EVALUATION REPORT

MP5 INSTALLATION AND DEPOLOX FOULING ANALYSIS REPORT

Compton Durville Water Treatment Works, Wessex Water

1 EXECUTIVE SUMMARY

Installation of a self-cleaning Halogen Systems MP5 chlorine residual monitor at Compton Durville water treatment works in October 2025 has revealed systematic over-dosing of chlorine driven by fouling of the existing Siemens Depolox amperometric membrane probe.

Analysis of 73 operational cycles over 65 days demonstrates that the Depolox sensor accumulates iron fouling deposits during operation, causing it to under-read chlorine residual. The control system compensates by dosing additional chlorine to maintain apparent setpoint. The MP5, installed as a monitor-only device, provides independent verification of this over-compensation.

2 KEY FINDINGS:

- MP5 has needed **no intervention** during a 5-month period, no calibration, no maintenance
- Chlorine residual measured by MP5 **rises by around 10%** per operational cycle (0.604 ppm → 0.671 ppm in first-to-last 10-minute averages)
- This is most likely caused by **overdosing** due to accumulation of **fouling** deposits on the Depolox sensor electrode during operation which makes the Depolox read low
- Depolox **cleaned at least twice** per month
- Linear accumulation over 20 hours averages to 5-6% fouling/overdosing effect
- Operator performs daily startup calibration of Depolox, reducing overnight accumulation
- Weekend effect: Without startup calibration, fouling accumulates 20% faster

3 SITE BACKGROUND

3.1 INSTALLATION CONTEXT

Compton Durville Water Treatment Works is a Wessex Water facility treating borehole water with elevated iron (Fe) content. The site has experienced chronic issues with chlorine residual monitoring, having previously evaluated both Kuntze and ATi amperometric probes before selecting the current Siemens Depolox system.

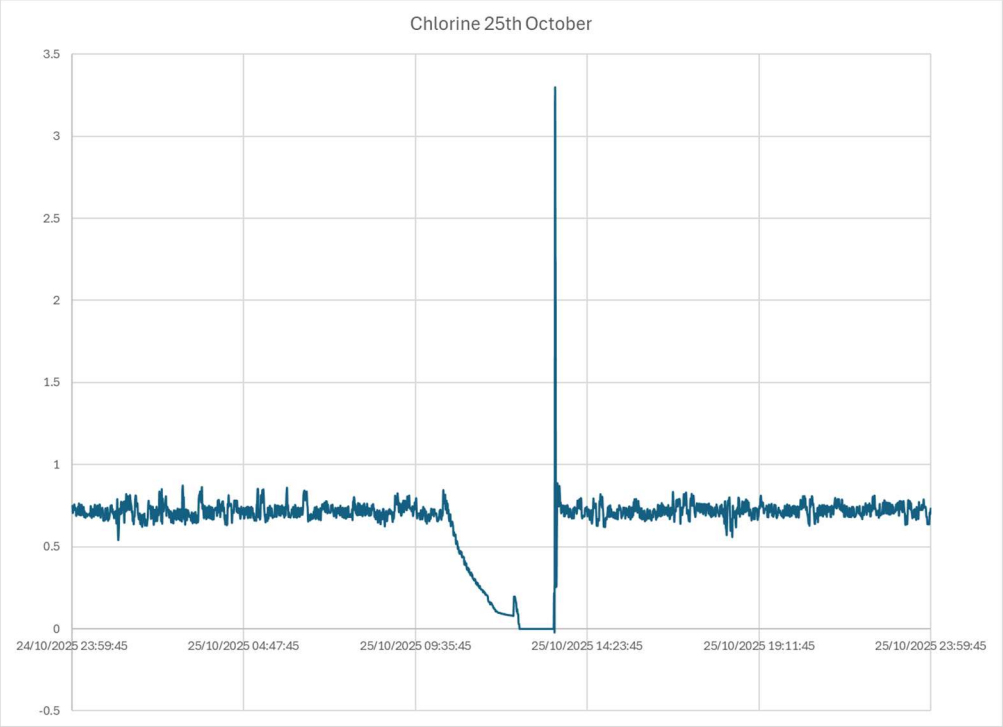
3.2 CURRENT SYSTEM CONFIGURATION

- Chlorine control: Siemens Depolox amperometric membrane probe
- Monitoring device under evaluation: Halogen Systems MP5 chlorine residual monitor (installed October 2025)
- Control logic: Depolox provides feedback for PID control of chlorine dosing
- MP5 function: Independent monitoring only (not integrated into control loop)

3.3 OPERATIONAL PATTERN

- Daily cycle: Plant shuts down 09:00-15:00 (6 hours)
- Operating period: 15:00-09:00 next day (~18 hours net operation)

- Startup behaviour: At restart, low flow causes chlorine spike (fixed dosing into a low flow); settles after ~5 minutes



4 MP5 INSTALLATION AND OBSERVATIONS

4.1 INSTALLATION DATE

October 24th, 2025

4.2 INITIAL OBSERVATIONS AT STARTUP

When the plant restarts a characteristic chlorine residual spike is observed:

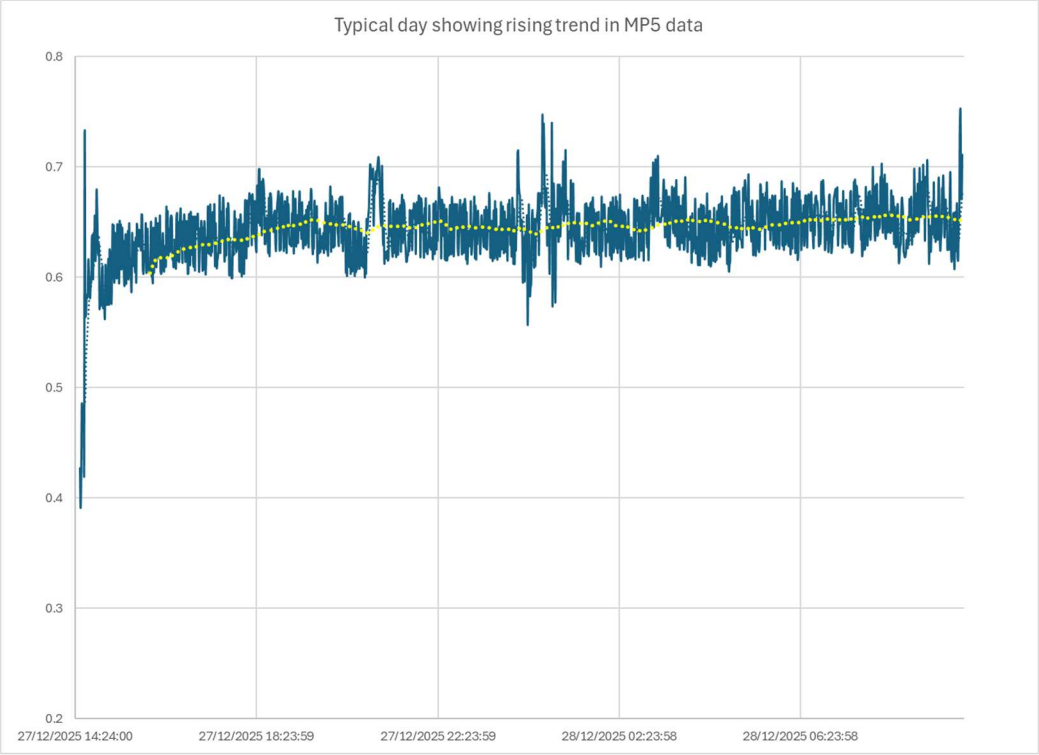
- Raw readings spike to between 3-10 ppm
- Over 5 minutes, signal settles to operational baseline (~0.6 ppm)
- This is consistent with chlorine dosing into low flow

4.3 MP5 SIGNAL BEHAVIOUR DURING DAILY OPERATION

During the 18-hour operational cycle:

- Expected behaviour: MP5 should remain relatively flat at setpoint (~0.6 ppm)

- Observed behaviour: MP5 consistently rises throughout operation, with measurable (~10%) rise from operational start to end
- MP5 readings “reset” to the expected value at the beginning of next run



5 MP5 AFTER 5 MONTHS

5.1 SUMMARY

The sensor end and flow cell were stained and coated. The electrodes were clean showing the effectiveness of the cleaning system. The sensor was given a wipe, the pre and post clean chlorine residual was unchanged, 0.7ppm before & 0.67 after. These values agreed with the average value of the two Depolox monitors (0.72 & 0.65ppm)

5.2 MP5 SENSOR CAP OUTER AND INNER SURFACES

5.3 MP SENSOR ELECTRODES BEFORE AND AFTER WIPING

6 DATA ANALYSIS METHODOLOGY

6.1 DATASET

- Period: October 24, 2025, to January 6, 2026 (65 days)
- Operational cycles analysed: 73 complete cycles
- Data resolution: Raw MP5 readings at 1-minute intervals
- Analysis methods: 10-minute average sampling at cycle start/end, multi-day accumulation analysis, day-of-week trend analysis

7 EVIDENCE OF DEPLOX FOULING AND OVER-DOSING

7.1 RISING MP5 FROM START TO END OF OPERATIONAL CYCLE

Key Finding: MP5 shows consistent and significant rise from the start of each operational cycle to the end, indicating that the Depolox is fouling is driving compensatory dosing.

7.1.1 START VS END ANALYSIS AVERAGED OVER ALL DATA SETS:

Cycle Phase	AVG MP5 Value (10-min avg)	Reading time
Start of operational cycle	0.6038 ppm	First 10 minutes
End of operational cycle	0.6714 ppm	Last 10 minutes
Total rise per cycle	+0.0676 ppm	+10.67%

7.1.2 INTERPRETATION:

If the Depolox were clean and functioning correctly, MP5 should remain flat at setpoint throughout operation (system maintains constant residual via PID control). The consistent 10.67% rise per cycle indicates:

- Depolox is under-reading chlorine residual due to fouling
- Control system continuously increases dosing to compensate for the underreading
- MP5 captures this over-compensation as a rising residual during the operational period

7.1.3 FOULING ACCUMULATION PATTERN:

The 10.67% rise per ~20-hour cycle represents linear accumulation of fouling deposits. If fouling accumulates linearly during the 20-hour operation:

- Accumulation rate: 10.67% ÷ 20 hours = 0.53% per hour
- Average fouling effect mid-cycle: ~5.3% above clean baseline
- This explains why the control system must continuously increase dosing throughout the day

7.2 DAY-OF-WEEK FOULING PATTERN

Fouling accumulation varies possibly due to operational differences:

Day	Mean rise ppm	Mean Rise%	Cycles
Sunday	+0.0837	+13.95%	11
Friday	+0.0797	+13.28%	10
Wednesday	+0.0700	+11.66%	10
Saturday	+0.0690	+11.49%	10
Monday	+0.0665	+11.08%	11
Thursday	+0.0551	+9.19%	9
Tuesday	+0.0499	+8.32%	12

Key finding: Sunday worst (+13.95%), Tuesday best (+8.32%)

7.3 OPERATOR CALIBRATION EFFECT

Critical Discovery: Reset between cycles exactly matches daily accumulation, indicating that the Depolox is recalibrated and/or cleaned by the operator at or around start up:

Metric	Weekday	Weekend
Daily accumulation	+0.0639 ppm	+0.0767 ppm
Overnight reset	-0.0626 ppm	-0.0798 ppm
Net change	~0.0013 ppm	~-0.0031 ppm

7.3.1 INTERPRETATION:

- Weekday: Operator calibrates Deplox at/around morning startup, effectively calibrating out the fouling from previous run
- Weekend: Without calibration, fouling accumulates continuously
- 20% difference in weekend vs weekday fouling in line with work schedule
- Daily calibration insufficient: Even with daily calibration, fouling re-accumulates #10%, +0.0676 ppm during single cycle

8 CHLORINE WASTE QUANTIFICATION

8.1 OVER-DOSING DUE TO FOULING

Based on the rising MP5 trend, the control system doses excess chlorine to compensate for Depolox under-reading caused by fouling:

8.1.1 PER OPERATIONAL CYCLE:

- Average rise: +0.0676 ppm (10.67%)
- This represents over-compensation required to maintain apparent setpoint against fouled sensor reading
- Mean overdose during each day is 5.3%
- Small cost per year in chemical ~£100-200

8.2 SYSTEM IMPACT

This over-dosing has two significant consequences:

- Cost: Excess chemical consumption and operational expense, samall
- Regulatory: Small risk of increased disinfection byproduct (DBP) formation risk from continuous over-chlorination

9 OPERATIONAL TIME SAVING

9.1 CALIBRATION OF DEPOLX SENSORS

The site uses a colorimeter to calibrate the Depolox. It takes roughly 5 minutes to take a sample and adjust the Depolox.

Estimated time spent on calibration over the period covered in the report is 5 hours

9.2 STRIP DOWN AND CLEANING

Feedback from operations and instrument technicians indicates that the Depolox monitors are stripped down and cleaned on a biweekly basis.

Estimated time spent on cleaning and strip down over the period covered in the report is 12 hours

10 ROOT CAUSE ANALYSIS

10.1 WHY EVOQUA UNDER-READS

The Evoqua Depolox amperometric membrane probe measures chlorine through oxidation of a polarized electrode surface. Iron deposits accumulate on the membrane, creating a diffusion barrier that reduces the measured signal below actual residual.

10.2 FOULING MECHANISM

- Source water composition: Site has Fe issues
- Treatment efficiency: Fe oxidized by chlorine, but deposits remain
- Membrane fouling: Deposits accumulate on Depolox membrane during operation
- Signal degradation: Membrane resistance increases, signal attenuates

- Control response: System increases dosing to maintain apparent setpoint
- Net result: Over-dosing captured by MP5 as rising residual throughout each cycle

10.3 WHY THIS ALSO OCCURRED WITH PREVIOUS SENSORS

Both Kuntze and ATi installations likely experienced similar fouling in this high-Fe environment, explaining site history of monitoring difficulties. The Depolox system appears equally susceptible to membrane fouling under these water quality conditions.

11 SUMMARY OF EVIDENCE

Evidence	Finding	Significance
MP5 rise per cycle	+10.67% from start to end	Direct proof of over-dosing compensation
Accumulation rate	+0.0676 ppm per 20-hour cycle	Quantifies fouling magnitude
Linear accumulation	~0.5%/hour = 5.3% average fouling	Explains continuous dosing increase
Overnight reset	-0.063 ppm daily calibration	Proves operator mitigates daily fouling
Weekend effect	20% faster fouling without calibration	Confirms calibration is effective but insufficient
Day-of-week variation	2.3× difference (Fri vs Tue)	Working patterns affect cumulative fouling effect fouling rate
Previous probe failures	Daily calibration not enough for Depolox	Depolox (& other membrane-based sensors) not ideal for high Fe/Mn waters

12 CONCLUSIONS

- MP5 read accurately and reliably in the same sample with no calibration or cleaning needed over a five-month period
- Depolox is fouling due to Fe deposits from source water composition
- Fouling causes under-reading of chlorine residual (10.67% per cycle)
- Control system over-compensates by continuously increasing dosing
- MP5 independent monitoring reveals this over-compensation clearly and unmistakably
- Operator daily calibration of Depolox provides critical mitigation
- But even daily calibration; fouling re-accumulates the next cycle

13 RECOMMENDATIONS

13.1 IMMEDIATE ACTIONS

- Continue MP5 monitoring; provides essential independent verification of Evoqua performance
- Document operator calibration logs; correlate timing and effectiveness with MP5 trends

13.2 SHORT-TERM

- Increase Evoqua maintenance frequency; consider 2-3 calibrations per shift to reduce fouling accumulation

13.3 MEDIUM-TERM

- Replace Depolox with MP5 on Compton Durville
- Measure if chlorine usage drops in line with report indication of 5% overdosing
- Roll out MP5 on sites were sensor fouling is an issue, e.g all high Fe/Mn sites

14 APPENDICES

14.1 START AND END MP5 READINGS

Date	Day of Week	Startup Time	Shutdown Time	Duration Hours	Av First 10min MP5	Avg Last 10min MP5	Diff	Reset Between Cycles
24/10/2025	Friday	06:32:32	03:24:39	20.9	0.6244	0.7274	0.103	0.0116
25/10/2025	Saturday	06:37:28	03:05:14	20.5	0.739	0.7689	0.0299	-0.0284
26/10/2025	Sunday	06:47:05	03:46:13	21	0.7405	0.7463	0.0058	-0.0099
27/10/2025	Monday	06:45:00	19:58:27	13.2	0.7364	0.8829	0.1465	-0.1086
28/10/2025	Tuesday	00:10:53	05:07:10	4.9	0.7743	0.6662	-0.108	-0.0043
28/10/2025	Tuesday	06:46:41	01:27:02	18.7	0.6618	0.69	0.0282	-0.0671
29/10/2025	Wednesday	07:01:50	03:29:36	20.5	0.6229	0.6299	0.007	-0.0069
30/10/2025	Thursday	06:34:35	03:36:49	21	0.623	0.6815	0.0585	0.025
31/10/2025	Friday	06:34:05	03:15:53	20.7	0.7065	0.6818	-0.025	-0.0172
01/11/2025	Saturday	06:39:43	03:09:53	20.5	0.6647	0.6824	0.0177	-0.0628
02/11/2025	Sunday	06:06:43	01:55:28	19.8	0.6195	0.6617	0.0421	0.002
03/11/2025	Monday	20:06:53	04:38:03	8.5	0.6637	0.6234	-0.04	0.0015
04/11/2025	Tuesday	07:05:28	01:40:18	18.6	0.6249	0.7076	0.0827	-0.1035
05/11/2025	Wednesday	07:00:59	03:22:32	20.4	0.6042	0.6748	0.0706	-0.0407
06/11/2025	Thursday	06:39:15	03:16:27	20.6	0.6341	0.6642	0.0301	-0.0446
07/11/2025	Friday	06:42:41	03:32:24	20.8	0.6195	0.6757	0.0562	-0.0175
08/11/2025	Saturday	06:44:24	02:40:48	19.9	0.6582	0.6697	0.0115	-0.1124
09/11/2025	Sunday	06:42:19	03:08:29	20.4	0.5573	0.6892	0.1318	-0.1196
10/11/2025	Monday	06:37:01	03:54:12	21.3	0.5695	0.6722	0.1027	-0.0641
11/11/2025	Tuesday	06:35:44	01:48:57	19.2	0.6082	0.6755	0.0674	-0.1377
12/11/2025	Wednesday	06:45:20	03:24:04	20.6	0.5378	0.6574	0.1195	-0.0698
13/11/2025	Thursday	06:35:24	03:25:59	20.8	0.5876	0.6667	0.0791	-0.104
14/11/2025	Friday	06:41:56	03:25:22	20.7	0.5627	0.6802	0.1175	-0.0962
15/11/2025	Saturday	06:39:49	02:02:34	19.4	0.5841	0.6899	0.1058	-0.1485
16/11/2025	Sunday	06:40:54	03:26:39	20.8	0.5414	0.7164	0.175	-0.1341
17/11/2025	Monday	06:35:35	03:18:13	20.7	0.5823	0.6704	0.0881	-0.0695
18/11/2025	Tuesday	06:40:35	02:07:57	19.5	0.6008	0.6685	0.0677	-0.0555
19/11/2025	Wednesday	06:58:01	03:31:14	20.6	0.6131	0.7577	0.1446	-0.1774
20/11/2025	Thursday	06:33:57	03:30:43	20.9	0.5803	0.6905	0.1102	-0.0724
21/11/2025	Friday	06:38:09	03:29:24	20.9	0.6182	0.7165	0.0983	-0.0604
22/11/2025	Saturday	06:37:32	02:51:12	20.2	0.6561	0.6943	0.0382	-0.0782
23/11/2025	Sunday	06:39:25	03:17:24	20.6	0.6161	0.6648	0.0488	-0.0417
24/11/2025	Monday	06:56:06	03:28:37	20.5	0.6232	0.6618	0.0386	-0.1031
25/11/2025	Tuesday	06:53:59	01:43:46	18.8	0.5587	0.6407	0.082	-0.0533
26/11/2025	Wednesday	07:09:55	03:21:17	20.2	0.5874	0.6719	0.0845	-0.0788
27/11/2025	Thursday	07:32:09	03:24:35	19.9	0.5932	0.6569	0.0638	-0.1007
28/11/2025	Friday	07:35:33	03:15:27	19.7	0.5562	0.6725	0.1163	-0.0995
29/11/2025	Saturday	07:36:33	03:01:37	19.4	0.573	0.6582	0.0852	-0.1454

30/11/2025	Sunday	07:36:03	02:49:17	19.2	0.5128	0.6659	0.1531	-0.106
01/12/2025	Monday	07:37:02	03:09:55	19.5	0.5599	0.6695	0.1096	-0.0755
02/12/2025	Tuesday	07:31:01	01:47:49	18.3	0.5941	0.6573	0.0632	-0.0671
03/12/2025	Wednesday	07:45:20	03:06:29	19.4	0.5902	0.6331	0.0428	-0.0009
04/12/2025	Thursday	07:31:30	03:09:53	19.6	0.6322	0.6868	0.0546	-0.106
05/12/2025	Friday	07:32:29	03:15:36	19.7	0.5808	0.6765	0.0957	-0.1037
06/12/2025	Saturday	07:33:29	02:52:15	19.3	0.5728	0.6623	0.0895	-0.0877
07/12/2025	Sunday	07:35:17	02:51:44	19.3	0.5746	0.6482	0.0735	-0.0861
08/12/2025	Monday	07:41:48	03:32:44	19.8	0.5621	0.6718	0.1098	-0.0762
09/12/2025	Tuesday	07:34:17	01:43:59	18.2	0.5956	0.6771	0.0815	-0.0748
10/12/2025	Wednesday	08:08:09	04:03:47	19.9	0.6023	0.6802	0.0779	-0.1085
11/12/2025	Thursday	07:32:22	03:49:57	20.3	0.5718	0.5722	0.0005	-0.0619
12/12/2025	Friday	07:00:29	03:23:30	20.4	0.5103	0.6032	0.0929	-0.1052
13/12/2025	Saturday	07:39:05	03:19:05	19.7	0.4981	0.617	0.1189	-0.1308
14/12/2025	Sunday	07:38:35	03:08:21	19.5	0.4862	0.6168	0.1307	-0.0748
15/12/2025	Monday	07:38:46	03:19:35	19.7	0.542	0.6096	0.0676	-0.0473
16/12/2025	Tuesday	07:35:52	01:38:39	18	0.5623	0.6282	0.0658	-0.0642
17/12/2025	Wednesday	07:49:30	07:59:43	0.2	0.5639	0.5523	-0.012	0.0065
17/12/2025	Wednesday	09:04:47	03:51:21	18.8	0.5588	0.6775	0.1186	-0.0238
18/12/2025	Thursday	07:34:04	03:21:05	19.8	0.6537	0.6927	0.039	-0.0818
19/12/2025	Friday	07:37:28	04:09:54	20.5	0.6108	0.6783	0.0675	0.0102
20/12/2025	Saturday	07:35:22	03:01:08	19.4	0.6885	0.7225	0.0341	-0.0659
21/12/2025	Sunday	07:33:15	03:06:51	19.6	0.6566	0.6917	0.0351	-0.0475
22/12/2025	Monday	07:39:46	03:40:50	20	0.6442	0.6485	0.0042	-0.0505
23/12/2025	Tuesday	07:39:58	01:59:11	18.3	0.598	0.6746	0.0766	-0.0627
24/12/2025	Wednesday	07:52:00	02:39:22	18.8	0.6119	0.6578	0.0458	-0.0319
25/12/2025	Thursday	07:38:03	02:54:29	19.3	0.6258	0.6864	0.0605	-0.0907
26/12/2025	Friday	07:38:20	03:21:27	19.7	0.5957	0.6698	0.0741	-0.1616
27/12/2025	Saturday	07:29:55	02:58:11	19.5	0.5082	0.6668	0.1587	-0.0403
28/12/2025	Sunday	07:31:48	03:24:14	19.9	0.6265	0.6702	0.0436	-0.0997
29/12/2025	Monday	07:32:48	03:19:48	19.8	0.5705	0.6425	0.072	-0.0268
30/12/2025	Tuesday	07:34:35	01:51:23	18.3	0.6156	0.6503	0.0347	-0.0898
04/01/2026	Sunday	07:40:31	03:43:27	44	0.5605	0.6418	0.0813	-0.0572
05/01/2026	Monday	07:40:00	03:43:27	20.1	0.5845	0.6169	0.0324	0.0159
06/01/2026	Tuesday	07:32:22	01:57:05	18.4	0.6328	0.6905	0.0576	

14.2 COST CALCULATOR

HYPOCHLORITE WASTE CALCULATOR			
Calculate excess chlorine cost from sensor fouling or over-dosing			
INPUT PARAMETERS			
Plant size (ML/day)	*ML/day*	**2.5**	
Residual chlorine setpoint (ppm)	*ppm*	**0.6**	
Hypochlorite strength (% available Cl)	*%*	**14.0**	
% Over-dosing	*%*	**5.0**	
Cost of hypochlorite (£/tonne)	*£/tonne*	**350.0**	
CALCULATIONS			
Daily ideal available chlorine (kg)	kg	1.5	
Daily actual available chlorine (kg)	kg	1.6	
Daily waste - available chlorine (kg)	kg	0.1	
Daily waste - hypochlorite product (kg)	kg	0.5	
Annual waste - hypochlorite product (tonnes)	tonnes	0.20	
Annual cost of excess hypochlorite (£)	£	£68.44	
Monthly cost of excess hypochlorite (£)	£	£5.70	
KEY OUTPUTS			
Annual hypochlorite wasted (tonnes)	tonnes	**0.20**	
Monthly cost of excess hypochlorite	£/month	**£5.70**	
SUMMARY			
Annual cost:	**£68.44**	£0,068	
Daily cost:	**£0.19**		
% of total chlorine budget wasted:	**5.0%**		

Report Date: February 9th 2026

Analysis Period: October 24, 2025 – January 6, 2026

Data Quality: 73 complete operational cycles, 1,094 data points per cycle