NATIONAL GRID ELECTRICITY DISTRIBUTION

FLEXIBLE OPERATION OF WATER NETWORKS ENABLING RESPONSE SERVICES (FLOWERS)

D1-1. FEASIBILITY REPORT

VERSION 4 - 29/04/2022 (D. PENFOLD, G.MAJOR)

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2 PROJECT OVERVIEW

The FLOWERS project will analyse the potential ability of South West Water's (SWW) network to embed energy flexibility capacity in the time difference (latency) between when Drinking Water and Waste Water are pumped and stored, and when it is used by the system. It will explore methods of delivering latency flexibility and analyse the feasibility of implementing it on SWW's systems. It will define the regulatory compliance and commercial viability requirements for the creation of a latency flexibility product which can be embedded within National Grid Electricity Distribution's electricity network control rooms. If appropriate, a recommendations document will be produced identifying the next steps for the development of latency flexibility capacity in ED2.

3 DOCUMENT PURPOSE

This document summarises and describes the actions that have been taken to collate a primary perspective from the SWW team on flexibly using energy at different times, or energy reduction initiatives, and the steps that we have taken to identify which SWW sites are connected to constrained substations or future constrained substations

This document will classify the relevance opportunity quality of each initiative identified and will also identify initiatives that fall outside of this project's brief that are worthy of bringing to SWW's and/or NGED's attention.

This document contains the results of an early, in-depth analysis on the energy usage of a specific SWW site, where it is connected to a NGED constrained substation. This analysis indicates which of the initiatives identified during the discussions with SWW could be implemented to deliver a mutual benefit to both utilities.

Section 4 of this document gives further details of the workshops and surveillance that were undertaken.

Section 5 provides a summary of the learning from the activities described in Section 4.

Section 6 details the classification given to each potential initiative identified during the workshops and/or the control room surveillance.

Section 7 of this document, provides a high-level overview of the data findings in relation to energy usage at SWW sites and the potential current impact that these are having on National Grid Electricity Distribution (NGED) substations.

4 ACTIONS TAKEN

The initial phase of the project was to gather knowledge and perspectives from the separate areas of SWW operations on how they could potentially reduce the energy usage of the various sites across their estate, be it on demand or for total energy consumption.

The three main areas that were interacted with were:

- Drinking Water Services (DWS)
- Wastewater Services (WWS)
- Control Room (CR)

A series of online workshops were held with the DWS and WWS teams to explain the project objectives and gather initial perspectives on potential initiatives to enable the reduction or shifting of energy use.

Personnel operating in the Control Room were shadowed on site, with additional interviews with some to understand how the CR currently operates and capture their viewpoints.

4.1 Workshop 1: Integrated 2ND March 2022

This workshop was used to introduce the three areas of the business to the project, set the scene for what the project was hoping to identify and explain what was required from the attendees.

Information Gathered

- **Drinking Water Services**

The majority of electricity usage is through pumping. This is in three stages:

  - Abstraction;
  - Interstage – Granular Activated Carbon (GAC); and,
  - Offsite – Distribution Network.

The sacrosanct element is the level of water in the reservoir prior to end-user distribution.

Currently, reservoirs are managed using MAX and MIN levels with alarming, which are implemented via local Programmable Logic Controller (PLC) written set-points. These are aligned with the potential risk on levels the business is willing to take.

There are peak demands in the morning and evening that coincide with people getting up and then returning home. Further discussion around the timings of these peaks is required as part of LFA 3.

Mayflower Water Treatment Works (WTW) was mentioned as being an alternative method of operating. This will be investigated further.

Feasible initiatives identified

i) 3 - 4 hour pump turndown/switch off
ii) Driving pumps harder to pre-fill reservoir

- **Wastewater Services**

The work required at the WWS treatment sites is greatly determined by the weather. Wet weather drives significantly more work as rainwater is mixed with sewerage, so the total volume needs treating.

Similar to the DWS currently control is predicated on maximum levels within storage tanks. Achieving max level drives more pumping, which is controlled with a mixture of local PLC systems. There could potentially be different seasonal maximum fill levels, driven by weather.

There are peak demands morning and evening that coincide with people getting up and then getting home. This is lagged to the electricity network peaks due to time for the water to reach the WWS site from the property.

DUOS avoidance is actioned for an hour, with blowers being switched off. It was noted that if blowers are switched off they need to work harder afterwards to rebalance the oxygen levels. These blowers are variable with further investigation to be undertaken as part of LFA3 of the operation and confirmation that these are Variable Speed Drive (VSD).

Biological Treatment on the WWS takes the form of aeration (air injection), pumping and UV treatment. A SCADA system is used to measure oxygen levels within the aeration, which is the determining factor for the aeration speed.

It is currently understood that the energy usage split is circa 40% aeration, 40% pumping and 20% UV treatment, but these need qualifying.

To avoid the treatment works being inundated, the storm tanks that are used to regulate the flow are not for casual usage and must be emptied within a time frame specified by the Environment Agency (EA).

It was evident that the capability to reduce pumping rates for the water would be constrained by operational needs to avoid unintended spill and the impact on the biological treatment systems, which need a constant flow of liquid.

Feasible initiatives identified

i) Forecast of fill & flow levels to change pump usage,
ii) Generate a new time managed profile/way of filling that could drive pumps harder to increase volume.
iii) Harder aerating on demand changing number of blowers in use,
iv) Reduced aerating on demand changing numbers of blowers in use,
v) Using SCADA system data to drive analytics of required blower usage. Blowers are circa 100 kW, pumps circa 20 kW

- **Control Room**

The majority of operations are based around ongoing maintenance, live issues and pre-planned volume needs. The CR operates a level of DUoS/TUoS power shifting, but this is a manual process.

The capacity of the CR to perform in-day liaison with the Distribution Network Operator (DNO) is limited but a potential warning process similar to Demand Side Response (DSR) could be set up.

Feasible Initiatives identified

i) Develop a “Pump Scheduling Tool” that would make planning pump times less manual.

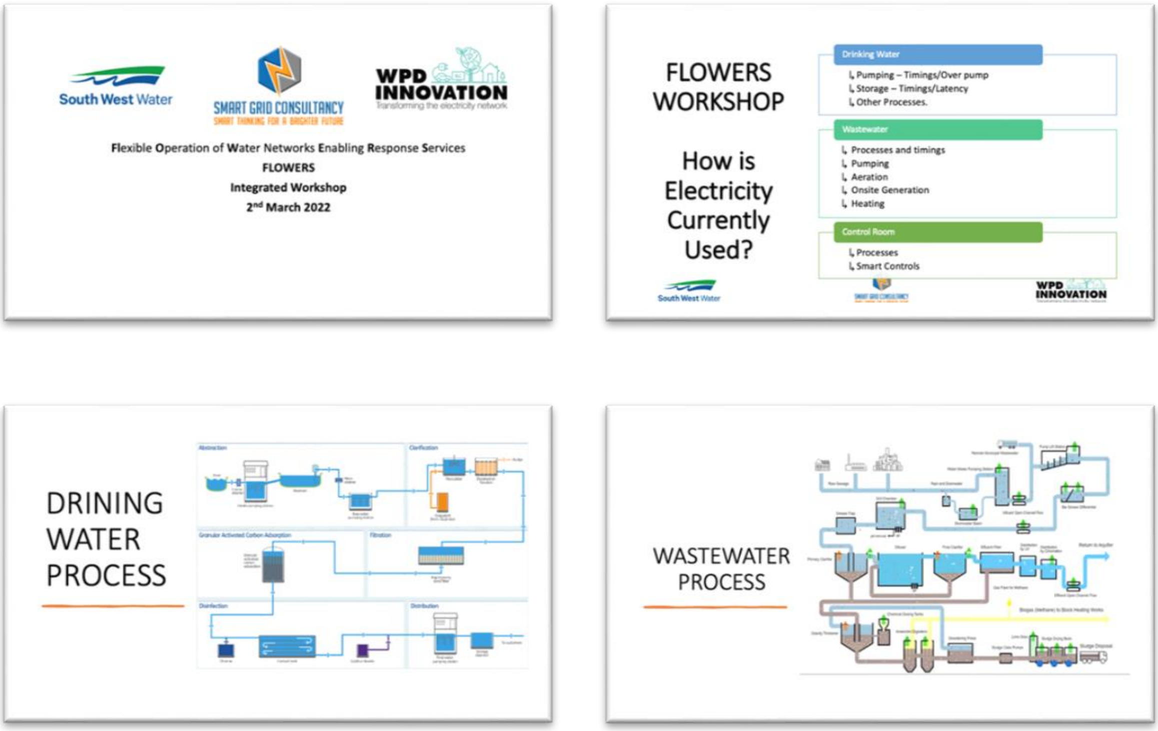


Figure 4-1 - Workshop 1 Slides

4.2 Workshop 2 – 4th March 2022

The second workshop was split into two separate events for DWS and WWS to allow more time for detailed discussions.

1) WWS Workshop 2

- **Information Gathered**

High rainfall/storm events have a benefit in filling reservoirs but increase chemical usage. SWW's Water Resources team, may be a good point of contact to review what is allowed from:

i) Managing compliance with abstraction licenses.
ii) Raw water storage position.
iii) Operation curves for impounding reservoirs.
iv) Net storage position triggers.
v) Borehole water pumping.

VSD are not necessarily appropriate, due to the actual pumping speed needed not allowing a variable usage pattern. Pump speeds are currently set to the optimum pump efficiency curve. However, increasing the pump size, then adding modern VSD may reduce energy usage. The major benefit would be seen in shifting usage time and/or increasing the pump sizes to reduce pumping time.

SWW have one wind turbine at Lowermoor WTW and a number of photovoltaic (PV) ground mount systems, with more sites earmarked for reservoir floating/mounted PV, with the procurement route being full ownership or via Power Purchase Agreements (PPA).

There are a number of hydroelectric spill turbines which only generate when water is spilling from the reservoir. The EA enforces a "compensation release into water course" to ensure too much water is not being taken from water courses.

Mary Tavy and Morwellham power generating stations were mentioned with a note made that investigation would be needed, as part of LFA4, of any impact on the ability to receive Renewables Obligation Certificates (ROCs) when implementing multiple pumping actions. The fleet of onsite generators are mainly standby and not grid tied.

Pump Scheduling Systems have previously been installed for DUoS / TUoS. A review of the performance of these needs to be undertaken to ensure controls are operating. Onsite Reservoir Profile systems also need reviewing to ensure set points are as expected.

- ***Feasible Initiatives identified***
  - i) Develop a "Pump Scheduling Tool" that would make planning pump times less manual – checking for any room for manoeuvre of current parameters to shift pumping.
  - ii) Hydro Electric Power (HEP) - review the usage of these and if they can be dispatched on demand
  - iii) PV ground mount - review future proposals for PV and identify target NGED grid supply points.
  - iv) Weather forecasting (specifically rain) - reduced need to extract into reservoirs from Water courses/aquifer
  - v) Drinking water Variable Speed Drives
    - a. A sharp demand curve would see energy benefit; however, there would not be so much benefit for shallow demand curves
  - vi) Pumps mismatch in terms of volume ability could be causing some energy overuse - Review maintenance schedules to improve energy efficiency and therefore free up capacity
  - vii) Borehole water review shifting pumping times – Water Resources team

Figure 4-2 - DWS Workshop 2 Slides

2) DWS Workshop 2

- **Information Gathered**

DUoS interventions have caused some issues previously, so extreme care needs to be taken when shifting energy usage. The nature of these issues will need to be detailed and mitigated as part of LFA 4.

There are 600 (soon to be 800) new Sewers for Adoption (SFA) style pump stations, where the surface water is separated from foul sewerage. Foul has 24 hours of storage as part of regulation and dedicated pumping which is controlled by basic switch levels controls. The volume of designed storage is calculated depending on buildings. Pre SFA this was combined into one system. The new SFA style stations mean much less rainwater is delivered to the WWS treatment sites.

Storm tanks usage is governed by EA regulation, with permits detailing how quickly each storm tank must be returned to availability.

Grit removal paddles run 24/7. If the paddles turned off, grit would build up and cause paddles to stop. There is a possibility of air injection into some grit removal set ups.

Screening is predominantly via some fixed metal screens and a number of revolving screens. This process is very low energy.

There is anaerobic digestion (AD) on some sites, such as Countess Wear. These systems are fairly old. The burning of the AD gasses generates circa 35% of the site energy needs. Having AD on some sites has resulted in the EA putting in place an ammonia license, meaning treating and removing the ammonia is possibly causing more energy usage to deal with the ammonia, with 0.6 MW plant converting it to nitrate.

UV Treatment is an EA consents enforced obligation to run. However, this is not an insignificant energy usage. For example, demanding 150 kW at Countess Wear.

Infiltration was raised as an ever-increasing issue, where pumping energy is increased due to the need to pump away infiltration from rivers or sea water.

Treatment works near watercourses or coasts, where water or seawater infiltrates the network, causes issues with processes involving chemicals and compromises ability to take equipment offline to replace or refurbish. Honiton sewage treatment works (STW) was named as an example.

Infiltration at some sites is driven by water table levels. In the summer, the water table level drops below infiltration point. In winter the level goes above infiltration point. The impact on energy usage and processes when this changes should be visible in the half hourly MPAN data. Prixford sewage pumping station (SPS) energy usage was named as an example.

Monitoring at the site Sandy Bay was mentioned; this needs further investigation to ascertain granularity and usability of the data. SWW also possesses a list of sites categorised as “Frequent Spillers”, which may be investigated.

Spring tides substantially impact Plymouth Central Network, with infiltration circa 400 litres per second. The pumping stations are being overrun with sea water, pumps are operating far more than needed to process sewage, and the equipment is being impacted by sea water degradation.

Aeration Control Systems are basic and need updating, with DUoS/TNUoS recovery timings needing to be understood and rolled out.

There is little or no celebrating or sharing of information relating to energy-saving achievements within the business.

- ***Feasible Initiatives identified***
    i) New SFA style pump stations - Profiling the levels of this storage to hold off or pre pump
    ii) Storm tanks usage during known dry days – needs EA licence review
    iii) Grit removal paddles potential to slow down during low demand
    iv) Anaerobic digesters and energy generation times – review generating schedule to assess if feasible to generate electricity during peak time.
    v) UV Treatment - review potential provision of LED for UV to reduce energy usage from fluorescent and review timings of usage where UV is used.
    vi) Pumps refurbishment programme - identify where the pumps have been refurbished and compare the energy usage to identify energy benefit.
    vii) Infiltration – develop profile or forecast seasonal impact and plan pumping accordingly.
    viii) Aeration Controls - smart controls for recovery period – Fluxton (Adaptive Aeration Control)
    ix) Behaviour change - performance reporting and sharing achievements.

Figure 4-3 - WWS Workshop 2 Slides

4.3 Control Room Surveillance – 22nd & 23rd March

- **Information Gathered**

It is evident that the CR team does not have visibility of onsite energy generation curves which could be used to drive pre-pumping planning. Approximately 60% of the WWS network may be controlled from the CR.

A System called “Aquametis” is being/has been used for settings input onsite. Pump profiles are based on set levels, with low/switch on at 75% and switch off at 90%.

There is a potential benefit to having NGED Control Room to SWW Control Room communications during power outages. SWW systems sometimes trip during NGED switching actions. There is potential for pre-warning when NGED is switching network configuration. Power quality issues and voltage fluctuations are also causing tripping of SWW pumps. It may be possible to expand the actions SWW carries out to mitigate these issues.

- **Feasible Initiatives identified**
  - i) Pump harder at weekends to reduce start of week energy demand
  - ii) Own onsite generation forecast to use for forward pumping.
  - iii) Review that all set points are as needed for current demand and operating as expected.
  - iv) Forecasting of the expected demand to enable adjustment of pumping/storage levels
  - v) Review the “Water Treatment Works Reliability Tracker” for info on NGED network impacts on SWW systems.
  - vi) Review site operating power factors

5 Summary of Information Gathered

This section gives an in-depth overview of the background context to the operation of a water utility and a few considerations on the interventions that could be investigated further to enable time shifting of, or the reduction of, the total energy use to enhance the headroom at the electricity network substation.

5.1 Drinking Water Services (DWS) Function

The majority of the DWS function's energy usage is related to pumping. This is based around the fill levels of reservoirs which are controlled by a number of simple trigger points, i.e. % of fill levels or fill in distance (metres).

This means that at a reservoir, when it reaches a certain fill height, the pumps switch off. When the reservoir reaches a certain low level point, the pumps switch on. As far as could be ascertained, there was no trend analysis of when reservoirs needed to be at a certain level, instead operating on a fill cycle based on trigger points.

Within the DWS function there are two types of reservoirs.

1) Impounding, where fresh water is collected
2) Service, where treated fresh water is held

The impounding reservoirs are filled via borehole extraction, watercourse extraction, water table infiltration or simple rainwater catchment.

The water is moved, either by gravity or pumped, to Water Treatment Works then onto Service reservoirs for distributing to end users.

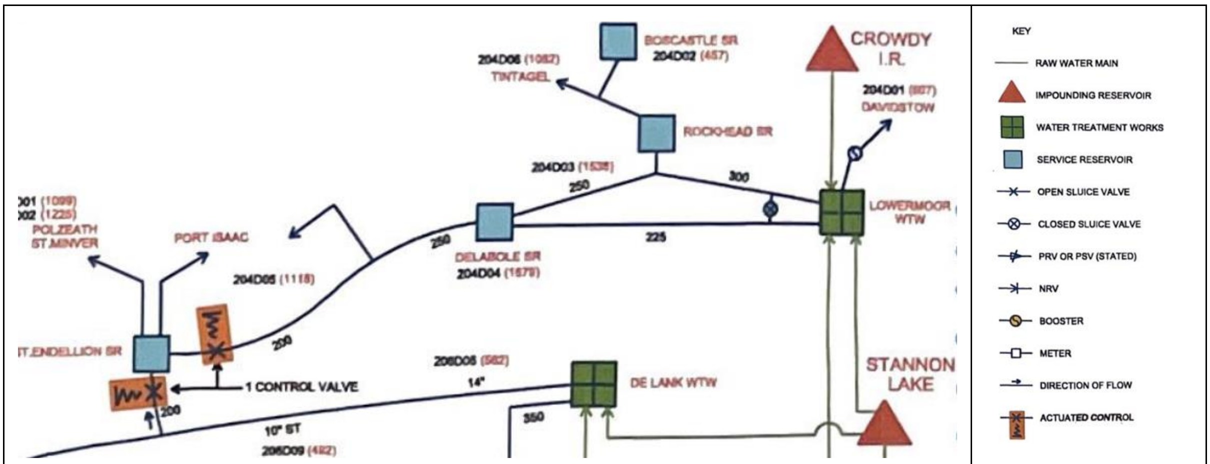


Figure 5-1Example DWS Network Map

Figure 5-2 Example DWS Network Map

Feasible interventions identified for the DWS function would be based around adjusting the pumping schedules of the pumping stations by altering the high and low set points. With the use of forward forecasting for water storage needs based on demand, the process could be improved further.

5.2 Waste Water Services (WWS) Function

The majority of the WWS function's operational energy usage is from the treatment of the Influent to the treatment works via the inlets.

There are three main areas of energy usage within a wastewater treatment plant:

1) Aeration in the activated sludge tanks
2) Ammonia removal
3) Ultraviolet (UV) treatment

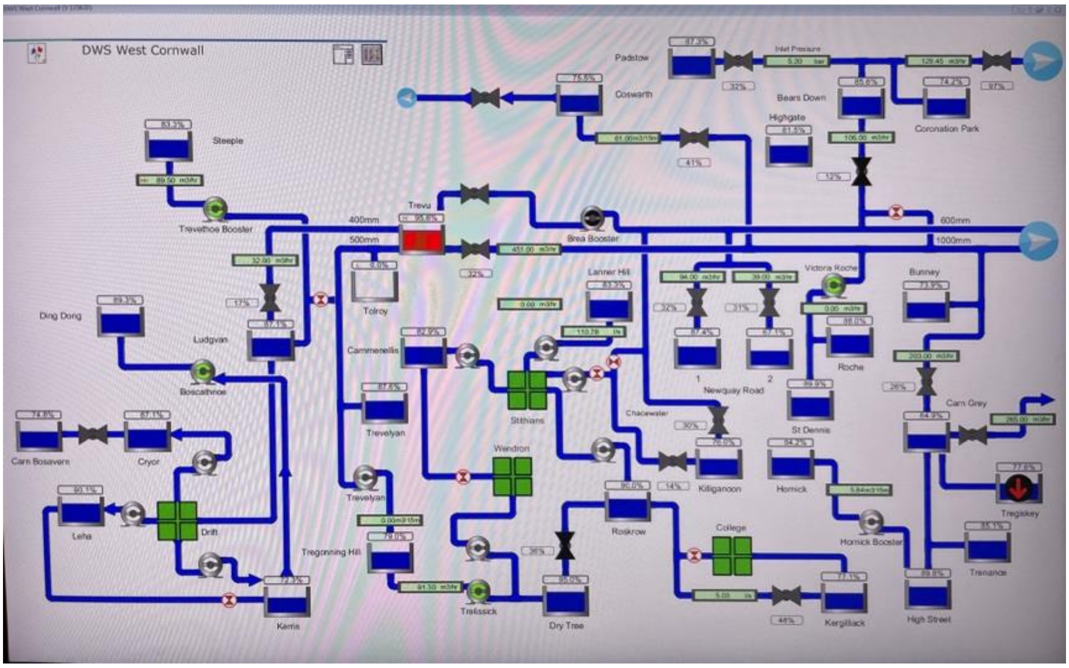
In the WWS network there are more pumping stations than the DWS function, but these are smaller and have some ability to hold liquid if the pumping was held off for several hours. However, this should be investigated during the next phase as there is feasibly 300 - 600 of these smaller pumping stations. The average annual kWh usage of these pumping stations is circa 75,000 kWh with a maximum of 3.9 MWh and a minimum of 1,750 kWh.

The volume of rain water entering the WWS network has a dominating effect on the energy usage of WWS treatment sites. The design of the waste water network in the UK means that rainwater is merged with sewerage, meaning that it needs to be treated as sewerage. Therefore, during rain events, this vastly increases the volume of liquid that treatment works need to deal with.

This influx of storm water is controlled using stormwater tanks. which hold this increased volume until the treatment facility can treat it. These stormwater tanks, on initial understanding, hold circa 300 minutes of stormwater at the maximum flow rate that the treatment works can treat; this is stipulated by the Environment Agency.

5.3 Control Room (CR)

The CR is currently an alarm reactive operation with very little forecasting or future planning of when pumping or other energy-intensive operations should be engaged. The CR have digital versions of the networks for ease of management of the alarms which are triggered predominantly when set points are breached.



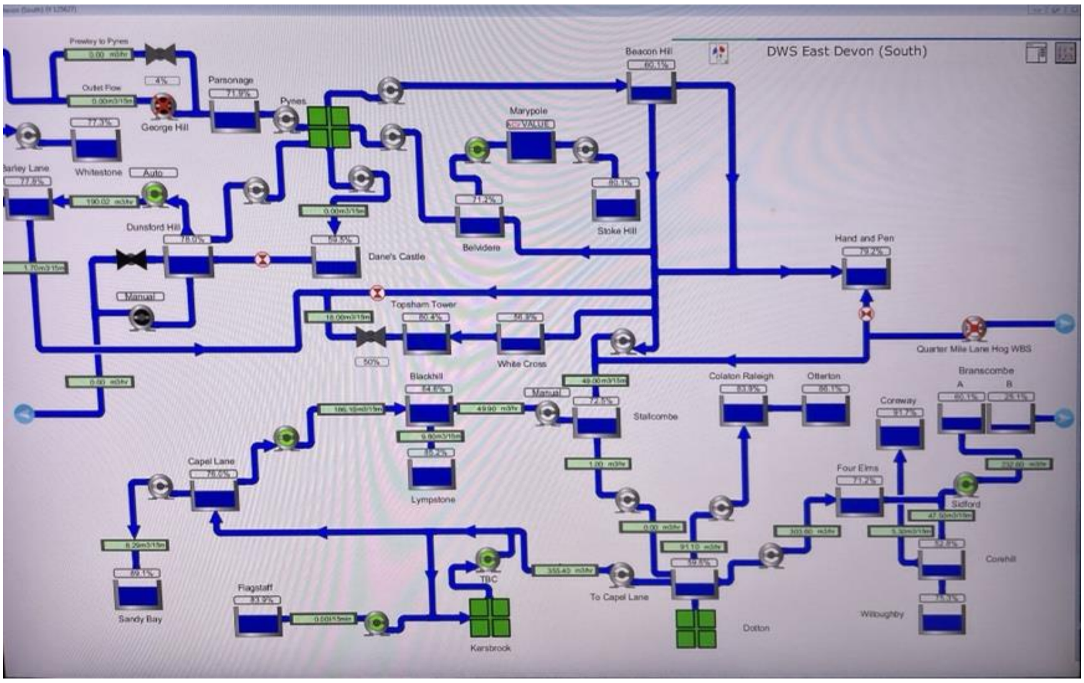


Figure 5-3 - Example DWS Control Room Network Screens

The CR uses several control systems to manage the DWS and WWS functions, with no one system capable of controlling all the assets:

1) Aquametis – Mainly for DWS
2) Paragon – Mainly for DWS
3) iWorks – Mainly for WWS

The Aquametis and Paragon systems are predominantly used within DWS to adjust the status of pumps, overriding the automatic, locally triggered, SCADA controlled switching to turn pumps on and off.

There is a system called iDatamart that holds historic information of the set points and trends of system component usage. This system needs to be investigated to ascertain if it could help the project team determine the energy usage of system components by cross-referencing information from it with MPAN data.

The CR currently implement a DUoS pump/aeration turn off, ramping down from 16:30 PM and ramping up from 19:00 PM. This is done manually from the CR, pump by pump, based on a schedule produced each morning by the CR team. The “DUoS Draft Schedule” identifies which pumps could be stopped during the DUoS period.

Action priority		Outstation		Pump Name		PLANNED ACTION 17:00 hr's		PLANNED ACTION 19:00 hr's	Duos Page	Flow to	Discrete nos.	NOTES ALL ** NOTES CAN ALSO BE ACTIONED FROM DUOS PUMP INHIBIT INDEX
		North Devon										
1	Y	Pilton WPS		Pump No 2 Control		STOP PUMP		START PUMP	1	Bratton Flemming SR	O0012, 013,014	
1	n	Pilton WPS	No.3 Duty	Pump No 3 Control					1	Bratton Flemming SR	O015, 016,017	
1	Y	Newbridge WPS	No1 Duty	Pump No 1 Control		STOP PUMP		START PUMP	1	Bratton Flemming SR	O004, 005, 006	
1	Y	Newbridge WPS		Pump No 2 Control		STOP PUMP		START PUMP	1	Bratton Flemming SR	O007, 008, 009	Perform an Update first - Switch to SCADA first O007, then stop on O009 turn on O008.
1	y	Blakewell Booster		Blakewell Pumps Operation		STOP PUMP		START PUMP	4	Horedown SR	O006,007,008 O009,010,011	Switch to SCADA to STOP. Switch to Auto to START. (Pumps may not start if Horedown level is high enough).
2	n	Bratton Flemming WTW		Bratton Down Booster					1	Bratton Down SR	O003	
3	y	Fairlynch Booster	No1 Duty	Inhibit Pump		STOP PUMP		START PUMP	2	Georgeham SR	O004,005,006 O007,008,009	Switch to SCADA first O004, 007 then STOP on O005 ,O008. To START SWITCH BACK TO AUTO O004, O007
1	y	Willand WPS		Woodgate Overide to Stop Pump		STOP PUMP		START PUMP	RDP	Woodgate SR	O026	Control from Willand page - O026 "Woodgate Pump Set Control Source"
1	y	Willand WPS		Roodloft Pump Control		STOP PUMP		START PUMP	RDP	Roodloft SR	O030	Control from Willand page - O030 "Roodloft Pump Set Control Source" Select Remote to stop pump / Select Local to start pump
2	y	Uplowman WBS		Pump No 1 & 2 Control		STOP PUMP		START PUMP	RDP	Hockworthy & Chimney Down SR	O004 & O007	Switch O004 & O007 to SCADA to STOP pumps. TO START PUMPS SWITCH BACK TO AUTO O004 & O007
1	n	Allers		Inhibit Pump					1	Bickham Moor SR	O00 1	**Stop pantacridge first and leave for 5minutes before shutting Allers and vice versa to restart. - Active to stop, Not Active to start (O001)
2	n	Pantacridge WPS		Pump No 1 & 2 Control					1	Bickham Moor SR	O001	Switch O001 to INHIBITED to STOP pumps. TO START PUMPS SWITCH BACK TO NORMAL O001
2	y	Dunsford Hill WPS		Barley Lane Pump Inhibit		STOP PUMP		START PUMP	2	Barley Lane SR	O002	**Control is from Digital Output.
1	n	Dunsford Hill WPS	16/03/22 - Pumps Not in Use today	Tottiford Duty Pump Control					RDP	KTT Transfer Flow	O003	Stop/start
N/A	y	Sidford WPS Pump1		Pump 1 Start/Stop Control		Follow Instruction NB1		Follow Instruction NB1	RDP	Gatcombe SR	O007	NB1
N/A	y	Sidford WPS Pump2		Pump 2 Start/Stop Control		Follow Instruction NB1		Follow Instruction NB1	RDP	Gatcombe SR	O008	NB1
3	y	Marypole Head SR		Inhibit Stoke Hill Control		STOP PUMP		START PUMP	2	Stoke Hill SR	O001	**Control is O001 from Marypole Head SR Digital Outputs. Select Active to stop pump // Select Not Active to start pump
2	y	Lyme Road WPS		Inhibit Pumps	>>	STOP PUMP	TAG	START PUMP	2	Raymonds Hill SR	O003	**Control is from Digital Output O003 "Pump set Inhibit status" to Stop select: "Active" to start select: "Not Active" Will need to Check Meter Tab M013 on RDP and make sure flows respond accordingly
1	n	Capel Lane		Blackhill Pump Inhibit					4	Blackhill SR	O006,007,008 O009,010,011	
3	y	Capel Lane		Sandy Bay Pump Inhibit		STOP PUMP		START PUMP	4	Sandy Bay SR	O014	**Control is O014 from Capel Lane DIGITAL OUTPUT Select ACTIVE to stop pump // Select NOT ACTIVE to start pump
1	n	Stallcombe SR WPS		Pump 3 Remote Control					RDP	Blackhill SR	O015, O016 & O017	
2	y	Alston WPS		Duty Pump Stop/Start Control Assist Pump Stop/Start Control		STOP PUMP		START PUMP	2	Hillhead SR	O006,007,008 O009,010,011	Switch to SCADA first O006,009 then STOP on O008,010 START on O007, O009, and switch back to AUTO on O006, O009
	n	Langridge Cross	Reduce Flow or Stop Pump #2	Pump1 + Pump 2					RDP	Blackdown SR Stanborough SR		Reduce HTZ to 41 (In Stages) Before stopping pumps

Figure 5-4 DUOS Schedule Sheet

The evidence of this DUoS procedure confirms that there is some capacity for latency within the DWS and WWS functions that could be time targeted depending on location and demand.

5.4 Environment Agency (EA)

The EA gives SWW permits/licenses to carry out each of its DWS and WWS activities. These detail items such as volumes and treatments that must be undertaken and are location-specific, so one size does not fit all locations. These can dictate:

1) How much water can be pumped from water courses and boreholes in any given timeframe.
2) How much stormwater must be removed from the storm tanks after any event over a given timeframe
3) How much foul water should be treated over any given timeframe.
4) Any further waste treatment that is required. For example, the removal of ammonia as seen at Countess Wear treatment site.

This means that any adjustments made to take advantage of latency within the systems would need to be closely checked in detail for alignment with the relevant EA permit/license stipulations.

5.5 Equipment Maintenance

Part of the scope of the FLOWERS project is to identify if it is feasible to reduce the overall energy demand of SWW sites to enable substation headroom to be freed up to allow more generation connections.

With this in mind it was noted that an improved replacement/maintenance regime could go a long way towards supporting the reduction of: total energy usage, associated carbon emissions and ongoing maintenance costs. This could be implemented by placing emphasis on replacing hard-to-maintain, energy-inefficient equipment with more modern energy-efficient equipment.

For example, some pumps in use exceed their designed operating age. These will need ever increasing maintenance work and will have been superseded with much more energy-efficient pumps.

Likewise, in the aeration process, the timing of diffuser replacement in the irrigation tanks could be further investigated to ensure the trigger point of using more energy than required is fully understood in relation to the costs associated with replacing the diffusers.

Both of these are examples, of where using more efficient equipment, could bring down the total energy demand of sites thus freeing up headroom at the network level for more renewable generation assets.

5.6 Overall Summary

It is evident that it will be more feasible to turn down pumping within the DWS function than it will be within the WWS function. This is largely due to the biological treatment process within the WWS treatment sites requiring a constant minimum flow of liquid to maintain the health of the biology.

There are several feasible interventions that could be implemented to enable shifting of when energy is used within DWS and WWS. These will be explained in greater detail in section 6 but as an example the strongest implementable initiatives from each sector are shown below;

1) In the DWS function taking advantage of some latency where pumping, at various pumping stations on the network, could be held off for a number of hours.
2) In WWS function taking advantage of modulating the blowers which are used within the aeration of the liquid that is being treated and the aeration of the ammonia plant where there is an ammonia license condition.

The CR currently has a lack of visibility of energy information that could enable them to make informed decisions on when to implement pump or blower turn-up or turn-down.

For example:

1) Choose to increase pump volumes, allowing subsequent latency during high stress periods for the electricity network, depending on the forecast amount of SWW own PV or green gas CHP electricity generation.
2) Choose to increase pump volumes during peak renewable energy generation which is causing stress on the wider electricity network or is being curtailed via Active Network Management (ANM)
3) Hold off pumping or modulate aeration at times of peak demand where generation is lacking.
4) Increasing or decreasing energy usage by having visibility of day-ahead energy prices.
5) Participate in behind the meter demand side response (DSR) programs for the ESO and or the DSO. Especially programs like demand turn up.

6 Classification of Opportunities

6.1 Classification

The opportunities identified during the workshops and control room surveillance have been classified into one of 5 groups.

- **Low hanging fruit** – opportunities that are achievable, feasible and have clear benefits.
- **More challenging** – opportunities that require some further investigation. It may be concluded these are too limited or risky, or are possible but require internal SWW investment (for which FLOWERS outcomes may support the business case).
- **Worthwhile with focus** – opportunities where focus needs constraining to identify the mutual electricity and water network benefits.
- **Energy management/efficiency** – opportunities that align with energy management rather than flexibility.
- **Out of scope** – opportunities which relate to other projects but could be of interest.

6.2 Low Hanging Fruit

Initiative	Detail
1. DWS & WWS - 3 to 4 hours turndown/switch off of pumps	• Currently being manually implemented as 'DUOS' turn down between 17:00 and 19:00. • Review timings to assess if would be more beneficial to do this when the local network has over demand issues.
2. WWS - Increasing and reducing aeration blowers for biological treatment	• Smart aeration control that can hold off or ramp up with updated Fluxton system
3. DWS & WWS - Produce pumping profile based on a model that creates a schedule for control room.	• Provide a forecasted pumping schedule that reflects the fill levels and treatment volumes that would be needed based on next day known factors. • Factors could be weather, population change, energy price signal, energy over generation (ANM), energy over demand, Demand Side Response and weekend pre pumping.
4. DWS - Drinking water reservoir pre-filling	• Pre-fill reservoirs when too much local generation is impacting the electricity network or SWW own generation is high. • Operation curves for impounding reservoirs and borehole water pumping

Initiative	Detail
	• Onsite energy generation forecast information tool for control room
5. Onsite Hydro & CHP generation	• Develop a better understanding of when this generation should be used or programmed
6. WWS - Re-Profiling levels of storage	• Hold off or pre-pump at new SFA style pump stations, Sewerage Pump Stations (SPS) and Sewerage Pump Station Terminals (SPST).
7. DWS & WWS - Review all set points are as needed for current demand and operating as expected	• Total review of all set points as implemented onsite to ensure no creep has happened since original implementation.

6.3 More challenging

Initiative	Detail
1. WWS - Timing of UV treatment usage	• Determine if UV treatment can be modularised with reduced flows.
2. WWS & DWS - Pump size increase and/or mismatch check versus volume requirements	• Review the benefit of increasing the pump sizes to enable quicker movement of the required volume of water. Thus shortening the operational hours. • Wrongly sized pumps or mismatched pumps could be driving increased energy usage.
3. WWS - Changing usage of infiltration pumping based on forecasting	• Profile the usage of increased pumping based on tidal flows to enable pre pumping.
4. DWS & WWS - Energy performance reporting, achievements sharing and Maintenance Management Information	• Development of site based energy reporting scorecards and targets. • Roll out of energy sub-metering to enable measurement of usage. • MI - Aid identification of above baseline energy usage to inform maintenance requirements
5. WWS - Adjusting timing of grit removal paddle operation	• Modularise the paddles kWh usage based on flow rates.

6.4 Worthwhile with Focus

Initiative	Detail
1. DWS - Pump Variable Speed Drives	• Identify where VSDs would be beneficial based on demand profile.
2. WWS - Sea water infiltration pumping.	• The amount of sea water infiltration is greatly impacting pumping energy usage. • This has been identified as a consequence of low maintenance of components used to restrict sea water infiltration.
3. WWS - Storm Tanks usage to hold off treatment works	• Use storm tanks to reduce flows to the treatment works when weather forecast is clearly zero rain • Would need a review of the EA permit and potential liaison with EA

6.5 Energy Management/Efficiency

Initiative	Detail
1. DWS - Pump Variable Speed Drives	• Identify where VSD's would be beneficial based on demand profile.
2. WWS - LED lighting for UV treatment	• Review the available LED technology to ascertain replacement of current fluorescent tubes reduction of total energy usage
3. WWS & DWS Reducing energy usage with refurbished pumps	• Compare the energy usage to identify energy benefit of pump refurbishment.
4. WWS - Ceramic filtration systems to reduce energy usage	• New design of filtration system as installed at Mayflower WTW could enable modulation of the filtration. • Energy kWh savings to be understood which could lead to re-classification of this item.
5. WWS & DWS - Power factor correction	• Ensuring a power factor as close as possible to one could reduce energy costs.

6.6 Out of Scope

Initiative	Detail
1. Operational link between NGED and SWW Control rooms to avoid outages	• A number of SWW pump outages have a causality attributed to NGED network switching - a "heads up" communication between the Control Rooms could be good to try an avoid these.
2. Review Water Treatment Works Reliability Tracker for info on NGED impacts on SWW systems	• Unclear if this drives increased energy usage.
3. Anaerobic Digestion and Ammonia licence Condition.	• Assess the energy balance of running the AD and CHPs where the treatment site has an Ammonia licence condition • There is potential, where this condition exists, the kWh needed to treat the Ammonia outweighs the kWh generated by the biogas CHP

7 Data Evaluation

7.1 Data Sources

The following data is being used to assess the energy demand on the substations that WW sites are connected to.

South West Water

1) NEMESIS - This is the company's energy management system, which contains energy, billing, mapping, and asset information.
2) MPAN half-hourly kWh usage
3) Sites with onsite generation (PV, CHP, Hydro and Wind)
4) Sites with PV planned

National Grid Electricity Distribution

For the SWW MPAN facing NGED substations

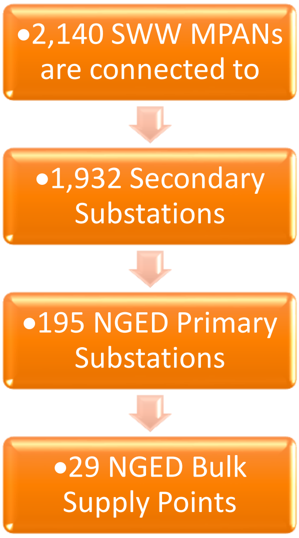
1) List of substations
2) Current substation headroom and constraints
    a. Over Demand
    b. Under Demand
3) Current Flexible Power procured services
4) Sustain, Secure, Dynamic & Restore
5) Future substation headroom and constraints

7.2 Actions Taken

The initial process was to obtain a list of all the SWW Meter Point Administration Number (MPAN) to ascertain the relevant NGED substations that SWW's sites connect to.

7.3 High Level Evaluation

The initial sweep of the SWW and NGED data highlights the following numbers:



- From these MPANs the four-year average annual electricity usage is 301,494,894 kWh
- The three largest energy using sites account for 15% of SWW total energy usage
    - Restormel Water Treatment Works, Lostwithiel, Cornwall using 17,921,810 kWh or 6.9% of SWW total site electricity usage.
    - Littlehempston Water Treatment Works, Totnes, Devon using 11,424,324 kWh or 4.4% of SWW total site electricity usage.
    - Torbay Wastewater Treatment Works, Brokenbury Quarry, Churston, Brixham using 10,096,855 kWh or 3.9% of SWW total site electricity usage.
- The remainder of the sites kWh usage is as below

Annual kWh Usage	Site count
2,000,000 - 9,999,999	19
1,000,000 - 1,999,999	31
500,000 - 999,999	49
100,000 - 499,999	174
50,000 - 99,999	153
10,000 - 49,999	509
5,000 - 9,999	252
1,000 - 4,999	736
100 - 999	65
< 100	141

7.4 Example energy demand and primary substation constraints.

The graphs below are an example of the data that will be produced during LFA3 to identify and quantify the opportunity windows at SWW sites. This particular example relates to Torbay Sewage Treatment Works. The relevant NGED primary substation and Constraint Management Zone (CMZ) for the Torbay STW is CMZ_T2A_SWE_0001.

As can be seen, the energy usage shape at Torbay STW is consistent. The amount of constraint varies seasonally and monthly. There is a constraint during the summer mainly at the peak time of 16:00 to 21:00. This changes during winter to be mainly all day from 09:00 to 21:00. The task is therefore to identify which of the initiatives listed in section 6 can be implemented at this site to reduce the constraint.

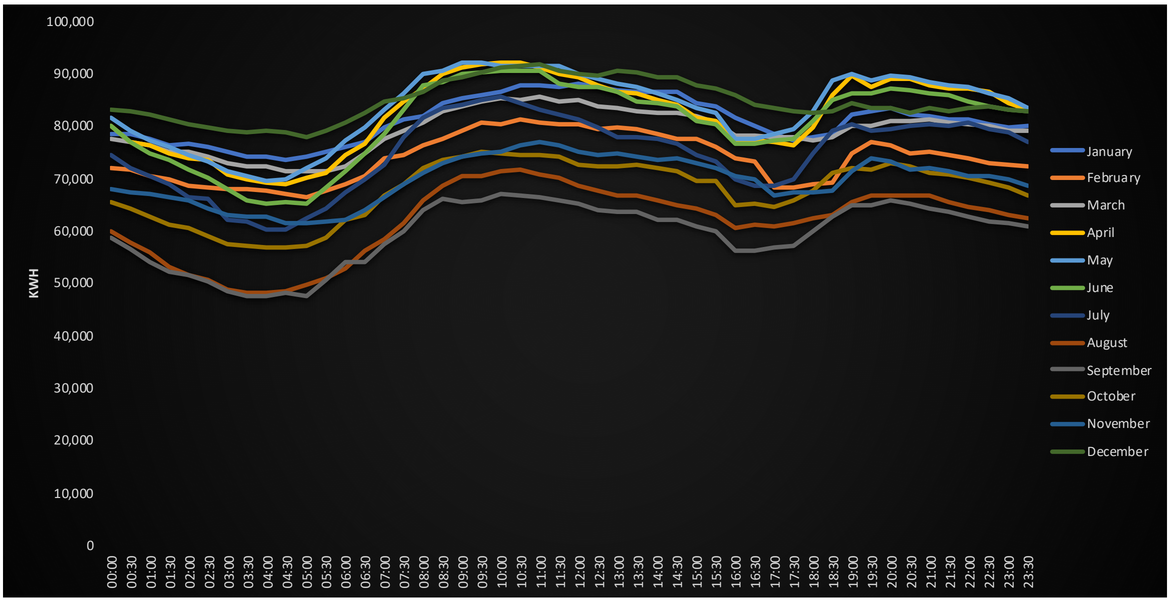


Figure 7-1 Torbay STW Average Monthly kWh Usage by Time of Day

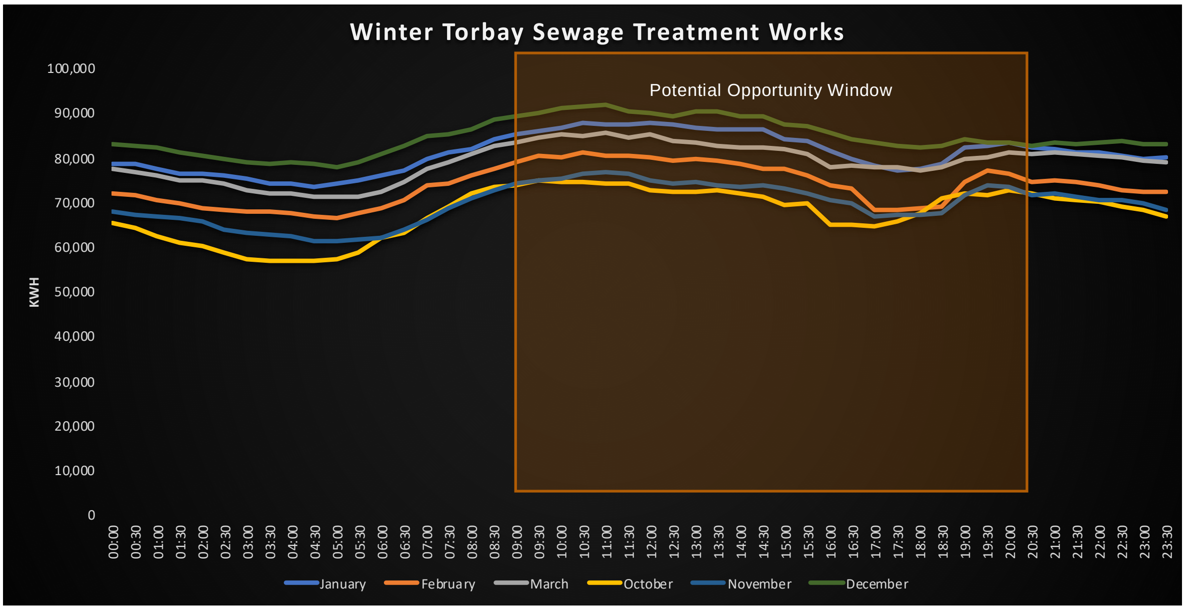


Figure 7-2 Torbay STW Winter Average Monthly kWh Usage by Time of Day

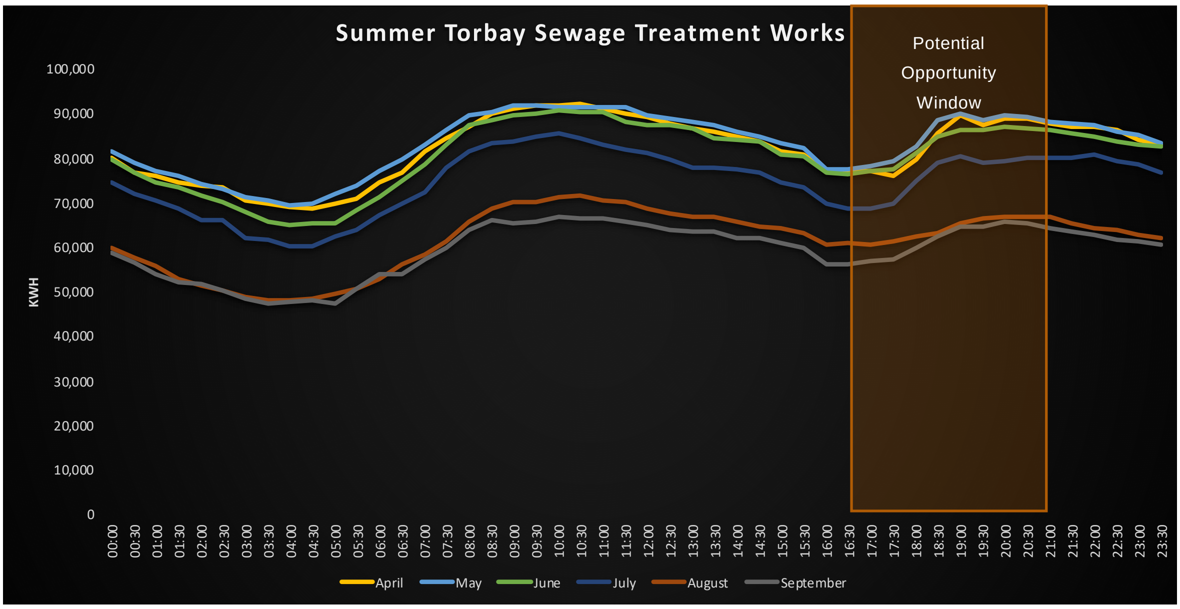


Figure 7-3 Torbay STW Summer Average Monthly kWh Usage by Time of Day

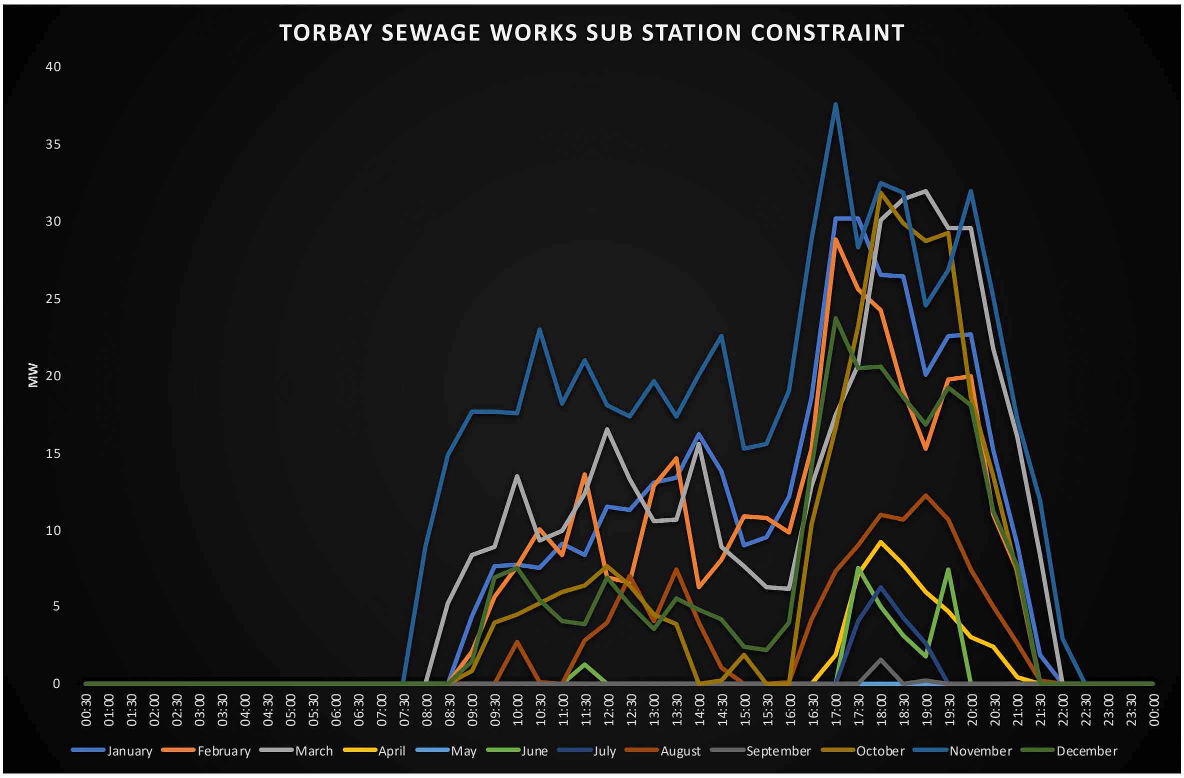


Figure 7-4 Torbay STW Sub Station Constraint

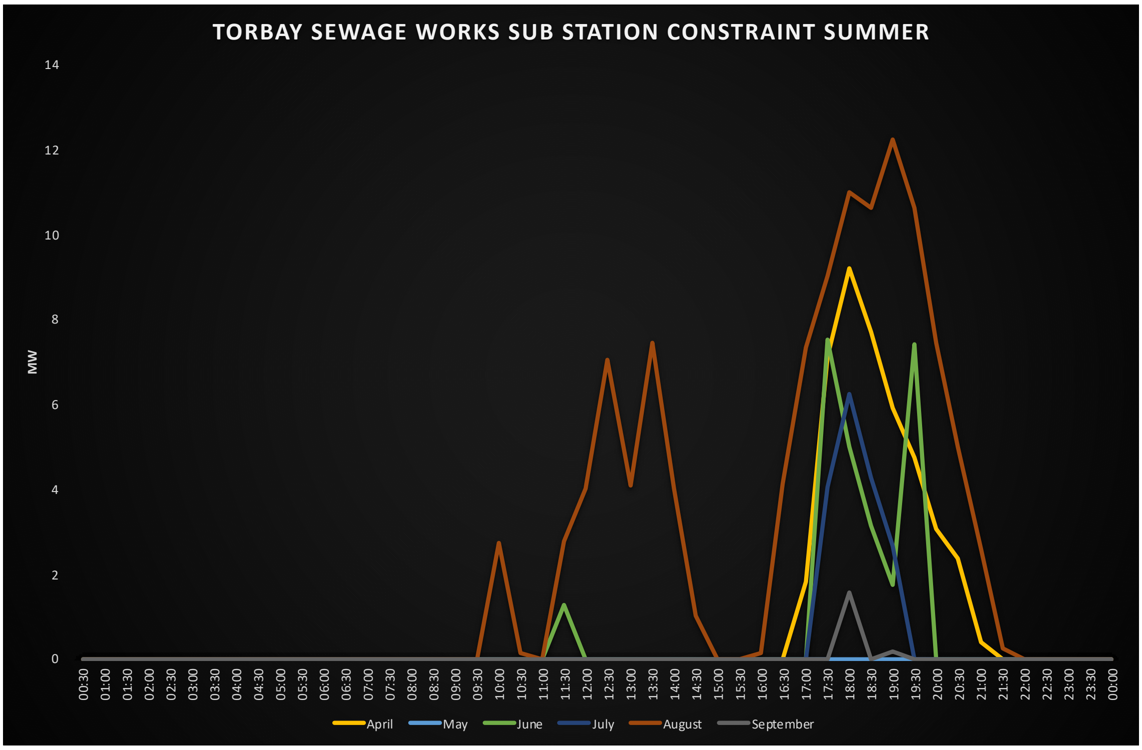


Figure 7-5 Torbay STW Sub Station Constraint Summer

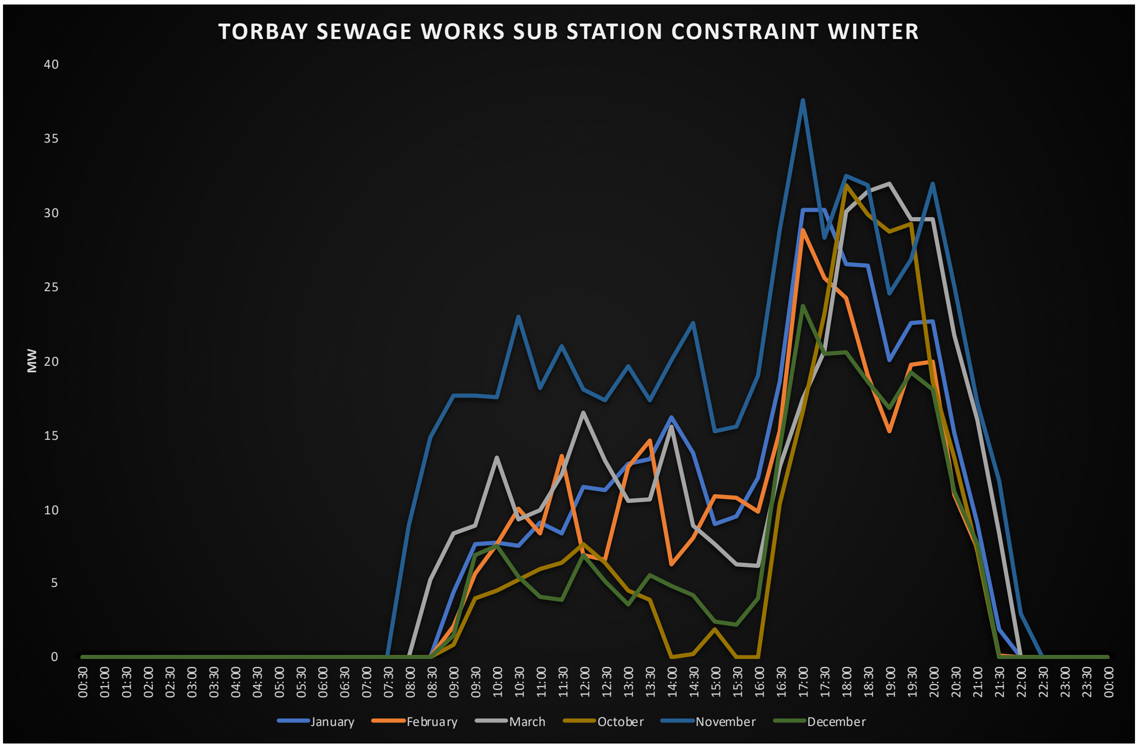


Figure 7-6 Torbay STW Sub Station Constraint Winter

8 Next Steps

- The NGED data cannot be interrogated using MS Excel due to the file sizes therefore, this work is being done using a SQ lite database.
- Once the different data sets have been matched to the SWW demand, generation needs to be considered, because this data is separate to the aforementioned and needs to be incorporated into the analysis
- Investigate where there is local over-generation, on the same substation that a SWW site is connected to, and where other parties are on ANM connection. Could SWW increase demand to remove the need to invoke the ANM.
- Classify SWW sites in known Constraint Management Zones (CMZ) as below:

SWW Site Name	SWW MPAN	NGED Substation Name	NGED Substation Number	In Constrained Management Zone	Possible Constrained Connection (Y/N)	Flexibility Services being Procured

- Classify SWW Sites not in CMZ's as below:

SWW Site Name	SWW MPAN	NGED Substation Name	NGED Substation Number	Other Opportunities (SWW Future Onsite Generation)	Possible Future Constrained Connection (Y/N)

- The Network Flexibility map will be overlaid with SWW sites. This will highlight positive correlations between NGED constraints and SWW demand and therefore opportunities for interventions.
- A deeper detailed investigation will be carried out on what would need to be true/put in place to progress the identified interventions.