



Pilot Testing Project Report:
Chlorine Demand Testing for the Palgrave-Caledon East
Drinking Water System

Walkerton Clean Water Centre

Research and Technology

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Disclaimer

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Acknowledgements

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List of Acronyms

DI Deionized water

DWS Drinking water system

Executive Summary

Background

The Palgrave-Caledon East drinking water system (DWS) is planning to increase the capacity of the Palgrave Well No. 4 from 30.3 L/s to 60.6 L/s and to upgrade the treatment processes to treat 5,218 m³/day of water. The Walkerton Clean Water Centre completed a chlorine demand test to determine what is the chlorine demand after 30 minutes and 60 minutes of contact time.

Objective

The objective of the study was to complete a chlorine demand test of the raw water after 30 and 60 minutes of contact time.

Approach

The bench-scale tests were conducted on-site at the Palgrave-Caledon East Drinking Water System. The tests involved dosing chlorine into raw water grab samples with increasing chlorine dosages and measuring free chlorine, total chlorine, pH and temperature after 30 minutes and 60 minutes of contact time. Using the same chlorine dosages, bottles containing deionized water (DI) were also tested.

Key Findings

Through the chlorine demand tests it was determined that:

- The chlorine demand of the raw water was on average 1.35 ± 0.08 mg/L after 30 minutes of contact time.
- The chlorine demand of the raw water was on average 1.36 ± 0.13 mg/L after 60 minutes of contact time.
- On average, the combined chlorine was 0.20 ± 0.09 mg/L, which was calculated as the difference between total chlorine and free chlorine.

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1. Introduction

The Palgrave-Caledon East drinking water system is owned and operated by the Region of Peel. Due to the increased water demand on the system, it is proposed to increase the supply capacity of Palgrave Well No. 4 from 30.3 L/s to 60.6 L/s and to upgrade the treatment processes to treat 5,218 m³/day of water. A chlorine demand test is required to satisfy the draft terms of reference for the Determination of Minimum Treatment for Municipal Residential Drinking Water Systems Using Subsurface Raw Water Supplies (MECP, 2019).

The Region of Peel has requested that the Walkerton Clean Water Centre (Centre) complete a chlorine demand test to determine what is the chlorine demand after 30 minutes and 60 minutes of contact time. The chlorine demand test is a standardized bench-scale method that determines the difference between initial and final chlorine concentrations (APHA 2017).

The objective of the study was to complete a chlorine demand test of the raw water after 30 and 60 minutes of contact time.

2. Materials and Method

2.1 Chlorine Demand Testing

The Centre completed the chlorine demand tests on-site at the Palgrave-Caledon East drinking water system (DWS). Personnel from the Region of Peel collected the raw water, which was used for the bench-scale tests.

Raw water grab samples were transferred into 250 mL chlorine demand free, amber glass containers. To achieve the chlorine demand free containers, the glassware was treated with 10 mg/L of chlorine solution for a minimum of 3 hours, rinsed with deionized water (DI) and then left to air dry. The chlorine demand tests were adapted from Standard Methods for the Examination of Water and Wastewater and Hach Method 10223, but additional bottles were used to ensure there was no headspace for each contact time instead of sampling from the same bottle twice (APHA 2017, Hach 2015).

12 samples were dosed with increasing chlorine concentrations. Six bottles were measured for free chlorine, total chlorine, pH and temperature after 30 minutes and the remaining six bottles were measured for free chlorine, total chlorine, pH and temperature after 60 minutes of contact time (Table 1). The bottles were stored in a cooler with no ice to maintain the temperature of the raw water. To monitor the stability of the chlorine solution, 12 additional bottles containing DI water were dosed with chlorine and measured for free chlorine, total chlorine, pH and temperature as a control.

Table 1. Chlorine Demand Test

Bottle No.	Dose (mg/L)	Contact Time (min)
1	2.0	30
2	2.0	60
3	2.5	30
4	2.5	60
5	3.0	30
6	3.0	60
7	3.5	30
8	3.5	60
9	4.0	30
10	4.0	60
11	5.0	30
12	5.0	60

2.2 Water Quality Analysis

Free chlorine residual, total chlorine residual, pH and temperature were analyzed throughout the test using the methods described below (Table 2).

Table 2. Methods of Water Quality Analysis

Parameter	Preparation	Method	Range
In-House Analysis			
Free Chlorine	N/A	Hach Method 8021	0.02 – 2.00 mg/L
Total Chlorine	N/A	Hach Method 8167	0.02 – 2.00 mg/L
pH	N/A	Hach Method 8156	0 – 14
Temperature	N/A	Hach Method 8156	N/A

3. Results and Discussion

The chlorine demand of the raw water was on average 1.35 ± 0.08 mg/L and 1.36 ± 0.13 mg/L after 30 and 60 minutes of contact time, respectively (Fig. 1, Fig. 2, Fig. 3). The average pH and temperature conditions were 7.69 ± 0.09 and $17.0 \pm 2.1^{\circ}\text{C}$, respectively. On average, the combined chlorine was 0.20 ± 0.09 mg/L, which was calculated as the difference between total chlorine and free chlorine.

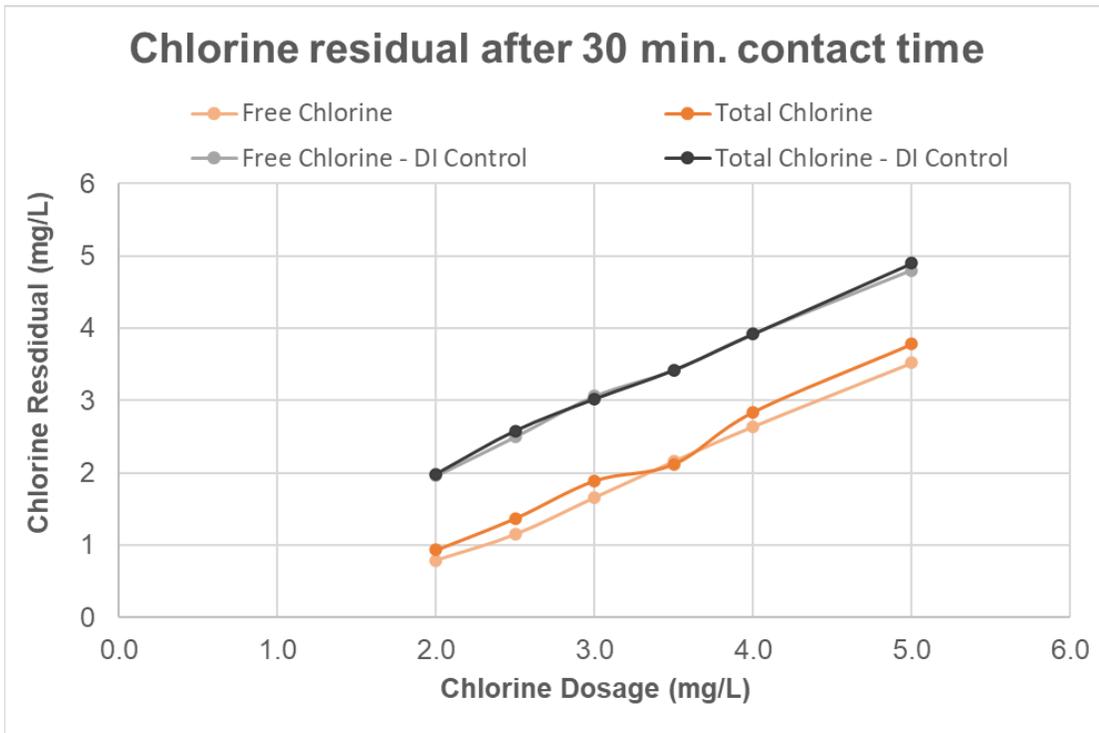


Figure 1. Chlorine Residual after 30 minutes of Contact Time

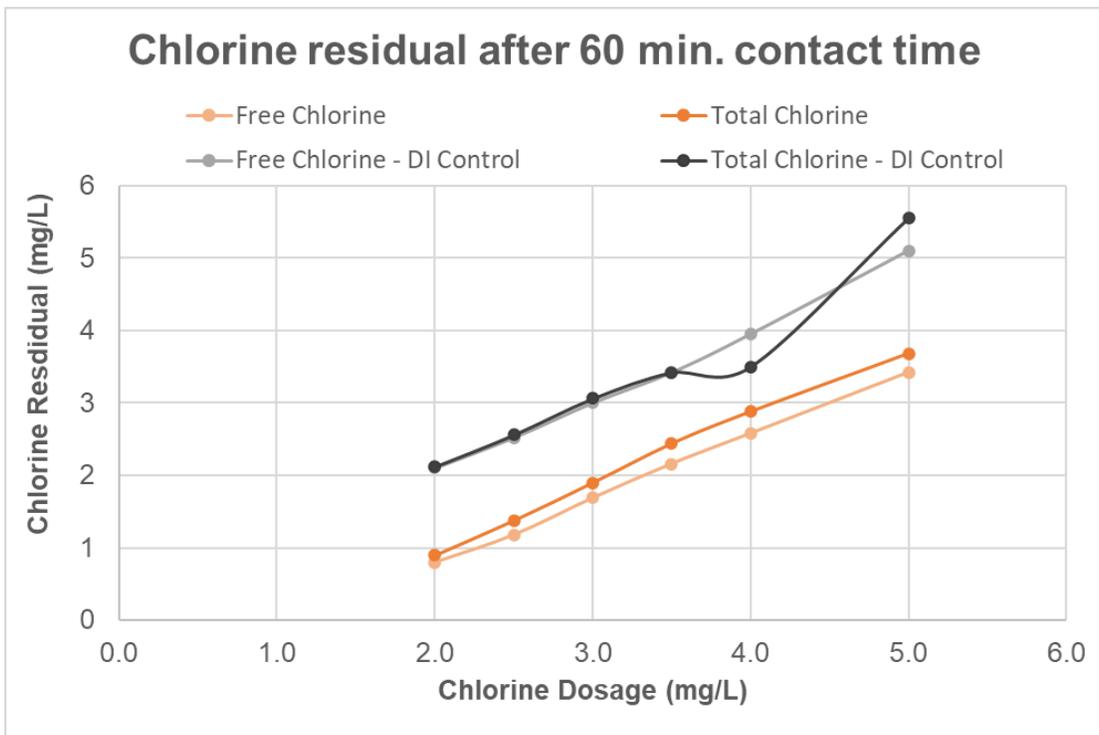


Figure 2. Chlorine Residual after 60 minutes of Contact Time

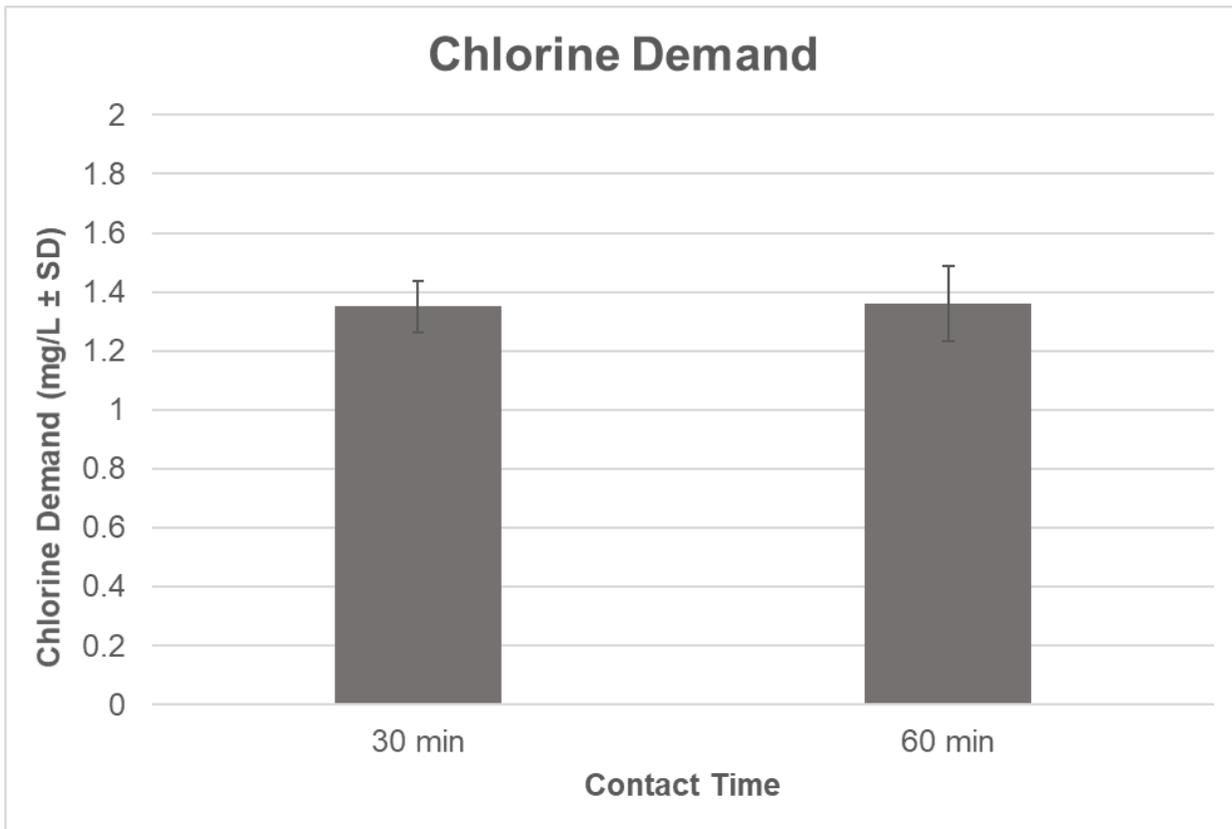


Figure 3. Chlorine Demand after 30 and 60 minutes. Note. SD is the standard deviation

4. Conclusion

Through the chlorine demand tests it was determined that:

- The chlorine demand of the raw water was on average 1.35 ± 0.08 mg/L after 30 minutes of contact time.
- The chlorine demand of the raw water was on average 1.36 ± 0.13 mg/L after 60 minutes of contact time.
- On average, the combined chlorine was 0.20 ± 0.09 mg/L, which was calculated as the difference between total chlorine and free chlorine.

5. References

American Public Health Association, American Water Works Association, Water Environment Federation (2017) *Standard Methods for the Examination of Water and Wastewater*, 23rd edition, Washington DC.

Hach (2015). Chlorine Demand (Method 10223).

Ministry of the Environment, Conservation and Parks (2019). Determination of Minimum Treatment for Municipal Residential Drinking Water Systems Using Subsurface Raw Water Supplies.

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