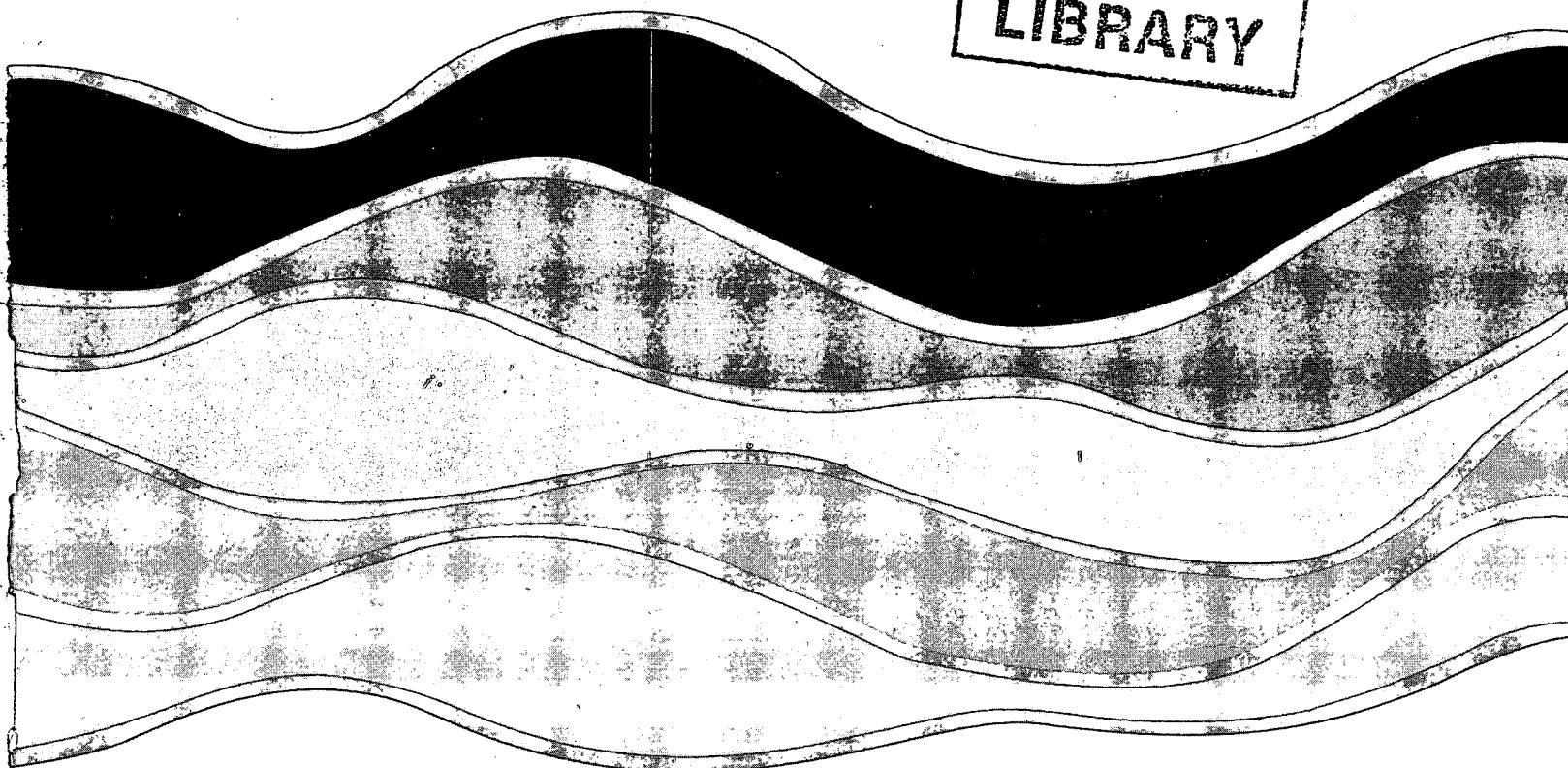
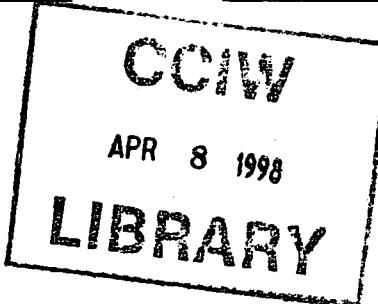
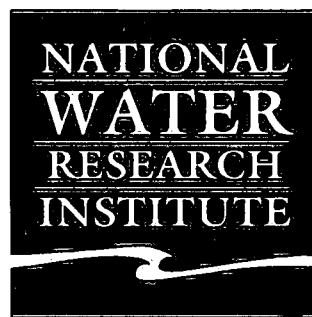


98-015 MASTER C.



CHRONIC TOXICITY OF HIGH AND LOW
INTENSITY UV DISINFECTED EFFLUENTS FROM
THREE SEWAGE TREATMENT PLANTS IN
ONTARIO: DATA REPORT

Q. Rochfort, I. Scott, R. McLeanis, A. Jurkovic,
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NWR Contribution No. 98-015

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Q. Rochfort, I. Scott, R. McInnis, A. Jurkovic, J. Marsalek and M. Servos

February 11, 1998

**Aquatic Ecosystem Protection Branch,
National Water Research Institute,
Canada Centre for Inland Waters,
867 Lakeshore Road, Burlington, ON L7R 4A6**

Management Perspective

The presence of chlorine compounds in disinfected municipal effluents may adversely impact on receiving water quality. Ultraviolet (UV) light disinfection has been suggested as an alternative to chlorination, as UV disinfection does not produce chlorinated compounds and therefore may result in less toxic effluents. However, recent studies suggest that certain chemical substances (such as polycyclic aromatic hydrocarbons, pesticides and humic substances), commonly found in municipal effluents, can break down upon exposure to ultraviolet light. This could result in an effluent that is potentially more toxic than the original wastewater. Concern was therefore expressed by the Ontario Ministry of Environment and Energy (MOEE), that UV systems may induce more toxicity in the effluent than the chlorination/de-chlorination techniques currently employed.

In order to recommend UV disinfection as a means of reducing effluent toxicity, an exploratory study was required to determine the potential for ultraviolet light, operated at levels required for disinfection, to induce chronic toxicity in municipal sewage effluents. Chronic toxicity was assessed by two tests: *Ceriodaphnia dubia* and fathead minnow 7 day tests.

Two treatment plants were selected to represent in place, low intensity and high intensity UV disinfection, and the effluent from a large municipal plant was treated with bench scale UV disinfection. Non-disinfected and bench scale chlorinated/de-chlorinated effluents were also compared to the UV treatment.

This data report would be of interest to wastewater researchers, design engineers and municipal wastewater treatment engineers and operators.

Sommaire à l'intention de la direction

La présence de composés chlorés dans les effluents municipaux désinfectés peut avoir des répercussions négatives sur la qualité des eaux réceptrices. On a suggéré de remplacer la chloration par la désinfection aux ultraviolets (UV), étant donné que cette méthode ne produit pas de composés chlorés et qu'elle devrait donc donner des effluents moins toxiques. Toutefois, des études récentes permettent de penser que certaines substances chimiques (p. ex. des hydrocarbures aromatiques polycycliques, des pesticides et des substances humiques) souvent présentes dans les effluents municipaux pourraient être décomposées sous l'action du rayonnement ultraviolet, produisant ainsi un effluent plus毒ique que les eaux usées non traitées. Le ministère de l'Environnement et de l'Énergie de l'Ontario (MEEO) s'est donc dit préoccupé par la possibilité que les systèmes de désinfection aux UV soient à l'origine d'une toxicité des effluents supérieure à celle due aux techniques de chloration/déchloration actuellement employées.

Afin que l'utilisation de la désinfection aux UV puisse être recommandée pour la réduction de la toxicité des effluents, on a dû effectuer une étude exploratoire pour vérifier si les rayonnements ultraviolets, aux intensités requises pour la désinfection, peuvent être à l'origine de toxicité chronique dans les effluents d'égouts municipaux. On a évalué la toxicité chronique à l'aide de deux essais de 7 jours utilisant *Ceriodaphnia dubia* et la tête-de-boule.

On a sélectionné deux stations d'épuration représentant les techniques déjà installées de désinfection aux UV à faible et à forte intensité, et on a traité des effluents d'une grande station d'épuration municipale à l'aide d'un système à petite échelle de désinfection aux UV. On a ensuite comparé ces effluents traités aux UV à des effluents non désinfectés et à des effluents chlorés/déchlorés à l'aide d'un système à petite échelle.

Ces données pourraient intéresser les chercheurs du domaine des eaux usées, les ingénieurs d'études, ainsi que les ingénieurs et les opérateurs des stations municipales d'épuration des eaux usées.

Abstract

UV irradiation is currently used in disinfection of treated wastewater effluents as a viable alternative to chlorination, which may lead to chronic toxicity effects of residual chlorine in the aquatic environment. Some current literature supports the hypothesis that UV light can induce changes in certain organic compounds, which become more toxic after UV irradiation. The determination of chronic toxicity of UV irradiated effluent was initiated by the Ontario Ministry of Environment and Energy (MOEE) and Environment Canada in order to support the continued use of this technology.

Samples of non-disinfected effluent, UV disinfected effluent and chlorinated/de-chlorinated effluent, from three different sewage treatment plants in Ontario, were tested for toxicity. At two of the plants, UV disinfection was applied in situ, either at low or high intensity. The third plant did not have UV disinfection, and therefore bench scale UV irradiation had to be performed in the laboratory. Chlorination/de-chlorination was also performed for all samples using a bench scale reactor. Two types of 7-day chronic toxicity tests, using the Cladoceran - *Ceriodaphnia dubia* and Fathead minnow - *Pimephales promelas*, were performed on these samples.

The majority of samples tested were non-toxic. No significant indications of UV-induced toxicity were found in the effluent samples tested, regardless of location or intensity of UV treatment. Generally effluent samples that were toxic before disinfection were also toxic after disinfection, however, several samples from one plant did show indications of increased toxicity after chlorination/de-chlorination.

The chronic toxicity testing performed on the samples collected confirms the results of earlier similar studies. UV irradiation for disinfection purposes does not increase effluent toxicity, which may occur with chlorination/de-chlorination, potentially harming the receiving water ecosystems.

Résumé

Pour la désinfection des effluents d'eaux usées traitées, on utilise communément l'irradiation UV, considérée comme une méthode viable de remplacement de la chloration, laquelle peut être à l'origine d'effets toxiques chroniques dus au chlore résiduel dans les milieux aquatiques. Certains articles récents appuient l'hypothèse selon laquelle le rayonnement UV pourrait causer des changements dans certains composés organiques, qui deviendraient plus toxiques après l'irradiation UV. Le ministère de l'Environnement et de l'Énergie de l'Ontario (MÉEO) et Environnement Canada ont entrepris de déterminer la toxicité chronique des effluents irradiés aux UV pour le soutien de cette technologie déjà en usage.

On a mesuré la toxicité d'échantillons d'effluents non désinfectés, d'effluents désinfectés aux UV et d'effluents chlorés/déchlorés provenant de trois stations d'épuration différentes de l'Ontario. Dans deux des stations, on a effectué la désinfection aux UV *in situ*, à basse ou à haute intensité. La troisième station ne disposait pas d'équipement de désinfection aux UV et on a donc effectué l'irradiation UV à petite échelle en laboratoire. On a également effectué la chloration/déchloration de tous les échantillons à l'aide d'un petit réacteur. Avec ces échantillons, on a effectué deux types de tests de toxicité chronique de 7 jours utilisant des cladocères (*Ceriodaphnia dubia*) et la tête-de-boule (*Pimephales promelas*).

La majorité des échantillons testés étaient non toxiques. Dans les échantillons d'effluents testés, on n'a noté aucun signe de toxicité significative causée par les UV, peu importe l'emplacement ou l'intensité du traitement UV. En général, les échantillons d'effluents qui étaient toxiques avant la désinfection l'étaient aussi après la désinfection, mais plusieurs échantillons d'une station présentaient des signes de toxicité accrue après la chloration/déchloration.

Les tests de toxicité chronique effectués avec les échantillons recueillis confirment les résultats d'études antérieures similaires. L'utilisation de l'irradiation UV pour la désinfection n'accroît pas la toxicité des effluents, mais cela peut être le cas avec la chloration/déchloration, qui peut avoir des effets néfastes sur les écosystèmes d'eaux réceptrices.

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1.0 INTRODUCTION

Ultraviolet (UV) irradiation is currently being used in disinfection of treated wastewater effluent. It is considered to be a viable alternative to chlorination, which may exert chronic toxicity effects in the aquatic environment due to residual chlorine. Recent studies suggest that UV light may induce changes in the effluent, which could then become more toxic after UV irradiation (Orr et al. 1992; Enviromega 1995). A joint study by the National Water Research Institute (NWRI) and the Ontario Ministry of Environment and Energy (MOEE) was initiated to investigate the potential of UV disinfection to induce chronic toxicity in municipal sewage treatment plant effluents.

Chronic toxicity testing of effluents from three sewage treatment plants was performed by NWRI, using the 7 day *Ceriodaphnia dubia* and fathead minnow bioassays. The treatment plants selected used: high intensity UV, medium intensity UV or chlorine disinfection. Each effluent was tested before and after treatment. The effluent from UV treatment plants was also chlorinated and de-chlorinated and compared to the in-place treated effluents. Non-disinfected effluent from the plant using chlorination (Plant C), was treated with medium intensity UV light in the laboratory and compared to in-place treated effluents. At least two samples from each plant were tested for toxicity using a full dilution series, while additional samples were evaluated at 100% concentration only.

Two primary objectives were identified for this project:

- Existing treatment plants were used to determine if UV disinfection systems currently operating at municipal treatment plants affect chronic toxicity of final effluents.
- Relative chronic toxicities of non-disinfected, UV and chlorine disinfected effluents were compared.

This report is essentially a data report, which describes the general trends observed in the samples collected. It does not discuss in detail the potential implications of the results obtained.

2.0 SITE DESCRIPTIONS

Three municipal wastewater treatment plants were investigated during this research. These were recommended by MOEE, and were representative of in-place operational UV disinfection systems, using both low and high intensity UV treatment systems. A bench scale UV system allowed for the inclusion of effluents from a large municipal plant, which currently does not use UV disinfection.

Samples for chronic toxicity tests were collected in 20 L plastic pails lined with food grade polyethylene liners. Chemical samples were collected using 500 mL plastic bottles, and bacteria samples were collected in 150 mL bottles with sodium thiosulfate added to remove residual chlorine.

2.1 Plant A

Plant A employs a conventional activated sludge treatment which comprises primary clarification, aeration tanks for biological treatment, followed by secondary clarification to separate activated sludge solids and cleansed sewage effluent. The settled activated sludge solids are either returned to the aeration tanks to sustain biological treatment of the sewage or taken for further treatment and off-site disposal. A low pressure, low-intensity, ultra-violet light process was used to disinfect the final effluent prior to discharge.

Plant A is designed to treat 9,900 m³/day. In 1996, it received an annual average flow of 7,100 m³/day of raw sewage, or 72% of its design capacity. Ten percent of its raw sewage originated from industrial and commercial sources; the remaining 90% were from residential sources. The annual average concentrations of carbonaceous biochemical oxygen demand (CBOD₅), total suspended solids (TSS), total phosphorus, (TP) and total ammonia in the treated effluent were 3 mg/L, 3 mg/L and 0.7 mg/L respectively. These represent average removals of 98%, 99%, 91% and 95%, respectively.

2.2 Plant B.

Plant B is a conventional activated sludge treatment plant with similar process configuration as plant A. The clarified effluent is disinfected by a medium pressure high intensity ultra-violet light process before being discharged into the receiving water.

Plant B is designed to treat 36,300 m³/day. In 1996 it received an annual average of 24,600 m³/day of raw sewage, or 68% of its design capacity. Twenty percent of the raw sewage was from industries and commercial establishments; 80% was from residential sources. The annual average concentrations of CBOD₅, TSS, TP and total ammonia in the treated effluent were 2 mg/L, 4 mg/L, 0.6 mg/L and 0.6 mg/L, respectively, representing an average removal of 98%, 97%, 89% and 95%, respectively.

2.3 Plant C

Plant C is also a conventional activated sludge treatment plant with a design capacity of 409,000 m³/day. Its effluent was disinfected by gaseous chlorine prior to discharge. In 1996, it received an annual average flow of 364,700 m³/day or 89% of its design capacity. Twenty-five percent of its raw sewage was from industrial and commercial sources; 75% was residential wastewater. The annual average concentrations in the treated effluent and removals of CBOD₅, TSS and TP were 5 mg/L, 9 mg/L, 0.6 mg/L and 98%, 95% and 88%, respectively. Unlike plants A and B, this plant was not designed nor operated to remove total ammonia. Its annual average total ammonia concentration in the treated effluent was about 13 mg/L.

3.0 METHODS

3.1 Bacterial Testing

MOEE laboratories were unavailable to analyze samples during certain sampling periods and, therefore, both MOEE and NWRI laboratories performed bacterial testing. MOEE performed only *E. coli* testing, whereas NWRI enumerated both fecal coliform and *E. coli*. The NWRI methods are presented below.

Fecal coliform bacteria are gram negative, non-spore forming bacilli which are cytochrome oxidase negative and ferment lactose. During the process of fermentation, gasses are released and trapped inside small inverted tubes. The numbers of positive tubes in each dilution were recorded and using a table, an estimate of fecal coliform numbers was achieved.

Escherichia coli are gram negative, oxidase negative bacteria which ferment lactose. They also produce the enzyme β -glucuronidase (which may also be found in *Salmonella* and *Shigella*), which degrades MUG (4-methylumbelliferyl- β -glucuronide) to produce 4-methylumbelliferone. This product fluoresces under long range UV light. The numbers of positive tubes in each dilution were recorded and then estimates were made as to the most probable number of *E. coli*.

Bacterial counts of fecal coliform and *Escherichia coli* were performed on samples which were less than 12 hours old, using A-1 broth with MUG. A five tube, three or four series, most probable number (MPN) test was used. In order to perform this test, the fresh water sample was used to inoculate the A-1 growth medium in five tubes. A series of 1:10 dilutions were made to lower the initial number of bacteria used in the inoculation. This range allows for more accurate estimates of total probable numbers. The samples were then capped and incubated for 24 hours at 44.5°C. A full description of these methods can be found in Dutka and Seidl (1993) and APHA (1989).

3.2 Chronic Toxicity Testing

Two types of 7-day chronic toxicity tests, using the Cladoceran - *Ceriodaphnia dubia* and Fathead minnow - *Pimephales promelas*, were performed on these samples. Chronic toxicity was assessed by determining the reproductive effect on *C. dubia* and the survival and growth of the fathead minnow.

3.2.1 *Ceriodaphnia dubia*

A *Ceriodaphnia dubia* neonate, less than 24 hours old, was placed in each test cup. A total of ten, 20 mL replicates for each concentration tested was used, and compared against a set of ten replicate controls. The control water and dilution water was tap water which had been de-chlorinated by continuous aeration for at least 4 days. A series of dilutions (100%, 50%, 25%, 12.5% and 6.25%) of the whole test solution was made for several tests at each site. Daily renewals of the test solutions were performed over the 7 day period of the test, at which time the neonates had matured and produced 3 broods of young.

The Environment Canada protocol EPS-1/RM/21 (1992) was followed regarding *Ceriodaphnia* culturing, feeding and test conditions. During the initial testing, however, it was discovered that only the 100% concentration showed reduced reproduction compared to the control water. For this reason, it was decided that a 100% pass/fail scan could be used to process more samples at each site. This additional capacity was used to construct a time series from daily samples at Plant A and Plant C. The effluents were sampled every day at the same time for 7 consecutive days. This helped to determine fluctuations in the toxicity of the effluent during a week.

3.2.2 Fathead Minnow

Ten fathead minnow larvae less than 24 hours old were placed in each test beaker. A total of four, 500 mL replicates for each concentration tested were used, and compared against a set of four replicate controls. The control water and dilution water was tap water which had been de-chlorinated by continuous aeration for at least 4 days. A series of dilutions (100, 50, 25, 12.5 and 6.25%) of the whole test solution was made for several

tests at each site. Daily renewals of the test solutions were performed over the 7 day period of the test. At the end of the test, the larvae were removed from the test solution and allowed to depurate in control water for 1 to 2 hours. The larvae were then counted, dried at 100°C for < 24 hours and weighed.

The Environment Canada protocol EPS-1/RM/22 (1992) was followed regarding fathead minnow culturing, feeding and test conditions. Chemical measurements were made for samples throughout the test duration and helped to provide insight as to changes in water quality over time. These measurements included: pH, conductivity, temperature, dissolved oxygen, ammonia and hardness.

3.3 Chemical Testing

MOEE laboratory provided analytical services for the analysis of a range of mostly inorganic parameters. These parameters included: Biochemical oxygen demand (C-BOD₅), solids (suspended, total and dissolved), nitrogen (nitrite, nitrate + nitrite, ammonia + ammonium, Total Kjeldahl nitrogen), phosphorus (phosphate, total phosphorus), Carbon (dissolved organic, dissolved inorganic), silicon and total metals (Al, Ba, Be, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, Ag, Sr, Ti, Va, Zn, Ca).

3.4 Bench Scale UV Irradiation

A Trojan 2000 pilot scale UV disinfection system was used for irradiation of Plant C effluent samples. This stainless steel, open channel, flow-through unit was rated to expose the effluent to greater than 27,500 $\mu\text{wes}/\text{cm}^2$, at a flow rate of 27 L/min, which was adequate for disinfection. The overall dimensions of the bench scale system were 183 cm long by 28 cm high by 4.5 cm wide. The UV exposure contact chamber was 90 cm long. This unit used 4 - 13.8 watt UV bulbs (in a stacked horizontal arrangement), shielded by quartz glass tubes, with a transmission efficiency of 65%. The effluent was fed to the unit by a submersible pump from a 300 L holding tank. Disinfected effluent was collected in 20 L plastic pails, lined with polyethylene bags.

3.5 Bench Scale Chlorination/De-chlorination

Bench scale chlorination was used to simulate the effect of conventional effluent disinfection techniques. It was effectively accomplished using a 60 L plastic reactor tank with a variable speed mixing device. Commercial laundry bleach (sodium hypochlorite) was added to the 50 L of effluent to achieve a free chlorine residual of 0.5 mg/L after 30 minutes. This generally required 10 mL of the bleach solution. After the 30 minute contact time, sodium sulfite (Na_2SO_3) 5 g/L solution was added until the total chlorine residual was zero (< 0.02 mg/L). This usually required 100 mL of the 5 g/L solution.

3.6 Sample Collection

Table 3.1 shows the sample collection dates and analyses performed for each. Sample codes were used to identify the location, order of collection and type of treatment. Samples from Plant A are designated by "A", Plant B by "B" and Plant C by "C". At each site, samples are numbered consecutively in the order of collection. The treatment that the sample received is then used as a suffix to each sample code for further distinction: UV - UV disinfected, CL - chlorinated/de-chlorinated and RW - non-disinfected (raw) effluent.

Table 3.1: Sample Collection

Sample Date	Location	Sample Coding	UV Disinfected (UV)	Chlorinated/ de-chlorinated (CL)	Non-disinfected Raw Effluent (RW)
Oct 23, 1996	Plant A	A-1	✓	✓	✓
Nov 6, 1996	Plant A	A-2	✓	✓	✓
Nov 21, 1996	Plant A	A-3	✓	✓	✓
Nov 22, 1996	Plant A	A-4	✓	✗	✓
Nov 23, 1996	Plant A	A-5	✓	✗	✓
Nov 24, 1996	Plant A	A-6	✓	✗	✓
Nov 25, 1996	Plant A	A-7	✓	✗	✓
Nov 26, 1996	Plant A	A-8	✓	✗	✓
Nov 27, 1996	Plant A	A-9	✓	✗	✓
Nov 28, 1996	Plant A	A-10	✓	✗	✓
Jan 8, 1997	Plant B	B-1	✓	✓	✓
Jan 17, 1997	Plant B	B-2	✓	✗	✓
Jan 22, 1997	Plant B	B-3	✓	✓	✓
Jan 24, 1997	Plant B	B-4	✓	✓	✓
Feb 5, 1997	Plant B	B-5	✓	✓	✓
Feb 14, 1997	Plant B	B-6	✓	✓	✓
Mar 19, 1997	Plant C	C-1	✓	✓	✓
Apr 2, 1997	Plant C	C-2	✓	✓	✓
Apr 25, 1997	Plant C	C-3	✓	✓	✓
Apr 26, 1997	Plant C	C-4	✓	✓	✓
Apr 27, 1997	Plant C	C-5	✓	✓	✓
Apr 28, 1997	Plant C	C-6	✓	✓	✓
Apr 29, 1997	Plant C	C-7	✓	✓	✓
Apr 30, 1997	Plant C	C-8	✓	✓	✓
May 1, 1997	Plant C	C-9	✓	✓	✓

✓ sample was collected for that test; ✗ no sample was collected for that test

4.0 RESULTS

The results of the *Ceriodaphnia* and fathead minnow chronic toxicity tests are summarized for each of the three plants in section 4.1. A more detailed description of the results is presented in sections 4.2 (*Ceriodaphnia*) and 4.3 (fathead minnow) showing calculated IC25 values and statistical significance for each test. In the *Ceriodaphnia* tests, IC25 values (IC is the abbreviation for "Inhibiting Concentration") represent the concentration of effluent at which 25% fewer organisms are produced compared to the control water. Fathead minnow IC25 values were calculated based on growth criteria. In these tests, the IC25 value would be the concentration of effluent at which the average weight of the exposed fish was 25% lower than those of the controls. IC25 values could only be calculated for tests where full dilution bioassays were performed. These are noted with an asterisk in Tables 4.1, 4.2 and 4.3. All other samples were assessed in "pass/fail" terms, using 100% effluent compared to a control.

The survival and reproduction observations recorded during the *Ceriodaphnia* tests are summarized in Tables found in Appendix A (*Ceriodaphnia* reproduction raw data). The survival and growth observations for fathead minnow tests are summarized in Appendix B (Fathead minnow survival and growth raw data). Basic water chemistry measurements were used as a guide to determine changes in water quality during the tests. These observations are summarized in Appendix C (Water Chemistry Data from Chronic Toxicity Tests). Samples were sent to MOEE labs for inorganic chemical analysis. The results of these water quality tests are presented in Appendix D (Water quality data, Inorganic chemistry). Bacterial data, used to asses the performance of the disinfection methods, are summarized in Appendix E (Bacterial counts).

4.1 Overview of *Ceriodaphnia* and Fathead Minnow Results

The two "endpoints" of each of the chronic toxicity bioassays can be summarized in a "pass/fail" table. Results are shown for UV disinfected effluent (UV), chlorinated/de-chlorinated effluent (CL) and raw (RW) non-disinfected effluent. Pale shading in the Table indicates that the tests were not performed on those samples and therefore no

conclusions could be drawn about their toxicity. Dark shading in each table indicates that the test failed, and therefore the sample exerted a toxic effect. The condition for failure of a test was based on criteria established in Environment Canada protocols. Survival failure was considered to occur if there was greater than 30% mortality in the 100% concentration for both *Ceriodaphnia* and fathead minnow tests. *Ceriodaphnia* reproduction failed when there was a statistically lower number of neonates produced in the 100% effluent when compared to those produced by the control organisms. Fathead minnow growth was considered to have failed when the larvae exposed to the 100% effluent were statistically lower in weight compared to those of the control larvae.

4.1.1 Plant A

Table 4.1 summarizes both the *Ceriodaphnia* and fathead minnow test results for samples taken at plant A. No toxic effects were noted in fathead minnow tests at this plant. *Ceriodaphnia* results showed failures in 3 of 10 UV disinfected samples and 4 of 10 raw effluent samples. Only one of three chlorinated/de-chlorinated samples was found to exhibit toxicity.

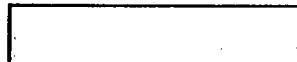
Notably, there were 5 days out of 10 where toxicity was evident. One case showed toxicity to *Ceriodaphnia* in raw and chlorinated/de-chlorinated effluent but the UV disinfected effluent was free of toxicity. In another case (where no chlorinated sample was collected), the UV disinfected effluent again showed no sign of toxicity where the raw effluent was toxic. Two cases showed that the UV disinfected effluent sample was toxic when the raw effluent was also toxic, and therefore, toxicity could not be directly attributed to the disinfection procedure.

In the case where *Ceriodaphnia* toxicity appeared after UV disinfection, but not in the raw effluent, reproduction in the experimental control was below that required by the protocol. Due to these conditions, the test data may not be completely valid and the observed toxicity may have been an artifact.

Table 4.1: Plant A - Ceriodaphnia and Fathead Minnow Effects

Date	(1996)	Oct 23*	Nov 6*	Nov 20	Nov 21	Nov 22	Nov 23	Nov 24	Nov 25	Nov 26	Nov 27
Treatment	Condition										
UV	CD-surv										
	CD-repro										
	FHM-surv										
	FHM-gro										
CL	CD-surv										
	CD-repro										
	FHM-surv										
	FHM-gro										
RW	CD-surv										
	CD-repro										
	FHM-surv										
	FHM-gro										

PASS



FAIL - 100%



No Sample



* indicates test performed with full dilution series - all other tests were 100% effluent Pass/Fail

4.1.2 Plant B

Table 4.2 summarizes both the *Ceriodaphnia* and fathead minnow test results for samples taken at plant B. At this plant, effluents were generally non-toxic to fathead minnows, but were notably toxic to *Ceriodaphnia*. *Ceriodaphnia* reproduction was affected for all 6 samples of raw and UV disinfected effluents. The reproduction rates for *Ceriodaphnia* were also negatively affected in 2 of 6 samples of the chlorinated/de-chlorinated effluent, although no response was detected in the fathead minnow tests. *Ceriodaphnia* survival was also affected for 1 of 6 raw effluent samples and 1 of 6 UV disinfected effluent samples, although on different days. Two of 6 samples were toxic to *Ceriodaphnia* for all three sample treatments (UV disinfected, chlorinated/de-chlorinated and raw effluents) and therefore the effect of disinfection on effluent toxicity could not be addressed.

Fathead minnow larval growth was reduced in both raw and UV disinfected effluent samples for only one day. Only the raw effluent sample showed some reduction in growth for one additional sample. Toxicity did not appear to be induced by disinfection, judging from the results of these tests.

4.1.3 Plant C

Table 4.3 summarizes both the *Ceriodaphnia* and fathead minnow test results for samples taken at plant C. Toxicity to *Ceriodaphnia* was generally only evident in raw effluent samples. No UV disinfected samples induced toxicity for *Ceriodaphnia*, and only one chlorinated/de-chlorinated sample showed evidence of inhibited reproduction. Four of 9 days showed reduced reproduction in raw effluent, while 5 of 9 samples showed reduced survival. Only two days showed both reduced survival and reproduction.

Fathead minnow tests showed high levels of toxicity at this plant. For 5 of 9 samples, the fathead tests demonstrated toxicity for raw and disinfected samples. One sample was toxic when raw, but the toxicity was removed after disinfection with either UV or chlorine. Due to this observed pattern, UV disinfection was not deemed to increase toxicity in these samples.

Table 4.2: Plant B - Ceriodaphnia and Fathead Minnow Effects

Date	(1997)	Jan 8	Jan 17	Jan 22	Jan 24	Feb 5*	Feb 14*
Treatment	Condition						
UV	CD-surv		██████				
	CD-repro	██████	██████	████████████████			
	FHM-surv						
	FHM-gro		██████				
CL	CD-surv		██████				
	CD-repro		██████	████████			
	FHM-surv		██████				
	FHM-gro		██████				
RW	CD-surv			██████			
	CD-repro	██████	██████	████████	████████	████████	
	FHM-surv						
	FHM-gro		██████		██████		

PASS



FAIL - 100%



No Sample

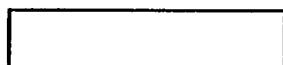


* indicates test performed with full dilution series - all other tests were 100% effluent Pass/Fail

Table 4.3: Plant C - *Ceriodaphnia* and Fathead Minnow Effects

Date	(1997)	Mar 18*	Apr 2	Apr 25	Apr 26	Apr 27	Apr 28	Apr 29	Apr 30	May 1
Treatment	Condition									
UV	CD-surv									
	CD-repro									
	FHM-surv									
	FHM-gro									
CL	CD-surv									
	CD-repro									
	FHM-surv									
	FHM-gro									
RW	CD-surv									
	CD-repro									
	FHM-surv									
	FHM-gro									

PASS



FAIL – 100%



No Sample



* indicates test performed with full dilution series - all other tests were 100% effluent Pass/Fail

4.2 *Ceriodaphnia* Results

The results of the *Ceriodaphnia* chronic toxicity tests are summarized in Tables 4.4 to 4.28. Most of the results from these bioassays demonstrated similar reproductive potential to that of the controls, which indicated non-toxic effluents. It was more likely that toxicity would be detected in the raw effluent than in disinfected effluents. In some cases which follow, IC₂₅ values could be calculated for the sample, however, the degree of variance associated with the results proved the calculated values not to be significant.

4.2.1 Plant A

This site did not demonstrate any significant chronic toxicity, regardless of disinfection method used. In several pass/fail tests, the raw effluent did show signs of chronic toxicity, however, no IC₂₅ values could be calculated as full dilution series tests were not performed.

Although the calculated IC₂₅ of the UV disinfected effluent (Table 4.4) was greater than 100% (denoting a pass), there were significantly ($p=0.05$) fewer neonates produced (12.7 vs. Control of 15.6 neonates/adult). For the raw effluent sample, an IC₂₅ of 100% was calculated. Here, however, there was only a $p=0.06$ associated with the value due to high variance in the reproductive rates of the raw sample. The effect was therefore not significant.

Only the chlorinated/de-chlorinated sample (Table 4.5) had significantly lower reproductive numbers than the control in this case (12.8 vs. 21.3 neonates per adult for the control). The IC₂₅ of 100% calculated for the raw effluent was not found to be statistically significant ($p=0.24$).

No chlorinated effluent was tested for the samples taken once per day for the following time series. Only the raw effluent (Table 4.7) was lower than the controls (15 vs. 21.25 neonates per adult) $p=0.012$. It should be noted, however, that a cleaner (containing potassium hydroxide and glycol) had been used to remove deposits from one of the treatment chambers, and foaming was evident at the outlet when samples were collected. Despite the presence of this cleaner in the effluent, the UV disinfected sample was non-toxic.

Both UV disinfected and raw effluents (Table 4.12) failed the 100% scan due to significantly lower reproductive rates. UV produced 11.6 neonates per adult ($p=0.001$) and raw produced 13.6 ($p=0.05$), whereas the control produced 18.4.

The test conditions for this experiment (Table 4.13) were not satisfactory. Control reproductive rates were down to 14.7 neonates per adult. However, the results showed that UV may have failed the 100% scan, with a significantly lower reproduction rate of 7.8. It is likely that the raw effluent would have passed (although still lower than the control) at 11.8.

4.2.2 Plant B

Far more toxicity was noted at this site than at the others. Raw (non-disinfected) samples were likely to be toxic. This was most likely due to the presence of ammonia or nitrite in the effluent, and may be related to cold weather performance.

UV disinfected effluent (Table 4.15) failed the 100% scan ($p=0.002$), by producing 16.2 neonates per adult, when compared to a control of 26.8. The raw effluent also failed by producing only 19.2 neonates per adult ($p=0.005$).

All samples failed the 100% scan (Table 4.16) with a significance of $p<0.001$. The UV disinfected effluent produced only 9 neonates per adult, the chlorinated/de-chlorinated effluent produced 10.7 and the raw effluent only produced 2 neonates per adult. The control adults produced an average of 31.4 neonates per adult.

Again, all samples failed the 100% scan (Table 4.17) with a significance of $p<0.001$. The UV disinfected effluent produced only 11.3 neonates per adult, the chlorinated/de-chlorinated effluent produced 13.3 and the raw effluent just produced 1.0 neonate per adult on average. The control, however, produced 25.3 neonates per adult, therefore demonstrating that the effluent was highly toxic.

UV disinfected and raw effluents (Table 4.18) both showed strong chronic effects, ($p<0.001$) and produced only 1.8 and 1.5 neonates per adult, respectively. The control broods produced 16.7 neonates per adult. An IC₂₅ value of 48% for both samples was calculated. The chlorinated/de-chlorinated effluent produced an IC₂₅ of 100%, however, it was not shown to be statistically significant.

All samples were significantly toxic on the 14th of February, 1997 (Table 4.19). An IC25 for the UV disinfected effluent of 100% ($p=0.009$), was the least toxic of the samples. The chlorinated/de-chlorinated sample was the most toxic with an IC25 of 68% ($p<0.001$), and the raw effluent produced an IC25 value of 73% ($p<0.001$).

4.2.3 Plant C

Generally samples from this site did not exhibit any strong toxicity in the chronic tests. The raw effluent was most likely toxic, and disinfection often had the effect of reducing the toxicity.

Full dilution tests were performed on the first two samples collected (Table 4.20 and 4.21), and no toxicity was detected. Subsequent tests used just the 100% concentrations. This allowed collection of additional samples in the form of a 7 day time series.

The chlorinated/de-chlorinated effluent (Table 4.25) failed the 100% scan, producing only 14.25 neonates per adult, even though the raw and UV disinfected effluent samples produced higher numbers of neonates. This may have been due to some residual chlorine effects.

UV disinfected and chlorinated/de-chlorinated effluents (Table 4.26) both passed the 100% scan with greater reproductive rates than the control (27.1 and 23.6 neonates per adult). The raw effluent produced only 16.7 neonates per adult, and therefore failed the scan ($p=0.001$). In addition, it was noted that the raw effluent had many deaths on the last day of the test, after two broods were produced.

Table 4.4: Plant A *Ceriodaphnia* - October 23, 1996

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	9	15.7		-	-
	S.D.		3.5			
UV	Mean	9	12.8	PASS	> 100 %	0.05
	S.D.		3.3			
CL	Mean	9	12.7	PASS	> 100 %	-
	S.D.		4.9			
RW	Mean	8	10.3	PASS	100 %	0.06
	S.D.		4.6			

Table 4.5: Plant A *Ceriodaphnia* - November 6, 1996

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	9	21.3		-	-
	S.D.		4.5			
UV	Mean	9	19.2	PASS	> 100 %	-
	S.D.		3.8			
CL	Mean	9	12.8	PASS	> 100 %	0.0003
	S.D.		4.2			
RW	Mean	8	16.4	PASS	100 %	0.24
	S.D.		4.5			

Table 4.6: Plant A *Ceriodaphnia* - November 20, 1996

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	7	15.3		-	-
	S.D.		2.8			
UV	Mean	7	20.1	PASS	-	0.03
	S.D.		4.6			
CL	Mean	4	14	FAIL	-	-
	S.D.		2.6			
RW	Mean	9	10.6	FAIL	-	0.003
	S.D.		2.4			

Table 4.7: Plant A Ceriodaphnia - November 21, 1996

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	8	21.1		-	-
	S.D.		2.4			
UV	Mean	9	19.1	PASS	-	-
	S.D.		7.0			
RW	Mean	9	15.0	FAIL	-	0.012
	S.D.		5.6			

Table 4.8: Plant A Ceriodaphnia - November 22, 1996

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	10	19		-	-
	S.D.		2.2			
UV	Mean	8	20.6	PASS	-	-
	S.D.		4.8			
RW	Mean	8	19.8	PASS	-	-
	S.D.		3.3			

Table 4.9: Plant A Ceriodaphnia - November 23, 1996

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	10	19		-	-
	S.D.		2.2			
UV	Mean	8	10.4	FAIL	-	1 E -6
	S.D.		2.6			
RW	Mean	10	12.4	FAIL	-	4 E -7
	S.D.		1.6			

Table 4.10: Plant A Ceriodaphnia - November 24, 1996

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	10	17.5		-	-
	S.D.		4.5			
UV	Mean	9	14.9	PASS	-	-
	S.D.		4.8			
RW	Mean	9	18.3	PASS	-	-
	S.D.		3.1			

Table 4.11: Plant A *Ceriodaphnia* - November 25, 1996

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	9	22.4		-	-
	S.D.		1.5			
UV	Mean	10	21.2	PASS	-	-
	S.D.		2.4			
RW	Mean	9	20.3	PASS	-	-
	S.D.		4.9			

Table 4.12: Plant A *Ceriodaphnia* - November 26, 1996

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	9	18.4		-	-
	S.D.		3.6			
UV	Mean	8	11.6	FAIL	-	0.001
	S.D.		3.5			
RW	Mean	8	13.6	FAIL	-	0.05
	S.D.		5.8			

Table 4.13: Plant A *Ceriodaphnia* - November 27, 1996

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	10	14.7		-	-
	S.D.		2.2			
UV	Mean	9	7.8	FAIL	-	0.0006
	S.D.		4.7			
RW	Mean	10	11.8	PASS	-	0.07
	S.D.		4.2			

Table 4.14: Plant B *Ceriodaphnia* - January 8, 1997

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	8	20.4		-	-
	S.D.		4.2			
UV	Mean	9	21.1	PASS	-	-
	S.D.		4.4			
CL	Mean	9	19.4	PASS	-	-
	S.D.		2.8			
RW	Mean	9	17.4	PASS	-	-
	S.D.		5.5			

Table 4.15: Plant B *Ceriodaphnia* - January 17, 1997

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	9	26.8		-	-
	S.D.		4.9			
UV	Mean	7	16.3	FAIL	-	0.002
	S.D.		6.1			
RW	Mean	10	19.2	FAIL	-	0.005
	S.D.		5.3			

Table 4.16: Plant B *Ceriodaphnia* - January 22, 1997

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	9	31.4		-	-
	S.D.		3.6			
UV	Mean	6	9.0	FAIL	-	1.7 E -8
	S.D.		3.4			
CL	Mean	7	10.7	FAIL	-	6 E -9
	S.D.		2.9			
RW	Mean	5	2.0	FAIL	-	4 E -10
	S.D.		0.0			

Table 4.17: Plant B *Ceriodaphnia* - January 24, 1997

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	10	25.3		-	-
	S.D.		5.2			
UV	Mean	7	11.3	FAIL	-	1 E -5
	S.D.		2.9			
CL	Mean	7	13.3	FAIL	-	7 E -5
	S.D.		3.3			
RW	Mean	10	1.0	FAIL	-	3 E -11
	S.D.		1.4			

Table 4.18: Plant B *Ceriodaphnia* - February 5, 1997

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	10	16.7		-	-
	S.D.		6.7			
UV	Mean	9	1.8	FAIL	48 %	7 E -6
	S.D.		2.3			
CL	Mean	8	10.5	PASS	100 %	0.19
	S.D.		6.3			
RW	Mean	9	1.6	FAIL	48 %	7 E -6
	S.D.		2.6			

Table 4.19: Plant B *Ceriodaphnia* - February 14, 1997

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	10	25.8		-	-
	S.D.		6.0			
UV	Mean	9	18.3	FAIL	100 %	0.009
	S.D.		5.0			
CL	Mean	10	13.0	FAIL	68 %	8 E -5
	S.D.		5.4			
RW	Mean	8	11.3	FAIL	73 %	0.0001
	S.D.		6.1			

Table 4.20: Plant C *Ceriodaphnia* - March 18, 1997

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	10	22.5		-	-
	S.D.		7.0			
UV	Mean	10	25.6	PASS	> 100 %	-
	S.D.		8.7			
CL	Mean	10	23.1	PASS	> 100 %	-
	S.D.		8.3			
RW	Mean	10	27.5	PASS	> 100 %	-
	S.D.		9.4			

Table 4.21: Plant C *Ceriodaphnia* - April 2, 1997

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	10	25.9		-	-
	S.D.		3.1			
UV	Mean	10	29.1	PASS	-	-
	S.D.		5.0			
CL	Mean	10	28.3	PASS	-	-
	S.D.		2.7			
RW	Mean	10	28.9	PASS	-	-
	S.D.		3.8			

Table 4.22: Plant C *Ceriodaphnia* - April 25, 1997

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	8	23.3		-	-
	S.D.		5.3			
UV	Mean	9	25.4	PASS	-	-
	S.D.		8.7			
CL	Mean	10	23.3	PASS	-	-
	S.D.		5.3			
RW	Mean	10	15.6	FAIL	-	0.001
	S.D.		2.8			

Table 4.23: Plant C *Ceriodaphnia* - April 26, 1997

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	8	23.3		-	-
	S.D.		5.3			
UV	Mean	10	17.5	PASS	-	-
	S.D.		6.4			
CL	Mean	8	23.8	PASS	-	-
	S.D.		6.2			
RW	Mean	5	10.0	FAIL	-	0.0008
	S.D.		4.7			

Table 4.24: Plant C *Ceriodaphnia* - April 27, 1997

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	10	26.4		-	-
	S.D.		5.3			
UV	Mean	10	23.9	PASS	-	-
	S.D.		6.0			
CL	Mean	10	22.4	PASS	-	-
	S.D.		4.0			
RW	Mean	10	24.1	PASS	-	-
	S.D.		8.3			

Table 4.25: Plant C *Ceriodaphnia* - April 28, 1997

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	8	26.4		-	-
	S.D.		5.3			
UV	Mean	10	24.4	PASS	-	-
	S.D.		6.8			
CL	Mean	8	14.3	FAIL	-	0.0006
	S.D.		6.7			
RW	Mean	5	27.0	FAIL	-	-
	S.D.		6.5			

Table 4.26: Plant C *Ceriodaphnia* - April 29, 1997

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	10	26.4		-	-
	S.D.		5.3			
UV	Mean	8	27.1	PASS	-	-
	S.D.		6.7			
CL	Mean	7	23.6	PASS	-	-
	S.D.		7.5			
RW	Mean	6	16.7	FAIL	-	0.001
	S.D.		2.8			

Table 4.27: Plant C *Ceriodaphnia* - April 30, 1997

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	10	20.5		-	-
	S.D.		6.6			
UV	Mean	8	22.8	PASS	-	-
	S.D.		5.2			
CL	Mean	9	25.0	PASS	-	-
	S.D.		5.9			
RW	Mean	7	14.1	FAIL	-	0.03
	S.D.		3.4			

Table 4.28: Plant C *Ceriodaphnia* - May 1, 1997

Treatment		Survival (out of 10)	Number of Live Neonates in 100% Concentration	Pass or Fail	IC25 Value	P Value
Control	Mean	10	20.5		-	-
	S.D.		6.6			
UV	Mean	9	22.4	PASS	-	-
	S.D.		7.4			
CL	Mean	6	19.2	FAIL	-	-
	S.D.		6.2			
RW	Mean	3	17.7	FAIL	-	-
	S.D.		7.2			

4.3 Fathead Minnow Results

The final effluents from Plant A and Plant B were generally not significantly toxic when assessed by the fathead minnow 7 day chronic bioassay. The effluent from the Plant C was significantly toxic but the toxicity was attributed to the higher ammonia concentrations in these samples. In most cases, there was no significant difference in either survival or growth of larvae exposed to a disinfected or non-disinfected sample. However, in three tests there was a significant difference in growth of fathead minnow larvae exposed to non-disinfected effluent versus those exposed to UV or chlorinated/de-chlorinated disinfected effluent. In two of these cases the non-disinfected sample caused a reduction in growth of the larvae compared to both types of disinfected samples (Table 4.42 and 4.45) and in the third the disinfected samples were more toxic than the non-disinfected (Table 4.53). This was believed to have been caused partly by the low dissolved oxygen concentration in the non-disinfected effluents and a high ammonia concentration in the disinfected effluent tested.

No IC₂₅ values could be generated due to the fact that none of the full dilution series tests conducted produced chronic toxicity. Only pass/fail findings could be determined.

The fathead minnow larval bioassay QA/QC indicates that the test results are accurate and reproducible. References and controls indicate that variability in reference dry weights may have been produced through the interbreeding of the fathead minnow culture with several genetic stocks throughout the time frame of the experiments. Similarly changes in the quality and quantity of the food provided during the project may have altered the reference growth weights between consecutive tests but did not interfere with the comparison of weights between treatments in that test.

4.3.1 Plant A

No chronic toxicity was observed in samples collected from this plant during scan tests (Tables 4.31 to 4.38). Similarly full dilution tests did not indicate toxicity at the 100% effluent concentration (Tables 4.29 to 4.30). The dissolved oxygen fell below the recommended cut-off concentration of 3.3 mg/L in the 100% non-disinfected sample (Table 4.30) but this did not affect the growth of the larvae significantly.

4.3.2 Plant B

No chronic toxicity was observed in four of six samples collected from this plant. The second sample proved to be toxic both before and after disinfection with UV light (Table 4.40), while only the non-disinfected effluent was toxic in the fourth sample (Table 4.42). It is uncertain why there was toxicity associated with the second and fourth samples collected from Plant B (Tables 4.40 & 4.42, respectively). Dissolved oxygen was not the factor in either of these cases. Ammonia was not measured and cannot therefore be assessed as the problem, however, effluent samples collected during the following month at the same plant indicated that ammonia concentrations were within the range of those producing toxicity in the Plant C samples (Tables 4.47 to 4.53), yet chronic toxicity was not apparent in those particular samples (Tables 4.43 and 4.44).

4.3.3 Plant C

Chronic toxicity was observed in seven of nine samples collected at this plant (Tables 4.45 to 4.53). Ammonia concentrations were on average greater than 4 mg/L in all effluents tested at Plant C and ranged as high as 10 mg/L. The high ammonia concentrations should have produced significant toxicity in the first Plant C samples, however, the large error associated with the growth values for these tests may have confounded the results of these analyses (Table 4.45). In the case of the last two samples, the difference in ammonia concentrations between the effluent that passed versus that which failed was not that great and below 4 mg/L in both cases (Tables 4.52 and 4.53). Other chemical constituents may be responsible for the reductions in growth observed in these tests.

Table 4.29: Plant A Fathead Minnow - October 23, 1996

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	8.72			0.70		
	(S.D.)	0.48			0.08		
UV	Mean	9.75	PASS	-	0.65	PASS	-
	(S.D.)	0.50			0.02		
CL	Mean	10.00	PASS	-	0.70	PASS	-
	(S.D.)	0.00			0.05		
RW	Mean	9.50	PASS	-	0.72	PASS	-
	(S.D.)	1.00			0.04		

Table 4.30: Plant A Fathead Minnow - November 6, 1996

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	9.75			0.53		
	(S.D.)	0.50			0.04		
UV	Mean	8.44	PASS	-	0.51	PASS	-
	(S.D.)	1.04			0.03		
CL	Mean	9.50	PASS	-	0.52	PASS	-
	(S.D.)	0.58			0.04		
RW	Mean	9.19	PASS	-	0.39	PASS	-
	(S.D.)	0.54			0.04		

Table 4.31: Plant A Fathead Minnow - November 20, 1996

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	9.50			0.57		
	(S.D.)	0.58			0.08		
UV	Mean	9.00	PASS	-	0.47	PASS	-
	(S.D.)	0.82			0.05		
CL	Mean	10.00	PASS	-	0.48	PASS	-
	(S.D.)	0.00			0.07		
RW	Mean	7.44	FAIL	0.003	0.48	PASS	-
	(S.D.)	1.85			0.08		

Table 4.32: Plant A Fathead Minnow - November 21, 1996

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	9.75			0.69		
	(S.D.)	0.50			0.10		
UV	Mean	10.00	PASS	-	0.59	PASS	-
	(S.D.)	0.00			0.06		
RW	Mean	10.00	PASS	-	0.64	PASS	-
	(S.D.)	0.00			0.03		

Table 4.33: Plant A Fathead Minnow - November 22, 1996

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	10.00			0.51		
	(S.D.)	0.00			0.10		
UV	Mean	9.50	PASS	-	0.50	PASS	-
	(S.D.)	1.00			0.04		
RW	Mean	10.00	PASS	-	0.51	PASS	-
	(S.D.)	0.00			0.03		

Table 4.34: Plant A Fathead Minnow - November 23, 1996

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	10.00			0.57		
	(S.D.)	0.00			0.05		
UV	Mean	9.72	PASS	-	0.56	PASS	-
	(S.D.)	0.56			0.11		
RW	Mean	10.00	PASS	-	0.57	PASS	-
	(S.D.)	0.00			0.02		

Table 4.35: Plant A Fathead Minnow - November 24, 1996

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	8.75			0.69		
	(S.D.)	0.50			0.09		
UV	Mean	8.75	PASS	-	0.67	PASS	-
	(S.D.)	0.50			0.05		
RW	Mean	9.00	PASS	-	0.63	PASS	-
	(S.D.)	0.00			0.04		

Table 4.36: Plant A Fathead Minnow - November 25, 1996

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	9.75			0.45		
	(S.D.)	0.50			0.02		
UV	Mean	9.00	PASS	-	0.43	PASS	-
	(S.D.)	0.82			0.02		
RW	Mean	9.25	PASS	-	0.48	PASS	-
	(S.D.)	0.96			0.13		

Table 4.37: Plant A Fathead Minnow - November 26, 1996

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	10.00			0.43		
	(S.D.)	0.00			0.02		
UV	Mean	9.00	PASS	-	0.45	PASS	-
	(S.D.)	1.41			0.05		
RW	Mean	9.50	PASS	-	0.48	PASS	-
	(S.D.)	0.58			0.04		

Table 4.38: Plant A Fathead Minnow - November 27, 1996

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	10.00			0.38		
	(S.D.)	0.00			0.06		
UV	Mean	10.00	PASS	-	0.42	PASS	-
	(S.D.)	0.00			0.01		
RW	Mean	10.00	PASS	-	0.38	PASS	-
	(S.D.)	0.00			0.02		

Table 4.39: Plant B Fathead Minnow - January 8, 1997

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
C1	Mean	9.75			0.74		
	(S.D.)	0.50			0.05		
UV	Mean	9.25	PASS	-	0.73	PASS	-
	(S.D.)	0.96			0.13		
RW	Mean	10.00	PASS	-	0.63	PASS	-
	(S.D.)	0.00			0.07		
C2	Mean	10.00			0.84		
	(S.D.)	0.00			0.04		
CL	Mean	10.00	PASS	-	0.79	PASS	-
	(S.D.)	0.00			0.05		

Table 4.40: Plant B Fathead Minnow - January 17, 1997

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	9.67			0.73		
	(S.D.)	0.58			0.02		
UV	Mean	9.75	PASS	-	0.53	FAIL	< 0.001
	(S.D.)	0.50			0.02		
RW	Mean	9.50	PASS	-	0.59	FAIL	< 0.001
	(S.D.)	0.58			0.02		

Table 4.41: Plant B Fathead Minnow - January 22, 1997

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	8.75			0.81		
	(S.D.)	1.89			0.09		
UV	Mean	9.75	PASS	-	0.70	PASS	-
	(S.D.)	0.50			0.05		
CL	Mean	9.25	PASS	-	0.79	PASS	-
	(S.D.)	1.50			0.06		
RW	Mean	9.50	PASS	-	0.72	PASS	-
	(S.D.)	0.58			0.07		

Table 4.42: Plant B Fathead Minnow - January 24, 1997

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	9.50			0.80		
	(S.D.)	1.00			0.04		
UV	Mean	9.25	PASS	-	0.75	PASS	-
	(S.D.)	0.96			0.08		
CL	Mean	10.00	PASS	-	0.74	PASS	-
	(S.D.)	0.00			0.02		
RW	Mean	9.75	PASS	-	0.66	FAIL	0.004
	(S.D.)	0.50			0.02		

Table 4.43: Plant B Fathead Minnow February 5, 1997

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	8.75			0.37		
	(S.D.)	0.50			0.03		
UV	Mean	8.75	PASS	-	0.40	PASS	-
	(S.D.)	0.96			0.03		
CL	Mean	9.00	PASS	-	0.43	PASS	-
	(S.D.)	1.41			0.04		
RW	Mean	9.50	PASS	-	0.40	PASS	-
	(S.D.)	0.58			0.02		

Table 4.44: Plant B Fathead Minnow - February 14, 1997

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	8.69			0.42		
	(S.D.)	0.47			0.03		
UV	Mean	9.00	PASS	-	0.37	PASS	-
	(S.D.)	0.82			0.03		
CL	Mean	8.25	PASS	-	0.38	PASS	-
	(S.D.)	1.50			0.04		
RW	Mean	9.19	PASS	-	0.41	PASS	-
	(S.D.)	1.06			0.01		

Table 4.45: Plant C Fathead Minnow - March 18, 1997

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	9.50			0.45		
	(S.D.)	0.58			0.02		
UV	Mean	8.25	PASS	-	0.34	PASS	-
	(S.D.)	0.50			0.06		
CL	Mean	9.47	PASS	-	0.38	PASS	-
	(S.D.)	0.61			0.09		
RW	Mean	9.25	PASS	-	0.32	FAIL	0.0286
	(S.D.)	0.50			0.03		

Table 4.46: Plant C Fathead Minnow - April 2, 1997

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	9.19			0.54		
	(S.D.)	0.54			0.08		
UV	Mean	8.97	PASS	-	0.47	PASS	-
	(S.D.)	0.82			0.07		
CL	Mean	8.97	PASS	-	0.53	PASS	-
	(S.D.)	0.82			0.02		
RW	Mean	10.00	PASS	-	0.50	PASS	-
	(S.D.)	0.00			0.03		

Table 4.47: Plant C Fathead Minnow - April 25, 1997

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	10.00			0.46		
	(S.D.)	0.00			0.03		
UV	Mean	9.75	PASS	-	0.35	FAIL	0.001
	(S.D.)	0.50			0.02		
CL	Mean	9.75	PASS	-	0.30	FAIL	< 0.001
	(S.D.)	0.50			0.02		
RW	Mean	9.75	PASS	-	0.32	FAIL	< 0.001
	(S.D.)	0.50			0.03		

Table 4.48: Plant C Fathead Minnow - April 26, 1997

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	10.00			0.46		
	(S.D.)	0.00			0.03		
UV	Mean	9.25	PASS	-	0.34	FAIL	0.001
	(S.D.)	0.96			0.03		
CL	Mean	9.50	PASS	-	0.35	FAIL	0.001
	(S.D.)	0.58			0.03		
RW	Mean	9.25	PASS	-	0.32	FAIL	< 0.001
	(S.D.)	0.96			0.02		

Table 4.49: Plant C Fathead Minnow - April 27, 1997

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	10.00			0.46		
	(S.D.)	0.00			0.03		
UV	Mean	8.72	PASS	-	0.32	FAIL	< 0.001
	(S.D.)	1.25			0.01		
CL	Mean	8.00	FAIL	0.032	0.35	FAIL	< 0.001
	(S.D.)	1.15			0.02		
RW	Mean	9.50	PASS	-	0.33	FAIL	< 0.001
	(S.D.)	0.58			0.02		

Table 4.50: Plant C Fathead Minnow - April 28, 1997

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	9.75			0.44		
	(S.D.)	0.50			0.02		
UV	Mean	7.50	PASS	-	0.26	FAIL	< 0.001
	(S.D.)	0.58			0.06		
CL	Mean	8.25	PASS	-	0.29	FAIL	0.001
	(S.D.)	2.06			0.02		
RW	Mean	8.75	PASS	-	0.28	FAIL	< 0.001
	(S.D.)	0.50			0.02		

Table 4.51: Plant C Fathead Minnow - April 29, 1997

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	9.75			0.44		
	(S.D.)	0.50			0.02		
UV	Mean	9.75	PASS	-	0.29	FAIL	0.001
	(S.D.)	0.50			0.02		
CL	Mean	8.50	PASS	-	0.32	FAIL	0.008
	(S.D.)	1.00			0.03		
RW	Mean	9.25	PASS	-	0.32	FAIL	0.009
	(S.D.)	0.96			0.02		

Table 4.52: Plant C Fathead Minnow - April 30, 1997

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	9.75			0.42		
	(S.D.)	0.50			0.03		
UV	Mean	10.00	PASS	-	0.38	PASS	-
	(S.D.)	0.00			0.02		
CL	Mean	9.75	PASS	-	0.36	FAIL	0.036
	(S.D.)	0.50			0.02		
RW	Mean	9.25	PASS	-	0.38	PASS	-
	(S.D.)	0.96			0.01		

Table 4.53: Plant C Fathead Minnow - May 1, 1997

		Survival (out of 10)	Pass or Fail	P Value	Growth (mg)	Pass or Fail	P Value
Control	Mean	9.75			0.42		
	(S.D.)	0.50			0.03		
UV	Mean	9.50	PASS	-	0.33	FAIL	0.001
	(S.D.)	0.58			0.03		
CL	Mean	9.50	PASS	-	0.35	FAIL	0.009
	(S.D.)	0.58			0.03		
RW	Mean	10.00	PASS	-	0.38	PASS	-
	(S.D.)	0.00			0.02		

5.0 CONCLUSIONS AND RECOMMENDATIONS

- No indications of UV-induced toxicity were found in the effluent samples tested, regardless of the plant tested and intensity of UV treatment. The majority of samples tested were non-toxic, however, effluent samples which were toxic before disinfection were also toxic after disinfection.
- The chronic toxicity testing performed on the samples studied confirms the results of earlier similar studies; the levels of UV irradiation required for disinfection purposes do not appear to increase effluent toxicity.

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Appendix A

***Ceriodaphnia* Reproduction**

Raw Data

A-1-UV

Dilution Replicate	Control Water	6.25	12.5	25	50	100
		%	%	%	%	%
1	16	14	20	24	16	19
2	11	13	15	20	13	11
3	10	13	20	14	19	14
4	18	22	9	21	11	17
5	14	23	17	21	7	11
6	20	18	17	17	12	12
7	18	15	15	7	14	10
8	19	15	22	19	15	9
9	15	21	25	19	15	12
10						
Average	16.67	16.89	17.78	17.88	13.38	12.78
S.D.	3.50	4.17	4.66	5.30	3.58	3.31
%	50	25	12.5	6.25	100	

A-2-UV

Dilution Replicate	Control Water	6.25	12.5	25	50	100
		%	%	%	%	%
1	20	32	27	15	18	16
2	21	32	29	23	19	18
3	19	25	28	21	18	15
4	18	26	27	23	20	19
5	19	27	23	23	20	20
6	19	23	20	28	21	22
7	26	20	28	21	21	22
8	17	30	25	21	21	25
9	30	25	21	21	27	
10						

A-1-CL

Dilution Replicate	Control Water	6.25	12.5	25	50	100
		%	%	%	%	%
1	16	9	22	14	25	11
2	21	13	19	13	14	
3	10	13	17	24	10	
4	18	12	15	13	20	12
5	14	17	12	12	24	14
6	20	15	14	13	18	10
7	18	24	19	5	8	16
8	19	19	11	28	13	4
9	15		21		13	11
10						

A-2-CL

Dilution Replicate	Control Water	6.25	12.5	25	50	100
		%	%	%	%	%
1	20	35	19	28	17	9
2	21	24	10	20	23	6
3	19	23	24	24	22	11
4	18	26	21	17	25	16
5	19	19	25	17	17	18
6	19	19	12	31	23	18
7	28	20	16	21	26	10
8	17	20	25	32	24	13
9	30	25	21	21	14	
10						

A-1-RW

Dilution Replicate	Control Water	6.25	12.5	25	50	100
		%	%	%	%	%
1	16	17	8	10	24	4
2	11	10	18	16	16	9
3	10	21	10	16	11	16
4	18	15	11	13	13	12
5	14	16	25	11	15	11
6	20	16	21	14	15	16
7	18	22	18			
8	19					
9	15					
10						

A-2-RW

Dilution Replicate	Control Water	6.25	12.5	25	50	100
		%	%	%	%	%
1	20	10	30	20	12	11
2	21	23	24	15	23	11
3	19	22	7	18	7	24
4	19	16	20	18	18	14
5	19	22	21	6	15	18
6	19	18	27	12	23	20
7	28	18	8	15	9	18
8	17	27	21	22	15	15
9	30	20	22	25	23	
10						

Average

S.D.	3.50	3.99	6.11	13.33	16.67	10.25
%	100	50	25	12.5	6.25	

Average	21.33	22.26	19.67	23.44	22.13	12.78
S.D.	4.50	5.39	5.83	6.68	3.40	4.15
%	100	50	25	12.5	6.25	

A-3-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	19					23
2	19					22
3	14					23
4	13					25
5	12					12
6	15					16
7	15					20
8						
9						
10						

Average **15.29**
S.D. **2.75**
% **100**

A-4-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	20					10
2	23					12
3	23					26
4	24					23
5	22					14
6	17					22
7	21					27
8	19					12
9						28
10						

Average **21.13**
S.D. **2.36**
% **100**

A-3-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	19					15
2	19					13
3	14					11
4	13					17
5	12					
6	15					
7	15					
8						
9						
10						

Average **15.29**
S.D. **2.75**
% **100**

A-4-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	20					10
2	23					
3	23					
4	24					
5	22					
6	17					
7	21					
8	19					
9						
10						

Average **21.13**
S.D. **2.36**
% **100**

A-3-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	19					12
2	19					13
3	14					7
4	13					13
5	12					8
6	15					8
7	15					13
8						10
9						11
10						

Average **15.29**
S.D. **2.75**
% **100**

A-4-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	20					10
2	23					
3	23					
4	24					
5	22					
6	17					
7	21					
8	19					
9						
10						

Average **21.13**
S.D. **2.36**
% **100**

15.00
5.63

A-6-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	18				25	
2	19				23	
3	15				24	
4	16				13	
5	21				23	
6	20				14	
7	21				19	
8	21				24	
9	18					
10	21					
Average	19.00				29.53	
S.D. %	2.21				4.75	
					100	

A-6-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	18				18	
2	19				19	
3	15				15	
4	16				16	
5	21				21	
6	20				20	
7	21				21	
8	21				21	
9	18				18	
10	21				21	
Average	19.00				29.53	
S.D. %	2.21				4.75	
					100	

A-6-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	18				25	
2	19				23	
3	15				24	
4	16				13	
5	21				23	
6	20				14	
7	21				19	
8	21				21	
9	18				21	
10	21				21	
Average	19.00				29.53	
S.D. %	2.21				4.75	
					100	

A-6-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	18				18	
2	19				19	
3	15				15	
4	16				16	
5	21				21	
6	20				20	
7	21				21	
8	21				21	
9	18				18	
10	21				21	
Average	19.00				29.53	
S.D. %	2.21				4.75	
					100	

A-6-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	18				24	
2	19				20	
3	15				15	
4	16				21	
5	21				24	
6	20				18	
7	21				16	
8	21				20	
9	18				20	
10	21					
Average	19.00				29.75	
S.D. %	2.21				3.33	
					100	

A-6-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	18				18	
2	19				19	
3	15				15	
4	16				16	
5	21				21	
6	20				20	
7	21				21	
8	21				21	
9	18				18	
10	21				21	
Average	19.00				29.75	
S.D. %	2.21				3.33	
					100	

A-7-JV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	13				9	
2	21				10	
3	16				19	
4	16				16	
5	19				23	
6	14				14	
7	17				18	
8	23				10	
9	11				15	
10	25					10

Average
S.D.
%17.50
4.48
100**A-8-UV**

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	23				2	
2	24				3	
3	20				4	
4	23				5	
5	22				6	
6	24				7	
7	21				8	
8	21				9	
9	24				10	

Average
S.D.
%21.20
2.35
100**A-7-CL**

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	13				9	
2	21				10	
3	16				19	
4	16				19	
5	19				20	
6	14				22	
7	17				15	
8	23				13	
9	11				19	
10	25				16	

Average
S.D.
%17.50
4.48
100**A-8-CL**

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	23				2	
2	24				3	
3	20				4	
4	23				5	
5	22				6	
6	24				7	
7	21				8	
8	21				9	
9	24				10	

Average
S.D.
%22.44
1.51
100**A-7-RW**

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	13				19	
2	21				19	
3	16				20	
4	16				22	
5	19				22	
6	14				15	
7	17				13	
8	23				19	
9	11				16	
10	25					10

Average
S.D.
%17.50
4.48
100**A-8-RW**

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	23				2	
2	24				3	
3	20				4	
4	23				5	
5	22				6	
6	24				7	
7	21				8	
8	21				9	
9	24				10	

Average
S.D.
%22.44
1.51
100

A-8-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	26				13	
2	18			10		
3	16			15		
4	20			12		
5	15			6		
6	16			17		
7	22			12		
8	16			8		
9	17					
10						

Average 18.44
S.D. 3.61
% 100

A-10-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	12					
2	16					
3	16					
4	16					
5	13					
6	15					
7	12					
8	13					
9	15					
10	19					

Average 14.70
S.D. 2.21
% 100

A-8-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	26					
2	18					
3	16					
4	20					
5	15					
6	16					
7	22					
8	16					
9	17					
10						

Average 18.44
S.D. 3.61
% 100

A-10-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	12					
2	16					
3	16					
4	16					
5	13					
6	15					
7	12					
8	13					
9	15					
10	19					

Average 14.70
S.D. 2.21
% 100

A-8-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	26				5	
2	18			19		
3	16			20		
4	20			9		
5	15			11		
6	16			9		
7	22			17		
8	16			19		
9	17					
10						

Average 18.44
S.D. 3.61
% 100

A-10-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	12					
2	18					
3	16					
4	16					
5	13					
6	15					
7	12					
8	13					
9	15					
10	19					

Average 14.70
S.D. 2.21
% 100

11.80
4.16

B-1-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	24					22
2	19					29
3	15					19
4	23					17
5	20					15
6	20					26
7	27					22
8	15					19
9						21
10						

Average 20.38
S.D. 4.21
% 100

B-2-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	26					
2	30					
3	27					
4	22					
5	31					
6	26					
7	33					
8	17					
9	29					
10						

Average 26.78
S.D. 4.89
% 100

B-1-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	24					21
2	19					21
3	15					23
4	23					17
5	20					15
6	20					19
7	27					21
8	15					22
9						16
10						

Average 20.38
S.D. 4.21
% 100

B-2-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	26					
2	30					
3	27					
4	22					
5	31					
6	26					
7	33					
8	17					
9	29					
10						

Average 26.78
S.D. 4.89
% 100

B-1-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	24					31
2	19					14
3	15					13
4	23					19
5	20					24
6	20					18
7	27					17
8	15					18
9						21
10						

Average 20.38
S.D. 4.21
% 100

B-2-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	26					
2	30					
3	27					
4	22					
5	31					
6	26					
7	33					
8	17					
9	29					
10						

Average 26.78
S.D. 4.89
% 100

B-3-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	36				6	
2	37				12	
3	26				13	
4	28				11	
5	31				6	
6	32				6	
7	31					
8	33					
9	29					
10						

Average 31.44
 S.D. 3.57
 % 100

B-4-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	30					
2	23					
3	16					
4	21					
5	32					
6	31					
7	29					
8	28					
9	22					
10	23					

Average 25.30
 S.D. 5.17
 % 100

B-3-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	36				11	
2	37				7	
3	26				14	
4	28				10	
5	31				12	
6	32				7	
7	31				14	
8	33					
9	29					
10						

Average 31.44
 S.D. 3.57
 % 100

B-4-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	30					
2	23					
3	16					
4	21					
5	32					
6	31					
7	29					
8	26					
9	22					
10	23					

Average 25.30
 S.D. 5.17
 % 100

B-3-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	36				2	
2	37				2	
3	26				2	
4	28				2	
5	31				2	
6	32					
7	31					
8	33					
9	29					
10						

Average 31.44
 S.D. 3.57
 % 100

B-4-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	30					
2	23					
3	16					
4	21					
5	32					
6	31					
7	29					
8	26					
9	22					
10	23					

Average 25.30
 S.D. 5.17
 % 100

B-6-UV

Dilution Replicate	Control Water	6.25	12.5	25	50	100
		%	%	%	%	%
1	18	17	23	19	9	0
2	22	18	17	17	9	0
3	11	16	22	15	24	5
4	12	19	28	15	12	0
5	25	15	11	8	18	2
6	17	18	23	23	24	0
7	10	21	14	9	18	0
8	10	24	13	16	15	4
9	13			16		5
10	29			16		
Average	16.70	18.60	18.88	18.33	16.13	1.78
S.D.	6.73	2.88	5.99	4.61	5.99	2.28
%	50	25	12.5	6.25	100	

B-6-UV

Dilution Replicate	Control Water	6.25	12.5	25	50	100
		%	%	%	%	%
1	32	12	9	18	30	14
2	26	16	11	17	33	13
3	26	15	19	14	29	13
4	17	15	16	16	32	16
5	30	22	10	13	27	28
6	18	20	14	25	32	21
7	24	12	12	20	39	18
8	33	15	25	20	39	21
9	32	17	14	12	27	21
10	20	13			26	
Average	26.80	16.70	14.44	18.66	30.10	18.33
S.D.	5.98	3.27	5.03	4.07	4.07	4.95
%	50	25	12.5	6.25	100	

B-6-CL

Dilution Replicate	Control Water	6.25	12.5	25	50	100
		%	%	%	%	%
1	18	18	18	20	7	22
2	22	19	14	12	24	10
3	11	10	16	28	19	13
4	12	19	12	10	18	12
5	25	9	22	17	16	4
6	17	19	16	28	12	2
7	10	28	23	18	4	7
8	10	12	16	10	23	14
9	13	18	16	16		
10	29		14			
Average	16.70	16.89	16.70	18.00	18.33	10.50
S.D.	6.73	5.84	3.47	7.46	6.75	6.32
%	50	25	12.5	6.25	100	

B-6-CL

Dilution Replicate	Control Water	6.25	12.5	25	50	100
		%	%	%	%	%
1	32	29	28	26	29	11
2	26	22	24	27	22	9
3	26	24	29	37	17	12
4	17	21	32	24	26	17
5	30	24	28	30	25	25
6	18	23	32	29	28	8
7	24	23	32	34	23	15
8	33	26	28	16	23	8
9	32	28	27	33	9	16
10	20		28			
Average	26.80	24.00	28.20	27.90	28.11	13.00
S.D.	5.98	2.51	2.53	5.65	4.62	5.37
%	100	50	25	12.5	6.25	

B-6-RW

Dilution Replicate	Control Water	6.25	12.5	25	50	100
		%	%	%	%	%
1	18	26	19	14	21	0
2	22	20	21	24	18	0
3	11	18	14	18	20	0
4	12	21	22	23	16	2
5	25	12	17	24	29	6
6	17	15	23	25	24	0
7	10	20	13	15	12	0
8	10	17	17	22	25	6
9	13	18	15			0
10	29	31				
Average	16.70	19.80	17.89	20.63	20.63	1.86
S.D.	6.73	5.41	3.59	4.34	5.40	2.60
%	100	50	25	12.5	6.25	

B-6-RW

Dilution Replicate	Control Water	6.25	12.5	25	50	100
		%	%	%	%	%
1	32	25	28	27	30	6
2	26	29	31	30	28	8
3	26	27	28	27	35	16
4	17	23	27	30	33	14
5	30	23	26	25	30	7
6	18	26	28	23	23	13
7	24	24	25	27	24	4
8	33	22	29	27	27	22
9	32	28	27	27	29	
10	20	27				
Average	26.80	26.40	28.56	27.20	31.20	11.26
S.D.	5.98	2.37	3.13	2.15	2.77	6.07
%	100	50	25	12.5	6.25	

C-1-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	22	30	19	33	29	30
2	16	31	33	18	30	34
3	19	27	28	27	33	35
4	18	27	16	31	34	20
5	32	26	31	33	35	16
6	13	25	18	17	32	37
7	24	21	28	28	18	19
8	18	27	23	29	33	15
9	33	24	22	29	19	32
10	30	24	25	26	18	18
Average	22.50	26.20	24.30	27.10	29.22	25.60
S.D.	7.03	2.94	5.70	5.57	6.36	8.73
%	50	25	12.5	6.25	100	

C-2-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	25	25	28	28	25	26
2	28	25	28	28	25	23
3	25	25	32	32	25	22
4	18	18	31	31	34	33
5	29	13	15	13	25	30
6	28	15	15	28	16	30
7	27	16	23	23	17	31
8	25	17	17	15	14	24
9	27	13	13	27	34	28
10	27	24	28	28	33	28
Average	25.00	25.00	25.00	25.00	25.00	25.10
S.D.	3.11	3.11	3.11	3.11	3.11	5.04
%	100	100	100	100	100	100

C-1-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	22	25	36	29	34	14
2	16	25	25	30	32	31
3	19	28	31	18	29	16
4	18	22	29	31	34	32
5	32	13	15	13	25	33
6	13	25	15	28	16	15
7	24	22	16	23	29	17
8	18	17	17	15	14	24
9	33	23	13	27	34	16
10	30	24	24	28	33	27
Average	22.50	22.22	22.10	24.30	27.44	23.10
S.D.	7.03	4.60	8.02	6.65	7.68	8.33
%	100	50	25	12.5	6.25	

C-2-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	25	25	28	28	25	24
2	28	25	25	25	28	28
3	25	25	32	32	25	28
4	18	18	31	31	34	30
5	29	13	15	13	25	30
6	28	15	15	28	16	30
7	27	16	23	23	17	31
8	25	17	17	15	14	24
9	27	13	13	27	34	28
10	27	24	28	28	33	28
Average	25.00	25.00	25.00	25.00	25.00	25.30
S.D.	3.11	3.11	3.11	3.11	3.11	2.67
%	100	100	100	100	100	

C-1-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	22	16	16	16	35	37
2	16	16	14	28	26	34
3	19	16	28	16	25	35
4	18	11	13	29	29	38
5	32	30	16	17	30	16
6	13	24	18	30	19	27
7	24	25	30	9	18	14
8	18	29	17	29	16	32
9	33	29	13	23	17	27
10	30	17	12	14	16	15
Average	22.50	21.30	17.70	21.10	23.20	27.50
S.D.	7.03	6.66	6.27	7.61	6.73	8.37
%	100	50	25	12.5	6.25	

C-2-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	25	25	28	28	25	28
2	28	25	25	25	28	29
3	25	25	32	32	25	34
4	18	18	31	31	34	30
5	29	13	15	17	30	29
6	28	15	15	28	16	24
7	27	16	23	23	17	31
8	25	17	17	15	14	28
9	27	13	13	27	34	27
10	27	24	28	28	33	30
Average	25.00	25.00	25.00	25.00	25.00	25.90
S.D.	3.11	3.11	3.11	3.11	3.11	3.84
%	100	100	100	100	100	

C-3-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	24					31
2	26					13
3	25					28
4	28					36
5	23					33
6	12					32
7	28					16
8	20					15
9						24
10						9

Average 23.25
S.D. 5.26
% 100

C-4-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	24					31
2	26					2
3	25					3
4	28					4
5	23					5
6	12					6
7	28					7
8	20					8
9						9
10						10

Average 23.25
S.D. 5.26
% 100

17.50
6.42
100

C-3-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	24					26
2	26					24
3	25					11
4	28					29
5	23					30
6	12					27
7	28					27
8	20					16
9						16
10						15

Average 23.25
S.D. 5.26
% 100

C-4-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	24					1
2	26					2
3	25					3
4	28					4
5	23					5
6	12					6
7	28					7
8	20					8
9						9
10						10

Average 23.25
S.D. 5.26
% 100

22.75
6.20

C-3-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	24					13
2	26					16
3	25					15
4	28					14
5	23					14
6	12					15
7	28					16
8	20					16
9						22
10						12

Average 23.25
S.D. 5.26
% 100

C-4-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	24					1
2	26					2
3	25					3
4	28					4
5	23					5
6	12					6
7	28					7
8	20					8
9						9
10						10

Average 23.25
S.D. 5.26
% 100

10.00
4.69

C-6-UV

Dilution Replicate	Control Water	8.25 %	12.5 %	25 %	50 %	100 %
1	32					24
2	28					23
3	24					20
4	24					30
5	14					11
6	24					32
7	30					25
8	28					28
9	27					26
10	32					20
Average	26.40					23.80
S.D. %	5.34					5.99
						100

C-6-UV

Dilution Replicate	Control Water	8.25 %	12.5 %	25 %	50 %	100 %
1	32					32
2	28					31
3	24					12
4	24					20
5	14					30
6	24					24
7	30					30
8	28					28
9	27					17
10	32					20
Average	26.40					24.40
S.D. %	5.34					6.79
						100

C-6-CL

Dilution Replicate	Control Water	8.25 %	12.5 %	25 %	50 %	100 %
1	32					22
2	28					24
3	24					24
4	24					26
5	14					26
6	24					24
7	30					14
8	28					26
9	27					20
10	32					18
Average	26.40					22.40
S.D. %	5.34					3.98
						100

C-6-CL

Dilution Replicate	Control Water	8.25 %	12.5 %	25 %	50 %	100 %
1	32					8
2	28					15
3	24					20
4	24					12
5	14					9
6	24					19
7	30					25
8	28					6
9	27					
10	32					
Average	26.40					26.40
S.D. %	5.34					5.34
						100

C-6-RW

Dilution Replicate	Control Water	8.25 %	12.5 %	25 %	50 %	100 %
1	32					10
2	28					30
3	24					32
4	24					31
5	14					28
6	24					27
7	30					23
8	28					22
9	27					29
10	32					9
Average	26.40					24.10
S.D. %	5.34					8.33
						100

C-6-RW

Dilution Replicate	Control Water	8.25 %	12.5 %	25 %	50 %	100 %
1	32					19
2	28					28
3	24					36
4	24					30
5	14					25
6	24					28
7	30					15
8	28					31
9	27					31
10	32					31
Average	26.40					27.00
S.D. %	5.34					6.48
						100

C-7-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	32					20
2	28					35
3	24					15
4	24					28
5	14					28
6	24					34
7	30					27
8	29					30
9	27					
10	32					

Average 26.40
S.D. 5.34
%

C-8-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1		16				
2		27				
3		32				
4		14				
5		18				
6		14				
7		26				
8		26				
9		15				
10		17				

Average 26.50
S.D. 6.57
%

22.75
5.20
100

C-7-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	32					14
2	28					26
3	24					15
4	24					34
5	14					20
6	24					27
7	30					29
8	29					
9	27					
10	32					

Average 26.40
S.D. 5.34
%

23.57
7.46

C-8-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1		16				
2		27				
3		32				
4		14				
5		18				
6		14				
7		26				
8		26				
9		15				
10		17				

Average 26.50
S.D. 6.57
%

23.60
7.07

C-7-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	32					20
2	28					18
3	24					13
4	24					19
5	14					16
6	24					14
7	30					14
8	29					
9	27					
10	32					

Average 26.40
S.D. 5.34
%

16.57
2.80

C-8-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1		18				
2		27				
3		32				
4		14				
5		18				
6		14				
7		26				
8		26				
9		15				
10		17				

Average 26.50
S.D. 6.57
%

14.14
3.39

C-8-UV

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	16					15
2	27					28
3	32					21
4	14					34
5	18					26
6	14					25
7	26					13
8	26					13
9	15					27
10	17					
Average	20.50					22.44
S.D.	6.57					7.42
%						100

C-8-CL

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	16					14
2	27					11
3	32					16
4	14					25
5	18					25
6	14					24
7	26					
8	26					
9	15					
10	17					
Average	20.50					19.17
S.D.	6.57					6.24
%	100					

C-8-RW

Dilution Replicate	Control Water	6.25 %	12.5 %	25 %	50 %	100 %
1	16					26
2	27					14
3	32					13
4	14					
5	18					
6	14					
7	26					
8	26					
9	15					
10	17					
Average	20.50					17.87
S.D.	6.57					7.23
%	100					

Appendix B

Fathead Minnow Survival and Growth

Raw Data

Test No: A-1

Survival		Dilutions					
	UV	\$	5.25	12.5	25	50	100
	Rep. 1	9.00	10.00	10.00	10.00	9.00	9.00
	Rep. 2	9.00	8.00	10.00	9.00	10.00	10.00
	Rep. 3	8.89	10.00	10.00	10.00	10.00	10.00
	Rep. 4	8.00		10.00	10.00	10.00	10.00
	Mean	8.72	9.33	10.00	9.75	9.67	9.75
	(S.D.)	0.48	1.15	0.00	0.50	0.68	0.50
	G/DCI	Rep. 1	9.00	9.00	9.00	10.00	10.00
	Rep. 2	8.00	8.00	10.00	10.00	10.00	10.00
	Rep. 3	10.00	10.00	10.00	9.00	10.00	
	Rep. 4	9.00	9.00	8.00	10.00	10.00	
	Mean	9.00	9.00	9.25	9.75	10.00	
	(S.D.)	0.82	0.82	0.86	0.50	0.00	
	RW	Rep. 1	8.89	8.00	10.00	10.00	10.00
	Rep. 2	8.00	10.00	10.00		8.00	
	Rep. 3	10.00	9.00	10.00	10.00	10.00	
	Rep. 4	10.00	9.00	8.00	10.00	10.00	
	Mean	8.72	8.75	9.75	10.00	9.50	
	(S.D.)	1.09	4.57	0.50	0.00	1.00	

Growth		\$	5.25	12.5	25	50	100
Rep. 1		0.64	0.71	0.64	0.51	0.59	0.64
Rep. 2		0.75	0.66	0.70	0.62	0.76	0.64
Rep. 3		0.78	0.68	0.63	0.57	0.75	0.67
Rep. 4		0.62	0.85	0.59	0.64	0.70	0.66
Mean		0.70	0.70	0.64	0.59	0.72	0.65
(S.D.)		0.08	0.12	0.06	0.06	0.04	0.02
Rep. 1			0.70	0.75	0.82	0.75	0.71
Rep. 2			0.68	0.74	0.66	0.71	0.66
Rep. 3			0.69	0.73	0.63	0.68	0.77
Rep. 4			0.64	0.69	0.66	0.62	0.66
Mean			0.68	0.73	0.79	0.69	0.70
(S.D.)			0.03	0.03	0.10	0.06	0.05
Rep. 1			0.72	0.76	0.80	0.85	0.71
Rep. 2			0.71	0.74	0.64	0.75	
Rep. 3			0.62	0.67	0.76	0.77	0.67
Rep. 4			0.78		0.81	0.68	0.75
Mean			0.71	0.72	0.73	0.77	0.72
(S.D.)			0.07	0.05	0.12	0.08	0.04

Test No: A-2

Survival		Dilutions					
	UV	\$	5.25	12.5	25	50	100
	Rep. 1	10.00	10.00	9.00	10.00	9.00	10.00
	Rep. 2	10.00	10.00	8.89	10.00	9.00	7.78
	Rep. 3	10.00	9.00	10.00	10.00	10.00	8.00
	Rep. 4	9.00	9.00	10.00	10.00	10.00	8.00
	Mean	9.75	9.50	9.47	10.00	9.50	8.44
	(S.D.)	0.50	0.58	0.61	0.00	0.58	1.04
	G/DCI	Rep. 1	8.89	10.00	8.00	10.00	9.00
	Rep. 2	9.00	10.00	10.00	10.00	10.00	
	Rep. 3	10.00	10.00	10.00	10.00	10.00	
	Rep. 4	8.00	9.00	10.00	10.00	10.00	
	Mean	9.22	9.75	9.50	10.00	9.50	
	(S.D.)	0.62	0.50	1.00	0.00	0.58	
	RW	Rep. 1	10.00	10.00	10.00	10.00	8.89
	Rep. 2	10.00	10.00	10.00	9.00		8.89
	Rep. 3	10.00	7.00	8.00	10.00	10.00	10.00
	Rep. 4	10.00	10.00	10.00	10.00	10.00	9.00
	Mean	10.00	9.25	9.75	9.75	10.00	9.19
	(S.D.)	0.00	1.50	0.50	0.50	0.00	0.54

Growth		\$	5.25	12.5	25	50	100
Rep. 1		0.47	0.54	0.51	0.51	0.43	0.50
Rep. 2		0.52	0.34	0.50	0.52	0.52	0.49
Rep. 3		0.53	0.46	0.56	0.59	0.58	0.50
Rep. 4		0.58	0.57	0.46	0.59	0.60	0.55
Mean		0.53	0.46	0.51	0.55	0.51	0.51
(S.D.)		0.04	0.10	0.04	0.04	0.06	0.03
Rep. 1			0.52	0.47	0.38	0.44	0.54
Rep. 2			0.54	0.44	0.46	0.49	0.50
Rep. 3			0.53	0.48	0.54	0.46	0.48
Rep. 4			0.51	0.46	0.56	0.46	0.57
Mean			0.53	0.46	0.46	0.46	0.52
(S.D.)			0.01	0.02	0.08	0.02	0.04
Rep. 1			0.32	0.42	0.46	0.38	0.40
Rep. 2			0.45	0.38	0.38	0.42	0.43
Rep. 3			0.36	0.41	0.42	0.39	0.42
Rep. 4			0.35	0.40	0.41	0.38	0.33
Mean			0.37	0.40	0.42	0.39	0.39
(S.D.)			0.06	0.02	0.03	0.02	0.04

Test No: A-3

Survival		Dilutions					
	UV	\$	5.25	12.5	25	50	100
	Rep. 1	9.00				9.00	
	Rep. 2	10.00				10.00	
	Rep. 3	10.00				8.00	
	Rep. 4	9.00				9.00	
	Mean	9.50				9.00	
	(S.D.)	0.58				0.82	
	G/DCI	Rep. 1				10.00	
	Rep. 2					10.00	
	Rep. 3					10.00	
	Rep. 4					10.00	
	Mean					10.00	
	(S.D.)					0.00	
	RW	Rep. 1				5.00	
	Rep. 2					8.00	
	Rep. 3					8.75	
	Rep. 4					7.00	
	Mean					7.44	
	(S.D.)					1.86	

Growth		\$	5.25	12.5	25	50	100
Rep. 1		0.53				0.52	
Rep. 2		0.51					0.47
Rep. 3		0.55					0.41
Rep. 4		0.68					0.48
Mean		0.57					0.47
(S.D.)		0.08					0.05
Rep. 1							0.39
Rep. 2							0.49
Rep. 3							0.56
Rep. 4							0.48
Mean							0.48
(S.D.)							0.07
Rep. 1							0.60
Rep. 2							0.42
Rep. 3							0.49
Rep. 4							0.42
Mean							0.48
(S.D.)							0.08

Survival	UV	C	6.25	12.5	25	50	100
	Rep. 1	10.00					10.00
	Rep. 2	9.00					10.00
	Rep. 3	10.00					10.00
	Rep. 4	10.00					10.00
	Mean	9.75					10.00
	(S.D.)	0.50					0.00

Growth	C	6.25	12.5	25	50	100
Rep. 1	0.63					0.65
Rep. 2	0.63					0.57
Rep. 3	0.63					0.68
Rep. 4	0.67					0.57
Mean	0.63					0.59
(S.D.)	0.10					0.06

RW	Rep. 1						10.00
	Rep. 2						10.00
	Rep. 3						10.00
	Rep. 4						10.00
	Mean						10.00
	(S.D.)						0.00

Rep. 1							0.63
Rep. 2							0.67
Rep. 3							0.60
Rep. 4							0.64
Mean							0.64
(S.D.)							0.03

Test No: A-5

Survival	UV	C	6.25	12.50	25.00	50.00	100.00
	Rep. 1	10.00					10.00
	Rep. 2	10.00					10.00
	Rep. 3	10.00					10.00
	Rep. 4	10.00					10.00
	Mean	10.00					10.00
	(S.D.)	0.00					1.00

Growth	C	6.25	12.50	25.00	50.00	100.00
Rep. 1	0.41					0.48
Rep. 2	0.42					0.47
Rep. 3	0.59					0.55
Rep. 4	0.60					0.50
Mean	0.51					0.50
(S.D.)	0.10					0.04

RW	Rep. 1						10.00
	Rep. 2						10.00
	Rep. 3						10.00
	Rep. 4						10.00
	Mean						10.00
	(S.D.)						0.00

Rep. 1							0.48
Rep. 2							0.55
Rep. 3							0.50
Rep. 4							0.50
Mean							0.51
(S.D.)							0.03

Test No: A-6

Survival	UV	C	6.25	12.5	25	50	100
	Rep. 1	10.00					8.89
	Rep. 2	10.00					10.00
	Rep. 3	10.00					10.00
	Rep. 4	10.00					10.00
	Mean	10.00					10.00
	(S.D.)	0.00					0.56

Growth	C	6.25	12.5	25	50	100
Rep. 1	0.52					0.65
Rep. 2	0.55					0.62
Rep. 3	0.64					0.41
Rep. 4	0.56					0.56
Mean	0.57					0.56
(S.D.)	0.05					0.11

RW	Rep. 1						10.00
	Rep. 2						10.00
	Rep. 3						10.00
	Rep. 4						10.00
	Mean						10.00
	(S.D.)						0.00

Rep. 1							0.57
Rep. 2							0.54
Rep. 3							0.58
Rep. 4							0.60
Mean							0.57
(S.D.)							0.02

Test No: A-7

Survival	UV	C	6.25	12.50	25.00	50.00	100.00
	Rep. 1	9.00					8.00
	Rep. 2	9.00					9.00
	Rep. 3	8.00					8.00
	Rep. 4	9.00					8.00
	Mean	8.75					8.75
	(S.D.)	0.50					0.50

Rep. 1							0.74
Rep. 2							0.62
Rep. 3							0.64
Rep. 4							0.67
Mean							0.67
(S.D.)							0.05

RW	Rep. 1						8.00
	Rep. 2						8.00
	Rep. 3						8.00
	Rep. 4						8.00
	Mean						8.00
	(S.D.)						0.00

Rep. 1							0.68
Rep. 2							0.61
Rep. 3							0.59
Rep. 4							0.63
Mean							0.63
(S.D.)							0.04

Test No: A-8

Survival	UV	£	<u>8.25</u>	<u>12.50</u>	<u>25.00</u>	<u>50.00</u>	<u>100.00</u>
	Rep. 1	10.00			8.00		
	Rep. 2	10.00			9.00		
	Rep. 3	10.00			8.00		
	Rep. 4	9.00			10.00		
	Mean	9.75			8.00		
	(S.D.)	0.50			0.82		
	RW	Rep. 1			10.00		
	Rep. 2				10.00		
	Rep. 3				9.00		
	Rep. 4				8.00		
	Mean				9.25		
	(S.D.)				0.86		

Growth

	£	<u>8.25</u>	<u>12.50</u>	<u>25.00</u>	<u>50.00</u>	<u>100.00</u>
Rep. 1	0.48					0.45
Rep. 2	0.44					0.44
Rep. 3	0.43					0.41
Rep. 4	0.44					0.42
Mean	0.45					0.43
(S.D.)	0.02					0.02
Rep. 1						0.39
Rep. 2						0.42
Rep. 3						0.43
Rep. 4						0.48
Mean						0.48
(S.D.)						0.13

Test No: A-9

Survival	UV	£	<u>8.25</u>	<u>12.5</u>	<u>25</u>	<u>50</u>	<u>100</u>
	Rep. 1	10.00			7.00		
	Rep. 2	10.00			10.00		
	Rep. 3	10.00			10.00		
	Rep. 4	10.00			10.00		
	Mean	10.00			9.00		
	(S.D.)	0.00			1.41		
	RW	Rep. 1			8.00		
	Rep. 2				8.00		
	Rep. 3				10.00		
	Rep. 4				10.00		
	Mean				9.50		
	(S.D.)				0.58		

Growth

	£	<u>8.25</u>	<u>12.5</u>	<u>25</u>	<u>50</u>	<u>100</u>
Rep. 1	0.40					0.47
Rep. 2	0.45					0.38
Rep. 3	0.45					0.47
Rep. 4	0.44					0.49
Mean	0.43					0.45
(S.D.)	0.02					0.06
Rep. 1						0.52
Rep. 2						0.44
Rep. 3						0.50
Rep. 4						0.46
Mean						0.48
(S.D.)						0.04

Test No: A-10

Survival	UV	£	<u>8.25</u>	<u>12.50</u>	<u>25.00</u>	<u>50.00</u>	<u>100.00</u>
	Rep. 1	10.00			10.00		
	Rep. 2	10.00			10.00		
	Rep. 3	10.00			10.00		
	Rep. 4	10.00			10.00		
	Mean	10.00			10.00		
	(S.D.)	0.00			0.00		
	RW	Rep. 1			10.00		
	Rep. 2				10.00		
	Rep. 3				10.00		
	Rep. 4				10.00		
	Mean				10.00		
	(S.D.)				0.00		

Growth

	£	<u>8.25</u>	<u>12.50</u>	<u>25</u>	<u>50</u>	<u>100</u>
Rep. 1	0.35					0.43
Rep. 2	0.34					0.43
Rep. 3	0.38					0.42
Rep. 4	0.47					0.40
Mean	0.38					0.42
(S.D.)	0.06					0.01
Rep. 1						0.40
Rep. 2						0.35
Rep. 3						0.38
Rep. 4						0.40
Mean						0.38
(S.D.)						0.02

Test No: B-1

Survival	UV	£	<u>8.25</u>	<u>12.5</u>	<u>25</u>	<u>50</u>	<u>100</u>
	Rep. 1	9.00			10.00		
	Rep. 2	10.00			10.00		
	Rep. 3	10.00			10.00		
	Rep. 4	10.00			8.00		
	Mean	9.75			9.25		
	(S.D.)	0.50			0.86		
	RW	Rep. 1			10.00		
	Rep. 2				10.00		
	Rep. 3				10.00		
	Rep. 4				10.00		
	Mean				10.00		
	(S.D.)				0.00		
	SDC	Rep. 1	10.00		10.00		
	Rep. 2	10.00			10.00		
	Rep. 3	10.00			10.00		
	Rep. 4	10.00			10.00		
	Mean	10.00			10.00		
	(S.D.)	0.00			0.00		

Growth

	£	<u>8.25</u>	<u>12.5</u>	<u>25</u>	<u>50</u>	<u>100</u>
Rep. 1	0.72					0.63
Rep. 2	0.80					0.67
Rep. 3	0.68					0.69
Rep. 4	0.75					0.91
Mean	0.74					0.73
(S.D.)	0.05					0.13
Rep. 1						0.69
Rep. 2						0.65
Rep. 3						0.64
Rep. 4						0.63
Mean						0.63
(S.D.)						0.07
Rep. 1	0.86					0.80
Rep. 2	0.78					0.73
Rep. 3	0.87					0.84
Rep. 4	0.85					0.78
Mean	0.84					0.79
(S.D.)	0.04					0.05

Test No: B-2

Survival	UV	<u>E</u>	<u>5.25</u>	<u>12.5</u>	<u>25</u>	<u>50</u>	<u>100</u>
	Rep. 1	9.00			9.00		
	Rep. 2	10.00			10.00		
	Rep. 3	10.00			10.00		
	Rep. 4				10.00		
	Mean	9.57			9.75		
	(S.D.)	0.58			0.50		
	RW	Rep. 1			10.00		
	Rep. 2				9.00		
	Rep. 3				9.00		
	Rep. 4				10.00		
	Mean				9.50		
	(S.D.)				0.58		

Growth

	<u>E</u>	<u>5.25</u>	<u>12.5</u>	<u>25</u>	<u>50</u>	<u>100</u>
Rep. 1	0.76					0.54
Rep. 2	0.71					0.54
Rep. 3	0.72					0.54
Rep. 4						0.50
Mean	0.73					0.53
(S.D.)	0.02					0.02
Rep. 1						0.62
Rep. 2						0.60
Rep. 3						0.57
Rep. 4						0.59
Mean						0.59
(S.D.)						0.02

Test No: B-3

Survival		<u>Dilutions</u>					
	UV	<u>E</u>	<u>5.25</u>	<u>12.5</u>	<u>25</u>	<u>50</u>	<u>100</u>
	Rep. 1	9.00			10.00		
	Rep. 2	10.00			10.00		
	Rep. 3	6.00			10.00		
	Rep. 4	10.00			9.00		
	Mean	8.75			9.75		
	(S.D.)	1.89			0.50		
	CV/DCI	Rep. 1			7.50		
	Rep. 2				10.00		
	Rep. 3				10.00		
	Rep. 4				10.00		
	Mean				9.25		
	(S.D.)				1.50		
	RW	Rep. 1			9.00		
	Rep. 2				9.00		
	Rep. 3				10.00		
	Rep. 4				10.00		
	Mean				9.50		
	(S.D.)				0.58		

	<u>E</u>	<u>5.25</u>	<u>12.5</u>	<u>25</u>	<u>50</u>	<u>100</u>
Rep. 1	0.65					0.64
Rep. 2	0.69					0.71
Rep. 3	0.68					0.75
Rep. 4	0.81					0.70
Mean	0.61					0.70
(S.D.)	0.09					0.05
Rep. 1						0.73
Rep. 2						0.62
Rep. 3						0.75
Rep. 4						0.87
Mean						0.79
(S.D.)						0.06
Rep. 1						0.68
Rep. 2						0.81
Rep. 3						0.67
Rep. 4						0.74
Mean						0.72
(S.D.)						0.07

Test No: B-4

Survival		<u>Dilutions</u>					
	UV	<u>E</u>	<u>5.25</u>	<u>12.5</u>	<u>25</u>	<u>50</u>	<u>100</u>
	Rep. 1	10.00			8.00		
	Rep. 2	10.00			9.00		
	Rep. 3	8.00			10.00		
	Rep. 4	10.00			10.00		
	Mean	9.50			9.25		
	(S.D.)	1.00			0.96		
	CV/DCI	Rep. 1			10.00		
	Rep. 2				10.00		
	Rep. 3				10.00		
	Rep. 4				10.00		
	Mean				10.00		
	(S.D.)				0.00		
	RW	Rep. 1			10.00		
	Rep. 2				10.00		
	Rep. 3				10.00		
	Rep. 4				9.00		
	Mean				9.75		
	(S.D.)				0.50		

	<u>E</u>	<u>5.25</u>	<u>12.5</u>	<u>25</u>	<u>50</u>	<u>100</u>
Rep. 1	0.76					0.74
Rep. 2	0.77					0.86
Rep. 3	0.84					0.74
Rep. 4	0.84					0.86
Mean	0.80					0.75
(S.D.)	0.04					0.08
Rep. 1						0.74
Rep. 2						0.77
Rep. 3						0.72
Rep. 4						0.73
Mean						0.74
(S.D.)						0.02
Rep. 1						0.65
Rep. 2						0.68
Rep. 3						0.65
Rep. 4						0.64
Mean						0.66
(S.D.)						0.02

Survival		Dilutions					
		C	2.25	12.5	25	50	100
UV	Rep. 1	9.00	10.00	10.00	10.00	4.00	10.00
	Rep. 2	8.00	8.33	10.00	9.00	9.00	9.00
	Rep. 3	9.00	1.00	10.00	10.00	10.00	8.00
	Rep. 4	9.00	9.00	10.00	9.00	7.00	8.00
	Mean	8.75	8.63	10.00	9.50	7.50	8.75
	(S.D.)	0.50	4.35	0.00	0.56	2.85	0.95
G/DCI	Rep. 1	9.00	2.00	8.89	10.00	9.00	
	Rep. 2	9.00	9.00	9.00	9.00	7.00	
	Rep. 3	9.00	3.00	10.00		10.00	
	Rep. 4	9.00	0.00	8.00	10.00	10.00	
	Mean	9.00	3.50	8.87	8.67	9.00	
	(S.D.)	0.00	3.57	0.82	0.56	1.41	
RW	Rep. 1	10.00	1.00	6.00	10.00	10.00	
	Rep. 2	10.00	8.00	1.00	7.00	8.00	
	Rep. 3	10.00	9.00	1.00	6.00	9.00	
	Rep. 4	9.00	0.00	0.00	6.00	10.00	
	Mean	9.75	4.50	1.75	6.75	9.50	
	(S.D.)	0.50	4.85	2.22	2.36	0.88	

Test No: B-5

Survival		Dilutions					
		C	2.25	12.5	25	50	100
UV	Rep. 1	9.00	8.00	10.00	10.00	8.00	9.00
	Rep. 2	8.00	10.00	8.00	8.00	10.00	10.00
	Rep. 3	8.75	8.00	9.00	10.00	10.00	8.00
	Rep. 4	9.00	9.00	10.00	7.00	9.00	9.00
	Mean	8.69	9.00	9.50	8.75	9.25	9.00
	(S.D.)	0.47	0.82	0.56	1.50	0.86	0.82
G/DCI	Rep. 1	10.00	9.00	9.00	10.00	9.00	
	Rep. 2	8.00	10.00	10.00	10.00	10.00	
	Rep. 3	9.00	10.00	7.00	10.00	7.00	
	Rep. 4	7.00	10.00	8.00	8.00	7.00	
	Mean	8.50	9.75	8.50	9.50	8.25	
	(S.D.)	1.29	0.50	1.29	1.00	1.50	
RW	Rep. 1	9.00	10.00	10.00	10.00	7.78	
	Rep. 2	10.00	10.00	10.00	9.00	10.00	
	Rep. 3	8.00	9.00	8.00	10.00	10.00	
	Rep. 4	10.00	10.00	10.00	10.00	9.00	
	Mean	9.25	9.75	8.50	9.75	9.19	
	(S.D.)	0.56	0.50	1.00	0.50	1.06	

Growth		Dilutions					
		C	2.25	12.5	25	50	100
Rep. 1	0.39	0.43	0.49	0.47	0.50	0.39	
Rep. 2	0.34	0.13	0.40	0.47	0.41	0.41	
Rep. 3	0.40	0.70	0.49	0.47	0.41	0.43	
Rep. 4	0.36	0.42	0.49	0.47	0.41	0.36	
Mean	0.37	0.42	0.47	0.47	0.43	0.40	
(S.D.)	0.03	0.23	0.04	0.00	0.04	0.03	
Rep. 1	0.48	0.65	0.42	0.51	0.48		
Rep. 2	0.37	0.38	0.54	0.41	0.39		
Rep. 3	0.49	0.43	0.47	0.00	0.42		
Rep. 4	0.43	0.00	0.41	0.47	0.44		
Mean	0.44	0.37	0.46	0.35	0.43		
(S.D.)	0.06	0.27	0.06	0.24	0.04		
Rep. 1	0.45	0.20	0.38	0.34	0.40		
Rep. 2	0.45	0.53	0.40	0.39	0.39		
Rep. 3	0.53	0.52	0.20	0.30	0.42		
Rep. 4	0.40	0.00	0.00	0.38	0.37		
Mean	0.46	0.31	0.24	0.35	0.40		
(S.D.)	0.05	0.26	0.18	0.04	0.02		

Test No: C-1

Survival		Dilutions					
		C	2.25	12.5	25	50	100
UV	Rep. 1	10.00	8.89	10.00	10.00	8.00	8.00
	Rep. 2	8.00	8.00	10.00	8.89	10.00	8.00
	Rep. 3	9.00	7.00	10.00	9.00	10.00	9.00
	Rep. 4	10.00	10.00	10.00	10.00	10.00	8.00
	Mean	9.50	8.47	10.00	9.47	9.75	8.25
	(S.D.)	0.58	1.28	0.00	0.61	0.50	0.50
G/DCI	Rep. 1	10.00	10.00	10.00	10.00	8.89	
	Rep. 2	8.00	6.00	10.00	8.89	8.00	
	Rep. 3	7.00	10.00	10.00	10.00	10.00	
	Rep. 4	10.00	10.00	10.00	9.00	10.00	
	Mean	8.75	8.75	10.00	9.47	9.47	
	(S.D.)	1.50	2.50	0.00	0.61	0.61	
RW	Rep. 1	10.00	6.00	9.00	9.00	9.00	
	Rep. 2	10.00	10.00	10.00	10.00	9.00	
	Rep. 3	9.00	9.00	8.00	10.00	9.00	
	Rep. 4	9.00	10.00	9.00	10.00	10.00	
	Mean	9.50	8.75	8.00	9.75	9.25	
	(S.D.)	0.56	1.59	0.82	0.50	0.50	

Growth		Dilutions					
		C	2.25	12.5	25	50	100
Rep. 1	0.45	0.38	0.28	0.34	0.41	0.41	
Rep. 2	0.47	0.51	0.33	0.39	0.39	0.26	
Rep. 3	0.42	0.39	0.44	0.40	0.32	0.34	
Rep. 4	0.48	0.41	0.32	0.36	0.49	0.34	
Mean	0.45	0.42	0.34	0.37	0.40	0.34	
(S.D.)	0.02	0.06	0.07	0.03	0.07	0.06	
Rep. 1	0.43	0.37	0.36	0.37	0.43		
Rep. 2	0.41	0.34	0.35	0.39	0.24		
Rep. 3	0.39	0.40	0.38	0.27	0.41		
Rep. 4	0.40	0.30	0.38	0.39	0.43		
Mean	0.41	0.36	0.37	0.35	0.38		
(S.D.)	0.02	0.04	0.01	0.06	0.08		
Rep. 1	0.35	0.32	0.42	0.46	0.31		
Rep. 2	0.48	0.50	0.33	0.37	0.34		
Rep. 3	0.46	0.40	0.41	0.34	0.35		
Rep. 4	0.50	0.43	0.34	0.27	0.28		
Mean	0.45	0.41	0.38	0.36	0.32		
(S.D.)	0.07	0.06	0.05	0.06	0.03		

Survival		Dilutions						Growth						
		C	8.25	12.5	25	50	100	C	8.25	12.5	25	50	100	
IV	Rep. 1	8.89					10.00	Rep. 1	0.60				0.58	
	Rep. 2	9.00					8.89	Rep. 2	0.42				0.42	
	Rep. 3	8.89					8.00	Rep. 3	0.55				0.45	
	Rep. 4	10.00					9.00	Rep. 4	0.59				0.44	
	Mean	9.19					8.97	Mean	0.54				0.47	
	(S.D.)	0.64					0.52	(S.D.)	0.08				0.07	
	G/DCI	Rep. 1					8.00	Rep. 1					0.51	
RW	Rep. 2						8.89	Rep. 2					0.54	
	Rep. 3						9.00	Rep. 3					0.51	
	Rep. 4						10.00	Rep. 4					0.56	
	Mean						8.97	Mean					0.53	
	(S.D.)						0.82	(S.D.)					0.02	
	Rep. 1						10.00	Rep. 1					0.49	
	Rep. 2						10.00	Rep. 2					0.48	
Test No: C-3	Rep. 3						10.00	Rep. 3					0.49	
	Rep. 4						10.00	Rep. 4					0.54	
	Mean						10.00	Mean					0.50	
	(S.D.)						0.00	(S.D.)					0.03	
	G/DCI	Rep. 1					10.00	Rep. 1					0.30	
	Rep. 2						10.00	Rep. 2					0.32	
	Rep. 3						8.00	Rep. 3					0.27	
RW	Rep. 4						10.00	Rep. 4					0.31	
	Mean						8.75	Mean					0.30	
	(S.D.)						0.50	(S.D.)					0.02	
	Rep. 1						10.00	Rep. 1					0.33	
	Rep. 2						10.00	Rep. 2					0.28	
	Rep. 3						8.00	Rep. 3					0.33	
	Rep. 4						10.00	Rep. 4					0.35	
Test No: C-4	Mean						8.75	Mean					0.32	
	(S.D.)						0.50	(S.D.)					0.03	
	G/DCI	Rep. 1					10.00	Rep. 1					0.32	
	Rep. 2						10.00	Rep. 2					0.35	
	Rep. 3						8.00	Rep. 3					0.39	
	Rep. 4						8.00	Rep. 4					0.36	
	Mean						8.25	Mean					0.35	
RW	(S.D.)						0.96	(S.D.)					0.03	
	Rep. 1						10.00	Rep. 1					0.39	
	Rep. 2						10.00	Rep. 2					0.33	
	Rep. 3						8.00	Rep. 3					0.34	
	Rep. 4						8.00	Rep. 4					0.31	
	Mean						8.50	Mean					0.34	
	(S.D.)						0.56	(S.D.)					0.03	
Survival	Dilutions	C	8.25	12.5	25	50	100	Growth	C	8.25	12.5	25	50	100
	IV	Rep. 1	10.00				10.00	Rep. 1	0.43				0.36	
	Rep. 2	10.00					10.00	Rep. 2	0.50				0.36	
	Rep. 3	10.00					8.00	Rep. 3	0.48				0.36	
	Rep. 4	10.00					9.00	Rep. 4	0.44				0.32	
	Mean	10.00					9.25	Mean	0.46				0.35	
	(S.D.)	0.00					0.96	(S.D.)	0.03				0.02	
G/DCI	Rep. 1						10.00	Rep. 1					0.30	
	Rep. 2						10.00	Rep. 2					0.32	
	Rep. 3						8.00	Rep. 3					0.27	
	Rep. 4						9.00	Rep. 4					0.31	
	Mean						8.75	Mean					0.30	
	(S.D.)						0.50	(S.D.)					0.02	
	Rep. 1						10.00	Rep. 1					0.33	
RW	Rep. 2						10.00	Rep. 2					0.28	
	Rep. 3						8.00	Rep. 3					0.33	
	Rep. 4						9.00	Rep. 4					0.35	
	Mean						8.75	Mean					0.32	
	(S.D.)						0.50	(S.D.)					0.03	
	Rep. 1						10.00	Rep. 1					0.32	
	Rep. 2						10.00	Rep. 2					0.35	
Test No: C-4	Rep. 3						8.00	Rep. 3					0.39	
	Rep. 4						9.00	Rep. 4					0.34	
	Mean						8.25	Mean					0.34	
	(S.D.)						0.96	(S.D.)					0.03	
	G/DCI	Rep. 1					10.00	Rep. 1					0.32	
	Rep. 2						10.00	Rep. 2					0.35	
	Rep. 3						8.00	Rep. 3					0.39	
RW	Rep. 4						8.00	Rep. 4					0.36	
	Mean						8.25	Mean					0.35	
	(S.D.)						0.96	(S.D.)					0.03	
	Rep. 1						10.00	Rep. 1					0.33	
	Rep. 2						10.00	Rep. 2					0.33	
	Rep. 3						8.00	Rep. 3					0.29	
	Rep. 4						9.00	Rep. 4					0.34	
Survival	Dilutions	C	8.25	12.5	25	50	100	Growth	C	8.25	12.5	25	50	100
	IV	Rep. 1	10.00				10.00	Rep. 1	0.43				0.39	
	Rep. 2	10.00					10.00	Rep. 2	0.50				0.33	
	Rep. 3	10.00					8.00	Rep. 3	0.48				0.34	
	Rep. 4	10.00					9.00	Rep. 4	0.44				0.31	
	Mean	10.00					9.25	Mean	0.46				0.34	
	(S.D.)	0.00					0.96	(S.D.)	0.03				0.03	
G/DCI	Rep. 1						10.00	Rep. 1					0.32	
	Rep. 2						10.00	Rep. 2					0.35	
	Rep. 3						8.00	Rep. 3					0.39	
	Rep. 4						9.00	Rep. 4					0.36	
	Mean						8.75	Mean					0.35	
	(S.D.)						0.56	(S.D.)					0.03	
	Rep. 1						10.00	Rep. 1					0.33	
RW	Rep. 2						10.00	Rep. 2					0.33	
	Rep. 3						8.00	Rep. 3					0.33	
	Rep. 4						9.00	Rep. 4					0.29	
	Mean						8.25	Mean					0.34	
	(S.D.)						0.96	(S.D.)					0.02	
	Rep. 1						10.00	Rep. 1					0.32	
	Rep. 2						10.00	Rep. 2					0.32	
Test No: C-4	Rep. 3						8.00	Rep. 3					0.39	
	Rep. 4						9.00	Rep. 4					0.34	
	Mean						8.25	Mean					0.32	
	(S.D.)						0.96	(S.D.)					0.02	
	G/DCI	Rep. 1					10.00	Rep. 1					0.32	
	Rep. 2						10.00	Rep. 2					0.35	
	Rep. 3						8.00	Rep. 3					0.39	
RW	Rep. 4						9.00	Rep. 4					0.36	
	Mean						8.50	Mean					0.34	
	(S.D.)						0.56	(S.D.)					0.03	
	Rep. 1						10.00	Rep. 1					0.32	
	Rep. 2						10.00	Rep. 2					0.33	
	Rep. 3						8.00	Rep. 3					0.33	
	Rep. 4						9.00	Rep. 4					0.29	
Survival	Dilutions	C	8.25	12.5	25	50	100	Growth	C	8.25	12.5	25	50	100
	IV	Rep. 1	10.00				10.00	Rep. 1	0.43				0.36	
	Rep. 2	10.00					10.00	Rep. 2	0.50				0.36	
	Rep. 3	10.00					8.00	Rep. 3	0.48				0.36	
	Rep. 4	10.00					9.00	Rep. 4	0.44				0.32	
	Mean	10.00					9.25	Mean	0.46				0.34	
	(S.D.)	0.00					0.96	(S.D.)	0.03			</		

Test No: C-6

Survival		Dilutions						Growth							
		£	6.25	12.5	25	50	100	£	6.25	12.5	25	50	100		
UV	Rep. 1	10.00					7.00	Rep. 1	0.43				0.33		
	Rep. 2	10.00					9.00	Rep. 2	0.50				0.30		
	Rep. 3	10.00					10.00	Rep. 3	0.48				0.32		
	Rep. 4	10.00					8.59	Rep. 4	0.44				0.33		
	Mean	10.00					8.72	Mean	0.46				0.32		
	(S.D.)	0.00					1.25	(S.D.)	0.03				0.01		
G/D/GI	Rep. 1						8.00	Rep. 1					0.36		
	Rep. 2						8.00	Rep. 2					0.34		
	Rep. 3						7.00	Rep. 3					0.37		
	Rep. 4						7.00	Rep. 4					0.31		
	Mean						8.00	Mean					0.35		
	(S.D.)						1.15	(S.D.)					0.02		
RW	Rep. 1						9.00	Rep. 1					0.33		
	Rep. 2						10.00	Rep. 2					0.32		
	Rep. 3						10.00	Rep. 3					0.33		
	Rep. 4						9.00	Rep. 4					0.36		
	Mean						9.00	Mean					0.33		
	(S.D.)						0.56	(S.D.)					0.02		

Test No: C-6

Survival		Dilutions						Growth						
		£	6.25	12.5	25	50	100	£	6.25	12.5	25	50	100	
UV	Rep. 1	10.00					7.00	Rep. 1	0.45				0.26	
	Rep. 2	9.00					8.00	Rep. 2	0.46				0.33	
	Rep. 3	10.00					7.00	Rep. 3	0.44				0.19	
	Rep. 4	10.00					8.00	Rep. 4	0.41				0.28	
	Mean	9.75					7.50	Mean	0.44				0.26	
	(S.D.)	0.50					0.68	(S.D.)	0.02				0.06	
G/D/GI	Rep. 1						10.00	Rep. 1					0.29	
	Rep. 2						10.00	Rep. 2					0.26	
	Rep. 3						7.00	Rep. 3					0.31	
	Rep. 4						6.00	Rep. 4					0.28	
	Mean						8.25	Mean					0.29	
	(S.D.)						2.06	(S.D.)					0.02	
RW	Rep. 1						9.00	Rep. 1					0.27	
	Rep. 2						9.00	Rep. 2					0.30	
	Rep. 3						8.00	Rep. 3					0.26	
	Rep. 4						9.00	Rep. 4					0.29	
	Mean						8.75	Mean					0.28	
	(S.D.)						0.50	(S.D.)					0.02	

Test No: C-7

Survival		Dilutions						Growth						
		£	6.25	12.5	25	50	100	£	6.25	12.5	25	50	100	
UV	Rep. 1	10.00					10.00	Rep. 1	0.45				0.31	
	Rep. 2	8.00					10.00	Rep. 2	0.46				0.30	
	Rep. 3	10.00					8.00	Rep. 3	0.44				0.29	
	Rep. 4	10.00					10.00	Rep. 4	0.41				0.26	
	Mean	8.75					8.75	Mean	0.44				0.29	
	(S.D.)	0.50					0.50	(S.D.)	0.02				0.02	
G/D/GI	Rep. 1						8.00	Rep. 1					0.31	
	Rep. 2						8.00	Rep. 2					0.30	
	Rep. 3						10.00	Rep. 3					0.30	
	Rep. 4						8.00	Rep. 4					0.36	
	Mean						8.50	Mean					0.32	
	(S.D.)						1.00	(S.D.)					0.03	
RW	Rep. 1						10.00	Rep. 1					0.30	
	Rep. 2						8.00	Rep. 2					0.36	
	Rep. 3						8.00	Rep. 3					0.31	
	Rep. 4						10.00	Rep. 4					0.31	
	Mean						9.25	Mean					0.32	
	(S.D.)						0.55	(S.D.)					0.02	

Test No: C-8

Survival

Dilutions							
		£	6.25	12.5	25	50	100
UV	Rep. 1	10.00				10.00	
	Rep. 2	9.00				10.00	
	Rep. 3	10.00				10.00	
	Rep. 4	10.00				10.00	
	Mean	9.75				10.00	
	(S.D.)	0.60				0.00	
SVDCI	Rep. 1					9.00	
	Rep. 2					10.00	
	Rep. 3					10.00	
	Rep. 4					10.00	
	Mean					9.75	
	(S.D.)					0.60	
RW	Rep. 1					9.00	
	Rep. 2					10.00	
	Rep. 3					8.00	
	Rep. 4					10.00	
	Mean					8.25	
	(S.D.)					0.96	

Growth

	£	6.25	12.5	25	50	100
Rep. 1	0.44					0.36
Rep. 2	0.46					0.37
Rep. 3	0.39					0.40
Rep. 4	0.41					0.40
Mean	0.42					0.38
(S.D.)	0.03					0.02
Rep. 1						0.36
Rep. 2						0.37
Rep. 3						0.34
Rep. 4						0.38
Mean						0.36
(S.D.)						0.02
Rep. 1						0.37
Rep. 2						0.39
Rep. 3						0.38
Rep. 4						0.39
Mean						0.38
(S.D.)						0.01

Test No: C-9

Survival

Dilutions							
		£	6.25	12.5	25	50	100
UV	Rep. 1	10.00				10.00	
	Rep. 2	9.00				9.00	
	Rep. 3	10.00				9.00	
	Rep. 4	10.00				9.00	
	Mean	9.75				10.00	
	(S.D.)	0.50				0.50	
SVDCI	Rep. 1					9.00	
	Rep. 2					9.00	
	Rep. 3					10.00	
	Rep. 4					10.00	
	Mean					9.50	
	(S.D.)					0.58	
RW	Rep. 1					10.00	
	Rep. 2					10.00	
	Rep. 3					10.00	
	Rep. 4					10.00	
	Mean					10.00	
	(S.D.)					0.00	

Growth

	£	6.25	12.5	25	50	100
Rep. 1	0.44					0.36
Rep. 2	0.46					0.31
Rep. 3	0.39					0.30
Rep. 4	0.41					0.36
Mean	0.42					0.33
(S.D.)	0.03					0.03
Rep. 1						0.36
Rep. 2						0.38
Rep. 3						0.36
Rep. 4						0.31
Mean						0.35
(S.D.)						0.03
Rep. 1						0.40
Rep. 2						0.36
Rep. 3						0.36
Rep. 4						0.39
Mean						0.38
(S.D.)						0.02

Appendix C

Water Chemistry Data from

Chronic Toxicity Tests

Test No: A-1		<u>C</u> mean	range (hi - lo)		<u>6.25</u> mean	range (hi - lo)		<u>25</u> mean	range (hi - lo)		<u>100</u> mean	range (hi - lo)		
	UV	pH	8	8.4	7.6	8.04	8.37	7.71	7.935	8.29	7.7	7.925	8.18	7.47
	D.O.	(mg/L)	6.86	8.20	5.50	6.76	8.4	5.1	6.75	8.6	4.9	6.75	8.6	4.9
	Cond.	(uSiem.)	291	301	281	316.5	328	305	403.5	429	378	675	688	662
	Amm.	(mg/L N)	0.225	0.45	0.00	0.175	0.35	0	0.2525	0.45	0.075	0.385	0.57	0.2
CVDCI	pH				7.93	8.34	7.52	7.91	8.26	7.56	7.775	8.06	7.49	
	D.O.	(mg/L)				6.46	8.3	4.6	6.7	8.5	4.9	6.45	8.6	4.3
	Cond.	(uSiem.)				334.5	361	308	396	402	380	713.5	725	701
	Amm.	(mg/L N)				0.18	0.21	0.15	0.0925	0.145	0.04	0.275	0.35	0.2
RW	pH				7.965	8.34	7.57	7.86	8.1	7.62	7.59	7.91	7.47	
	D.O.	(mg/L)				6.8	8.4	5.4	6.7	8.5	4.9	6.25	8.1	4.4
	Cond.	(uSiem.)				330.5	356	305	397	415	379	690	700	660
	Amm.	(mg/L N)				0.085	0.17	0	0.21	0.42	0	0.13	0.26	0
Test No: A-2		<u>C</u> mean	range (hi - lo)		<u>6.25</u> mean	range (hi - lo)		<u>25</u> mean	range (hi - lo)		<u>100</u> mean	range (hi - lo)		
UV	pH	7.82	8.26	7.38	7.805	8.22	7.39	7.875	8	7.35	7.245	7.68	6.81	
	D.O.	(mg/L)	6.75	9.10	4.40	6.8	9.1	4.5	6.575	9.15	4	6.5	8.9	4.1
	Cond.	(uSiem.)	310.5	339	282	310	334	286	385.5	397	374	674.5	714	635
CVDCI	pH				7.885	8.25	7.52	7.775	8.04	7.51	7.23	7.64	6.82	
	D.O.	(mg/L)				6.925	9.05	4.8	7.035	9.17	4.9	6.975	8.35	4.6
	Cond.	(uSiem.)				320	333	307	402.5	420	385	690	723	675
RW	pH				7.795	8.28	7.31	7.84	7.86	7.32	7.225	7.66	6.79	
	D.O.	(mg/L)				6.5	9.1	3.9	6.71	9.12	4.3	6.4	8.8	3.2
	Cond.	(uSiem.)				316	326	306	382	391	373	647.5	687	628
Test No: A-3		<u>C</u> mean	range (hi - lo)		<u>100</u> mean	range (hi - lo)								
UV	pH	7.91	8.37	7.45	6.79	7.21	6.37							
	D.O.	(mg/L)	6.07	7.76	4.38	6.455	9.28	3.63						
	Cond.	(uSiem.)	397.5	439	356	779.5	877	682						
CVDCI	pH				6.8	7.24	6.36							
	D.O.	(mg/L)				6.91	10.13	3.69						
	Cond.	(uSiem.)				328	327	725						
RW	pH				7.105	7.97	6.24							
	D.O.	(mg/L)				6.965	8.26	3.65						
	Cond.	(uSiem.)				779.5	879	680						

<u>Test No: A-4</u>		<u>C</u> mean	range (hi - lo)		<u>100</u> mean	range (hi - lo)	
<u>UV</u>	<u>pH</u>	7.91	8.37	7.45	6.79	7.21	6.37
	<u>D.O.</u> (mg/L)	6.78	7.76	3.80	6.47	9.28	3.66
	<u>Cond.</u> (uSiem.)	397.5	439	356	779.5	877	682
<u>RW</u>	<u>pH</u>				7.105	7.87	6.24
	<u>D.O.</u> (mg/L)				6.766	8.26	3.25
	<u>Cond.</u> (uSiem.)				779.5	879	680
<u>Test No: A-5</u>		<u>C</u> mean	range (hi - lo)		<u>100</u> mean	range (hi - lo)	
<u>UV</u>	<u>pH</u>	7.96	8.36	7.56	7.14	7.54	6.74
	<u>D.O.</u> (mg/L)	6.305	8.12	4.49	6.76	13.02	4.5
	<u>Cond.</u> (uSiem.)	378	408	348	739.5	835	644
<u>RW</u>	<u>pH</u>				7.105	7.6	6.77
	<u>D.O.</u> (mg/L)				8.13	12.26	4
	<u>Cond.</u> (uSiem.)				787.5	832	643
<u>Test No: A-6</u>		<u>C</u> mean	range (hi - lo)		<u>100</u> mean	range (hi - lo)	
<u>UV</u>	<u>pH</u>	7.955	8.36	7.55	7.27	7.65	6.89
	<u>D.O.</u> (mg/L)	6.135	7.97	4.30	8.105	12.33	3.88
	<u>Cond.</u> (uSiem.)	328.5	408	249	685.5	814	517
<u>RW</u>	<u>pH</u>				7.105	7.46	6.75
	<u>D.O.</u> (mg/L)				7.835	11.64	4.03
	<u>Cond.</u> (uSiem.)				723	817	629
<u>Test No: A-7</u>		<u>C</u> mean	range (hi - lo)		<u>100</u> mean	range (hi - lo)	
<u>UV</u>	<u>pH</u>	7.895	8.36	7.43	7.215	7.63	6.8
	<u>D.O.</u> (mg/L)	6.61	8.12	5.10	8.5	12	5
	<u>Cond.</u> (uSiem.)	379.5	430	329	713	814	612
<u>RW</u>	<u>pH</u>				7.145	7.56	6.73
	<u>D.O.</u> (mg/L)				8.505	12.44	4.57
	<u>Cond.</u> (uSiem.)				784.5	797	612

		<u>C</u> mean	range (hi - lo)		<u>100</u> mean	range (hi - lo)	
<u>Test No: A-8</u>							
<u>UV</u>	<u>pH</u>	7.806	8.36	7.45	7.875	7.42	6.73
	<u>D.O.</u> (mg/L)	8.746	8.25	8.24	7.83	11.16	4.7
	<u>Cond.</u> (uSiem.)	388	420	316	722.5	804	673
<u>RW</u>	<u>pH</u>		7.06	7.42	6.68		
	<u>D.O.</u> (mg/L)		7.78	11.04	4.48		
	<u>Cond.</u> (uSiem.)		786	834	676		
<u>Test No: A-9</u>							
<u>UV</u>	<u>pH</u>	7.87	8.36	7.58	7.12	7.48	6.76
	<u>D.O.</u> (mg/L)	8.88	7.97	5.21	7.406	10.59	4.22
	<u>Cond.</u> (uSiem.)	288.5	397	336	813.5	882	785
<u>RW</u>	<u>pH</u>		7.605	8.28	6.73		
	<u>D.O.</u> (mg/L)		8.88	8.76	3.96		
	<u>Cond.</u> (uSiem.)		912.5	854	771		
<u>Test No: A-10</u>							
<u>UV</u>	<u>pH</u>	8.066	8.36	7.75	7.1	7.49	6.71
	<u>D.O.</u> (mg/L)	7.276	8.92	5.63	6.48	7.8	5.18
	<u>Cond.</u> (uSiem.)	345.5	397	294	887	852	822
<u>RW</u>	<u>pH</u>		6.986	7.42	6.57		
	<u>D.O.</u> (mg/L)		6.986	8.56	5.15		
	<u>Cond.</u> (uSiem.)		737.5	885	610		
<u>Test No: B-1</u>							
<u>UV</u>	<u>pH</u>	7.91	8.44	7.38	7.76	8.18	7.32
	<u>D.O.</u> (mg/L)	7.115	8.85	5.38	7.01	9.05	4.97
	<u>Cond.</u> (uSiem.)	418	480	342	828	1093	789
<u>S/DCI</u>	<u>pH</u>		7.66	8.08	7.22		
	<u>D.O.</u> (mg/L)		8.91	8.28	4.66		
	<u>Cond.</u> (uSiem.)		937	1002	872		
<u>RW</u>	<u>pH</u>		7.66	7.83	7.25		
	<u>D.O.</u> (mg/L)		8.7	8.2	3.8		
	<u>Cond.</u> (uSiem.)		949	1021	877		

<u>Test No: B-2</u>		<u>C</u>	mean	range (hi - lo)	<u>100</u>	mean	range (hi - lo)	
		pH			D.O.	(mg/L)	Cond.	(uSiem.)
<u>UV</u>	pH	8.125	8.6	7.65	7.705	8.11	7.3	
	D.O.	6.745	8.49	5.00	6.415	8.09	3.74	
	Cond.	(uSiem.)	378.5	409	350	908.5	857	844
<u>RW</u>	pH				7.8	8.07	7.13	
	D.O.	(mg/L)			6.58	8.94	4.18	
	Cond.	(uSiem.)			948	984	912	
<u>Test No: B-3</u>		<u>C</u>	mean	range (hi - lo)	<u>100</u>	mean	range (hi - lo)	
	UV	pH	8.07	8.56	7.58	7.88	8.05	7.27
<u>UV</u>	D.O.	(mg/L)	6.86	8.57	6.25	6.46	8.81	4.11
	Cond.	(uSiem.)	327	384	270	1247	1549	945
	<u>Cl/DCI</u>	pH			7.77	8.1	7.44	
<u>RW</u>	D.O.	(mg/L)			7.22	8.36	5.08	
	Cond.	(uSiem.)			1173	1375	971	
	<u>Cl/DCI</u>	pH			7.57	8	7.14	
<u>RW</u>	D.O.	(mg/L)			5.515	7.83	3.2	
	Cond.	(uSiem.)			1126.5	1316	837	
<u>Test No: B-4</u>		<u>C</u>	mean	range (hi - lo)	<u>100</u>	mean	range (hi - lo)	
	UV	pH	7.99	8.43	7.55	7.705	8.09	7.32
<u>UV</u>	D.O.	(mg/L)	7.085	8.57	5.50	7.6	8.68	5.32
	Cond.	(uSiem.)	327	384	270	789.5	918	661
	<u>Cl/DCI</u>	pH			7.78	8.11	7.45	
<u>Cl/DCI</u>	D.O.	(mg/L)			7.185	8.48	4.85	
	Cond.	(uSiem.)			827	958	686	
	<u>RW</u>	pH			7.575	7.86	7.19	
<u>RW</u>	D.O.	(mg/L)			6.925	8.16	3.49	
	Cond.	(uSiem.)			791.5	822	681	

Test No: B-5		mean	range (hi - lo)		mean	range (hi - lo)		mean	range (hi - lo)		mean	range (hi - lo)		
UV		pH	8.115	8.4	7.83	8.03	8.33	7.83	7.985	8.07	7.72	7.985	7.90	7.34
	D.O.	(mg/L)	7.00	8.16	6.20	7.17	8.76	6.58	8.915	8.56	6.06	8.97	8.35	4.39
	Cond.	(uSiem.)	325.5	363	268	375	392	356	480.5	474	427	711.5	800	623
	Amm.	(mg/L N)	0.1	0.20	0.00				0.725	0.9	0.55	2.2	2.4	2
G/DCI	pH		8.075	8.34	7.81	8	8.14	7.86	7.78	8.06	7.8			
	D.O.	(mg/L)		7.075	8.7	6.45	7.225	8.7	8.76	7.935	8.94	6.33		
	Cond.	(uSiem.)		380.5	425	354	470.5	491	460	894.5	831	778		
	Amm.	(mg/L N)				0.8	0.8	0.4	1.95	2.3	1.6			
RW	pH		8.085	8.29	7.84	7.985	7.96	7.75	7.405	7.64	7.17			
	D.O.	(mg/L)		7.285	9.11	8.42	8.575	8.5	4.95	8.73	7.76	3.8		
	Cond.	(uSiem.)		370.5	400	341	405.5	470	332	768.5	801	730		
	Amm.	(mg/L N)				0.835	0.5	0.17	1.875	1.7	0.45			
Test No: B-6		<u>C</u>	mean	range (hi - lo)		<u>S₂₅</u>	mean	range (hi - lo)		<u>25</u>	mean	range (hi - lo)		
UV		pH	8.14	8.65	7.63	8.085	8.55	7.84	8.075	8.35	7.8	7.79	8.15	7.43
	D.O.	(mg/L)	7.02	8.67	6.37	7.17	8.45	6.89	7.185	8.84	6.67	7.38	8.41	5.35
	Cond.	(uSiem.)	370	393	347	412	444	380	483	513	473	972	913	831
	Amm.	(mg/L N)	0.115	0.23	0.00				1.05	1.2	0.8	4.8	5.5	3.5
G/DCI	pH			7.95	8.29	7.63	8	8.3	7.7	7.985	8.21	7.82		
	D.O.	(mg/L)			7.17	8.52	6.82	7.3	8.59	8.01	7.385	8.06	6.68	
	Cond.	(uSiem.)			380	434	364	634.5	680	481	918.5	958	881	
	Amm.	(mg/L N)					1.35	1.5	1	4.3	5.4	3.2		
RW	pH		8.08	8.45	7.67	7.975	8.14	7.81	7.68	7.95	7.21			
	D.O.	(mg/L)			7.175	8.47	6.88	8.08	8.18	8.2	8.485	7.99	4.98	
	Cond.	(uSiem.)			387.5	409	368	491.5	494	469	982	935	829	
	Amm.	(mg/L N)					0.85	0.7	1	3.3	3.1	3.6		
Test No: C-1		<u>C</u>	mean	range (hi - lo)		<u>S₂₅</u>	mean	range (hi - lo)		<u>25</u>	mean	range (hi - lo)		
UV		pH	8.06	8.37	7.73	8.015	8.3	7.73	7.94	8.01	7.67	7.915	8.13	7.1
	D.O.	(mg/L)	8.085	7.76	4.43	8.805	7.4	4.21	8.075	7.47	4.68	8.88	7.92	8.2
	Cond.	(uSiem.)	362	378	346	417.5	436	389	498	505	403	1167	1222	1112
	Amm.	(mg/L N)	0.2	0.40	0.00				1.3	1.4	1.2	6.8	7.5	3.5
	Hard.	(mg/L CaCO ₃)	180					920		920				
G/DCI	pH			8.03	8.31	7.75	7.975	8.17	7.78	7.82	8	7.24		
	D.O.	(mg/L)				8.83	7.23	4.33	8.285	7.59	4.4	8.265	8.27	4.82
	Cond.	(uSiem.)				428.5	462	399	691.5	628	636	1288	1282	1174
	Amm.	(mg/L N)						1.3	1.5	1	6.78	7.5	4	
	Hard.	(mg/L CaCO ₃)					180		180					
RW	pH		7.985	8.26	7.73	7.985	8.05	7.88	7.47	7.97	8.07			
	D.O.	(mg/L)	8.085	7.45	3.94	8.885	7.51	4.28	8.19	7.89	2.7			
	Cond.	(uSiem.)	410	462	378	698.5	693	630	1163.5	1184	1103			
	Amm.	(mg/L N)					0.81	1.2	0.42	3.15	4	2.3		
	Hard.	(mg/L CaCO ₃)					180		240					

Test No: C-4

		C		100		range (hi - lo)	
		mean	range (hi - lo)	mean	range (hi - lo)		
<u>UV</u>	<u>pH</u>	7.82	8.42	7.22	7.83	8.25	7.41
	<u>D.O.</u> (mg/L)	7.045	8.58	5.51	6.06	8.18	3.82
	<u>Cond.</u> (uSiem.)	379	401	357	1177.5	1221	1134
	<u>Amm.</u> (mg/L N)	0.26	0.40	0.12	0.16	7.3	5
	<u>Hard.</u> (mg/L CaCO ₄)	160					

CI/DCI

<u>CI/DCI</u>	<u>pH</u>	7.825	8.23	7.42		
	<u>D.O.</u> (mg/L)	6.868	8.26	5.45		
	<u>Cond.</u> (uSiem.)	1249.5	1306	1183		
	<u>Amm.</u> (mg/L N)	6.1	7.2	5		
	<u>Hard.</u> (mg/L CaCO ₄)					

RW

<u>RW</u>	<u>pH</u>	7.876	8.12	7.23		
	<u>D.O.</u> (mg/L)	5.896	7.72	4.07		
	<u>Cond.</u> (uSiem.)	1224.5	1282	1157		
	<u>Amm.</u> (mg/L N)	6.2	7.4	5		
	<u>Hard.</u> (mg/L CaCO ₄)	200				

Test No: C-5

		C		100		range (hi - lo)	
		mean	range (hi - lo)	mean	range (hi - lo)		
<u>UV</u>	<u>pH</u>	7.82	8.42	7.22	7.73	8.11	7.35
	<u>D.O.</u> (mg/L)	7.045	8.58	5.51	6.18	7.89	4.47
	<u>Cond.</u> (uSiem.)	379	401	357	1127.5	1170	1085
	<u>Amm.</u> (mg/L N)	0.26	0.40	0.12	0	8.5	8.5
	<u>Hard.</u> (mg/L CaCO ₄)	160					

CI/DCI

<u>CI/DCI</u>	<u>pH</u>	7.795	8.23	7.36		
	<u>D.O.</u> (mg/L)	6.41	8.12	4.7		
	<u>Cond.</u> (uSiem.)	1214	1260	1168		
	<u>Amm.</u> (mg/L N)	9.5	10	9		
	<u>Hard.</u> (mg/L CaCO ₄)					

RW

<u>RW</u>	<u>pH</u>	7.71	8.12	7.3		
	<u>D.O.</u> (mg/L)	8.7	7.83	3.57		
	<u>Cond.</u> (uSiem.)	1175	1236	1114		
	<u>Amm.</u> (mg/L N)	9.25	10	8.7		
	<u>Hard.</u> (mg/L CaCO ₄)	200				

Test No: C-6

		mean		range (hi - lo)		mean		range (hi - lo)	
		pH	8.105	8.4	7.81	7.99	8.18	7.8	
	<u>D.O.</u> (mg/L)	7.945	8.58	5.51	8.66	8.04	5.28		
	<u>Cond.</u> (uSiem.)	412.6	467	358	1063	1134	882		
	<u>Amm.</u> (mg/L N)	0.515	0.53	0.50	10	10	10		
	<u>Hard.</u> (mg/L CaCO ₄)	160							

CWDCIRWTest No: C-7

		C mean		range (hi - lo)		100 mean		range (hi - lo)	
		pH	8.105	8.4	7.81	7.865	8.18	7.53	
	<u>D.O.</u> (mg/L)	7.945	8.58	5.51	8.22	8.1	4.34		
	<u>Cond.</u> (uSiem.)	412.6	467	358	1112.6	1157	1088		
	<u>Amm.</u> (mg/L N)	0.515	0.53	0.50	8.25	8.5	6		
	<u>Hard.</u> (mg/L CaCO ₄)	160							

		pH		range (hi - lo)		7.86		8.18		7.54	
		D.O.	(mg/L)	8.005	8.12	5.19					
	<u>Cond.</u> (uSiem.)			1226	1306	1146					
	<u>Amm.</u> (mg/L N)			6	6	6					
	<u>Hard.</u> (mg/L CaCO ₄)										

		pH		range (hi - lo)		7.87		8.49		7.45	
		D.O.	(mg/L)	8.005	8.16	3.85					
	<u>Cond.</u> (uSiem.)			1168.5	1251	1082					
	<u>Amm.</u> (mg/L N)			5.5	5.5	5.5					
	<u>Hard.</u> (mg/L CaCO ₄)			200							

<u>Test No: C-8</u>		<u>mean</u>	<u>range (hi - lo)</u>		<u>mean</u>	<u>range (hi - lo)</u>		
<u>UV</u>	<u>pH</u>	8.106	8.4	7.81	7.865	8.13	7.58	
	<u>D.O.</u> (mg/L)	6.81	8.54	4.68	6.035	8.07	4	
	<u>Cond.</u> (uSiem.)	406	453	357	1140	1192	1088	
	<u>Amm.</u> (mg/L N)	0.28	0.33	0.23	3	3	3	
	<u>Hard.</u> (mg/L CaCO ₄)	140						
	<u>pH</u>				7.925	8.24	7.61	
<u>CV/DCI</u>	<u>D.O.</u> (mg/L)				6.25	8.25	4.25	
	<u>Cond.</u> (uSiem.)				1224	1293	1155	
	<u>Amm.</u> (mg/L N)				3.35	3.4	3.3	
	<u>Hard.</u> (mg/L CaCO ₄)							
	<u>pH</u>				7.78	8.15	7.37	
	<u>D.O.</u> (mg/L)				6.906	7.55	4.26	
<u>RW</u>	<u>Cond.</u> (uSiem.)				1148	1242	1054	
	<u>Amm.</u> (mg/L N)				3.2	3.2	3.2	
	<u>Hard.</u> (mg/L CaCO ₄)				220			
	<u>pH</u>							
	<u>C</u>	<u>mean</u>	<u>range (hi - lo)</u>		<u>100</u>	<u>mean</u>	<u>range (hi - lo)</u>	
	<u>pH</u>	8.106	8.4	7.81	7.89	8.24	7.54	
<u>UV</u>	<u>D.O.</u> (mg/L)	6.81	8.54	4.68	6.276	8.17	4.38	
	<u>Cond.</u> (uSiem.)	406	453	357	1140	1179	1101	
	<u>Amm.</u> (mg/L N)	0.28	0.33	0.23	4	4	4	
	<u>Hard.</u> (mg/L CaCO ₄)	140						
	<u>pH</u>				7.845	8.15	7.54	
	<u>D.O.</u> (mg/L)				6.066	8.11	4.02	
<u>CV/DCI</u>	<u>Cond.</u> (uSiem.)				1230	1286	1174	
	<u>Amm.</u> (mg/L N)				3.8	3.8	3.8	
	<u>Hard.</u> (mg/L CaCO ₄)							
	<u>pH</u>							
	<u>D.O.</u> (mg/L)				7.435	7.91	7.36	
	<u>Cond.</u> (uSiem.)				6.96	8.08	3.84	
<u>RW</u>	<u>Amm.</u> (mg/L N)				1147	1194	1100	
	<u>Hard.</u> (mg/L CaCO ₄)				3.45	3.8	3.1	
	<u>pH</u>				220			

Appendix D

Water Quality Data

Inorganic Chemistry

Plant A
Chemical Data

Date	Sample	CBOD-5	TSS	Total Solids	TDS	Nitrite	Nitrate + Nitrite	Amonium	P(PO4)	TKN	Total Phosphorus	DOC	Dissolved Si (SiO2)							
		(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	IC (mg/L)	(mg/L)						
23-Oct-98	A-1-UV	3.2	9	490	480	0.42	18.4	0.25	0.44	0.85	0.74	4.6	22.4	3.94						
	A-1-CL	2.4	7	510	502	0.245	18.7	0.25	0.48	1.1	0.86	4.7	21.2	3.92						
	A-1-RW	3.4	8.5	504	498	0.47	18.4	0.15	0.44	0.85	0.78	4.3	22.2	3.9						
08-Nov-98	A-2-UV	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a						
	A-2-CL	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a						
	A-2-RW	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a						
21-Nov-98	A-3-UV	2	14	516	502	0.51	23.9	0.45	0.24	1.95	0.8	5	8.4	3.94						
	A-3-CL	2.4	12	542	532	0.23	24.1	0.5	0.22	1.8	0.74	4.9	8	3.94						
	A-3-RW	n/a	18.5	520	504	0.28	24.5	0.2	0.24	2.15	0.8	4.5	7.8	3.98						
Date	Sample	Al	Ba	Be	Cd	Co	Cr	Cu	Fe	Pb	Mg	Mn	Mo	Ni	Ag	Sr	Tl	Va	Zn	Ca
		(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
23-Oct-98	A-1-UV	0.42	0.01	< 0.001	< 0.001	< 0.001	< 0.001	0.08	0.94	< 0.005	11.6	0.015	< 0.005	< 0.002	< 0.001	0.19	< 0.001	< 0.001	0.018	58.6
	A-1-CL	0.4	0.01	< 0.001	< 0.001	< 0.001	< 0.001	0.04	0.77	< 0.005	11.5	0.015	< 0.005	< 0.002	< 0.001	0.13	< 0.001	< 0.001	0.015	58.6
	A-1-RW	0.4	0.01	< 0.001	< 0.001	< 0.001	< 0.001	0.055	0.63	< 0.005	11.3	0.01	< 0.005	< 0.002	< 0.001	0.125	< 0.001	< 0.001	0.015	58.6
08-Nov-98	A-2-UV	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	A-2-CL	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	A-2-RW	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
21-Nov-98	A-3-UV	0.83	0.011	< 0.001	< 0.001	< 0.001	0.002	0.018	0.034	< 0.005	10.7	0.022	< 0.001	< 0.002	0.002	0.12	< 0.001	< 0.001	0.024	63.1
	A-3-CL	0.815	0.012	< 0.001	< 0.001	< 0.001	< 0.001	0.017	0.057	< 0.005	10.8	0.023	< 0.001	< 0.002	< 0.001	0.121	< 0.001	< 0.001	0.025	53.6
	A-3-RW	0.835	0.013	< 0.001	< 0.001	< 0.001	< 0.001	0.019	0.067	< 0.005	10.8	0.022	< 0.001	< 0.002	< 0.001	0.119	< 0.001	< 0.001	0.024	52.4

Plant B
Chemical Data

Date	Sample	CBOD-5 (mg/L)	TSS (mg/L)	Total Solids (mg/L)	TDS (mg/L)	Nitrite (mg/L)	Nitrate + Nitrite (mg/L)	Ammonium (mg/L)	P(PO4) (mg/L)	TKN (mg/L)	Total Phosphorus (mg/L)	DOC (mg/L)	Dissolve IC (mg/L)	Si (SiO2) (mg/L)
08-Jan-97	B-1-UV	n/a	14	482	468	1.81	5.3	7.3	0.08	0.55	0.42	3.9	53	3.48
	B-1-CL	n/a	8.5	530	524	1.48	5.15	6.5	0.12	0.25	0.38	4.1	52.4	3.48
	B-1-RW	n/a	9.5	480	470	6	5.55	6	0.04	8	0.56	< 0.1	< 0.02	< 0.02
17-Jan-97	B-2-UV	n/a	8	472	464	3.13	4.4	7.7	0.04	0.25	0.3	n/a	n/a	n/a
	B-2-CL	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	B-2-RW	n/a	10	464	454	4.53	5.55	6.15	0.04	7.5	0.26	n/a	n/a	n/a
22-Jan-97	B-3-UV	n/a	11	646	636	5.35	8.65	2.55	0.16	n/a	0.5	3.7	40.2	3
	B-3-CL	n/a	8	648	654	5.05	5.7	5.15	0.18	0.53	0.46	3.9	42.4	3.04
	B-3-RW	n/a	10	630	620	7.8	9	0.75	0.12	0.95	0.42	3.6	39.4	3.02
24-Jan-97	B-4-UV	n/a	7	468	460	3.1	9.8	0.15	0.18	1	0.56	3.8	41.2	3.3
	B-4-CL	n/a	9.5	502	492	7.2	9.7	0.05	0.2	0.7	0.42	3.7	41.2	3.22
	B-4-RW	n/a	8	474	464	2.5	9.55	0.05	0.16	0.95	0.4	3.5	41.6	3.2
05-Feb-97	B-5-UV	n/a	5	426	420	6	7.45	1.6	0.38	2.35	0.62	3.8	38.8	2.74
	B-5-CL	n/a	5	456	452	4.8	6.9	1.8	0.36	2.9	0.68	3.8	36.6	2.74
	B-5-RW	n/a	6.5	428	420	5.35	7.9	0.5	0.32	1.3	0.66	3.5	35.2	2.72
14-Feb-97	B-6-UV	n/a	4	480	458	3.75	8.75	4.55	0.52	5.15	0.8	4.8	40	3
	B-6-CL	n/a	5	480	478	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	B-6-RW	n/a	4.5	462	458	0.12	10.5	2.65	0.52	3.55	0.7	5.1	39	3

Plant B
Chemical Data

Date	Sample	Al (mg/L)	Ba (mg/L)	Be (mg/L)	Cd (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Po (mg/L)	Pb (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	Ni (mg/L)	Ag (mg/L)	Sr (mg/L)	Tl (mg/L)	Va (mg/L)	Zn (mg/L)	Ca (mg/L)	
08-Jan-97	B-1-UV	0.28	0.019	< 0.001	< 0.001	0.002	0.004	0.015	0.087	0.01	11.7	0.01	< 0.001	< 0.002	0.002	0.148	< 0.001	< 0.001	0.028	72.1	
	B-1-CL	0.235	0.019	< 0.001	< 0.001	< 0.001	< 0.001	0.013	0.021	< 0.005	11.6	0.007	0.002	< 0.002	< 0.001	0.147	< 0.001	< 0.001	0.023	71.7	
	B-1-RW	0.2	0.018	< 0.001	< 0.001	< 0.001	< 0.001	0.013	< 0.001	< 0.005	11.9	< 0.007	< 0.001	< 0.002	< 0.001	0.15	< 0.001	< 0.001	0.021	73.4	
17-Jan-97	B-2-UV	n/a																			
	B-2-CL	n/a																			
	B-2-RW	n/a																			
22-Jan-97	B-3-UV	0.415	0.018	< 0.001	< 0.001	0.003	< 0.001	0.034	0.033	< 0.005	10.7	0.016	< 0.001	< 0.002	0.002	0.148	< 0.001	< 0.001	0.027	64.8	
	B-3-CL	0.525	0.019	< 0.001	< 0.001	0.002	< 0.001	0.017	0.026	< 0.005	11	0.015	0.002	< 0.002	0.002	0.151	< 0.001	< 0.001	0.025	68.2	
	B-3-RW	0.435	0.018	< 0.001	< 0.001	0.002	< 0.001	0.015	0.026	< 0.005	10.9	0.014	< 0.001	< 0.002	0.002	0.149	< 0.001	< 0.001	0.026	65.3	
24-Jan-97	B-4-UV	0.255	0.017	< 0.001	< 0.001	< 0.001	< 0.001	0.011	0.009	< 0.005	12	0.008	< 0.001	< 0.002	0.002	0.188	< 0.001	< 0.001	0.019	73.8	
	B-4-CL	0.245	0.017	< 0.001	< 0.001	< 0.001	< 0.001	0.002	0.015	0.018	< 0.005	12	0.008	< 0.001	< 0.002	< 0.001	0.157	< 0.001	< 0.001	0.021	74.2
	B-4-RW	0.285	0.017	< 0.001	< 0.001	< 0.001	< 0.001	0.013	0.014	< 0.005	11.7	0.007	< 0.001	< 0.002	0.002	0.152	< 0.001	< 0.001	0.019	72.4	
05-Feb-97	B-5-UV	0.155	0.012	< 0.001	< 0.001	0.003	< 0.001	0.013	0.01	< 0.005	10	0.01	0.002	< 0.002	< 0.001	0.13	< 0.001	< 0.001	0.015	62.2	
	B-5-CL	0.25	0.012	< 0.001	< 0.001	< 0.001	< 0.001	0.016	0.016	< 0.005	10.1	0.01	0.002	< 0.002	< 0.001	0.131	< 0.001	< 0.001	0.016	62.4	
	B-5-RW	0.245	0.014	< 0.001	< 0.001	< 0.001	< 0.001	0.016	0.103	< 0.005	10.7	0.011	0.004	< 0.002	< 0.001	0.138	< 0.001	< 0.001	0.019	65.9	
14-Feb-97	B-6-UV	0.12	0.013	< 0.001	< 0.001	< 0.001	0.002	0.017	0.021	< 0.005	10.9	0.008	< 0.001	< 0.002	< 0.001	0.13	< 0.001	< 0.001	0.03	61.4	
	B-6-CL	n/a																			
	B-6-RW	0.13	0.012	< 0.001	< 0.001	< 0.001	< 0.001	0.014	0.045	< 0.005	11.1	0.008	< 0.001	< 0.002	< 0.001	0.128	< 0.001	< 0.001	0.033	62.6	

Plant C

Chemical Data

Date	Sample	CBOD-6 (mg/L)	TSS (mg/L)	Total Solids (mg/L)	TDS (mg/L)	Nitrite (mg/L)	Nitrate + Nitrite (mg/L)	Ammonium (mg/L)	P(PO4) (mg/L)	TKN (mg/L)	Total Phosphorus (mg/L)	DOC (mg/L)	Dissolved IC (mg/L)	Si (SiO2) (mg/L)
19-Mar-07	C-1-UV	4.0	9.5	668	648	0.38	7.45	5.1	0.12	6.3	0.28	8.4	34.2	2.78
	C-1-CL	3.6	7	700	698	0.135	7.75	4.8	0.12	6.15	0.28	8.7	33.8	2.8
	C-1-RW	5.4	11	650	640	0.635	9	3.75	0.12	4.55	0.32	4.8	34.8	2.62
02-Apr-07	C-2-UV	4.6	9.5	658	648	0.19	1.7	4.45	0.44	5.6	0.72	6.2	48.6	3.08
	C-2-CL	5.2	10	732	724	0.04	1.5	1.8	0.6	6.35	0.78	7	49.6	3.1
	C-2-RW	8	6.5	694	688	0.29	1.8	4.55	0.4	4.05	0.64	5.2	45.4	3.04
25-Apr-07	C-3-UV	3.2	9	668	658	0.165	0.7	4.25	0.52	6.75	0.8	n/a	n/a	n/a
	C-3-CL	2.8	10	642	632	0.21	0.75	4.55	0.5	6.85	0.84	8.3	49.6	2.82
	C-3-RW	4.6	9	634	626	0.455	0.95	4.3	0.48	6.75	0.76	7.3	50.6	2.8
26-Apr-07	C-4-UV	4.8	12	624	612	0.165	0.75	5.35	0.78	7.85	1.14	7.5	50.2	2.84
	C-4-CL	2	12.5	680	648	0.14	0.75	5.15	0.78	8	1.2	7.8	49.4	3
	C-4-RW	4.4	7	626	620	0.205	0.9	5.2	0.68	7.65	1.02	6.9	50.4	2.86
27-Apr-07	C-5-UV	5	31.5	588	564	0.635	3.35	7.55	0.4	12.1	1.16	6.6	44	2.62
	C-5-CL	1.6	9	614	604	0.79	2.25	9.35	0.24	12	0.5	6.6	46.6	2.78
	C-5-RW	6.2	5	588	562	0.935	2.3	9.5	0.2	12	0.38	6.1	48.6	2.78
28-Apr-07	C-6-UV	3.2	13	626	616	0.9	4.95	0.75	0.38	9.55	0.68	5.8	40.2	2.88
	C-6-CL	3	18	572	554	0.27	3.8	10.5	0.48	11.6	0.82	6	43.8	2.7
	C-6-RW	3.2	4.5	534	530	2.04	5.5	8.75	0.3	7.65	0.44	5	38.4	2.84
29-Apr-07	C-7-UV	4.2	12	680	668	0.285	0.95	6.4	0.8	7.65	1.2	6.2	48.4	2.78
	C-7-CL	3.4	13.5	608	598	0.165	0.75	6.35	0.64	6.4	1.2	6.7	48.6	2.84
	C-7-RW	4.6	8	588	580	1.23	2.4	4.85	0.78	3.95	0.88	5.4	45.6	2.8
30-Apr-07	C-8-UV	18.2	24	608	584	0.48	0.9	3.5	0.52	5.25	1.16	6.5	48.2	2.78
	C-8-CL	4.2	12	638	624	0.11	0.4	3.7	0.48	5.6	0.72	6.5	46.6	2.82
	C-8-RW	12.8	6.5	600	592	0.85	1.05	3.25	0.4	3.25	0.58	5.5	48	2.78
01-May-07	C-9-UV	17.9	12.5	604	592	0.19	0.45	4.45	0.6	6	0.88	6.6	47.4	2.62
	C-9-CL	6.4	13	648	634	0.105	0.38	4.25	0.6	6.2	0.92	6.6	46.6	2.62
	C-9-RW	14.2	9.5	610	600	0.89	1.55	n/a	0.58	n/a	0.88	6.6	48.6	2.62

Plant C

Chemical Data

Date	Sample	Al	Ba	Be	Cd	Co	Cr	Cu	Fe	Pb	Mg	Mn	Mo	Ni	Ag	Sr	Tl	Va	Zn	Ca
		(mg/L)																		
19-Mar-87	C-1-UV	0.05	0.093	<0.001	<0.001	0.002	0.002	0.024	0.688	<0.005	12.8	0.051	0.004	<0.002	0.002	0.231	<0.001	<0.001	0.038	69.9
	C-1-CL	0.045	0.087	<0.001	<0.001	<0.001	<0.001	0.017	0.673	<0.005	13.2	0.052	0.005	<0.002	<0.001	0.238	<0.001	<0.001	0.032	61.7
	C-1-RW	0.075	0.098	<0.001	<0.001	<0.001	<0.001	0.012	1.22	<0.005	13.2	0.06	0.004	<0.002	<0.001	0.238	<0.001	<0.001	0.032	61.6
02-Apr-87	C-2-UV	<0.005	0.128	<0.001	<0.001	<0.001	<0.001	0.024	0.714	0.015	14.1	0.055	0.012	<0.002	0.003	0.257	<0.001	<0.001	0.053	68.5
	C-2-CL	0.1	0.128	<0.001	<0.001	<0.001	0.002	0.019	0.787	<0.005	13.9	0.056	0.011	<0.002	<0.001	0.259	<0.001	<0.001	0.05	67.5
	C-2-RW	<0.005	0.121	<0.001	<0.001	<0.001	0.002	0.011	0.432	<0.005	13.7	0.053	0.011	<0.002	0.003	0.249	<0.001	<0.001	0.05	66.6
25-Apr-87	C-3-UV	0.045	0.093	<0.001	<0.001	<0.001	0.003	0.037	0.84	<0.005	12.5	0.061	0.022	<0.002	<0.001	0.229	<0.001	<0.001	0.053	57
	C-3-CL	0.06	0.093	<0.001	<0.001	0.002	0.003	0.03	0.771	<0.005	12.4	0.061	0.022	<0.002	0.002	0.229	<0.001	<0.001	0.051	57.3
	C-3-RW	0.015	0.087	<0.001	<0.001	0.004	0.003	0.009	0.697	<0.005	11.8	0.058	0.021	<0.002	<0.001	0.216	<0.001	<0.001	0.048	53.9
26-Apr-87	C-4-UV	0.07	0.161	<0.001	<0.001	0.002	0.004	0.03	1.42	0.01	12.4	0.06	0.023	0.008	0.002	0.234	<0.001	<0.001	0.059	68.5
	C-4-CL	0.085	0.161	<0.001	<0.001	0.002	0.004	0.017	1.43	<0.005	12.2	0.059	0.022	0.008	<0.001	0.23	<0.001	<0.001	0.055	55.4
	C-4-RW	0.025	0.158	<0.001	<0.001	0.002	0.004	0.009	0.875	<0.005	12.4	0.06	0.022	0.008	<0.001	0.233	<0.001	<0.001	0.049	56.4
27-Apr-87	C-5-UV	0.14	0.192	<0.001	0.002	0.002	0.008	0.071	3.5	0.015	12.3	0.067	0.01	<0.002	0.004	0.23	<0.001	0.002	0.068	65.2
	C-5-CL	0.14	0.179	<0.001	<0.001	<0.001	0.002	0.022	0.602	<0.005	12.1	0.052	0.01	<0.002	0.002	0.225	<0.001	<0.001	0.049	54.7
	C-5-RW	0.08	0.179	<0.001	<0.001	<0.001	<0.001	0.013	0.28	<0.005	12.2	0.053	0.01	<0.002	<0.001	0.227	<0.001	<0.001	0.044	55.2
28-Apr-87	C-6-UV	0.115	n/a	n/a	0.002	0.004	0.003	0.032	1.04	<0.005	n/a	0.049	0.01	<0.002	0.004	0.23	<0.001	0.002	0.068	65.2
	C-6-CL	0.1	n/a	n/a	<0.001	0.003	0.003	0.025	1.59	<0.005	n/a	0.055	0.008	<0.002	n/a	n/a	n/a	n/a	0.044	n/a
	C-6-RW	0.03	n/a	n/a	<0.001	0.002	<0.001	0.007	0.219	<0.005	n/a	0.04	0.008	<0.002	n/a	n/a	n/a	n/a	0.044	n/a
29-Apr-87	C-7-UV	0.088	n/a	n/a	<0.001	0.002	0.003	0.048	1.22	<0.005	n/a	0.061	0.014	<0.002	n/a	n/a	n/a	n/a	0.033	n/a
	C-7-CL	0.08	n/a	n/a	<0.001	0.002	0.002	0.027	1.2	<0.005	n/a	0.064	0.014	<0.002	n/a	n/a	n/a	n/a	0.051	n/a
	C-7-RW	0.045	n/a	n/a	<0.001	0.002	0.002	0.009	0.574	<0.005	n/a	0.058	0.015	<0.002	n/a	n/a	n/a	n/a	0.05	n/a
30-Apr-87	C-8-UV	0.09	n/a	n/a	<0.001	0.002	0.008	0.038	0.62	<0.005	n/a	0.072	0.022	<0.002	n/a	n/a	n/a	n/a	0.044	n/a
	C-8-CL	0.036	n/a	n/a	<0.001	0.002	0.003	0.017	1.26	<0.005	n/a	0.063	0.016	<0.002	n/a	n/a	n/a	n/a	0.051	n/a
	C-8-RW	0.03	n/a	n/a	<0.001	0.002	0.004	0.008	0.681	<0.005	n/a	0.061	0.016	<0.002	n/a	n/a	n/a	n/a	0.05	n/a
01-May-87	C-9-UV	0.085	n/a	n/a	0.003	0.004	0.005	0.01	0.89	0.01	n/a	0.061	0.015	<0.002	n/a	n/a	n/a	n/a	0.045	n/a
	C-9-CL	0.085	n/a	n/a	<0.001	0.002	0.004	0.015	1.08	<0.005	n/a	0.059	0.014	<0.002	n/a	n/a	n/a	n/a	0.044	n/a
	C-9-RW	0.055	n/a	n/a	<0.001	0.002	0.004	0.028	1.22	<0.005	n/a	0.059	0.013	<0.002	n/a	n/a	n/a	n/a	0.045	n/a

Appendix E

Bacterial Counts

Bacteria Results

Plant A

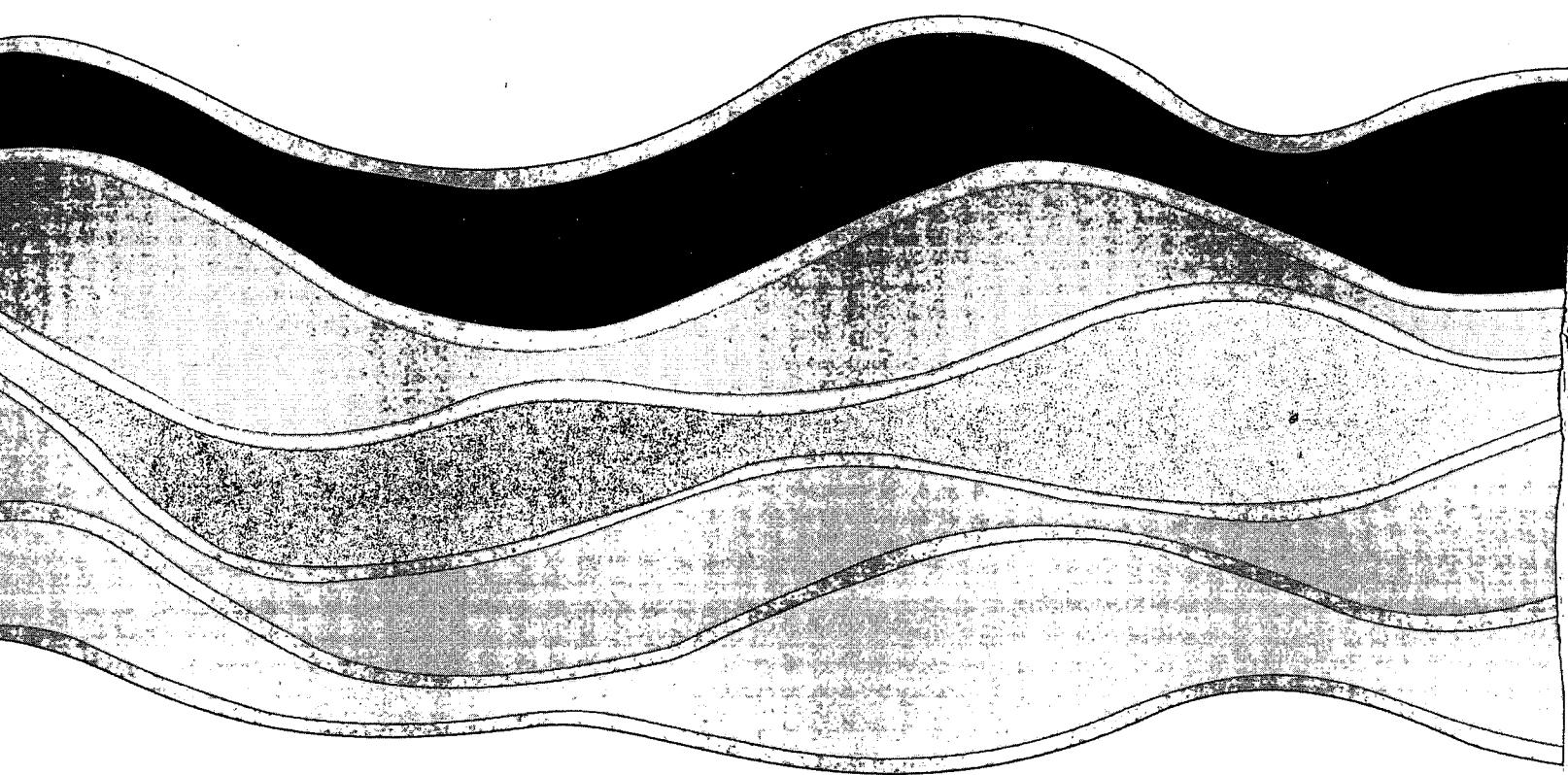
Date	Sample	F. coliform (#/100mL)	E.coli (#/100mL)
23-Oct-96	A-1-UV	n/a	n/a
	A-1-CL	n/a	n/a
	A-1-RW	n/a	n/a
06-Nov-96	A-2-UV	n/a	n/a
	A-2-CL	n/a	n/a
	A-2-RW	n/a	n/a
21-Nov-96	A-3-UV	n/a	4
	A-3-CL	n/a	10
	A-3-RW	n/a	4300

Plant B

Date	Sample	F. coliform (#/100mL)	E.coli (#/100mL)
08-Jan-97	B-1-UV	n/a	68
	B-1-CL	n/a	4
	B-1-RW	n/a	9700
17-Jan-97	B-2-UV	23	<2
	B-2-CL	<2	<2
	B-2-RW	33000	13000
22-Jan-97	B-3-UV	n/a	136
	B-3-CL	n/a	12
	B-3-RW	n/a	20000
24-Jan-97	B-4-UV	n/a	n/a
	B-4-CL	n/a	n/a
	B-4-RW	n/a	n/a
05-Feb-97	B-5-UV	n/a	28
	B-5-CL	n/a	4
	B-5-RW	n/a	12600
14-Feb-97	B-6-UV	1300	280
	B-6-CL	<2	<2
	B-6-RW	35000	35000

Plant C

Date	Sample	F. coliform (#/100mL)	E.coli (#/100mL)
19-Mar-97	C-1-UV	n/a	n/a
	C-1-CL	n/a	n/a
	C-1-RW	n/a	n/a
02-Apr-97	C-2-UV	n/a	4
	C-2-CL	n/a	4
	C-2-RW	n/a	18000
25-Apr-97	C-3-UV	13	<2
	C-3-CL	8	2
	C-3-RW	16000000	70000
26-Apr-97	C-4-UV	13	2
	C-4-CL	2	<2
	C-4-RW	330000	170000
27-Apr-97	C-5-UV	130	49
	C-5-CL	2	2
	C-5-RW	130000	14000
28-Apr-97	C-6-UV	49	<2
	C-6-CL	<2	<2
	C-6-RW	49000	49000
29-Apr-97	C-7-UV	23	<2
	C-7-CL	8	<2
	C-7-RW	220000	21000
30-Apr-97	C-8-UV	40	<2
	C-8-CL	13	<2
	C-8-RW	330000	33000
01-May-97	C-9-UV	8	8
	C-9-CL	11	8
	C-9-RW	490000	35000



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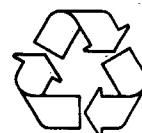


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