Nanopure Medium Water Purification – Dental Office Water Treatment Testing

August 6, 2015, Draft FinalReport (Internal use only - not for publication)

David K. Stevens, PhD.
Utah Water Research Laboratory
Utah State University
Logan, UT 84322-8100
david.stevens@usu.edu
435 797 3229

Executive Summary

This project was undertaken to test the efficacy of the NanoPure Dental Water filter for effective removal of bacteria from water used in dental offices, and to validate previous observations of temperature reduction and oxygen increases as water passes through the filter.

Three replicate filters were assembled on a test bench with appurtenant water and air supply, and control systems, and the effluent from each filters was sent through ~ 36 in of four channel dental tubing to a Midwest Quiet Air Highspeed Shell 4-hole dental handpiece. The flow sequences were designed to mimic the operation of dental handpieces in a clinical setting, with intermittent operation during working hours and no flow at night and over weekends, in accordance with ADA protocols (ADA 2014). A feed consisting of tap water augmented with two types of bacteria with more than 500 colony forming units (CFU, a surrogate for bacteria concentration) were fed to the filters from June1 through July 20, 2015. The influent and effluent from the filters were sampled for bacteria counts, temperature, and dissolved oxygen concentration twice daily Monday through Friday, skipping holidays. Data were recorded and entered manually into a Microsoft Excel spreadsheet for archiving, and analyzed using statistical software.

The data analysis showed that the Nanopure filters were highly effective in removing high levels of bacteria. The bacterial concentrations in the filter inlet averaged approximately 2,400 CFU/mL while those in the filter effluents averaged less than 0.5 CFU/mL, well below Centers for Disease Control (CDC) guidelines of 10 CFU/mL for dental water systems. In addition, water temperatures decreased from filter inlet to outlet by 0.25 to 1 degrees Celsius (0.5 to 2 degrees F), similar to expectations prior to the study. In contrast, dissolved oxygen concentrations decreased from 0.5 to 5 mg/L, opposite of prior expectations with the larger decreases seen in the morning samples, after the water had stagnated overnight or over a weekend in the filter/tubing system. This decrease is likely due to the high levels of bacteria added to the filters and tubing consuming oxygen via respiration and consumption of organic matter released during bacterial deactivation in the filters.

In conclusion, the NanoPure Dental Water filter was highly effective in removing high levels of bacteria under conditions typical of water use in a clinical setting. Influent bacterial concentrations exceeded typical values in tap water by a factor of 1,000 or more, while the effluent concentrations consistently met CDC guidelines over the full 50 days of operation. The temperature

decrease across the filters would serve to suppress bacterial regrowth and biofilm formation in downstream dental tubing. The decrease in dissolved oxygen was unexpected and is likely due to the high bacterial levels consuming oxygen in the filters. More study will be required to fully understand the oxygen changes.

Introduction

Scope of work

The work has involved testing the NanoPure process for provision of pure water for dental office purposes. To do so, we followed the procedures of the ADA (ADA 2014[1]), in which a number of commercial dental unit water treatment systems were evaluated. Using the description in ADA (2014), we carried out the following activities. We first designed and fabricated a system test stand consisting of the NanoPure unit, air pressure and water supply piping and valves, flow meters, reservoir bottles, and controls. Once the test stand was fabricated and tested, we began testing according to the following list of tasks.

Task List

a. Fabricate test stand

b. Obtain and sufficient quantities of test water so that each test will be carried out from a batch of water homogenized chemically except for the addition of any test constituents (microbial contaminants as agreed upon with client)

c. Start up the equipment to test for leaks and other operational problems prior to starting the purification testing procedures

d. Add water treatment challenges (microbiological agents) to the feed at levels similar to those used by ADA (2014). The challenge water will be sampled and analyzed before feeding to the NanoPure system, and twice daily throughout the test.

e. Sterilize any required tubing and other equipment prior to starting each test in an autoclave at the UWRL at 125^{o}C for 30 minutes.

f. Operate the NanoPure system at flow rates and for operating cycles of one minute followed by resting for four minutes from 8 am to 5 pm each working day, for a period of time specified by the client for each set of operating conditions considered.

g. Collect, preserve, and analyze samples taken daily over the testing period as agreed upon by the client. Analytical work for process control and evaluation were carried out in the Environmental Quality Laboratory (EQL) at the Utah Water Research Laboratory (UWRL) at Utah State University (USU).

h. Perform Quality Assurance/Quality Control activities to ensure data quality, in accordance with the general QA/QC plan for the EQL and with a Quality Assurance Project Plan (QAPP) developed specifically for this project.

i. Enter operating conditions and analytical results into a database at the UWRL for graphical and statistical analysis.

j. Analyze results and write final report draft.

k. Decommission the test stand and return the NanoPure system to the client.

---

1. ADA. 2014. A Laboratory Evaluation of Dental Unit Water Treatment Systems. ADA Professional Product Review. **9**(2):9-17.

l. Address comments concerning the final report, and revise report for final submission.

Results

System Fabrication

Test system fabrication was completed and operation was begun on April 1 to test operation of the equipment and controls using Logan, UT, tap water. Photos of the test stand are shown in Figure 1, with the overall apparatus, and details of the pumps, controls, tubing, and storage and collection reservoirs shown in Appendix I.

The filters were mounted on 3/4" plywood with clamps. Filters were connected to the flow system using flexible ,, tubing (1/4") with brass connectors and valves. The flow system consisted of a 20 L feed reservoir (~5 gallons), pump inlet tubing, a Masterflex ,,, 8 channel peristaltic pump calibrated to deliver 25 mL flow per minute, 1/4" discharge tubing, a tubing/dental tubing adaptor, ~36" 4-channel dental tubing, and ,,, handp ieces.

System operation

Data collection began on May 5 with determine of the temperature and dissolved oxygen concentration for the filter influent flow and the three filter effluent flows twice/day for each filter either first thing in the morning, at midday, or at the end of the working day. During the first week of testing, May 5 to May 9, influent samples were obtained from the influent reservoir and effluent samples were obtained from each handpiece. Beginning May 13 through June 1, influent and effluent samples were obtained from just upstream of the filter and just downstream from the filter to eliminate any changes in temperature and oxygen in the tubing leading to the filters and from the filters through the tubing and handpieces. On May 14, the influent to each of the filters was measured independently to determine the variability associated with sampling these influent lines. All other influent measurements were carried out on a single influent sample. The temperature and oxygen data are tabulated in Appendix I.

Due to complexities and added costs associated with using the pathogenic bacteria *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* as done in the ADA testing report (ADA 2014), the non-pathogenic organisms *Pseudomonas fluorescens* and *Escherichia coli* were substituted for the microbiological portion of the study. These organisms were obtained from the national repository for consistent microorganism cell lines, ATCC, (http://www.atcc.org/) as freeze-dried cultures, and were reconstituted as viable cultures on May15 using industry standard culturing techniques. After several days growth, the cultures were rinsed and enumerated to ensure that the numbers of viable cells added to the test apparatus were targeted to be at least 500 colony forming units (cfu) per mL, as specified in ADA (2014) as the upper bound of tap water that would meet Safe Drinking Water Act guidelines.

Culture addition began on May 25 in order to condition the filters to the presence of the organisms prior to sampling. This continued through May 29 and microbial sampling was begun June 1. These samples were tested for counts of total colony forming units using the procedure in Appendix II. After aseptic filtration using autoclaved sampling and filtration apparatus with 0.45 μm filters, samples are incubated at $22 \pm 2^{o}C$ for 48 ± 4 hrs prior to enumeration. Temperature

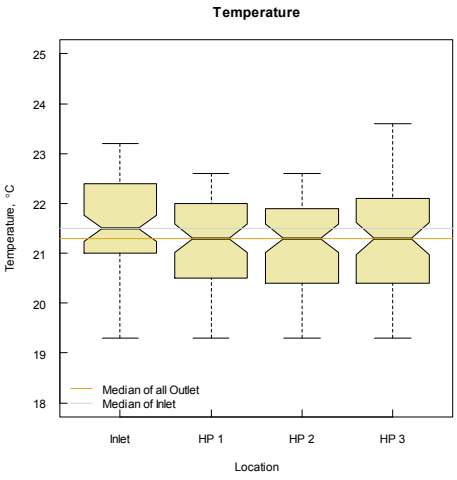
and oxygen measurements were continued throughout the study.

No temperatue and oxygen samples were collected on May 11 and 12 due to modifications to plumbing and other changes to the system. In addition, the apparatus was moved to a more secure location in the laboratory in anticipation of the addition of the bacteria on May 18. The temperature in the original location was controlled at 16 ± 1^{o}C and at the second location, the air is at room temperature, controlled by thermostat. On the following day, the air compressor failed, necessitating the use of water lab building air for driving the hand pieces. This required further modification of the system and the addition of filters for the building air to remove possible particulates, oil, and moisture prior to introduction to the handpieces. This caused samples to be missed on May 18 and 19. May 25 was a holiday and no sample was obtained. Due to equipment problems on four of the sampling dates (May 20-22 and 27), only one sampling event was possible.

Data Analysis

Temperature. Results for the temperature and dissolved oxygen changes across the Nanopure medium filters are plotted vs. time in Figure 1. We see in the figure that the temperatures in the cooler controlled temperature room were, in general, cooler than in at room temperature. In addition, dissolved oxygen, which has a higher saturation level at lower temperatures, is generally lower at room temperature.

For the first 6 sampling events, effluent samples were obtained from the handpieces and show temperature decreases from influent to effluent of ~ 2°C. After May 13, influent and effluent samples were obtained from just upstream and just downstream of the Nanopure filters. The temperatures still decreased but the decrease is smaller, < 1°C. It is speculated that the pre-May 13 effluent samples cooled as the water passed through the handpieces and by evaporation during it's brief contact with the cool, dry, air in the discharge collection chamber. Additional cooling may have occurred as the water passed through the dental tubing.



The inlet and outlet temperatures are compared in the figure to the right, as a box and whisker statistical plot for data taken after moving the apparatus to the warmer location on May 13. The hour glass shapes contain the range of the middle 50% of the observations, with the 'waist' at the middle, or median, value. The shape on the left is for the influent samples. Those on the right are for the three filter effluents. This figure shows that the water temperature decreased from a median temperature of 22°C in the inlet to about 21.32°C in the effluent, or 0.71 C (1.27°F). Though a smaller change than originally anticipated (2°F), this is a significant temperature decrease. The results were consistent regardless of the time of day, However, there were statistically different results on Monday relative to the rest of the week, likely due to changes in room temperature over the weekend when the air conditioning in the lab is turned down. The temperature changes across each of the filters were not different.

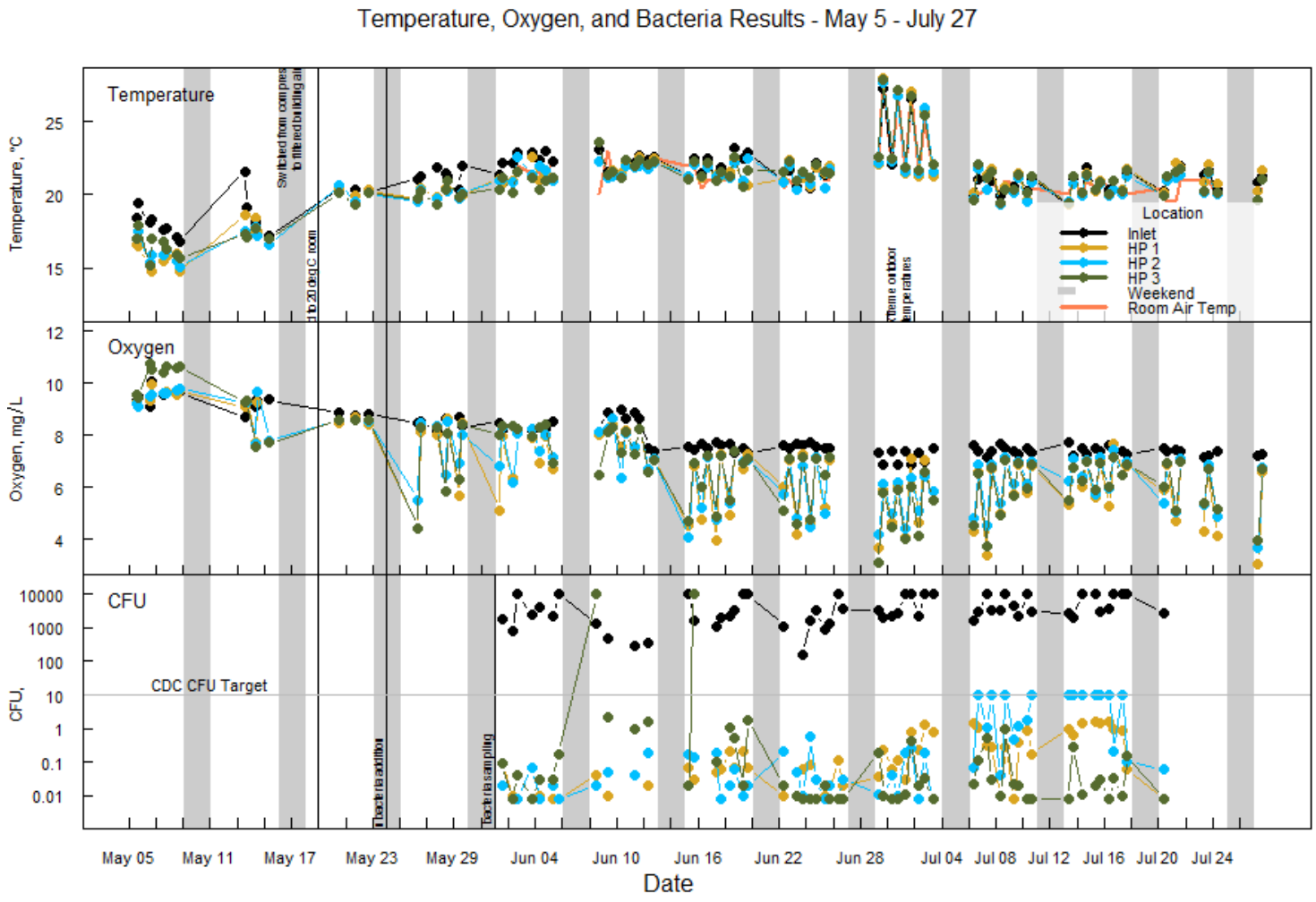
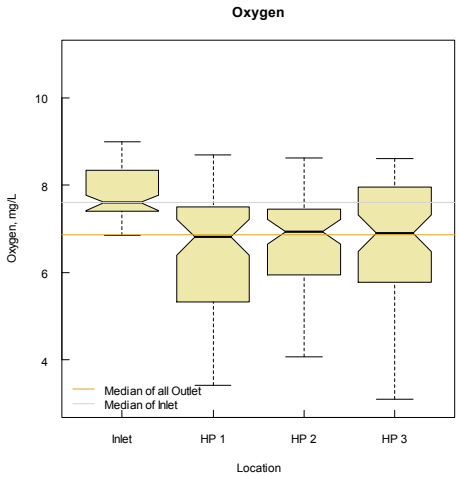


Figure 1: Temperature and Dissolved Oxygen Monitoring Results - May 5 to June 25. Inlet is the influent and HP- 2, 3, and 4 are the effluents from the three filters.

Oxygen. Oxygen results were less consistent generally for the pre-May 13 samples than for post May 13. Effluent oxygen levels were generally greater than or nearly equal to the influent oxygen levels for those samples. Because of the spraying occurring through the handpiece, those observations were not represenative of the direct discharge from the handpiece, and thus were not representative of the change in oxygen across the filters. After May 13, at warmer temperature and with bacteria addition (starting May 25), the oxygen results were more consistent, however there were significant differences in the oxygen change depending on the time of day of the sampling event. For clarity, the oxygen panel in Figure 1 is expanded and replotted with lines connecting samples from the same time of each day in Figure 2. For morning samples (7:50 am - 8:30 am), the effluent dissolved oxygen levels were 1-4 mg/L LOWER than in the influent, consistently across all three filters. This is tentatively assumed to be due to the bacteria remaining in the Nanopure filter spaces not filled with carbon overnight. This low DO water is flushed out and by the midday and evening sampling events, the oxygen levels in the influent and effluent are essentially the same. Statistical analysis was used to assess if there is a statistically significant difference (even though the difference may not be of significance to dental operations)

For dissolved oxygen, the variability is larger (~4 to 9 mg/L) reflecting the combining of the morning samples, lower in oxygen content, with the afternoon samples that were at or near saturation. The figure to the right shows the overall results with a clear decrease from filter influent to effluent. The oxygen data were then separated into morning and afternoon groups and plotted in Figures 2 and 3, below. We see now, that for the morning samples, the oxygen content is the effluent is consistently lower than in the inlet samples, but for the afternoon after 96 use cycles during each day, there is onlya small difference in oxygen content from inlet to outlet. The reason for the larger range of outlet concentrations in the morning is likely that the samples were taken at times ranging from 45 - 90 minutes after the daily cycles had begun. In addition, samples taken on Monday were statistically different than the rest of the week for morning and afternoon sampling events. Statistical results are provided in Appendix IV.



The box and whisker plot with the observations segregated by time of day, Figure 3, summarizes the difference between the two sample times. The analysis in Appendix IV shows that overall the difference between the oxygen levels from inlet to outlet was -1.12 mg/L. The differences in the morning were an average of 1.62 mg/L larger than in the afternoon, while the samples taken on Mondays were, on the average, another 0.85 mg/L lower than the rest of the week.

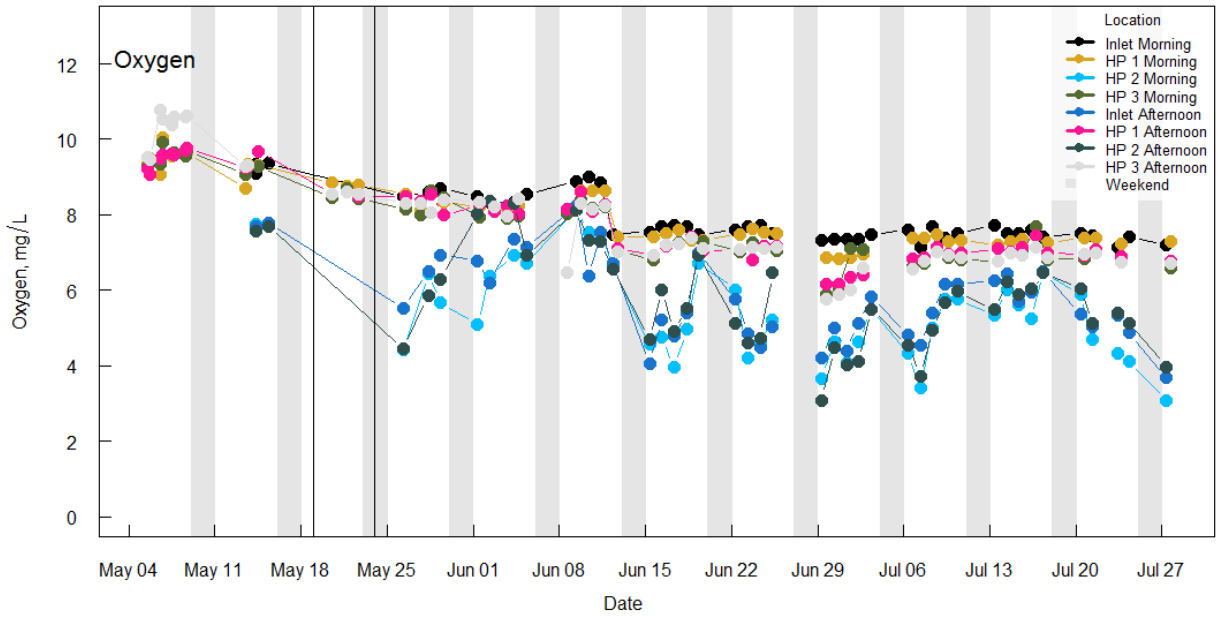


Figure 2: Expanded time series plot of oxygen observations, connected by time of day, May 13-June 30, 2015

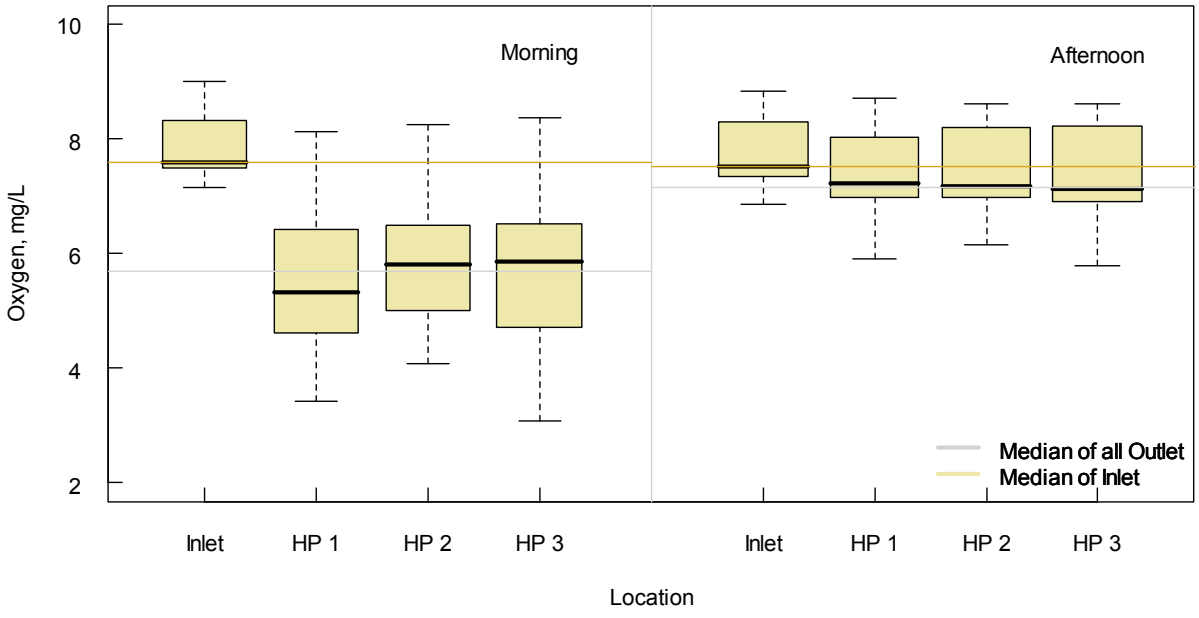
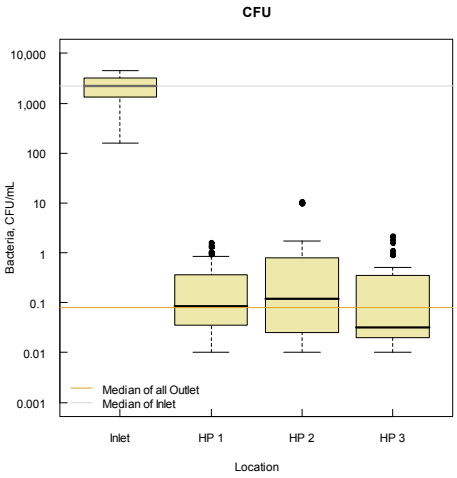


Figure 3: Box and whisker plot of oxygen observations, separated by time of day, May 13-June 30, 2015

Bacteria Monitoring. As mentioned above, monitoring for heterotrophic plate count began June 1. For the influent samples, two dilutions are used: 0.1 mL influent sample and 0.5 mL influent sample. These small samples are added to 25 mL of dilution water and filtered though 0.45 µm membrane filters, and then the apparatus is rinsed using a 0.1% peptone rinse water solution to ensure all bacteria are trapped on the filter. The filter is removed and placed in a disposable petri dish with R2A agar, then labeled and placed in an incubator at 22°C for 48-96 hr. For the effluent handpiece samples 95-105 mL of sample is filtered through the 0.45 µm filters and the apparatus is rinsed as above and placed on R2A agar and incubated for 48-96 hr at 22°C. The number of colonies that grow after incubation are counted by hand and the counts are divided by the sample volume to determine the numbers of colonies per mL of sample. These are plotted in the bottom panel in Figure 1.



The influent sample using 0.5 mL nearly always produced too many colonies to count (see example photos in Appendix I), while the 0.1 mL samples were usually countable. Most of the effluent samples produced very few colonies (usually < 10), even with ~100 mL of sample. The one exception is for the filter #3 sample on June 9 and 15 for which the numbers of colonies were too many to count. Review of the procedures and QA/QC testing showed the possibility of contamination of these samples due to contamination in the rinse water and these values were removed from the analysis.

A summary of the plate counts are found in the figure (right), and in Table 1[1] where we see that replicate filter produces an effluent with the bacteria concentrations well below the standard of 10 cfu/mL. The mean $\log_{10}$ removal was 4.1, or an average of a factor of nearly 12,000.

Statistical analysis of the bacteria data is provided in Appendix IV. Because of the frequently highly variable and skewed nature of these observations, to meet the assumptions of the analysis, they were transformed using the base 10 logarithm for analysis. In Appendix IV we see that the column labeled 'Estimate' has the estimated log-removal from the inlet to the combined outlet of

Table 1: Summary Data for Bacteria Removal

Location	Total Plate Count, CFU/mL	Confidence Interval CFU/mL[a]		Average log removal
Inlet	1,828	1,479	2,239	
HP 1	0.133	0.092	0.0.192	4.14
HP 2	0.221	0.128	0.381	3.92
HP 3	0.128	0.064	0.256	4.15

a.Range of results with a 95% chance of having the true mean

1.The values in the table for the Inlet were modified slightly from the figure due to the presences of Inlet counts recorded as 'Too numerous to count'. These are censored observations and are treated as described in Helsel (2012).

the three filters of 4.31 (factor of ~20,000). We find from this analysis that only the sample location, that is the inlet vs. the three filter outlets, was significant as having an impact on the bacterial counts. In addition, all filters had statistically similar bacterial counts. Neither time of day nor whether it is Monday had significant impact on those counts.

Other

During the research, a few issues that may be of relevance to the application of the Nanopure filters were identified. First, one of the filters began leaking after ~4 weeks of operation (filter #3). The filter was disassembled, the threads were cleaned, and the filter was reassembled to try to stop the leak. However this was unsuccessful, prompting the use of caulking to minimize the leak externally. This was mostly successful, but a slow leak has continued throughout the study. However, even with the leak, the effluent bacterial counts were consistently lower than the standard of 10 CFU/mL.

Second, during the week of July 20, the feed microbial concentration increase by a factor of 100, due to an error in dilution, for two days. Outlet samples from those two days, though slightly discolored and difficult to filtered still me the <10 cfu/mL guidelines, demonstrating the resilience of the Nanopure filters in face of failure of the upstream water quality control systems.

Secondly, the handpieces used had persistent problems with clogging of the small water tubing inside the handpiece after the introduction of bacteria to the inlet tank, causing problems with consistent flow through each handpiece. Ultrasonic cleaning for 5 minutes would restore flow temporarily but the handpiece would clog again in less than a day. Considering that the clogging only started with the introduction of relatively high bacteria levels (> 500 CFU/mL), this is felt to be an artifact of those high levels and are not likely to be found in dental practice.

Third, due to the failure of the oil-less compressor in May, and subsequent conversion to the filtered (both particulate and oil filters) building compressed air, we observed some pass though of particulates and compressor oil into the some of the handpiece samples, as the air is flowing during sampling. This created some difficulty in reading bacterial counts for effluent samples, however, bacterial counts on the interior surface of the membrane filters remained low.

Lastly, the filters produced a yellowish color and what appeared to be a varnish to the surface of the membrane filters (see photos in Appendix I). That this was coming from the filters and not the building air was tested by parallel QA/QC samples taken from the hand piece and from the tubing before the water entered the dental tubing/hand piece lines. Both of those samples exhibited this phenomenon. This coloring and sheen were not seen in the inlet samples. Analysis of the make-up of this color/varnish is beyond the scope of this project, but is mentioned here as something that may affect practical application of the filters.

Comparison with ADA results from the report

The results reported here compare favorably with those reported in the ADA laboratory testing of a variety of water treatment units (ADA 2014), that ranged in price from $150 per line to nearly $11,000 for a whole office system. The tested commercial units, with the exception of two units, consistently met the HPC requirement of < 10 cfu/mL, as did the Nanopure units studied here.

Summary

These results demonstrate that the Nanopure filters effectively remove both *Pseudomonas fluorescens* and *Escherichia coli* bacteria, non-pathogenic surrogates for the *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* pathogenic organisms in the ADA protocol. In no cases, except those explained by known experimental error, did the effluent concentration of the total of these two organisms exceed the 10 CFU/mL standard, even with the influent concentrations 2-4 times higher than in the ADA protocol.

Temperature and oxygen measurements (roughly 2x daily) showed a slight temperature drop across the filters, and a slight oxygen drop in the afternoon samples, with a larger oxygen decrease in the morning first-flush samples. The large morning oxygen drop demonstrates microbial respiration occurring in the filters, in the dental tubing, and/or the handpieces when allowed to sit overnight or over a weekend.

References

ADA. 2014. A Laboratory Evaluation of Dental Unit Water Treatment Systems. ADA Professional Product Review. **9**(2):9-17.

Helsel, 2012. Statistics for Censored Environmental Data Using Minitab and R, 2nd Edition. John

Wiley and Sons. Hoboken, NJ. 324 p.

Appendix I - Sample photographs of colonies

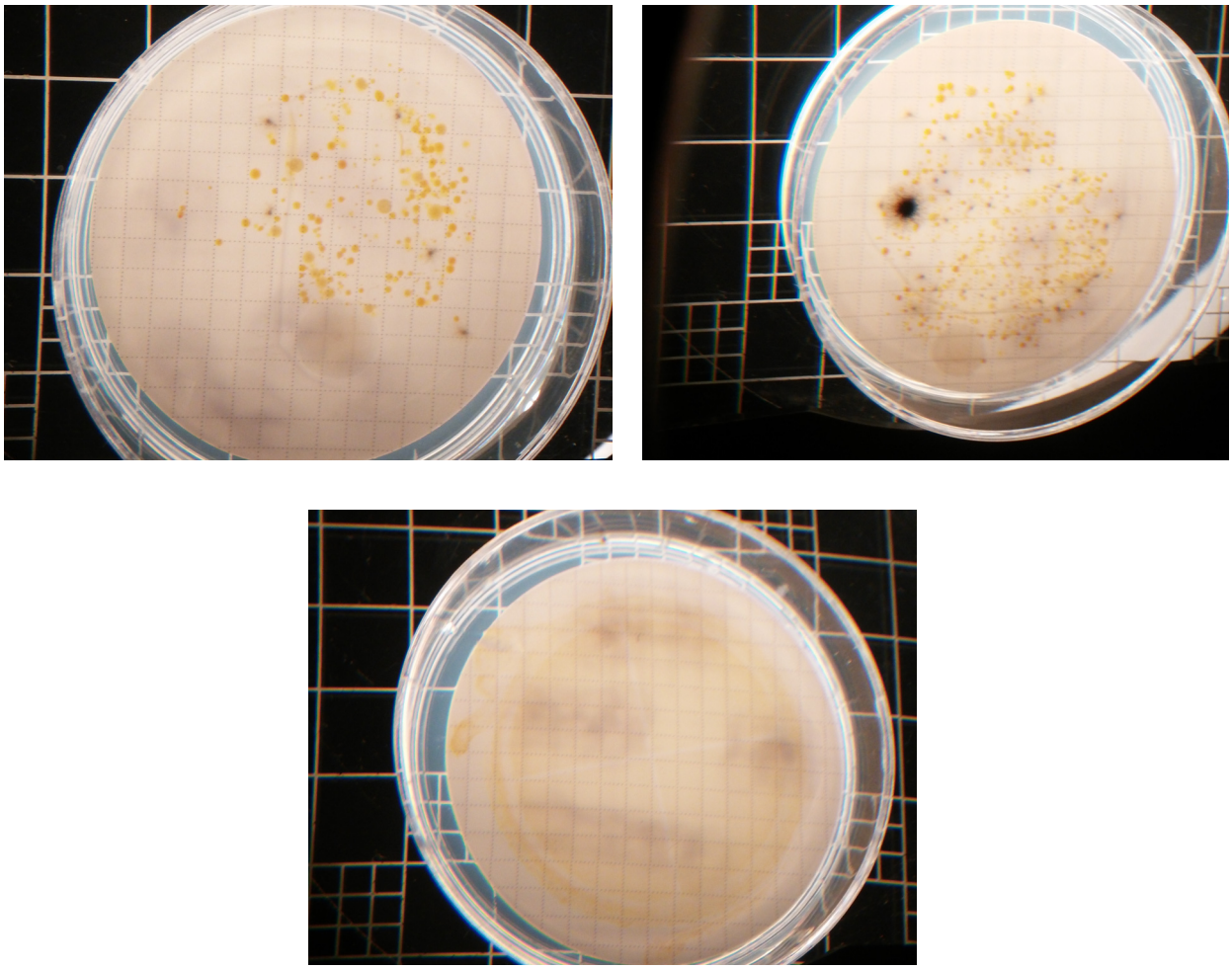


Figure 4: Sample Filters for biological analysis. Upper left = inlet sample - 0.1 mL, Upper right = inlet sample - 0.5 mL (large dark spot on the filter is mold), Bottom Center = Effluent Sample - 100 mL (dark smudges are the writing on the plate holding the filter)

Appendix II - Measurement procedure for bacterial testing

29 May 2015

Darwin Sorensen

Bacteriological Enumeration Procedure for
Evaluation of Dental Unit Water Treatment Systems

Overview

a. Guidance is provided for doing heterotrophic plate counts of bacteria in the influent and effluent from dental water treatment filters and their appurtenances.

b. A membrane filter plate count procedure is used.

c. The procedure assumes that chlorinated municipal tap water has been dechlorinated and amended with cultured bacteria (e.g. *Escherichia coli* and *Pseudomonas fluorescens*) capable of growth on R2A medium at 22 ± 2 °C ("room temperature").

Reagents and apparatus

a. Millipore S-Pak membrane filters, white, gridded, 0.45 µm, 47 mm

b. 0.1% peptone rinse water

c. 95% ethanol

d. Vacuum filtration apparatus, autoclave sterilized

e. Vacuum filtration flask

f. Filter forceps

g. Bunsen burner

h. 1 mL serological pipets

Procedure

a. Collect samples into autoclave sterilized polypropylene bottles

b. Wipe down the lab bench with wet paper towels to remove dust, etc.

c. Assemble filtration apparatus onto the filtration flask being careful not to touch or otherwise contaminate the interior funnel parts

d. Pour ~ 1 cm depth of ethanol into a small beaker

e. Remove the filtration funnel from the apparatus and place it upside down on the lab bench

f. Open an S-pack filter

g. Alcohol-flame the filter forceps

h. Remove the white, gridded membrane from the pack and place it, gridded side up on the filtration apparatus base

i. Replace and tighten the filtration funnel

j. For analysis of effluent samples and the rinse water blank:
    i. Pour 100 mL or a smaller, known volume of sample (~25 mL for rinse water) into the funnel and immediately turn on the vacuum source until the sample has all passed through the filter
    ii. Rinse the funnel with a minimal volume of rinse water
    iii. Turn off and release the vacuum
    iv. Remove the filter funnel
    v. Alcohol-flame the filter forceps
    vi. Remove the filter from the apparatus and roll the filter onto the surface of a R2A agar plate being careful not entrap air beneath the filter
    vii. Invert the plate with the filter, label the bottom of the plate with the date, sample time, sample source and volume filtered
k. For analysis of influent samples:
    i. Pour ~25 mL of rinse water into the funnel
    ii. Pipet 0.1 mL of the influent sample into the water in the funnel
    iii. Immediately turn on the vacuum source until the sample has all passed through the filter
    iv. Repeat the procedures in 3.j.ii-vii above.
l. Incubate the plates, inverted at 22 ± 2 °C for 48 ± 4 h
m. Count the colonies and report colony forming units CFU/mL

Appendix III - Table of data

Date/Time	Location	Temperature	Oxygen	CFU	Date/Time	Location	Temperature	Oxygen	CFU
2015-05-05 13:00:00	Inlet	18.4	9.34	-	2015-05-27 16:55:00	Inlet	21.9	8.12	-
2015-05-05 13:00:00	HP 1	16.6	9.27	-	2015-05-27 16:55:00	HP 1	19.8	8.01	-
2015-05-05 13:00:00	HP 2	17	9.23	-	2015-05-27 16:55:00	HP 2	19.7	8.35	-
2015-05-05 13:00:00	HP 3	17	9.53	-	2015-05-27 16:55:00	HP 3	19.3	8.29	-
2015-05-05 17:15:00	Inlet	19.4	9.48	-	2015-05-28 08:20:00	Inlet	21.5	8.62	-
2015-05-05 17:15:00	HP 1	16.5	9.42	-	2015-05-28 08:20:00	HP 1	20.5	6.45	-
2015-05-05 17:15:00	HP 2	17.5	9.07	-	2015-05-28 08:20:00	HP 2	20.4	6.49	-
2015-05-05 17:15:00	HP 3	17.9	9.46	-	2015-05-28 08:20:00	HP 3	20.4	5.85	-
2015-05-06 12:35:00	Inlet	18.1	9.07	-	2015-05-28 13:30:00	Inlet	21.3	8.57	-
2015-05-06 12:35:00	HP 1	15.2	9.35	-	2015-05-28 13:30:00	HP 1	20.4	8.63	-
2015-05-06 12:35:00	HP 2	15.4	9.49	-	2015-05-28 13:30:00	HP 2	20.2	8.55	-
2015-05-06 12:35:00	HP 3	15.2	10.77	-	2015-05-28 13:30:00	HP 3	21	8.05	-
2015-05-06 17:20:00	Inlet	18.3	10.05	-	2015-05-29 08:20:00	Inlet	20.4	8.69	-
2015-05-06 17:20:00	HP 1	14.8	9.93	-	2015-05-29 08:20:00	HP 1	19.8	5.67	-
2015-05-06 17:20:00	HP 2	15.9	9.58	-	2015-05-29 08:20:00	HP 2	19.7	6.93	-
2015-05-06 17:20:00	HP 3	17	10.52	-	2015-05-29 08:20:00	HP 3	19.8	6.29	-
2015-05-07 13:00:00	Inlet	17.6	9.56	-	2015-05-29 13:40:00	Inlet	22	8.34	-
2015-05-07 13:00:00	HP 1	15.5	9.63	-	2015-05-29 13:40:00	HP 1	19.9	8.45	-
2015-05-07 13:00:00	HP 2	15.9	9.63	-	2015-05-29 13:40:00	HP 2	20.1	7.99	-
2015-05-07 13:00:00	HP 3	16.8	10.38	-	2015-05-29 13:40:00	HP 3	20	8.41	-
2015-05-07 17:15:00	Inlet	17.7	9.6	-	2015-06-01 08:30:00	Inlet	21.4	8.49	-
2015-05-07 17:15:00	HP 1	15.8	9.65	-	2015-06-01 08:30:00	HP 1	21.1	5.09	-
2015-05-07 17:15:00	HP 2	16.2	9.6	-	2015-06-01 08:30:00	HP 2	21	6.79	-
2015-05-07 17:15:00	HP 3	16.3	10.61	-	2015-06-01 08:30:00	HP 3	20.4	8.04	-
2015-05-08 14:00:00	Inlet	17.1	9.6	-	2015-06-01 12:40:00	Inlet	22.2	8.2	1850
2015-05-08 14:00:00	HP 1	16	9.57	-	2015-06-01 12:40:00	HP 1	20.8	7.94	0.09
2015-05-08 14:00:00	HP 2	15.5	9.71	-	2015-06-01 12:40:00	HP 2	21.1	8.27	0.02
2015-05-08 14:00:00	HP 3	15.9	10.58	-	2015-06-01 12:40:00	HP 3	21.2	8.33	0.09
2015-05-08 17:15:00	Inlet	16.8	9.64	-	2015-06-02 07:45:00	Inlet	22.2	8.34	818.18
2015-05-08 17:15:00	HP 1	14.8	9.71	-	2015-06-02 07:45:00	HP 1	21	6.37	0.01
2015-05-08 17:15:00	HP 2	15.1	9.78	-	2015-06-02 07:45:00	HP 2	20.9	6.2	0
2015-05-08 17:15:00	HP 3	15.7	10.62	-	2015-06-02 07:45:00	HP 3	20.1	8.36	0
2015-05-13 12:50:00	Inlet	21.6	8.69	-	2015-06-02 16:45:00	Inlet	22.9	8.16	10000
2015-05-13 12:50:00	HP 1	18.6	9.08	-	2015-06-02 16:45:00	HP 1	-	-	0
2015-05-13 12:50:00	HP 2	17.5	9.24	-	2015-06-02 16:45:00	HP 2	22.6	8.09	0
2015-05-13 12:50:00	HP 3	17.3	9.27	-	2015-06-02 16:45:00	HP 3	21.6	8.22	0.04
2015-05-13 17:15:00	Inlet	19.1	9.34	-	2015-06-03 17:55:00	Inlet	22.9	8.19	2380
2015-05-13 17:15:00	HP 1	17.4	9.26	-	2015-06-03 17:55:00	HP 1	22.6	7.9	0
2015-05-13 17:15:00	HP 2	17.2	9.29	-	2015-06-03 17:55:00	HP 2	21.4	8.25	0.07
2015-05-13 17:15:00	HP 3	17.1	9.31	-	2015-06-03 17:55:00	HP 3	21.2	7.96	0
2015-05-14 08:20:00	Inlet	18.2	9.09	-	2015-06-04 08:00:00	Inlet	22.4	8.32	3980
2015-05-14 08:20:00	HP 1	18.4	7.75	-	2015-06-04 08:00:00	HP 1	21	6.94	0.01
2015-05-14 08:20:00	HP 2	17.8	7.69	-	2015-06-04 08:00:00	HP 2	22	7.36	0
2015-05-14 08:20:00	HP 3	17.7	7.58	-	2015-06-04 08:00:00	HP 3	20.3	8.31	0.03
2015-05-14 08:30:00	Inlet	17.9	9.23	-	2015-06-04 17:00:00	Inlet	23	8.23	-
2015-05-14 08:30:00	In 1	17.6	9.42	-	2015-06-04 17:00:00	HP 1	21.4	7.97	-
2015-05-14 08:30:00	In 2	17.2	9.42	-	2015-06-04 17:00:00	HP 2	21.7	8.02	-
2015-05-14 08:30:00	In 3	17.9	9.34	-	2015-06-04 17:00:00	HP 3	21	8.44	-
2015-05-14 12:00:00	Inlet	17.7	9.35	-	2015-06-05 07:45:00	Inlet	22.3	8.55	2310
2015-05-14 12:00:00	HP 1	17.3	9.32	-	2015-06-05 07:45:00	HP 1	21.2	6.71	0
2015-05-14 12:00:00	HP 2	17.5	9.27	-	2015-06-05 07:45:00	HP 2	21	7.15	0.02
2015-05-14 12:00:00	HP 3	17.2	9.69	-	2015-06-05 07:45:00	HP 3	21.2	6.93	0.03
2015-05-15 08:20:00	Inlet	17.2	9.36	-	2015-06-05 17:00:00	Inlet	-	-	10000
2015-05-15 08:20:00	HP 1	-	-	-	2015-06-05 17:00:00	HP 1	-	-	0
2015-05-15 08:20:00	HP 2	16.6	7.79	-	2015-06-05 17:00:00	HP 2	-	-	0
2015-05-15 08:20:00	HP 3	17	7.7	-	2015-06-05 17:00:00	HP 3	-	-	0.17
2015-05-20 13:20:00	Inlet	20.4	8.84	-	2015-06-08 12:00:00	Inlet	-	-	1310
2015-05-20 13:20:00	HP 1	20.3	8.47	-	2015-06-08 12:00:00	HP 1	-	-	0.04
2015-05-20 13:20:00	HP 2	20.7	8.56	-	2015-06-08 12:00:00	HP 2	-	-	0.02
2015-05-20 13:20:00	HP 3	20.1	8.56	-	2015-06-08 12:00:00	HP 3	-	-	10000
2015-05-21 17:00:00	Inlet	20.3	8.75	-	2015-06-08 16:00:00	Inlet	23.1	8.14	-
2015-05-21 17:00:00	HP 1	19.9	8.7	-	2015-06-08 16:00:00	HP 1	22.3	8.02	-
2015-05-21 17:00:00	HP 2	19.5	8.6	-	2015-06-08 16:00:00	HP 2	22.3	8.14	-
2015-05-21 17:00:00	HP 3	19.3	8.61	-	2015-06-08 16:00:00	HP 3	23.6	6.47	-
2015-05-22 17:00:00	Inlet	20.2	8.79	-	2015-06-09 09:00:00	Inlet	21.6	8.89	490
2015-05-22 17:00:00	HP 1	20.3	8.43	-	2015-06-09 09:00:00	HP 1	21.4	8.13	0.01
2015-05-22 17:00:00	HP 2	20.1	8.5	-	2015-06-09 09:00:00	HP 2	21.2	8.24	0.05
2015-05-22 17:00:00	HP 3	20.1	8.56	-	2015-06-09 09:00:00	HP 3	21.4	8.12	2.16
2015-05-26 08:10:00	Inlet	21.1	8.48	-	2015-06-09 17:40:00	Inlet	21.5	8.64	-
2015-05-26 08:10:00	HP 1	19.7	4.41	-	2015-06-09 17:40:00	HP 1	21.7	8.4	-
2015-05-26 08:10:00	HP 2	19.5	5.52	-	2015-06-09 17:40:00	HP 2	21.3	8.62	-
2015-05-26 08:10:00	HP 3	19.7	4.45	-	2015-06-09 17:40:00	HP 3	21.6	8.29	-
2015-05-26 12:35:00	Inlet	21.3	8.55	-	2015-06-10 09:00:00	Inlet	21.5	9	-
2015-05-26 12:35:00	HP 1	20.5	8.14	-	2015-06-10 09:00:00	HP 1	21.5	7.55	-
2015-05-26 12:35:00	HP 2	20.3	8.48	-	2015-06-10 09:00:00	HP 2	21.3	6.38	-
2015-05-26 12:35:00	HP 3	20.2	8.29	-	2015-06-10 09:00:00	HP 3	21.2	7.33	-

Date/Time	Location	Temperature	Oxygen	CFU	Date/Time	Location	Temperature	Oxygen	CFU
2015-06-10 16:10:00	Inlet	22.4	8.64	-	2015-06-24 08:00:00	Inlet	20.5	7.71	1660
2015-06-10 16:10:00	HP 1	22.2	8.17	-	2015-06-24 08:00:00	HP 1	20.6	4.62	0.08
2015-06-10 16:10:00	HP 2	22	8.09	-	2015-06-24 08:00:00	HP 2	20.8	4.48	0.5579
2015-06-10 16:10:00	HP 3	22.4	8.14	-	2015-06-24 08:00:00	HP 3			
2015-06-11 08:50:00	Inlet	22.2	8.84	280	2015-06-24 16:00:00	Inlet	22.2	7.54	3410
2015-06-11 08:50:00	HP 1	22	7.5	0.04	2015-06-24 16:00:00	HP 1	21.9	7.12	0.03
2015-06-11 08:50:00	HP 2	21.9	7.53	0.04	2015-06-24 16:00:00	HP 2	22.1	7.18	0.03
2015-06-11 08:50:00	HP 3	22	7.29	0.97	2015-06-24 16:00:00	HP 3	22.1	7.12	-0.01
2015-06-11 17:10:00	Inlet	22.7	8.63	-	2015-06-25 08:00:00	Inlet	21.4	7.52	940
2015-06-11 17:10:00	HP 1	22.6	8.22	-	2015-06-25 08:00:00	HP 1	21.5	5.23	0.01
2015-06-11 17:10:00	HP 2	22	8.26	-	2015-06-25 08:00:00	HP 2	20.5	5.02	0
2015-06-11 17:10:00	HP 3	22.4	8.23	-	2015-06-25 08:00:00	HP 3	21.6	6.46	0.02
2015-06-12 08:40:00	Inlet	22.4	7.48	370	2015-06-25 16:30:00	Inlet	21.9	7.5	1330
2015-06-12 08:40:00	HP 1	22.1	6.6	0.02	2015-06-25 16:30:00	HP 1	22	7.06	0
2015-06-12 08:40:00	HP 2	21.8	6.71	0.19	2015-06-25 16:30:00	HP 2	21.8	7.18	0.02
2015-06-12 08:40:00	HP 3	22.1	6.57	1.6	2015-06-25 16:30:00	HP 3	21.5	7.13	-0.01
2015-06-12 17:20:00	Inlet	22.6	7.41	-	2015-06-26 08:00:00	Inlet	-	-	-
2015-06-12 17:20:00	HP 1	22.5	7.05	-	2015-06-26 08:00:00	HP 1	-	-	-
2015-06-12 17:20:00	HP 2	22.2	7.1	-	2015-06-26 08:00:00	HP 2	-	-	-
2015-06-12 17:20:00	HP 3	22.3	7.03	-	2015-06-26 08:00:00	HP 3	-	-	-
2015-06-15 08:00:00	Inlet	21.2	7.55	10000	2015-06-26 17:00:00	Inlet	-	-	-
2015-06-15 08:00:00	HP 1	21.3	4.56	0.07	2015-06-26 17:00:00	HP 1	-	-	-
2015-06-15 08:00:00	HP 2	21.3	4.07	0.176	2015-06-26 17:00:00	HP 2	-	-	-
2015-06-15 08:00:00	HP 3	21.1	4.7	0.02	2015-06-26 17:00:00	HP 3	-	-	-
2015-06-15 16:20:00	Inlet	22.5	7.42	1590	2015-06-29 08:05:00	Inlet	22.1	7.33	-
2015-06-15 16:20:00	HP 1	22.3	6.81	0.03	2015-06-29 08:05:00	HP 1	22.1	3.67	-
2015-06-15 16:20:00	HP 2	22.1	6.94	0.14	2015-06-29 08:05:00	HP 2	22.2	4.21	-
2015-06-15 16:20:00	HP 3	22.3	6.92	10000	2015-06-29 08:05:00	HP 3	22.6	3.09	-
2015-06-16 07:45:00	Inlet	21.5	7.68	-	2015-06-29 16:20:00	Inlet	27.2	6.87	2120
2015-06-16 07:45:00	HP 1	21.2	4.77	-	2015-06-29 16:20:00	HP 1	27.9	5.9	0.24
2015-06-16 07:45:00	HP 2	21.3	5.21	-	2015-06-29 16:20:00	HP 2	27.6	6.15	0.01
2015-06-16 07:45:00	HP 3	21.3	6.02	-	2015-06-29 16:20:00	HP 3	27.8	5.78	0.01
2015-06-16 16:00:00	Inlet	22.5	7.51	-	2015-06-30 08:15:00	Inlet	22.1	7.36	2220
2015-06-16 16:00:00	HP 1	22.2	7.19	-	2015-06-30 08:15:00	HP 1	22.4	4.65	0.06
2015-06-16 16:00:00	HP 2	21.9	7.18	-	2015-06-30 08:15:00	HP 2	22.3	5.01	0.04
2015-06-16 16:00:00	HP 3	22.2	7.21	-	2015-06-30 08:15:00	HP 3	22.5	4.47	0
2015-06-17 08:00:00	Inlet	21	7.72	1110	2015-06-30 17:00:00	Inlet	26.7	6.85	2800
2015-06-17 08:00:00	HP 1	21.4	3.95	0.05	2015-06-30 17:00:00	HP 1	27.1	6	0.11
2015-06-17 08:00:00	HP 2	21.3	4.78	0.19	2015-06-30 17:00:00	HP 2	26.7	6.17	0.01
2015-06-17 08:00:00	HP 3	21	4.9	0.1	2015-06-30 17:00:00	HP 3	27.1	5.88	0
2015-06-17 16:00:00	Inlet	21.9	7.59	2000	2015-07-01 08:15:00	Inlet	21.6	7.37	10000
2015-06-17 16:00:00	HP 1	21.3	7.27	0.06	2015-07-01 08:15:00	HP 1	21.5	4.1	0.03092
2015-06-17 16:00:00	HP 2	21.4	7.22	0	2015-07-01 08:15:00	HP 2	21.6	4.4	0.185561
2015-06-17 16:00:00	HP 3	21.6	7.22	-	2015-07-01 08:15:00	HP 3	21.9	4.01	0.0111111
2015-06-18 08:00:00	Inlet	21.4	7.68	2250	2015-07-01 16:45:00	Inlet	26.5	6.88	10000
2015-06-18 08:00:00	HP 1	21.6	4.96	0.2	2015-07-01 16:45:00	HP 1	27	7.12	0.81
2015-06-18 08:00:00	HP 2	21.2	5.39	0.02	2015-07-01 16:45:00	HP 2	26.7	6.34	0.26
2015-06-18 08:00:00	HP 3	21.3	5.51	1.1	2015-07-01 16:45:00	HP 3	26.7	6	0.42
2015-06-18 17:00:00	Inlet	23.2	7.34	3460	2015-07-02 08:05:00	Inlet	21.7	7.35	2220
2015-06-18 17:00:00	HP 1	22.3	7.38	0.07	2015-07-02 08:05:00	HP 1	21.3	4.63	0.2315947
2015-06-18 17:00:00	HP 2	22.2	7.41	0.06	2015-07-02 08:05:00	HP 2	21.5	5.13	0
2015-06-18 17:00:00	HP 3	22.6	7.38	0.5	2015-07-02 08:05:00	HP 3	21.7	4.12	0.02
2015-06-19 08:00:00	Inlet	22.5	7.48	10000	2015-07-02 16:50:00	Inlet	25.4	6.97	10000
2015-06-19 08:00:00	HP 1	20.8	6.71	0.21	2015-07-02 16:50:00	HP 1	25.7	7.07	1.3189474
2015-06-19 08:00:00	HP 2	21	6.99	0.01	2015-07-02 16:50:00	HP 2	25.9	6.41	0.18
2015-06-19 08:00:00	HP 3	20.6	6.92	0.02	2015-07-02 16:50:00	HP 3	25.4	6.6	0.0315747
2015-06-19 17:00:00	Inlet	22.9	7.33	10000	2015-07-03 08:10:00	Inlet	21.3	7.48	10000
2015-06-19 17:00:00	HP 1	20.7	7.28	0.07	2015-07-03 08:10:00	HP 1	21.3	5.49	0.79
2015-06-19 17:00:00	HP 2	22.5	7.04	0.02	2015-07-03 08:10:00	HP 2	21.6	5.82	0
2015-06-19 17:00:00	HP 3	21.7	7.1	1.84	2015-07-03 08:10:00	HP 3	22.1	5.5	0
2015-06-22 08:15:00	Inlet	21	7.59	1150	2015-07-03 17:00:00	Inlet	-	-	-
2015-06-22 08:15:00	HP 1	21	6.01	0.01	2015-07-03 17:00:00	HP 1	-	-	-
2015-06-22 08:15:00	HP 2	20.9	5.76	0.2	2015-07-03 17:00:00	HP 2	-	-	-
2015-06-22 08:15:00	HP 3	21.6	5.13	0.02	2015-07-03 17:00:00	HP 3	-	-	-
2015-06-22 17:00:00	Inlet	21.7	7.48	-	2015-07-06 08:20:00	Inlet	19.8	7.6	1670
2015-06-22 17:00:00	HP 1	22.4	7.03	-	2015-07-06 08:20:00	HP 1	20.1	4.32	1.4
2015-06-22 17:00:00	HP 2	22	7.09	-	2015-07-06 08:20:00	HP 2	19.7	4.83	0.07
2015-06-22 17:00:00	HP 3	22.3	7.08	-	2015-07-06 08:20:00	HP 3	19.6	4.53	0.0210632
2015-06-23 08:00:00	Inlet	20.6	7.68	-	2015-07-06 16:45:00	Inlet	21.1	7.4	2920
2015-06-23 08:00:00	HP 1	21	4.21	-	2015-07-06 16:45:00	HP 1	22	6.61	1.03
2015-06-23 08:00:00	HP 2	20.4	4.84	0.05	2015-07-06 16:45:00	HP 2	21.8	6.85	10
2015-06-23 08:00:00	HP 3	21	4.62	0.01	2015-07-06 16:45:00	HP 3	22.1	6.55	0.11
2015-06-23 17:00:00	Inlet	21.5	7.62	160	2015-07-07 08:20:00	Inlet	20.4	7.14	10000
2015-06-23 17:00:00	HP 1	21.2	7.25	0.06	2015-07-07 08:20:00	HP 1	21.4	3.42	0.3
2015-06-23 17:00:00	HP 2	21.5	6.8	0.01	2015-07-07 08:20:00	HP 2	20.3	4.55	1.04
2015-06-23 17:00:00	HP 3	21.6	7.13	-0.01	2015-07-07 08:20:00	HP 3	21.2	3.71	0.5125

Date/Time	Location	Temperature	Oxygen	CFU	Date/Time	Location	Temperature	Oxygen	CFU
2015-07-07 15:45:00	Inlet	21	7.4	3500	2015-07-21 14:30:00	Inlet	22	7.4	-
2015-07-07 15:45:00	HP 1	21.8	6.71	0.28	2015-07-21 14:30:00	HP 1	21.9	7.02	-
2015-07-07 15:45:00	HP 2	21.6	6.86	9.803929	2015-07-21 14:30:00	HP 2	21.4	7.08	-
2015-07-07 15:45:00	HP 3	21.6	6.76	0.03	2015-07-21 14:30:00	HP 3	21.8	6.98	-
2015-07-08 08:10:00	Inlet	19.9	7.68	3320	2015-07-22 08:30:00	Inlet	-	-	-
2015-07-08 08:10:00	HP 1	19.4	5.01	0.01	2015-07-22 08:30:00	HP 1	-	-	-
2015-07-08 08:10:00	HP 2	19.3	5.41	0.04	2015-07-22 08:30:00	HP 2	-	-	-
2015-07-08 08:10:00	HP 3	19.4	4.94	0.01	2015-07-22 08:30:00	HP 3	-	-	-
2015-07-08 16:50:00	Inlet	20.6	7.49	10000	2015-07-22 14:30:00	Inlet	-	-	-
2015-07-08 16:50:00	HP 1	20.6	7.06	0.27	2015-07-22 14:30:00	HP 1	-	-	-
2015-07-08 16:50:00	HP 2	20.3	7.14	10	2015-07-22 14:30:00	HP 2	-	-	-
2015-07-08 16:50:00	HP 3	20.4	7.02	0.9159474	2015-07-22 14:30:00	HP 3	-	-	-
2015-07-09 08:40:00	Inlet	20.6	7.4	4420	2015-07-23 08:30:00	Inlet	21.4	7.13	-
2015-07-09 08:40:00	HP 1	20.2	5.76	0	2015-07-23 08:30:00	HP 1	20.9	4.32	-
2015-07-09 08:40:00	HP 2	20.1	6.16	0.45	2015-07-23 08:30:00	HP 2	20.1	5.34	-
2015-07-09 08:40:00	HP 3	20.3	5.68	0.0252632	2015-07-23 08:30:00	HP 3	20.2	5.41	-
2015-07-09 15:30:00	Inlet	21.3	7.3	2330	2015-07-23 15:20:00	Inlet	21.7	7.22	-
2015-07-09 15:30:00	HP 1	21.5	6.86	0.3682039	2015-07-23 15:20:00	HP 1	22.1	6.8	-
2015-07-09 15:30:00	HP 2	21.2	6.96	1.2	2015-07-23 15:20:00	HP 2	21.5	6.9	-
2015-07-09 15:30:00	HP 3	21.4	6.93	0.02	2015-07-23 15:20:00	HP 3	21.6	6.73	-
2015-07-10 08:20:00	Inlet	20.2	7.5	10000	2015-07-24 07:45:00	Inlet	20.4	7.41	-
2015-07-10 08:20:00	HP 1	19.6	5.78	0.83	2015-07-24 07:45:00	HP 1	20.8	4.12	-
2015-07-10 08:20:00	HP 2	19.5	6.15	1.7	2015-07-24 07:45:00	HP 2	20	4.87	-
2015-07-10 08:20:00	HP 3	20.1	5.97	0	2015-07-24 07:45:00	HP 3	20.1	5.14	-
2015-07-10 15:45:00	Inlet	21.1	7.33	3160	2015-07-24 14:30:00	Inlet	-	-	-
2015-07-10 15:45:00	HP 1	21.3	6.82	0.17	2015-07-24 14:30:00	HP 1	-	-	-
2015-07-10 15:45:00	HP 2	20.9	6.98	10	2015-07-24 14:30:00	HP 2	-	-	-
2015-07-10 15:45:00	HP 3	21.3	6.88	0	2015-07-24 14:30:00	HP 3	-	-	-
2015-07-13 08:40:00	Inlet	19.3	7.71	2760	2015-07-27 08:30:00	Inlet	20.9	7.2	-
2015-07-13 08:40:00	HP 1	19.3	5.33	1.0093922	2015-07-27 08:30:00	HP 1	20.2	3.07	-
2015-07-13 08:40:00	HP 2	19.5	6.26	9.8031569	2015-07-27 08:30:00	HP 2	19.6	3.69	-
2015-07-13 08:40:00	HP 3	19.4	5.48	0	2015-07-27 08:30:00	HP 3	19.6	3.97	-
2015-07-13 16:45:00	Inlet	21.2	7.2	2090	2015-07-27 16:00:00	Inlet	21.3	7.28	-
2015-07-13 16:45:00	HP 1	21.3	6.76	0.67	2015-07-27 16:00:00	HP 1	21.7	6.6	-
2015-07-13 16:45:00	HP 2	20.8	7.1	10.526579	2015-07-27 16:00:00	HP 2	21.1	6.78	-
2015-07-13 16:45:00	HP 3	21.3	6.76	0.29	2015-07-27 16:00:00	HP 3	21.1	6.7	-
2015-07-14 08:40:00	Inlet	20	7.52	10000					
2015-07-14 08:40:00	HP 1	19.9	6	1.43					
2015-07-14 08:40:00	HP 2	19.9	6.43	9.9000099					
2015-07-14 08:40:00	HP 3	20.1	6.22	0.0105316					
2015-07-14 15:45:00	Inlet	21.9	7.29	-					
2015-07-14 15:45:00	HP 1	21.5	6.98	-					
2015-07-14 15:45:00	HP 2	21.3	7.03	-					
2015-07-14 15:45:00	HP 3	21.4	7	-					
2015-07-15 08:35:00	Inlet	20.4	7.51	10000					
2015-07-15 08:35:00	HP 1	20.2	5.61	1.62					
2015-07-15 08:35:00	HP 2	20.3	5.71	10					
2015-07-15 08:35:00	HP 3	20.4	5.9	0.02					
2015-07-15 15:45:00	Inlet	21	7.37	3130					
2015-07-15 15:45:00	HP 1	21	7	1.48979					
2015-07-15 15:45:00	HP 2	20.8	7.13	10					
2015-07-15 15:45:00	HP 3	20.9	6.92	0.03					
2015-07-16 08:20:00	Inlet	20.4	7.6	3670					
2015-07-16 08:20:00	HP 1	19.9	5.25	1.62					
2015-07-16 08:20:00	HP 2	19.9	5.94	10					
2015-07-16 08:20:00	HP 3	20	6.04	0					
2015-07-16 17:00:00	Inlet	20.4	7.46	10000					
2015-07-16 17:00:00	HP 1	20.3	7.68	0.95					
2015-07-16 17:00:00	HP 2	20.4	7.46	0.2					
2015-07-16 17:00:00	HP 3	21	7.13	0.0315747					
2015-07-17 08:30:00	Inlet	20.4	7.41	10000					
2015-07-17 08:30:00	HP 1	20.4	6.47	0.85					
2015-07-17 08:30:00	HP 2	20	6.49	10					
2015-07-17 08:30:00	HP 3	20.2	6.46	0.01					
2015-07-17 16:30:00	Inlet	21.6	7.25	10000					
2015-07-17 16:30:00	HP 1	21.8	6.82	0.06					
2015-07-17 16:30:00	HP 2	21.3	7	0.1					
2015-07-17 16:30:00	HP 3	21.7	6.88	0.1578937					
2015-07-20 08:30:00	Inlet	20.2	7.52	2780					
2015-07-20 08:30:00	HP 1	20.1	5.89	0					
2015-07-20 08:30:00	HP 2	19.9	5.37	0.0631895					
2015-07-20 08:30:00	HP 3	19.9	6.04	0					
2015-07-20 16:00:00	Inlet	21.3	7.39	-					
2015-07-20 16:00:00	HP 1	21.3	6.85	-					
2015-07-20 16:00:00	HP 2	21	6.92	-					
2015-07-20 16:00:00	HP 3	21.3	6.95	-					
2015-07-21 07:45:00	Inlet	21.3	7.44	-					
2015-07-21 07:45:00	HP 1	22.2	4.71	-					
2015-07-21 07:45:00	HP 2	21.2	5.03	-					
2015-07-21 07:45:00	HP 3	21.6	5.13	-					

Appendix IV - Statistical Summaries

Oxygen summary

```
Simultaneous Tests for General Linear Hypotheses

Multiple Comparisons of Means: Dunnett, Tukey Contrasts

Fit: aov(formula = value ~ isInlet + AMPM + isMonday, data = Tmp[Tmp$variable ==
    variable & Tmp$Location %in% c("Inlet", "HP 1", "HP 2", "HP 3"), ])

Linear Hypotheses:
                              Estimate Std. Error t value     Pr(>|t|)
isInlet: TRUE - FALSE == 0       1.122      0.133    8.42 < 0.00000001 ***
AMPM: Morning - Afternoon == 0  -1.623      0.117  -13.86 < 0.00000001 ***
isMonday: TRUE - FALSE == 0     -0.845      0.152   -5.55   0.00000016 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p values reported -- single-step method)
```

Temperature Summary

```
Simultaneous Tests for General Linear Hypotheses

Multiple Comparisons of Means: Dunnett, Tukey Contrasts

Fit: aov(formula = value ~ isInlet + AMPM + isMonday, data = Tmp[Tmp$variable ==
    variable & Tmp$Location %in% c("Inlet", "HP 1", "HP 2", "HP 3"), ])

Linear Hypotheses:
                              Estimate Std. Error t value Pr(>|t|)
isInlet: TRUE - FALSE == 0       0.415      0.242    1.71   0.2398
AMPM: Morning - Afternoon == 0  -0.260      0.213   -1.22   0.5292
isMonday: TRUE - FALSE == 0      0.893      0.277    3.23   0.0041 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p values reported -- single-step method)
```

Bacteria Summary (analysis done using $\log_{10}$(CFU))

```
Simultaneous Tests for General Linear Hypotheses

Multiple Comparisons of Means: Dunnett, Tukey Contrasts

Fit: aov(formula = value ~ isInlet + AMPM + isMonday, data = Tmp[Tmp$variable ==
    variable & Tmp$Location %in% c("Inlet", "HP 1", "HP 2", "HP 3"),])

Linear Hypotheses:
                              Estimate Std. Error t value Pr(>|t|)
isInlet: TRUE - FALSE == 0       4.305      0.145   29.66  <0.0001 ***
AMPM: Morning - Afternoon == 0  -0.213      0.133   -1.61     0.29
isMonday: TRUE - FALSE == 0      0.106      0.156    0.68     0.87
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p values reported -- single-step method)
```