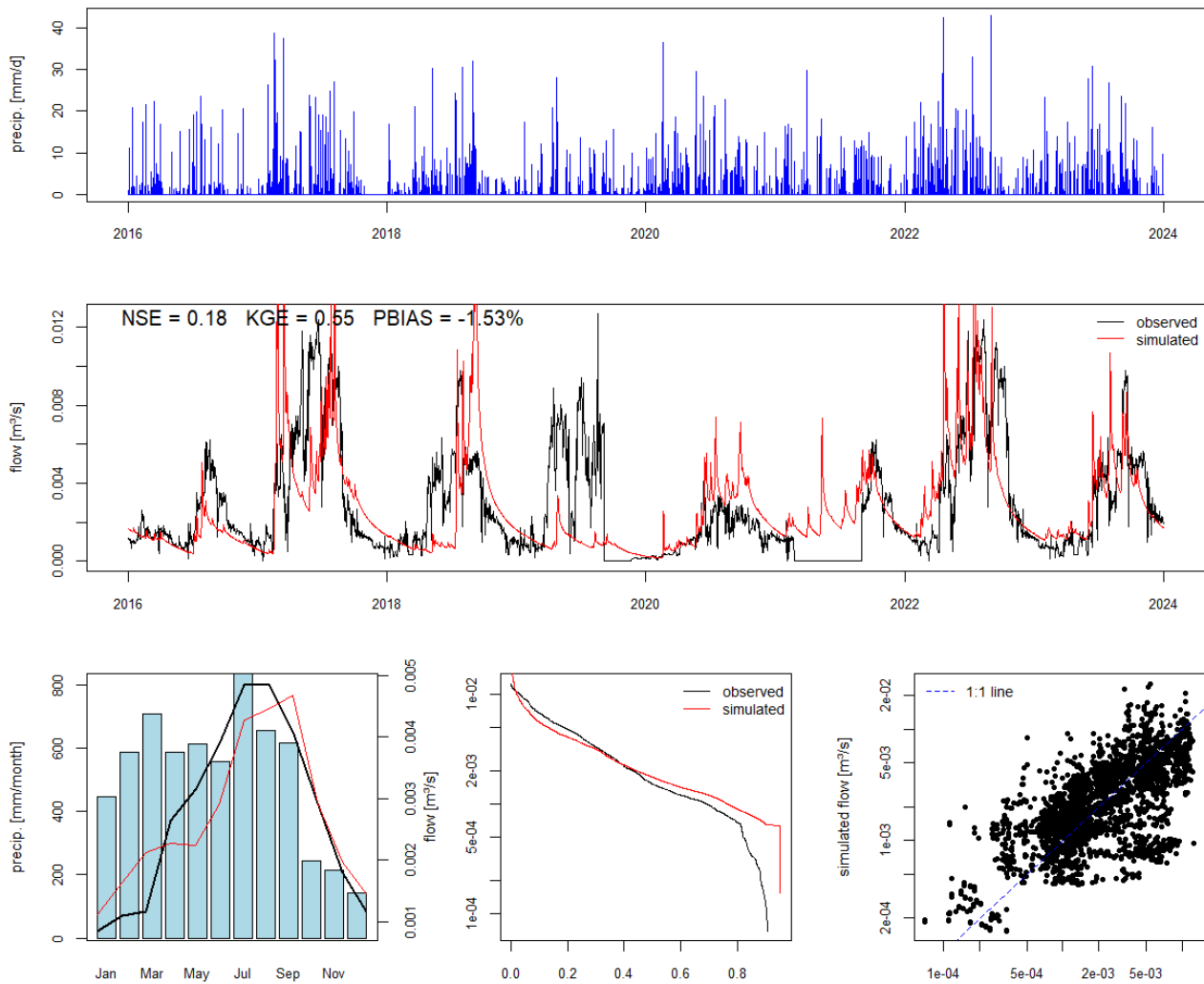


Figure A-7: Model performance graphs

### Model calibration - Blackbridge

The model has been set up the calibrate to observed flow data from the cloud forest gauge at the Blackbridge abstraction point over the period November 2021-2023, using a 10-year model warm-up. This period does not cover either of the recent droughts and does not have as long a record for calibration as Osbournes, however this is one of the longer and better-quality records available. The final calibrated parameters are given in Table A-3.

Table A-3: Parameter values used in the final calibrated Blackbridge model

Parameter	Value	Definition	Unit
X <sub>1</sub>	1200	Production store capacity	mm
X <sub>2</sub>	-2	Intercatchment exchange coefficient	mm/d
X <sub>3</sub>	100	Routing store capacity	mm
X <sub>4</sub>	2.5	Unit Hydrograph time constant	d
X <sub>5</sub>	0.24	Inter catchment exchange threshold	-
X <sub>6</sub>	55	Coefficient for emptying exponential store	mm

Model performance against the observed is summarised in Figure A-8. The flow duration curve comparisons (particularly at higher flows) and the flow signature pattern for monthly flow estimates compare well, particularly within the context of the uncertainty within the observed data. The model is not capturing the smaller surface water events that occur however, as evidenced by the poor fit of the flow duration curve between the 50th percentile and 10th percentile flows. However, it was difficult to achieve a better fit without compromising the model performance at low flows. As model statistics are good and as flows respond seasonally in line with observed flows and are volumetrically similar (where data is reliable) this is acceptable. The modelled flows are considered a reasonable representation of the observed and are suitable for use in Aquator modelling.

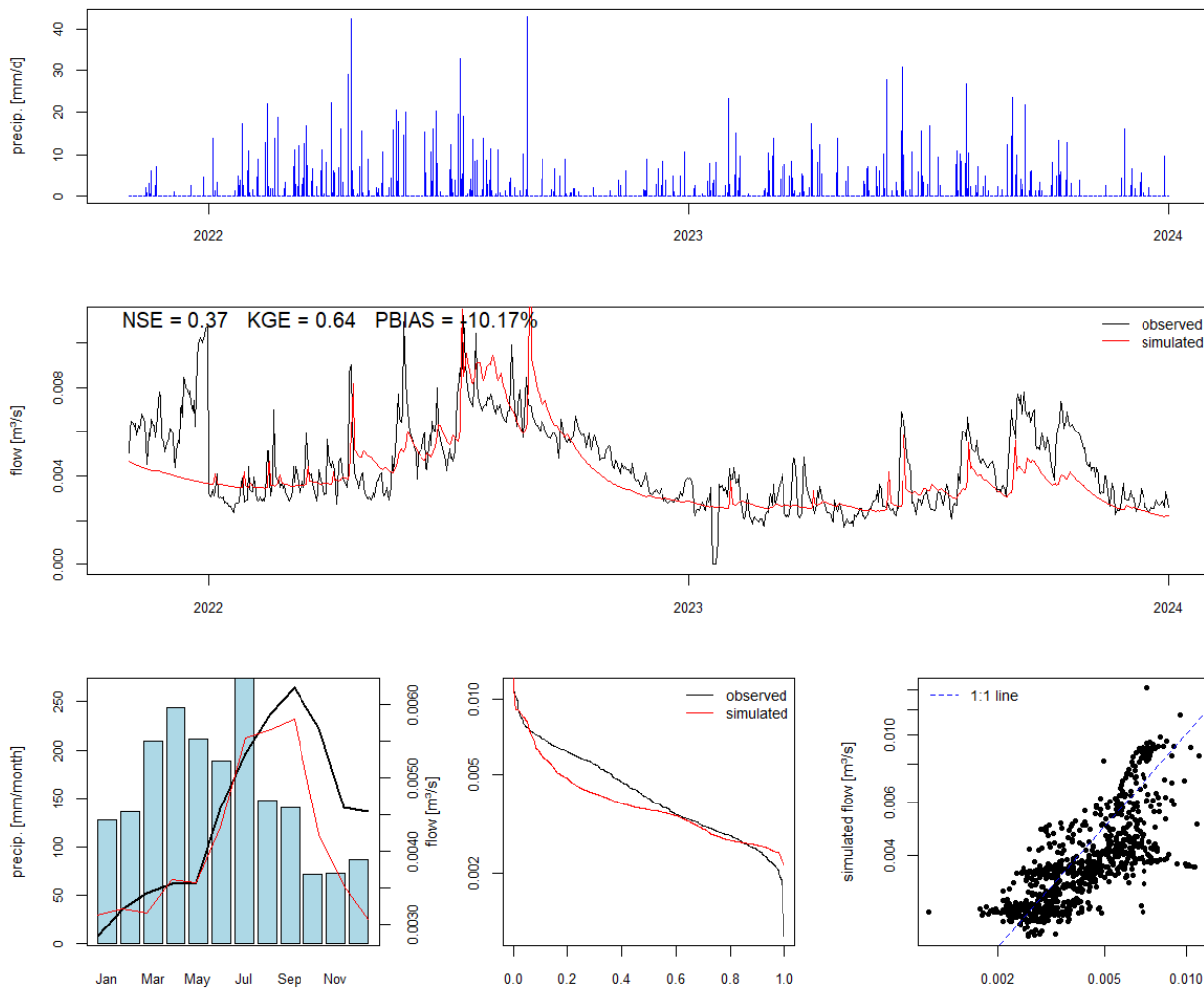


Figure A-8: Model performance graphs

### Estimation of long-term inflows

Following calibration, the models were run for the long-term period 1927-2024, with a one-year warm-up period. The model outputs were then checked for validity, including checks like ensuring consistency with low flows during known drought periods.

The flow time series modelled using GR6J required scaling to produce representative flow data for each catchment contributing inflows to the water resources system. This was achieved by scaling the modelled flows by the ratio of the catchment area used in the GR6J model to the area of each target catchment. This approach assumes that flow is directly correlated to catchment area.

To achieve this, the area of each catchment of interest had to be calculated. This required a digital elevation model (DEM) for catchment delineation, which was derived using contour data of 10m resolution available for the island (as provided by SHG) converted into a 10m DEM using GRASS tools in QGIS. The resulting DEM is shown in Figure A-9.

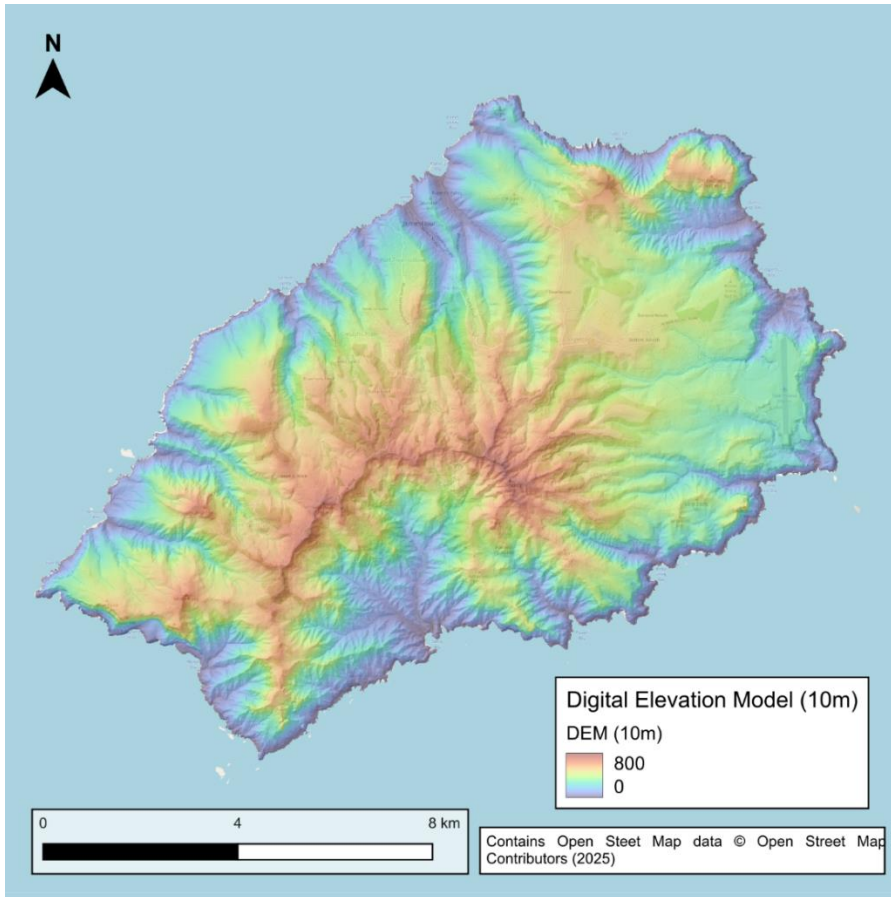


Figure A-9 10m resolution Digital Elevation Model (DEM) of St Helena

The 10m DEM was imported into the HEC-HMS rainfall-runoff modelling software and this was used to delineate catchments for abstraction points. These catchment areas are given in Table A-4.

Table A-4 Catchment areas of abstraction catchments and ratios used to scale modelled discharges to abstraction catchment areas

Catchment Name	Catchment area (km <sup>2</sup> )
Gents Bath	0.18
Osbornes	0.18
Oakbank	0.42
Harpers	1.02
Black Bridge	2.09
Drummonds Point	1.11
Lower Wells	0.14
Legs + Figtree	0.14
Jimmy Lots	0.23
Deep Valley	0.17

The GR6J flows were scaled using the derived catchment areas to represent flows at the relevant abstraction points. Spring fed catchments were scaled using the catchment area of Osbornes, whilst catchments fed by surface runoff were scaled using the catchment area of Black Bridge. The derived inflows were input into the Aquator model and used to run the model for the historical period. The flows were then validated within the Aquator model, to check if these inflows matched with observed volumes within the water resources system. Please see Section A.5 for details.

### A.3.3 Groundwater inflows

Groundwater provides an important contribution to water supply on St Helena, both directly through borehole abstraction and indirectly through baseflow support to springs and surface watercourses. However, the available groundwater dataset is limited in duration and spatial coverage, reflecting the small number of monitored boreholes and relatively short periods of record.

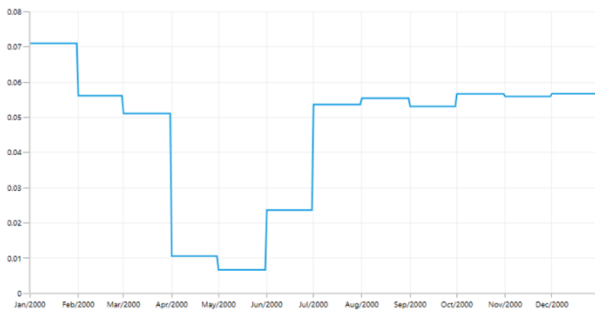
Groundwater inflows used within the water resources model were therefore derived using a simplified, proportionate approach, based on available observed abstraction and level data. For each borehole included in the model, annual average groundwater inflow profiles were developed using the mean of observed data aggregated by calendar month. These profiles capture broad seasonal variability while avoiding over-interpretation of short or discontinuous datasets.

The adopted approach reflects the following considerations:

- Groundwater level records at most boreholes are short (generally less than five years) and do not support robust derivation of long-term trends or drought frequency relationships.
- Observed groundwater levels tend to show relatively stable behaviour, with limited short-term response to rainfall events and minimal drawdown on commencement of pumping, suggesting a buffered system and/or abstraction broadly balanced by recharge during the observation period.
- In the absence of reliable long-term recharge or sustainable yield estimates for individual boreholes, the use of annual average monthly inflows provides a reasonable representation of groundwater availability for strategic planning purposes.

The resulting groundwater inflow profiles were implemented as fixed monthly inputs within the water resource system model, representing average conditions rather than event-driven responses. This is consistent with the overall modelling principle adopted for the WRMP, which prioritises robust system-scale behaviour over detailed process representation where data are limited. Example profiles are shown in Figure A-10.

Borehole No.5



Willow Bank Borehole

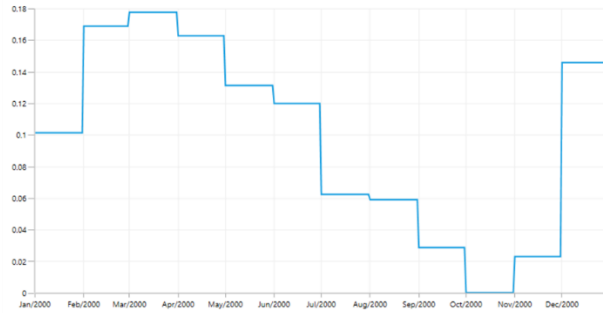


Figure A-10. Example annual flow profiles for Borehole No 5 and Willow Bank.

Groundwater inflows were subsequently tested within the integrated water resources model alongside surface water inflows and reservoir storage dynamics.

Upon testing the model, it was decided to use maximum supply values and use costs combined with bespoke rules to control the operation of the boreholes and how they are used within the model rather than the profiles. This was because the relatively short period record limited the realism of the profiles when applied in the model. The maximum values applied are given in Table A-5.

Table A-5: Supply values assigned to active boreholes within the St Helena supply system

Borehole name	Maximum allowed supply (m <sup>3</sup> /day)
Borehole No. 5	400
Fishers Valley	252
Willow Bank	200
Warrens Gut	218

The total Modelled system behaviour was reviewed to ensure that resulting abstractions, storage volumes and operational patterns were broadly consistent with observed system performance and operational experience.

Future updates to the WRMP would benefit from extended groundwater monitoring records, improved abstraction logging, and targeted hydrogeological investigations to refine recharge estimates and better characterise drought resilience of individual boreholes.

#### A.3.4 Conclusions

The GR6J rainfall-runoff model was selected as the most appropriate tool for hydrological modelling on St Helena due to its simplicity, ease of calibration, and suitability for simulating baseflow-dominated/ephemeral catchments. Rainfall and potential evapotranspiration inputs were developed using catchment-mean values derived from Thiessen polygon weighting, with historical rainfall extended to 1926 through disaggregation of monthly data. Calibration was undertaken using observed flow data from Osbournes and Black Bridge, representing spring-fed and mixed flow regimes respectively. Despite limitations in data availability and quality, the model produced flow estimates that aligned well with observed

seasonal patterns and volumes, particularly for low-flow conditions, which are critical for water resources management. Overall, the model performance is considered to be fit for purpose.

Following calibration, the model was run over the period 1927-2024, with outputs scaled by catchment area to estimate flows at individual abstraction points. These scaled flows were then input into the Aquator model for validation (Section A.5).

A number of assumptions have been made during this process. These are as follows:

- The GR6J model structure is appropriate for simulating the hydrological response of both spring-fed and ephemeral catchments on St Helena.
- Observed flow data used for calibration, although limited in length, are assumed to be reliable and of sufficient quality to derive reliable model parameters. It is worth noting however that the calibration is limited by gauge data quality at both sites used.
- Rainfall and potential evapotranspiration inputs derived using Thiessen polygon methods are considered to provide representative catchment-mean values despite the relatively limited spatial distribution of gauges.
- PET estimates based on median daily values from available stations are assumed to represent long-term climatic conditions adequately in the absence of a continuous PET record.
- Rainfall totals in both the recent (daily) and historical (monthly) record are accurate and representative.
- The disaggregation of historical monthly rainfall data into daily values provides a sufficiently accurate estimate for long-term water resources modelling, particularly over seasonal and annual timescales.
- Short period of calibration record at both gauges limits the reliability of flow over the longer-term period.
- Flow is assumed to be directly proportional to catchment area when scaling modelled flows to represent ungauged abstraction points.

With these assumptions in mind the following actions are recommended to help improve this assessment in future:

- Future monitoring should aim to improve the spatial and temporal coverage of both flow and climate data, particularly in currently ungauged or data-sparse catchments, to strengthen model calibration and validation.
- Installation of dedicated flow gauges upstream of abstraction points would improve data quality and reduce uncertainties caused by water withdrawals. In addition, spot flow measurements should be used to verify and improve the quality of the flow data produced by gauges.
- Rainfall disaggregation methods should be reviewed and refined as new daily datasets become available, to improve the accuracy of long-term historical inputs.
- Further validation of modelled flows against the observed should be undertaken in future as it becomes available, especially under drought conditions, to ensure the ongoing reliability of model outputs for operational decision-making.

## A.4 Demand modelling

### A.4.1 Overview

Water demand on St Helena is dominated by domestic household consumption, with additional contributions from non-household users including agriculture, commercial premises, government facilities and internal operational uses. Demand is sensitive to population change, economic activity and climate variability, and is significantly influenced by system leakage and losses.

The objectives of the demand assessment are to:

- establish a robust baseline of current water demand based on metered data;
- forecast how demand may change over time under a range of plausible future scenarios; and
- provide demand inputs for the supply-demand balance and options appraisal.

Overall water demand for St Helena consists of both household and non-household demand (measured and unmeasured), as well as water losses unaccounted for after being put into the distribution system (physical losses (leakage), commercial losses) for operational use. The methodology follows UK Water Industry Research (UKWIR) guidance, adapted proportionately to reflect St Helena's scale, data availability and high level of metering. Demand is derived primarily from measured consumption data, with explicit allowances for leakage, metering uncertainty and future population change.

### A.4.2 Data and inputs

A summary of the different demand components, the data available and selected approach to incorporate this into the demand calculations is summarised in Table A-6 below with more details in the relevant sections below.

Table A-6: Summary of the different demand components, the data available and selected approach to incorporate this into the demand calculations.

Demand component	Available data	Selected approach
Metered household demand - treated and untreated	SHG 2021 census data detailing AD treated vs untreated household consumption.  Consumption data provided by Connect Saint Helena Ltd (CSH).  St. Helena Population Projections 2022-2051	CSH domestic consumption data for treated water informs treated demand. SHG census data used for proportionality of treated and untreated water demand, per AD.
Metered commercial, agricultural and governmental demand - treated and untreated	Consumption data provided by CSH.	Included in demand as non-household demand.
Unmetered consumption data (domestic and non-domestic)	No available data	The Water Plan produced by CSH for the 2023/24 financial year noted no unmetered consumption. Therefore, this has not been included in the demand assessments.
Water taken unbilled, and operational loss	No available data	Included within the leakage assessment - assumed to remain constant over plan period.
Leakage	CSH: WTW outflows and AD consumption.	Ascertain difference between outgoing WTW flows (relevant per AD) and AD total consumption.

#### A.4.3 Metered consumption data

The demand assessment is primarily based on metered consumption data extracted from the FD JBA WRMP Consumption Data spreadsheet (Sheets: Group A, B and C), provided by Connect Saint Helena Ltd. The use of measured consumption reflects the high level of metering coverage on the island and reduces reliance on proxy or national default assumptions.

Consumption records were grouped using SLA codes as follows:

- Household (domestic) demand: SLA 110 and 120
- Non-household demand: SLA 130-193, including agriculture, commercial premises, government facilities and internal operational use

This classification is consistent with UKWIR methodology and allows household demand to be expressed on a per-capita basis while treating non-household demand separately.

For future projections, a non-household demand growth rate of +1% per annum (compound) has been applied uniformly across the forecast horizon. This assumption reflects potential changes in economic activity, service provision and non-domestic water use at a strategic planning level.

In addition to this generic growth allowance, specific known or planned water users, including industrial developments (such as the fisheries facility at Rupert's and the proposed brewery -recently commencing operations), have been explicitly incorporated into the demand calculations. An allowance for increased tourism-related demand has also been included within the increasing population scenario, ensuring that future non-household demand is not understated.

#### A.4.4 Agricultural demand

Agricultural demand is identified as a distinct component within the non-household dataset and is included within total non-household demand for forecasting purposes. An irrigation demand profile was developed from observed consumption patterns for agricultural users in the metered dataset and adjusted to reflect known seasonal influences such as rainfall variability and crop growth cycles.

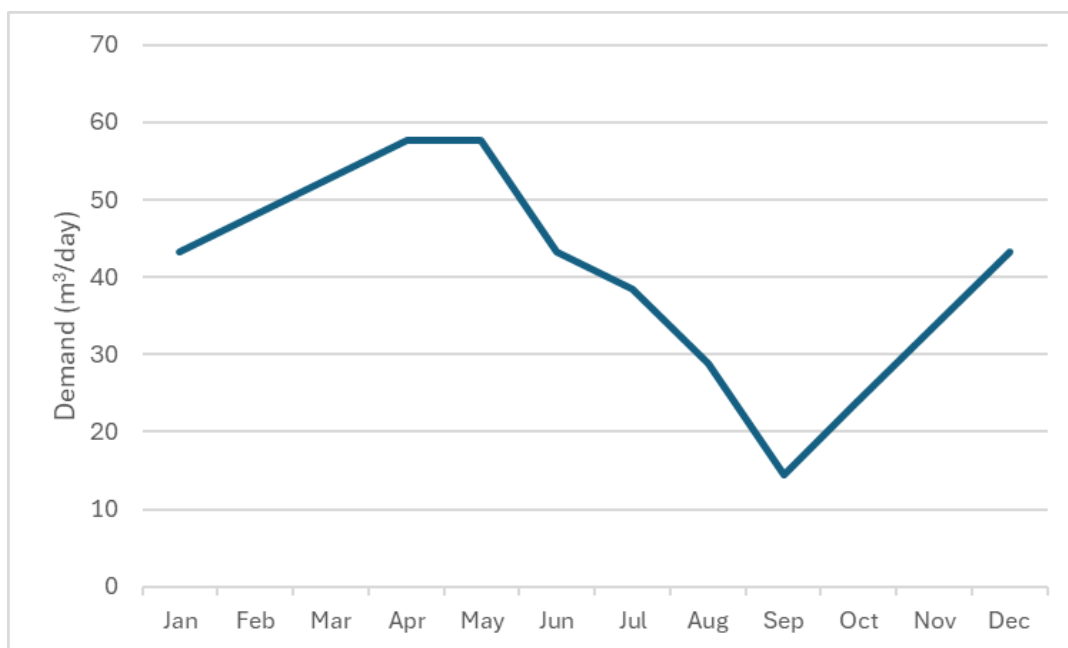


Figure A-11: Monthly irrigation demand profile

The irrigation profile reflects the tendency for agricultural demand to increase during dry periods and peak planting/growth seasons, consistent with local climate patterns. This seasonal behaviour was validated against available rainfall data for St Helena and adjusted to align with expected crop water requirements over the growing season. The approach is consistent with methods used in catchment and agricultural water planning studies in similar island or semi-arid contexts (e.g., literature reference on crop-water requirements and rainfall correlation).

For future projections, adjustments to irrigation demand were included in both the stable and increasing population scenarios. These adjustments assume a modest percentage increase in irrigated area and associated water use, reflecting the likelihood of incremental expansion in productive agricultural land under these scenarios. The assumed increases in irrigated area are based on a combination of:

- observed historical trends in irrigation uptake on St Helena;
- judgement on plausible agricultural growth given market, land use and economic development trajectories; and
- literature evidence on irrigation expansion under similar demographic and economic conditions<sup>2</sup>.

Under the stable population scenario, irrigation water use is assumed to increase at a moderate rate, consistent with small-scale expansion of high-value crops and incremental increases in irrigation intensity. Under the increasing population scenario, a relatively higher rate of irrigated area expansion and water use intensity is assumed, reflecting greater agricultural activity and food production demand. These adjustments are applied within the non-household growth framework and are consistent with the overall demand scaling factors used in the WRMP demand scenarios.

#### A.4.5 Population forecast

Future populations have been forecasted for St Helena in 5-year increments by the St Helena Government Statistics (SHGS) Office in 2022, under several different scenarios. The approach of a 'cohort-component' method was used, which factors in expected migration, births and deaths per year whilst considering the gender of individuals. Annual population projections have been predicted using these values at an annual resolution, assuming even population change distribution between the 5-yearly population forecast provided by St Helena Government. The AD specific projections have then been derived, using the island-wide distribution factor of population from the 2021 (latest) census.

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<sup>2</sup> Pathak, R.; Magliocca, N.R. Assessing the Representativeness of Irrigation Adoption Studies: A Meta-Study of Global Research. *Agriculture* 2022, 12, 2105. <https://doi.org/10.3390/agriculture12122105>

Population scenarios used within this demand assessment, using SHGS are:

- **Present Day Scenario or Steady Scenario** - baseline (no net migration)
- **Scenario 3 or Declining Scenario** - more residents leave than return (-ve net migration)
- **Scenario 5 or Increasing Scenario** - returning residents, and new arrivals (+ve net migration)

Figure A-12 shows these annual population projections, per AD.

For the population forecast beyond 2041 any extrapolation is subject to significant uncertainty. Population projections beyond 25 years face inherent uncertainties arising from various complex factors. Demographers employ sophisticated models and methodologies, yet predicting long-term demographic trends proves challenging. Fertility rates, influenced by societal, economic, and cultural changes, are unpredictable, as are mortality rates impacted by medical advancements and unforeseen health crises. Migration patterns, shaped by political, economic, and environmental factors, present uncertainties, and the unpredictability of global events, such as pandemics or wars, further compounds the challenge. Of course, due to the isolated nature of St Helena, global issues are less likely to pose any significant projection uncertainties. Moreover, the interplay of technological shifts, economic changes, and cultural dynamics introduces additional layers of unpredictability, making long-term projections susceptible to unforeseen shifts in societal structures and behaviours.

These uncertainties are compounded by the influence of government policies, potential changes in political landscapes, and the dynamic nature of cultural norms. Environmental factors, including climate change and natural disasters, can significantly alter population dynamics over extended periods. Modelling assumptions, essential for projecting future trends, may not hold true in the face of evolving conditions, and feedback loops arising from demographic shifts further contribute to the complexity of long-term projections.

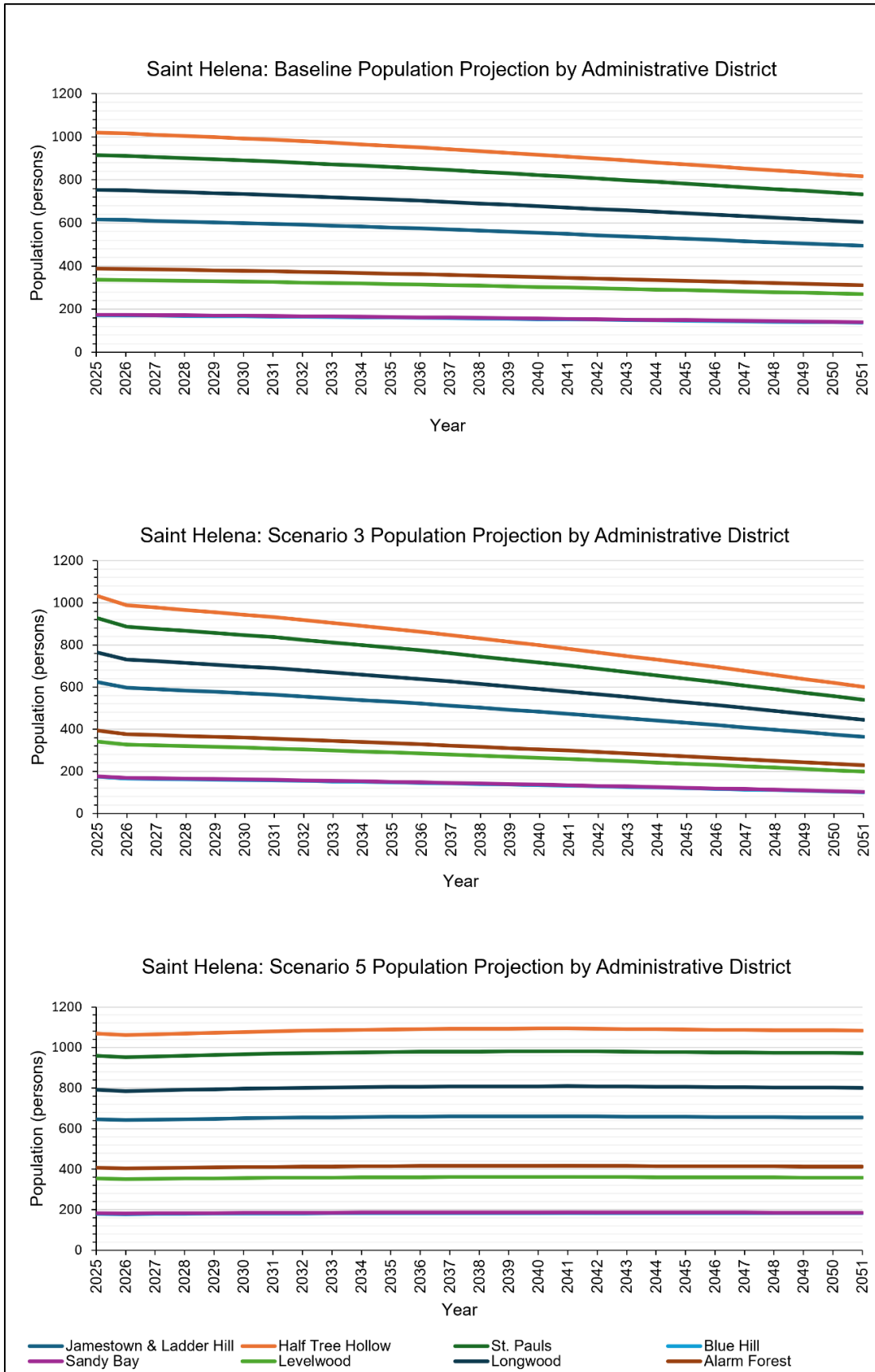


Figure A-12. Baseline, Scenario 3 (-ve net migration) and Scenario 5 (+ve net migration gain) for St Helena Island, per Administrative District

#### A.4.6 Leakage and system adjustments

Leakage and unaccounted-for water represent a significant component of system demand and are explicitly included in the assessment using the following fixed inputs:

- Leakage allowance: 45% of total demand (applied to household + non-household demand, reflecting current system performance)
- Metering and unbilled consumption adjustment: +5% uplift applied to total demand to account for:
  - meter under-registration,
  - faulty or poorly performing meters, and
  - unbilled or unregistered consumption.

These adjustments are consistent with typical UKWIR practice where detailed correction factors are not available and ensure that demand is not understated.

#### A.4.7 Per capita consumption

Per capita consumption is the mean volume of water used per person each day. This is calculated by dividing household demand by the population. This value was derived from consumption data based on meter readings as provided by CSH and varies between the different demand centres, between 190 and 220 l/p/d. This is compared to a UK average of 136.5 l/p/d.

#### A.4.8 Non-household demand

Growth in non-household demand will depend on the rate of economic growth on the island. The growth in population in the St Helena Government migration Scenario 3 and 5 will be used as a proxy for economic growth, and non-household demand will be assumed to grow at the same percentage per year as the population.

#### A.4.9 Seasonal and drought demand uplift

Baseline demand values represent average annual demand. However, demand varies seasonally (tending to peak in summer) and interannually increasing during dry or drought periods. A seasonal demand profile has been calculated from the consumption data for the entire island. The monthly variability in demand around the average demand is shown in Figure A-13. This highlights that demand peaks in summer between the months of December-January and is lowest in winter between July-September.

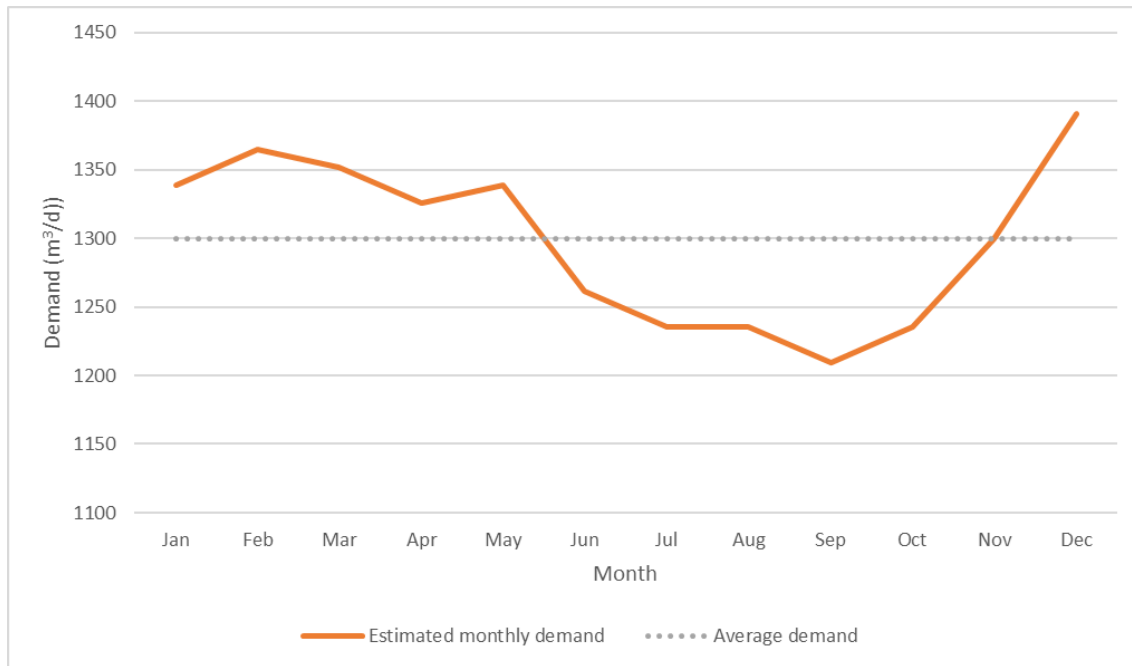


Figure A-13: Monthly St Helena demand profile

To reflect dry-year conditions a drought demand uplift of +20% has been applied. This value is based on analysis of historic consumption during the 2019-2020 drought period and reflects increased outdoor, agricultural and discretionary water use during prolonged dry conditions. This has been used to stress test the model and also in the drought planning process.

#### A.4.10 Headroom and uncertainty allowance

In addition to scenario testing and drought uplift, a precautionary headroom allowance has been applied to reflect residual uncertainty in both demand and supply forecasting. This is a headroom allowance of +20%. This reflects uncertainty associated with long-term population trends, future leakage performance, climate variability and data limitations, and ensures a robust planning basis.

#### A.4.11 Demand forecast

A demand forecast was then created from the following components:

- Household demand (per capita consumption multiplied by the population) (Note: population data beyond 2036 has been extrapolated to provide a longer-term projection to 2062)
- Non-household demand (growing at the same rate as the population)
- Leakage (assumed to be constant in baseline scenario)

A summary of the demand forecast is contained in Table A-7.

Table A-7 Demand forecast, with demands in m<sup>3</sup>/d

Scenario	2025	2040	2050	2065
Steady	1419	1462	1490	1490
Declining	1419	1391	1363	1277
Increasing	1419	1647	1732	1945

#### A.4.12 Comparison with wastewater planning project demands

While developed separately, the WRMP demand assessment and the Wastewater Treatment Works (WWTW) planning study draw from the same underlying population projections and recent consumption data.

The WRMP applies a linear, island-wide forecasting approach consistent with UKWIR methodology to assess potable water demand to 2065. The WWTW study applies a Monte Carlo simulation approach to test local-scale sensitivities, particularly around concentrated commercial and non-household wastewater flows in Jamestown and Half Tree Hollow.

Despite methodological differences reflecting different planning purposes, both studies test a comparable range of population and demand uncertainty and are considered compatible.

## A.5 Base Water Resources Modelling

### A.5.1 The St Helena supply system

The water supply system on St Helena is characterised by limited natural water resources, complex topography, and a high degree of operational interdependency between abstraction, storage, treatment, pumping, and distribution. The system has evolved incrementally over time and comprises multiple discrete sources and supply zones rather than a single integrated network.

There are four main raw water zones, Redhill, Hutts Gate, Levelwood and Chubb's Spring (or Jamestown). These areas have their own supplies, storage and treatment works, and supply water to different districts. These zones are distributed across the island but are mainly focused within the central and northern regions, aligning where the majority of the population live.

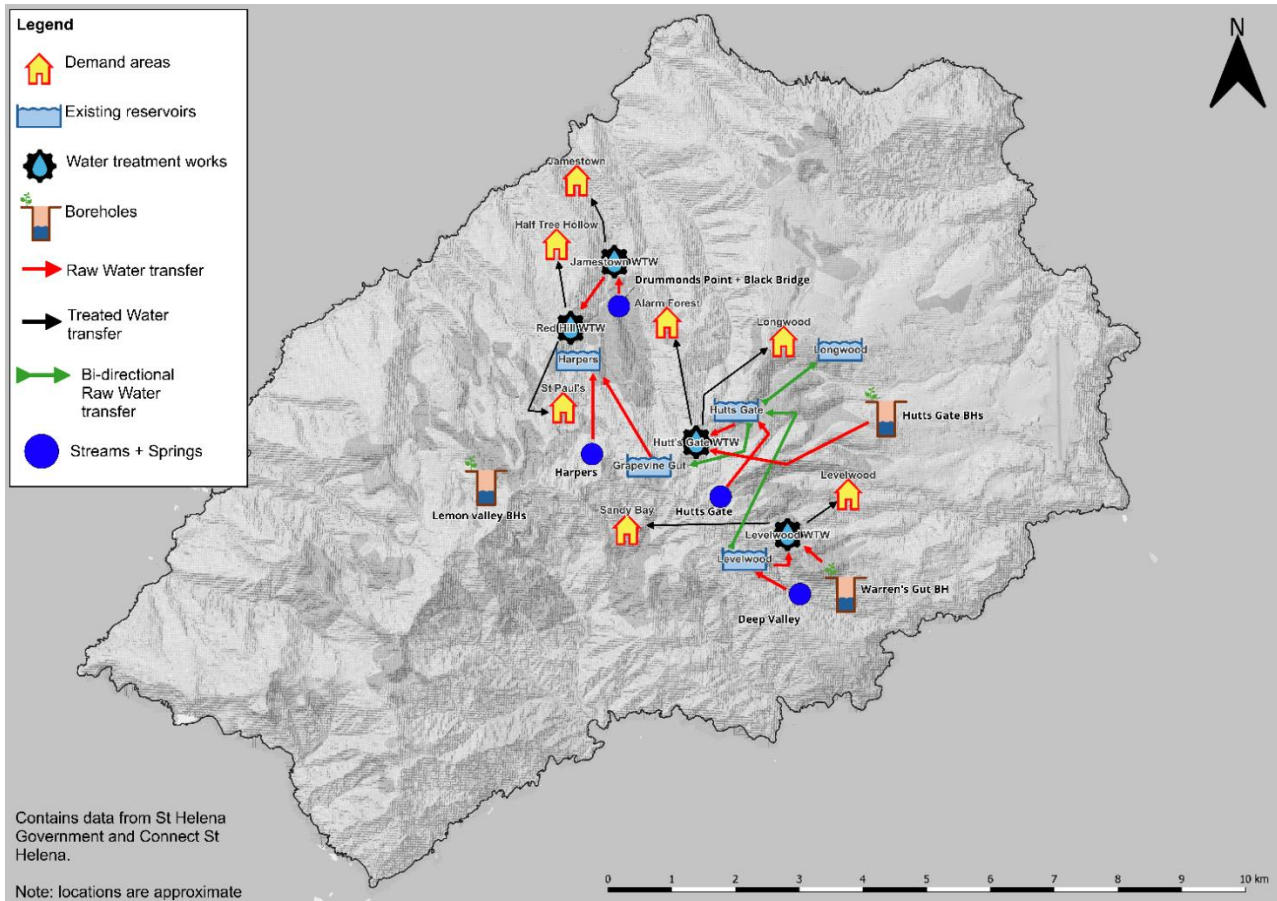


Figure A-14: Schematic of the St Helena water supply system

There are some districts which rely on smaller distribution networks of untreated supplies with no or limited connections to WTW. Sandy Bay is connected to the Levelwood WTW; however, most residents still rely on untreated supplies. Residents in Bluehill rely on untreated groundwater supplies from boreholes located in Lemon valley. In total, all water distribution systems supplied 517,007 m<sup>3</sup> of water for the entire island in 2019, with 14.2% of this being untreated.

**Water Sources**

Rainfall distribution across the island is uneven due to its topography. The central highlands receive higher precipitation, supporting lush vegetation, whereas lower coastal regions are comparatively arid. Mist capture by endemic vegetation provides over 40% of effective precipitation in the uplands. Groundwater on St Helena flows from the central high-lying recharge areas towards the lower-lying points of discharge, namely springs. It has been estimated that over 56% of the groundwater recharge occurs in the high-lying areas (Toens & Partners, 2000). During dry periods, mist capture becomes the dominant source of water for recharge and is also therefore an important contributor to water availability. This habitat is degraded and is at risk from factors such as invasive species and pathogens, which is a significant issue for water resources.

As a result of this the majority of water collection on the island is within the upland areas. St Helena relies primarily on surface water abstractions, the majority of supply coming from

springs and streams, supplemented in some areas by groundwater abstractions. Source yields of the surface water sources are highly variable and closely linked to rainfall patterns, making the system particularly sensitive to seasonal and inter-annual climate variability. The borehole sources are more drought resilient and tend not to show the same sensitivity to rainfall.

### **Storage Infrastructure**

Water storage is provided through a network of small reservoirs and tanks distributed across the island. Within the four main raw water zones, Connect Saint Helena Ltd currently have twelve raw water reservoirs, four of which are used to supply water for agricultural consumers. The total capacity of the reservoirs across the island is 116,219 m<sup>3</sup>, which is used to store raw water abstracted from the supplies outlined above before treatment. The majority of reservoirs are offline. Only Grapevine Gut and Hapers 2 receive water from their own natural catchment.

Reservoir storage is complemented by use of tanks across the island which provide an additional storage across the network of 5,507 m<sup>3</sup>. Tanks are used to store both raw water pretreatment and treated water within the distribution system.

Storage plays a critical role in balancing supply and demand, managing diurnal variation, and providing short-term resilience to interruptions in abstraction. However, overall storage capacity is limited relative to demand and drought risk, and storage volumes can be rapidly depleted during extended dry periods. Storage is therefore a key vulnerability within the system.

### **Treatment and Water Quality**

Raw water from sources is treated to meet public health standards before distribution. In the course of stakeholder engagement, including discussions with staff at Connect Saint Helena Ltd, concerns have been raised about the taste and aesthetic quality of drinking water in certain parts of the island. While the water consistently meets World Health Organization (WHO) microbiological safety standards, there is an ongoing perception among some customers that the taste or odour of water is unpleasant or inconsistent. Dissatisfaction with taste can lead to reduced public confidence in the supply, increased reliance on bottled water, and even reluctance to follow water efficiency guidance, such as reusing or drinking stored water during drought alerts.

These concerns are acknowledged in the St Helena Water Strategy 2020-2050, which highlights the importance of not only delivering safe water but also ensuring that it is clear, neutral in taste, and odourless. The strategy outlines targets for reducing complaints, monitoring appearance using NTU values at treatment sites, and improving microbiological levels at consumer meters.

Connect has advised that current treatment processes are primarily geared toward ensuring safety, using chlorination and basic filtration, and that technical capacity for more advanced aesthetic control is currently limited. Changes to sources, storage, or operating regimes must ensure continued compliance with public health regulations, particularly during drought periods when raw water quality may deteriorate.

## Distribution Network and Pumping

The distribution network is extensive relative to the size of the population and is strongly influenced by the island's steep and variable topography. Water must often be pumped between areas of different elevation, resulting in a highly energy-intensive supply system. Due to the steepness of the island high water pressure is also an issue, causing leaks and the need for pressure reducing measures such as valves across the distribution network.

## System Performance and Losses

Non-revenue water, including leakage and unbilled consumption, represents a significant challenge for the system. Losses reduce the effective yield of available resources and increase the cost per cubic metre of billed water. The condition of parts of the distribution network, combined with challenging terrain, makes leakage detection and repair resource intensive. Reducing losses is therefore a key opportunity for improving both water resource efficiency and cost-effectiveness.

### A.5.2 How the supply system is operated

The raw water supply system is operated to maximise storage to maintain the reliability of supply. If reservoir storage falls abstraction from the available sources is maximised. As mentioned previously, the borehole sources tend to be more drought resilient and therefore these sources are reserved for drought periods. When reservoir stocks fall CSH will commence operation of these boreholes. Each raw water zone is operated independently the majority of the time, however some limited connections between the zones exist which allow water to be moved around the island in drought to try and balance supply and demand and improve storages. Operation of boreholes and pumping water between zones has significant associated cost and is energy intensive, therefore this is only deployed during times of need. When supply is more plentiful operation of the supply network is operated in a way that tries to reduce and optimise efficiency and cost.

During dry or drought periods reservoir stocks are monitored to assess the rate of decline and the potential risk to supply. Reservoir stocks are used to trigger actions such as:

- Water-user compliance strategies, including public communication campaigns, and voluntary savings.
- Maximising use of all available sources and moving water through internal transfers between zones.

In drought restrictions on water use may need to be applied for non-essential users, with even tighter restrictions placed in a severe drought. Please see the accompanying drought plan for a fuller description of the actions taken in dry weather and a review of the operational management practices and drought management measures currently undertaken on St Helena.

## **Aquator XV Model Build**

A water resources model is a mathematical or computational tool designed to simulate water systems. These models help predict the movement, availability, quality, and distribution of water in natural and engineered environments. They are a critical decision-support tool for water resources planning as they enable planners to understand the maximum supply of the system given its constraints and allow them to test the impact of future scenarios such as climate change and population change.

A variety of different water resources modelling software packages are available. Aquator XV was chosen as the modelling software used for the St Helena base water resources model as it is the predominantly used software by the UK water industry. Aquator is a modelling software designed to simulate the operation and management of complex water supply systems. It uses a rule-based approach to replicate interactions between water sources, treatment facilities, reservoirs, pipelines, and demand centres. By applying detailed operational rules and constraints, Aquator can model scenarios such as drought events, varying demand patterns, or infrastructure failures, providing outputs on water availability, system reliability, and performance under different conditions. Its intuitive graphical interface allows clear visualisation of system behaviour, aiding decision-makers in evaluating infrastructure investments, operational changes, and management strategies.

This section summarises the setup of each treated water supply zone in the Aquator XV model and describes how different water supply components such as reservoirs, boreholes, inflows and storage tanks were incorporated within the model. The model build was based on network schematics provided by Connect Saint Helena Ltd and the model was set up based on information provided by Connect Saint Helena Ltd. Operational rules were implemented based on discussions with Connect Saint Helena Ltd around the operation of their system as well as information gathered from site visits whilst on-island.

### **Model component setup**

The components of the Aquator model were set up using information provided by Connect Saint Helena Ltd, the results of the hydrological modelling (section A.3.2) and the demand modelling (section A.4). The methodology for setting up each component type is presented in Table A-8.

Table A-8: Aquator model component types and their setup methodologies

Component type	Setup methodology
Reservoirs	The storage capacities of the reservoirs were set up using the depths and volumes provided by Connect Saint Helena Ltd. A control curve was derived and applied for each reservoir. These are 365-day profiles which govern when abstraction occurs to refill the reservoir and when reservoir storage can be used to meet customer demand.
Surface water catchments and abstractions	Surface water catchment components were set up with the flows derived from the hydrological modelling. The surface water catchments provide inflows to the reservoir components of the model through abstraction points. The surface water abstraction components were set up with maximum daily abstractions to prevent unrealistic volumes being abstracted in the model.
Groundwater abstractions (boreholes)	Groundwater abstractions were set up with maximum daily abstractions to prevent unrealistic volumes from being abstracted in the model. They were also set up with a high cost to supply water in comparison with reservoirs and surface water abstractions. This was to reflect the prioritisation of these sources by Connect Saint Helena Ltd over more costly groundwater abstractions.
Demand centres	Demand centres represent an area of customer demand. Each demand centre in the model was assigned a demand based on the demand modelling detailed in section A.4. The demand centres were all assigned the same monthly demand factor profile, which is multiplied by the base demand to represent seasonal demand variations.
Storage tanks	Storage tanks were set up using Aquator's service reservoir component as this most closely matches the operation of the storage tanks. Water can still pass through a service reservoir component when it is at full capacity, which aligns with the capabilities of the storage tanks. The volumetric capacities of storage tanks were aggregated for each treated water supply zone using information provided by Connect Saint Helena Ltd.
Water treatment works	No specific setup was required for water treatment works.

### **Redhill treated water supply zone**

The Redhill supply zone is comprised of four reservoirs (Scotts Mill, Harpers 1, Harpers 2 and Harpers 3) which feed into Redhill water treatment works. There is both a raw and treated water tank at the treatment works. The reservoir inflows are provided by surface water abstractions at Osbornes, Oakbank and Gents Bath springs as well as Francis Plain Gut at Harpers 2 weir. Scotts Mill reservoir can import water from Grapevine Gut reservoir in the Hutts Gate supply zone, if storage in the Redhill reservoirs falls below 40% or Scotts Mill falls below 44%.

### **Jamestown treated water supply zone**

The Jamestown supply zone is supplied by surface water abstractions at Drummonds Point and Black Bridge, as well as from Tom Peters, Chubbs and Hambess springs. These abstractions directly supply Jamestown water treatment works. Water can be exported from Jamestown water treatment works to Scotts Mill reservoir in the Redhill supply zone, storage in the Redhill reservoirs falls below 50%, allow transfer from Jamestown WTW to Scotts Mill reservoir. There are no reservoirs in the Jamestown treated water supply zone, but there is a raw and treated water tank at the treatment works.

### **Hutts Gate treated water supply zone**

The Hutts Gate supply zone comprises three drinking water supply reservoirs (Hutts Gate 1, Hutts Gate 2 and Grapevine Gut) and three agricultural water supply reservoirs (Millfield, Longwood 1, Longwood 2). These reservoirs can all feed into the Hutts Gate water treatment works via Hutts Gate 2 reservoir, which also has raw and treated water tanks.

Hutts Gate 1 and Hutts Gate 2 reservoirs are fed by three boreholes (Borehole No.5, Fishers Valley borehole and Willow Bank borehole) and three surface water catchments (Wells, Figtree and Leggs). The water from surface water catchments (primary) and from the willow bank borehole (secondary) is used in preference to the more expensive borehole sources in Fisher's valley. The water from Borehole No. 5 and Fishers valley may only be used when the storage in Hutts Gate drops below 50 and 35% respectively.

Grapevine Gut reservoir is fed by the Grapevine Gut surface water catchment and can exchange water with Hutts Gate 2 reservoir. If storage in Grapevine Gut reservoir falls below 26% then the model is not allowed to transfer to Hutts Gate 2 reservoir until Grapevine Gut reservoir has recovered to 100% storage. The model is also not allowed to transfer water from Grapevine Gut to Hutts Gate while the transfer from Hutts gate to Grapevine Gut is occurring.

The agricultural reservoirs are all fed by overflow from Hutts Gate 2 reservoir. If storage in the Hutts Gate reservoirs drops below 50% then water can be transferred back from the agricultural reservoirs to Hutts Gate for water supply. Hutts Gate 2 reservoir can also exchange water with Levelwood reservoir in the Levelwood supply zone. This is only allowed in the model if storage in Levelwood reservoir falls below 50% and storage in Hutts Gate 2 reservoir is 100% (or full).

## **Levelwood treated water supply zone**

The Levelwood supply zone consists of one reservoir (Levelwood), fed by the Deep Valley surface water catchment, and one borehole (Warrens Gut). These feed into the Levelwood water treatment works, which has a clear and treated water tank and supplies the Levelwood and Sandy Bay demand centres.

Water can be bi-directionally exchanged between Levelwood and Hutts Gate 2 reservoirs. If storage in Hutts Gate 2 reservoir falls below 50% and storage in Levelwood reservoir is above 50%, allow transfer of water from Levelwood reservoir to Hutts Gate 2 reservoir. Warrens Gut Borehole can also directly supply Hutts Gate 2 reservoir.

## **Model schematics**

Two Aquator XV models were built for St Helena's water resources system using the schematics and data provided by Connect Saint Helena Ltd. One model was simplified by not representing the storage tank elements of the water resources system, and the other was built with the storage tanks included. This was done to develop an understanding of how the storage tanks affect the operation of the system and its available supply.

The model schematic for the Aquator model built without tanks is shown in Figure A-15 (a) and the model with tanks is shown in Figure A-15 (b). These schematics represent Connect Saint Helena Ltd's reservoirs, river abstractions, boreholes, storage tanks and water treatment works and pipe network and the connectivity between them. This dictates how water can be moved around the model when runs are being carried out. Figure A-15 (c) provides a key for interpreting the mode schematics.

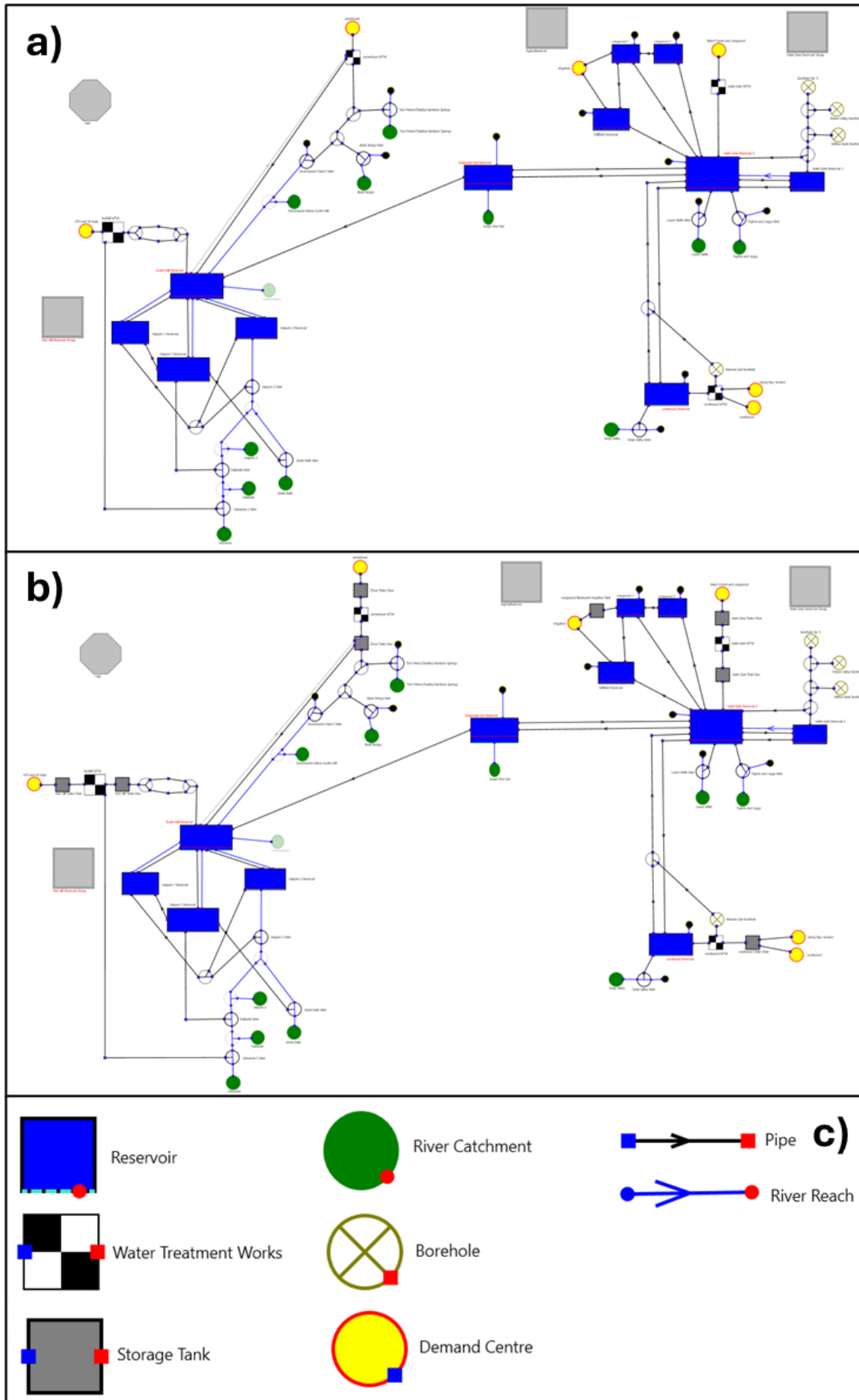


Figure A-15. a) Base DO model without tanks schematic (Aquator XV), b) Base DO model with tanks schematic (Aquator XV), c) Key to Aquator XV model schematics

### A.5.3 Aquator model performance

Observed daily abstraction and reservoir storage data was provided by Connect Saint Helena Ltd from 2016 to 2024. This data was used to benchmark the Aquator model and to assess final performance at replicating observed operations.

This section details the model performance for each zone of St Helena's treated water system. The final performance was assessed using the Aquator model including storage tanks. It is worth noting when viewing these results that it is unlikely that the model will be able to replicate exact flows through the system, which is heavily influenced by manual interventions. As a result of this and the nature of the system, many flows and levels are highly variable on a small scale a behaviour that is both difficult and unnecessary to predict.

Standard performance metrics therefore do not apply well to this modelling, and a more holistic view on performance has been taken. Evaluations of model performance have therefore been based on whether the model has replicated seasonal and annual patterns in flows as well as more general, larger-scale trends. This is called benchmarking and is adopted as standard practice in UK water companies for assessing their system models.

#### Jamestown treated water supply zone

The inflow to Jamestown WTW is shown in Figure . This is calculated as the total abstraction from Drummonds Point, Black Bridge and Tom Peters/Chubbs/Hambess springs. The observed data shows greater variability than the modelled data, however, are similar in terms of overall volumes. Note, the drop in observed data in 2016 and from mid-2023 onwards is thought to be as a result of missing data from the Drummonds point abstraction.

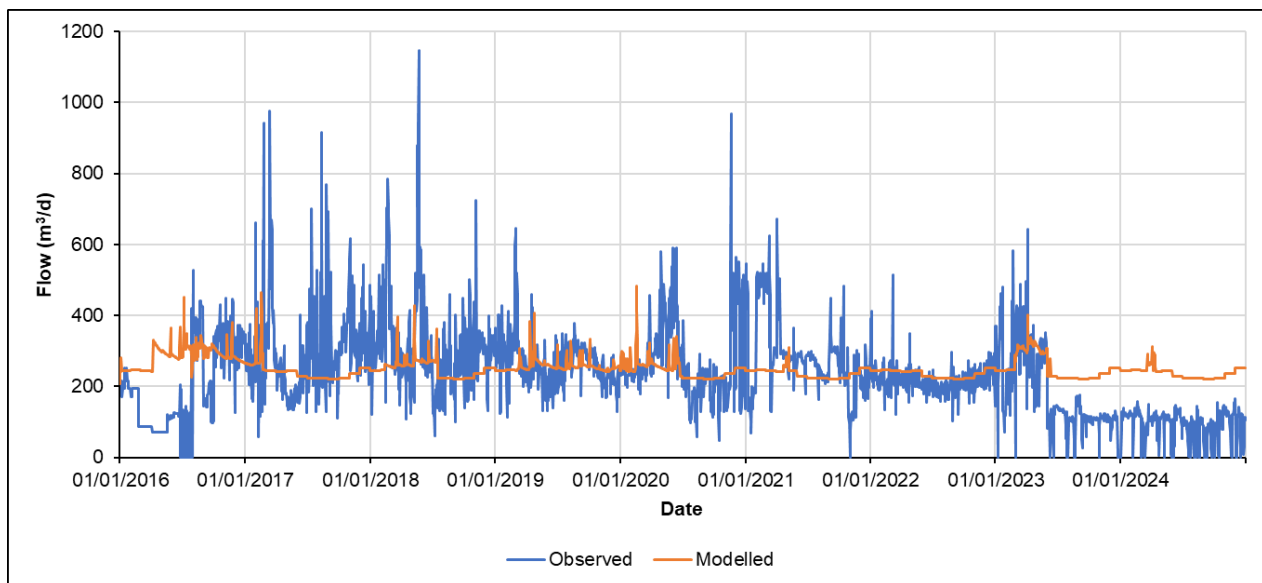


Figure A-16 Inflow to Jamestown WTW 2016-2024 (total abstraction from Drummonds Point, Black Bridge and Tom Peters/Chubbs/Hambess springs)

A comparison between the observed and modelled flow from Jamestown WTW to Scotts Mill reservoir is shown in Figure . The timing of the use and volume of the transfer is well matched, particularly from March 2019 to July 2020.

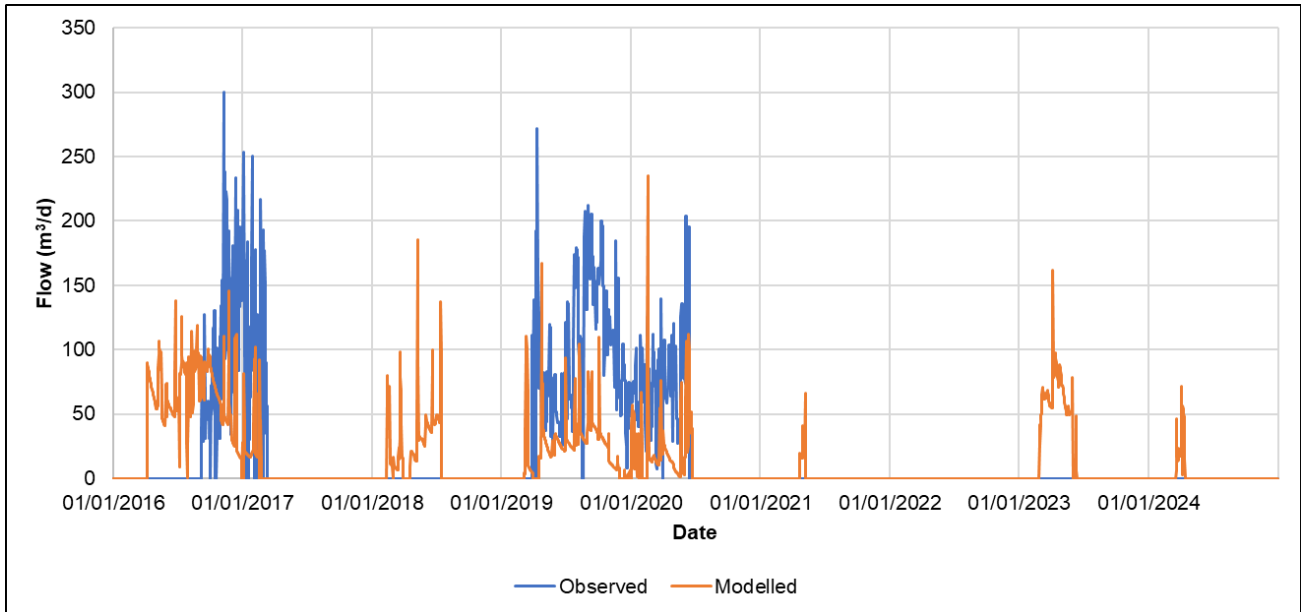


Figure A-17 Flow through Jamestown WTW to Scotts Mill reservoir transfer 2016-2024

### Redhill treated water supply zone

The model results in Figure give a satisfactory representation of the observed storages, particularly with timings of drawdown and refill. Drawdowns in 2017, 2019/20 and 2023 were underpredicted by the model due to the mean demands used in the model as opposed to drought demands. When the mode was run using the demands from the 2020 drought, the reservoir drawdowns in 2019/20 and 2023 area more closely aligned to the observed time series.

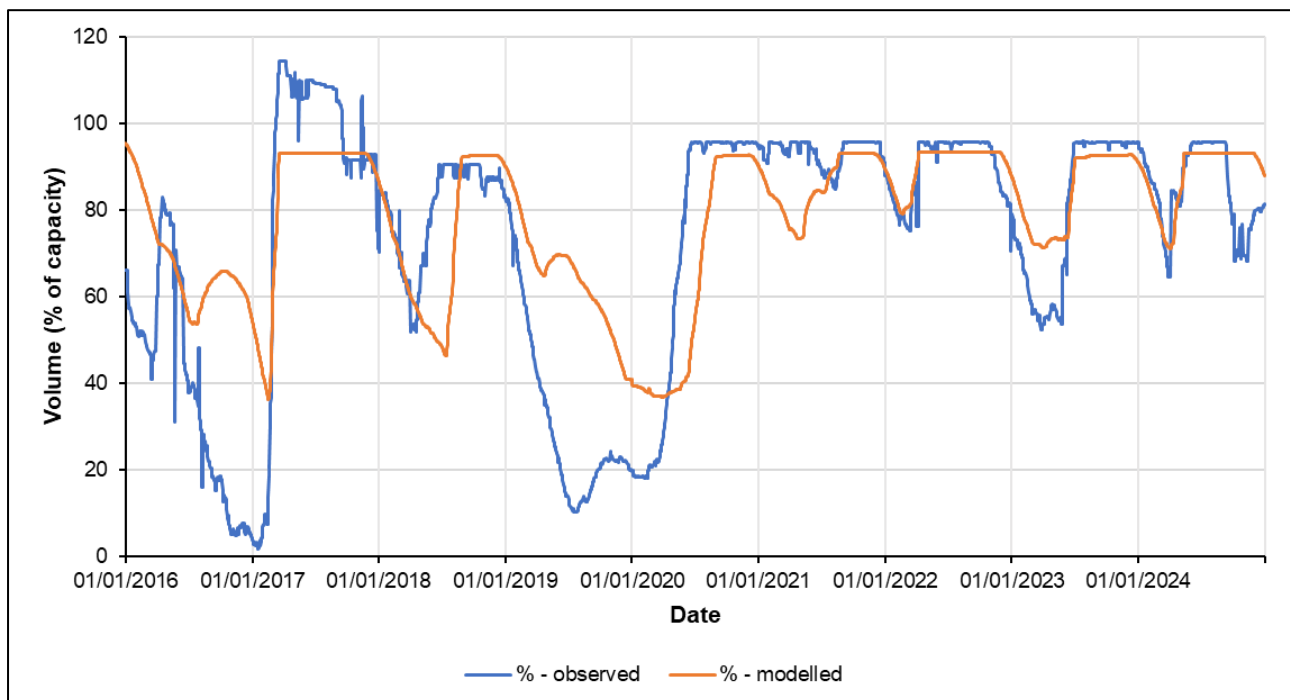


Figure A-18 Redhill reservoir group comparison of observed and modelled reservoir storage

### 2016-2024

Annually, the modelled annual reservoir storage is within 10% of the observed storage besides 2016 and 2019 as is shown by Figure . The mean monthly reservoir storage profile shows that the modelled storage has difference of between 0.2 and 18% percent compared to observed storage. The modelled profile shows storage falling in January then rising from February to May, which is consistent with the observed profile. However, the modelled profile continues to increase until August.

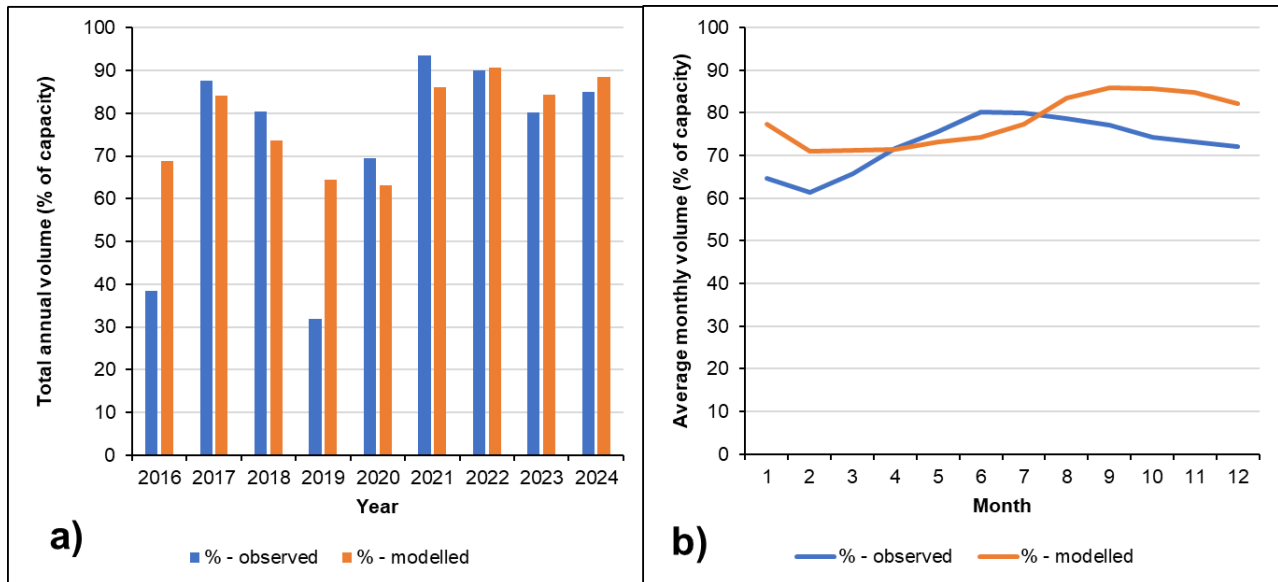


Figure A-19 Redhill reservoir group comparison of observed and modelled total annual (a) and mean monthly (b) reservoir storage 2016-2024

The modelled abstraction from Osbornes Weir, shown in Figure A-20, matches well in timing and magnitude with the observed abstraction. This match provides confidence in the hydrological modelling.

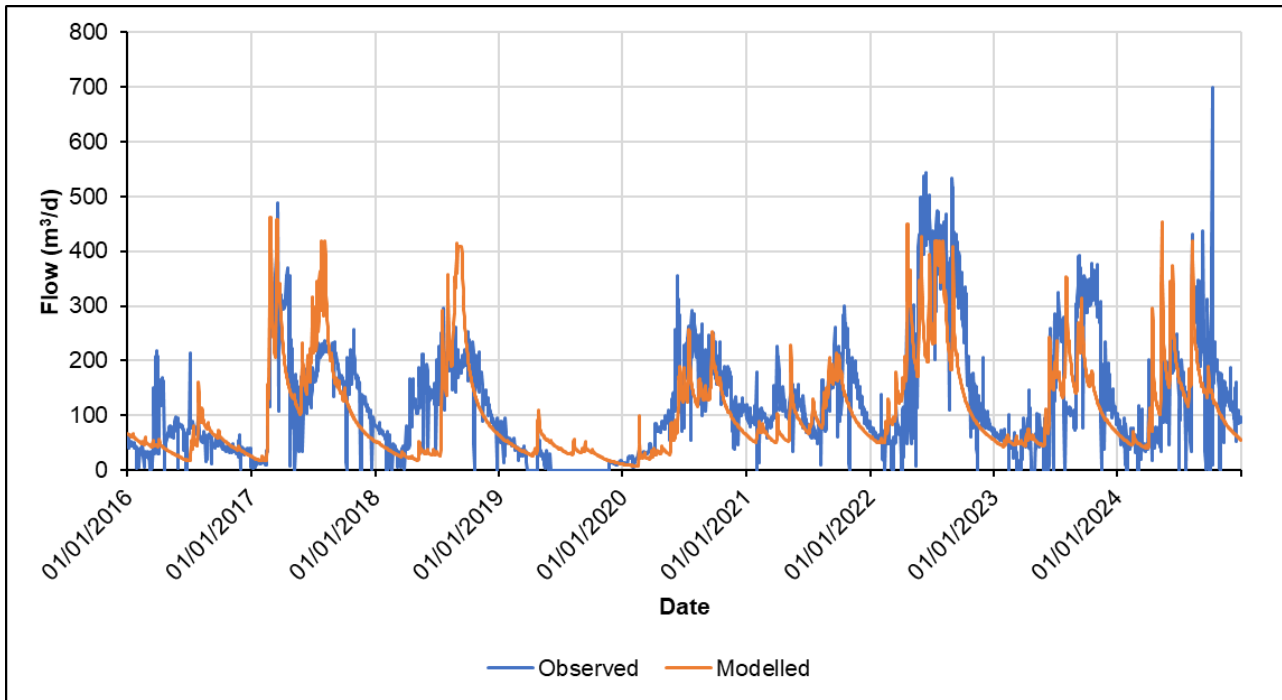


Figure A-20 Modelled vs observed abstraction from Osbornes Weir 2016-2024

### Hutts Gate treated water supply zone

The modelled storage for the Hutts Gate reservoirs and Grapevine Gut shown in Figure A-21 follows the typical range of volumes seen in the observed storage but is more variable. The timing of reservoir drawdowns aligns well between the modelled observed storages besides the period between January 2016 and June 2017. Annually, the modelled volume has a difference of 2-17% compared to the observed volumes (excluding 2016 and 2017). The mean monthly modelled storage had a 2-19% difference in comparison to the observed storage.

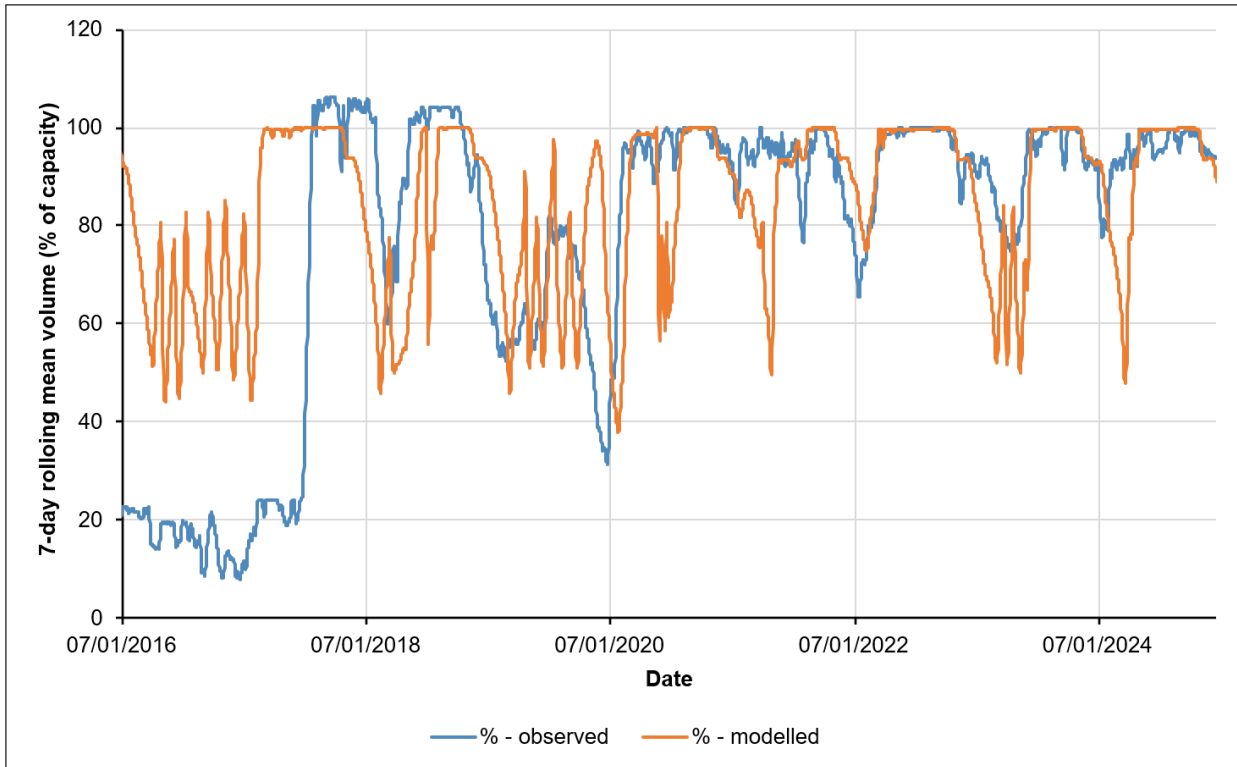


Figure A-21 Hutts Gate reservoirs (including Grapevine Gut) comparison of observed and modelled reservoir storage 2016-2024

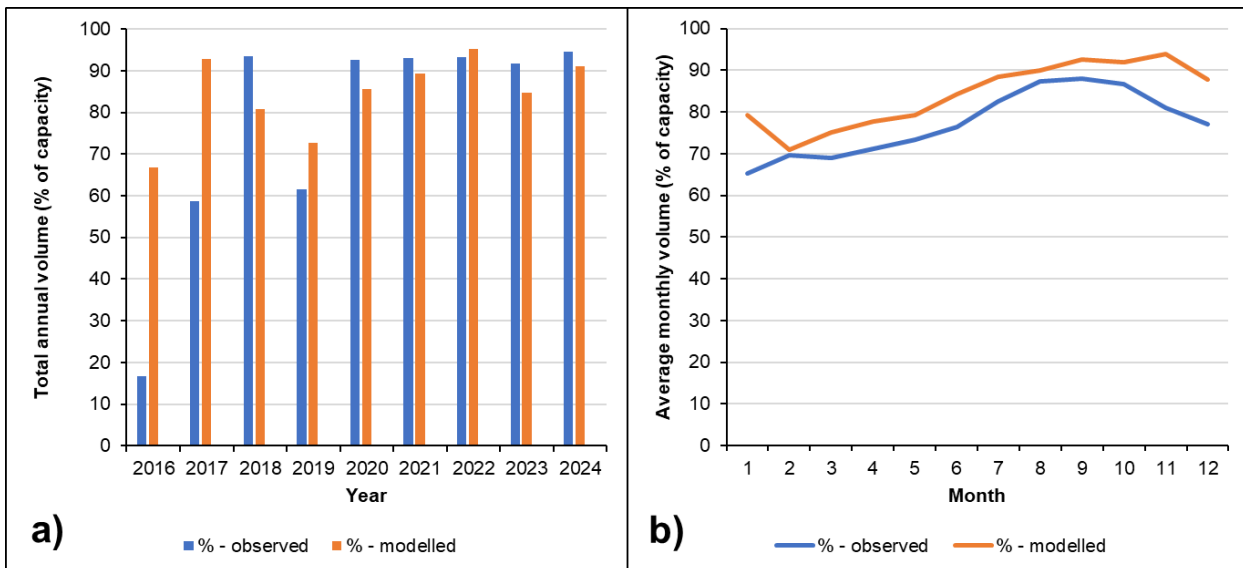


Figure A-22 Hutts Gate reservoirs (including Grapevine Gut) reservoir comparison of observed and modelled total annual (a) and mean monthly (b) reservoir storage 2016-2024

Modelled abstraction at Lower Wells Weir matches well in terms of timing and magnitude with the observed abstraction as shown in Figure A-23.

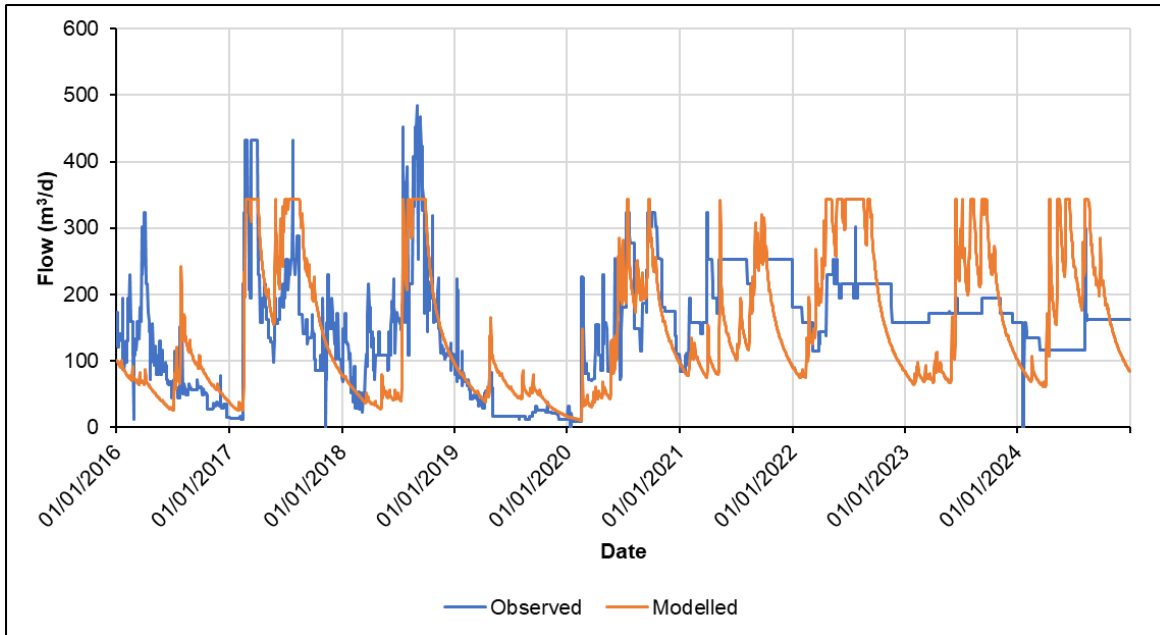


Figure A-23 Lower Wells Weir comparison of modelled and observed abstraction 2016-2024

The modelled flow through the transfer between Longwood 1 reservoir and Hutts Gate 2 reservoir in Figure A-24 shows the transfer being used more frequently in comparison with the observed data. It is likely that the model cannot replicate the manual and reactive operations of this transfer.

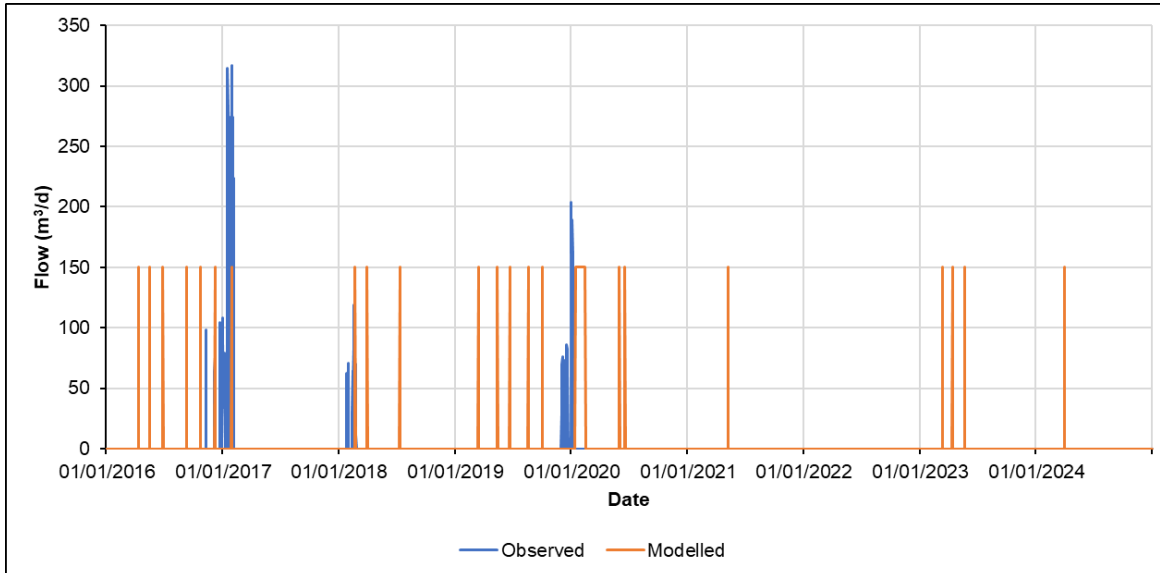


Figure A-24 Longwood 1 to Hutts Gate 2 transfer comparison of modelled and observed flow 2016-2024

The modelled abstraction from Borehole No.5 shown in Figure A-25 matches well in timing and magnitude with the observed abstraction between April 2019 and April 2020. Though model simulates abstraction for a longer time period than the observed abstraction occurred. The model also simulates abstraction outside of the observed abstraction period, though only for short periods. This reflects the fact that the actual operation of the borehole is not as simplistic as that represented within the model.

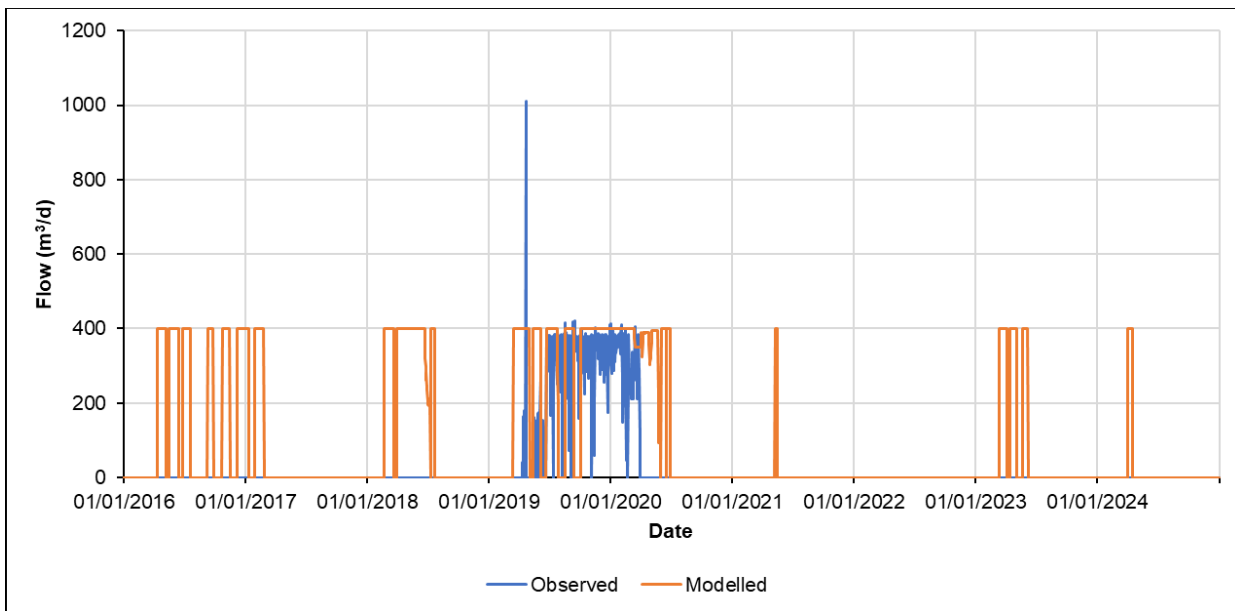


Figure A-25 Borehole No.5 comparison of modelled and observed abstraction 2016-2024  
The modelled and observed abstraction for Fishers Valley Borehole, shown in Figure A-26, are well matched in timing and magnitude between January 2020 and May 2020.

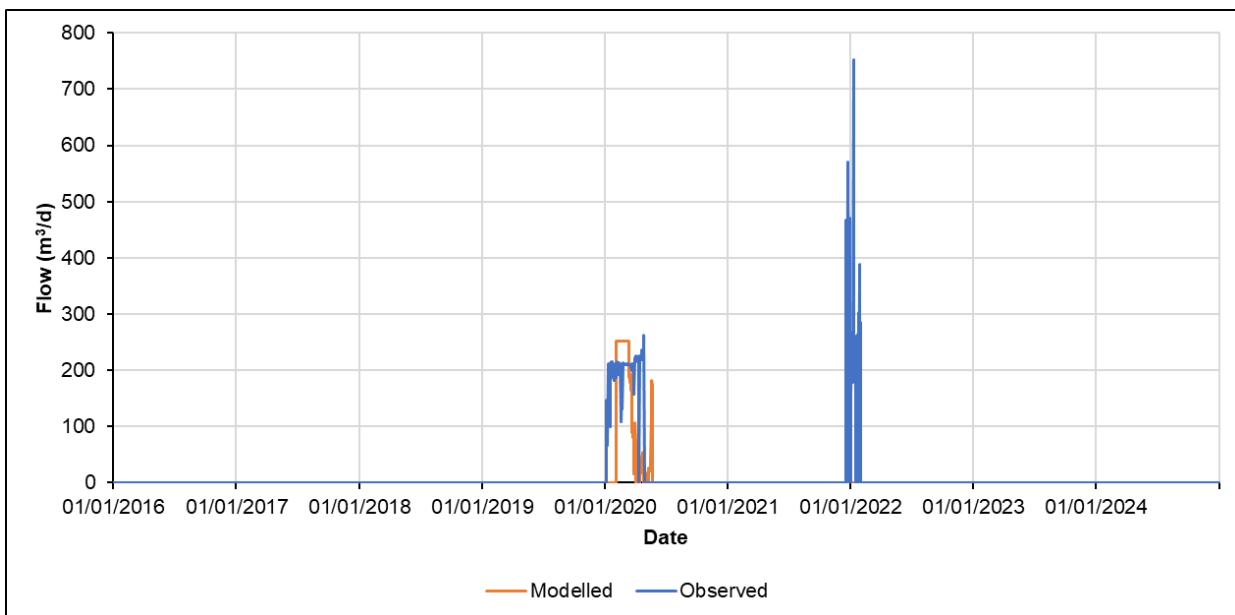


Figure A-26 Fishers Valley Borehole comparison of modelled and observed abstraction 2016-2024

Figure A-27 shows that for Willowbank borehole the timing and magnitude of the observed and modelled abstraction matches very well. The observed is generally more variable than the modelled, which is to be expected given the nature of how these abstractions are represented within the model.

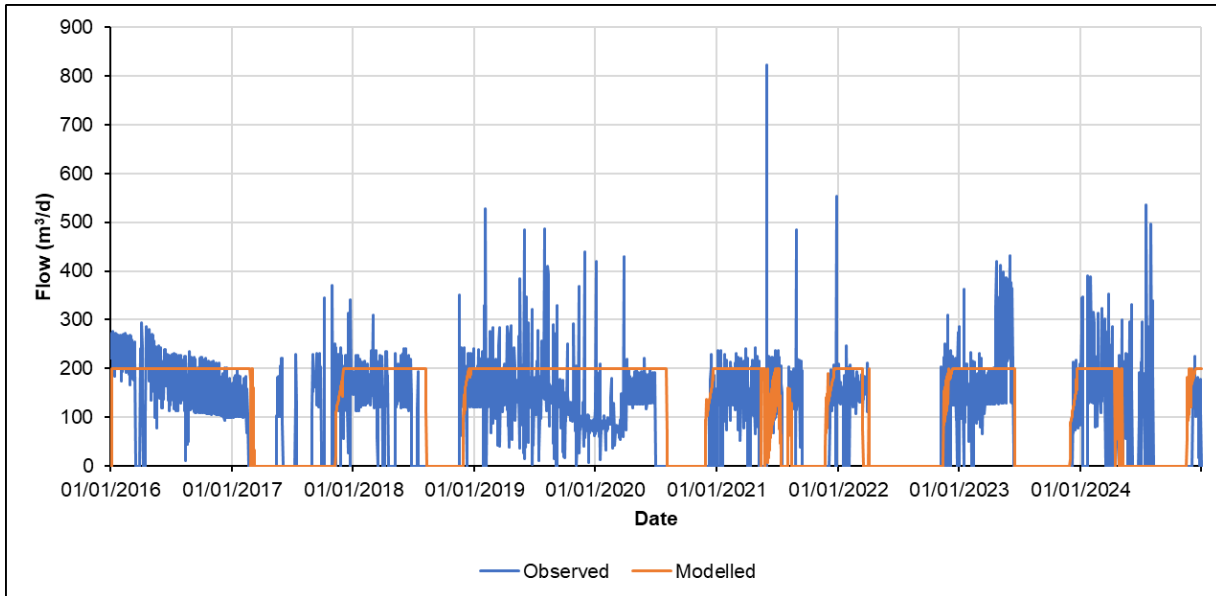


Figure A-27 Willowbank Borehole comparison of modelled and observed abstraction 2016-2024

### Levelwood treated water supply zone

The modelled storage for Levelwood reservoir shown in Figure A-28 follows the typical range of volumes seen in the observed storage but is more variable. The reservoir draws down more rapidly than the observed and refills more slowly, likely due to the model struggling to replicate the daily inflows and outflows of this small storage.

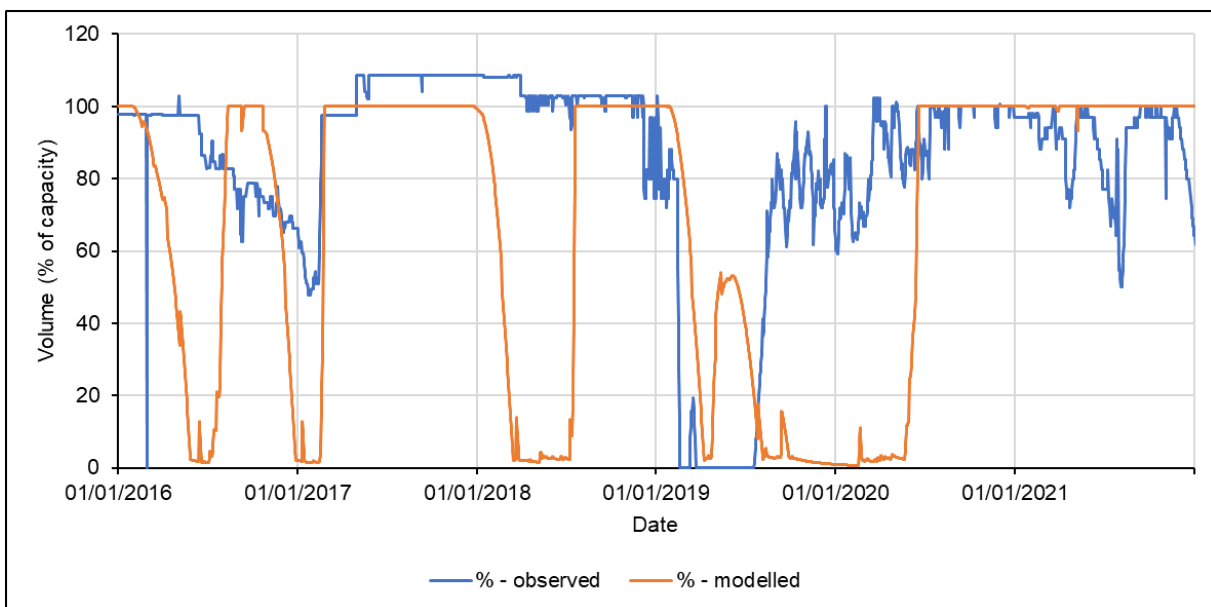


Figure A-28: Levelwood reservoir comparison of observed and modelled reservoir storage 2016-2024

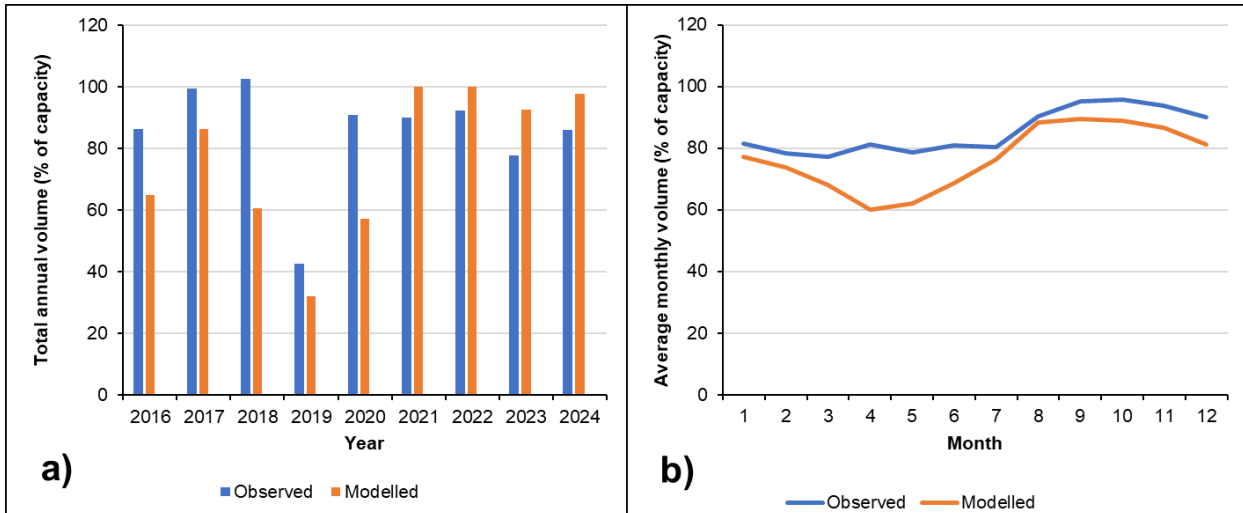


Figure A-29: Levelwood reservoir comparison of observed and modelled total annual (a) and mean monthly (b) reservoir storage 2016-2024

The modelled abstraction shown in Figure A-30 from Warrens Gut Borehole has a relatively good match in terms of timing with the observed abstraction between March 2019 and February 2020. However, as shown in Figure A-30, the magnitude of modelled abstraction underestimated the observed with a difference of 118% in 2019. Outside of this period, model simulates abstraction from the borehole more frequently than was observed.

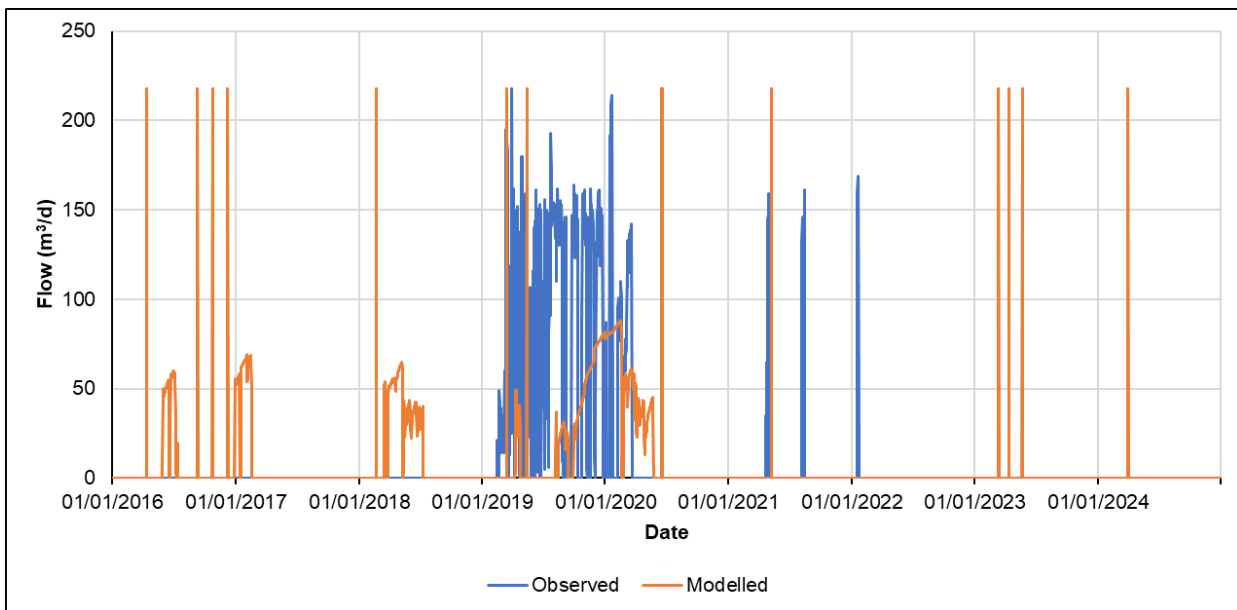


Figure A-30 Warrens Gut Borehole comparison of modelled and observed abstraction 2016-2024

## A.6 Base Yield and Deployable Output

### A.6.1 Introduction

The deployable output (DO) of a water resources system is defined as the volume of water that can be reliably supplied, considering system constraints across the full period of record. These constraints include infrastructure capacity and abstraction rules, as well as hydrological limitations such as periods of low flow.

In line with UK best practice, DO is linked to a defined level of service, which reflects how often supply shortfalls are permitted to occur. This same principle was applied to define the system DO for St Helena. Under this approach, DO is estimated as the highest level of demand that can be met without failure, within a specified frequency of occurrence, commonly expressed as a return period. For example, a 1-in-5-year DO corresponds to a demand level that the system would be unable to meet, on mean, no more than once every five years.

Within the Aquator model, DO is determined by running the model across a range of demand values between defined minimum to maximum at set intervals. The number of supply failures at each demand level is recorded and an extreme value distribution is then applied to the results to derive the deployable output associated with a given return period (e.g. 1 in-100-year or 1 in-500-year DO).

St Helena does not currently have a legislated level of service for public water supply, so an appropriate service level was established as part of this project. In England, water companies are required to meet a 1 in-500-year level of service. However, this is likely to be disproportionate to the needs and context of St Helena. The selected level of service must strike a balance between resilience, feasibility, and affordability, while aligning with the island's strategic objectives. Following discussions with SHG and CSH, a 1 in-100-year level of service was agreed. This is the demand that can be met by the system with a 1% probability of failure in any given year.

The Aquator water resources model, as described in Section A.4.12, was used to estimate deployable output for the overall St Helena water supply system, as well as for the individual treated water zones.

### A.6.2 System Deployable Output

The model was analysed for DO over the historic period 1927 to 2024. The results are given in Table A-9.

Table A-9: Results of the island wide baseline DO analysis. The 1 in 100-year DO is highlighted in bold text.

Return Period (years)	DO (m <sup>3</sup> /d)	
	No tanks	Tanks
5	1941	2263
10	1759	2089
20	1711	2004
30	1694	1953
40	1663	1931
50	1662	1931
60	1662	1931
70	1659	1930
80	1659	1930
90	1659	1930
<b>100</b>	<b>1659</b>	<b>1930</b>

This shows that the baseline 1 in 100-year DO of the St Helena system is 1659 m<sup>3</sup>/d, not including tank storage. The DO for this model is constrained by Jamestown as this system has no reservoir storage and therefore no buffer. Including tank storage increases the DO to 1930 m<sup>3</sup>/d. This suggests that the tanks offer significant additional resilience in the St Helena system, in the order of 270 m<sup>3</sup>/d (15% increase). In the tanks model the DO is still constrained by Jamestown demonstrating the benefit that the tanks have in modulating and mitigating temporary supply failures in this zone.

### A.6.3 Individual yields for treated water supply zones

The tanks Aquator model was also used to define the individual yield of each treated water supply zone. The model was run with transfers between zones disabled to understand the DO of each zone as a standalone. The results are given in Table A-10. No constraints (e.g., pipe capacities and maximum abstraction rates) have been included in this analysis.

Table A-10: Baseline 1 in 100-year DO's for the individual treated water supply zones

Zone	DO (m <sup>3</sup> /d)
	Tanks
Redhill	308.5
Jamestown	263.0
Hutts Gate	947.5
Levelwood	240.1
Total DO	1759.1

The analysis shows that the majority of water supply on the island is concentrated in the eastern region, particularly around Hutts Gate and Levelwood. This is due to the additional resilience provided by groundwater resources in this area, which can be used to supplement reservoir storage during drought conditions. In contrast, the Redhill and Jamestown supply zones have lower yields. These zones are more dependent on spring and surface water sources, which are significantly less resilient during dry periods and often reduce to zero when there is no rainfall.

Operationally it is understood that Levelwood struggles to meet its required demand currently, particularly in drought. However, this is due to the capacity and age of the WTWs rather than the available supply. This analysis suggests if these operational constraints were removed (i.e., if Levelwood were upgraded) then it would be able to meet a demand of 240 m<sup>3</sup>/d, which is mainly due to the additional resilience added by Warrens Gut borehole. The surface water storage in this zone and spring inputs on their own would have a much lower yield.

The analysis therefore indicates that most of the available water resource lies within the eastern part of the island, while the highest population and the majority of total demand are located in the west. This results in an existing imbalance between supply and demand across the resource zones, which must be considered in future water resources planning and options appraisal. Disabling transfers between the different supply zones further reduces the resilience of Redhill. This highlights the importance of inter-zone transfers in maintaining reservoir levels in drought, particularly for Redhill which has limited natural supply and high demands.

#### A.6.4 Conclusions

The baseline DO for the St Helena supply system is 1659 m<sup>3</sup>/d, based on historic hydrological conditions and agreed levels of service. The analysis shows that the inclusion of tank storage increases the overall resilience of the system to 1930 m<sup>3</sup>/d, particularly in supply zones with limited or no natural storage, such as Jamestown.

The zone-level analysis further highlights the spatial variability in water resource availability across the island. Hutts Gate and Levelwood, located in the east, show higher yields due to the added resilience provided by groundwater sources, such as the Warrens Gut and Borehole No. 5. In contrast, Redhill and Jamestown are more vulnerable to supply shortfalls due to their dependence on less reliable spring and surface water sources. These vulnerabilities are exacerbated when inter-zone transfers are disabled, underlining the critical role that these transfers play in ensuring resilience during drought conditions.

The analysis also reveals an imbalance between resource availability and demand, with most of the supply capacity located in the south-eastern part of the island, while the highest population and demand are concentrated in the north. This spatial mismatch will be carefully considered in future water resources planning and options appraisal.

## A.7 Sensitivity to climate change

### A.7.1 Introduction

Climate change is expected to significantly influence future water availability in future and is therefore a key factor in assessing how the balance between supply and demand may evolve. Variations in rainfall, temperature, and evapotranspiration affect both reservoir inflows and groundwater recharge, which are vital supply inputs on St Helena. Assessing these impacts ensures that water supply systems remain resilient and adaptable under a range of future climate scenarios and aids in selection of long-term options.

### A.7.2 Literature review

The available literature on the impacts of climate change on St Helena was reviewed in order to support the incorporation of climate change into the base water resources modelling. The primary available literature sources and a summary of their key information is given in Table A-11. There are no regional climate projections available for St Helena as the small size of the island means that global climate models grid cells are too large and therefore can't represent St Helena's local conditions.

Table A-11 Summary of available climate change literature for St Helena

Title	Citation	Source Type	Key information
Climatic changes in the subtropical Southeast Atlantic: the St. Helena Island Climate Index (1893-1999)	Feistal et al., 2003	Academic journal paper	The paper derives a climate index for St Helena based on monthly temperature, pressure and rainfall data from 1893-1999. The key trends shown by the data were increasing air temperature (0.9 °C/100 years) and decreasing precipitation (10mm/100 years)
Climate Change in the UK Overseas Territories	Brown, 2008	Report (Joint Nature Conservation Committee)	The report highlights potential impacts of climate change on St Helena, although does not provide data on these. The noted impacts are, increased erosion in easter St Helena, reduction in fish stocks, disruption to weather patterns, altitudinal shifts in vegetation zones and worsening of ecological imbalances. The report notes an increasing trend in air temperature (2°C/60 years) which is a greater rate than that observed by Feistal et al. (2003). A slight decreasing trend in rainfall is noted but no figures are given.
Assessing climate change and its likely impact on	Wade et al., 2015	Report (Met Office)	The report focusses on the potential infrastructure needs of the Overseas Territories in response to climate change. For St Helena, drought is noted

Title	Citation	Source Type	Key information
selected UK Overseas Territories: Inception Report			as an important issue due to changing rainfall patterns and limited water resources. The report projects by 2035-2065 relative to 1961-1990. Under RCP2.6 air temperature was projected to increase by 1°C and precipitation to decrease by 4%. Under RCP2.6 air temperature was projected to increase by 1.6°C and precipitation to decrease by 7%.
PLUS051 Water Security and Sustainable Cloud Forest Restoration on St Helena	Sansom et al.,	Report (SHG, Connect Saint Helena Ltd, EMD, Arctium, UKCEH)	<p>The report summarises the available information on climate change from the University of Cape Town Climate Information Platform and the World Bank Climate Change Knowledge Portal.</p> <p>The University of Cape Town Climate Information Platform is developed from local scale climate models based on the larger IPCC model for Africa. For the 2040-2060 period the Climate Information Platform shows that increase in average temperature for St Helena may be between 0.7 and 1.8°C under both the RCP4.5 and RCP8 scenarios. Over the same period, the Climate information platform shows that June is expected to 30% drier than current long-term average (LTA) rainfall at Bottom Woods weather station, whilst January, September and November are expected to be 14-26% wetter than current LTA rainfall. This is for RCP4.5 and RCP8 scenarios.</p> <p>The World Bank Climate Change Knowledge Portal interprets data from the IPCC CIM5 global climate model. Climate change projections for St Helena are for 2080-2099 against a reference period of 1986 to 2005. The projections show median island temperatures increasing by 2°C and a 5% increase or decrease in annual rainfall based on the LTA at Bottom Woods weather station.</p>

### A.7.3 Deriving climate change inflows

Due to the limited availability of detailed climate projections for St Helena, the World Bank Climate Change Knowledge Portal was used as the primary data source, as these projections are the most up to date. This represents a first-stage assessment aimed at understanding the potential impacts of climate change on the island's water resources. The method adopted for this study reflects a practical response to the information currently available and the constraints of the project timetable.

The portal provides climate projections for a number of variables including precipitation and temperature anomalies for a range of Representative Concentration Pathways (RCPs) and future time horizons (epochs). For this study, the 2060s epoch (2050-2079) was selected to represent how climate change is projected to impact on flows to the end of the planning period. Two emission scenarios, RCP4.5 and RCP8.5, were chosen to capture a plausible range of potential futures:

- RCP4.5 represents a stabilising, moderate emissions pathway with a projected global warming by 2100 (relative to pre-industrial levels) of 1.9 to 3.5°C
- RCP8.5 represents a high-emission scenario, with a projected global warming by 2100 (relative to pre-industrial levels) of 3.5 to over 5.0°C.

RCP2.6 was not considered, as it is now regarded as unlikely to be achieved under current global emission trajectories. Assessing RCP4.5 and 8.5 therefore gives a realistic best- and worst-case estimate of potential climate change impact.

Median results from the climate model ensemble were extracted for both variables. Precipitation data were provided as monthly percentage change factors, allowing these to be applied directly to baseline rainfall series used in hydrological modelling. These are shown in Figure A-31, together with the 10th and 90th percentile ranges to illustrate the spread of potential outcomes. The ensemble indicates that reduced summer rainfall is the most likely outcome under future climate conditions. However, the presence of wetter projections within the upper percentile range suggests that wet summers may still occur, albeit with reduced frequency and likelihood compared to the historical baseline.

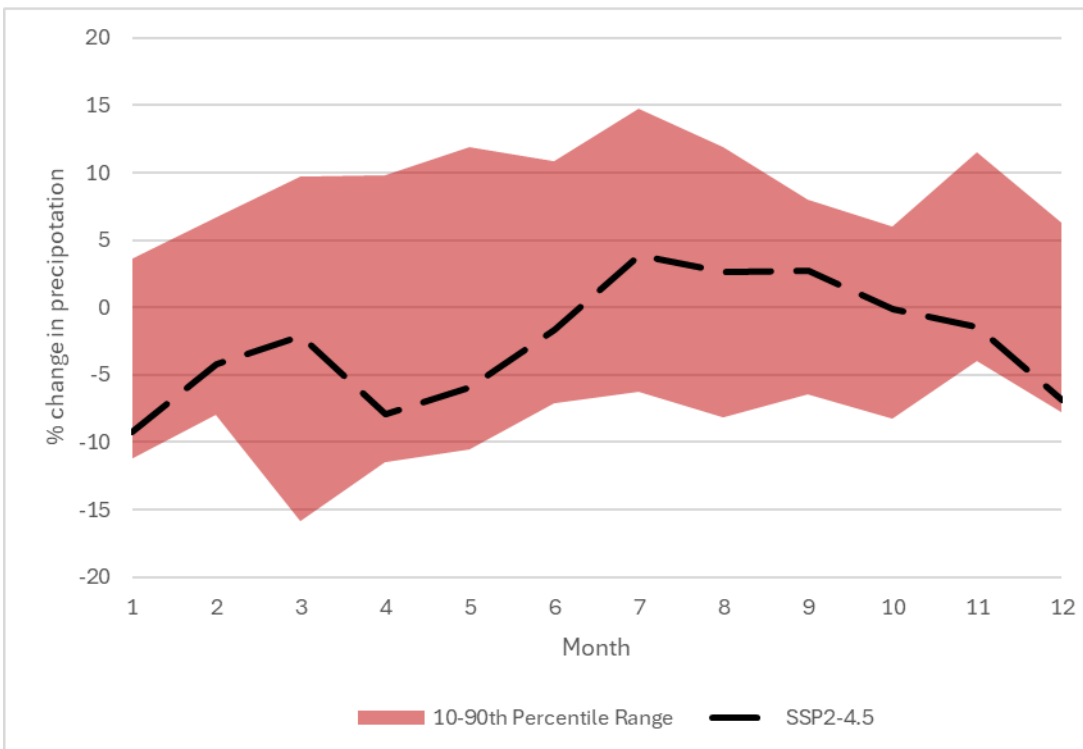
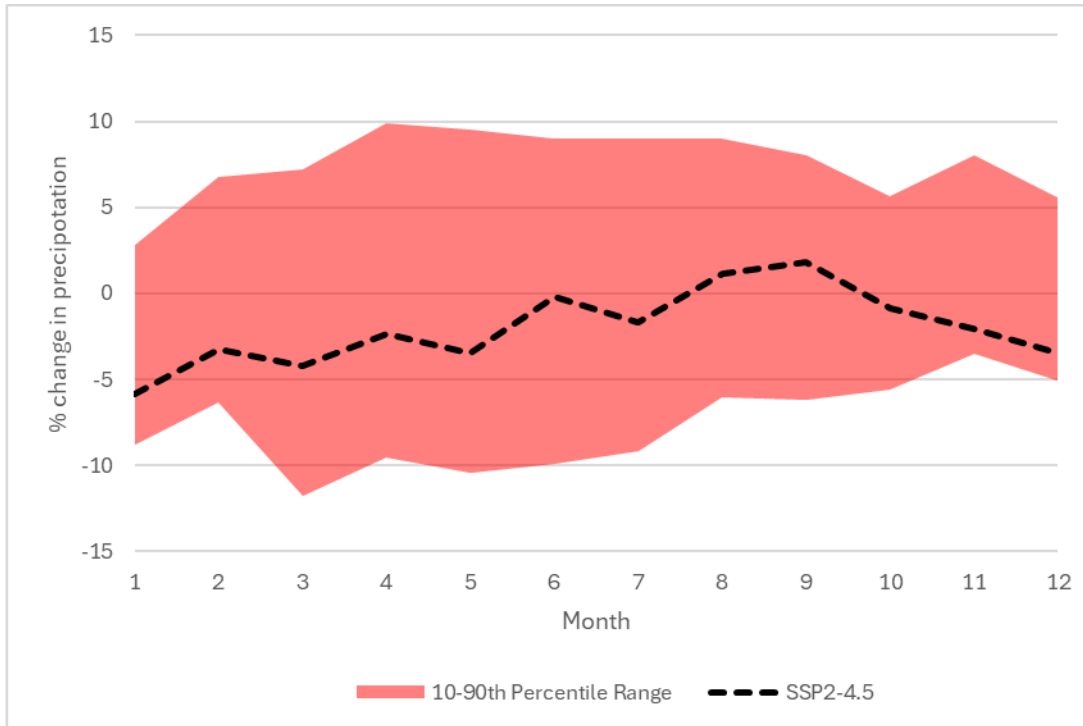


Figure A-31: Median monthly percentage change factors shown with the 10-90th percentile confidence interval

Potential Evapotranspiration (PET) projections were not directly available through the portal. Therefore, to estimate the impact of increased temperatures on PET estimates of future PET were derived from temperature anomalies using the Oudin method (Oudin et al., 2005). Baseline and future monthly mean temperature profiles were extracted, and from these, a monthly percentage change factor in PET was calculated for each climate scenario

(Figure A-32). These factors were then applied to the baseline PET series to generate climate-adjusted PET datasets.

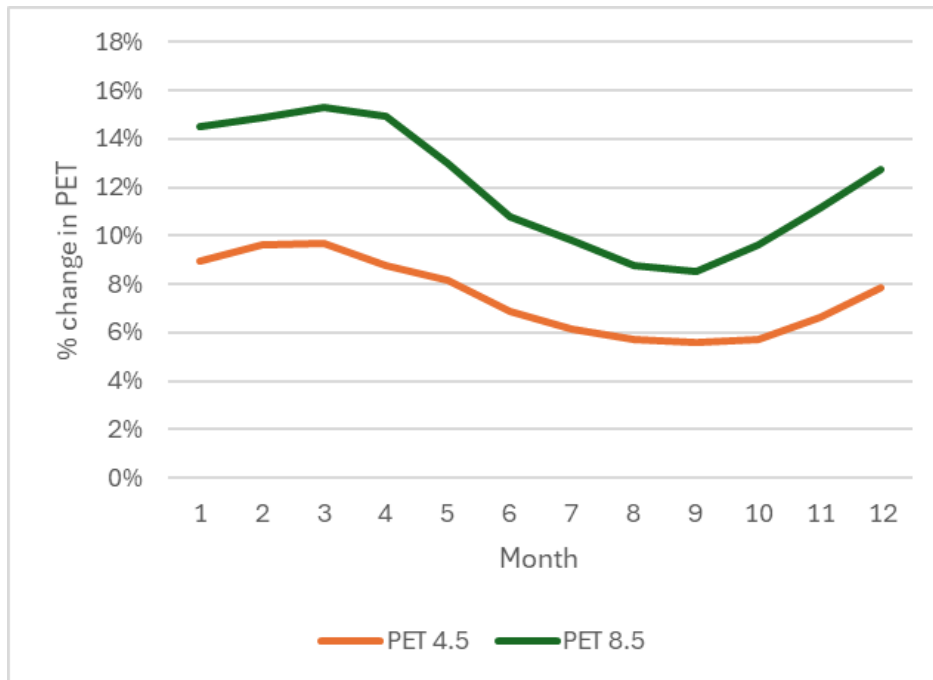


Figure A-32: Climate-adjusted PET datasets for the RCP4.5 and RCP8.5 emission scenarios

The GR6J rainfall runoff models were run using the climate change rainfall and PET datasets to generate climate change flows for each scenario. These were added to the Aquator water resources model which was then run to obtain climate change values of deployable output.

#### A.7.4 Impacts on DO

The two climate scenarios were run in the Aquator model and the system DO was assessed. For the 2060s. The results of these Aquator runs are summarised in Table A-12 below. Please note that there were some issues with the no tanks RCP8.5 DO runs related to the number of failures and length of simulation period, which meant the 1 in 100-year return period could not be estimated. The ratio between the RCP4.5 and RCP8.5 DO's were applied from the tanks model to the no tanks results for RCP4.5 in order to estimate the no tanks RCP8.5 DO.

Table A-12: Impact of climate change on 1 in 100-year DO

RCP	No Tanks		Tanks	
	RCP4.5	RCP8.5	RCP4.5	RCP8.5
2060s DO (m <sup>3</sup> /d)	1325	1306	1745	1726
Change from Base DO (m <sup>3</sup> /d)	-334	-353	-185	-204
Change from Base DO (%)	-20	-21	-10	-11

Linear interpolation between the base DOs and 2060s DOs from Table A-12 Table produced annual profiles of DO impact across the planning horizon (2025-2065). These are shown below for the tanks model in Figure A-33 and the no tanks model in Figure A-34.

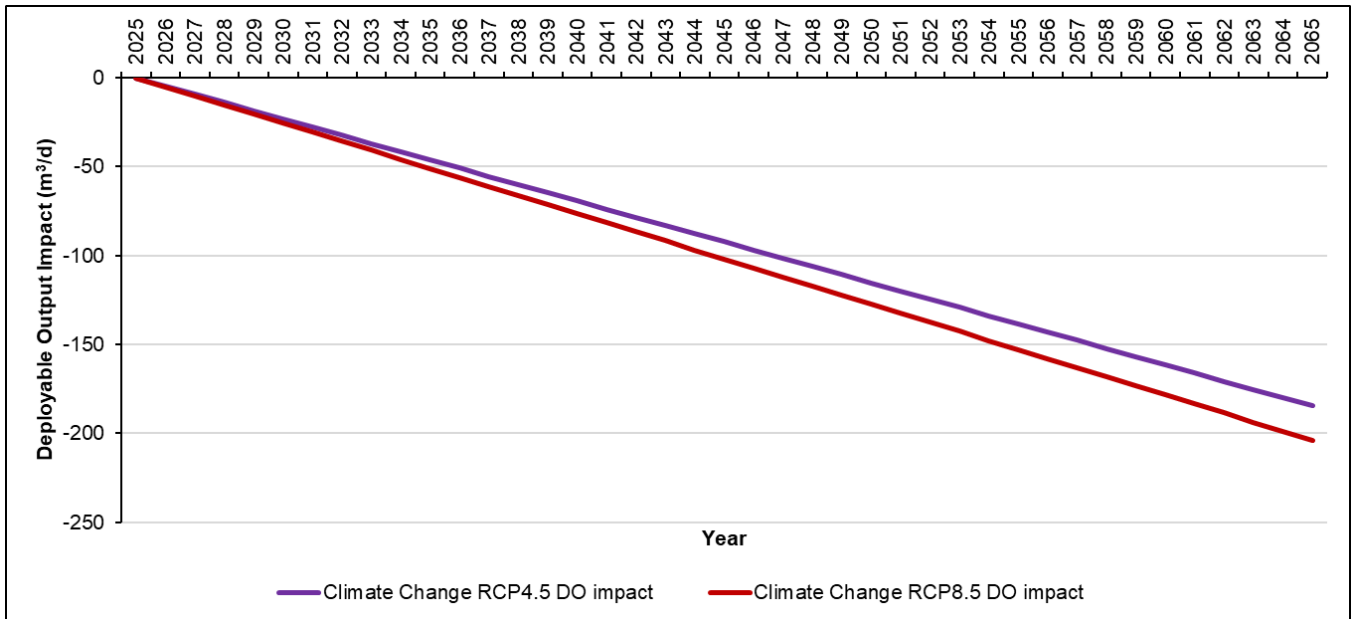


Figure A-33 Climate change DO impact - tanks model

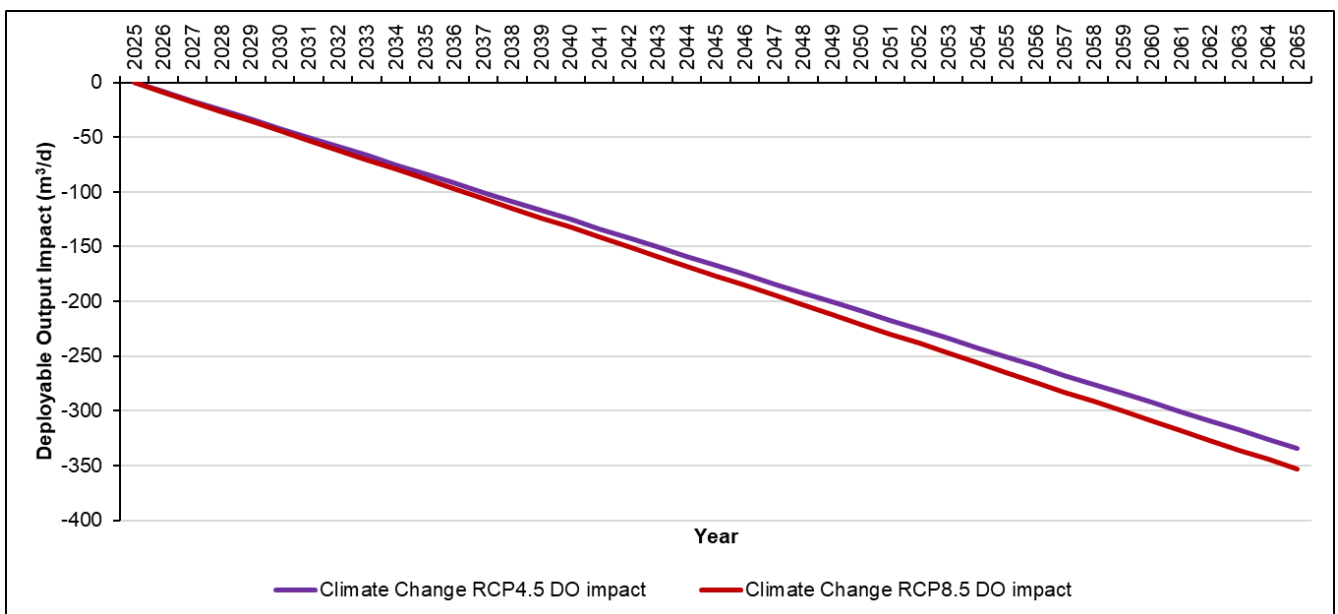


Figure A-34 Climate change DO impact - no tanks model

### A.7.5 Supply forecast

As a worst-case scenario for planning the no tanks DO results have been taken forward for use in the supply demand balance. In UK best practice an allowance is made to account for the impact of outage which is an allowance for planned and unplanned events that lead to the temporary loss of output from supply sources. Outage covers a range of influences from power failure to short term pollution incidents. No outage assessment has been undertaken as part of the St Helena WRMP, however, given the age and condition of some of the water supply infrastructure, particularly the tanks and WTW, the risk of outage on St Helena is considered to be quite high. Therefore, not considering the additional resilience added by the tanks has essentially been used instead of an application of an outage allowance as the most conservative and reasonable worst-case scenario in terms of supply.

The supply forecast derived for the St Helena supply system is given in Table A-13 for key milestones.

Table A-13: Supply forecast derived for the St Helena supply system

Component (m3/d)	2025	2030	2040	2050	2060	2065
1 in 100-year DO	1659	1659	1659	1659	1659	1659
Climate Change RCP4.5 DO impact	0	-42	-125	-209	-292	-334
Climate Change RCP4.5 DO	1659	1617	1534	1450	1367	1325
Climate Change RCP8.5 DO impact	0	-44	-133	-221	-309	-353
Climate Change RCP8.5 DO	1659	1615	1526	1438	1350	1306

As previously mentioned, the WRMP has prioritised establishing a reliable baseline of existing water resources and infrastructure using established and simple methods and techniques. This supply forecast therefore represents a starting point, which can be improved upon as needed as better tools, methods and data become available.

The supply forecast contains significant inherent uncertainty and has been limited by the data available.

## A.8 Baseline Supply Demand Balance

### A.8.1 Overview and approach

Supplies and demands are forecast over the 40-year plan period, taking into account climate change and population change. These forecasts are then compared to assess the supply demand balance. If the supply-demand balance is in surplus (supply is greater than demand), then there is enough water to meet demand to the planned level of service. If the balance is in deficit (demand greater than supply), supply enhancement, new supply options and/or demand management are needed to meet demand. This concept is demonstrated in Figure A-35.

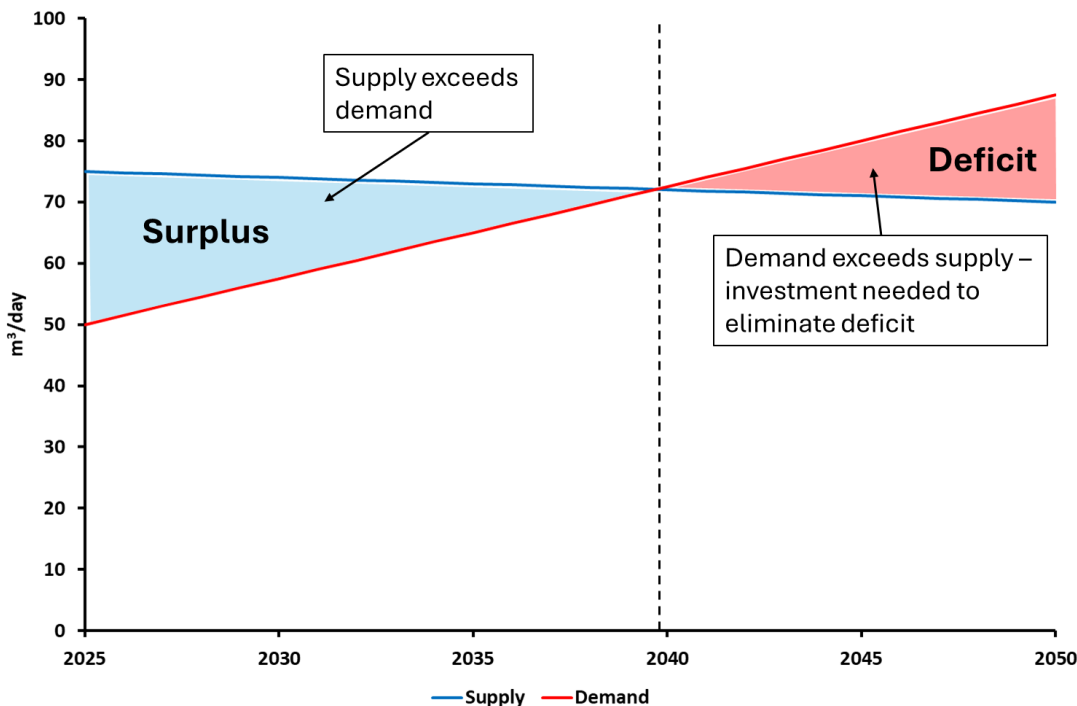


Figure A-35: Example schematic of the supply-demand balance

A supply demand balance (SDB) shows how the water available to Connect Saint Helena Ltd compares with the demand from their customers. This is set out over the whole plan horizon (2025-2065) to show the time period over which investment in options is required to maintain a surplus of supply.

The supply demand balance is intended to indicate when, and under which future there may be a deficit. Understanding when a deficit may occur allows planning of what options should be initiated and when to mitigate the risk of a deficit before it occurs. These options could be demand-side, for example water efficiency and leakage reductions, or supply-side for example developing a new supply source or increasing storage capacity. These form the key output of the plan.

Supply demand balances are created for a range of current and future scenarios to allow exploration of a range of possible conditions. This allows planning for a range of future conditions ranging from best to worst case. This takes into account the inherent

uncertainties within forecasting supply and demand in future. It is extremely difficult to predict what may happen in future, for example how demographics might change, what technologies may be available, or how climate change impacts will be realised. Assessing a range of scenarios therefore allows for a degree of adaptive planning to be built into the plan.

### A.8.2 Scenario planning

A number of future scenarios have been explored as part of the plan process to make the plan as resilient as possible. These scenarios cover a range of plausible futures, accounting for how population and demographics might change and the impact of climate change and the uncertainty involved. By assessing multiple future scenarios this allows adaptability to be built into the plan inherently. The following future water resource impact scenarios have been considered:

- High impact scenario - represents a future high population growth and economic development, high climate change impacts
- Moderate impact scenario - steady population growth and economic development, more moderate climate change impacts
- Low impact scenario - low population growth, more moderate climate change impacts

### A.8.3 Supply demand balance forecast

The supply demand balance forecast for St Helena is shown in Table A-14 and Figure A-36. This shows that the system is currently in surplus, but under the moderate to high impact scenarios is expected to go into a deficit in future. It is important to note that the current estimated surplus does not mean there are not current supply issues within the system (e.g., drought resilience is not captured here) however indicates that in average conditions there is enough supply to meet demand, which is known to be the case.

Table A-14: Supply demand balance results for St Helena. All values in m<sup>3</sup>/d

	2025	2030	2040	2050	2060	2065
Future supply under climate change (RCP4.5)	1659	1618	1534	1450	1367	1325
Future supply under climate change (RCP8.5)	1659	1615	1527	1438	1350	1306
Steady Demand	1419	1434	1462	1490	1490	1490
Declining Demand	1419	1410	1391	1363	1306	1277
Increasing Demand	1419	1495	1647	1732	1874	1945
<b>Low impact scenario</b>	<b>240</b>	<b>208</b>	<b>143</b>	<b>88</b>	<b>61</b>	<b>48</b>
<b>Moderate impact scenario</b>	<b>240</b>	<b>184</b>	<b>72</b>	<b>-40</b>	<b>-124</b>	<b>-165</b>
<b>High impact scenario</b>	<b>240</b>	<b>120</b>	<b>-120</b>	<b>-293</b>	<b>-524</b>	<b>-639</b>

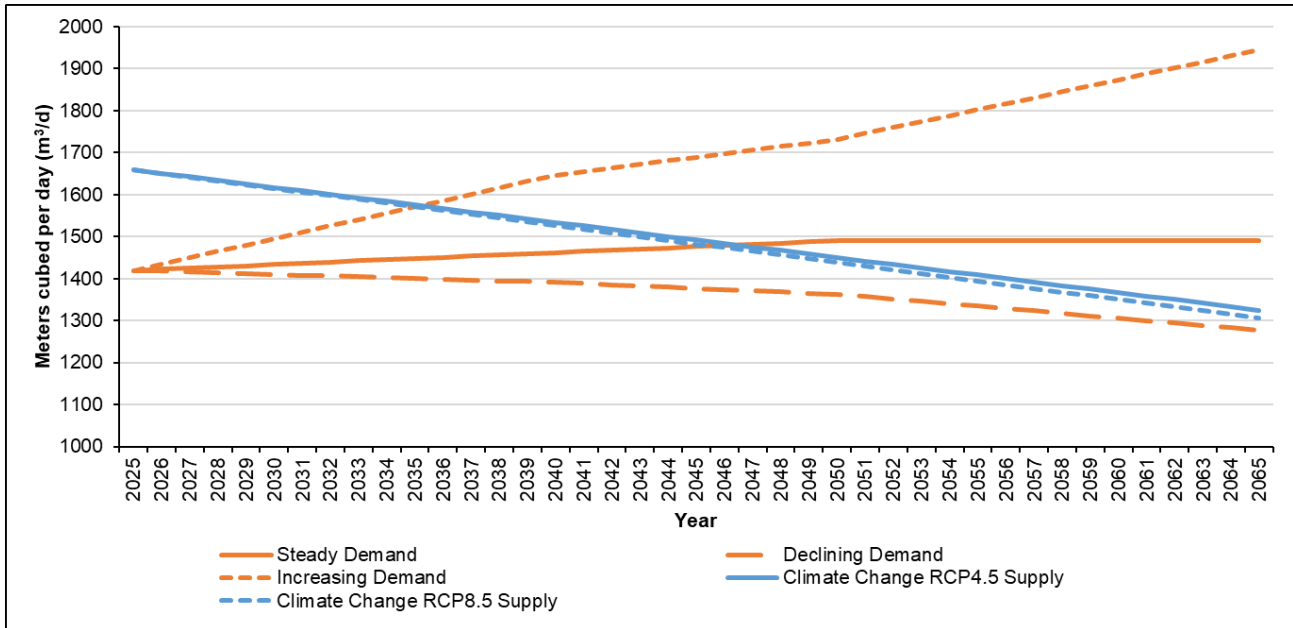


Figure A-36: Supply demand balance for St Helena

Under the moderate impact scenario, the system is surplus until 2050, after which the deficit increases in size towards 2065 to 165 m<sup>3</sup>/d. To put this into context this is 12% of the current demand. This will require investment to prevent this deficit occurring in future if this demand scenario is followed.

The high impact scenario would lead to deficit earlier in the planning horizon, from 2034 onwards. This deficit continues to increase as demand increases and supply decreases due to climate change impacts, reaching 639 m<sup>3</sup>/d by 2065, which is 45% of the current demand. Under this scenario, investment and option implementation would be required at a greater rate and more substantial investment than the steady demand scenario would ultimately be necessary.

Under the low impact scenario, a surplus is maintained throughout the planning horizon and therefore investment is not required to close the SDB deficit. However, investment may still be necessary to account for peak demands and outages (e.g. reservoirs out of commission, water treatment works failure) or to enhance drought resilience.

## A.9 Conclusions and recommendations

This stage of the St Helena Water Resources Management Plan (WRMP) has assessed current and potential future pressures on the island’s water supply system. The WRMP represents the first comprehensive and integrated assessment of water supply and demand for St Helena and has focused on establishing a robust and transparent baseline using proportionate, well-established methods.

A demand forecast has been developed incorporating household demand, non-household demand and leakage. Significant uncertainty remains within the demand assessment, particularly in relation to future population change, economic activity, leakage levels and

unbilled consumption. These uncertainties have been addressed through the use of multiple demand scenarios and the application of appropriate headroom allowances.

In parallel, a hydrological assessment has been undertaken to characterise inflows from surface water, spring and groundwater sources. These inflows, together with the demand forecast, have been integrated within a system-wide water resources model representing the operation of the St Helena supply system.

The water resources model has been benchmarked against observed operational data for the period 2016-2024 and performs well at system level, including during the 2019/2020 drought. The model is therefore considered fit for purpose for strategic water resources planning and has been used to establish a base deployable output (DO) for the system. A level of service equivalent to a 1 in 100-year event (1% annual probability of supply failure) has been adopted for planning purposes.

The base system deployable output is estimated at approximately 1,659 m<sup>3</sup>/day. Under the moderate and high demand growth scenarios, forecast demand is projected to exceed this supply by the late 2030s. This indicates that while the system is currently meeting demand, intervention will be required over the planning horizon to maintain resilience and avoid a future supply-demand deficit.

It is important to note that the supply-demand balance is only one indicator of system performance. Even where average demand can be met, the St Helena supply system remains vulnerable to drought impacts, water quality constraints and operational limitations, which are already evident during dry periods and high-rainfall events. Addressing these issues is therefore necessary in the near term, irrespective of longer-term supply-demand outcomes.

The assessment has been undertaken using the best available data and methods, but inherent uncertainties remain due to data limitations and the evolving nature of the system. The results presented in this WRMP should therefore be viewed as a baseline that can be progressively refined as monitoring improves and operational experience increases. This would possibly be revised on the next cycle of the WRMP.

Key assumptions, uncertainties and recommended future improvement actions are summarised below.



Theme	Type	Key assumptions	Recommended actions
Hydrological assessment	Model structure	GR6J is appropriate for representing hydrological responses of both spring-fed and ephemeral catchments on St Helena.	Reassess model suitability as additional flow data become available and consider alternative model structures if required.
	Flow data availability and quality	Calibration data are limited in length but assumed to be reliable; gauge data quality constrains calibration at both sites. Short calibration periods limit confidence in long-term simulated flows.	Improve spatial and temporal coverage of flow monitoring, particularly in ungauged catchments. Install dedicated gauges upstream of abstraction points and supplement with spot flow measurements.
	Rainfall	Rainfall totals in recent (daily) and historical (monthly) records are accurate and representative. Thiessen polygon weighting provides representative catchment-mean rainfall despite sparse gauge coverage. Disaggregation of historical monthly rainfall to daily values provides sufficiently accurate inputs for long-term modelling at seasonal and annual scales.	Expand rainfall gauge network and review catchment rainfall estimation methods as new data become available. Review and refine disaggregation methods as additional daily rainfall records become available.
	PET	PET estimates based on median daily values adequately represent long-term climatic conditions in the absence of continuous records.	Improve PET monitoring and consider alternative PET estimation methods where data allow.
	Spatial scaling of flows	Flow is directly proportional to catchment area when scaling GR6J outputs to ungauged abstraction points.	Validate scaling assumptions using future gauging and targeted flow measurements.
	Groundwater inputs	The supplies from groundwater are based on observed data, actual borehole yields are not known.	Update with borehole yields should this information become available.

Theme	Type	Key assumptions	Recommended actions
	Validation and robustness	Two-step validation against observed flows and system-level volumes is sufficient to provide representative inflows.	Undertake ongoing validation, particularly during drought periods, as longer observational records become available.
Water resources modelling	System representation	The model schematics, assets, and connectivity based on CSH information accurately represent the four raw water zones and key infrastructure.	Update the model schematics as infrastructure changes occur and improve asset metadata where gaps remain.
	Operational rules	Rule-based representation adequately reflects the behaviour of a largely manually operated system under normal and drought conditions.	Refine operational rules over time using operator feedback and data from future drought events to better reflect real-world decision-making.
	Benchmarking and calibration	Observed data from 2016-2024 are sufficient to benchmark model performance, with particular reliance on the 2019/2020 drought as a critical test period.	Extend benchmarking as longer operational datasets become available, especially covering a wider range of hydrological conditions.
Demand	Metered consumption data	Metered consumption data are representative of actual water use across household and non-household customers. Data gaps, meter under-registration and faulty meters are assumed to be adequately captured through a uniform +5% uplift.	Improve data quality checks and reconciliation between billed consumption and system input volumes.
	Population projections	Linear extrapolation of historic population trends provides a reasonable basis for long-term demand forecasting. Declining, stable and increasing population scenarios adequately capture plausible future uncertainty.	Update demand scenarios accordingly in future WRMP cycles.



Theme	Type	Key assumptions	Recommended actions
	Household occupancy	An average household occupancy of 2.2 persons per household remains representative over the planning horizon.	Reconfirm household occupancy assumptions following future census updates or targeted household surveys.
	Non-household demand growth	A 1% compound annual growth rate adequately represents long-term changes in non-household demand, with specific known developments added explicitly.	Refine non-household demand forecasts using sector-specific information as new developments are confirmed (e.g. tourism, industrial or agricultural expansion).
	Agricultural and irrigation demand	Irrigation demand profiles derived from metered data, rainfall patterns and crop growing seasons adequately represent current and future agricultural water use. Assumed increases in irrigated area under stable and increasing scenarios are modest and evidence based.	Improve agricultural abstraction monitoring and metering. Review irrigation assumptions as land use, crop types or irrigation practices change.
	Leakage and losses	Leakage remains at 45% of total demand over the planning horizon, reflecting current system performance.	Update leakage assumptions as leakage reduction activities are implemented and performance improves. Reflect revised leakage levels in future WRMP updates.
	Drought demand response	A +20% drought uplift adequately represents increased demand during prolonged dry periods based on observed drought behaviour.	Reassess drought demand uplift following future drought events and as demand management measures are implemented.
	Overall uncertainty and headroom	A 20% headroom allowance sufficiently captures residual uncertainty in demand forecasting, including behavioural change, climate variability and data limitations.	Review headroom assumptions as monitoring improves and uncertainty reduces, particularly following improvements in leakage control and metering accuracy.



Theme	Type	Key assumptions	Recommended actions
	Metered consumption data	Metered consumption data are representative of actual water use across household and non-household customers. Data gaps, meter under-registration and faulty meters are assumed to be adequately captured through a uniform +5% uplift.	Continue meter replacement and calibration programmes. Improve data quality checks and reconciliation between billed consumption and system input volumes.
	Population projections	Linear extrapolation of historic population trends provides a reasonable basis for long-term demand forecasting. Declining, stable and increasing population scenarios adequately capture plausible future uncertainty.	Review population projections periodically as new census data or SHG demographic forecasts become available. Update demand scenarios accordingly in future WRMP cycles.

## **B Options appraisal and best value planning**

### **B.1 Summary**

This appendix presents the options appraisal and best value planning undertaken to support the St Helena Water Resources Management Plan (WRMP). Its purpose is to demonstrate that a robust, proportionate and transparent process has been applied to identify a portfolio of options that collectively manage water supply risk over the planning horizon.

The purpose of the options appraisal was to develop a portfolio of interventions that collectively manages risk across a wide range of future conditions, including future climate and demand conditions. A staged approach was taken, following UK best practice in which a long list of options is progressively screened and developed to create a shortlist of options which are carried forward into the Water Resources Management Plan (WRMP).

### **B.2 Purpose**

This appendix documents the options appraisal and best value planning process undertaken to inform the Water Resources Management Plan WRMP for St Helena. It provides details on how options were identified, screened, assessed and prioritised, and explains how the preferred portfolio of interventions was developed.

The purpose of this appendix is to demonstrate that a robust, proportionate and evidence-based process has been applied to identify a portfolio of options that collectively manage water supply risk over the planning horizon. The appendix supports the conclusions set out in the main WRMP report and should be read alongside the supply-demand assessment (Appendix A), environmental appraisal (Appendix D) and institutional enablers (Appendix C).

This appendix distinguishes between strategic options subject to comparative appraisal and other interventions that are considered low regret, enabling or baseline actions and are therefore not included in the formal options ranking.

### **B.3 The process of options appraisal**

A wide range of options have been developed and assessed to understand how the forecast future supply deficit can be addressed. As per UK best practice the options appraisal has been undertaken using a staged approach, in which a long list of options is progressively screened and developed to create a shortlist of options which are carried forward into the WRMP. This process is shown in Figure .

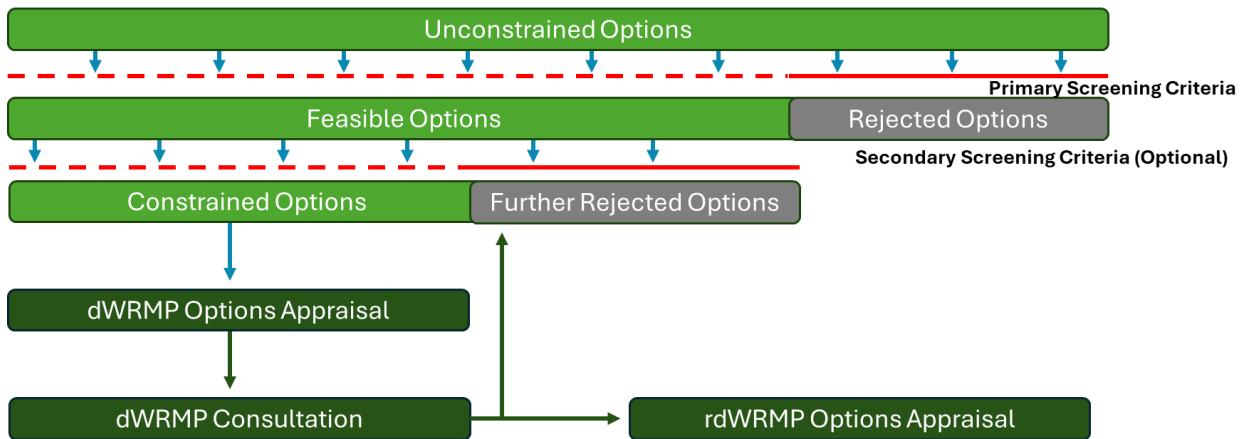


Figure B-37: WRMP options appraisal process

## B.4 Best value planning

The purpose of the appraisal was not to select “one solution”, but to develop a portfolio of interventions that collectively manage risk across a wide range of future conditions. This is particularly important for St Helena where uncertainty is high (climate variability, small population changes, data limitations), and where major infrastructure investment must be proportionate, scalable and affordable.

This approach is consistent with best value planning, which seeks to provide the required level of resilience and service at the lowest whole-life cost, while accounting for environmental, social and deliverability constraints. Best value planning involves choosing options based on a variety of metrics which can include economic cost, environmental impact, customer popularity, biodiversity net gain, generational equity and innovation. There are no fixed metrics to use,

The options appraisal was designed to support an adaptive pathway approach (as illustrated in Figure B-38), in which:

- Low-regret actions are progressed immediately because they are beneficial in almost all futures
- Short-term options address emerging deficits and operational vulnerabilities within the next few years
- Medium-term options are triggered if adverse climate or demand conditions begin to materialise
- Long-term strategic options are retained as a safety net for worst-case futures.

Adaptive planning allows consideration of multiple preferred plans/options. The adaptive plan sets out how decisions will be made between these plans.

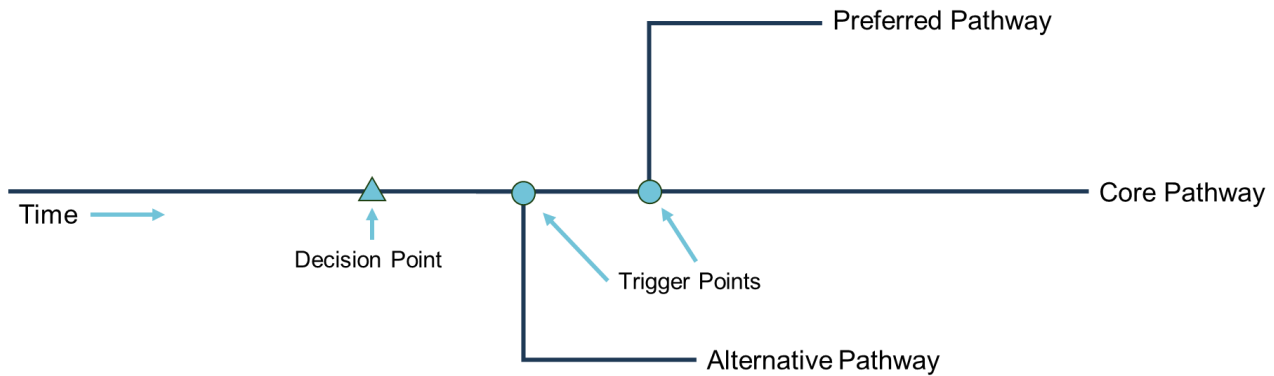


Figure B-38: Adaptive planning approach

## B.5 Options identification and long list screening

### B.5.1 Identification of long list options

The initial long list of options was developed through:

- Baseline system assessment and stakeholder engagement (SHG, CSH and other partners)
- Review of previous technical studies (including groundwater investigations and Cloud Forest evidence)
- Identification of operational constraints and vulnerabilities (e.g., limited storage buffers, high leakage, treatment limitations after heavy rainfall)
- Consideration of solutions used in comparable island settings and UK WRMP practice as standard.

The initial long list of options is given in Table B-15.

Table B-15: Initial long list of options considered for St Helena

Option category	Option type	Long-list options considered	Primary purpose
Demand management	Customer behaviour and efficiency	Water efficiency advice and campaigns; promotion of water-saving devices; targeted engagement for high-use customers	Reduce demand; defer supply investment
	Metering and tariffs	Universal metering; smart metering; revised tariff structures; scarcity or drought tariffs	Improve efficiency; demand control
	Rainwater harvesting	Rainwater harvesting for new developments; retrofitting existing buildings; community and public-building pilots	Reduce potable demand; drought resilience
Distribution and Leakage	Leakage reduction	Active leakage control; pressure management; mains replacement; customer supply pipe leakage	Recover existing supply; resilience
	Network monitoring	District metered areas; enhanced telemetry; reservoir drawdown monitoring	Improve operability and control
Operational & treatment	Treatment optimisation	Process optimisation; sediment management; wash water reuse; treatment upgrades	Improve yield reliability; water quality



Option category	Option type	Long-list options considered	Primary purpose
	Operational rules	Revised operating rules for reservoirs and transfers; earlier drought interventions	Improve resilience without new assets
Surface water supply	New or enhanced abstractions	New stream intakes; optimisation of existing abstractions; winter flow capture	Increase supply availability
	Raw water transfers	Inter-catchment or inter-zone raw water transfers	Improve system flexibility
Groundwater supply	Borehole development	New boreholes; rehabilitation of existing boreholes; increased use of historic boreholes	Increase supply diversity
	Conjunctive use	Coordinated surface-groundwater operation	Improve drought resilience
Storage	New storage	New reservoirs; off-line storage; tank storage	Increase buffering and resilience
	Storage enhancement	Raising existing dams; expanding reservoir capacity; operational storage re-use	Improve local and system resilience
Connectivity	Treated water transfers	Enhanced inter-zone connectivity; strategic transfer pipelines	Improve system-wide resilience
Water reuse	Non-potable reuse	Reuse for irrigation, construction, public buildings	Reduce potable demand



Option category	Option type	Long-list options considered	Primary purpose
	Indirect reuse	Blending with raw or treated water (where appropriate)	Strategic drought resilience
Desalination	Permanent desalination	New permanent desalination plant	Strategic drought supply
	Temporary / modular desalination	Emergency or modular desalination units	Emergency resilience
Catchment & nature-based	Catchment management	Land management; erosion control; recharge protection	Improve water quality and sustainability
	Nature-based solutions	Cloud Forest restoration; fog/mist harvesting; small retention features	Long-term resilience
Agricultural water	Efficiency and sharing	Efficient irrigation; agricultural storage; shared infrastructure	Reduce pressure on public supply
Drought & emergency	Emergency measures	Tankering; temporary abstractions; emergency treatment	Short-term drought response
	Demand restrictions	Temporary use bans; staged restrictions	Protect supplies during drought
Innovative / unconventional	Novel concepts	Offshore storage; alternative capture methods; emerging technologies	Completeness and due diligence

### B.5.2 Screening approach

Each long list option was qualitatively and quantitatively assessed against a set of screening criteria. The screening process was used to:

- Remove options with poor feasibility or disproportionate cost.
- Group related options (e.g., groundwater as a family of staged interventions)
- Identify combinations that provide better value than standalone measures.

A comprehensive set of evaluation criteria were developed which aligned with the key objectives of the water resource management plan. A value from 0-5 was assigned for each metric, with 0 being the lowest rating and 5 the highest.

The metrics were then ranked from most to least important based on a combination of engagement with SHG and CSH, and best judgement. Each metric was then weighted using the Rank Sum weighting method<sup>3</sup>, in which the weighting applied to the scores for each metric are proportional to the rank of that metric in relation to all the metrics. The metric descriptions, rankings and weightings are presented in Table .

Table B-16: Options screening metrics, with descriptions, ranks and weights

Metric	Description	Rank	Weight
Infrastructure Requirements	Physical infrastructure needs for each option to determine feasibility and potential costs.	3	0.13
Water Resource Benefit	Yield	1	0.15
Climatic Suitability	Considering the local climate conditions and how well they align with the operational requirements of the option.	12	0.01
Environmental Impact	Potential environmental consequences of implementing the option, aiming to minimize negative effects.	10	0.04
Synergies with Other Initiatives	Potential to complement or enhance other projects and initiatives.	7	0.08
Time of implementation	Time required from inception to implementation.	5	0.10
Biodiversity Impacts	Effects on local biodiversity and ecosystem service	11	0.03
Community Acceptance	The level of support or opposition from the local community, considering the option's impact on their quality of life, health, and economic prospects.	9	0.05

<sup>3</sup> Ezell, B., Lynch, C.J., & Hester, P.T. (2021) 'Methods for Weighting Decisions to Assist Modelers and Decision Analysts: A Review of Ratio Assignment and Approximate Techniques.', *Applied Sciences*, 11(21), 10397.

Metric	Description	Rank	Weight
Costs	The financial investment required for implementation and ongoing maintenance of the option.	2	0.14
Operational Complexity	Intricacies involved in managing and maintaining the option, including technical, logistical, and administrative aspects.	4	0.12
Scalability	The potential for the option to be expanded or adapted in size and capacity to meet future requirements or opportunities.	6	0.09
Energy Requirements & Carbon Footprint	Analysis of the amount and type of energy needed to operate the option and how this demand will be met sustainably.	8	0.06
Infrastructure Requirements	Physical infrastructure needs for each option to determine feasibility and potential costs.	3	0.13
Nature-Based / Low-Carbon	The extent to which the option uses natural processes and avoids carbon-intensive infrastructure	13	0.03
Carbon Footprint	Contribution to greenhouse gas emissions and climate impact.	14	0.02
Environmental Co-Benefits	Provision of environmental co-benefits such as erosion, invasive species, habitat recovery, or groundwater quality.	15	0.02
Scalability	The potential for the RO to be expanded or adapted in size and capacity to meet future requirements or opportunities (e.g. new funding or knowledge).	16	0.01

Each long-listed option was then assigned a value for each metric. At this stage values were assigned based on best judgement, applying knowledge from existing schemes and understanding of the local context in which the options sit. The total score of the option, taking into account metric weightings, was used to rank the options from highest to lowest overall score.

### B.5.3 Findings of the Multi Criteria Analysis (MCA)

The results of the MCA show that demand-side management and behaviour-change options (metering, tariffs, conservation advice and water-saving devices) consistently perform best in comparison to other options because they are low cost, low energy and quick to implement. The drawback of these options is that they do not deliver much in terms of water resource benefits, as they are aimed at changing behaviour. Therefore, the benefits they deliver are relatively low and uncertain. Catchment management and other

nature-based solutions also perform well, as they have high scores for environmental impact, biodiversity and community acceptance as well as being relatively low cost and scalable. However again these options deliver relatively small and uncertain water resource benefits.

Leakage reduction and efficiency measures have high scores, as they deliver reliable water resource benefits while being comparatively affordable and operationally manageable, without having large infrastructure requirements. In contrast, capital-intensive supply options such as new reservoirs, desalination, tankering and advanced treatment score poorly overall because their high energy demand, cost, infrastructure complexity and long delivery times outweigh their yield benefits in an island context.

The MCA suggests that options should be prioritised as demand-first, leakage-focused and nature-based, with more expensive supply options retained only as long-term or emergency contingencies as required.

## **B.6 Further refinement of the options list**

The long list of options have been refined to capture more local solutions relevant to St Helena, screening options that perform poorly in the above MCA or are considered disproportionate to the island's needs.

The suggested options are as follows:

- Cloud Forest Restoration
- Catchment Management
- Sustainable Land Management
- Optimising System Connectivity
- Demand Management (e.g. metering, tariffs)
- Leakage Reduction (smart detection, pressure mgmt.)
- Strategic Storage Expansion (tanks/reservoirs)
- Link with Wastewater/Flooding/Energy Strategies
- New Reservoirs (e.g. Levelwood or Redhill)
- Upgrade Harpers 2 Dam
- Groundwater Recharge Schemes
- Reuse Existing Groundwater Boreholes
- Use of Private Supplies (e.g. Solomons)
- Bulk Water Imports (Tanker or Barge)
- Universal Smart Metering

## **B.7 Feedback on options screening**

The options above were presented to SHG, CSH, ENRP and the FCDO for review and comment, before selection of the shortlist of options to be taken forward for more detailed assessment provided. Their views are summarised below.

Overall, stakeholders were supportive of the proposed demand management options and the expansion of storage options (particularly the upgrade of Harpers 2 reservoir) for their potential to have both short-term and long-term beneficial impacts, whilst remaining low cost. They were also supportive of the nature-based solutions proposed such as fog capture and groundwater recharge schemes. It was noted that these schemes should align with the work being carried out by the Cloud Forest Project.

Further options were proposed with regards to water reuse and efficiency. Rainwater harvesting and greywater reuse were suggested for households and community buildings, with a suggestion of a pilot at St Paul's Primary School. Other options proposed were training in leakage detection and water treatment and amendments to tariffs to incentive responsible water use.

CSH prioritised options focussing on demand management, leakage reduction, strategic storage expansion, wastewater reuse and reuse of existing groundwater boreholes. They also proposed additional options for increasing monitoring of reservoir drawdown and accounting for additional volumes required from the system for fire suppression.

## **B.8 Options shortlist**

Based on the MCA and stakeholder feedback, an options shortlist was produced for progression into options appraisal. This options shortlist is presented and outlined in Table B-17.



Table B-17: Options shortlist

Type of option to model	Option Number	Details	Location
Storage	1	New reservoir (agricultural land sacrifice) and pipeline for connectivity	Longwood
Storage	2	Storage (pond/tank expansion) and pipeline for connectivity	Longwood
Storage	3	Harpers 2 raise	Harpers Valley
Storage	4	Additional dam in cascade to existing	Levelwood
Demand management	8	Rainwater harvesting	New build areas (Half Tree Hollow, Bottom Woods) + retrofitting older buildings
Demand management	9	Leakage reduction	Island-wide
Demand management	10	Rainwater harvesting	New build areas + retrofit
Nature based	11	Catchment management including cloud forest restoration	Peaks/Green Heartland ridges
Wastewater re-use	12a	Non-potable reuse	Half Tree Hollow
Wastewater re-use	12b	Next to prison	Bottomwood/Longwood area near the new prison site
Groundwater	13	Borehole re-use (fractured aquifer)	Molly's Gut
Groundwater	14	Borehole rehabilitation	Frenches Gut (Lemon Valley)
Groundwater	15	Borehole rehabilitation / limited expansion	Iron Pot (Lemon Valley)



Type of option to model	Option Number	Details	Location
Groundwater	16	Borehole rehabilitation	Dry Gut (BHDG5)
Connectivity	19	Enhancing connectivity	Jamestown/Redhill and Hutts gate with Redhill
Desalinisation	20	New desalination plant	Youngs Valley/Breakneck Valley

The shortlist intentionally spans multiple categories because no single option can address the forecast risks in isolation. Some measures primarily improve resilience and operability or address other key problems currently impacting the supply system rather than increasing supply. Options have been aligned to help achieve the targets outlined within the St Helena Water Strategy. The sections below give more details on these options.

### B.8.1 Reservoirs

Reservoir storage options have been shortlisted to improve drought resilience and operational flexibility by increasing buffering within the system, rather than to materially increase long-term yield. The WRMP focuses on enhancement of existing storage assets and proportionate new storage where deliverable, with options phased according to complexity, cost and risk.

The principal reservoir interventions considered are:

- Longwood storage (expansion and new storage): The Longwood area has been identified as suitable for additional storage based on advice from the reservoir supervising engineer. The land is relatively flat, access is good, and there is local capability to undertake construction works. Options include incremental expansion of existing agricultural storage and, in the medium term, construction of a new reservoir. These options are considered comparatively straightforward from an engineering perspective and scalable, with lower delivery risk than more constrained sites.
- Harpers system additional storage: This option primarily involves restoring lost capacity at Harpers 2 reservoir through works associated with dam safety and seepage mitigation. The indicative costs for this option assume that storage gains are achieved mainly through works to the existing Harpers 2 asset. There is also potential for limited additional downstream storage within the Harpers system, which could deliver further resilience benefits but would require additional civil works and would likely increase overall costs. These downstream options have therefore not been developed in detail at this stage.
- Levelwood additional storage: Additional storage at Levelwood has been identified as a potential medium-term option to address very limited local buffering. The site is constrained and would require more complex engineering, including integration with upgrades to the Levelwood Water Treatment Works. As a result, this option is considered higher risk and more costly relative to the scale of benefit and is retained as a medium-term intervention only.
- Potential storage downstream of Grapevine Gut reservoir was raised during the latest public consultation. This option has emerged too late in the current WRMP cycle to be assessed proportionately and is therefore treated as a longer-term strategic option to be explored in future plan reviews or feasibility studies.

Overall, the reservoir strategy prioritises incremental and lower-risk storage enhancements in the near to medium term, while safeguarding more complex or higher-cost options for future consideration if required.

### B.8.2 Demand management

Demand management options have been shortlisted to reduce pressure on the potable water supply system, improve drought resilience and defer the need for more capital-intensive supply-side interventions. These options perform strongly in the MCA and stakeholder engagement due to their affordability, deliverability and compatibility with a wide range of future scenarios.

The shortlisted demand management interventions include:

- **Leakage reduction (island-wide):** Leakage reduction is a core component of the WRMP demand strategy and focuses on recovering existing supply through active leakage control, pressure management, improved monitoring and operational practices. While the absolute water resource benefit is uncertain and incremental, leakage reduction improves system resilience, reduces operational stress during drought and represents good value under all futures.
- **Rainwater harvesting for new developments:** Rainwater harvesting in new build areas is proposed as a policy-led measure, implemented through planning and building control mechanisms. This option reduces growth-related increases in potable demand and improves household-level resilience during dry periods. It is considered a low-regret intervention as systems can be incorporated efficiently at construction stage.
- **Rainwater harvesting retrofitting of existing properties:** Retrofitting rainwater harvesting systems to existing buildings is included as a voluntary, incentive-led option. Uptake is expected to be partial and phased, reflecting affordability, willingness to participate and practical constraints. While individual benefits are modest, collective uptake can contribute meaningfully to demand reduction and drought resilience.
- **Household and building demand savings:** Complementary to the above, the fitting of basic water-efficiency devices in households (such as low-flow shower heads, tap aerators, cistern displacement devices and efficient fittings) has been identified as a low-regret demand management measure. These devices:
  - are low cost and quick to deploy;
  - deliver immediate and persistent reductions in household water use;
  - reduce peak demand and drought vulnerability;
  - lower abstraction, treatment and pumping requirements; and
  - reduce operational stress during periods of poor raw water quality.

International and UK experience indicates that such measures typically deliver 5–10% reductions in household demand, depending on baseline usage and uptake levels. While

the precise saving achievable on St Helena is uncertain, even modest reductions deliver meaningful system-wide benefits given the island's constrained storage and treatment capacity. Household water efficiency devices are not relied upon to close long-term deficits on their own, but reduce pressure on the system, improve drought resilience and defer higher-cost supply interventions.

### B.8.3 Cloud forest restoration

Cloud Forest restoration does not provide immediate deployable water supply and is not relied upon to close forecast supply-demand deficits within the planning period. Instead, it contributes to long-term system resilience through:

- Improved interception of cloud moisture and rainfall
- Enhanced infiltration and reduced rapid runoff
- Reduced sediment mobilisation and associated impacts on raw water quality and infrastructure
- Increased resilience of catchments to climate variability

These benefits are cumulative and increase over time, complementing other measures in the preferred plan.

Cloud Forest restoration is inherently a long-term, phased intervention. For WRMP appraisal purposes, the option has been assessed over a 25 to -30-year planning horizon, consistent with the wider water resources planning framework, while recognising that benefits will extend beyond this period.

Delivery is assumed to take place in the following broad phases:

- Phase 1 - Ongoing delivery and consolidation (Years 0 to -5): continuation of existing restoration activities, including targeted planting, assisted regeneration, access control, erosion management and baseline monitoring.
- Phase 2 - Expansion and adaptive management (Years 5 to -15): scaling up restoration in priority areas informed by monitoring, with continued invasive species control and maintenance of earlier works.
- Phase 3 - Long-term stewardship (Years 15 to -30+): ongoing management and protection of restored areas to safeguard benefits and prevent degradation.

### B.8.4 Wastewater reuse

A separate study to this is looking at upgrading the current wastewater treatment works and systems on St Helena, which presents opportunities to reuse treated wastewater for non-potable uses. Non-potable wastewater reuse, often called reclaimed water or water recycling, is the practice of treating used water to a standard safe for specific activities that do not require drinking-quality water. This water can be used for purposes such as irrigation or for Urban and domestic use, supplying water for toilet flushing, laundry, car washing, and street cleaning.

The volumes of water that are available are small however wastewater reuse can provide a reliable, locally controlled supply that remains stable even during water restrictions. Re-using water locally often consumes less energy than pumping freshwater and reduces pressure on treated water systems by reducing the amount used for purposes for which it is not required. In addition, diverting wastewater in this way reduces the volume of effluent discharged into sensitive ecosystems. Reclaimed water is typically priced lower than potable water, providing a financial incentive for industrial and commercial users.

The proposed wastewater re-use schemes that have been considered under the WRMP are:

- Half Tree hollow water recycling- this is localised option that would use treated water for irrigation/amenity use in the half tree hollow area. The water would be distributed using a van tanker at regular intervals
- Bottom woods water recycling- The millennium forest project relies on greywater/stormwater tanks at Bottoms wood for irrigation of new trees. At present they receive water from the current tank system, however this is due to be replaced as part of the new prison project. This highly localised option therefore looks at constructing a stormwater collection pond on the new prison site. Collected storm water or treated effluent from the prison could be used to feed the Millenium forest via gravity. Remaining volumes could be distributed in the Longwood /Bottomwood area via a van tanker.

#### B.8.5 Groundwater options

Boreholes can provide an additional source during peak demand or drought, reducing pressure on surface water systems. They are particularly useful as a contingency measure, even if they cannot provide large volumes on a sustained basis. Reusing existing groundwater boreholes offers a relatively low-cost and practical option to supplement supply, particularly during dry periods. Compared with major new infrastructure, these costs are modest though there would be associated pumping and energy costs.

However, during work undertaken under the Cloud Forest project (DPLUS103), inspection of the 15 deep boreholes drilled by WSP in 2017 showed that most were 'losing' water, meaning the boreholes had pierced an impermeable geological boundary. As a result, groundwater from upper layers drained downwards into deeper formations. The deep drilling targeted the unconformity between the Middle and Upper Shield volcanics, which includes a basal tuff layer. Drilling too close to this boundary likely punctured this impermeable tuff, creating downward leakage pathways.

Anecdotally it is known this has occurred on the island in the past, where explorative deep drilling has caused the draining of shallow aquifers used for supply. Typical examples where these deep boreholes are responsible for the interception of the shallow groundwater within a perched aquifer are Molly's Gut and Ladies Bath. Ladies Bath became dry as did the boreholes of Molly's Gut, as the perched aquifers were punctured, allowing shallow groundwater to leak into the deeper aquifer system.

Groundwater has therefore been retained as a grouped, staged option set because it has potential to provide resilient supply, however the yields and sustainability of these supplies are uncertain and further testing and monitoring is required to better understand the supply available from these sources. The approach taken forward is therefore adaptive:

- Rehabilitation/re-use of existing boreholes (where evidence suggests potential and where asset condition allows)
- Further investigation and development of fractured aquifer resources, subject to phased hydrogeological assessment and pumping tests.

Groundwater options are therefore retained for appraisal where data allows, with progression contingent on evidence and funding. Borehole remediation (fixing and relining currently operating boreholes which are damaged/leaking) in particular is a significant need on the island, to prevent loss of this essential freshwater resource to the sea. This is particularly relevant given its strategic importance in managing and mitigating drought. Progressing this option in particular is recommended.

### B.8.6 Desalination

St. Helena, as an island in the Atlantic is surrounded by sea water. Under the WRMP potential sites for desalination have been scoped including Youngs Valley or Breakneck Valley which would allow water to be fed into Redhill and Jamestown supply zones. Desalination therefore offers a plentiful supply which is drought resilient, but it is expensive to process sea water to potable standards, using large volumes of electricity, and unless renewable power generation is used, it also has a high carbon cost. Careful consideration also needs to be given to the disposal of the byproducts of desalination (e.g., Brine) to ensure it does not impact on marine biota. Due to the high costs, despite being a reliable resource, desalination is probably best suited as an occasional drought supply. The issue with this however, is that often desalination plants do not perform well when mothballed and will often breakdown, meaning they cannot be used within a drought. They also require high amounts of specialised maintenance. However, desalination technologies are evolving in line with increasing global need and therefore these drawbacks may change in future as this sector evolves. For this reason, desalination has been retained only as a long-term option, providing a safety net against severe or worst-case futures.

## B.9 Options Appraisal

### B.9.1 Introduction

More detailed options appraisal was carried for shortlisted options to evaluate their water resources benefits, costs and environmental impacts. This was used to show whether shortlisted options had a sufficient water resource benefit to be implemented and to ensure that they are financially and environmentally feasible.

### B.9.2 Water resources benefit assessment

## Introduction

Quantification of the benefits to water resources from supply and demand-side options has been done using the St Helena water resources model. As a worst-case scenario, the model with tanks not represented has been used to assess options, using the expected demand in 2065.

Each option was modelled individually and run to assess the impact on:

- The system deployable output (if applicable)
- Local reservoir storages (average and during the 2019/2020 drought event)

The methodologies for modelling and assessing each option are detailed below, including any associated assumptions and uncertainties. Not all options have been modelled, due to high uncertainties associated with the potential benefits or as the option is not intended to improve supply.

## Modelling details

Details of how the options have been modelled within the water resources model are outlined in Table B-18.

Table B-18: Options modelling details

Option	Details
1 & 2	<p>Only the new reservoir option has been modelled, with the expectation that similar gains in storage can be gained from each option. A new reservoir with a capacity of 20,000 m<sup>3</sup> has therefore been added to the model, connected with the other reservoirs in the Longwood group. The reservoir receives overflow from Hutts Gate reservoirs, which is the current source of supply to the existing longwood reservoirs. The additional stored water is then fed back to Hutts gate for treatment and distribution and treatment. Currently the longwood reservoirs are only used for public water supply when required in drought. The rules on this back transfer have therefore been relaxed to be used on an as needed basis (Note: the model still uses the existing gravity fed supplies and boreholes as a priority). The following assumptions have been made under the modelling:</p> <ul style="list-style-type: none"> <li>• No space/area constraints in creating or expanding new reservoir storage. This will require some sacrifice of agricultural land.</li> <li>• Infrastructure that supports back transfer of water is suitable for more frequent use.</li> <li>• The main purpose of the reservoirs is still for agricultural use.</li> </ul>
3	<p>The option has been modelled in a simplistic way by increasing the storage in Harpers 2 from 24,500 m<sup>3</sup> to 30,000 m<sup>3</sup>. It has been assumed that all other inflows and operations remain the same.</p>
4	<p>The reservoir capacity has been set as half of the current capacity 1,130 m<sup>3</sup> and uses the existing supplies available to fill the reservoir. It is assumed no other operational rules would change.</p>

Option	Details
9 & 10	These demand-side options have been modelled in Aquator as a 20% (respectively) reduction in demand at every demand centre in the model.
19	A constant supply of 500 m <sup>3</sup> /day has been modelled feeding into Scotts Mill reservoir. A cost has been added to this supply to ensure the model will only prioritise this source in drought.
20	This option has been modelled removing all constraints on transfers to allow the model to move water

### **Modelling results- deployable outputs analysis**

Deployable Output (DO) analysis has been carried out on the supply-side options detailed above. The analysis has been carried out using the St Helena water resources model.

The assessment of DO involves estimating the volume of water that can be supplied to demand centres without a failure occurring, while accounting for system constraints. Using the historical timeseries for the model, the occurrence of failures at different demands can be expressed as a 'Return Period' which indicates the chance of the system failing in a given period. These return periods are linked to the systems required level of service which for St Helena is a 1 in 100-year (i.e., a 1% chance of a disruption to supply in any given year). To avoid repetition, a more detailed description DO is provided in the main St Helena WRMP report and in Appendix A.

The St Helena water resource model DO is not particularly sensitive to changes in model configuration. DO runs have therefore been carried out by removing some of the constraints and operating rules on transfers between the different treated water zones, in order to show impacts on DO.

Changing the demand does not impact on model DO, therefore only the modelled supply side options were included in this assessment. The Supply-side Options involved in DO assessment were as follows:

- Option 2: New Reservoir at longwood group (agricultural land sacrifice)
- Option 3: Raising storage levels on Harpers Valley
- Option 4: Additional reservoir at Levelwood
- Option 19: Desalination plant
- Option 20: Enhanced connectivity

The 100-year DO of the options has been compared against the baseline DO and is ranked in terms of benefit. These are shown plotted in Figure B-39Figure below, to show how the options compare.

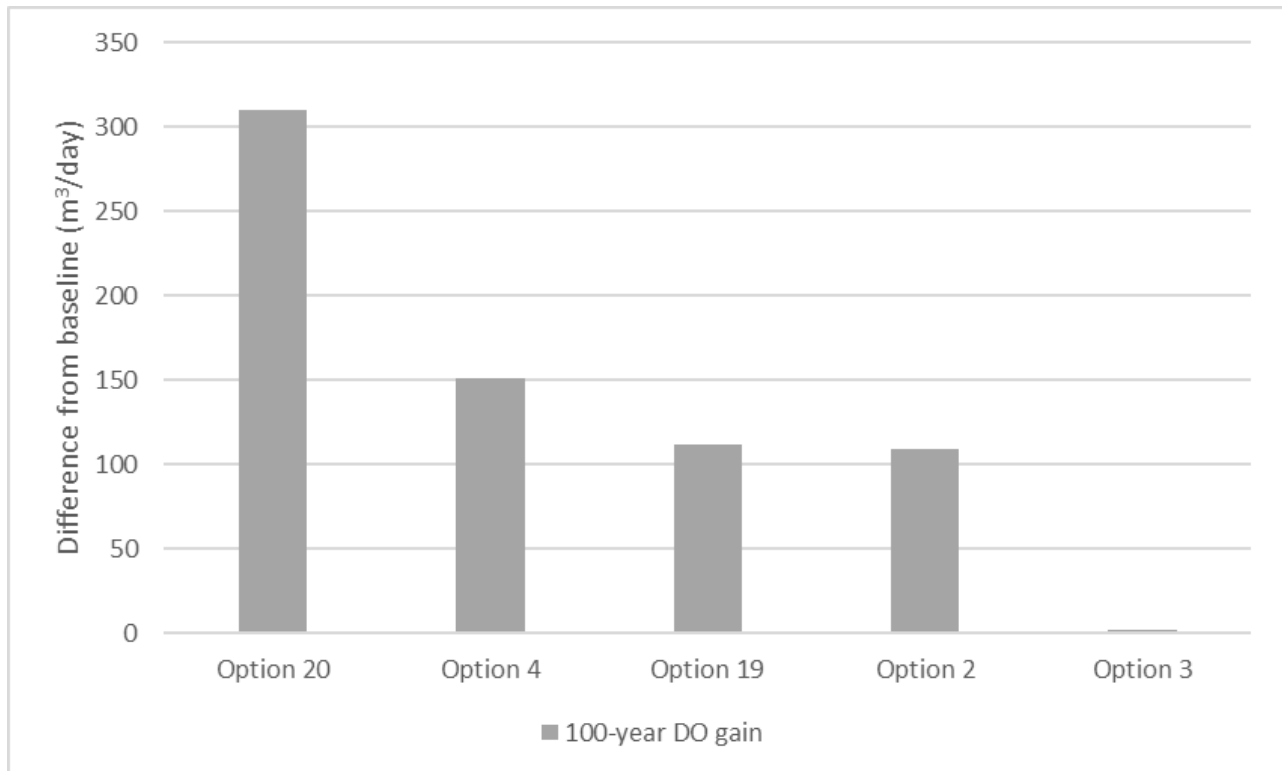


Figure B-39: Estimated increase in DO from the baseline for each option

The deployable outputs (DO) analysis indicates that at higher return periods, the modelled DO is only marginally affected by the additional or enhanced supply provided by any of the supply-side options. When compared with the baseline total island demand of approximately 1,400 m<sup>3</sup>/day, it is evident that none of the options deliver anywhere near an extra day of resilience at the required level of service. This is largely because many of the options are small-scale and local in nature, limiting their influence on the wider supply system. Furthermore, drought impacts in some years, particularly in Redhill and Jamestown, are severe, and incremental improvements do little to prevent system failures during these periods. Overall, the baseline system has very limited additional water available during severe droughts, even when existing sources are used more proactively.

The DO modelling has been done assuming that there is enhanced connectivity from east (Hutts Gate) to west (Redhill), but not for the reverse as this does not currently exist. The system DO may therefore be limited, as benefits on the west side do not get transferred across and the model starts to fail to meet demand on the east side, particularly as more water is being transferred out of the zone.

Within the context of these marginal increases it appears that the greatest benefits come from having enhanced connectivity across the whole system. This is an interesting finding as this is the only option modelled that has no additional supply but relies more on moving existing water supplies around as and when it is needed, keeping reservoirs and storages fuller for longer. This suggests that more active operation of sources and supplies (i.e., not waiting for reservoirs to hit 50% before activating drought management measures), may have good benefits in terms of supply resilience.

Option 4 (increasing storage in Levelwood) has the second highest benefits in terms of DO increases. This suggests that within the context of enhanced connectivity, it is Levelwood that is constraining the available supply. This is to be expected given that it has limited storage and resource. Increasing the available storage in this zone therefore has relatively high benefits on system DO.

Option 2 (New/Expanded storage in Longwood) and Option 19 (Desalination) deliver similar benefits in terms of DO. The impact of the new reservoir on DO may be constrained by the need for transfer of water between Longwood to Hutts Gate then Hutts Gate to Redhill and Jamestown. The DO increase from Option 19 is constrained by the lack of water transfer from east to west, leading to the model DO being constrained by demand failures on the west side. Option 3 leads to very little benefit in terms of DO. This is to be expected, as it is more of a resilience option than a supply option.

### **Modelling results - impacts of options on reservoir storage**

Given the number of constraints associated with the DO on St Helena, reservoir storage metrics have therefore been calculated to demonstrate any more local benefits which may not be realised as part of the DO modelling. These have been calculated for the individual groups of storages at Hutts Gate, Longwood, Redhill and Levelwood as well as the total storage on the island. The benefits in terms of additional storage have been assessed for:

1. Change in the average monthly reservoir storage compared to baseline over the entire modelled period
2. Change in the absolute average and minimum reservoir storage during the 2020 drought event compared to baseline.

The change in storage has been expressed in terms of additional days supply, to contextualise the changes and allow comparison between zones. This has been done by calculating the gain in storage then dividing it by the present-day modelled demand. These demands are given in Table .

Table B-19: Demands used to estimate benefits from options (present day). Longwood demand is estimated as Agricultural demand plus Hutts Gate as can feed both demand centres.

Reservoir group	Demand (m3/day)
Total storage	1420
Hutts Gate	480
Longwood	570
Redhill	440
Levelwood	110

The additional storage benefits are shown on Table . The highest gains in additional modelled storage come from Option 2. This is to be expected as under this option there is

an additional 20,000 m<sup>3</sup> available for use. This therefore results in the largest gains to storage on both a local scale and a system scale.

Table B-20: Additional days of average monthly storage provided by each option compared to baseline

Option	Total	Hutts Gate	Longwood	Redhill	Levelwood
Option 2	14	0	36	0	0
Option 3	4	0	0	12	0
Option 4	1	0	0	0	10
Option 9	2	1	1	4	1
Option 10	2	1	1	4	1
Option 19	3	0	0	11	0
Option 20	1	1	1	1	1

As to be expected, options that enhance local resilience provide the most benefit at an individual resource zone scale. For example, Option 3 and Option 19 have the highest impact on Redhill in terms of additional days storage and Option 4 has the highest impact on Levelwood storages, giving an average of 11-days additional supply. None of the options have a significant impact on Hutts Gate storages, likely due to the limited size of the reservoirs and strict controls on the supplies and demands that can be used to fill and empty these reservoirs (i.e., if an option draws down the reservoirs, then more supply is used to fill the reservoirs).

The storage benefits during the 2020 drought are shown in

Table . This shows that Option 19 (desalinisation) has the biggest impact on total reservoir storages, due to the significant improvement in Redhill storages both on average and minimum storages. The model results indicate that minimum storages would be significantly improved, allowing for an additional 131-days of storage from the baseline. This essentially suggests these reservoirs are not drawn down at all. This indicates that, as previously stated, the addition of a drought resistant supply at Redhill would have significant benefits at both a local and system scale. Option 2 and Option 19 also improve significantly on days' supply on a local and system level. This shows that while they may not have a significant impact on DO, they do have significant resilience benefits.

Table B-21: Additional number of days' supply in storage during 2020 drought event, expressed in terms of average storage throughout the event and minimum storage during the event

Option	Total storage		Hutts Gate		Longwood		Redhill		Levelwood	
	Ave.	Min.	Ave.	Min.	Ave.	Min.	Ave.	Min.	Ave.	Min.
Option 2	16	14	2	-1	38	51	0	0	-1	0
Option 3	2	0	-1	0	0	1	6	1	0	0
Option 4	0	0	0	0	0	0	0	0	11	0
Option 9	5	7	1	2	2	12	13	23	12	0
Option 10	5	7	1	2	2	12	13	23	9	0
Option 19	19	37	-1	0	0	5	60	131	0	0
Option 20	9	21	6	14	3	16	17	51	23	20

Reducing demands (Options 9 and 10) also has a good impact on system storages, particularly in terms of total storage (7-additional days at minimum) and locally at Redhill and Levelwood. Options 3 and 4 (additional storage) have impact at a local level on average storages but not minimum storages. This is likely due to the limited storage these provide, however the impact on average storage shows that these options have benefits during reservoir drawdown and refill, but do not significantly improve the supply available at minimum storage (i.e., you get to the same position, but it takes longer and recovery is faster).

### **Discussion**

The water resource benefits analysis has demonstrated that the St Helena water supply system has significant interdependencies as well as local challenges and stresses, which makes quantifying water resource benefits using only deployable output as an indicator inappropriate. Examining the impacts on reservoir storages (average, and over a key drought periods), has given a much clearer view on the benefits of the different options at a more local level and a system level. A key conclusion from the water resources benefit assessment is that no single option in isolation can address the supply demand imbalance on St Helena. Instead, a combination of options working cohesively at a local level is required to address these issues. In addition, while benefits can be realised to storages, the means of getting and transporting the water to where it is needed in order to address projected future demand deficits. This can be realised operating the existing system more proactively and making use of existing supplies without adding additional resilience.

## B.10 Options shortlist ranking

The water resources benefits assessment along with the cost assessment in Section B.12 has been used within a final ranking of the options.

A comprehensive set of evaluation criteria were developed which aligned with the key objectives of the water resource management plan. A value from 0-5 was assigned for each metric, with 0 being the lowest rating and 5 the highest.

The metrics were then ranked from most to least important based on a combination of engagement with SHG and CSH, and best judgement. Each metric was then weighted using the Rank Sum weighting method<sup>4</sup>, in which the weighting applied to the scores for each metric are proportional to the rank of that metric in relation to all the metrics. The metric descriptions, rankings and weightings are presented in Table B-22.

Table B-22: Options screening metrics, with descriptions, ranks and weights

Metric	Description	Rank
Infrastructure Requirements	Physical infrastructure needs for each RO to determine feasibility and potential costs.	5
Water Source Reliability (reliability of supply)	Consistency and dependability of the water source that each RO would utilize.	3
CAPEX	Capital costs of implementing option	2
OPEX (operational costs)	Operational costs of operating/maintaining option	2
Environmental and Biodiversity Impact	Potential environmental consequences of implementing the RO, aiming to minimize negative effects.	8
Water Resource Benefit	Yield	1
Synergies with Other Initiatives	Potential to align with or build on work in wastewater, flooding, energy, biodiversity, or agriculture.	12
Carbon Footprint	Contribution to greenhouse gas emissions and climate impact.	14
Operational Complexity	Intricacies involved in managing and maintaining the RO, including technical, logistical, and administrative aspects.	10

<sup>4</sup> Ezell, B., Lynch, C.J., & Hester, P.T. (2021) 'Methods for Weighting Decisions to Assist Modelers and Decision Analysts: A Review of Ratio Assignment and Approximate Techniques.', *Applied Sciences*, 11(21), 10397.

Metric	Description	Rank
Scalability	The potential for the RO to be expanded or adapted in size and capacity to meet future requirements or opportunities (e.g. new funding or knowledge).	16
Stakeholder preference	RO discussed as a preference by stakeholders	6
Deliverability / Logistical Complexity	Deliverability of RO given local workforce, materials, import limitations, or terrain	11
Nature-Based / Low-Carbon	The extent to which the option use natural processes and avoids carbon-intensive infrastructure	13
Affordability	Cost to users (bill increase)	9
Quick Win Potential	Early benefits of RO or potential to build momentum (even at small scale)	4
Resilience Contribution	Extent of increase in drought, climate, or system resilience.	7
Environmental Co-Benefits	Provision of environmental co-benefits such as erosion, invasive species, habitat recovery, or groundwater quality.	15

The findings of this more detailed MCA are equivalent to the previous assessment of the long list of options. Leakage reduction has the highest score, as it delivers reliable water resource benefits while being comparatively affordable, scalable and operationally manageable, without having large infrastructure requirements. In contrast, capital-intensive supply options such as new reservoirs relatively poorly because their high energy demand, cost, infrastructure complexity and long delivery times outweigh their yield benefits in an island context. Enhanced storage at Redhill, enhanced connectivity and rainwater harvesting also score highly, along with catchment restoration. These options are all relatively small, but are affordable and operationally manageable whilst delivering local benefits for resilience.

The MCA therefore maintains the same end message and suggests that options should be prioritised as demand-first, small and scalable while delivering local benefits for resilience, with more expensive supply options retained only as long-term or emergency contingencies as required.

### B.11 Phasing of options

The purpose of phasing is to provide a route map that prioritises actions that are beneficial under most futures, while retaining the ability to scale up investment if adverse conditions

begin to materialise. Progression between phases is guided by evidence from monitoring and review (e.g. demand trends, drought frequency, storage behaviour, and asset performance), rather than time alone so phasing has to remain flexible.

Options are grouped into the following broad phases. Individual options may be implemented progressively across more than one phase, reflecting their scalable or staged nature:

- Phase 1: Low-regret actions (2026-2028) - immediate measures that improve resilience and efficiency under almost all futures and/or address current operational vulnerabilities.
- Phase 2: Short-term system strengthening (2028-2035) - scalable, deliverable measures that improve system performance and reduce reliance on reactive drought operations.
- Phase 3: Medium-term resilience upgrades (2035-2050) - more substantial investments triggered if adverse climate or demand conditions begin to materialise and/or where asset condition requires upgrade.
- Phase 4: Strategic resilience options (post-2050) - high-cost, high-reliability contingency options retained as a safety net for worst-case futures.

## **B.12 Cost assessment**

Cost assessment within the WRMP has been undertaken to support best value planning, not to identify the lowest-cost option in isolation. In line with UK WRMP good practice, costs are considered alongside water resource benefits, environmental impacts, resilience contribution, deliverability and affordability.

The cost assessment is intended to:

- provide an order-of-magnitude understanding of capital and operational cost differences between options;
- identify options that may be disproportionate or unaffordable in the St Helena context;
- inform option sequencing and phasing within an adaptive pathway; and
- highlight where further cost refinement would be required at project feasibility stage.

### **B.12.1 Cost components considered**

Consistent with UK WRMP guidance, costs have been considered on a whole-life basis, including:

- Capital expenditure (CAPEX): Costs associated with planning, design, construction, installation and commissioning of assets or interventions.
- Operational expenditure (OPEX): Ongoing costs associated with operation, maintenance, monitoring, staffing, energy use and consumables over the asset life.

- Asset lifetime and renewal assumptions: Indicative asset lifetimes have been applied to allow comparison between short-life and long-life options.

Where appropriate, logistics and import factors relevant to St Helena have been incorporated to reflect the practical realities of delivery on an isolated island.

At this stage of planning, costs are necessarily indicative. Estimates have been derived using:

- benchmark costs from comparable schemes
- scaling to reflect option size and complexity and
- professional judgement informed by local context and delivery constraints.

In line with UK WRMP practice, cost estimates at this strategic stage should be interpreted as suitable for option comparison and screening but not suitable for procurement or investment approval without further refinement.

Uncertainty is higher for novel or site-specific options (e.g. desalination, new reservoirs), options requiring land acquisition or complex permitting, options with strong dependency on energy prices or imported materials.

This uncertainty reinforces the need for adaptive planning, rather than early commitment to high-cost options.

#### B.12.2 Rainwater harvesting - costing and assumptions

Rainwater harvesting has been appraised as a decentralised demand management intervention, suitable for reducing potable water demand for non-potable uses. Costs are presented at strategic WRMP level and are intended to be indicative and proportionate, supporting comparison with other shortlisted options rather than detailed design.

Unit costs are benchmarked against UK domestic rainwater harvesting system data and adjusted to reflect St Helena delivery conditions, including regional sourcing (e.g. via South Africa) and the potential use of enabling measures such as bulk procurement and customs or duty incentives.

A moderate uplift factor has therefore been applied to UK installed costs.

Table B-23: Rainwater harvesting indicative costs

Parameter	Assumption
UK installed cost - new build (UK prices based on professional installation)	£6,000 per system
UK installed cost - retrofit (UK prices based on professional installation)	£7,200 per system
St Helena logistics adjustment	x1.15
Adopted unit cost - new build	£6,900 per system
Adopted unit cost - retrofit	£8,280 per system
Annual OPEX	£50 per system
Asset lifetime	25 years

Rainwater harvesting is assumed to be implemented in new properties through planning and building control mechanisms. For WRMP appraisal purposes, uptake is assumed for 75 new dwellings over the planning horizon.

Table B-24: Rainwater tanks indicative costs - new properties

Cost component	Value
Number of systems	75
Unit CAPEX	£6,900
Total CAPEX	£518k
Annual OPEX per system	£50
Total annual OPEX	£3.8k
Asset lifetime	25 years
Lifetime OPEX	£94k

Retrofit uptake is assumed to be voluntary and supported by enabling measures (e.g. incentives, grants, duty relief). For appraisal purposes, uptake is assumed for 320 existing properties, representing approximately 20% of the housing stock.

Table B-25: Rainwater tanks indicative costs - retrofitting existing properties

Cost component	Value
Number of systems	320
Unit CAPEX	£8,280
Total CAPEX	£2,650k
Annual OPEX per system	£50
Total annual OPEX	£16k
Asset lifetime	25 years
Lifetime OPEX	£400k

Assumptions:

- Uptake assumptions are indicative and reflect a moderate and achievable level of adoption rather than universal rollout.
- ~1,900-2,000 households as the base housing stock. According to the 2021 Population & Housing Census for St Helena, 4,439 people living on the island in February 2021. The same census counted 1,937 occupied households on St Helena, giving an average household size of approximately 2.3 residents per household.
- Unit costs reflect regional sourcing routes and assume that procurement and policy measures can partially offset island logistics costs.
- Replacement of individual components (e.g. pumps, controls) within the 25-year lifetime is assumed to be accommodated within ongoing operational expenditure.

- Costs will be refined at future plan reviews as delivery mechanisms and funding arrangements are clarified.

### B.12.3 Reservoirs costings and assumptions

Reservoir options represent long-life strategic infrastructure and provide significant benefits in terms of buffering seasonal variability, improving drought resilience and increasing operational flexibility. However, their cost profiles vary substantially depending on site conditions, constructability, dam safety requirements, and the extent of associated infrastructure required for integration into the wider system.

Indicative costs have been developed at a strategic WRMP level and are intended to reflect the relative complexity, risk and functionality of each option rather than detailed design solutions. At this stage, cost estimates are suitable for option comparison and phasing decisions but not for procurement or investment approval.

The costing approach for reservoir options includes:

- Earthworks, embankments and lining where required
- Dam safety and spillway provisions appropriate to asset size and risk
- Inlet, outlet and draw-off structures
- Basic access and site works
- Allowance for construction supervision and commissioning

Costs exclude land acquisition (where applicable), detailed treatment works upgrades, and broader enabling measures unless explicitly stated.

### B.12.4 Nature based solution Cloud Forest restoration costing assumptions

Cloud Forest restoration is already being progressed on St Helena through ongoing initiatives aimed at protecting and restoring high-altitude native forest and associated catchment functions. These activities deliver a range of environmental and socio-economic benefits, including biodiversity protection, climate resilience, erosion control and landscape value. Within the WRMP, Cloud Forest restoration is therefore treated not as a new intervention, but as the continuation and phased enhancement of an existing programme, with water security recognised as one of several co-benefits. The option is included to reflect the role that long-term catchment condition can play in supporting sustainable water resource management alongside engineered supply and storage interventions.

Costs have been developed at a strategic WRMP level and reflect the continuation of an existing programme, rather than a single discrete capital project. Capital expenditure is assumed to be concentrated in the earlier phases, reflecting establishment and restoration works, while operational expenditure reflects ongoing management, maintenance and monitoring.

#### **Capital expenditure (CAPEX)**

CAPEX includes site preparation, planting and restoration works, erosion control measures, fencing or access management where required, and mobilisation and setup costs.

Indicative CAPEX is expected to be incurred primarily in Phases 1 and 2. Indicative total CAPEX is between £100k - £300k (phased).

### Operating expenditure (OPEX)

OPEX reflects the ongoing nature of Cloud Forest restoration and includes vegetation management, invasive species control, maintenance of physical measures, monitoring and stewardship. OPEX is assumed to continue across the full planning horizon. Indicative annual OPEX: £40k - £60k per year.

Cloud Forest restoration is included as an option within the WRMP to ensure its contribution to long-term resilience and water security is recognised alongside engineered options. However, it is not directly compared with supply options on a deployable output basis, and its implementation is not contingent on the selection of any single strategic option.

The continuation and enhancement of Cloud Forest restoration is considered compatible with a wide range of future scenarios and is well suited to phased delivery and external funding mechanisms. It therefore represents both a strategic option and a low-regret complementary action within the overall plan.

#### B.12.5 Indicative asset lifetimes used

The table below provides indicative asset lifetimes applied at a strategic level to support whole-life cost comparison between WRMP options. These values are not design lives and do not imply automatic renewal. They are used solely to contextualise costs and sequencing within the WRMP.

Indicative asset lifetimes are based on typical values used in UK WRMPs and comparable infrastructure schemes. Actual asset performance and renewal timing would depend on condition, operation, maintenance and future supply-demand requirements.

Table B-26: Indicative asset lifetimes for WRMP options

Asset / intervention type	Indicative asset lifetime (years)	Notes on use in WRMP
New reservoirs / major dams	60-100	Long-life strategic assets; high upfront cost; renewal decisions likely to be review-led rather than automatic
Reservoir upgrades / raises	40-75	Extends life of existing assets; renewal dependent on condition and performance
Water treatment works (major process assets)	25-40	Includes filters, clarifiers, mechanical and electrical plant; phased renewal likely
Pipelines / trunk mains	50-80	Dependent on material, installation quality and ground conditions
Pumping stations and major pumps	20-30	Renewal typically staged; energy efficiency upgrades may occur earlier

Asset / intervention type	Indicative asset lifetime (years)	Notes on use in WRMP
Groundwater boreholes	25-40	Highly variable; dependent on hydrogeology, abstraction regime and maintenance
Desalination plant	20-30	High energy dependency; renewal sensitive to technology change and operating costs
Leakage detection equipment	5-10	Operational tools rather than permanent assets
Customer meters	10-20	Renewal driven by accuracy, policy and technology evolution
Rainwater harvesting systems (tanks, fittings)	15-30	Dependent on materials, maintenance and use
Nature-based / catchment measures	Variable (10-50+)	Benefits may increase over time; require ongoing maintenance rather than renewal

Table B-27: Summary of shortlisted option costs

Option	Estimated CAPEX (£k)	Estimated annual OPEX (£k) with x1.35 logistics factor	Estimated lifetime (years)	Estimated lifetime OPEX (£k)
1 - Longwood New Reservoir	770*	21	75	1560
2 - Longwood Expansion	124*	3.3	75	251
3 - Harpers 2 Expansion	146	3.9	75	296
4 - Levelwood New Reservoir	751	20	75	1522
8 - Rainwater Tanks New Properties	518	3.8	25	94
9 - Leakage Reduction	114	10	10	101
10- Rainwater Tanks Retrofitting	2,650	16	25	400
11 - Cloud forest restoration (including fog harvesting)	200	4.5	10	45
12a - Water recycling Half Tree Hollow	81	10	25	253
12b - Water recycling Bottoms Wood	115	13.5	25	338
13 - Molly's Gut Borehole	69	2	30	61



Option	Estimated CAPEX (£k)	Estimated annual OPEX (£k) with x1.35 logistics factor	Estimated lifetime (years)	Estimated lifetime OPEX (£k)
16 - Dry Gut Borehole	57	2	30	61
19 - Connectivity	150	2	50	101

\* Excludes associated enabling works for water sharing of agricultural water (see section B.13).

Replacement costs have been considered in a proportionate manner. For long-life strategic assets (e.g. reservoirs, trunk mains), full replacement within the WRMP horizon is unlikely and renewal decisions would be subject to future review based on asset condition and system performance. For shorter-life assets (e.g. pumps, treatment plant, meters, rainwater harvesting systems), replacement or major refurbishment within the planning horizon has been implicitly accounted for through assumed asset lifetimes and ongoing operational expenditure.

## B.13 Low regret or enabling actions additional costing

These options were not part of the options appraisal as they are considered necessary for the water resource management on the island. Low-regret actions are not alternatives to strategic options. They are measures that deliver benefits under almost all future scenarios and reduce current operational risk, regardless of whether future demand or climate pressures materialise as forecast.

### B.13.1 Agricultural raw-water management at Longwood

Agricultural users currently abstract untreated raw water from the Longwood reservoirs using limited shared pumping infrastructure. Access is effectively unmanaged, with a single pump and no formal allocation or monitoring, resulting in a “first-come-first-served” arrangement. During periods of constraint or pump unavailability, agricultural users may revert to the domestic potable supply, increasing pressure on public water resources.

Improving the management of agricultural raw-water abstraction at Longwood is therefore considered a low-regret enabling measure, as it would reduce operational risk and demand pressure on the potable system regardless of which strategic supply or storage options are taken forward. For this reason, the measure is not included as a standalone option within the comparative options appraisal but is identified as an enabling intervention that should be progressed independently of the preferred plan.

This proposed measure includes:

- A formalised raw-water offtake from each of the Longwood reservoirs
- Dedicated pumping capacity for agricultural use (e.g. duty/standby or equivalent resilience)
- Flow metering and telemetry at the agricultural offtake
- User-level metering (e.g. per-farm or per-branch) to enable equitable allocation
- Control valves and basic regulation to support seasonal or conditional operation

The measure does not assume any change in agricultural water policy or guaranteed allocations, but provides the infrastructure required to support controlled operation in line with agreed rules. However, to successfully implement these changes a water sharing allocation study should be conducted alongside the infrastructure/engineering assessment which will facilitate fair sharing.

Indicative planning-level costs for the enabling package are:

- Capital expenditure (CAPEX): £150k - £200k
- Annual operating expenditure (OPEX): £6k - £20k per year

The indicative capital cost allowance includes provision for a range of enabling infrastructure elements required to support controlled agricultural raw-water abstraction from the Longwood reservoirs. This includes reservoir offtake works (such as chambers, screening and associated civil works, dependent on the condition of existing draw-off structures and access); dedicated pumping capacity and controls (including duty/standby arrangements, pumps, control panels and variable speed drives where required); metering

and telemetry at the agricultural offtake (including flow meters, data loggers, communications and alarms); user-level metering for approximately ten agricultural users (typically in the order of £1k-£3k per user); valves, flow regulation and physical separation measures (including isolation valves, flow control devices and backflow protection); and associated electrical works, system integration and commissioning. Farm-side distribution infrastructure is assumed to already be in place and is not included.

This is expected to deliver system-wide benefits across all futures, including:

- Reduced reliance on potable water for agricultural use
- Improved operational control and equity of access
- Reduced risk during dry periods and pump outages

As such, the measure is considered appropriate to progress as a low-regret enabling action, independent of the selection or timing of strategic supply options.

Further development of this measure would be subject to a focused feasibility and implementation study, including confirmation of operating rules, stakeholder agreements and detailed design.

#### B.13.2 Household and buildings demand savings

At this strategic WRMP stage, water-efficiency devices are costed as a programme-level intervention, rather than on a per-property mandatory rollout basis. The intent is to reflect realistic delivery through a combination of targeted installations, voluntary uptake, and integration with other programmes (e.g. meter replacement, plumbing works or property upgrades).

Indicative assumptions used for planning purposes are:

- Unit cost per household (supply and fitting of basic devices): £20–£50
- Delivery approach: targeted and voluntary uptake rather than universal rollout
- Indicative uptake: 20–40% of households over Phase 1–2
- OPEX: minimal, largely limited to programme administration
- Asset life: devices assumed to deliver benefits over 10–15 years

At this stage, costs are intentionally conservative and proportionate. The primary purpose of including this option is to recognise its strategic value and early deliverability, rather than to optimise precise cost-benefit ratios.

Water-efficiency devices are treated within the WRMP as a low-regret enabling measure, suitable for early implementation regardless of which strategic supply options are progressed. They are therefore:

- included in Phase 1 of the WRMP phasing as an early action;
- not ranked directly against major supply options within the MCA; and
- assumed to contribute to reducing baseline demand and headroom requirements over time.

The contribution of demand savings should be reviewed and refined in future WRMP cycles as uptake data, monitoring and customer engagement outcomes improve.

### B.13.3 Water treatment works renewal and replacement and associated water quality improvements

Water treatment works improvements, renewal and replacement form an integral part of the WRMP and are required to ensure the continued provision of safe, reliable and compliant drinking water. These interventions are not alternatives to strategic supply options but underpin the effective operation of the entire water supply system. As such, they are considered within the WRMP as phased interventions, sequenced to address immediate operational vulnerabilities first, followed by planned asset replacement where required.

The WRMP therefore proposes a two-stage approach to treatment improvements:

1. Immediate operational and water quality improvements, delivered as early interventions to reduce risk and improve resilience.
2. Planned renewal and replacement of treatment assets, prioritised based on asset condition, risk and system importance.

#### **Stage 1: Immediate operational and water quality improvements**

A number of operational improvements have been identified within the main WRMP as priority actions that can be implemented in the near term. These measures are intended to reduce the frequency and severity of treatment constraints, particularly during high-turbidity events associated with heavy rainfall.

These include:

- Installation of sediment traps and improved sediment management upstream of intakes and treatment works, reducing solids loading and improving treatment robustness.
- Chlorine boosting and enhanced disinfection control, improving residual maintenance across the network and increasing resilience during operational upsets.

Operational optimisation and operator training, including improved monitoring, process control and response procedures during challenging raw-water conditions.

These measures do not increase deployable output but improve the reliability and consistency of treated water availability and therefore support overall system resilience.

Table B-13: Indicative costs for Stage 1 actions

Cost component	Indicative CAPEX (£000)	Indicative annual OPEX (£000/yr)	Notes
Sediment traps and intake sediment management	30 - 80	2 - 5	Minor civil works and routine clearance
Chlorine booster installations	20 - 60	3 - 6	Booster units, controls, consumables
Monitoring, optimisation and training	10 - 30	2 - 4	Instrumentation, procedures and staff time
Indicative total	60 - 170	7 - 15	Early WRMP interventions

## Stage 2: Planned treatment works renewal and replacement

In parallel with immediate improvements, the WRMP identifies the need for phased renewal and replacement of water treatment works assets over the planning horizon. This reflects asset age, condition, evolving regulatory standards and increasing operational stress associated with climate variability.

Replacement and major refurbishment works may include:

- Mechanical and electrical plant replacement
- Filter, clarification and wastewater system upgrades
- Sludge handling improvements
- Electrical, control and resilience upgrades

The Levelwood Water Treatment Works is identified as the first priority for replacement, reflecting its age, condition and limited ability to reliably treat increasingly variable raw water at the capacity required. Replacement of Levelwood WTW is therefore proposed to be progressed ahead of other treatment works, subject to feasibility and funding confirmation, within the next 2-5 years.

Other treatment works would be addressed subsequently in line with asset condition assessments and system priorities. The costs below are per site.

Table B-14: Indicative costs for Stage 2 actions

Cost category	Indicative cost range
Capital expenditure (CAPEX)	£0.8m - £2.5m (phased)
Annual operating expenditure (OPEX)	£40k - £100k per year
Typical asset life	25-40 years



## B.14 Summary and conclusions

This appendix has documented the options appraisal and best value planning process undertaken to support the St Helena Water Resources Management Plan (WRMP). The appraisal has been designed to be robust, proportionate and appropriate to the island context, recognising high uncertainty, limited data availability and the need for affordable, scalable and deliverable interventions.

The options appraisal confirms that no single intervention can address future water supply risks in isolation. Instead, resilience for St Helena is best achieved through a portfolio of complementary measures, combining demand management, operational improvements, nature-based solutions and targeted infrastructure investment. This approach is consistent with UK WRMP good practice and reflects the specific vulnerabilities of small island systems, where flexibility and operability are as important as absolute supply volume.

### Key findings from the appraisal

The multi-criteria assessment and subsequent modelling indicate that:

- Demand-side and operational measures (including leakage reduction, rainwater harvesting and improved system operation) consistently provide good value, are affordable, and can be implemented quickly. While their individual water resource benefits are modest and uncertain, collectively they play a critical role in reducing pressure on the system and deferring or reducing the need for high-cost supply options.
- Nature-based and catchment measures, particularly Cloud Forest restoration, deliver wide-ranging environmental and resilience benefits and perform strongly in qualitative appraisal. Although they do not provide immediate deployable output, their cumulative benefits to infiltration, runoff moderation, sediment control and climate resilience justify their inclusion as a core component of the WRMP portfolio.
- Supply-side infrastructure options such as new or expanded storage, groundwater reuse and water reuse schemes improve local and system resilience rather than materially increasing deployable output at island scale. Their value lies primarily in extending storage duration during droughts, improving recovery and reducing operational stress.
- High-cost strategic options such as desalination provide strong drought resilience but perform poorly in comparative appraisal due to cost, energy dependency and complexity. These options are therefore retained as long-term contingencies rather than near-term investments.



Option family	Primary benefit type	Indicative benefit to system	Indicative cost range (CAPEX / OPEX)	Preferred phasing
Operational efficiency & demand management (leakage, pressure, monitoring)	Demand reduction & resilience	Reliable recovery of existing supply; reduced drought stress; improved operational control	CAPEX: £0.1-0.3m OPEX: £10-20k/yr	Low-regret → Short-term (ongoing thereafter)
Rainwater harvesting - new builds	Demand substitution	Reduces potable demand growth; improves household	CAPEX: ~£0.5m total OPEX: ~£4k/yr	Low-regret → Short-term
Rainwater harvesting - retrofit	Demand substitution	Moderate island-wide demand reduction; resilience	CAPEX: ~£2.7m OPEX: ~£16k/yr	Short-term → Medium-term
Water quality & treatment - early improvements (sediment traps, chlorine boosters, training)	Reliability & compliance	Fewer outages; improved robustness during high-turbidity events	CAPEX: £60-170k OPEX: £7-15k/yr	Low-regret (immediate)
WTW renewal & replacement (per site)	Reliability & compliance	Long-term treatment resilience; reduced operational risk	CAPEX: £0.8-2.5m per WTW OPEX: £40-100k/yr	Medium-term (Levelwood first)
Cloud Forest restoration	Long-term resilience & co-benefits	Improved infiltration, reduced sediment, climate resilience (cumulative)	CAPEX: £0.1-0.3m (phased) OPEX: £40-60k/yr	Low-regret → Ongoing
Agricultural raw-water management (Longwood)	Enabling / demand protection	Reduces potable abstraction; improves equity and control	CAPEX: £150-200k OPEX: £6-20k/yr	Low-regret (early)
Wastewater recycling (non potable)	Reliability	Reduces treated water use	CAPEX: £80-120k per scheme (≈£100k typical) OPEX: £10-15k/yr	Low regret -Ongoing
Storage - Longwood expansion	Storage & buffering	Incremental resilience; low construction risk	CAPEX: ~£0.1-0.2m OPEX: ~£3k/yr	Short-term



Option family	Primary benefit type	Indicative benefit to system	Indicative cost range (CAPEX / OPEX)	Preferred phasing
Storage - Harpers system improvements	Storage & asset protection	Restores lost capacity; improves Redhill resilience	CAPEX: ~£0.15m OPEX: ~£4k/yr	Short- to Medium-term
Storage - Levelwood additional reservoir	Local resilience	Improves constrained zone resilience; requires treatment upgrades	CAPEX: ~£0.7-0.8m OPEX: ~£20k/yr	Medium-term
Storage - Longwood new reservoir	Strategic buffering	Large drought buffer; supports agricultural & public supply	CAPEX: ~£0.8m+ OPEX: ~£20k/yr	Medium- to Long-term
Connectivity & system integration	System flexibility	Enables better use of existing resources; amplifies other options	CAPEX: ~£0.15m OPEX: ~£2k/yr	Short- to Medium-term
Groundwater rehabilitation & reuse	Supply diversity	Improves drought resilience at local scale	CAPEX: £50-100k per borehole OPEX: £2-5k/yr	Short- to Medium-term
Non-potable reuse	Demand substitution	Reduces potable demand in specific growth areas	CAPEX: £80-120k per scheme OPEX: £10-15k/yr	Short- to Medium-term
Strategic contingency options (desalination)	Drought security	High-reliability supply for worst-case futures	CAPEX: £3-6m+ OPEX: High, energy-dependent	Strategic / Post-2050

## C Institutional, legal and regulatory adjustments required

This appendix summarises the institutional arrangements and the key legal and regulatory changes that may be required to enable delivery of the preferred WRMP pathway. It focuses on practical ‘enablers’ that allow options to be planned, funded, permitted, implemented and operated in a transparent and accountable way.

This includes:

- Changes to existing legislation and regulation
- New or updated guidance and standards
- Customs and behavioural incentives

### C.1 Evidence base and sources reviewed

The institutional, legal, regulatory and incentive-based enablers identified in this appendix are informed by a review of existing St Helena legislation, policy documents, regulatory arrangements and publicly available information, alongside established UK water resources management planning practice applied proportionately to the St Helena context.

The sources reviewed include, but are not limited to:

#### St Helena legislation and statutory instruments

- Water Ordinance and associated regulations
- Utility Services Ordinance and the Utilities Operating Licence for Connect Saint Helena Ltd
- Planning and Development Control legislation and associated guidance
- Public health legislation and drinking water quality requirements
- Utilities Regulatory Authority (URA) statutory duties, directives and licence conditions

#### St Helena policy and strategy documents

- St Helena Water Resource Strategy (2020–2050)
- Relevant SHG policy statements and committee papers where available
- URA annual reports and published determinations

#### Operational and institutional information

- Publicly available information on the roles and responsibilities of SHG, CSH and URA
- Published tariff consultations and regulatory notices
- Available documentation relating to water supply operations, drought management and monitoring arrangements

#### Online and publicly available sources

- St Helena Government and Utilities Regulatory Authority websites
- Published licence documents, directives and guidance notes
- Public consultation materials relating to utility services and tariffs

#### UK water resources planning good practice

- UK Water Resources Management Planning (WRMP) guidance and principles (including adaptive pathways, plan–monitor–review cycles, and separation of policy, delivery and regulation)
- Established UK water company practice in relation to leakage management, drought planning, demand management, abstraction control and non-potable water use

The review was undertaken to identify practical enablers relevant to the preferred WRMP pathway. The list of sources is not exhaustive, and additional legislative, regulatory or institutional adjustments may be identified as options are progressed through feasibility, design and implementation stages.

### **C.2 Rainwater harvesting**

Several households in St Helena already make use of rainwater harvesting (RWH), either as a supplementary supply or for non-potable uses. The preferred WRMP pathway assumes that wider and more reliable uptake of RWH can contribute to demand reduction and drought resilience, particularly for non-essential uses.

To enable RWH to contribute meaningfully to WRMP outcomes, additional planning, building control and guidance measures are required.

Key enablers include:

- Planning and building control guidance that encourages or requires RWH in new development and major refurbishments, particularly for public buildings and high-demand premises. Also clarifies when RWH systems can be installed under simplified or proportionate consent routes.
- Technical standards and guidance covering: minimum storage sizing approaches; first-flush diversion; backflow prevention and separation of potable and non-potable systems.
- Customs and fiscal incentives, such as duty relief for approved tanks, fittings and components, to reduce capital cost barriers.

Without these enablers, uptake of RWH is likely to remain inconsistent and insufficient to deliver the demand reductions assumed in the WRMP.

### **C.3 Recycled and non-potable water**

Recycled and non-potable water options (e.g. reuse for irrigation, construction or other non-potable purposes) have the potential to reduce pressure on the public water supply during dry periods. However, these options require explicit legal and

public health frameworks to ensure safety, clarity of responsibility and public confidence.

Key enabling requirements include:

- Legal and regulatory clarity that non-potable water supplies are permitted, with clear delineation of responsibilities for operation, monitoring and enforcement.
- Public health standards and approval routes, including defined water quality classes for different non-potable uses; sampling, monitoring and reporting requirements; incident response procedures.
- Planning and building control guidance addressing design standards, pipe labelling and signage; backflow prevention and cross-connection controls.
- A clear policy position on the scope and limits of reuse (e.g. non-potable reuse only, unless future policy decisions are taken).

In line with UK WRMP practice, recycled water options should be enabled in principle but only progressed where the supporting regulatory and health frameworks are in place.

#### **C.4 Abstraction control**

Several of the WRMP options suggest increased reliance on managed abstractions, particularly groundwater, alongside improved understanding of abstraction impacts during drought.

To support this, abstraction management requires clearer and more consistent institutional and regulatory arrangements.

Key enablers include:

- Registration and control of abstractions, covering surface water and groundwater abstraction; recording and reporting of abstraction volumes; proportionate metering requirements for significant users.
- Operational abstraction rules, linked to drought stages and sustainability triggers.
- Protection of sources, including safeguarding of recharge areas and controls on activities that may affect yield or water quality.

These measures allow abstractions to be managed proactively and transparently, rather than through reactive supply restrictions.

#### **C.5 Water quality**

One of the key findings from this study is that water quality, taste and increased sediment levels are material issues within the current system, and that these issues have, over time, undermined public confidence in the water supply, treatment processes and operating regimes delivered by CHS. This lack of trust increases the reputational and behavioural risks associated with both routine operation and

drought response, and can reduce public acceptance of necessary operational changes.

Maintaining public health protection and restoring confidence therefore requires robust, transparent and consistently applied operational and regulatory frameworks for water quality, covering both treatment and distribution.

A particular issue identified is the current reliance on FAO guidance for drinking water quality, which provides variable and context-dependent threshold values for certain parameters. While FAO guidance is valuable as a reference, variability in thresholds and interpretation can make it difficult to apply consistently in day-to-day operations, regulatory oversight and public communications. This lack of consistency creates uncertainty for operators, regulators and customers, and does not support the development of stable operating regimes or clear compliance expectations.

To address this, the WRMP identifies the need for clearly defined drinking water quality standards at treatment and point of supply, supported by consistent monitoring, reporting and assurance arrangements.

Key enabling measures include:

- Clear alignment between water supply legislation and public health regulation, including the adoption of defined drinking water quality standards, compliance responsibilities and escalation procedures that can be applied consistently across the system.
- Standard Operating Procedures (SOPs) covering treatment operation, response to high sediment or turbidity events, sampling, incident response and customer communications, ensuring that operational decisions are predictable and defensible. These may already be available and can be re-invigorated.

Together, these measures provide the regulatory foundation needed to ensure that existing and future WRMP options can be operated safely, consistently and transparently, while supporting public confidence in the water supply. This approach is consistent with the principles of Drinking Water Safety Planning applied in the UK and internationally, adapted proportionately to the St Helena context.

## **C.6 Agricultural water**

Agriculture is defined as a clear strategic priority for St Helena's economic development and resilience. Agricultural water use represents both a pressure on the public water supply during dry periods and an opportunity for low-regret resilience through efficiency and sharing.

Delivery of the WRMP therefore requires targeted standards, proportionate regulation and incentives that:

- support efficient agricultural water use;
- facilitate shared infrastructure and cooperative management;

- align agricultural tariffs with scarcity signals while protecting livelihoods.

Key enablers include:

- An Agricultural Water Use Code of Practice or equivalent document, covering efficient irrigation methods, leakage control, basic metering/recording and drought good practice.
- Proportionate abstraction controls and
- A clear set of standards or legal framework to enable water sharing and shared infrastructure (e.g. storage, transfer).

Tariff reform and incentives, including:

- efficiency-based tariff structures;
- duty or tax relief for efficient irrigation equipment and on-farm storage;
- targeted support for shared infrastructure that reduces pressure on the public supply.

Without these measures, agricultural demand risks increasing reliance on higher-cost public supply and emergency measures during droughts.

## **C.7 WRMP implementation, review and governance**

The Water Resources Management Plan (WRMP) should be treated as a live, adaptive planning framework, rather than a static document. Effective delivery of the preferred WRMP pathway therefore requires clear governance, regular monitoring, and periodic review, consistent with established UK water resources management planning practice and applied proportionately to the St Helena context.

### **C.7.1 Implementation and accountability**

At present, overall responsibility for strategic decision-making and funding of the WRMP rests with St Helena Government (SHG), reflecting its policy role, ownership interests and responsibility for approving and funding major capital investment. Connect Saint Helena Ltd (CSH), as the licensed water service provider, is responsible for operational delivery of agreed WRMP actions within its licensed remit, under oversight from the Utilities Regulatory Authority (URA).

In the future, a greater degree of responsibility for WRMP implementation could sit with CSH, provided that: (a) the operating licence provides sufficient duration and certainty to support long-term investment; (b) funding and tariff arrangements enable recovery of capital and operational costs associated with strategic water resources options; and (c) licence conditions and regulatory incentives are explicitly aligned with WRMP delivery. Subject to these changes, CSH could assume a role more closely aligned with UK water company practice.

Key implementation actions to support effective WRMP delivery include:

- Integration of WRMP actions into CSH's annual business planning, operational programmes and investment processes, within the strategic and funding framework set by SHG;
- Preparation of an annual WRMP implementation statement, setting out progress against agreed actions, expenditure, monitoring results and any proposed adjustments to sequencing or assumptions;
- Review of the WRMP implementation statement by SHG and URA to inform policy oversight, regulatory determinations and future investment decisions.

This mirrors UK WRMP good practice, where delivery is supported by annual reporting, regulatory scrutiny and adaptive review, applied proportionately to the St Helena context.

### C.7.2 Review and update cycle

In the UK, statutory Water Resources Management Plans are subject to a formal review and update cycle, typically every four to five years, supported by annual monitoring and reporting. While St Helena is not subject to UK statutory requirements, the same principle of periodic review is considered good practice because water resource systems are dynamic, and the assumptions underpinning long-term plans can change over time. Factors such as climate variability and drought experience, changes in population and economic activity, evolving environmental objectives, asset condition, operational performance and emerging technologies can all materially affect the suitability and timing of preferred options.

Regular review ensures that the WRMP remains relevant, evidence-based and proportionate, allowing decisions to be adjusted in response to new information rather than relying on outdated assumptions. A periodic update also supports transparency and accountability, providing a structured opportunity to review performance, confirm or amend option triggers, and reassess affordability and environmental impacts. Applied appropriately to the St Helena context, this approach strengthens the credibility of the WRMP and reduces the risk of either over-investment in unnecessary infrastructure or under-preparedness for future drought and supply risks.

It is recommended that the WRMP is reviewed annually at a high level through a WRMP implementation statement or equivalent document to confirm that assumptions, triggers and delivery schedules remain appropriate; and a more comprehensive review and update of the WRMP is undertaken at an appropriate strategic interval (for example every five years), or earlier where monitoring indicates that assumptions are no longer valid or where significant changes occur (e.g. prolonged drought, demand shifts, policy or regulatory changes). The review horizon should remain flexible and proportionate, reflecting the scale of the system, the pace of change, and the adaptive pathways set out in the plan.



### C.7.3 Summary of key proposed institutional, legal and regulatory actions

Table C-1 summarises the key proposed actions identified in this appendix to enable delivery of the preferred WRMP pathway. The table focuses on priority, actionable enablers, drawing together requirements for governance, planning, legislation, standards, incentives and monitoring.

The actions listed are not exhaustive, but represent those considered most critical to enabling delivery, improving public confidence, and ensuring the WRMP operates as a live, adaptive framework consistent with UK water resources planning good practice and proportionate to the St Helena context.

Ref	Theme	Key proposed action	Primary mechanism	Lead organisation	Supporting bodies	When required	WRMP elements enabled
1	WRMP governance	Establish or confirm WRMP Steering Group and produce WRMP implementation guidance (ToR, roles, meeting cycle, decision gates)	SHG committee arrangement + guidance	SHG (ENRP)	CSH, URA, Planning, Health, Finance	Immediate (0–3 months)	All options; governance
2	Customer engagement	Implement behaviour-change and communications plan (drought stages, water quality messaging, efficiency, reporting leaks)	Communications strategy	CSH	SHG, URA	Early & ongoing	Demand management ; drought
3	Abstraction control	Register and regulate surface and groundwater abstractions, including proportionate metering and reporting	Subsidiary regulations	SHG (AGC/ENRP)	URA, CSH	Early	Groundwater ; drought
4	Drought management	Formalise drought stages, restrictions, exemptions and enforcement	Regulations + Drought Plan	SHG	CSH, URA	Early	Drought; emergency supply
5	Source protection	Enable source protection zones and planning controls to safeguard water sources and recharge areas	Regulations + planning hooks	SHG (ENRP)	Planning, Health	Early–mid	Catchment; water quality

Ref	Theme	Key proposed action	Primary mechanism	Lead organisation	Supporting bodies	When required	WRMP elements enabled
6	URA alignment	Align CSH Utilities Licence conditions with WRMP delivery (reporting, NRW, resilience, drought readiness)	Licence modifications	URA	CSH, SHG	Early	All options
7	WRMP delivery	Produce WRMP implementation guidance (annual reporting, monitoring, review, change control)	Guidance document	SHG	WRMP Steering Group	Early	All options
8	Water quality standards	Define consistent drinking water quality standards and treatment commissioning/operational standards	Development of standards	CSH + Health	Health	Early	Treatment; public confidence
9	Planning – rainwater harvesting	Introduce planning and building control guidance to require or encourage rainwater harvesting, with simplified consent routes and technical standards	Planning guidance + building control standards	Planning Authority	SHG (ENRP), CSH, Health	Early	Demand reduction; drought resilience
10	Planning & regulation – recycled water	Establish clear legal, public health and planning framework for non-potable and recycled water use	Subsidiary regulations + health + planning guidance	SHG (AGC / Health)	Planning, CSH, URA	Before reuse options	Non-potable reuse; demand reduction

Ref	Theme	Key proposed action	Primary mechanism	Lead organisation	Supporting bodies	When required	WRMP elements enabled
11	Tariff incentives	Introduce efficiency-promoting tariff structures, including signals for rainwater harvesting and recycled water use	Tariff policy / URA approval	URA + Finance	CSH	Early–mid	Demand; drought
12	Customs incentives	Provide duty relief for WRMP equipment and water-efficiency goods	Customs policy	Finance / Customs	CSH	Early–mid	NRW; treatment; demand
13	Agricultural water	Develop Agricultural Water Use Code of Practice and enable water sharing and shared infrastructure	Guidance + proportionate regulation	SHG (ENRP)	CSH, URA, Agriculture reps	Early–mid	Agricultural demand; resilience
14	Transparency	Publish an annual WRMP scorecard / implementation summary	Reporting	URA + CSH	SHG	Ongoing	All options
15	WRMP review	Implement annual WRMP review and periodic full update (e.g. ~5-yearly or trigger-led)	Governance process	SHG	CSH, URA	Ongoing	Adaptive planning

## D Environmental Assessment

### D.1 Purpose and context

This appendix presents a strategic environmental screening of the water resource options considered within the St Helena Water Resources Management Plan (WRMP). The purpose of the screening is to support option development and phasing by identifying the likely environmental effects, risks and opportunities associated with different option families, and to ensure that environmental considerations are embedded early within the WRMP process.

The approach is consistent with UK water company WRMP practice and the principles of Strategic Environmental Assessment (SEA), proportionately adapted to reflect the scale of the St Helena system, the nature of the options under consideration, and the availability of environmental baseline information. At this stage of the WRMP, the assessment is strategic and qualitative, rather than project-specific, and is intended to:

- establish a transparent, auditable environmental screening baseline;
- identify options that are likely to deliver net environmental benefit (“low-regret”);
- highlight options with potentially higher environmental risk requiring mitigation or further assessment; and
- inform option sequencing, safeguarding and future appraisal.

This appendix does not replace the need for project-level environmental assessment. Where options progress beyond the WRMP into design and delivery, appropriate statutory and non-statutory assessments (e.g. Environmental Impact Assessment, Habitats Regulations-style assessment where relevant, permitting assessments) would be undertaken as required.

### D.2 Environmental baseline and sensitivity context

St Helena’s natural environment is internationally recognised for its exceptional ecological value and vulnerability, and this context is fundamental to water resources planning. The island has one of the highest levels of endemism per unit area in the world, combined with highly sensitive geomorphology and tightly coupled hydrological–ecological processes. As a result, relatively small changes in land use, abstraction pressure or catchment condition can have disproportionate environmental consequences.

#### **Terrestrial biodiversity and endemic species**

St Helena supports a globally significant assemblage of endemic terrestrial flora and fauna, many of which are restricted to very small and fragmented habitats, particularly within the central upland areas. Numerous endemic plant species occur only within remnant Cloud Forest and associated upland habitats, several of which

are classified as Critically Endangered or Endangered (Cronk, 2000; Cairns-Wicks et al., 2016). These ecosystems are highly sensitive to physical disturbance, changes in soil moisture, erosion, and the introduction or spread of invasive species.

Because of the limited extent and fragmented nature of these habitats, even localised infrastructure works, access routes or changes in hydrological regime can result in irreversible habitat loss or degradation if not carefully managed. This sensitivity is a key consideration for WRMP option development, particularly where options involve land take, excavation, or construction within upland or catchment areas.

### **Catchment characteristics, erosion and sediment dynamics**

The island's topography is steep and dissected, with short, responsive catchments that react rapidly to rainfall. Many catchments are erosion-prone, reflecting a combination of steep slopes, shallow soils, historic land clearance, grazing pressure and invasive vegetation (Sansom et al., 2023). During intense rainfall events, rapid runoff leads to high sediment mobilisation, delivering fine material directly into streams, springs, abstraction points and reservoirs.

This behaviour has been widely documented through operational experience and research undertaken as part of the Cloud Forest Programme (DPLUS051; DPLUS103). Sediment mobilisation is not an occasional phenomenon but a recurring system stressor, closely linked to rainfall intensity rather than total rainfall volume. As such, climate variability and projected increases in rainfall intensity pose an increasing risk to both water quality and aquatic habitats.

### **Linkages between catchment condition and water quality**

There is a strong and well-evidenced linkage on St Helena between catchment condition, sediment delivery and raw water quality. Degraded vegetation cover, compacted soils and unstable slopes contribute directly to elevated turbidity, colour and suspended solids during rainfall events. These effects propagate rapidly through the water supply system due to limited upstream buffering and small reservoir volumes.

Research associated with the Cloud Forest restoration programme demonstrates that improvements in vegetation cover and soil stability can reduce sediment mobilisation, enhance infiltration and moderate runoff response (Sansom et al., 2023). This makes catchment condition a primary control on treatability and operational resilience, rather than a secondary environmental consideration.

### **Limited natural buffering and system vulnerability**

Unlike larger mainland systems, St Helena's watercourses and reservoirs provide limited natural buffering against water quality shocks. Reservoirs are generally small, many are offline, and only a limited number receive direct catchment inflow. As a result, changes in raw water quality can translate quickly into treatment challenges, operational interventions, or service impacts.

This lack of buffering means that environmental impacts associated with WRMP options—particularly those affecting erosion rates, sediment delivery or abstraction timing—can have immediate and system-wide effects, reinforcing the need for precautionary, adaptive planning.

### **Importance of upland environments and Cloud Forest habitats**

The central upland areas, including Cloud Forest habitats, are critical not only for biodiversity but also for water security. Mist capture by endemic vegetation contributes significantly to effective precipitation and groundwater recharge, particularly during dry periods (Toens & Partners, 2000; Sansom et al., 2023). These areas therefore play a dual role as ecological assets and functional components of the water supply system.

Degradation of upland habitats increases erosion risk, reduces infiltration, and undermines the resilience of springs and baseflows during drought. Conversely, restoration and protection of these environments deliver multiple co-benefits, including biodiversity recovery, reduced sediment loads, improved raw water quality, and enhanced drought resilience.

### **Groundwater**

Groundwater plays a very important role in the resilience of the St Helena water supply system relative to its volumetric contribution. Boreholes and spring-supported baseflows provide a more drought-resilient source of supply compared to surface water abstractions, which are highly sensitive to short-term rainfall variability.

Within the WRMP context, groundwater contributes to system resilience in three principal ways:

- direct abstraction from boreholes, particularly during drought periods;
- sustained baseflow support to springs and surface water sources; and
- buffering of short-term rainfall deficits through delayed release of stored subsurface water.

This buffering function is critical in a system characterised by small, flashy catchments and limited surface storage.

St Helena's hydrogeology is complex and spatially variable, reflecting the island's volcanic origin, steep topography and fractured rock aquifers. Recharge processes are dominated by upland infiltration, with groundwater generally flowing from the central highlands toward lower-lying discharge zones in the form of springs and seepage to surface watercourses.

Available studies indicate that a substantial proportion of groundwater recharge occurs in the upland areas, particularly within and adjacent to Cloud Forest habitats. These areas receive higher effective precipitation due to:

- increased rainfall at elevation; and
- mist interception by endemic vegetation, which can contribute a significant proportion of effective moisture input during dry periods.

This process is particularly important during droughts, when rainfall inputs are reduced but mist interception continues to provide moisture to soils and shallow groundwater systems.

There is strong evidence that Cloud Forest condition is directly linked to groundwater recharge and baseflow stability on St Helena. Healthy Cloud Forest and associated upland vegetation:

- enhance infiltration by improving soil structure and organic content;
- reduce rapid surface runoff and erosion;
- promote delayed subsurface flow pathways; and
- sustain groundwater recharge during periods of low rainfall.

Conversely, degradation of upland habitats—through invasive species, soil compaction, erosion or vegetation loss—reduces infiltration capacity and increases rapid runoff. This results in:

- reduced groundwater recharge;
- increased sediment delivery to watercourses and reservoirs; and
- greater variability and vulnerability of spring and borehole yields.

From a WRMP perspective, this establishes Cloud Forest restoration and protection as a functional water resource intervention, not solely a biodiversity measure.

### **Implications for WRMP option development**

Taken together, these characteristics mean that water resource options on St Helena can affect the environment through multiple, interconnected pathways, including:

- land take and habitat disturbance during construction;
- changes in soil stability and erosion rates;
- altered sediment delivery to streams, springs and reservoirs;
- abstraction pressures affecting surface water–groundwater interactions; and
- increased energy use and associated emissions linked to pumping, transfers or desalination.

In this context, environmental effects are core determinants of system resilience and sustainability. WRMP options that reduce pressure on sensitive catchments, improve land condition, and lower operational stress on the supply system are therefore strongly aligned with both environmental protection and long-term water security objectives.

## Environmental risks associated with groundwater development

While groundwater abstraction provides resilience benefits, it also carries environmental risks if not carefully managed. Potential impacts include:

- reduction in spring flows that support surface water ecosystems;
- alteration of baseflow regimes in streams, particularly during dry periods;
- localised drawdown effects where abstraction is concentrated; and
- cumulative impacts where multiple boreholes are operated without coordinated management.

These risks are heightened in systems with limited long-term groundwater monitoring data and poorly constrained recharge estimates, as is the case on St Helena.

The connectivity between Cloud Forest condition, groundwater recharge and system resilience has important implications for WRMP option appraisal:

- Catchment restoration options deliver indirect but material benefits to groundwater sustainability and should be treated as low-regret, system-wide resilience measures.
- Groundwater options should not be assessed in isolation, but in combination with catchment condition and abstraction management.
- Short-term gains from increased groundwater abstraction could undermine long-term resilience if recharge processes are degraded.
- Environmental screening must therefore consider hydro-ecological linkages, not just direct construction impacts.

This reinforces the WRMP strategy of combining modest, controlled groundwater use with long-term investment in catchment condition, monitoring and adaptive management.

### D.3 Environmental screening of options

Environmental screening has been undertaken to provide an early, proportionate assessment of the potential environmental effects of the WRMP options, in line with UK water company WRMP practice. The purpose of screening is not to undertake project-level Environmental Impact Assessment, but to:

- identify where options may pose material environmental risks that influence their suitability, phasing or need for further assessment;
- distinguish between options that are environmentally low-risk or beneficial and those that require more cautious treatment;
- ensure that environmental constraints and opportunities are embedded within best value planning and adaptive pathways, rather than considered after option selection.

The screening is therefore used to inform option shortlisting, phasing and the identification of enabling or “low-regret” actions, rather than to approve or reject individual schemes.

## D.4 Screening approach

Environmental screening was undertaken qualitatively, drawing on:

- the environmental baseline and published evidence for St Helena;
- knowledge of option type, scale and location;
- professional judgement informed by UK WRMP and SEA practice; and
- stakeholder input, including from the Cloud Forest Project and environmental specialists.

Options were screened against the following broad environmental receptors:

- biodiversity and habitats;
- soils, erosion and sediment processes;
- surface water and groundwater;
- landscape and land use;
- carbon and energy; and
- cumulative and indirect effects.

The screening considers both construction/implementation impacts and longer-term operational impacts, recognising that some options may have short-term disturbance but long-term environmental benefit, or vice versa.

## D.5 Summary of screening outcomes

The environmental screening highlights clear differentiation between option types:

**Demand management and catchment-based options** (e.g. leakage reduction, water efficiency devices, rainwater harvesting, catchment management and Cloud Forest restoration) consistently perform well. These options:

- reduce abstraction pressure on sensitive sources;
- lower sediment mobilisation and treatment stress;
- deliver biodiversity and climate co-benefits; and
- involve minimal physical disturbance.

They are therefore considered environmentally low-risk and strongly beneficial under almost all future scenarios.

**Reservoir storage options** provide important resilience benefits but have more mixed environmental outcomes. Impacts are highly site-dependent:

- options at Longwood and within the Harpers system are relatively lower risk due to use of existing infrastructure and less constrained land;
- Levelwood additional storage carries higher relative risk due to site constraints, treatability issues and limited scale of benefit; and
- potential downstream storage at Grapevine Gut is recognised as a strategic option that would require future, dedicated environmental assessment before progression.



**Groundwater options** offer resilience benefits but are environmentally sensitive due to potential impacts on springs, baseflows and groundwater-dependent ecosystems. Screening indicates that groundwater use should be:

- staged and monitored;
- closely linked to recharge understanding; and
- aligned with catchment and Cloud Forest restoration to avoid long-term ecological impacts.

High-reliability supply options, such as desalination, perform poorly in environmental screening due to high energy use, carbon emissions and potential marine impacts. These options are therefore retained only as long-term contingency measures, consistent with UK WRMP best practice.



Option family	Key environmental receptors affected	Likely impacts (construction / implementation)	Likely impacts (operation / long term)	Overall screening outcome
Reservoir storage (Longwood expansion / new storage)	Soils, habitats, sediment, landscape	Localised land take and soil disturbance; risk of sediment mobilisation during earthworks; temporary habitat disturbance	Improved system buffering reduces drought abstraction pressure elsewhere; potential local habitat loss permanent	Moderate adverse (local), moderate beneficial (system)
Reservoir storage (Harpers system additional storage)	Sediment, surface water, habitats	Works largely within existing asset footprint; limited additional disturbance; downstream works could increase footprint if pursued	Reduced drawdown stress and emergency operation; improved sediment control upstream benefits water quality	Low–moderate adverse, moderate beneficial
Reservoir storage (Levelwood additional storage)	Habitats, soils, water quality	Constrained site increases construction complexity; higher risk of disturbance relative to benefit	Improved local resilience but limited system-wide gain; requires WTW upgrade to avoid water quality risk	Moderate adverse, low–moderate beneficial
Strategic storage (Grapevine Gut – future option)	Habitats, landscape, watercourses	Potentially significant land take and habitat disturbance; unknown sediment impacts	Long-term resilience benefit uncertain; risk of ecological impact without strong mitigation	Potentially high adverse – deferred
Demand management (leakage reduction)	Water resources, carbon	Minimal physical disturbance; works largely within existing network	Reduced abstraction pressure across all sources; reduced energy use and emissions	Strong net beneficial
Demand management (rainwater harvesting, devices)	Water resources, urban environment	Minimal environmental disturbance; small-scale installations	Reduces potable demand and drought stress; neutral to positive biodiversity effect	Strong net beneficial
Groundwater rehabilitation and reuse	Groundwater, springs, surface water ecosystems	Minimal land disturbance at existing borehole sites	Increased abstraction may affect springs/baseflows if unmanaged; improves drought resilience if controlled	Low–moderate risk, beneficial if managed



Option family	Key environmental receptors affected	Likely impacts (construction / implementation)	Likely impacts (operation / long term)	Overall screening outcome
New groundwater development (future)	Groundwater-dependent ecosystems	Site-specific disturbance; drilling impacts	Higher abstraction risk; potential long-term ecological effects if recharge limited	Moderate–high risk – precaution required
Connectivity and transfers	Energy, carbon, water resources	Limited construction footprint (pipes, pumps)	Increased energy use; improves system flexibility and reduces emergency measures	Low adverse, moderate beneficial
Wastewater reuse (non-potable)	Water resources, public health	Localised construction impacts; treatment upgrades	Reduces potable demand; risk if controls fail; positive reuse benefits	Moderate beneficial, manageable risk
Desalination (strategic)	Marine environment, carbon	High construction footprint; brine discharge risk	High energy and carbon intensity; drought-resilient supply	High adverse, contingency only
Catchment management (sediment traps, land management)	Soils, habitats, water quality	Small-scale disturbance; largely reversible	Reduced sediment load; improved raw water quality; biodiversity co-benefits	Strong net beneficial
Cloud Forest restoration	Biodiversity, groundwater recharge, erosion	Very low physical disturbance; restoration-based	Improved infiltration, reduced erosion, groundwater resilience; strong biodiversity benefit	Strong net beneficial (low regret)

# E Public Consultation

## E.1 Purpose

Consultation was undertaken as part of the WRMP development to ensure that local knowledge, priorities and concerns were reflected in the identification and appraisal of options. Consistent with UK water company WRMP practice, the objectives of consultation were to:

- raise awareness of current and future water resource challenges on St Helena;
- test support for a range of potential options and strategic directions;
- identify social, operational and environmental considerations not evident from technical analysis alone; and
- improve the robustness and acceptability of the preferred plan.

Consultation focused on early engagement, recognising that the WRMP sets a long-term framework rather than making immediate delivery commitments.

## E.2 Consultation activities undertaken

Engagement was undertaken through a combination of:

- Public consultation meetings and presentations, including targeted sessions in key locations such as Longwood;
- An online and paper-based survey, open for approximately three months;
- Stakeholder discussions with government officers, Connect Saint Helena Ltd staff, farmers and land managers; and
- Informal feedback gathered during site visits and technical workshops.

The consultation approach was designed to be proportionate to the scale of the island and accessible to a broad cross-section of the community.

## E.3 Survey results

### **Concern about water security and resilience**

A majority of respondents expressed concern about water shortages, with over half reporting being very concerned. Many respondents indicated they had experienced restrictions or supply issues during recent dry periods.

These concerns align closely with the technical evidence base developed for the WRMP.

### **Strong support for low-regret and “common sense” measures**

Across both survey responses and meeting discussions, there was strong and consistent support for low-regret options, including leakage reduction; rainwater harvesting; catchment and nature-based solutions; and targeted improvements to existing infrastructure (e.g. fixing known issues at Harpers 2).

These options were widely viewed as sensible, affordable and beneficial regardless of future uncertainty.

### **Storage options**

Additional storage options, particularly in the Longwood area, attracted general support but also prompted discussion about land use and agricultural impacts. Key points raised included:

- recognition that Longwood is one of the wetter parts of the island and therefore a logical location for storage;
- concern about potential loss of agricultural land, balanced by acknowledgement that much of the land is government-owned and that affected areas may be relatively small;
- interest in whether new or expanded storage could improve availability of raw water for agriculture, not just potable supply; and
- requests for clearer comparison between proposed reservoir sizes and existing storage.

These discussions reinforced the need to balance technical efficiency with social and land-use considerations and informed how storage options are framed and phased within the WRMP.

### **Agricultural water use and water sharing emerged as a key issue**

A recurring theme, particularly from farmers and operational staff, was confusion and frustration around the current interface between treated and raw water for agricultural use. Issues raised included:

- limited pressure and capacity on raw water systems, leading some farmers to use treated water instead;
- shared pump houses and informal scheduling arrangements between users;
- first-come-first-served abstraction creating inequity during dry periods; and
- absence of a clear policy or framework for agricultural water allocation and sharing.

These discussions highlighted that improving agricultural water resilience is not only a supply issue, but also a governance and infrastructure issue. As a result, the WRMP recognises agricultural water sharing as an enabling, low-regret intervention, even where it is not treated as a standalone supply option.

### **Groundwater: perceived reliability but acknowledged uncertainty**

Groundwater was widely perceived by the stakeholders as a reliable drought resource. However, consultation with technical staff and informed stakeholders emphasised:

- uncertainty around sustainable yields;

- clogging and siltation issues at some boreholes;
- salinity risks at specific sites; and
- the need for proper testing and investigation before expansion.

This reinforced the WRMP approach of retaining groundwater as a resilience option, but not relying on it as a primary solution without further evidence.

### **Water quality and acceptability as a community concern**

Water quality, particularly taste, chlorine smell and colour, emerged as one of the most frequently mentioned issues in survey responses. While this does not indicate non-compliance, it clearly demonstrates that customer acceptability is a major determinant of perceived service quality and trust.

This feedback directly informed the WRMP emphasis on:

- sediment management;
- treatment works resilience; and
- distribution system considerations, not just raw water availability.

## **E.4 How consultation influenced the WRMP**

Consultation feedback has directly informed the WRMP in the following ways:

- reinforcing the prioritisation of low-regret, early actions such as leakage reduction, rainwater harvesting and catchment management;
- shaping how storage options are described, particularly the framing of Longwood storage as beneficial but not automatically “low regret”;
- highlighting the need to explicitly address agricultural water sharing and policy, even where this sits outside traditional supply-side appraisal;
- supporting a cautious, evidence-led approach to groundwater development; and
- elevating water quality and acceptability as core resilience outcomes alongside supply–demand balance.

Overall, consultation confirmed strong alignment between community priorities and the WRMP’s proposed direction, while adding valuable nuance around land use, agriculture and customer experience.