

Water Treatment Project

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Industry: Train Operating Company

Railway – Rolling Stock Maintenance Depot (also applicable to Real Estate and Stations)

Assets: Infrastructure assets supporting train maintenance:

- Low pressure cold and drinking water systems
- Industrial and office hot water systems
- Office and Rolling Stock - Toilets and Sanitary Equipment
- Pressurised cleaning systems including steam
- Water storage units – portable and fixed
- HVAC
- Effluent management systems

What is the idea proposed for improving performance?







































Fitment of a water treatment system to the depot incoming supply. This treatment is as used in hospitals and uses two treatments, one a disinfectant, the other causes limescale to form in suspension rather than on water system components. The water is becoming **safe to drink** after this treatment without risk of Legionella.

The idea is in complete alignment with GWR and parent organisation First group core values and strategies.

Traditional approach

Traditionally, water softness level is achieved through introduction of water softeners using salt as a main component. Mitigating the risk of Legionella, this creates additional problems and requirements in the water distribution system – i.e. salt bridges, manual top-up, uneven dosing, salt stains, corrosion, additional water treatment when released in the sewage water system while negatively affecting health of human beings, biological species or the earths soil i.e. high blood pressure, high PH level, skin related diseases, unsuitable biological water environment etc.

Various treatment effectiveness against bacteria comparison table is shown below (Red symbol – ineffective, Blue effective): Chlorine dioxide, Temperature, Chlorine, Silver/Copper ionisation, UV, Ozone

	ClO2	Temp	Cl2	Ag/ Cu	UV	O3
Effective against legionella		Not always	Not always			
Effective against heterotrophic bacteria		Not always	Not always			
Effective against biofilm						
Protects the whole system						
Not affected by pH						
Not affected by water hardness						
Easy to monitor						

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Why we did it

- High risk of contracting Legionella and Water Borne Bacteria
- Poor equipment performance, reliability and labor-intensive maintenance requirements (descaling, top-up, sampling, testing, system flushing)
- Risk of hot water injuries
- Wasted energy, high utility costs and CO2 emissions
- Safe drinking water and environment for all

What problem is the idea trying to address?

Limescale build up in the asset systems using incoming or stored water from utility provider. When water is delivered in high water consumers like rolling stock depots they are stored in individual tanks. Water is used for train wash, top-up, depot and office cleaning from heavy stains like waste oil, animal remains, effluent, staff hygiene etc.

Hard water creates limescale build-up in all systems that consume water regardless standing or moving water contributes to blockages, shorter asset life, poor equipment performance and forms a perfect environment for water borne bacteria growth – i.e. Legionella which can be deadly or cause serious long term illness.

Some details of the problems and opportunities are listed below:

Infrastructure – as discussed above water is used for number of activities from cleaning to performing maintenance, consumption and personal hygiene

1. Safe water we constantly needed to keep water temperature above 60 C° - Legionella's living environment is around 22-55 C° – increasing running costs, energy consumption, asset life and risk of injury
2. Hard water was creating limescale build-up in HVAC, boilers, tanks and hygiene equipment creating additional strain on components like heating cores, pumps, nozzles, hydraulic accumulators etc. causing failures contributing to train production downtime, suboptimal utility consumption (gas, electricity, water), asset performance and premature failures
3. At least 1 per week – L8 Legionella legislation mandates every water outlet and dog-leg (end point) including emergency equipment must be flushed continuously for at least 5 min regardless of the water flow rate or consumption and disinfected.
4. At least 1 major descaling activity per week consuming min 1 FTE per site (depending on size and location) and speed depends on knowledge and experience to localise and mitigate the issue
5. Mandatory sampling and water testing is required – which shown regular non-compliance and bacteria presence additional site downtime contribution
6. Traditional water softeners require 1 FTE weekly (depending on size and location) to perform visual inspection and/or top-up, safe storage of chemicals and training

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Rolling Stock – More than 60% of the fleet provides catering and hygiene services for the public

1. When this hygiene systems are defective, toilet stops need to be made at stations that have them, leading to **customer dissatisfaction or timetable disruption**
2. Water used in trains is unsafe to drink – customers need to purchase tap water from the train catering service or station shops consuming more **plastic products**
3. Trains have limited fresh water supply – depending on customer refreshment demand they require regular top-up of portable carts at major stations and these require **additional care** to safely store fresh water – **bacteria free**

Actions

- Pilot test in controlled environment followed by business justification
- Partnering with the vendor to deliver results and depot stakeholders
- Utilising contracted test lab and 3rd party lab to verify findings and success
- Compliance ACOP L8 and HSG274 standards for sampling requirements and site audit – Internal and External
- Set measures for success and timeline – Utilised the official depot energy report and forecast from 2016 – 2022, Local HSE reports and incident registers, CMMS data
- Lessons learned
- Rollout across sites

Vendor Benefit Estimate

1	Reduction in temperature from storage at 60 °C to 50 °C would result in energy savings of £90.071.00 per annum estimated
2	Reduction in the requirement to disinfect the tanks and down services and resampling actions will result in a saving of £10100.00 per annum (Only one unit served and maintained)
3	Reduced level of risk due to on-line treatment
4	No requirement to undertake emergency disinfections or disruptive actions to bacteria or legionella counts
5	Temperature monitoring to be replaced by chlorine dioxide testing by Aegis
6	The capital pay-back period is less than 10 months based on the current water usage and occupancy rates

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Team Benefit Estimate

1	Reduction in temperature from storage at 60°C to 50°C would result in energy savings of £67498.00 per annum , based on reducing the heat exchange temperature at each property. This will not have a noticeable effect on the operation as water is generally blended to 43°C for comfortable use .
2	Reduction in the requirement to disinfect/descale the tanks and down services will result in a saving of £3600.00 per annum
3	Reduction in requirement for softener salt £6000.00 per annum
4	Reduced level of risk due to on-line treatment
5	No requirement to undertake emergency disinfections or disruptive actions to bacteria or legionella counts
6	Temperature monitoring to be replaced by chlorine dioxide testing by Aegis therefore reducing flushing, Legionella testing and outlet disinfection saving £6933.00 per annum
7	The capital pay-back period is less than 11 months based on the predicted water usage and occupancy rates

Assumptions

- **10°C** drop in the normal operating temperature gives a **47% reduction in CO²** emissions (We can drop it another 5-10 °C and reap more benefits with controlled trial)
- **Operating hours** (Based on Industry Standards and Boiler Actual Consumption): 5250/year (based on 14.5 hours heating of the water per day)
- **Energy usage**= 5250 x (660 KW)= **3,47 million Kwh**
- **Electricity savings**= 3,47 million Kwh x 16.0%= 555,200 kWh= **61072 GBP/year @** (0,11/kWh)
- **CO2 savings**= 555,200kWh/2325=238 tons= **6426 GBP/year (at 27 GBP/ton)**
- **Total savings from Energy (TSFM):** 61072 + 6426 = **67,498 GBP/year**
- **Total Savings per Depot (Estimate):** TSFM + Man-Hours to Descale/Disinfect Tanks & Sanitary Elements + No Softener Use (Salt) + Reduced Flushing, Legionella Testing Premium and Risk Assessment, Outlet Disinfection + No Boiler, Boiler Parts and Sanitary Elements replacement every Year = 67.498 + 3600 + 6000 + 6933 + 6000 = **Estimated £90.031**

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	OBJECTIVE	TIMEFRAME	MEASURES OF SUCCESS
1	<i>Fresh Drinking Water (Train Fleet, Plant and Buildings) and Successful Elimination of Waterborne Bacteria</i>	2019/20	<i>Zero "0" Waterborne Bacteria Count</i>
2	<i>Asset Life Extension and Limescale Elimination</i>	2019/20	<i>No More Descaling/Desinfecting Work Performed on Water Distribution System and Sanitary Elements Limescale free</i>
3	<i>Eliminated Premium Fees for Frequent Sampling and Water Testing</i>	2019/20	<i>Water Testing Report and Risk Assessment</i>
4	<i>Savings Achieved/ Return on Investment</i>	2019/20	<i>Est £90.071 excluding Premiums Paid for Legionella Discovery and Contracting Waterborne Disease</i>

	Input	TIMEFRAME	Planned	Actual
1	<i>System Design and System Trial</i>	<i>Supplier Recommended 4 Weeks of Trial and Install</i>	<i>4-8 Weeks</i>	<i>4 Weeks of Trial and 1 day installation</i>
2	<i>Materials</i>		<i>£4687.5 ex VAT per Unit x 16 Units Supply of Hatamet per 25 litres £107.50 ex vat Supply of Twin OX per box £855.00 ex vat</i>	<i>£4687.5 ex VAT per Unit x 16 Units Supply of Hatamet per 25 litres £107.50 ex vat Supply of Twin OX per box £855.00 ex vat</i>
3	<i>External Labour Costs</i>		<i>Monitoring and Testing per Year per Unit - £855 Service and Maintenance Package for all Units: £900 per Unit x 16 Units</i>	<i>Monitoring and Testing per Year per Unit - £855 Service and Maintenance Package for all Units: £900 per Unit x 16 Units</i>

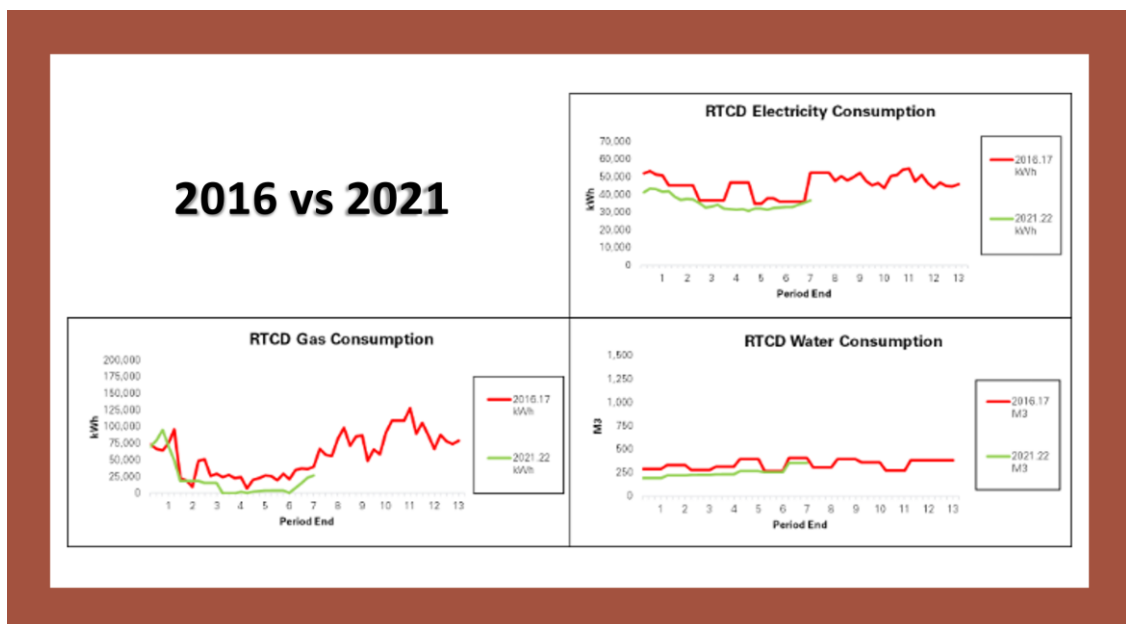
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Results

This brought a number of benefits from reduced or eliminated salt addition, reduced utilities usage, improved water quality especially were stored in tanks. Importantly for this submission the limescale does not build up on the train water system components (mostly valves and filters) which adversely affects reliability.

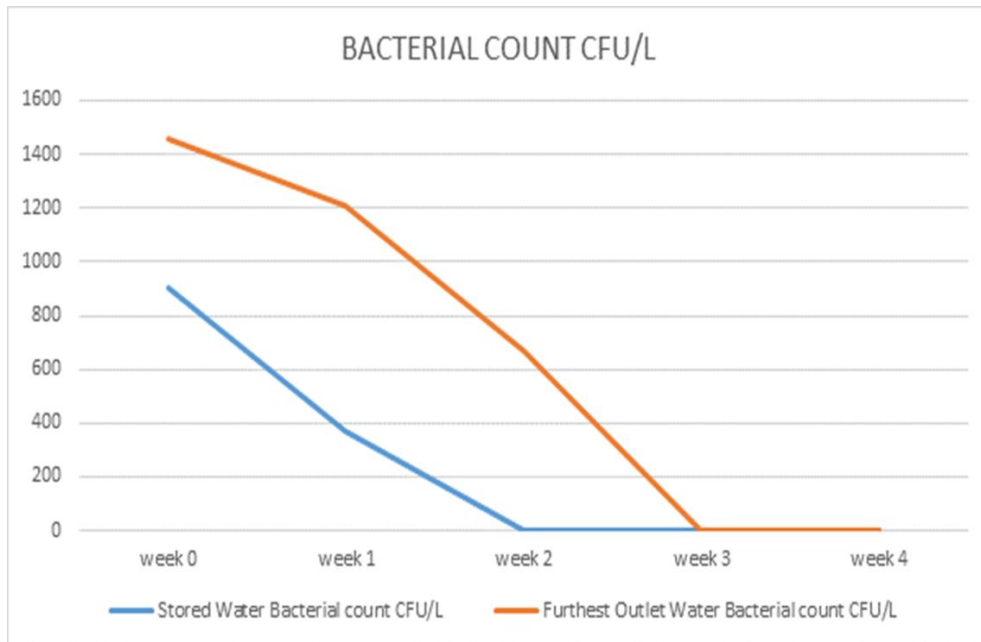
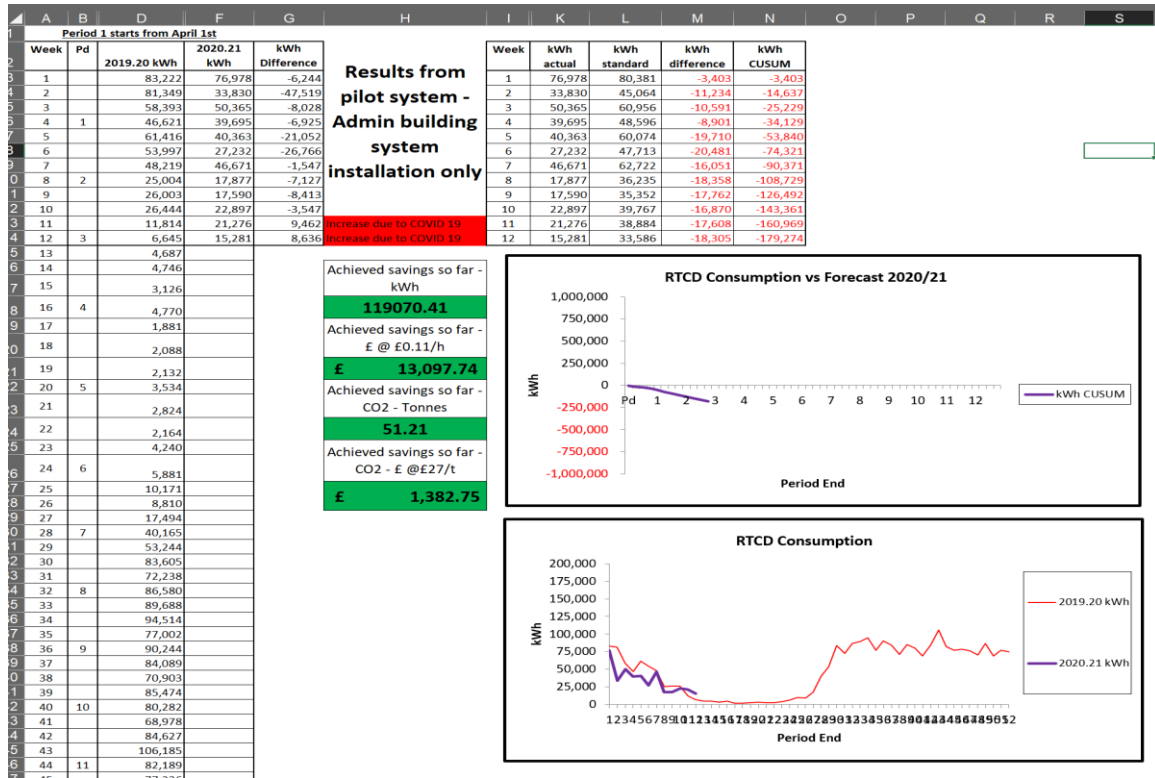
Below are results achieved after successful testing period and the project was named as First Group Best Practice Case Study:

- ✓ Eliminated Risk of Legionella and Water borne Bacteria
- ✓ Reduced Maintenance Resources - Automated Dosing
- ✓ System Recovery and Rejuvenation
 - ✓ Safe Drinking Water
 - ✓ No Limescale Build-up
- ✓ No System Flushing = Water Saving
- ✓ Eliminated Risk of Injuries from HOT Water
- ✓ Minimum Requirement for Water Sampling and Testing
- ✓ Optimum Equipment Performance - Optimum Flow
- ✓ c. 10% Electricity Savings (£)
- ✓ c. 20% GAS Savings (£)
- ✓ c. 40% CO² Savings (£)
- ✓ Reduced Total Cost of Ownership (£)
- ✓ Descaling Activities - **“ZERO”** workorders in 1 year+
- ✓ Equipment Life Extension and Improved Uptime - **“ZERO”** breakdowns in 1 year+
- ✓ Reduced Maintenance Resources - Easy Maintenance and Top Up



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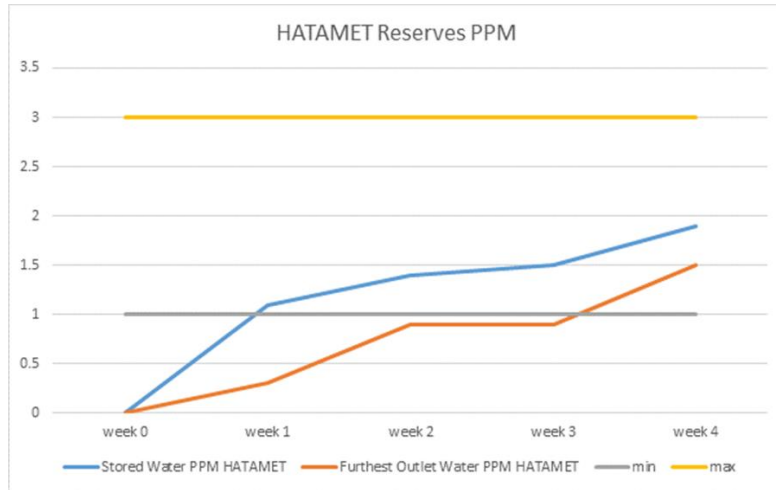
Pilot results realisation are shown below (1 Period = 28days), we had increased hygiene demand during Covid-19 period compared to previous years.



✓ Tap water safe to drink ✓ **“ZERO”** harmful bacteria after Week 3

After 3 weeks water was safe to drink everywhere.

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✓ Biofilm removed ✓ Scale build-up removed ✓ Equipment protected ✓ Protective layer formed

I week 3 equipment was free from scale build up and after week 4 protective layer was formed adding protection to water distribution systems.

The diagram below shows the projects contribution in reduction in work orders, man-hours and defects while increasing PM delivery and compliance.



Water Treatment Project

The results of the project also reflected in OpEx expenditure contribution as shown below:

Plant and Buildings Opex since 2016 -> YTD

	Budget	Actual	Difference
FY1617	£ 2,205,000	£ 2,148,000	£ 57,000
FY1718	£ 2,112,876	£ 2,294,027	-£ 181,151
FY1819	£ 2,171,538	£ 2,385,636	-£ 214,098
FY1920	£ 2,274,120	£ 2,329,471	-£ 55,351
FY2021	£ 2,294,211	£ 1,678,313	£ 615,898

