City of Winnipeg
Water and Waste Department

PHASE 2 Technical Memorandum for Red and Assiniboine Ammonia Criteria Study

Technical Memorandum # T1.0

Phase 2 Toxicity Workstream: Ammonia Toxicity-Testing Program in 1999 and 2000

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This Technical Memorandum (T.M.) is one of a series of T.M.s intended for internal discussion. It is not intended as a report representing policy or direction of the City of Winnipeg.

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LIST OF ACRYNOMS AND ABBREVIATIONS

ACRM	=	Aquatic Community Risk Model
ASTM	=	American Society for Testing and Materials
BOT	=	beginning of test
CAEAL	=	Canadian Association for Environmental Analytical Laboratories
CEC	=	Clean Environment Commission
CI	=	confidence interval
cm	=	centimetre
CoW	=	City of Winnipeg
DFO	=	Department of Fisheries and Oceans
D.O.	=	Dissolved Oxygen
E	=	treated effluent from the NEWPCC
EOT	=	end of test
ERC	=	Ecological Risk Criterion

g	=	gram
GPS	=	global positioning system
$HgCl_2$	=	mercuric chloride
ICP	=	inhibitory concentration percent estimate
ICPIN	=	inhibitory concentration percent estimate software program
L	=	Litre
mL	=	millilitre
mg	=	milligram
MSWQO	=	Manitoba Surface Water Quality Objectives
N	=	Nitrogen
NEWPCC	=	North End Water Pollution Control Centre
NH_3	=	unionized ammonia
NH_4^+	=	ionized ammonia
NH_3-N	=	total ammonia nitrogen
NH_4Cl	=	ammonium chloride
OECD	=	Organization for Economic Co-operation and Development
PSL-2	=	Priority Substance List - 2
RW	=	river water from the Red River
SCC	=	Standards Council of Canada
USEPA	=	United States Environmental Protection Agency
WAWW	=	whole animal wet weight
WERF	=	Water Environment Federation Research Foundation
WPCC	=	Water Pollution Control Centre

GLOSSARY

Acute-exposure – a brief exposure to a stressor or the effects associated with such an exposure. It can refer to an instantaneous exposure (i.e., oral gauge) or continuous exposures, from minutes to a few days, depending on the life span of the organism[a]. For the present study, acute-exposure refers to a test-duration that is ≤96 hrs.

Ammonium chloride – NH_4Cl; white granular powder with a moleculer weight of 53.49 μ (reagent grade) was used in the present study as an ammonia (NH_3) source, when dissolved in de-ionized water.

Bioassay – a test used to evaluate the relative potency of a chemical by comparing its effect on living organisms with the effect of a control[a].

Control – a treatment in a toxicity test or in a field study that duplicates all the conditions of the exposure treatments or test sites except that the control contains no test substance this determine the absence of toxicity under basic test conditions[a].

Chronic-exposure – involving a stimulus that is lingering or continuous over a long period of time[a]. For the present study, chronic-exposure refers to a test duration >96 hours.

Endpoint – a biological response that can be measured and expressed quantitatively (e.g., endpoint growth expressed as a net change in length of a test organism).

Flow through system – an exposure system for aquatic toxicity tests in which control water and test solution flow into and out of test chambers continuously[a].

Fry - very young or newly hatched fishes.

EC_X – Effective Concentration. The concentration of a stressor that is estimated to be effective in producing a biological response, other than mortality, in *x*% of organisms over a specific time interval (e.g., 96-hr EC_{20}).

ICPIN – a computer-based statistical program whereby LC_xs or EC_xs are calculated using the linear interpolation method.

In situ - in its place; in its natural setting (i.e., not under laboratory conditions).

Juvenile fish – young fish that have not reached sexual maturity.

LC_x – Lethal Concentration (median). The concentration of a stressor that is estimated to be lethal to *x*% of the test organisms over a specific time interval (e.g., 96-hr LC_{50}).

Semi-static system – an exposure system for aquatic toxicity tests in which test chamber solutions are renewed daily[a].

Serial dilutions – a procedure whereby the highest concentration of a test solution is diluted by equal amounts to form a series of progressively more dilute concentrations of the test solution.

Static system – an exposure system for aquatic toxicity tests in which test chambers contain solutions of the test material or control water that are not changed during the test. Depending upon conditions, a static system may or may not be in equilibrium[a].

Sublethal – below the level that causes death[a].

Toxic – causing or having the potential to cause adverse effects to organisms or populations[a].

Toxicity – the inherent potential or capacity of a material to cause adverse effects in a living organism[a].

[a] Definition obtained from CCME 1999

1. INTRODUCTION

The City of Winnipeg is undertaking a comprehensive assessment of the basis for regulating ammonia in the Winnipeg reaches of the Red and Assiniboine rivers to help determine the need, costs, impacts and benefits of controlling ammonia in effluent from its Water Pollution Control Centres (WPCCs). The study includes 13 integrated workstreams.

The “Toxicity-testing” workstream is a key component of the Ammonia-Criteria Study designed to establish the toxicity of ammonia in representative indigenous cool-water species. Toxicity test results will be used to “calibrate” and build the existing (i.e., public-domain) ammonia-toxicity dataset on which current regulatory guidelines are based. The results are also expected to greatly assist in the definition of locally-appropriate ammonia objectives for protection of aquatic biota in the study area rivers.

1.1 AMMONIA TOXICITY

A detailed overview of ammonia toxicology is provided by the United States Environmental Protection Agency (USEPA 1998) in the 1998 update of ambient water-quality criteria for ammonia. Briefly, the toxicity of ammonia to aquatic organisms has been primarily attributed to the unionized form of ammonia (i.e., NH_3) which exists in equilibrium in aqueous ammonia solutions with the ammonium ion and hydroxide ion (c.f. Emerson *et al*. 1975). The concentration of ammonia in the unionized form (hereafter, “NH_3”) is primarily influenced by pH and temperature, with the unionized fraction increasing in concentration with increasing pH and temperature. However, when expressed in terms of unionized ammonia, a given concentration of ammonia is generally more toxic at lower temperatures (e.g., 5°C) than higher temperatures (e.g., 25°C). Mechanisms for toxicity in organisms continue to be elucidated.

Ammonia is present naturally in low levels in aquatic systems, most commonly as a result of fish excretions and bacterial decomposition of organic matter such as algae. Other sources of ammonia in the Red and Assiniboine rivers include upstream agricultural runoff and some discharges from certain upstream industrial activities. Within the City of Winnipeg, treated effluent from the City’s three WPCCs also contributes to ammonia in these rivers at levels that occasionally exceed Manitoba Surface Water Quality Objectives (MSWQO) (Wardrop/Tetr*ES* 1991). There has been no evidence to indicate that these levels are harmful to aquatic life (Wardrop/Tetr*ES* 1991). However, prior to this study, the specific effects of ammonia on selected species of aquatic life in either the Red or Assiniboine rivers had not undergone comprehensive examination.

This is the first study to create and provide data on the ammonia sensitivity of:

- northern pike;
- mid-Canadian genetic strains of walleye, fathead minnow (a standard test matrix), lake whitefish, lake trout, white sucker, floater mussel, and fingernail clam; and
- Ontario genetic strains of walleye and *Ceriodaphnia dubia*.

This is only the second public report of ammonia sensitivity using local river water instead of "laboratory water" (CDM 1997). The previous study at Moorehead, Minnesota, tested only fathead minnows using Red River water as dilution water.

1.2 TOXICITY AND RISK ASSESSMENT OF CHEMICAL MIXTURES

1.2.1 Theoretical Considerations

Multichemical exposure in receiving environments, especially in such 'sinks' as public waterways, is the rule rather than an exception. Chemical mixtures in the environment can be and generally are complex, consisting of parent compounds, reaction or transformation products along with other residues and potentially inert materials. Exposure of biota to combinations of pollutants may sometimes result in unexpected consequences, i.e., significantly lower or greater toxic response than a simple summation of the response induced by the mixture components taken individually. Such effects, the consequence of a phenomenon termed as toxicological interactions, may be beneficial (one chemical affording protection against the toxic effects of another) or hazardous (one chemical increasing the toxicity of the other) (Canadian Toxicity Information Network 1998).

The toxicological interactions are frequently described using terms like antagonism, potentiation and synergism. Antagonism results when one component of the mixture interferes with another in such a way that the total toxic response is less than the sum of the individual responses. The protection against mercury toxicity afforded by selenium is a typical example of this category. Potentiation of responses occurs when substances of negligible toxicity enhance the response of other toxic substances. A classical example of this category of combined responses is the ketone-haloalkane interaction. Synergistic responses occur when all substances in the mixture induce toxicity but their combined response is greater than the sum of the response of the component parts of the mixture. Enhanced toxicity observed during combined exposure to haloacetic acids and haloalkanes is an example of this category (Canadian Toxicity Information Network 1998).

A realistic approach to the assessment of risk associated with exposure to toxicants should consider the consequences of combined exposures to them as well; because such exposures - simultaneous or sequential - may produce effects quantitatively and/or qualitatively different from the expected additive responses. Therefore, the identification of the occurrence of toxic interactions among pollutants is logically an important aspect of the overall process of mixture risk assessment. The "quantitative" consideration of interactions in mixture risk assessment, however, continues to represent a challenge to the scientific and regulatory communities (Canadian Toxicity Information Network 1998).

1.2.2 Approach in This Study

In the present study, the potential interactions of ammonia with other effluent constituents were considered in developing a program to adequately assess ammonia toxicity from WPCC discharges to the Red and Assiniboine Rivers. The approach used included direct comparisons between toxicity data generated from side-by-side and simultaneous laboratory tests using one of two treatments: (a) serial dilutions of ammonia-spiked river water and (b) serial dilutions of ammonia spiked effluent. By keeping all other variables constant, it was intended that the toxic effects of ammonia as the sole toxicant be isolated from those observed in complex ammonia-containing effluent mixtures.

Three possible outcomes were possible from this type of simultaneous testing of chemical mixtures:

- the toxic effects between the two treatments may be no different from one another
  - this would suggest that ammonia is the sole effluent constituent capable of producing adverse responses in target organisms;
- the toxic effects of ammonia as the sole toxicant may exceed the toxic effects of the effluent
  - this would suggest that a chemical constituent of the effluent produces an antagonistic response, thus reducing ammonia toxicity; or
- the toxic effects of ammonia as the sole toxicant may be less than those observed when test-populations are exposed to effluent
  - this would suggest either that a synergistic response has occurred between the ammonia and other effluent constituents or that something in the effluent other than ammonia is capable of producing a toxic response.

The first scenario is the most desirable outcome because it eliminates uncertainties and concerns about the adequacy of basing criteria development on tests conducted with spiked river water. Environmentally and economically (for the discharger in this case, the City of Winnipeg), reduced ammonia toxicity in the presence of other effluent constituents is the most desirable outcome because it suggests that the potential risk to aquatic organisms in a water-body receiving complex ammonia-containing effluent-mixture discharges is significantly less than the risk associated with ammonia discharges only. The third possible outcome would promote the development of a more extensive testing-regime to identify all potentially toxic chemical constituents of the effluent and to quantify the toxicity associated with each chemical separately or in various combinations. Such an extensive toxicity assessment is almost prohibitively costly when using whole mixtures of varying compositions.

1.3 TEST-PROGRAM OBJECTIVE

The objectives guiding the planning and execution of this workstream were:

- to determine site-specific ammonia sensitivity of key indigenous fish and invertebrate species in consideration of local river pH, and temperature regimes and other limnological factors;
- to derive locally-appropriate protective criteria using site-specific data.

1.4 RATIONALE FOR TOXICITY TESTING PROGRAM

Toxicity testing is necessary for a number of reasons, specifically:

- Of approximately 50 fish species native to the Red and Assiniboine rivers, the sensitivities of only three local species have been documented in the public-domain dataset (USEPA 1998; Table 1-1);
  - the sensitivity of these three species is moderate and unlikely to represent the full range of fish sensitivities in the study area.
  - establishing the ammonia sensitivities of key local species allows the published dataset for toxicity to be expanded to allow calculation of protective criteria pursuant to the "Resident Species" provisions of the USEPA 1998 guidance document for deriving locally-appropriate criteria.
  - by contrast, once "Resident Species" provisions (per USEPA 1998) are applied, and irrelevant toxicity data are excluded (as recommended) from the combined toxicological dataset, standard errors can be derived for the dataset, and for taxa of specific interest. This allows determination of dose-response thresholds considered to be "significant" (e.g., the "probable effects" zone, where measured response consistently exceeds variability in the dataset attributed to natural variation, experimental error, etc.; e.g., Figure 1-1). Choosing an appropriate "significant effects concentration" (e.g., EC_{20}), which accounts for the majority (e.g., 80%) of the predictable or probable response to the stressor, is important in determining "how much protection is enough".

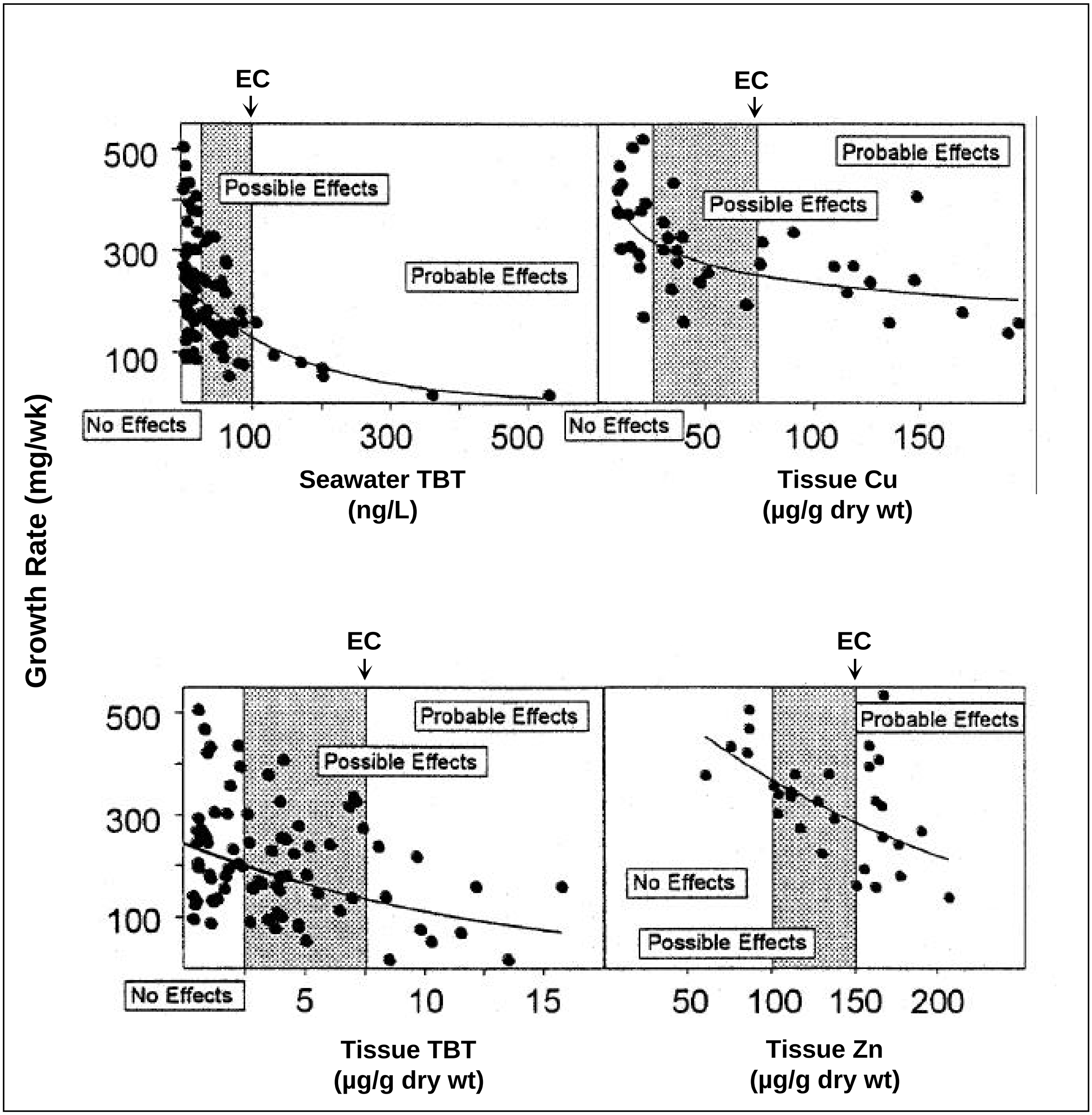
- Relying exclusively on the existing public domain toxicity data for derivation of criteria to protect local biota adopts uncertainties and conservativisms associated with test conditions not necessarily representative of the Red and Assiniboine Rivers;

TABLE 1-1

GAPS IN AVAILABLE SUB-LETHAL DATASET

Aquatic Biota	Red River	Assiniboine River	Documented Toxicity[a]
Native fish species	47	49	3
Introduced species	6	3	1 (Rainbow trout)[b]
Other fish species	--	--	5 Cutthroat trout Sockeye salmon Green sunfish Bluegill Smallmouth Bass
Key Sport species	Channel Catfish Walleye Sauger Northern pike Goldeye Mooneye Freshwater Drum Yellow perch	Channel Catfish Walleye Sauger Northern pike Goldeye Mooneye Freshwater Drum Yellow perch	Channel Catfish
Key Forage species	Emerald shiner Various shiners and minnows Fathead minnow Silver chub Channel Catfish (young) Bullhead catfish (young) Carp (young) White suckers (young)	Emerald shiner Various shiners and minnows Fathead minnow Silver chub Channel Catfish (young) Bullhead catfish (young) Carp (young) White suckers (young)	Fathead minnow Young Channel Catfish White sucker (Young)
Invertebrates	Refer to benthic studies	Refer to benthic studies	***Pelagic*** *Ceriodaphnia* sp. *Daphnia magna* ***Benthic*** *Musculium tranversum* (Fingernail clam species) *Hyallela azteca* (amphipod)

[a]From U.S. EPA 1998; list of acceptable chronic (EC_{20}) tests
[b]Non-indigenous Hatchery escapees (Rare)



Source: Modified from Salazar and Salazar, 1995

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Illustration of use of dose-reponse data to define "effects zones", to assist definition of threshold concentrations of "significant" effects (ie. EC_n)

Figure 1-1

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  - this means that criteria so derived could exceed or be less than the “real” protection requirements of these aquatic environments.

- Testing of local species during various life stages under spring, summer or winter conditions permits the development of site-specific temporal, spatial and seasonal protective criteria;
  - this approach is consistent with Manitoba Environment and CCME procedures for derivation of locally-appropriate criteria (cf., Figure 1-2).

- Determining the ammonia sensitivity of key local species responds to and fulfills Recommendation No. 6 of the Clean Environment commission (“CEC”) in its 1992 report (CEC 1992) which supported the City of Winnipeg’s position in recommending that site-specific and locally-appropriate toxicity testing be done to create confidence in the derivation of appropriate protective water-quality criteria. The CEC stated:

  "Detailed site-specific studies should be undertaken to determine both the acute toxic and chronic effects of un-ionized ammonia from wastewater effluent on the cool-water aquatic life of the rivers. Members of the scientific community within Manitoba should be invited to collaborate in the study design. Recommendations should be available before July 1997 as to the program required to deal with un-ionized ammonia in wastewater at the water pollution control sites along the river system being considered.

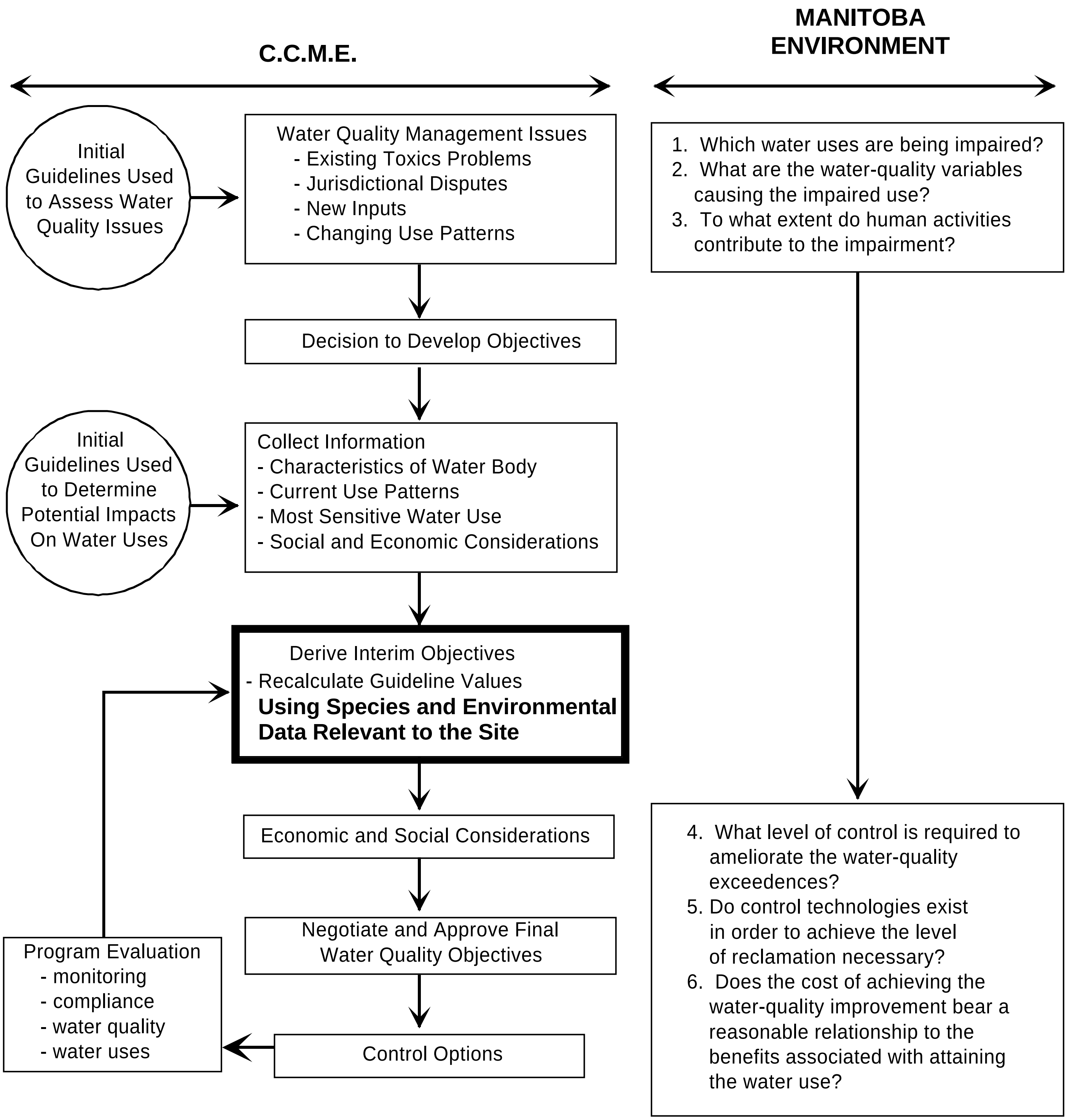
  The study results will be utilized to establish the un-ionized ammonia objective at public hearings to be held within six months of the completion of the study."

- Testing key local species and establishing their sensitivities to NH_3 will help to substantiate the costs or savings that will be realized in considering investment options for wastewater ammonia discharges for WPCCs to meet locally-appropriate protective criteria.

1.5 LINKAGE TO “INTEGRATION” WORKSTREAM

This document summarizes activities performed and information generated during the “Toxicity-Testing Workstream” of the ammonia-criteria study. Included is a general description of the

RELATIONSHIP OF C.C.M.E. AND MANITOBA APPROACHES TO DERIVATION OF WATER QUALITY GUIDELINES



Sources: CCME 1999; Chapter 4, Fig.2
Williamson, 1990

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Figure 1-2

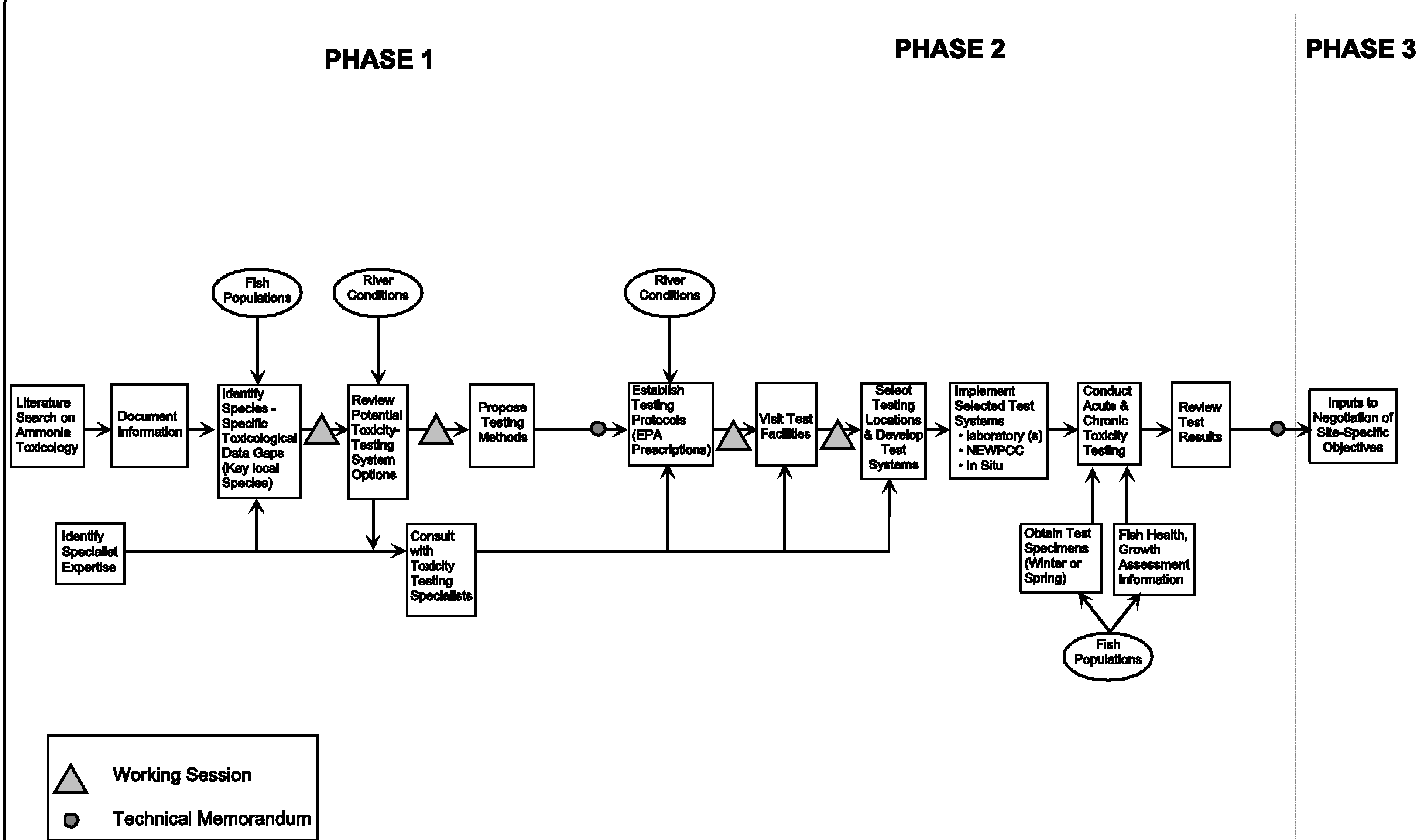
toxicity-testing program, from original design through program evolution and final implementation. The primary focus of this document is to describe the details of methods used and the results derived during laboratory and *in situ* toxicity testing. The implications of initial results for criteria development are also briefly discussed. A complete summary of data interpretation will be presented in a related document as part of the "Integration Workstream".

2. DESIGN OF TOXICITY-TESTING PROGRAM

2.1 ORIGINAL DESIGN

The original design of the toxicity-testing program was derived from prior work completed by Tetr*ES*' principals on this issue (MacLaren Plansearch 1987), including a study-scoping report prepared for the City of Winnipeg (by Tetr*ES* Consultants (1993). This work was done following the CECs recommendation for site-specific toxicity testing (CEC 1992). The original design was described in the February 1999 Draft Workplan (Tetr*ES* Consultants 1999a) and was presented at workshops held on September 24 (cf. Tetr*ES* Consultants 1998) and February 18 and 19, 1999. An overview of the activities intended to comprise the toxicity-testing workstream is shown in Figure 2-1. As part of the workshop agenda, review and comment of the toxicity-testing program was solicited from workshop attendees that included representatives from municipal, provincial and federal governments (including regulatory agencies), key members of the scientific community, and project consultants. Guidance provided by participants of the workshop helped to organize various components of Phase 1 of the Ammonia-Criteria Study development, as illustrated in Figure 2-1. Some of the suggestions provided at the workshop include the following:

- Reviewing existing acute and chronic-exposure databases to
  - determine standard test-acceptability criteria;
  - validate the reproducibility of key tests that most greatly influence the derivation of current guidelines; and
  - determine whether these key tests need to be repeated.
- Re-evaluating work done by Borgmann (1994), (a key test), in which the amphipod species *Hyalella azteca* was found to be highly sensitive to ammonia, and determining whether this species inhabits Manitoba waters. If *H. azteca* is indigenous to the Red and Assiniboine rivers, then invertebrate testing was to be expanded to include survival and reproduction effects for this species;
  - sensitivity analysis on the *Hyalella* endpoint data had indicated the importance of testing the species under local conditions;
  - small changes in the *Hyalella* data would likely have considerable influence on any Ecological Risk Criterion derived for the local aquatic community.



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Ammonia Toxicity Workstream Overview

Figure 2-1

- Establishing river conditions (i.e., effluent mixing zones, flow conditions, annual water chemistry variability, etc.) and preferred fish habitat zones and typical distribution patterns.
  - it was considered essential to consider fish behaviour and movement in relation to the *in situ* ammonia gradient to establish the risk of animal-exposure to ammonia. If avoidance behaviour to areas of high ammonia concentration could be demonstrated, then the relative importance of establishing site-specific sensitivities diminishes and time budget and energy expenditures could be redirected into other workstreams. Alternately, if aquatic biota were found to be at medium or high risk to elevated ammonia concentrations, the establishment of typical river conditions could aid in designing laboratory tests that more closely reflect *in* situ conditions.
- Determining the species of fish and invertebrates that would provide the most valuable data in the laboratory;
  - e.g., small home-range species exposed to ammonia should be selected over species that migrate through ammonia plumes because the former have an increased probability of developing toxic effects.
- Determining the species of fish and invertebrates that are indigenous to the study area and are capable of providing comparable datasets with literature reported in the public domain.
- Validating that candidate bivalve species are indigenous to the Red and Assiniboine Rivers.
  - some “trade-offs” may need to be made between testing species that are most representative of the study area versus those that are most easily attainable.
- Considering how best to use new technologies.
- Evaluating all proposed studies for their explicit contribution to “weight of evidence” and prioritize the studies accordingly;
  - e.g., prior to initiating the test-program, the relative importance of evaluating “other” chemical stressors in effluent and their contribution to ammonia toxicity would need to be established.
- Considering parallel/simultaneous *in situ* and lab test options for bivalve and other invertebrate communities.

The dynamic nature of the toxicity-testing workstream has allowed continuous incorporation of feedback from reviewers (e.g., Tetr*ES* Consultants 1999b) and has allowed the toxicity program design to evolve to accommodate factors that have influenced various Phase 2 components of the toxicity-testing workstream.

2.2 PROGRAM EVOLUTION

Evolution of the workplan for the toxicity-testing workstream has been influenced by feedback from Ammonia-Criteria Study Workshop participants and a number of other key factors including:

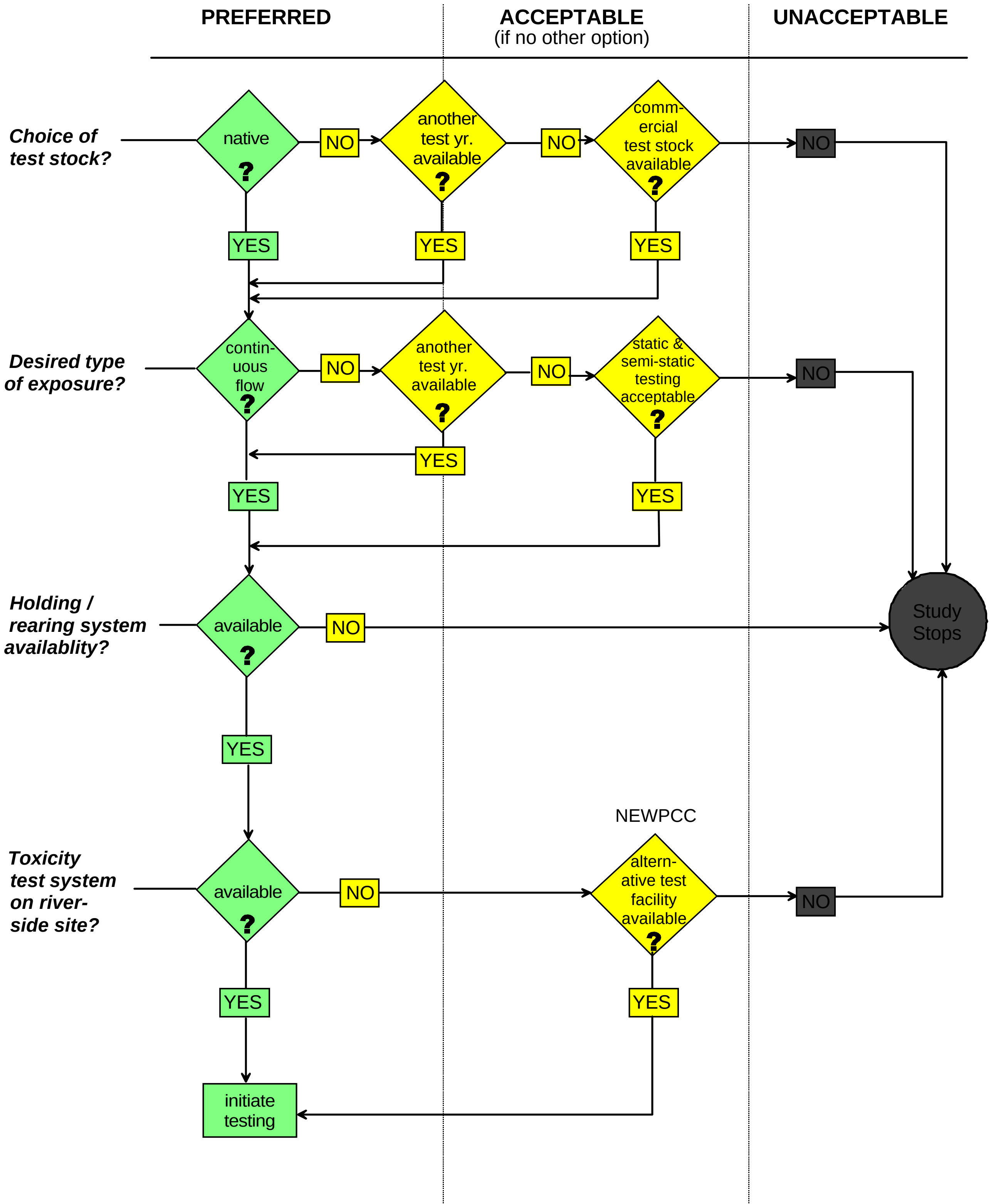
- availability of appropriate test specimens and rearing facilities;
- unpredictable weather conditions influencing test-specimen acquisition, mobile-lab facility siting and toxicity-testing schedules;
- disease outbreaks in test stock, associated with high fungal loads in spring runoff;
- discovery that the preferred (riverside) site for the mobile laboratory could not be made available and the process of finding ways of doing the testing at the North End Water Pollution Control Centre (NEWPCC);
- "trial and error" in developing holding and rearing techniques for test specimens that had not been previously tested for ammonia toxicity;
- test-schedule alterations influenced by availability of suitable and cost-effective testing facilities and infrastructure; and
- the possibility of a strike by public-sector workers in the middle of the testing program.

To efficiently assess the numerous factors that influenced the design and schedule of the toxicity-testing program, key decisions during the program were made based on the then-current availability of critical components necessary for the initiation of a specific toxicity test, using a standardized "decision tree" (c.f. Figure 2-2).

This "decision tree" was relied upon on many occasions in 1999 and 2000 as the test program evolved in response to a wide variety of externalities.

2.3 FINAL DESIGN FOR 1999 PROGRAM

Figure 2-3 illustrates the timing and activities performed as part of the toxicity-testing workstream in 1999 and 2000. The toxicity-testing program schedule and activities were dynamic and substantially influenced by factors noted in Section 2.2. The result has been the



Decision-Tree for Design of Toxicity Testing Program
Figure 2-2

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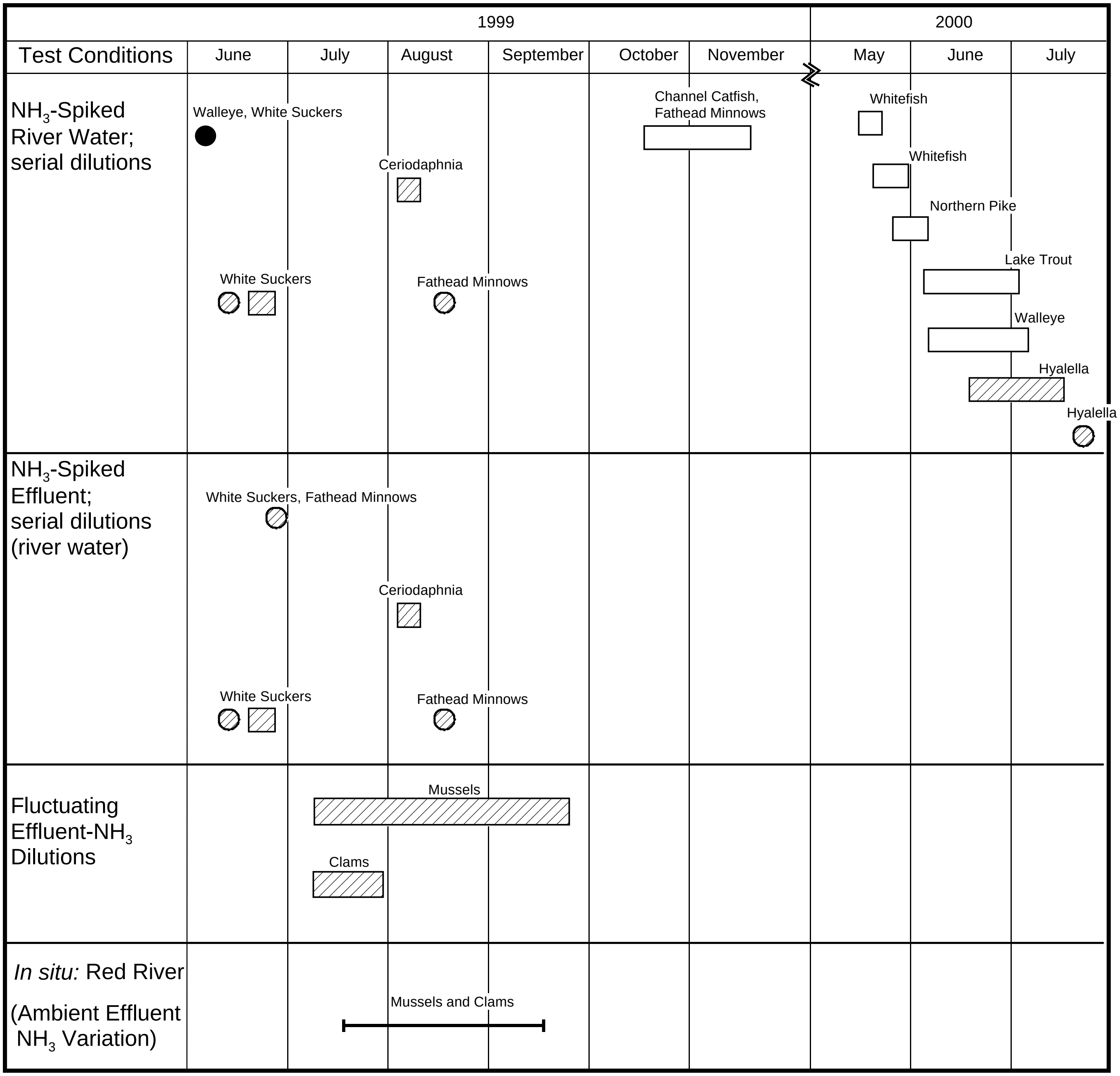
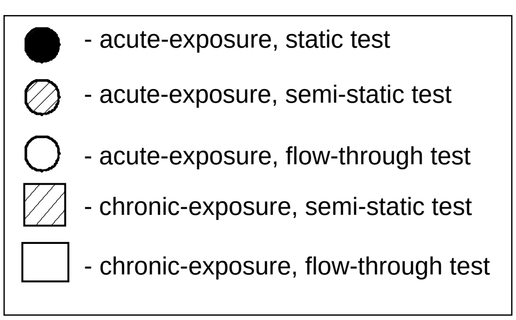


Notes: Details of these tests are described in Section 3.0 (also ref. Table 3-1)



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Ammonia Toxicity-Test Program; 1999 and 2000
Figure 2-3

development and execution of an effective toxicity program that has contributed valuable information to the existing dataset while coping with a variety of external constraints.

The initial conceptual design of the toxicity program involved the construction and utilization of a temporary and mobile laboratory facility for river-side chronic-exposure testing of various fish and invertebrate species native to the Red and Assiniboine Rivers. Difficulties and delays encountered in siting the facility promoted the implementation of a series of acute-exposure tests conducted under static or semi-static conditions at the NEWPCC (c.f., Figure 2-3). These tests are simpler in design and require less space than flow-through test apparatii and provided valuable information about appropriate ammonia-exposure concentrations to use in subsequent long-term testing. Side-by-side acute-exposure tests using serial dilutions of ammonia-spiked river water and ammonia-spiked effluent were also included in the initial program design for reasons discussed in Section 1.2.

When a suitable location was found at the NEWPCC for the flow-through laboratory in the fall of 1999 and the testing apparatus was constructed, long-term (i.e., up to 30 day) “chronic-exposure” tests were initiated. Similar tests were conducted in the flow-through laboratory in the spring and summer of 2000 (cf. Figure 2-3).

The species of fish or invertebrates used for ammonia-toxicity testing depended largely on the availability of the target test-specimens and the study team’s ability to successfully hold and rear them in the laboratory until they were ready for testing. Although difficulties were encountered during the two-year testing-period, the initial program objectives were successfully met. Tests were completed using 5 indigenous fish species, 2 indigenous bivalve species and 2 species of other invertebrates of ecological, economic or social significance (cf. Tetr*ES* Consultants 1999a).

3. TESTING METHODS

3.1 1999/2000 PROGRAM

Toxicity tests completed during the 1999 and 2000 test-seasons include both acute and chronic unionized ammonia-exposures with seven fish species and four invertebrate species. All test specimens obtained within the Red and Assiniboine River watersheds, or from Ontario, were collected pursuant to provisions of Scientific Collection permits issued by either Manitoba Fish Habitat Management Section of Manitoba Conservation (formerly Manitoba Environment) or the Ontario Ministry of Natural Resources (OMNR). Table 3-1 summarizes the types of toxicity tests performed on each species, referenced by test number. Details of the test conditions are provided in Appendix A. Unless otherwise stated, "NH_3-N" in this text refers to total ammonia-nitrogen and "NH_3" refers to unionized ammonia.

3.1.1 <u>Fish Testing</u>

Fish (i.e., channel catfish *(Ictalurus punctatus),* fathead minnow *(Pimephales promelas)*, lake trout (*Salvelinus namacycwl*), lake whitefish (*Coregonus clupeaformis*), northern pike (*Esox lucius*), walleye *(Stizostedion vitreum)*, and white sucker *(Catostomus commersoni)*,) were exposed to various NH_3 concentration-gradients under static, semi-static and/or continuous-flow conditions for exposure-periods ranging from 72 hours to 30 days (c.f. Appendix A). All testing methods followed ASTM protocols (1996) or USEPA protocols for acute-exposure testing (1993) or chronic-exposure testing (1994). Acute and chronic-exposure effects were determined by comparing the survival and/or growth of test organisms with average exposure-concentrations of NH_3 for each test.

Test fish were captured "locally" (i.e., within Manitoba, Saskatchewan or Ontario waters draining into the Red and Assiniboine drainage basins) or were obtained from North American government or commercial hatcheries (c.f. Appendix A). Collection and Handling Permits obtained from Manitoba Conservation (formerly Manitoba Department of Natural Resources) and the OMNR are provided in Appendix B. Prior to test initiation, fish were either held for a minimum of 24 hours in tanks containing Red River water in the laboratory or they were held off-site in a continuous-flow holding-tank receiving La Salle River water. The holding sites enabled the fish to acclimate to site-specific water-chemistry conditions, specifically temperature, pH and dissolved oxygen (DO), before entering the exposure systems.

3.1.1.1 Acute-exposure Testing

Newly hatched (i.e., 72-hour) or young (i.e., 8- to 39-day) fathead minnow, white sucker and walleye fry were exposed to a range of NH_3 concentrations in spiked Red River water with and without treated effluent from the North End Water Pollution Control Center (NEWPCC) (c.f. Table 3-1 and Appendix A). Red River water was manually obtained from a location approximately 0.5 km upstream of the NEWPCC outfall and transported in 20L carboys to a laboratory at the NEWPCC. Mortality of the test-organisms was monitored daily. Cumulative percent-survival data measured at 72 or 96 hours (i.e., test-termination) were used in regression analysis in conjunction with analytical measurements to determine the NH_3 concentrations that produced 20% and 50% lethality (i.e., "LC_{20}" and "LC_{50}").

Ten fry were added to 1-L polyethylene chambers with 500 to 750 ml of test solution (c.f. Appendix A). The exposure solutions were prepared once at the beginning of the static tests (i.e. T1A&B) and daily for all semi-static tests (i.e. T2A&B, T3A&B, T4A&B, T6A&B). Appendix C contains a detailed description of the protocol used to prepare exposure solutions. In summary, a measured amount of ammonium-chloride solution (i.e. NH_4Cl dissolved in de-ionized water) was added to either river water or effluent to elevate the NH_3-N concentration to the highest desired nominal test concentration (e.g. 32 mg/L). Initial NH_3-N concentrations in the effluent were determined using a CHEMet® Ammonia Kit. If the background NH_3-N concentration was higher than the highest desired nominal concentration, then the effluent was diluted with river water until the desired nominal test concentration was obtained. Subsequent exposure-concentrations were obtained by serially diluting the solutions with river water by a factor of 0.5. Three to four replicates were prepared for each exposure-concentration with the number of replicates being determined by the supply of fish surviving the holding/acclimation period and available for testing (c.f. Appendix A). The 1-L polyethylene chambers were held in continuously flowing water baths bathed by Winnipeg tap water (Figures 3-1 and 3-2) to maintain test temperatures of 15 to 21^{o}C (c.f. Appendix A).

TABLE 3-1

AMMONIA TOXICITY TESTS CONDUCTED DURING THE 1999/2000 PROGRAM

TEST-ORGANISM	DURATION/TEST-TYPE	DILUTION WATER	SOURCE OF AMMONIA	NOMINAL [NH_3] or % EFFLUENT
FISH – 1999 TESTING				
Fathead Minnows – fry (U.S. Stock – Lab Raised)	• 96-hr, semi-static • 72-hr,. semi-static • 72-hr,. semi-static	• Red River water • Red River water • Red River water	• Effluent and NH_4Cl^a • NH_4Cl • Effluent and NH_4Cl^a	• 1.0 to 64 mg/L • 1.0 to 32 mg/L • 1.0 to 32 mg/L
Fathead Minnows - juvenile (U.S. Stock – Lab Raised)	• 29-day, flow-through	• Red River water	• NH_4Cl	• 0.5 to 8 mg/L
Fathead Minnows - sub-adult (Local Stock – Captured)	• 30-day, flow-through	• Red River water	• NH_4Cl	• 0.5 to 16 mg/L
Walleye – fry (Local Stock – Hatchery Raised)	• 96-hr, static	• Red River water	• NH_4Cl	• 1.0 to 125 mg/L
White Sucker – fry (Local Stock – Reared)	• 96-hr, static • 96-hr, semi-static • 96-hr, semi-static • 10-day (96-hr), semi-static • 10-day (96-hr), semi-static • 96-hr, semi-static	• Red River water • Red River water • Red River water • Red River water • Red River water • Red River water	• NH_4Cl • NH_4Cl • Effluent and NH_4Cl^a • NH_4Cl • Effluent and NH_4Cl^a • Effluent and NH_4Cl^a	• 1.0 to 125 mg/L • 0.5 to 32 mg/L • 0.5 to 32 mg/L • 0.5 to 32 mg/L • 0.5 to 32 mg/L • 1.0 to 64 mg/L
Channel Catfish – Juvenile (U.S. Stock – Lab Raised)	• 30-day, flow-through	• Red River water	• NH_4Cl	• 0.5 to 16 mg/L
FISH – 2000 TESTING				
Northern Pike – fry (Local Stock – Hatchery Raised)	• 12-day, flow-through	• Red River water	• NH_4Cl	• 0.5 to 8.0 mg/L
Walleye – fingerlings (ON Stock – Hatchery Raised)	• 30-day, flow-through	• Red River water	• NH_4Cl	• 0.5 to 6.0 mg/L
Lake Whitefish – fry (Local Stock – Hatchery Raised) * Treated for fungal infection prior to test start	• 13-day, flow-through	• Red River water	• NH_4Cl	• 0.5 to 8.0 mg/L
Lake Whitefish – fry (Local Stock – Hatchery Raised) * Disease-free	• 5-day, flow-through	• Red River water	• NH_4Cl	• 0.5 to 8.0 mg/L
Lake Trout – fingerlings (Local Stock – Hatchery Raised)	• 30-day, flow-through	• Red River water	• NH_4Cl	• 0.5 to 8.0 mg/L
INVERTEBRATE – 1999 TESTING				
Giant Floater Mussel (Local Stock – Collected)	• 66-day laboratory semi-static • 62-day in-situ chronic exposure	• Red River water • Red River water (*in situ*)	• Effluent • Effluent; varying distances from outfall	• 1.5% - 100% effluent • variable
Grooved Fingernail Clam (Local Stock – Collected)	• 8-day laboratory semi-static • 62-day in-situ chornic exposure	• Red River water • Red River water (*in situ*)	• Effluent • Effluent; varying distances from outfall	• 1.5% - 100% effluent • variable
Ceriodaphnia dubia (E.S.G Stock – Lab Raised)	• 7-day, semi-static • 7-day, semi-static	• Red River water • Red River water	• NH_4Cl • Effluent and NH_4Cl^a	• 2 to 64 mg/L • 2 to 64 mg/L
INVERTEBRATE – 2000 TESTING				
Hyallela (Lab Stock)	• 30-day, semi-static • 96-hr semi-static	• Red River water • Red River water	• NH_4Cl • NH_4Cl	• 0.5 to 8.0 mg/L • 1.9 to 60 mg/L

Notes:
a = ammonium chloride (NH_4Cl reagent grade) was used to adjust ammonia concentration in effluent if it was less than the highest exposure-concentration

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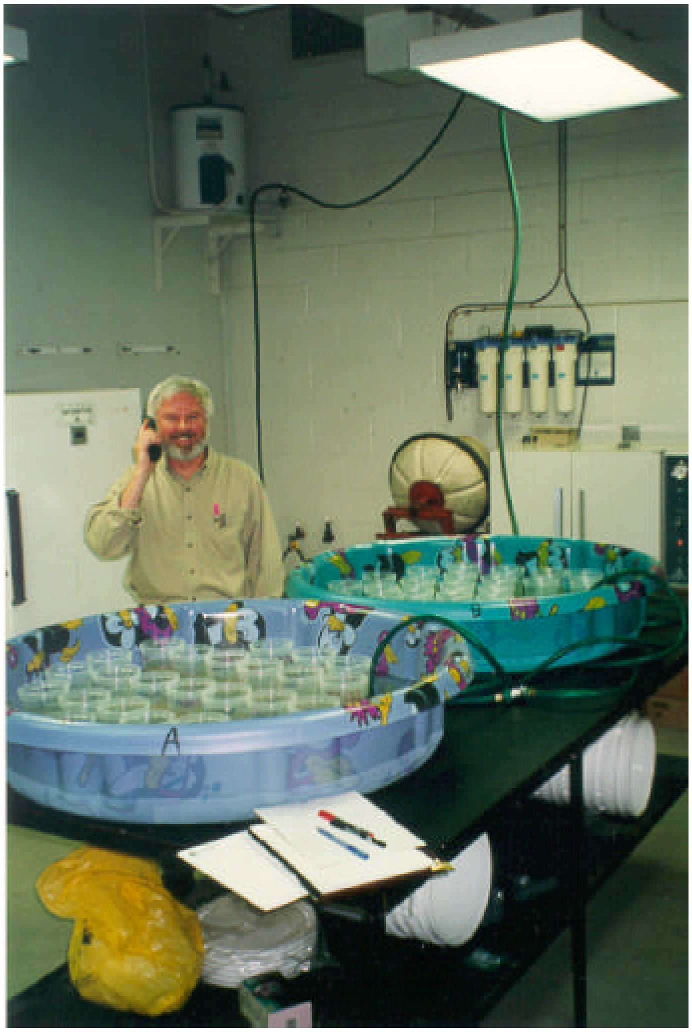
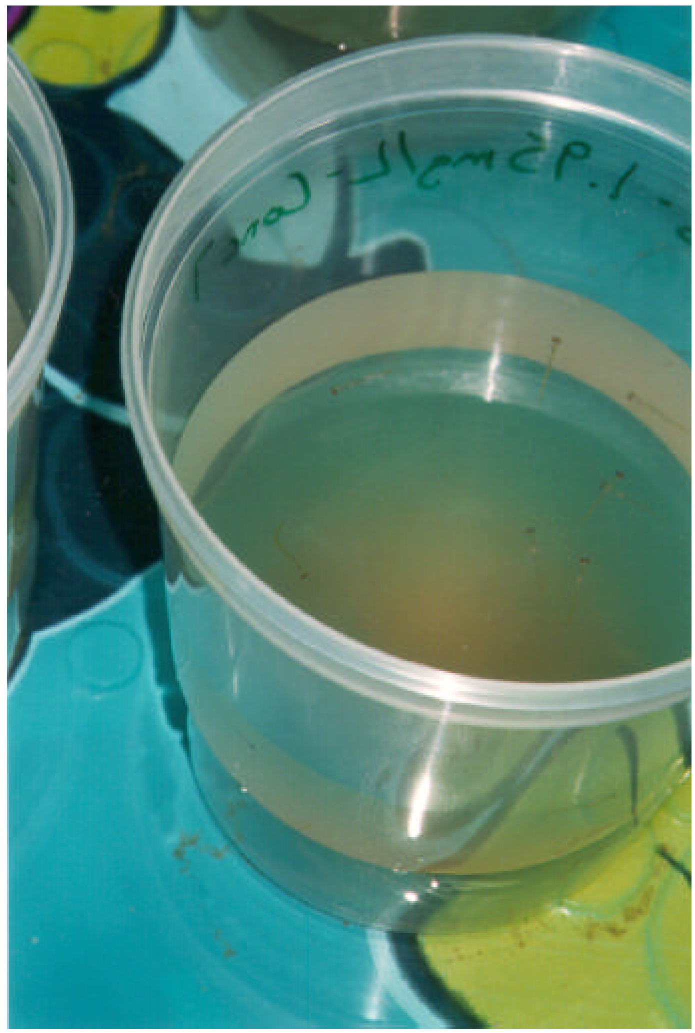
Test Chambers and Waterbaths used for Static and Semi-static Fish Toxicity Testing

Figure 3-1



Scientific Advisor, Gordon
Craig, adjacent to water baths and
test chambers for acute lethality tests
*(trying to appease angry test fish by calling
out for pizza)*



White Sucker fry used in toxicity tests

**Static and Semi-Static Fish Toxicity
Testing Facility at the NEWPCC**
Figure 3-2

Temperature, pH, dissolved oxygen (DO), and conductivity measurements were recorded daily for all test chambers or a representative sample of test chambers. 'Representative-samples' were obtained from randomly selected test chambers at "high", "medium" and "low" exposure concentrations under the assumption that all test conditions across the exposure gradient would be represented in the samples. Mortality checks were preformed once daily for all test chambers and dead fish were noted and removed from the exposure system. During semi-static testing, mortality checks were conducted prior to replenishing test solutions and water quality measurements were collected within 4 hours after test solution exchange.

NH_3-N concentrations were determined from 5 to 30 ml samples of test solution collected daily from one replicate of each exposure concentration per species tested. Analyses were done on-site at the NEWPCC lab using a Technicon Auto Analyser II (Figure 3-3) and the phenate colourimetric method (c.f. Clesceri *et al.* 1998). All samples not analysed within 24 hours were preserved with 0.5 to 1.0 ml of mercuric chloride ($HgCl_2$) and stored in a refrigerator at 4^oC. Results reported by the NEWPCC lab are documented in Appendix D. These data, together with test-temperature and pH measurements, were used to calculate average NH_3 concentrations according to Emerson *et al.* (1975), as described in Appendix E. Percent-survival data were used with NH_3 exposure concentrations to estimate LC_{20} and LC_{50} concentrations by linear interpolation, as described in Appendix F.

Modifications to the test system were made as relative size differences and age classes of test species changed, thus altering space requirements and rates of DO and food consumption for the fish. Test solution volume, and the addition of continuous aeration and feeding-regimes, changed accordingly (c.f. Appendix A).

During the first four tests (i.e., T1A&B, T2A&B), the fry retained yolk sacs and were not actively feeding. On the third day of T1A and T1B, one drop of Wardley Liquid-Baby-Fish Food was placed into each test chamber, but was not eaten by the fry. During the third and subsequent tests, fish began actively feeding and were fed approximately 4.4 mg (dry weight) of newly hatched, live, brine shrimp twice daily for all but the final day of the each test (c.f. Appendix A). Fish were not fed within 24 hours of test termination to ensure that all food was completely digested and eliminated from the gut prior to making whole-body dry-weight measurements.

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Determining Ammonia Concentrations in Toxicity Test Water Samples
Figure 3-3

At the end of each test, live fish were removed from the exposure chambers, counted, placed on labeled and tared aluminium foil sheets and dried at 103^{o}C for at least 2 and not more than 24 hours. The foils holding the fish were removed from the oven and weighed to the nearest 10^{-4} grams to quantify differences in fish weights across the exposure gradient.

3.1.1.2 Chronic-Exposure Testing

Seven species of fish (i.e., white sucker, fathead minnows, channel catfish, walleye, northern pike, lake whitefish and lake trout) of various age classes were subjected to chronic unionized ammonia-exposure for 5 to 30 days (c.f. Appendix A). Two of the tests (i.e., T3A&B) with white sucker were semi-static and test protocols have been described in Section 3.1.1.1 and Appendix C. All other chronic tests (i.e., T8, 9, 11, 14, 15, 18, 20 and 21) were conducted in a flow-through exposure system described below.

A flow-through laboratory was constructed in the dewatering building of the NEWPCC (Figure 3-4) and was continuously supplied with water from the Red River to facilitate site-specific testing. The river water was pumped from a point approximately 0.5 km upstream from the NEWPCC outfall (Figure 3-5), pushed through a 900-meter underground pipeline and deposited into a 2500-liter holding-tank (Figure 3-6) within the laboratory. The holding tank served as a primary settling chamber for suspended solids and provided a two-hour water-reserve necessary for maintaining water supplies within the laboratory when the river-water-pump intake needed cleaning. A settling chamber was necessary since high suspended solids in the Red River (100 to 400 mg/L) would have plugged the diluters (described later).

From the holding tank, water was pumped through a filter and into an 80-liter container (referred to as the “river water-chamber”) secured near the top of a 12-ft heavy-duty shelving unit (Figure 3-7). From this chamber, water was distributed to a series of testing tables (Figures 3-8 and 3-9) and holding tanks (Figure-3-10) through two gravity-fed, 1¼-inch ABS pipes (Figure 3-11). River water was also directed through (a) a PVC gate valve for tests conducted in 1999 and (b) a “swing arm” device for tests conducted in 2000 both to control the flow of water into an 80-liter “mixing-chamber” located three feet beneath the river water chamber (Figures 3-7 and 3-12). Flow rates through the swing-arm were controlled by adjusting the height of an extension of tubing directed at 90^o angles from the side of a bucket. This motion altered the head-pressure

Location of the continuous flow toxicity lab at the dewatering building,City of Winnipeg North End Water Pollution Control Center

Figure 3-4

River water supply pump located on the Red River adjacent to the Bergen Cut-Off

Figure 3-5

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River water holding tank
Figure 3-6

Water distribution tower with the river water and ammonia distribution chambers
Figure 3-7

Continuous flow toxicity laboratory within the Dewatering Building at NEWPCC
Figure 3-8

Toxicity lab from another perspective
Figure 3-9

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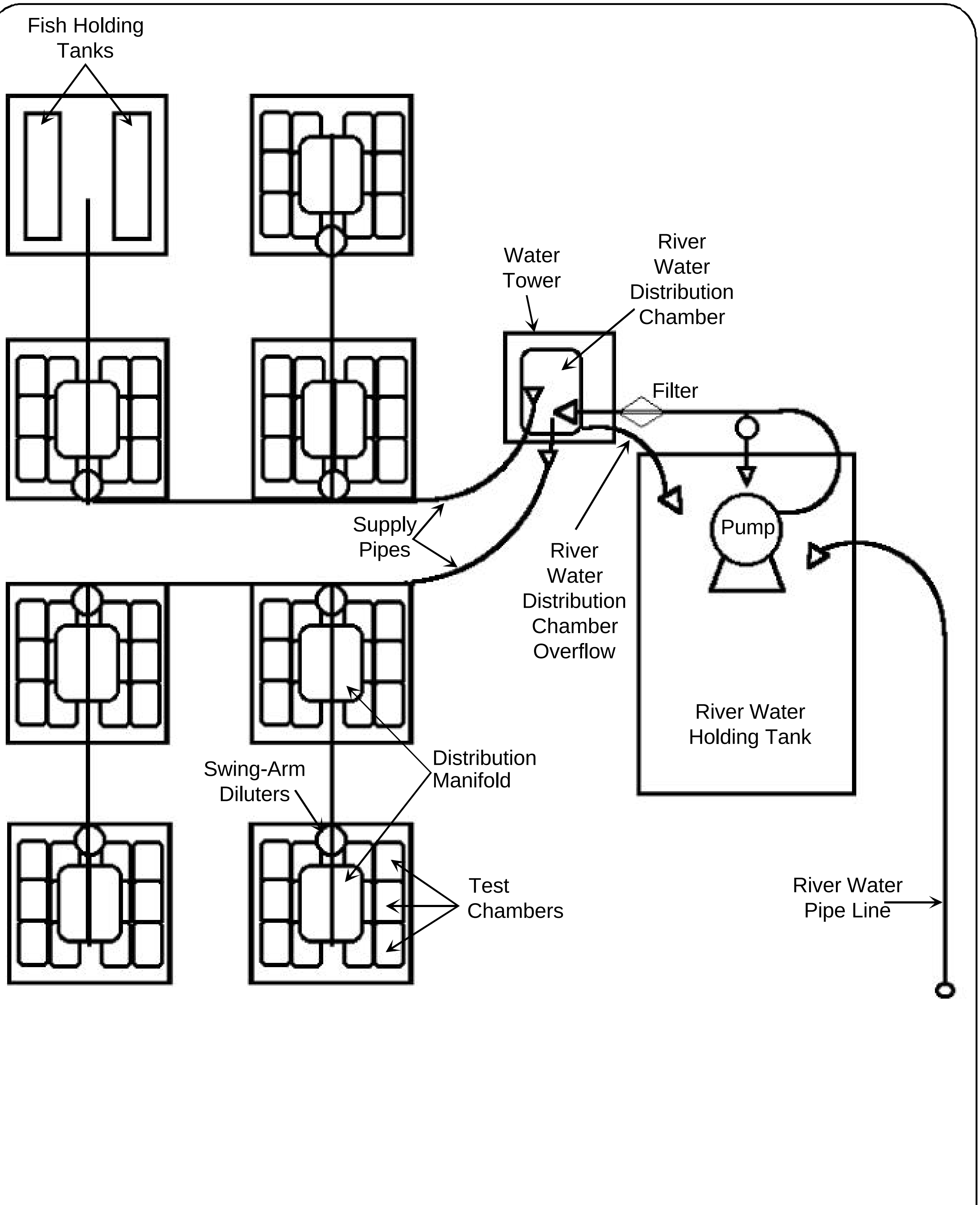
Fish holding facilities continuously supplied with Red River water
Figure 3-10



Schematic of Toxicity Lab Layout at NEWPCC

Figure 3-11

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Ammonia mixing chamber on water tower
Figure 3-12

Ammonia NH_4Cl stock container and dosing pump
Figure 3-13

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differential between the overflow drain near the top of the bucket and the mouth of the tubing, thus controlling the flow of water through the arm. The swing-arm system replaced the gate valve in the second year of testing because it was more stable and the water flow could be adjusted with a higher degree of accuracy.

Ammonia was introduced to the system through a LMI™ dosing pump that supplied a highly concentrated solution of dissolved ammonium chloride (NH_4Cl) from NH_4Cl-stock container to the mixing-chamber (Figure 3-13). The NH_4Cl stock was prepared according to the protocol described in Appendix G. From the mixing-chamber, an ammonia-solution was distributed to the testing tables through a second set of ABS piping arranged in a similar configuration as that used to distribute the river water.

At each testing table, exposure-solutions were prepared using a diluter system that was fed a continuous supply of ammonia solution and river water. Exposure concentrations were controlled by adjusting the flow rates in the diluter system with a series of PVC gate valves and "swing arms" (Figures 3-14 and 3-15) (c.f. Appendix G). A flow-splitting device (referred to as the "distribution-manifold") directed the exposure solution to test chambers equipped with overflows and designed for continuous test-solution replenishment (Figure 3-16). The minimum daily replacement rate of test solution was 29 times per day. Four replicate test chambers were used for all flow-through tests except tests 20 and 21 which had only 3 replicates each due to lower fish density prior to test start and limited space availability at each testing table (cf. Appendix A).

The number of organisms distributed to each test chamber was a function of test type and animal size and density at test start. Ten organisms were held in each test chamber for both semi-static tests and between 12 and 26 were used in flow-through tests (Appendix A). Fish were fed with food recommended by government and commercial hatcheries, as described in Appendix A. Fish were not fed within 24 hours of test termination to ensure that all food had been completely digested and eliminated from the gut prior to whole-body dry-weight measurements.

The dilution system was checked daily to ensure that nominal NH_3-N concentrations were maintained. Adjustments were made to the flow rates, if necessary, to achieve the desired nominal concentrations. Once the system stabilized, water temperature, pH and DO

River water and ammonia swing arm diluters at the 0.5mg/L exposure table
Figure 3-14

Top view of the river water and ammonia swing arm diluters
Figure 3-15

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Water in the test chamber is continuously renewed by water supplied through the distribution manifold

Figure 3-16

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measurements were obtained from a representative sample of test chambers for each species. During 1999 testing, actual NH_3-N exposure concentrations were measured from 60 ml samples collected prior to and following calibration using a Chemet® Ammonia Kit and the NEWPCC's Technicon Auto Analyzer II, respectively. Measurements were taken twice daily to account for variability in exposure concentrations due to changes in flow rates in the diluter systems resulting from sediment build-up. For tests conducted in 2000, both methods of NH_3-N analysis were completed for the first 10 days of testing, but improved stability of the test system from changes made to the primary and secondary diluters eliminated the necessity of collecting duplicate samples. For the remainder of the 2000 test program, water samples were collected following calibration and analysed with the Techinon Auto Analyzer II only. All water samples analyzed by the NEWPCC lab were obtained, preserved, and stored according to the protocol described for the acute-exposure tests (cf. Section 3.1.1.1). Results are reported in Appendix D.

Fish mortality for each test was checked daily using one of two methods of inspection; (a) visual-inspection method and (b) net-collection method. Visual inspections of the fry were possible because fry were held in small test chambers with screened bottoms inserted into a second set of containers equipped only with drains. Using this design, the inner container could be lifted and the volume of water within the container reduced, thus enabling dead fish to be counted and removed from the test chambers. Juvenile fish were held in larger containers and because the turbidity of the water (40-150 mg/L TSS) made it impossible to see the fish, a net was used to swipe the bottom of the test chambers and collect and remove dead fish. Dead fish were counted and recorded, then discarded.

At the end of each test, surviving fish were removed from the test chambers, counted and terminated using either a lethal dose of MS-222 (tricane or Finquel), or thermal shock with hot tap water. The fish were then placed on labelled and tared aluminium-foil trays, dried at $103^{o}C$ for 24 to 48 hours then weighed to the nearest 10^{-4} gram.

Average NH_3 concentrations for each chronic test were calculated based on daily temperature, pH and NH_3-N concentrations according to Emerson *et al.* (1975) (c.f. Appendix E). Survival and growth data were used with the NH_3 exposure concentrations to estimate the $LC_{50/20}$ and $EC_{50/20}$ concentrations by linear interpolation, as described in Appendix F.

3.1.2 Bivalve Tests

An *in situ* field bioassay and a concurrent laboratory toxicity-test were conducted using two species of local bivalves, floater mussels (*Pyganodon grandis)* and fingernail clams (*Sphaerium simile*). Approximately 1600 floater mussels and 4000 fingernail clams ranging in age between 1 and 3 years were collected from La Salle River, Starbuck, Manitoba (Figure 3-17). A temporary work-site was established in Starbuck for test preparations that included sorting the bivalves (Figure 3-18), obtaining morphometric measures (e.g., initial weights and lengths) using electronic balances and electronic vernier calipers (Figure 3-19), and securing the test-organisms in thin nylon mesh bags (Figure 3-20). The mussels and clams were placed into mesh bags to facilitate measuring shell lengths, whole-animal wet weights, and end-of-test tissue and shell weights on individuals. For the field study, the floater mussels were distributed with 39 individuals per bag; the fingernail clams were distributed with 100 per bag. For the laboratory test, the floater mussels were distributed with 19 individuals per bag; the fingernail clams were distributed with 50 per bag. Cinched cable ties were used to separate bivalves in the mesh bags and maintain position within the bag. Ample water circulation and equal exposure to test-conditions was ensured by placing the individuals into compartments made of an open mesh material.

The goal of the *in situ* field study was to quantify exposure to effluent discharged from the NEWPCC through bioaccumulation and/or morphometric and survivorship measurements and to quantify effects of that exposure through growth measurements. The goal of the laboratory test was to expose the bivalves to treated effluent concentrations that were similar to *in situ* exposure-concentrations and determine the concentrations that produced a lethal or sub-lethal effect (i.e., growth) in 20% and 50% of the animals based on percent survival and whole-animal wet weight (WAWW) measurements.

3.1.2.1 *In situ* Test

A complete description of the *in situ* bioassay is provided as a separate report, Appendix H. A summary of the study is provided here. After making beginning-of-test (BOT) WAWW and shell-length measurements, and securing them in mesh bags, the bags were secured to frames made from rigid 0.6 m x 1.0 m PVC material. Each PVC frame contained three bags of floater

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Screening and Sorting Bivalves from the LaSalle River
Figure 3-17

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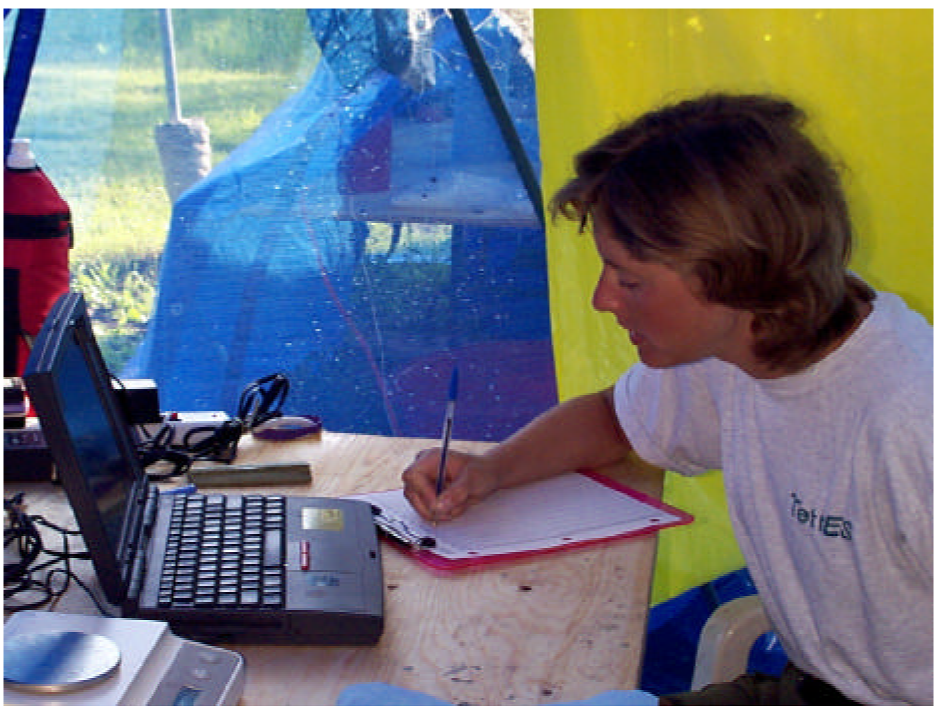
Facilities Used for Preparation of Bivalve Test Cages and Sorting of Bivalves
Figure 3-18



Measuring Bivalve Morphometric Parameters and Recording Data

Figure 3-19

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Preparing Mussel Strings

Preparing Clam Strings

Preparing Strings of Mussels and Clams for *in situ* Test Cages

Figure 3-20

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mussels and two bags of fingernail clams. The PVC frame was then wrapped in heavy plastic mesh (mesh size: 8 mm) to deter predators (Figure 3-21). Three replicate cages were prepared for each of the seven field stations shown in Figure 3-22. For each station, one temperature monitor was fastened to one of the three replicate cages. To complete the deployment array, lines and floats were attached to the cages in such a manner that the three cages assigned to a given site were tied together (Figure 3-23).

The locations of the seven field stations were identified in the field with a Global Position System (GPS) and the three cages assigned to a given station were deployed as a unit. Distribution of each set of replicate cages at each sample station had been predetermined by reference to a model simulation of the centreline of the plume for the river flow rate just prior to deployment (Figure 3-24). Prior to their release, anchors were fastened to each cage to increase the sinking rate and reduce the horizontal travel distance of the cages before they settled to the river floor. Subsurface floats marked the location of the submerged cages and all cages were secured to the shoreline with a weighted, camouflaged line. Initial deployment sites and details of deployment cages and protocol are given in Table 3-2 with termination locations given in Table 3-3 and Appendix H.

The Red River flow rate varied greatly (as did other quality parameters) over the summer, especially during the test program (Figure 3-25 & Table 3-3). High flows during cage deployment in July gave way to lower rates in August. Lower flow rates meant that the NEWPCC effluent plume had greater momentum entering the river, moving the mixing zone further offshore and away from the cages. To maintain exposure of the cages to the effluent plume, they were moved to the new plume centreline on August 18, 1999. When flows rose dramatically in September 1999 and the mixing-zone plume moved closer to the shore, the cages were again re-deployed along the apparent centreline of the plume, to attempt to maintain their exposure to the NEWPCC effluent (c.f. Figure 3-25). Water chemistry was monitored at each station in the river, once the cages had been deployed, in July, August and September 1999 (c.f. Tables 3-5, 3-6, and 3-7).

The caged bivalves were deployed for 65 days beginning on July 14, 1999. While it was intended that the exposure would be longer, a dramatic increase in floating logs and other debris present in the river because during late-summer flooding (c.f. Figure 3-25) threatened the integrity of the cages and therefore the entire *in situ* program.

Clam and Mussel String Positions on Cage Frame

Attaching Predator Mesh

Cage Construction for *in situ* Bivalve Test

Figure 3-21

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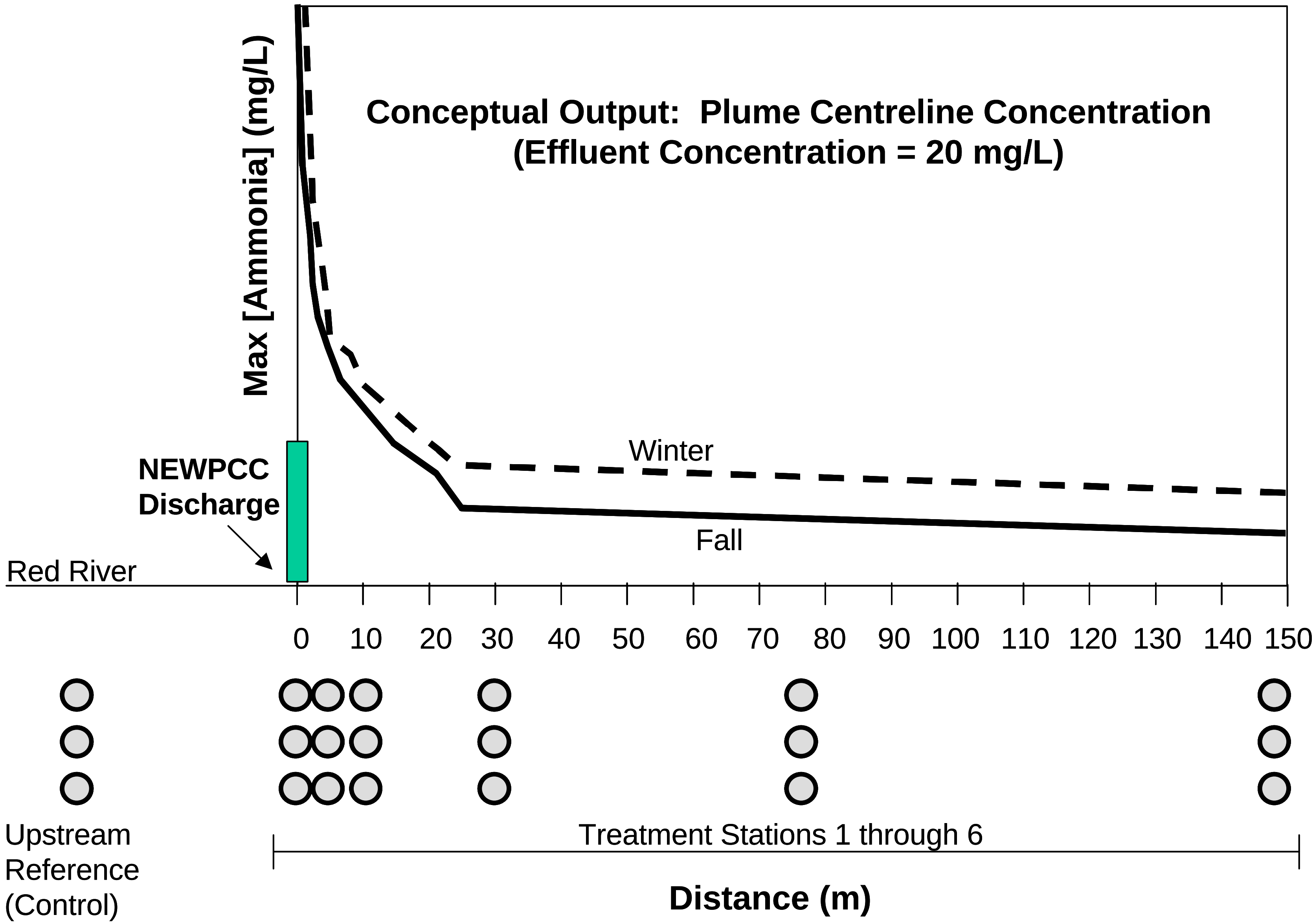

Source: Salazar (*Pers. Comm.* Apr. 5, 1999)

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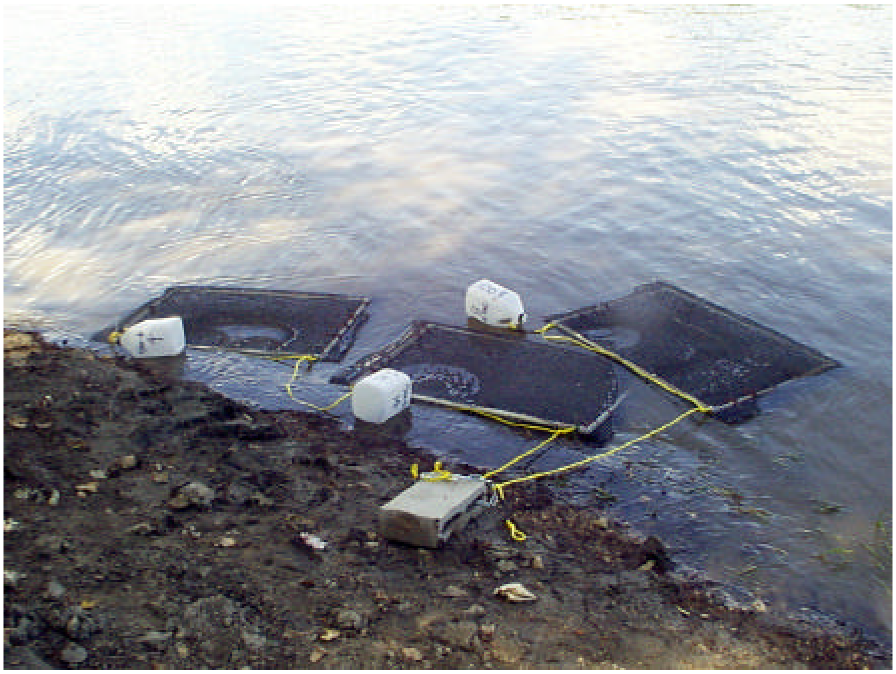
Caged Bivalve Deployment Configuration at NEWPCC
Figure 3-22

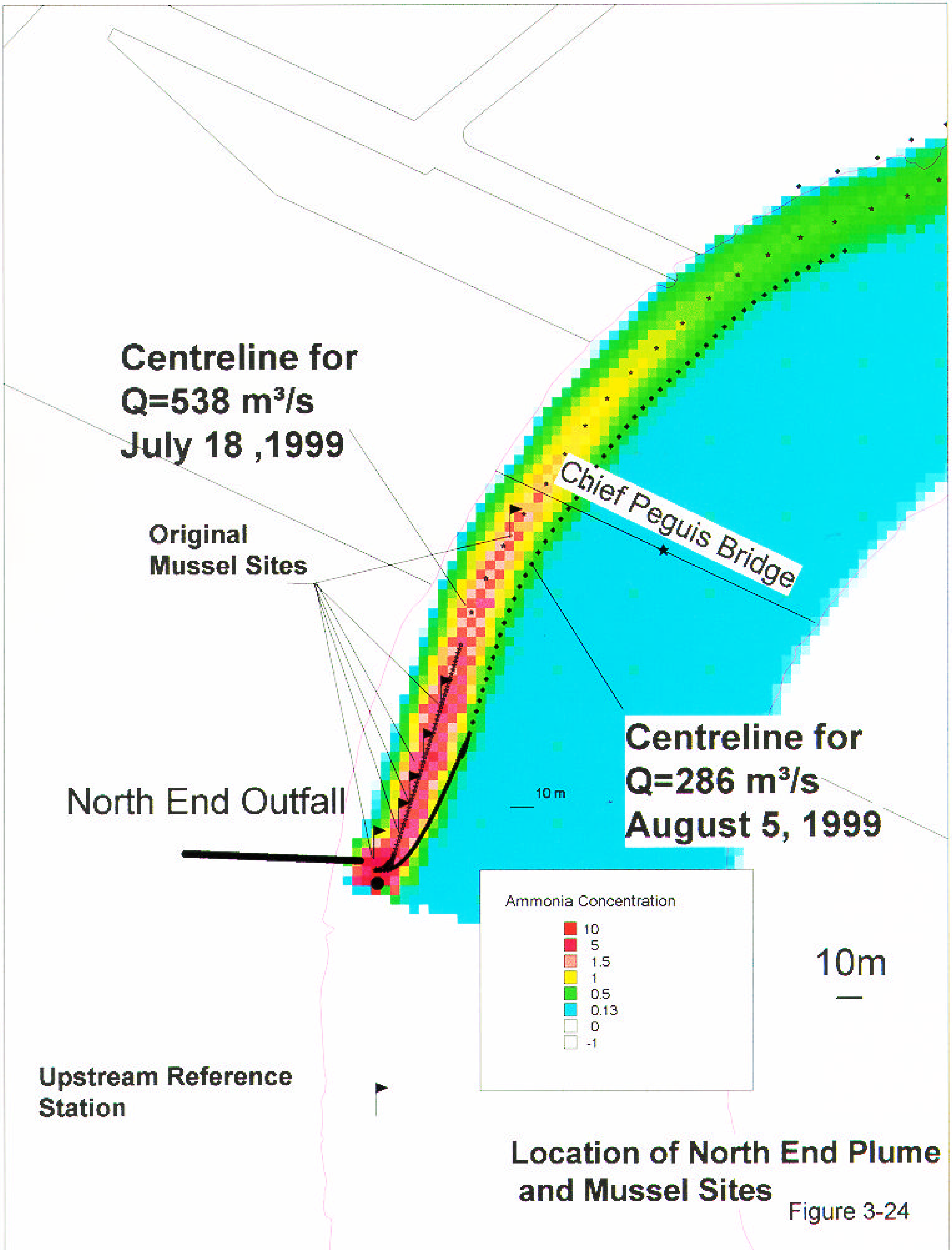


Cage Stations Kept Submersed Prior to Transportation to Deployment Sites

Cage Stations Taken Individually by Boat to Deployment Sites

Preparation for Deployment of Bivalve Stations

Figure 3-23



Location of North End Plume and Mussel Sites

Figure 3-24

TABLE 3-2

Initial Bivalve Station Positions, July 14, 1999

Station #	Cage #'s*	Distance from Outfall (m)	UTM Northing	UTM Easting
1	2,10,13	5	5534770.06	636370.566
2	6,17,24	10	5534725.218	636372.211
3	5,7,21	30	5534761.395	636379.709
6	4,8,14	50	5534850	636404
5	9,18,23	75	5534850	636430
4	11,15,22	150	-	-
Reference	12,16,19	100 m upstream	5534534	636377

*Note: Approximately 3 meters distance between cages (positions and distances from outfall are approximate due to high river velocites while setting mussel cages).

TABLE 3-3

Order of Bivalve Stations At Termination of In Situ Experiment

Station #	Cage #'s	Distance from Outfall (m)	Date Pulled	Order of Pulling*
1	2,10,13	5	Sept. 16	6
2	17,6,24	25	Sept. 16	5
6	4,8,14	40	Sept. 16	4
5	23,22,18	60	Sept. 16	2
3	5,7,21	100	Sept. 16	3
4	11, 15, 22	150	Sept. 16	1
Reference	12,19,16	100 m upstream	Sept. 17	7

*Notes: Stations were not pulled in order due to limited visability of all float markers. Station and Cage positions were altered at some sites during the course of the experiment due to very high water velocities and snagging of cages while setting cages and monitoring water chemistry.

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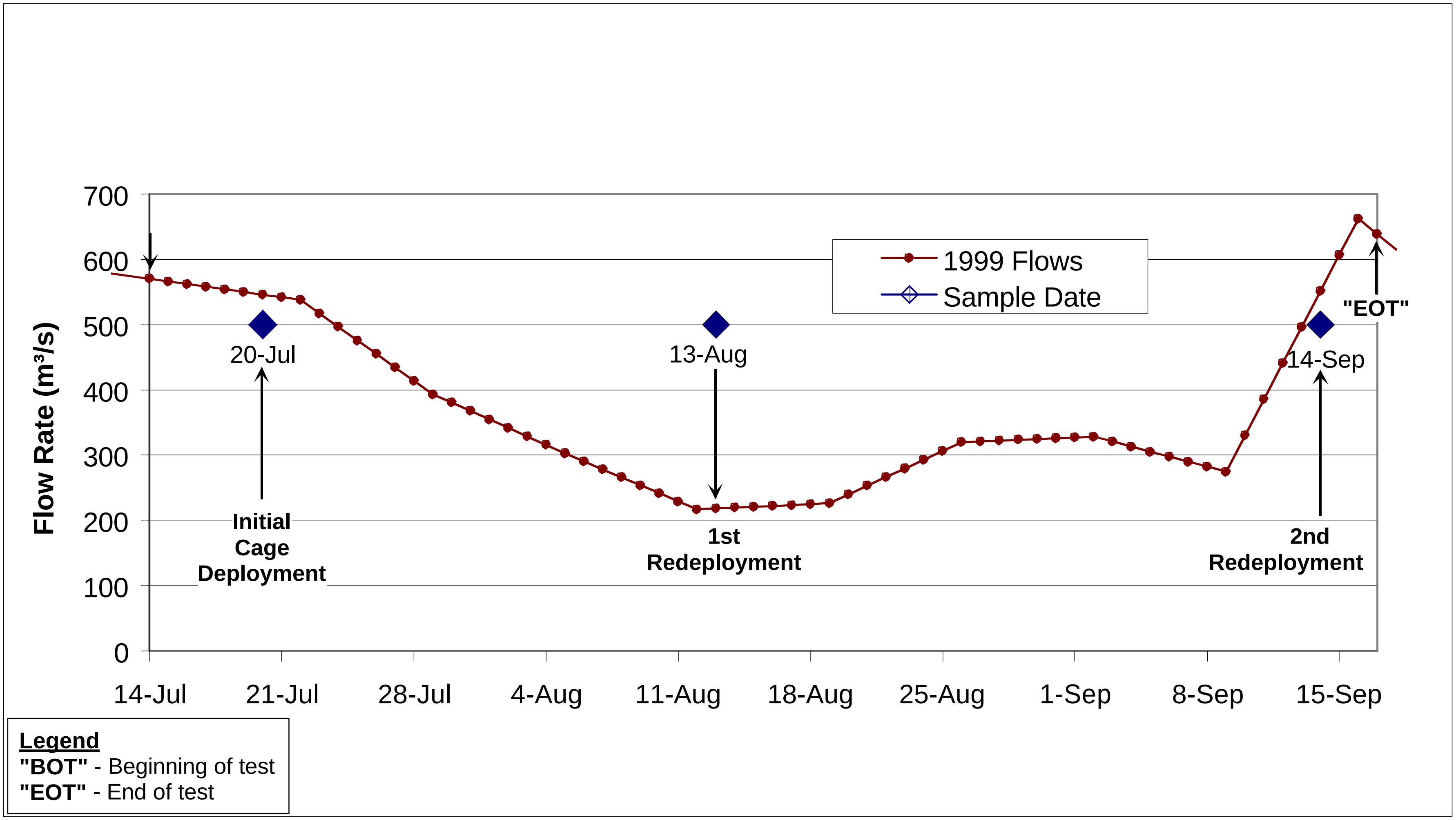

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Red River Flows at Lockport in 1999 During *In Situ* Mussel Tests
Figure 3-25

Table 3-4
River Conditions and Theoretical Plume Centreline During In Situ Mussel Tests

	Date	Flow (m^3/s)	River Temperature	Effluent Temperature	Ammonia Concentration at Centreline of Plume as Extimated by CORMIX					
					Distance Downstream in metres					
					5	18.75	47.5	63.75	70	150
	15-Jul-99	566	23.0	19.5	9.28	5.05	3.95	3.40	3.20	1.16
*	22-Jul-99	538	23.0	20.0	9.23	4.97	3.95	3.39	3.19	1.69
	29-Jul-99	394	25.0	20.5	8.94	4.34	3.64	3.34	3.23	2.06
	5-Aug-99	303	23.5	21.0	8.80	3.99	2.52	2.16	1.89	1.18
*	12-Aug-99	217	21.9	21.0	8.59	3.81	1.92	1.82	1.78	1.40
	19-Aug-99	227	21.2	21.0	9.05	3.87	1.86	1.77	1.74	1.43
	26-Aug-99	320	22.9	20.8	8.83	4.26	2.58	2.21	2.10	1.14
	2-Sep-99	328	21.0	20.6	8.89	4.29	2.62	2.24	2.13	1.14
	9-Sep-99	275	16.8	20.3	8.71	4.53	2.73	1.48	1.45	1.16
*	16-Sep-99	663	14.0	20.0	8.40	7.23	4.30	3.06	2.73	0.91

*Sample Dates

TABLE 3-5

Water Chemistry Monitoring at Bivalve Placement Stations, July 20, 1999

Station #	Bivalve Cage #'s	Distance from Outfall (m)	Ammonia Concentration[a] (mg/l)		Ph	Temp. (^{o}C)	D.O.[b] (mg/l)	Cond.[c] uS	Velocity (m/sec)
			2m Depth	3m Depth					
1	2,10,13	5	2.5	2.5	8.0 / 7.6[d]	22.6 / 22.6	7.53 / 7.58	730 / 800	1.0 / 1.1
2	6,17,24	20	2	2	7.6 / 7.7	22.6 / 22.7	7.46 / 7.52	750 / 760	1.3 / 1.1
3	5,7,21	30	1.5	1.5	7.9 / 7.6	23.2 / 23.1	7.47 / 7.5	750 / 740	1.1 / 1.1
6[e]	4,8,14	50	-	-	-	-	-	-	-
5	9,18,23	75	2	1.5	7.7 / 7.8	23.2 / 23.2	7.51 / 7.49	730 / 750	1.2 / 1.2
4[f]	11,15,22	150	-	-	-	-	-	-	-
Reference	12,16,19	100 m upstream	0.2	0.2	8.3 / 8.3	23.3 / 23.3	7.61 / 7.63	700 / 700	1.2 / 1.0

[a] = Ammonia concentrations taken using a ChemMet Kit

[b]D.O. = Disolved Oxygen

[c]Cond. = Conductivity

[d] = For all other parameters, measurements taken at 2m and 3m depth, respectively, are separated by "/"

[e] = Float marker not visable; parameters not measured.

[f] = Water pump failed; surface Ammonia = 0.2 mg/l, pH = 8.3, Temp. = 23.4

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TABLE 3-6

Water Chemistry Monitoring at Bivalve Placement Stations, Aug. 13, 1999

Station #	Bivalve Cage #'s	Distance from Outfall (m)	Max. Depth (m)	Ammonia Concentration[a] (mg/l)	Ph	Temp. (°C)	D.O.[b] (mg/l)	Cond.[c] uS	Velocity (m/sec)
1	2,10,13	5	4.5	2 (<0.3) / 7 (6.9)[d]	7.3 / 7.4	21.2 / 21.1	7.87 / 8.0	840 / 830	0.5 / 0.4
2	6,17,24	20	5	5 / 4 (6)	7.4 / 7.5	21.2 / 21.2	8.17 / 8.18	790 / 790	-[e]
6	4,8,14	50	5	Surface (S) = 4 5m = 3	S = 7.6 5m = 7.7	S = 21.3 5m = 21.2	S = 8.18 5m = 8.19	S = 770 5m = 750	-
5	9,18,23	70	5	3m = 4 5m = 4	3m = 7.6 5m = 7.6	3m = 21.3 5m = 21.3	3m = 8.15 5m = 8.11	3m = 770 5m = 760	-
3	5,7,21	95	6	3m = 3 (3.7) 5m = 4	3m = 7.7 5m = 7.6	3m = 21.2 5m = 21.2	3m = 8.27 5m = 8.48	3m = 880 5m = 860	-
4	11,15,22	150	4	3m = 3 4m = 4	3m = 7.8 4m = 7.7	3m = 21.2 4m = 21.2	3m = 8.29 4m = 8.07	3m = 870 4m = 880	-
Reference	12,16,19	100 m upstream	4.5	3m = 0.1 (<0.3)	8.4	21.1	8.05	810	0.3

[a] = Ammonia concentrations from samples analyzed at the NEWPCC lab = ( ), other measurements taken using ChemMet kit

[b] D.O. = Disolved Oxygen

[c] Cond. = Conductivity

[d] = Measurements taken at 2m and 4m depth, respectively, are separated by "/"

[e] = Velocity meter not working

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TABLE 3-7

Water Chemistry Monitoring at Bivalve Placement Stations, Sept. 14, 1999

Station #	Bivalve Cage #'s	Distance from Outfall (m)	Ammonia Concentration[a] (mg/l)	Ph	Temp. (^oC)	D.O.[b] (mg/l)	Cond.[c] uS
1	2,10,13	5	3.5[d]	7.4	15	9.1	570
2	6,17,24	25	<0.5	8.2	14.5	8.73	510
6	4,8,14	40	<0.5	8.1	14.5	8.76	510
5	9,18,23	60	<0.5 [1.5]	8.1 [7.4]	14.5 [14.6]	[8.8]	520 [550]
3	5,7,21	100	<0.5 [1.5]	8 [7.4]	14.5 [14.6]	8.79 [9]	510 [530]
4	11,15,22	150	<0.5	8	14.5	8.79	510
Reference	12,16,19	100 m upstream	-	-	-	-	-

[a] = Measurements taken using ChemMet kit

[b]D.O. = Disolved Oxygen

[c]Cond. = Conductivity

[d] = All measurments taken at 3m depth; measurements taken in morning, with those taken in afternoon denoted [ ].

Note: High river velocities resulted in variable plume position. Plume was closer to shore at the time morning measurements were taken. Plume position was variable during the day. During the afternoon, the three stations furthest from the plume were exposed to effluent as indicated by pH of 7.7 or less. Other cages were not moved closer to shore where the plume was due to shallow water.

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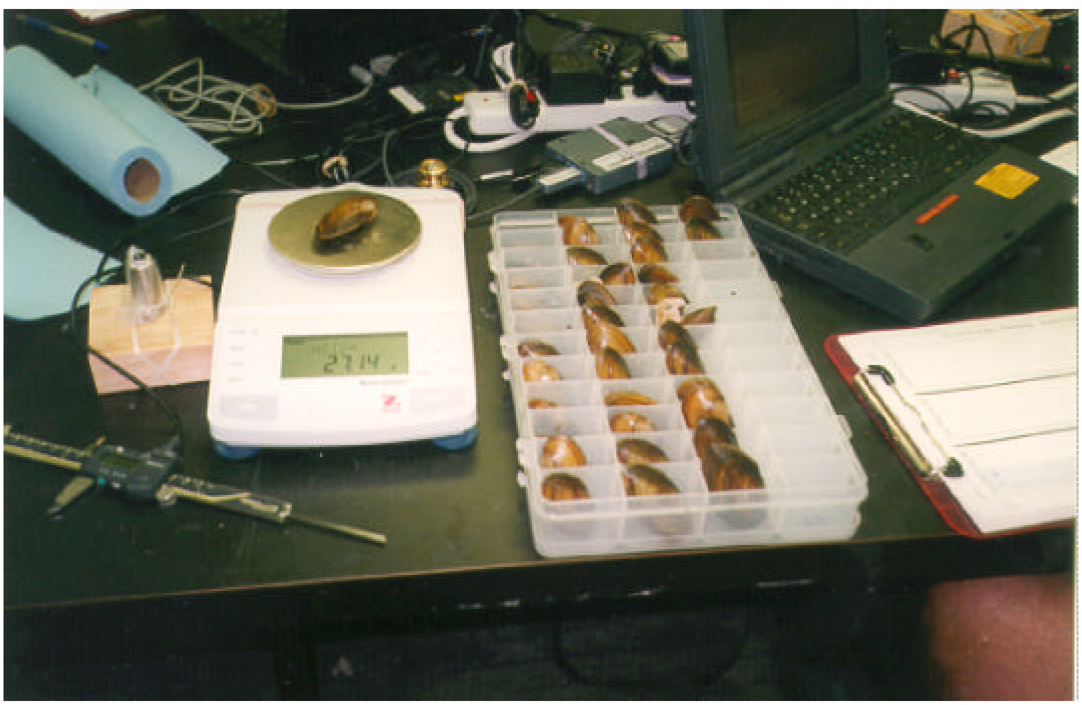
At the end of the exposure period the cages were retrieved from the river (c.f. Table 3-4) and transported to the NEWPCC laboratory for end-of-test (EOT) measurements. For the floater mussels, the number of dead individuals was recorded and all live mussels were measured for WAWW, shell length, tissue weight and shell weight (Figure 3-26) (c.f. Appendix H). Tissues were removed from the shells, weighed and retained for chemical analysis for coprostanol and cholesterol by the Centre Saint-Laurent in Monteal. The ratio of coprostanol to cholesterol ("Cop: Chol") is a biomarker for exposure to human sewage (Gagne *pers. comm.* 2000). The purpose of the mussel tissue-chemical analyses was to verify and quantify, if possible, exposure to NEWPCC effluent. The fingernail clams experienced high mortality and therefore, measurements focused primarily on survival rather than growth. Some fingernail clams were measured for WAWW and shell length, but no tissues were collected, weighed, or retained for chemical analysis.

Data from the temperature monitors, recorded in 15-minute intervals, were downloaded using the instruments' data recovery software following test termination. Water chemistry measurements were made three times throughout the test (i.e. near the beginning, middle and end) to verify exposure concentrations along the dilution gradient in the river.

3.1.2.2 Laboratory Test

Floater mussels and fingernail clams were exposed to a series of effluent concentrations under semi-static conditions for a period of 66-days and 8-days, respectively. Effluent concentrations ranged between 1.5% and 100% and represented decreasing effluent concentrations from the NEWPCC outfall. The selected exposure concentrations of effluent were intended to correspond to the concentrations expected at the field stations. River water collected manually 0.5 km upstream from the NEWPCC outfall was used to achieve the desired dilutions of effluent. It was also used as the control water.

For the laboratory bivalve tests, the test-chambers consisted of 36 inch, PVC pipes capped at the bottom (Figure 3-27). For the floater mussels, 2.5L of test-solution was added to each chamber; 1.0L of test-solution was used for the fingernail clams. Six effluent concentrations (i.e. 100%, 25%, 12.5%, 7%, 3% and 1.5%) plus a control of pure river water were replaced daily according to the procedure described below:



Re-measuring Mussels at Termination of Bivalve Tests

Figure 3-26

muslmeas
s\01\0110\22\99tox

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Laboratory Bivalve Test Set-up

Figure 3-27

1) Remove bivalves from test-chambers containing 100% river water and 100% treated effluent. Discard and replace old test-solution with daily grab samples of river water and effluent. Replace bivalves.
2) Mix 5-L of treated effluent with 15-L of river water to obtain an effluent concentration of 25%.
3) Remove bivalves from test-chambers containing 25% effluent. Distribute 10-L of the solution mixed in (2) to the test-chambers and replace bivalves. (Note: retain excess 10-L solution).
4) Add 10-L of river water to the 10-L of 25%-solution. (i.e., dilute by a factor of 0.5).
5) Repeat steps (3) and (4) until the mixture has been diluted in half 5 times (i.e., effluent concentration = 1.56%).

Three replicate chambers were prepared for each effluent concentration and the controls. Test chambers were distributed between two water baths and secured with plastic screens (cf. Figure 3-27). The water baths were used to maintain an average temperature of approximately 21^{o}C. The test chambers were aerated continuously at a rate of 235 to 285 ml/min (cf. Appendix A).

DO concentrations, pH, temperature, conductivity and NH_3-N concentrations were measured daily from one replicate of each exposure concentration and control group for each species. Mortality checks were completed at least three times per week for all test chambers and everyday for test chambers containing 100% or 25% effluent. If any dead organisms were found during the mortality check, they were removed from the mesh bags, their lengths were measured and recorded, and they were discarded.

On the 14th day of the floater mussel-test, approximately 0.4 grams of organic material collected from La Salle River were added to each test-chamber to supplement the food supply already present in the effluent river water mixture. From Day 15 until the end of the test on Day 66, 0.1 to 0.4 grams of this organic material, live brine shrimp or dissolved *Spirulina* algae pellets were added to the test chambers to provide a varied diet for the floater mussels.

At test termination, the number of dead floater mussels was recorded and all live mussels were measured for WAWW, shell length, tissue weight and shell weight (Figure 3-26) (c.f. Appendix H). Tissues were removed from the shells, weighed, and retained for chemical analysis for coprostanol and cholesterol by the Centre Saint-Laurent. The net change in mass of each floater mussel from the BOT to EOT was paired with nominal treated effluent concentrations to generate inhibitory concentrations affecting the growth of 50% and 20% of the test-population (c.f. Appendix F). Similarly, percent-survival data were used together with nominal treated effluent concentrations to generate $LC_{50/20}$ values for the floater mussels and the fingernail clams (c.f. Appendix F). Growth metrics were not used for response-analysis of fingernail clams to NH_3 exposure.

3.1.3 <u>Other Invertebrate Testing</u>

3.1.3.1 *Ceriodaphnia dubia*

Two semi-static tests were conducted on *Ceriodaphnia dubia* over seven days to assess the survival and reproduction of organisms exposed to varying concentrations of NH_3 in (1) Red River water and (2) treated effluent diluted with Red River water. Tests were conducted by ESG International laboratories in Guelph, Ontario, according to Environment Canada protocol (EPS 1/RM/21). Copies of ESG's reports are provided in Appendix I. ESG International Inc. is accredited/certified by the Canadian Association for Environmental Analytical Laboratories (CAEAL) and the Standards Council of Canada (SCC).

Two grab samples of Red River water were collected by Tetr*ES* personnel and transported in 20 L carboys to ESG International at the start of the study. Similarly, grab samples of treated effluent were shipped on the first, second and sixth days of the tests. Sufficient supplies of effluent were sent on Day 2 to be used on the third, fourth and fifth days of the tests. All river water and effluent samples were stored at a temperature of 6^oC prior to use (c.f. Appendix I).

The test-organisms were cultured from ESG stock and only neonates (i.e. <24 hr) were used. Each test consisted of six NH_3 concentrations plus a control group to which 10 replicate test-chambers containing one organism each were exposed. Test-organisms were fed 0.2 ml of YCT food and algae once daily.

Test-solutions were replenished daily according to the protocol described by ESG in Appendix I. Test-organisms were checked daily for mortality and/or offspring and daily initial and final measurements of temperature, pH, DO and conductivity were obtained. A summary of test-conditions for both tests (i.e., T12A&B) is provided in Table 3-1 and Appendix A.

Prior to and following daily replacements of river water and effluent test-solutions, ESG personnel collected 30 ml samples of each exposure-solution for analysis by the NEWPCC laboratory. Results are reported in Appendix D. The NH_3-N data generated was used to calculate NH_3 concentrations as described previously for acute-exposure tests with fish (i.e., Section 3.1.1.1 and Appendix E). Similarly, this information was used together with survival and reproduction data to generate $LC_{50/20}$ and $EC_{50/20}$ concentrations by linear interpolation (c.f. Appendix F).

3.1.3.2 *Hyalella* azteca

Pollutech Enviroquatics Limited was retained by Tetr*ES* to conduct a 28-day, chronic-exposure test and a 96-hr acute-exposure test on *Hyalella azteca* using ammonia-spiked Red River water. Grab samples of river water were collected from a pump located approximately 0.5 km upstream of the NEWPCC outfall. The water was shipped to Pollutech for use in acclimating the test-organisms and subsequently as the toxicant-containing medium. Details of the test-conditions are reported in Table 3-1 and Appendix A.

The test procedure was very similar to that used by Borgman (1994), considered the seminal test published to date of *Hyalella* sensitivity to ammonia. In brief, 104-day old *H. azteca* were held in one-litre clear plastic cups containing approximately 450 ml of ammonia/river-water solution. Five exposure concentrations ranging between 0.5 mg/L and 8.0 mg/L (total ammonia) plus a control group containing only river water were used for the 28-day test. Organisms used in the 96-hr test were held in 6 different test solutions ranging between 1.9 mg/L and 60 mg/L (total ammonia) plus a control group. The highest nominal exposure concentrations were obtained by the addition of ammonium chloride stock solution to river water in predetermined volumes. The remaining concentrations were made using a half by half dilution series. Five replicates of each exposure concentration and ten replicates of control solution were used during the 28-day test. Each replicate contained 20 organisms each. Two replicates containing 10 organisms each were in place for control and exposure test solutions during the 96-hr test.

Test solutions were aerated vigorously prior to use and were replaced as indicated in Appendix A. Appendix A also describes the feeding regimes for these two tests.

Survival and reproduction were measured at least once per week during the 28-day test. The number of neonates produced per adult female was used to quantify reproduction rates. Survival rates were monitored daily for the acute-exposure test, but due to the short test duration, reproduction was not an appropriate endpoint.

Unionized ammonia concentrations were calculated at the end of each test using test-temperature, test pH and nominal total-ammonia concentration measurements. Temperature and pH measurements were obtained using a VWR pH meter Model 2000. Nominal total-ammonia concentrations were verified on-site with a Hach kit for both tests and off-site for the 28-day test using an Auto Analyser stationed at the NEWPCC in Winnipeg. Unionized ammonia concentrations together with the respective survival and reproduction data were entered into the ICPIN program and used to derive $EC_{50/20}$ and/or $LC_{50/20}$ results.

4. RESULTS

4.1 FISH TESTING

A key focus of the design of the testing program was satisfaction of applicable test protocols, such as ASTM, OECD, USEPA or Environment Canada. The degree of satisfaction of either ASTM or USEPA protocols for acute- and chronic-exposure toxicity tests conducted with fish is shown in Appendix J, Tables J-1 and J-2. Explanations are provided when test conditions deviated from recommended test-acceptability criteria.

4.1.1 Acute-exposure

Ten acute-exposure tests were completed under static or semi-static conditions using walleye, white sucker and fathead minnow fry. Each test produced a mortality response for 20% and 50% of the organisms in each test population and corresponding $LC_{50/20}$ values are documented in Appendix K, Table K-1. Where more than one test was conducted for a single species, the geometric mean of all LC_{50} and of all LC_{20} values was calculated and is reported in Table 4-1. These data indicate relative sensitivities of fish-species exposed to NH_3 in (a) river water and (b) treated effluent.

NH_3 concentrations in spiked river water that were lethal to 50% of the walleye, white sucker and fathead minnow test-organisms (i.e., LC_{50}s) were 0.337 mg/L, 0.384 mg/L and 0.569 mg/L, respectively (c.f., Table 4-1). These data suggest the following relative species sensitivity: walleye > white sucker > fathead minnow. However, this trend was not maintained with lower NH_3 concentrations. NH_3 became acutely toxic to 20% of walleye test-populations at 0.269 mg/L and to white sucker test-populations at 0.242 mg/L, suggesting that walleye are less sensitive to NH_3 exposure than white sucker. Fathead minnows continued to show the greatest degree of tolerance when tested under local conditions, obtaining an LC_{20} value of 0.272 mg/L.

When the relative sensitivities of white sucker and fathead minnows to NH_3 exposure in treated effluent were compared, stressor concentrations that produced mortality responses in 50% or 20% of the test-populations were similar to one another, being values between 0.255 and 0.298

TABLE 4-1: LETHAL CONCENTRATIONS OF NH_3 FOR TEST POPULATIONS OF FISH AFTER ACUTE-EXPOSURE

	Pooled LC_{50} values (mg NH_3/L)		Pooled LC_{20} values (mg NH_3/L)	
Test Species	**River Water Spiked with NH_3**	**Effluent Spiked with NH_3**	**River Water Spiked with NH_3**	**Effluent Spiked with NH_3**
Walleye	0.337 (1)		0.269 (1)	
White Sucker	0.384 (3)	0.298 (3)	0.242 (3)	0.259 (3)
Fathead Minnow	0.569 (1)	0.287 (2)	0.272 (1)	0.255 (2)

Notes:

1. *Pooled* refers to the average percent-response of test-organisms in $\underline{n}$ replicate-exposure vessels (where $\underline{n}$ = the number of replicates as given in Appendix A).
2. LC_x = the concentration of a stressor that is estimated to be lethal to x% of test-organisms over a specific time interval (e.g., 96 hr LC_{50}).
3. NH_3 = unionized ammonia (i.e., stressor).
4. The number of tests (n) used to derive LC_{50} and LC_{20} values is given in brackets. When n>1, the geometric mean of the corresponding number of tests is reported. Lethal ammonia concentrations for each test (denoted by test number and duration) are reported in Table K-1, Appendix K.
5. All $LC_{50/20}$ values were derived via linear interpolation using the ICPIN program as described in Appendices F and F-1.

mg/L (c.f., Table 4-1). These results suggests that a threshold limit of NH_3 tolerance in effluent exists at approximately 0.275 mg/L. Below this limit, the mortality rate is relatively low (<20%), but above this threshold value, mortality rates increase substantially. LC_{20} values for fish exposed to NH_3 in river water and effluent are not significantly different, however the tolerance of white sucker and fathead minnow to NH_3 decreased by 22% and 50%, respectively, when they were held in spiked effluent. This suggests a synergistic response between NH_3 and other constituents in treated effluent for these species when the NH_3 concentration is greater than about 0.275 mg/L.

Growth effects were quantified based on whole body dry weights at test termination, but no statistically significant effects were observed.

NH_3 concentrations were calculated at end of each test based on daily temperature, pH and NH_3-N data. These data and results are reported in Appendix E-1, Tables E1-E10. In general, higher NH_3-N concentrations in test-chambers produced higher NH_3 concentrations. However, 3 of 10 tests using NH_3-spiked effluent deviated from this trend (i.e., Tests 4A, 4B and 6B). During these tests, exposure vessels containing the highest NH_3-N concentrations had lower proportions of NH_3 than subsequent exposure concentrations in the dilution series. A substantial reduction in pH was observed at higher exposure concentrations in each of these three tests, and it is likely that the greater percentage of effluent lowered the pH and shifted the ratio of ionized to NH_3 in favour of the former.

In general, the number of surviving test organisms decreased with increasing NH_3 exposure and in 6 of 10 tests, and 100% mortality was attained in the highest exposure-concentrations (c.f., Appendix F-1, Tables F1-F10). Partial mortality was observed in at least two exposure concentrations for all tests. The USEPA recommends that survivorship in the controls equal 90% or greater during acute-exposure testing (Appendix J, Table J-1) and in 7 of 10 tests documented here, control group survival was greater than 95%. Higher mortality rates of 30% and 23% were observed in control groups for Tests 1A and 2A&B, respectively but these data were smoothed and adjusted for control-mortality during statistical analysis as explained in Appendix F so that the toxic effects of NH_3 would not be overestimated (c.f., Appendix F).

Between six and eight exposure concentrations were used for all 10 acute-exposure tests, but a control group containing 100% river water was in place for only 8 of 10 tests. Where such controls were lacking, test chambers containing the lowest effluent concentration that produced survival rates similar to those experienced by control-organisms in other acute-exposure tests were used as surrogate controls during data analysis (Appendix F-1, Tables F-7 and F-8).

DO concentrations for acute-exposure tests measured between 62% and 93% saturation (Appendix L, Table L-1). Tests 1A and B had mean percent saturation values of 78% and 77% plus or minus 17% and 15%, respectively. The variation in DO levels observed throughout Tests 1A and B is typical of non-aerated static testing because the fixed amount of DO present in solution initially is gradually consumed throughout the test. Similar results are reported in the public-domain literature (e.g., Bergerhouse 1992). Tests 6A and B were aerated continuously and therefore maintained DO levels close to the saturation point (i.e., 93% ± 5%).

4.1.2 <u>Chronic-exposure</u>

Ten semi-static or flow-through chronic-exposure tests ranging in length between 5 and 30 days were completed using white sucker, lake whitefish, and northern pike fry and juvenile channel catfish, fathead minnows, walleye and lake trout. Exposure periods of fish held in the flow-through laboratory were variable due to:

- the occurrence of cannibalism in the northern pike (test T18 – terminated for this reason after 12 days),
- a pump failure (test T14 – terminated after 5 days); and
- control-organism mortality greater than 20% (test T15 – terminated after 13 days).

Tests with lake trout and whitefish were conducted opportunistically, as benchmark tests, but these results will be discussed independently of the derivation of a site-specific Ecological Risk Criterion because the fish are not indigenous to the Red and Assiniboine Rivers.

Average NH_3 concentrations and the corresponding mortality or growth effects on test fish as measured by percent survival and dry weights at test termination are tabulated in Appendix F-2, Tables F11-F29. LC_{20} results created with these data are reported in Table 4-2 and suggest that northern pike is the most sensitive local species tested, followed by channel catfish and walleye. LC_{20} values for these three tests are 0.130 mg/L, 0.163 mg/L and 0.204 mg/L,

TABLE 4-2: LETHAL AND EFFECTIVE CONCENTRATIONS OF NH_3 FOR TEST POPULATIONS OF FISH AFTER CHRONIC-EXPOSURE

	Endpoint: Survival		Endpoint: Growth	
Test Species	**Pooled LC_{50} values ($mg\ NH_3/L$)**	**Pooled LC_{20} values ($mg\ NH_3/L$)**	**Pooled EC_{50} values ($mg\ NH_3/L$)**	**Pooled EC_{20} values ($mg\ NH_3/L$)**
White Sucker	0.496 (3A – 10 day)[a]	0.359 (3A – 10 day)[a]	**	**
	0.278 (3B – 10 day)[b]	0.218 (3B – 10 day)[b]	**	**
Channel Catfish	0.353 (T8 – 30 day)[a]	0.163 (T8 – 30 day)[a]	**	**
Local Fathead Minnow	** >0.575 (T9–30 day)[a]	** >0.575 (T9 – 30 day)[a]	**	0.518 (T9 – 30 day)[a]
Imported Fathead Minnow	** >0.303 (T11 – 29 day)[a]	** >0.303 (T11 – 29 day)[a]	**	**
Walleye	** >0.243 (T21 – 30 day)[a]	0.204 (T21 – 30 day)[a]	**	**
Northern Pike	0.431 (T18 – 12 day)[a]	0.130 (T18 – 12 day)[a]	**	**
Lake Whitefish –untreated	0.430 (T14 – 5 day)[a]	0.355 (T14 – 5 day)[a]	Not measured	Not measured
-treated	0.451 (T15 – 5 day)[a]	0.377 (T15 – 5 day)[a]	Not measured	Not measured
-treated	0.244 (T15 – 13 day)[a]	0.152 (T15 – 13 day)[a]	Not measured	Not measured
Lake Trout	0.252 (T20 – 30 day)[a]	0.027 (T20 – 30 day)[a]	**	**

Notes:

1. *Endpoint* refers to a biological response that can be measured and described quantitatively. Here, survival is quantified as the percentage of live organisms at test-termination; growth is measured as a change (increase/decrease) in body weight (based on dry weights at test-termination) across test-exposure gradients compared to dry weights of the controls.
2. *Pooled* refers to the average percent-response of test organisms in $\underline{n}$ replicate-exposure vessels (where $\underline{n}$ = the number of replicates, as given in Appendix A).
3. *NH_3* = unionized ammonia (i.e., stressor).
4. LC_x = the concentration of a stressor that is estimated to be lethal to x% of test organisms over a specific time interval (e.g., 10 day LC_{50}).
5. EC_x = the concentration of a stressor that is estimated to be effective in producing a sub-lethal biological response in x% of test organisms over a specific time interval (e.g., 10 days EC_{50}).
6. Test number and duration of exposure are given in brackets.
7. ** No linear interpolation estimate could be calculated for LC/EC_{50} or LC/EC_{20} value since none of the pooled group response means were less than 50% or 80% of the control response means, respectively. The $LC_{50/20}$ values are logically greater than the highest exposure concentration tested.
8. [a]Ammonia Source: ammonium chloride (NH_4Cl)
   [b]Ammonia Source: treated effluent and NH_4Cl
9. untreated – fish were not afflicted with a fungal infection prior to test-start
   treated – fish were afflicted and treated for a fungal infection prior to test-start
10. Reported $LC_{50/20}$ and $EC_{50/20}$ values were derived via linear interpolation using the ICPIN program described in Appendices F and F-2.

respectively. White sucker were exposed to NH_3 in both river water and effluent and showed a higher degree of tolerance in 20% of the test population than walleye, regardless of the treatment (i.e., white sucker LC_{20} [spiked river water] = 0.359 mg/L, white sucker LC_{20} [spiked effluent] = 0.218 mg/L versus walleye LC_{20} [spiked river water] = 0.204 mg/L). However, when white sucker were exposed to spiked, treated effluent, 50% of the test population died in 0.278 mg NH_3/L, a concentration almost half as much as needed to kill 50% of the population in spiked river water but only 22% greater than needed to kill 20% of the population in spiked effluent. This suggests that there is a constituent in effluent that enhances the toxicity of NH_3 to white sucker at NH_3 concentrations between 0.218 mg/L and 0.278 mg/L. No measurable effects on growth were detected during these tests.

Test 9 (i.e., local fathead minnows exposed to NH_3 in river water) had a consistently low percent-mortality of approximately 5% for all exposure-concentrations and Test 11 (i.e., imported fathead minnows exposed to NH_3 in river water) had a control mortality of 14% with similar or lower mortality responses in exposure chambers (c.f., Appendix F-2, Tables F-17, F-19 and Graphs F-17, F-19). Point estimates of lethal NH_3 concentrations could not be computed statistically, but the highest concentrations of NH_3 tested that did not result in significant differences in mortality across exposure gradients in comparison with the controls (i.e., the no-observable-effective-concentration or NOEC) for Tests 9 and 11 are reported in Table 4-2 as 0.575 mg/L and 0.303 mg/L, respectively.

Growth effects, based on dry weights per fish at test termination, were observed in 20% of the local fathead minnow test population (i.e., T9), yielding an EC_{20} of 0.518 mg NH_3/L (c.f., Table 4-2). The dry weights and corresponding NH_3 concentrations used to calculate the EC_{20} are tabulated in Appendix F-2, Table F-18 and are plotted in Appendix F-2, Graph F-18.

Two tests were completed using lake whitefish treated for a fungal infection prior to test start (T15) and disease-free lake whitefish (T14). A pump failure terminated T14 after only 5 days of exposure and results are based on mortality counts obtained prior to the shut-down. Only one exposure concentration (i.e., nominal NH_3-N concentration = 2.0 mg/L) was affected by the pump failure during Day 2 of T15 and the test was allowed to continue for 11 days. On Day 13, the control mortality had risen to 20% and the test was therefore terminated. The results produced by T14 have been validated with results generated by T15 after 5 days of exposure. The LC_{50} and LC_{20} values reported in Table 4-2 for these two tests (i.e., LC_{50} = 0.430 mg/L

[T14], 0.451 mg/L [T15]; LC_{20} = 0.355 mg/L [T14], 0.377 mg/L [T15]) differed by <6%, suggesting that reproducible data had been generated from these tests. However, after 13 days of exposure, the degree of tolerance to NH_3 by 50% and 20% of the lake whitefish test-population had dropped to 0.244 mg/L and 0.152 mg/L, respectively (c.f. Table 4-2).

Lake trout fingerlings held in exposure chambers for 30 days lost 20% of their test population at an exposure concentration of 0.027 mg/L (cf. Table 4-2). However, the concentration of unionized ammonia required to produce ~50% mortality was 0.252 mg/L, a concentration similar to that required to produce the same effect on white sucker, lake whitefish and (potentially) on walleye (cf. Table 4-2).

NH_3 concentrations were calculated daily and averaged at the end of each test. The temperature, pH and NH_3-N data used during these calculations have been averaged for presentational purposes and are compiled in Appendix E-2, Tables E-11 to E-21. In 1999, test organisms were exposed to NH_3 concentrations ranging from 0.02 to 0.87 mg/L with background (i.e. Red River) levels of <0.01 mg/L (i.e., T3A, T3B, T8, T9, and T11). In 2000, the NH_3 concentrations ranged from 0.03 to 0.72 mg/L, with background levels of <0.03 mg/L (i.e., T14, T15, T18, T20 and T21).

Sufficient DO levels were maintained throughout each chronic-exposure test that oxygen tension ought not to have been a factor in the observed responses (c.f., Appendix L, Table L-2). Test solutions were replaced daily during tests 3A and B and yielded DO concentrations of 68% $\pm$ 10% saturation. Tests 8, 9, 11, 14, 15 had continuous test-solution replacement that maintained DO levels near the saturation/super-saturation point. Mean percent-saturation levels dropped to 90% and 87% during Tests 20 and 21 despite continuous-flow conditions, probably because of elevated summer temperatures and higher biochemical oxygen demand (BOD) in the Red River. On Day 13 of T20 and Day 9 of T21, all test chambers were aerated to maintain sufficient DO levels and as a contingency against a pump-failure event.

4.2 BIVALVE TESTING

4.2.1 ***In situ*, Chronic-exposure Tests**

4.2.1.1 Verifying Plume Exposure in Mussels

The late-summer flooding that caused the termination of the test at Day 65 arose from peak flows that changed the dispersion pattern of the NEWPCC effluent plume in the river (c.f. Figure 3-24). As noted in section 3.1.2.1, high river flows in July, followed by lower late summer (August) flows, followed by high September summer flows, caused changes in the exposures of the *in situ* test cages to the effluent plume (c.f. Figure 3-25). Notwithstanding efforts to re-deploy the cages to remain placed down the centreline of the plume in August and September, variation in river flows revised uncertainty about the extent of consistent exposure of the test organisms to the plume.

Tetr*ES* accordingly retained the Centre Saint-Laurent of Environment Canada to test mussel tissues for cholesterol and coprostanol as these steroids are considered biomarkers of human sewage. A high-pressure thin-layer chromatographic technique (Hoskin and Bandler 1987) offered the potential for verifying and quantifying chronic exposure to sewage biomarkers and was relied upon for testing of 21 end-of-test ("EOT") soft-tissue mussel samples from each of the 7 hypothetical plume-centreline monitoring stations. Table 4-3a provides the data on the concentrations of the human fecal steroids in the EOT mussel-tissue samples, and also the coprostanol:cholesterol ("Cop:Chol") ratio. Table 4-3b provides the same dataset where possible data outliers are removed. These data are presented in graphical format as Figures 4-2a and 4-2b.

The data indicate a linear trend for the EOT Cop:Chol ratio with downstream distance from the NEWPCC outfall. Because the ratio is considered a more precise biomarker for human fecal exposures than the concentrations of either coprostanol or cholesterol alone (Gagne pers. comm.. 2000), the linearity of the trend lines appears to confirm:

- chronic exposure to sewage effluent distinct from river-water exposure;
- that if exposure to the plume was inconsistent over the 65-day exposure period, sufficient quantities of human-sewage steroids present in effluent were nevertheless accumulated in the mussels to demonstrate exposure; and
- that effluent exposure can be quantified by means of an indirect or inferential measurement (such as the Cop:Chol ratio).

TABLE 4-3a

Ratio of Coprostanol/Cholesterol in the Complete Mussel Dataset Exposed to the NEWPCC Effluent

Distance from Outfall	Sample identification	Station #	Coprostanol ug/g	Cholesterol ug/g	Coprostanol/Cholesterol Ratio	Coprostanol/Cholesterol Average by Plume Sector	Coprostanol/Cholesterol Std Dev
Upstream Reference	07 12	7	1.77	8.22	0.21	0.13	0.09
	07 16	7	1.93	52.98	0.04		
	07 19	7	1.35	9.14	0.15		
5 to 25 metres	01 02	1	0.53	8.49	0.06	0.07	0.05
	01 10	1	1.56	10.25	0.15		
	01 13	1	1.04	43.63	0.02		
	02 06	2	0.56	9.17	0.06		
	02 17	2	0.95	11.40	0.08		
	02 24	2	0.32	9.27	0.03		
30 to 100 metres	03 05	3	1.12	51.85	0.02	0.10	0.05
	03 17	3	1.76	10.22	0.17		
	03 21	3	0.64	10.00	0.06		
	05 09	5	1.39	8.73	0.16		
	05 19	5	0.96	13.11	0.07		
	05 23	5	1.50	10.61	0.14		
	06 04	6	1.22	11.48	0.11		
	06 08	6	1.48	10.97	0.14		
	06 14	6	0.31	7.58	0.04		
150 metres	04 22	4	3.55	12.48	0.28	0.21	0.10
	04 11	4	1.28	12.65	0.10		
	04 15	4	2.08	8.53	0.24		

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TABLE 4-3b

Ratio of Coprostanol/Cholesterol in the Mussel Dataset Exposed to the NEWPCC Effluent with Outliers Removed

Distance from Outfall	Sample identification	Station #	Coprostanol ug/g	Cholesterol ug/g	Coprostanol/Cholesterol		
					Ratio	Average by Plume Sector	Std Dev
Upstream Reference	07 12	7	1.77	8.22	0.21	0.18	
	07 16	7	1.93	52.98	*'		
	07 19	7	1.35	9.14	0.15		
5 to 25 metres	01 02	1	0.53	8.49	0.06	0.08	0.04
	01 10	1	1.56	10.25	0.15		
	01 13	1	1.04	43.63	*'		
	02 06	2	0.56	9.17	0.06		
	02 17	2	0.95	11.40	0.08		
	02 24	2	0.32	9.27	0.03		
30 to 100 metres	03 05	3	1.12	51.85	*'	0.11	0.06
	03 17	3	1.76	10.22	0.17		
	03 21	3	0.64	10.00	0.06		
	05 09	5	1.39	8.73	0.16		
	05 19	5	0.96	13.11	0.07		
	05 23	5	1.50	10.61	0.14		
	06 04	6	1.22	11.48	0.11		
	06 08	6	1.48	10.97	0.14		
	06 14	6	0.31	7.58	0.04		
150 metres	04 22	4	3.55	12.48	0.28	0.21	0.10
	04 11	4	1.28	12.65	0.10		
	04 15	4	2.08	8.53	0.24		

Note: "*" values have been removed from the analysis as anomalous results due to the elevated cholesterol values noted.

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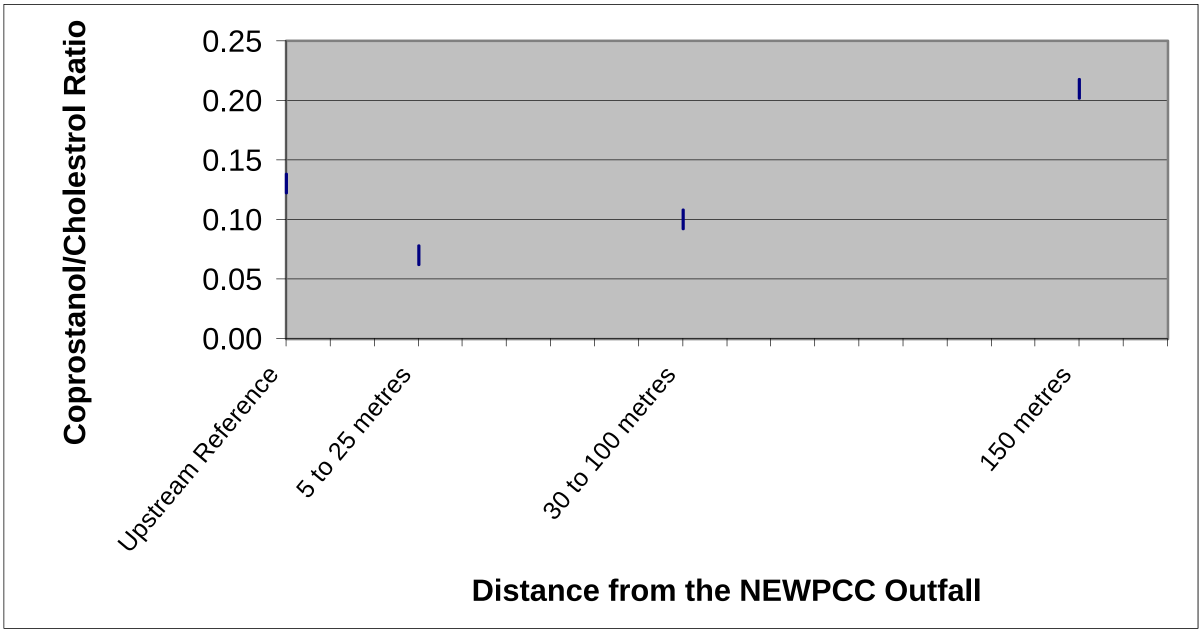

Figure 4-1a

Ratio of Coprostanol/Cholesterol in the Mussels Exposed to the NEWPCC Outfall - Complete Dataset

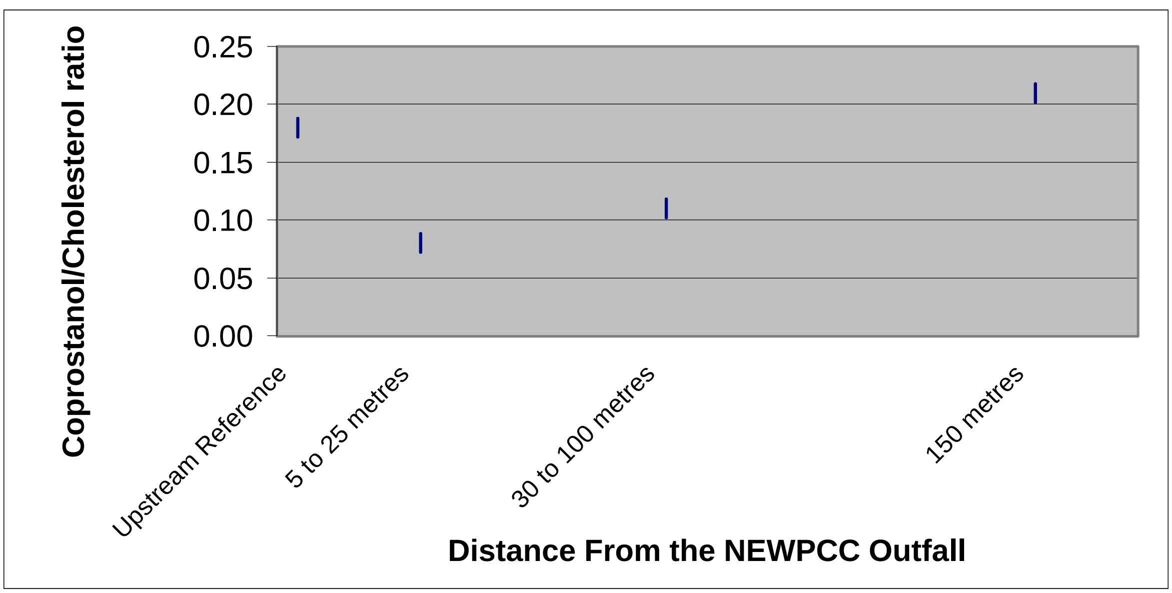

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Figure 4-1b

Ratio of Coprostanol/Cholesterol in the Mussels Exposed to the NEWPCC Outfall with Outliers Removed

4.2.1.2 Survival and Growth Responses

All cages were successfully retrieved after the 65-day deployment period. Survival for floater mussels was very high while survival for fingernail clams was much lower than expected. The study accomplished its major objectives: (1) to evaluate exposure and effects of ammonia associated with effluent from the COW - NEWPCC, and (2) to critically evaluate the utility of existing ammonia criteria based on a combination of laboratory and field toxicity tests.

Notwithstanding the evidence of a linear trend in exposure to effluent with distance downstream (cf. Figure 4-1a, 4-1b), there was no statistically significant difference in floater mussel survival among stations. There were, however, differences in growth for several metrics. Length growth rate was the most discriminating metric in terms of detecting differences among stations; length and length growth rate were the most discriminating for establishing relationships with distance from the diffuser and measured ammonia concentrations. Average mussel survival for floater mussels was 98% over the 65-day exposure period. Survival ranged from 95.7% at Station 70 m downstream from the outfall to 100% at Station 150 m downstream from the outfall. Increases in average shell lengths were relatively small but consistent across stations, with an overall average of approximately 3%. Increases in average weight were moderate at all stations, with an overall average of approximately 27%. Average tissue and shell weights increased 26 and 35%, respectively, when compared to the beginning-of-test (BOT) estimates. Length growth rates were calculated to facilitate comparisons with literature values that are commonly expressed in terms of shell length increase per unit time. Length growth rates among stations ranged from 0.116 to 0.316 mm/week with an overall average of 0.200 mm/week (cf. Appendix H). The highest length growth rate were found for mussels at the Reference Station located upstream of the NEWPCC outfall and the lowest at Station 1, the nearest station downstream of the outfall. All mussels in exposure station had significantly lower growth rates than the reference except mussels at Station 5, situated 70 m downstream of the outfall.

There was significant fingernail clam mortality that precluded making many of the growth measurements. There was no statistically significant difference in fingernail clam survival among stations, but a statistically significant relationship between survival and distance from the outfall was found. Based on the whole-animal wet-weight measurements made on surviving individuals, there was little to no growth in the fingernail clams during the exposure period.

A complete presentation of the results for the in-situ field bioassay is provided under separate cover (i.e., Appendix H).

4.2.2 Laboratory, Chronic-exposure Tests

Exposure to the various concentrations of effluent produced growth and survival responses in the floater mussels and a survival response in the fingernail clams as shown in Table 4-4. Lethal concentrations of treated effluent to 50% and 20% of the floater mussel test-population after 66 days of exposure are 62.9% and 30.1%, respectively. It should be noted, however, that control mortality, although accounted for during statistical analysis, was high at test termination (c.f., Appendix F-3, Table F-30) and increased from 16% to 39% during the final 11 days of exposure. This result reflects difficulties experienced with holding bivalves for prolonged periods of time in a laboratory setting, particularly in regards to maintaining an adequate food supply, and results should be considered with caution.

Growth of the floater mussels, quantified as a net change in weight from the beginning to the end of the test when exposed to low concentrations of treated effluent (i.e., 1.56% and 3%), was enhanced by 23-32% compared with growth of the control organisms (c.f., Appendix F-3, Table F-31 and Graph F-31). This result suggests that in low concentrations, one or more constituents of the treated effluent provided a food source that was unavailable to organisms exposed to pure river water. ANOVA statistical analysis of the dataset indicated growth to be lower in all effluent concentrations except the 1.5% test concentration (c.f., Appendix H). Multiple Range testing failed to identify the lowest effluent exposure as different from the controls (c.f., Appendix H). This is probably due to the fact that any change in growth within the laboratory system was very slight. Growth inhibition to 50% and 20% of the test population exposure was determined, using ICPIN analysis, to be 5.9% and 4.3% treated effluent, respectively (cf. Table 4-4).

Because of the high mortality, the fingernail clam test (i.e., T5B) was terminated after 8 days and survival data were generated (c.f., Appendix F-3, Table 32). A mortality-response curve in the data for the fingernail clams indicates an LC_{50} of 52.6% and an LC_{20} of 22.2% (Table 4-4, Appendix F-3, Graph F-32). No other endpoints were measured for the fingernail clams.

TABLE 4-4: LETHAL AND EFFECTIVE CONCENTRATIONS OF TREATED EFFLUENT FOR TEST POPULATIONS OF BIVALVES AFTER CHRONIC-EXPOSURE

		Endpoint: Survival		Endpoint: Growth	
Test Species	**Test No./ Duration**	**Pooled LC_{50} values (% effluent)**	**Pooled LC_{20} values (% effluent)**	**Pooled EC_{50} values (% effluent)**	**Pooled EC_{20} values (% effluent)**
Floater mussels	T5A - 66 days	62.9	30.1	5.9	4.3
Fingernail clams	T5B – 8 days	52.6	22.2		

Note:

1. *Endpoint* refers to a biological-response that can be measured and described quantitatively. Here, survival is quantified as the percentage of live organisms at test-termination; growth is measured as a change (increase/decrease) in net whole animal weight (WAWW) across test-exposure gradients compared to the net WAWW in the controls.
2. *Pooled* refers to the average percent-response of test organisms in n replicate-exposure vessels, where (n = the number of replicates as given in Appendix A).
3. LC_x = the concentration of a stressor that is estimated to be lethal to x% of test organisms over a specific time interval (e.g., 66 day LC_{50}).
4. EC_x = the concentration of a stressor that is estimated to be effective in producing a sub-lethal biological response in x% of test organisms over a specific time interval (e.g., 66 day EC_{50}).
5. Reported $LC_{50/20}$ and $EC_{50/20}$ values were derived via linear interpolation using the ICPIN program described in Appendices F and F-3.

Average DO concentrations were maintained near the saturation point for both bivalve-tests (Appendix L, Table L-3). For the first few days of the test, problems were experienced with the aeration system and DO levels in select test-chambers dropped to concentrations below 50% for short periods of time up to a few hours. After this problem was corrected, aeration was constant for the duration of the test.

4.2.3 <u>Other Invertebrate Testing</u>

4.2.3.1 *Ceriodaphnia dubia*

Two chronic-exposure tests, 7-days in duration, were completed using *Ceriodaphnia dubia* neonates. In the first test (i.e., T12A), the neonates were exposed to river water spiked with ammonia; in the second test (i.e., 12B), the neonates were exposed to treated effluent spiked with ammonia. Results of the tests show that NH_3 in river water produces an inhibitory effect on reproduction (measured as the total number of offspring produced during 7 days) in 50% of females at 1.460 mg/L and in 20% of females at 0.490 mg/L (Table 4-5). Similarly, NH_3 in treated effluent produced an inhibitory effect on reproduction in 50% and 20% of females at 1.553 mg/L and 1.114 mg/L, respectively (Table 4-5). These results, contrary to those produced during acute-exposure tests with fish, suggest that a constituent may be present in the effluent that reduces the toxicity effects of ammonia for this invertebrate. This result is most obvious at lower NH_3 levels that affect up to 20% of the population. Test organisms could tolerate NH_3 levels in spiked effluent that were twice as concentrated as ammonia levels in spiked river water.

Average NH_3 concentrations were calculated at the end of each test based on daily test-temperature, test-pH and NH_3-N data (c.f., Appendix E-3, Tables E22-E23). These values together with the average number of offspring produced in all replicates of each exposure concentration, were analyzed using the linear interpolation method and the ICPIN program (c.f., Appendix F). Appendix F-3, Graphs F-33 and F-34 provide a visual representation of the datasets and the calculated $EC_{50/20}$ values.

Average DO concentrations reported in Appendix L, Table L-3 were maintained near the saturation point with only a small standard deviation of ± 8%.

TABLE 4-5: LETHAL AND EFFECTIVE CONCENTRATIONS OF NH_3 FOR TEST POPULATIONS OF *Ceriodaphnia dubia* and *Hyalella azteca*

	Endpoint Survival		Endpoint Reproduction	
Test Species	**Pooled LC_{50} Values (mg NH_3/L)**	**Pooled LC_{20} Values (mg NH_3/L)**	**Pooled EC_{50} Values (mg NH_3/L)**	**Pooled EC_{20} Values (mg NH_3/L)**
Ceriodaphnia dubia	Not calculated	Not calculated	1.460 (T12A-7 day)[a] 1.553 (T12B-yday)[b]	0.490 (T12A-7 day)[a] 1.114 (T12B-7 day)[b]
Hyalella azteca	>0.783 (T22-28 day)[a] 3.035 (T23-96 hr)[a]	>0.783 (T22-28 day)[a] 2.176 (T23-96 hr)[a]	** not measured	** not measured

Note:

1. Endpoint refers to a biological response that can be measured and described quantitatively. Here, survival is quantified as the percentage of live organisms at test termination; reproduction is measured as a change (increase/decrease) in the number of neonates produced per female across test-exposure gradients compared to the number produced per female in the controls.
2. *Pooled* refers to the average percent-response of test organisms in n replicate-exposure vessels, where (n = the number of replicates as given in Appendix A).
3. NH_3 = unionized ammonia (i.e., stressor).
4. LC_x = the concentration of a stressor that is estimated to be lethal to x% of test organisms over a specific time interval (e.g., 28 day LC_{50}).
5. EC_x = the concentration of a stressor that is estimated to be effective in producing a sub-lethal biological response in x% of test organisms over a specific time interval (e.g., 28 day EC_{50}).
6. Test number and duration of exposure are given in brackets.
7. **No linear interpolator estimate could be calculated for LC/EC_{50} or LC/EC_{20} values since none of the pooled group response means were less than 50% or 80% of the control response mean, respectively. The $LC_{50/20}$ values are logically greater than the highest exposure concentration tested.
8. [a]Ammonia Source: ammonium chloride (NH_4Cl)
   [b]Ammonia sources: treated effluent and NH_4C1
9. Reported $LC_{50/20}$ and $EC_{50/20}$ values were derived via linear interpolation using the ICPIN program as described in Appendices F and F-3.

4.2.3.2 *Hyalella azteca*

Two tests were completed using *Hyalella azteca* adults exposed to ammonia spiked river water for 28 days (i.e., T22) or 96 hours (i.e., T23). The longer of the two tests was conducted first and survival or reproduction effects of exposed organisms were not statistically different than responses observed in control organisms. Consequently, the concentration of unionized ammonia required to produce a response in this invertebrate species is greater than 0.783 mg NH_3/L, the highest exposure-concentration tested (c.f. Table 4-5).

To define the level of unionized ammonia required to generate a response in *H. azteca*, a 96 hour $LC_{50/20}$ test was conducted using toxicant concentrations that were significantly higher than those used during the first test. From these data, it was determined that a 20% lethal-response occurs after 96 hour of exposure to 2.18 mg NH_3/L (c.f., Table 4-5). Also, 50% of the organisms died when exposed to 3.03 mg NH_3/L for the same amount of time. Overall, these results suggest that although unionized ammonia is toxic to *H. azteca* at elevated concentrations, the tolerance level of this organism is high compared to that of many other aquatic organisms (c.f. Tables 4-1, 4-2, and 4-5).

The data used to generate these results are recorded in Appendix E-3, Tables E24-E25 and Appendix F-3, Tables F36-F37 and are plotted together with ICP-generated results in Appendix F-3, Graphs F36-F37.

Average DO concentrations for the 28 day test were maintained at 77 $\pm$ 23% saturation. The 96 hour test had average DO concentrations of 90 $\pm$ 13% saturation (c.f., Appendix L, Table L-3). The former test may have had a slightly lower average DO concentration and higher standard deviation than the latter because test-solutions were replaced less frequently (i.e., once every 3 or 4 days instead of every second day). Also, a greater number of organisms was held in each test-chamber of the 28-day test.

5. DISCUSSION

In 1999, the USEPA published its *Update of Ambient Water-quality Criteria for Ammonia* for the protection of freshwater aquatic life. Both acute and chronic-exposure data are documented. Chronic-exposure data generated in studies reported by the USEPA (1999) can be compared with data derived by Tetr*ES* Consultants in the toxicity-testing program for the City of Winnipeg.

Table 5-1 tabulates LC/EC_{20}s for chronic-exposure studies with three species of fish (i.e., fathead minnows, white sucker and channel catfish) and two species of invertebrates (i.e., *Ceriodaphnia dubia* and *Hyalella azteca*) that are common to both the EPA dataset and to Tetr*ES*' dataset. All public domain results have been converted from total ammonia to NH_3 by reversing the calculations described by USEPA (1999, p. 107). Datasets were considered comparable if test-duration, life-stage of test-organisms, and endpoint-of-interest were the same or similar for a particular species.

Fathead minnow survival data showed a high degree of variance between LC_{20}'s calculated using data generated by Mayes et al. (1986) versus Tetr*ES* Consultants. The lethal unionized ammonia concentration affecting 20% of the test-population studied by Mayes et al. (1986) was 0.33 mg/L. Alternately, neither of the two tests conducted by Tetr*ES* on fathead minnows produced a lethality response in more than 20% of the population. Therefore, the concentration required to achieve this result is greater than the highest exposure concentration used during the two tests (i.e., >0.58 mg NH_3/L and >0.30 mg NH_3/L) (c.f., Table 5-1). These variances may reflect differences between test-conditions used by the two research groups, varying sensitivities between the test-populations or age differences between test-populations. The third suggestion is probable because Tetr*ES* conducted tests on juvenile fish whereas fathead minnow fry were tested by Mayes et al. (1983). Generally, fish fry exhibit a higher degree of sensitivity to environmental stressors than older, juvenile fish (USEPA, 1999). Test-conditions established by each of the two research groups were similar; both exposed fathead minnows to various concentrations of dissolved ammonium chloride diluted with river water for 28 to 30 days. However, differences in test-temperatures, test-pHs, exposure-technique, and source of river water may have also influenced the relative sensitivities of the two test-populations.

Table 5-1
COMPARISON BETWEEN TETRES' RESULTS AND RELEVANT PUBLIC-DOMAIN RESULTS FOR SELECTED CHRONIC-EXPOSURE TESTS

	Species	*Reference (from USEPA 1999) /Test No. (TetrES)	Test Description	Endpoint[a]	LC/EC_{20}[b] (mg NH^3/L)[c]	Comparable Datasets?				
Public-Domain results	Fathead minnow	Swigert and Spacie (1983)	30-day ELS[d] test with fry[e]	biomass[f]	0.165	N				
	Fathead minnow	Mayes et al. (1986)	28-day ELS[d] test with fry[e]	survival	0.330	Y				
TetrES' results	Fathead minnow	T9	30-day ELS[d] test with juveniles[g]	growth	0.520	N				
	Fathead minnow	T9	30-day ELS[d] test with juveniles[g]	survival	>0.58	Y				
	Fathead minnow	T9	29-day ELS[d] test with juveniles[g]	survival	>0.30	Y				
Public-Domain results	White sucker	Reinbolt and Pescitelli (1982[a])	31-day ELS[d] test with fry[e]	survival	>0.245		Y			
Tetr*ES*' results	White sucker	T3A	10-day ELS[d] test with fry[e]	survival	0.360		Y			
Public-Domain results	Channel Catfish	Swigert and Spacie (1983)	30-day ELS[d] test with fry[e]	biomass[f]	0.504			N		
	Channel Catfish	Reinbolt and Pescitelli (1982[b])	30-day ELS[d] test with fry[e]	growth	0.542			N		
	Channel Catfish	Colt and Tchobanoglous (1978)	31-day ELS[d] test with juveniles[g]	survival	$\geq$0.823 - $\leq$0.936			Y		
Tetr*ES*' results	Channel Catfish	T8	30-day ELS[d] test with juveniles[g]	survival	0.170			Y		
Public-Domain results	Ceriodaphnia dubia	Willingham (1987)	7-day LC[h] test with neonates[i]	reproduction	1.300				Y	
	Ceriodaphnia dubia	Nimmo et al. (1989)	7-day LC[h] test	reproduction	0.640				Y	
Tetr*ES*' results	Ceriodaphnia dubia	T12A	7-day LC[h] test with neonates[i]	reproduction	0.500				Y	
Public-Domain results	Hyalella azteca	Borgmann (1994)	10-wk LC[h] test with neonates[i]	reproduction	<0.091					Y
Tetr*ES*' results	Hyalella azteca	T22	28-day LC[h] test adults	reproduction	>0.783					Y

a - *Endpoint* refers to a biological response that can be measured and expressed quantitatively
b - LC_{20} = the concentration of a stressor that produces a mortality-response in 20% of test-organisms
EC_{20} = the concentration of a stressor that produces an inhibitory, sublethal-response in 20% of test-organisms
c- NH_3 = unionized ammonia
d - ELS = early life-stage (i.e., from shortly after fertilization through embryonic, larval, or early juvenile development)
e - fry = newly hatched or young fish
f - biomass = the product of a survival and a growth response
g - juvenile = young fish that have not reached sexual maturity
h - LC = life cycle (i.e., all life stages including the reproductive cycle)
i - neonates = newly hatched (<24hrs) invertebrates

A 20% reduction in growth of juvenile fathead minnows studied by Tetr*ES* was observed at 0.52 mg NH_3/L, a concentration more than 1.5X greater than the lethal concentration produced from data generated by Mayes et al. (1986). Also, a 30-day early life-stage test conducted by Swigert and Spacie (1983) reported sublethal responses at concentrations much lower than that required by Tetr*ES*' test-population (c.f. Table 5-1). The endpoint used by Swigert and Spacie (1983) was biomass, the product of survival and weight data, and generated an EC_{20} value of 0.17 mg NH_3/L. This value is more than 3X lower than the one generated by Tetr*ES* (i.e., 0.52 mg NH_3/L). The greater degree of tolerance to sublethal toxicity-effects exhibited in Tetr*ES*' test-organisms is consistent with observations noted above and may also reflect differences in life stages of the fish, test-conditions used or relative sensitivities of the test-organisms themselves.

Results generated by Tetr*ES* regarding NH_3 toxicity to white sucker are comparable with those reported by Reinbolt and Pescitelli (1982a) because both research groups conducted chronic-exposure tests with fry using survival as an endpoint. However, the exposure-concentrations used by Reinbolt and Pescitelli (1982a) were not high enough to bracket a 20% reduction in survival and therefore, an undefined concentration greater than 0.25 mg/L, (i.e., the highest exposure-concentration tested) is required to produce this result. This conclusion supports Tetr*ES'* results of an LC_{20} of 0.36 mg/L (c.f., Table 5-1).

Tetr*ES*' test-results with channel catfish are most readily comparable with results generated by Colt and Tchobanoglous (1978). Both research groups conducted ammonia toxicity tests on juvenile channel catfish for one-month using survival as an endpoint. However, LC_{50} values generated by these tests vary considerably (c.f. Table 5-1) and results generated by Tetr*ES* suggest that channel catfish are approximately 5X more sensitive to unionized ammonia exposure than data reported by Colt and Tchobanoglous (1978) would otherwise suggest. Furthermore, tests conducted by Swigert and Spacie (1983) and Reinbolt and Pescitelli (1982b) using channel catfish fry (i.e., a more sensitive life-stage than juveniles) monitored growth to yield EC_{20}'s of 0.50 mg NH_3/L and 0.54 mg NH_3/L, respectively that are 3X greater than the LC_{20} value of 0.17 mg NH_3/L (c.f. Table 5-1) reported by Tetr*ES*.

An EC_{20} for *Ceriodaphnia dubia* calculated by Tetr*ES* was similar to, but slightly more conservative than, the EC_{20} reported by Nimmo et al. (1989) (i.e., 0.50 mg NH_3/L versus 0.64 mg NH_3/L). However, both of these studies suggest that the sensitivity of *C. dubia* to NH_3 is more than two times greater than results produced during a similar test by Willingham (1987) would otherwise indicate. Willingham (1987) reported an EC_{20} of 1.30 mg NH_3/L (c.f. Table 5-1).

Finally, tests conducted on *Hyalella azteca* yield vastly different results as illustrated in Table 5-1. Borgmann (1994) conducted two 10-week life-cycle tests with less than one week old *H. azteca* and found that reproduction (measured as the number of neonates produced per replicate) in the lowest exposure-concentration tested was compromised by 25% compared to the control group. From these results USEPA (1999) report an EC_{20} value of <1.58 mg N/L at pH=7.94 and 25^{o}C which is equivalent with an EC_{20} of <0.09 mg NH_3/L. Alternately, reproduction was not affected by 20% at unionized ammonia concentrations up to 0.78 mg/L in *H. azteca* tested by Pollutech and reported by Tetr*ES*. This test was conducted for 28 days using adult amphipods, but these variations in test-protocols cannot fully explain the 9-fold increase in tolerance levels of *H. azteca* to unionized ammonia. The more probable explanation is that a constituent of Red River water reduces the toxicity effects of unionized ammonia to *Hyalella* observed by Burgmann.

In general, the local tests indicated both more and less sensitivity than the public domain dataset for the same species. No simple trend was observed indicating the importance of comprehensive testing of local species using local river water to develop criteria.

6. SUMMARY AND CONCLUSIONS

Throughout the Toxicity Workstream, 26 ammonia toxicity tests were completed on 11 different species of aquatic life including 7 fish species and 4 invertebrate species. This is a considerable technical accomplishment when compared with:

- 27 tests completed on 13 species which were found to be technically acceptable in an Environment Canada literature review of world-wide ammonia toxicity tests used to evaluate the toxicity of ammonia and in deriving a national protective criteria for Canada; and
- 28 tests completed on 12 species accepted by the USEPA in its world-wide literature review of the tests applicable for deriving a protective ammonia criteria for the USA.

Of the tests completed, in the present study, seven can be used directly in the derivation a chronic-criteria for ammonia. These tests were conducted on five fish species and two invertebrate species. Each test meets the objective of being an in-laboratory chronic-exposure test, using ammonia spiked river water (as opposed to effluent spiked river water), on local species found in the Red and Assiniboine rivers. A summary of these tests and the LC_{20} or EC_{20} values for each species is given in Table 6-1. Three of the tests were completed using the most sensitive key sport species, northern pike, channel catfish and walleye and have very good time-exposure-mortality datasets which can be used in the development of species-specific risk assessments.

Ten acute-toxicity tests were done on three fish species using both NEWPCC effluent and ammonia treatments. Resulting LC_{20} values are very similar despite the treatment and consequently, these tests confirm that ammonia is likely the main toxicant in NEWPCC effluent.

Four tests on two species of bivalves were done both in the laboratory and *in situ* downstream of the NEWPCC discharge-plume. The exposure to effluent of the *in situ* test was confirmed using coprostanol/cholesterol ratio. This ratio is considered a biomarker for human fecal exposures. The in-laboratory testing of bivalves showed signs of high mortalities in the controls indicating that laboratory testing of bivalves is difficult due to problems with feeding. The *in situ* bivalve tests assessed the impact of NEWPCC effluent (rather than ammonia only) and

TABLE 6-1

Summary of Tests to be Used Directly in Criteria Development

	Common Name	Species Name	Number of tests	Un-ionized Ammonia µg/L[1]	Test Type	EndPoint[2]	Duration Days	Mean pH[3]	Mean Temperature[3] °C
Fish	Catfish	*Ictalurus punctatus*	1	163	Flow Through	LC20	30	8.4	8.5
	Fathead Minnow	*Pimephales promelas*	1	518	Flow Through	EC20-Growth	30	8.4	8.5
	Northern Pike	*Esox lucius*	1	130	Flow Through	LC20	13	8.5	17
	Walleye	*Stizostedion vitreum*	1	204	Flow Through	LC20	30	8.1	18
	White Sucker	*Catostomus commersoni*	1	359	Semi Static	LC20	10	8.2	17.5
Invertabrates		*Ceriodaphnia dubia*	1	490	Semi Static	EC20-Reproduction	7	8.2	24
		Hyalella azteca	1	>780	Semi Static	LC20 EC-20 Reproduction	28	8.2	24

Notes:

1. All Tests used Ammonium Chloride as ammonia source (rather than effluent) and Red River water for dilution.
2. The lowest of either the LC20 (lethal concentrations at with 20% mortality) or EC20 (effective concentration with 20% reduction and specific effect) was used as the critical endpoint in criteria development
3. Temperature and pH varied throughout the test (details given in Appendix A).

therefore are useful as “other lines-of-evidence” to corroborate that the site-specific criteria selection is appropriate.

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APPENDIX A

AQUATIC TOXICITY-TEST CONDITIONS

APPENDIX A
AQUATIC TOXICITY TEST CONDITIONS

FISH TESTS

	Acute-Exposure "Warmwater" Test Conditions[a]						
TEST NUMBER	1A	1B	2A/2B	3A/3B	4A	4B	6A/6B
SPECIES - Common Name - *Scientific Name*	Walleye *Stizostedion vitreum*	White Sucker *Catostomus commersoni*	White Sucker *Catostomus commersoni*	White Sucker *Catostomus commersoni*	White Sucker *Catostomus commersoni*	Fathead Minnow *Pimephales promelas*	Fathead Minnow *Pimephales promelas*
AGE at Test Start	8 days	18 days	24 days	29 days	39 days	72 hours	72 hours
LIFE-CYCLE STAGE[c]	fry	fry	fry	fry	fry	fry	fry
WET WEIGHT	~ 1.7 mg[e]	~ 1.98 mg[e, f]	~ 3.1 mg[e]	~ 3.5 mg[e]	~ 7.4 mg[e]	~ .46 mg[e]	~ .46 mg[e]
SOURCE	SERM Fish Cultural Station (SK)	Grand Rapids (Cedar Lake) (MB)	Grand Rapids (Cedar Lake) (MB)	Grand Rapids (Cedar Lake) (MB)	Grand Rapids (Cedar Lake) (MB)	Aquatic Biosystems Inc. (CO, USA)	Aquatic Biosystems Inc. (CO, USA)
TEST TYPE (Static, Semi-static, flow-through)	Static	Static	Semi-static	Semi-static	Semi-static	Semi-static	Semi-static
DURATION	96 hrs	96 hrs	96 hrs	96 hrs 10 days	96 hrs	96 hrs	72 hrs
EXPOSURE VOLUME	600 mL	600 mL	500 mL	500 mL	500 mL	500 mL	750 mL
REPLACEMENT RATE	none	none	500 mL/d	500 mL/d	500 mL/d	500 mL/d	750 mL/d
NUMBER OF ORGANISMS/VESSEL	10	10	10	10	10	10	10
NUMBER OF REPLICATES/CON.	3	3	3	3	3	3	4
AERATION RATE (mL/Min.)	none	none	none	none	none	none	~ 45 mL/min
D.O. RANGE: mean ± SD (mg/L)[g]	8.1 ± 1.5	8.5 ± 1.2	6.1 ± 0.5	96 hrs 7.4 ± 0.50 10 days 6.9 ± 0.70	7.9 ± 0.6	7.5 ± 0.9	8.2 ± 0.5
TEMPERATURE RANGE: mean ± SD (°C)[g]	15.8 ± 1.1	15.7 ± 0.9	15.4 ± 0.9	96 hrs 17.5 ± 1.5 10 days 17.5 ± 1.0	18.2 ± 0.3	18.3 ± 0.3	20.9 ± 0.1
PH RANGE (min – max)[g]	8.2 – 8.4	8.2 – 8.5	8.0 – 8.3	96 hrs 8.1 – 8.3 10 days 8.0 – 8.4	8.1 – 8.4	8.0 – 8.3	8.5 – 8.8
FOOD TYPE	Liquid Baby Fish Food	Liquid Baby Fish Food	Not fed	Live Shrimp Brine	Live Shrimp Brine	Live Shrimp Brine	Live Shrimp Brine
FEEDING RATE	1 drop on day 3	1 drop on day 3	n/a	2 x daily ~ 4.4 mg dry wt.	2 x daily ~ 4.4 mg dry wt.	2 x daily ~ 4.4 mg dry wt.	2 x daily ~ 4.4 mg dry wt.

	Chronic-Exposure "Coldwater" Test Conditions			Chronic-Exposure "Warmwater" Test Conditions				
TEST NUMBER	8	9	11	14	15	18	20	21
SPECIES - Common Name - *Scientific Name*	Channel Catfish *Ictalurus punctatus*	Fathead Minnow *Pimephales promelas*	Fathead Minnow *Pimephales promelas*	Lake Whitefish (not diseased) *Coregonus clupeaformis*	Lake Whitefish (treated for a fungal infection prior to test start)	Northern Pike *Esox lucius*	Lake Trout *Salvelinus namacycush*	Walleye *Stizostedion vitreum*
AGE at Test Start	117 days	~ 90 days[b]	35 – 45 days	2½ - 3 weeks	3 - 3½ weeks	1½ weeks	5 - 5½ months	39 days
LIFE-CYCLE STAGE[c]	juvenile	juvenile	juvenile[d]	fry	fry	fry	juvenile	juvenile
WET WEIGHT	~ 5000 mg	~ 1300 mg	~ 47 mg	not measured	not measured	~ .23 mg[e]	650 mg	300 – 500 mg
SOURCE	Aquatic Research Organisms (NH, USA)	Local Drainage Pond/Winnipeg (MB)	Aquatic Resources (CA, USA)	Grand Rapids Hatchery (MB)	Grand Rapids Hatchery (MB)	SERM Fish Cultural Station (SK)	Grand Rapids Hatchery (MB)	Leonard's Walleye Culture (ON)
TEST TYPE (Static, Semi-static, flow-through)	Flow-through	Flow-through	Flow-through	Flow-through	Flow-through	Flow-through	Flow-through	Flow-through
DURATION	30 days	30 days	29 days	5 days	13 days	12 days	30 days	30 days
EXPOSURE VOLUME	10 L	10 L	1 L	700 mL	700 mL	700 mL	8 L	8 L
REPLACEMENT RATE	200 mL/min	200 mL/min	200 mL/min	400 mL/min	400 mL/min	400 mL/min	400 mL/min	400 mL/min
NUMBER OF ORGANISMS/VESSEL	15	20	15	12	20	20	26	20
NUMBER OF REPLICATES/CON.	4	4	4	4	4	4	3	3
AERATION RATE (mL/Min.)	none	none	none	none	none	none	~310 mL/min	~310 mL/min
D.O. RANGE: mean ± SD (mg/L)[g]	12.0 ± 1.3	12.3 ± 1.1	12.9 ± 1.8	10.4 ± 0.9	10.2 ± 1.2	10.3 ± 0.4	8.7 ± 0.7	8.5 ± 0.6
TEMPERATURE RANGE: mean ± SD (°C)[g]	8.8 ± 1.4	8.4 ± 1.4	7.6 ± 2.1	14.4 ± 0.8	16.1 ± 1.1	16.8 ± 0.4	17.7 ± 1.1	17.8 ± 1.3
PH RANGE (min – max)[g]	8.2 – 8.5	8.2 – 8.6	8.3 – 8.6	8.4 – 8.6	8.4 – 8.6	8.4 – 8.6	7.9 – 8.6	7.9 – 8.5
FOOD TYPE	Trout Chow	Trout Chow	Live Shrimp Brine	Kyowa 400B dry food	Kyowa 400B dry food	live daphnia	(a) live daphnia or (b) trout chow	(a) live daphnia or (b) frozen daphnia
FEEDING RATE	Day 1 - 23: 1.0g Day 24 - 30: 1.5g	Day 1 - 23: 1.0g Day 24 - 30: 1.5g	0.2 g x 2 daily wet weight	3 x daily 0.06g	3 x daily 0.06g	2.6 g 3x daily	3 x daily (a) 2.6 g or (b) 1.7g	3 x daily (a) 2.6 g or (b) 2.7g

INVERTEBRATE TESTS

	Chronic-Exposure "Warmwater" Test Conditions				
TEST NUMBER	5A	5B	12 A/B	22	23
SPECIES - Common Name - *Scientific Name*	Floater Mussels *Pyganodon grandis*	Fingernail Clams *Sphaerium simile*	Daphnia *Ceriodaphnia dubia*	Amphipod *Hyalella azteca*	Amphipod *Hyalella azteca*
AGE at Test Start	1 – 3 years	1 – 3 years	< 24 hrs	104 days	28 days
LIFE-CYCLE STAGE[c]	- -	- -	neonate	adult	adult
WET WEIGHT	weight: 1.8 g length: 26.6 mm	weight: 0.28 g length: 10.5 mm	not measured	not measured	not measured
SOURCE	La Salle River (MB)	La Salle River (MB)	ESG International's stock (ON)	AIB (Amphipods in Bio-assays) (ON)	offspring of adults used as controls in T22
TEST TYPE (Static, Semi-static, flow-through)	Semi-static	Semi-static	Semi-static	Semi-static	Semi-static
DURATION	66 days	8 days	7 days	28 days	96 hrs
EXPOSURE VOLUME	2.5 L	1 L	15 mL	450 mL	450 mL
REPLACEMENT RATE	2.5 L/d	1.0 L/d	15 mL/d	450 mL per 3-4d	450 mL on Day 2
NUMBER OF ORGANISMS/VESSEL	19	50	1	20	10
NUMBER OF REPLICATES/CON.	3	3	10	Control 10 Other – 5	2
AERATION RATE (mL/Min.)	~ 235mL/min	~ 285mL/min	none	None	None
D.O. RANGE: mean ± SD (mg/L)[g]	8.6 ± 0.6	8.0 ± 0.6	12A: 8.4 ± 0.6 12B: 8.6 ± 0.8	6.5 ± 1.9	7.8±1.1
TEMPERATURE RANGE: mean ± SD (°C)[g]	20.6 ± 1.6	22.7 ± 1.0	12A: 24.0 ± 0.3 12B: 24.0 ± 0.2	23.9 ± 0.9	24.2±0.6
PH RANGE (min – max)[g]	7.9 – 8.8	7.9 – 8.7	12A: 8.2 – 8.5 12B: 8.3 – 8.5	7.9 – 8.6	7.8-8.4
FOOD TYPE	Varied organic material collected from LaSalle River, newly hatched brine shrimp, *Spirulina* algae	Not fed	YCT and algae	Tetra Min ground food	Not fed
FEEDING RATE	0.1 – 0.4 g daily b/w Days 15–66	n/a	0.2 mL daily	5 mg 3x/wk (min)	n/a

Notes:

a 2 of the 10 tests (i.e., T3A/T3B) also include a chronic-exposure test because statistical analysis was done on data collected after 96 hrs (i.e., acute-exposure) and 10-days (i.e., chronic-exposure)
b fish were captured locally, therefore, exact age approximated
c Fry = very young or newly hatched fish; Juvenile = young fish that have not reached sexual maturity; Neonates = newly hatched (<24 hrs) invertebrates
d age class is similar to that of white sucker (T4A) which are denoted as "fry", but the mean weight is 6 times greater, so the fathead minnow test population for T11 is denoted as "juvenile"
e dry weights were measured and converted to wet weights based on body-water:tissue ratio of 77.8%:22.2%
f dry weights were determined by graphical extrapolation of fish weight data from T2A/B, T3A/B, T4A
g only control group test conditions reported

TetrES
CONSULTANTS

APPENDIX B

LIVE FISH COLLECTION AND HANDLING PERMITS

MANITOBA DEPARTMENT OF NATURAL RESOURCES
FISH HABITAT MANAGEMENT SECTION

LIVE FISH HANDLING PERMIT

Issued under the authority of the Fisheries Act (Federal and Provincial) and the Manitoba Fishery Regulations, the Fishing Licence Fee Regulation, and the Fishing Licence Fee Regulations made thereunder.

Issued to: Mr. Don Harron

of: TetrES Consultants, 603-386 Broadway Wpg. MB

is hereby authorized to handle live fish subject to the following conditions:

1. Purpose of Permit: See Attached

2. Location: See Attached

3. Effective Date: 3-May-99 to 30-Jun-99 inclusive.

4. Special Conditions: Destroy all fish on completion of studies.

Shelley Matkowski
Issued By

Fish Enhancement Biologist
Title

4-May-99
Date of Issue

Signature of Permittee

Permit Number: 99-08

Attachment to Live Fish Handling Permit # 99-08

To transport and hold walleye, pike and white sucker fry for toxicity tests in Winnipeg. The walleye and pike fry will be acquired from Qu'Appelle Hatchery, SK; the white sucker will be hatched in a temporary facility on the La Salle River in Starbuck, MB from eggs collected from the Saskatchewan River spawners at Grand Rapids.

MANITOBA DEPARTMENT OF NATURAL RESOURCES
FISH HABITAT MANAGEMENT SECTION

SCIENTIFIC COLLECTION PERMIT

Issued under the authority of the Fisheries Act (Manitoba) and the Fishing Licence Regulation and Fishing Licence Fee Regulation made thereunder.

Issued to: Ernie Watson, K. Mathers, A. Partridge, M. Gifford, D. Haron

of: TetrEs Consultants, 603-386 Broadway Wpg. MB 942-2505

is hereby authorized to collect, transport and possess fish within the Province of Manitoba subject to the following conditions:

1. Release live fish only in the water from which they were taken.
2. Fish may not be sold, traded or bartered.
3. The use of chemicals and explosives as aids in collecting fish is prohibited.
4. This permit expires on 30-Jun-99 following date of issue.
5. A report must be submitted to Fisheries Branch, Box 40, 200 Saulteaux Crescent, Winnipeg, MB R3J 3W3 upon expiration of this permit indicating; location, species, number and disposition of the collected specimens.
6. Special Conditions: Authorization to collect 300 fingernail clams and 300 Pyganodon grandis mussels from St. Malo Lake or La Salle River by means of shovel or dredge, and to use these mussels in toxicity tests in the Red River.

Shelley Matkowski

Issued By

Fish Enhancement Biologist

Title

8-Jun-99

Date of Issue

Signature of Permittee

Permit Number: 99-28

MANITOBA DEPARTMENT OF NATURAL RESOURCES
FISH HABITAT MANAGEMENT SECTION

SCIENTIFIC COLLECTION PERMIT

Issued under the authority of the Fisheries Act (Manitoba) and the Fishing Licence Regulation and Fishing Licence Fee Regulation made thereunder.

Issued to: Marlene Gifford, TetrEs Consultants

of: 603-386 Broadway, Winnipeg MB 942-2505

is hereby authorized to collect, transport and possess fish within the Province of Manitoba subject to the following conditions:

1. Release live fish only in the water from which they were taken.
2. Fish may not be sold, traded or bartered.
3. The use of chemicals and explosives as aids in collecting fish is prohibited.
4. This permit expires on 31-Jul-99 following date of issue.
5. A report must be submitted to Fisheries Branch, Box 40, 200 Saulteaux Crescent, Winnipeg, MB R3J 3W3 upon expiration of this permit indicating; location, species, number and disposition of the collected specimens.
6. Special Conditions: See Attached.

Shelley Matkowski
Issued By

Fish Enhancement Biologist
Title

11-May-99
Date of Issue

Marlene M. Gifford
Signature of Permittee

Permit Number: 99-06

Attachment to Scientific Collection Permit #99-06

May 11, 1999

To collect live specimens of indigenous fish species from the Red River and its tributaries using scine nets, dip nets, and minnow traps. Up to 10 specimens of each species may bc used for educational display in aquariums in the city of Winnipeg. Please contact local Natural Resource Officer prior to each collection (945-7258).

MANITOBA DEPARTMENT OF NATURAL RESOURCES
FISH HABITAT MANAGEMENT SECTION

LIVE FISH HANDLING PERMIT

Issued under the authority of the Fisheries Act (Federal and Provincial) and the Manitoba Fishery Regulations, the Fishing Licence Fee Regulation, and the Fishing Licence Fee Regulations made thereunder.

Issued to: Marlene Gifford, TetrES Consultants

of: 603-386 Broadway, Winnipeg MB R3C 3R6

is hereby authorized to handle live fish subject to the following conditions:

1. Purpose of Permit: To import fish into Manitoba for toxicity testing purposes.

2. Location: City of Winnipeg, North End Pollution Centre

3. Effective Date: 22-Jun-99 to 30-Nov-99 inclusive.

4. Special Conditions: Fish fry will be tested at the North End Pollution Control Centre. All fish must be euthanized at the termination of the study. Water in which thefish are shipped and tested must be disposed of via the sewer system at the treatment plant.

Lorimer Thompson

Issued By

Chief, Fish Habitat

Title

22-Jun-99

Date of Issue

Signature of Permittee

Permit Number: 99-16

MANITOBA DEPARTMENT OF NATURAL RESOURCES
FISH HABITAT MANAGEMENT SECTION

SCIENTIFIC COLLECTION PERMIT

Issued under the authority of the Fisheries Act (Manitoba) and the Fishing Licence Regulation and Fishing Licence Fee Regulation made thereunder.

Issued to: Karen Mathers, Donald Harron

of: TetrES Consultants Inc. 603-386 Broadway, Winnipeg, MB R3C 3R6

is hereby authorized to collect, transport and possess fish within the Province of Manitoba subject to the following conditions:

1. Release live fish only in the water from which they were taken.

2. Fish may not be sold, traded or bartered.

3. The use of chemicals and explosives as aids in collecting fish is prohibited.

4. This permit expires on 30-Sep-99 following date of issue.

5. A report must be submitted to Fisheries Branch, Box 40, 200 Saulteaux Crescent, Winnipeg, MB R3J 3W3 upon expiration of this permit indicating; location, species, number and disposition of the collected specimens.

6. Special Conditions: As on attached Schedule 1.

Shelley Matkowski

Issued By

Stock Enhancement Biologist

Title

Signature of Permittee

5-Jul-99

Date of Issue

Permit Number: 99-33

SCHEDULE 1. SCIENTIFIC COLLECTION PERMIT NO. 99-33

Authorization to collect 3,000 *Pyganodon grandis* mussels (northern floater) and 2,500 *Sphaerium simile* (grooved fingernail clam) of the ages 1-3 years from the LaSalle River near Starbuck, MB, by means of shovels and screens. All other fauna captured incidentally are to be released immediately on site.

Those clams that are retained will be held in the LaSalle River at the residence of TetrEs biologist Don Harron of Starbuck, or the City of Winnipeg North End Water Pollution Control Centre (NEWPCC), until needed for *in-situ* toxicity tests in the Red River. The clams will then be deployed in cages within 200 m of the NEWPCC until late September when they will be removed and evaluated. All clams are to be destroyed at the conclusion of the study. Shells may be retained for scientific purposes.

MANITOBA DEPARTMENT OF NATURAL RESOURCES
FISH HABITAT MANAGEMENT SECTION

SCIENTIFIC COLLECTION PERMIT

Issued under the authority of the Fisheries Act (Manitoba) and the Fishing Licence Regulation and Fishing Licence Fee Regulation made thereunder.

Issued to: Don Harron, Marlene Gifford

of: TetrES Consultants, 603-386 Broadway, Winnipeg MB 942-2505

is hereby authorized to collect, transport and possess fish within the Province of Manitoba subject to the following conditions:

1. Release live fish only in the water from which they were taken.
2. Fish may not be sold, traded or bartered.
3. The use of chemicals and explosives as aids in collecting fish is prohibited.
4. This permit expires on 31-Oct-99 following date of issue.
5. A report must be submitted to Fisheries Branch, Box 40, 200 Saulteaux Crescent, Winnipeg, MB R3J 3W3 upon expiration of this permit indicating; location, species, number and disposition of the collected specimens.
6. Special Conditions: To collect juvenile and larval fish from the Red River and tributaries in the Winnipeg area.

Shelley Matkowski
Issued By

Fish Enhancement Biologist
Title

Ronald [illegible]
Signature of Permittee

29-Jul-99
Date of Issue

Permit Number: 99-38

Ministry of
Natural Resources

Ministère des
Richesses naturelles

Ontario

Scientific Collection and Live Fish Transfer Licence

Under the Fish and Wildlife Conservation Act and the Regulations, and subject to thje limitations thereof and the limitations of the Fisheries Act (Canada) and the Ontario Fishery Regulations, 1989 as amended, this licence is granted to :

NAME: Amy Partridge and Assistants
of Tetres Consultants Inc.
603- 386 Broadway
Winnipeg, Manitoba
R3C 3R6

To collect sucker spawn and milt from the waters of Kenora Ministry of Natural Resources District excluding any waters that are classified as fish sanctuaries or have closed seasons for that species for the purposes of water toxicity studies to be conducted at the home site or auxiliary building of Tetres Consultants Inc. . Harvesting of the fish for milking is to be done by legal angling means normally available to an angler licenced under an Ontario sport fishing licence .

The authorized collection period will cover the time April 28th through to and including May 10th .

Live spawn and milt may be transported from Ontario to the Tetres Consultant facilities in Manitoba . No adult fish may be transported under this licence and no live spawn may be released into any waterbody in Ontario or Manitoba other than the host waterbody and the Tetres holding tanks.

Any Manitoba authorization required for importation will be the responsibility of the applicant licencee .

Issued at the Kenora District Ministry of Natural Resources office this 28th day of April 2000 .

Amy Partridge
Licencee

Licence Issuer/ Fisheries Officer

MANITOBA CONSERVATION
FISH HABITAT MANAGEMENT SECTION

LIVE FISH HANDLING PERMIT

Issued under the authority of the Fisheries Act (Federal and Provincial) and the Manitoba Fishery Regulations, the Fishing Licence Fee Regulation, and the Fishing Licence Fee Regulations made thereunder.

Issued to: Mr. Don Harron

of: TetrES Consultants, Winnipeg, MB 942-2505

is hereby authorized to handle live fish subject to the following conditions:

1. Purpose of Permit: To import or collect and hold fish and fish eggs as listed on permit attachment #00-03

2. Location: Fish & Eggs will be held at the City of Winnipeg Northend Water Pollution Control Centre or residence of Mr. Don Harron.

3. Effective Date: 4-Apr-00 to 31-Jul-00 inclusive.

4. Special Conditions: All fish to be destroyed upon completion of research.

Shelley Matkowski
Issued By

Fish Enhancement Biologist
Title

4-Apr-00
Date of Issue

Signature of Permittee

Permit Number: 00-03

Attachment to Live Fish Handling Permit #00-03

The following fish and fish eggs may be imported/collected and held

1000	northern pike eggs/fry from Qu'Appelle Hatchery, Saskatchewan
1000	walleye eggs/fry from Qu'Appelle Hatchery, Saskatchewan
1000	lake whitefish eggs/fry from Grand Rapids Hatchery &
1000	lake trout fingerlings from Grand Rapids Hatchery
800	fathead minnows from Aquatic Biosystems, Colorado
5000	white sucker eggs/fry from spawning runs in southern Manitoba streams
1000	walleye fingerlings from a hatchery in Southern Ontario

MANITOBA CONSERVATION
FISH HABITAT MANAGEMENT SECTION

SCIENTIFIC COLLECTION PERMIT

Issued under the authority of the Fisheries Act (Manitoba) and the Fishing Licence Regulation and Fishing Licence Fee Regulation made thereunder.

Issued to: Mr. Don Harron

of: Tetres Consultants - Winnipeg MB 942-2505

is hereby authorized to collect, transport and possess fish within the Province of Manitoba subject to the following conditions:

1. Release live fish only in the water from which they were taken.
2. Fish may not be sold, traded or bartered.
3. The use of chemicals and explosives as aids in collecting fish is prohibited.
4. This permit expires on 31-Jul-00 following date of issue.
5. A report must be submitted to Fisheries Branch, Box 40, 200 Saulteaux Crescent, Winnipeg, MB R3J 3W3 upon expiration of this permit indicating; location, species, number and disposition of the collected specimens.
6. Special Conditions: To collect and hold 1,500 fingernail clams from the LaSalle River near Starbuck, Manitoba. All clams to be destroyed upon completion of research. Notify local Natural Resource Officer prior to collection.

Shelley Matkowski

Issued By

Fish Enhancment Biologist

Title

Signature of Permittee

4-Apr-00

Date of Issue

Permit Number: 00-11

APPENDIX C

PREPARATION OF TEST-SOLUTIONS FOR STATIC AND SEMI-STATIC TESTS CONDUCTED ON FISH

Ammonia Stock Preparation:

Time Prepared: beginning of test
Ammonia Source: ammonium chloride (NH_4Cl)
Desired stock concentration: 1 mg NH_3-N/ml solution

Q: To prepare 1000 mL of stock with an NH_3-N concentration of 1.0 mg/mL, 1000 mg NH_3-N is needed. NH_3-N is obtained through the addition of NH_4Cl to deionized water. How many grams of NH_4Cl are required to produce the desired concentration?

Molecular weight of N = 14.007µ
Molecular weight of NH_4Cl = 53.492µ

So, $\frac{1.0\text{g } NH_3\text{-N}}{x \text{ g } NH_4Cl} = \frac{14.007\mu}{53.492\mu}$ x = 3.82 g NH_4Cl

A: 3.82 g NH_4Cl must be added to each 1.0 L of deionized water to prepare an ammonia-stock with 1.0 mg NH3-N/mL solution.

Procedure for Preparing River Water (RW) Stock:

Time Prepared: (a) prior to initiation of static-tests
(b) prior to initiation of semi-static tests and once daily in 24hr intervals following test-start

Assume: (1) Test-solution volume = 500 ml
(2) Highest nominal N-NH_3 concentration = 32 mg/L

Procedure:

(1) Pour 32 mL of ammonia-stock (@1.0 mg NH_3-N/mL) into a 1.0 L graduated cylinder and fill to 1.0 L with river water (i.e. concentration = 32 mg/L) (FigureC-1).

TetrES
CONSULTANTS INC.

dilute
s\01\0110\22\99tox

Preparing Ammonia Test Solutions for Static and Semi-static Fish Toxicity tests

Figure C-1

(2) Pour 500 ml of (1) into test-chambers of one replicate-series marked for the highest exposure-concentration. (Note: 500 ml of RW-stock will remain in graduated cylinder; do not discard) (Figure C-1).

(3) Refill graduated cylinder to 1.0 L with river water (i.e. add 500 ml of RW thus diluting the solution by a factor of 0.5).

(4) Repeat step (2) and (3) until NH_3-N concentration is equal to the lowest exposure-concentration in the dilution-series.

(5) Repeat step (1)-(4) for each set of replicates for each test.

Procedure for Preparing Effluent (E) stock:

Time Prepared: (a) prior to initiation of static-tests

(b) prior to initiation of semi-static tests and once daily in 24 hr intervals following test-start

Assume: (1) Test-solution volume = 500 mL

(2) Highest nominal NH_3-N concentration = 32 mg/L

Procedure:

(1) Obtain a grab sample of effluent and measure the NH_3-N concentration using a CHEMet® Ammonia Kit.

If the measured NH_3-N concentration is less than the highest nominal concentration:

(2) Perform the following calculation: subtract the measured concentration from the desired concentration. (e.g. If effluent is at 20 mg/L and we want a concentration of 32 mg/L, then we must add 32-20=12 mg NH_3-N/L E-stock).

(3) Multiply the result of (2) by the volume of E-stock that we need to prepare. In this case, we need to prepare 1.0 L of E-stock for each replicate-exposure (i.e. 500 mL for the highest exposure-test-chamber and 500 mL for the dilution-series). If there are 4 replicate test-chambers for each NH_3-N exposure-concentration, we need to prepare 4.0 L of effluent stock. So: 12 mg NH_3-N/L E-stock * 4.0 L E-stock = 48 mg.

(4) Since the ammonia-stock concentration = 1.0 mg NH_3-N/ml, the number of mg of N-NH_3 determined in (3) equals the number of milliliters of ammonia-stock that must be added to the effluent to obtain the highest nominal exposure-concentration. Drain an equal volume of effluent that will be replaced with ammonia stock and add the ammonia-stock.

If the measured NH_3-N concentration is greater than the highest nominal concentration:

(2) Determine the concentration of NH_3-N in the volume of effluent required for the dilution-series. (e.g. If effluent at 34 mg/L and we have 4.0 L of effluent, we have 136 mg (34 mg/L*4.0 L) of NH_3-N.

(3) Solve for x where x is the total volume of effluent-stock required:

actual [NH_3-N] in x L = highest nominal [NH_3] in 1.0 L

(e.g.136 mg/xL = 32 mg/L; x = 4.25L In order to obtain the highest nominal concentration of 32 mg/L, we must have 136 mg in 4.25 L.)

(4) Determine the volume of RW that must be added to the effluent-stock in order to dilute it to the desired NH_3-N concentration. That is, subtract the volume of effluent from the total volume of effluent stock required. (e.g. 4.25 L – 4.0 L = .25 L or 250 ml)

(5) Perform appropriate serial-dilutions as described for the RW-stock (i.e., steps (2)-(5)).

Notes:

(1) Variations to the above procedures for preparing RW-stock include mixing and diluting larger volumes of stock to (a) accommodate increasing test-chamber volumes and (b) reduce the number of times step (1) –(4) have to be repeated by filling test-chambers for more than one replicate at a time.

(2) The volume of solution added to each test-chamber was determined in one of two ways. (a) Place each test-chamber on a tared scale and fill with stock until the weight equals the desired volume (assumption: stock density = 1.0 g/ml) (Figure C-1); or (b) fill each test-chamber to a pre-measured depth indicative of the desired volume.

For all semi-static testing, test-chambers consisted of 1 L polyethylene containers into which a second container with a screened bottom was inserted. The diameter of the mesh was large enough to allow water to diffuse across the membrane but small enough to retain all fish in the ‘insert-container’. During daily replacement of the test-solutions, the insert-container (plus the fish) were slowly withdrawn from the old test-solution and lowered into fresh stock.

APPENDIX D

NEWPCC LABORATORY RESULTS FOR DAILY TOTAL-AMMONIA-NITROGEN (NH_3-N) CONCENTRATIONS

(Tables enclosed are Preliminary Results)

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	D. De Luca	REPORT TO:	Marlene
DATE SUBMITTED:	June 04,1999	ADDRESS:	Tetres
DATE SAMPLED:	June 04,1999		
SAMPLED BY:	Marlene	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Samples
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	NH3-N				
1	SB-Cont1	08-Jun-99	<1.0				
2	SB-Cont2	08-Jun-99	<1.0				
3	SB-1	08-Jun-99	2.2				
4	SB-2	08-Jun-99	4.5				
5	SB-4	08-Jun-99	6.7				
6	SA-8	08-Jun-99	8.7				
7	SB1-8	08-Jun-99	11.6				
8	SB2-8	08-Jun-99	11.7				
9	SB3-8	08-Jun-99	11.6				
10	SC-8	08-Jun-99	4.1				
11	SB-15	08-Jun-99	19.8				
12	SB-30	08-Jun-99	23.6				
13	SB-62	08-Jun-99	29.1				
14	SB-125	08-Jun-99	63.2				
15	WB-Cont1	08-Jun-99	<1.0				
16	WB-Cont2	08-Jun-99	<1.0				
17	WB-1	08-Jun-99	1.8				
18	WB-2	08-Jun-99	4.0				
19	WB-4	08-Jun-99	6.8				
20	WA-8	08-Jun-99	8.3				
21	WB1-8	08-Jun-99	12.1				
22	WB2-8	08-Jun-99	12.2				
23	WB3-8	08-Jun-99	12.2				
24	WC-8	08-Jun-99	8.6				
25	WB-15	08-Jun-99	14.4				
26	WB-30	08-Jun-99	26.0				
27	WB-62	08-Jun-99	33.2				
28	WB-125	08-Jun-99	61.1				
29	La Salle 1	08-Jun-99	<1.0				
30	La Salle 2	08-Jun-99	<1.0				
31	La Salle 3	08-Jun-99	<1.0				
32							
	QC data: (verification stds.)						
	QC data: (standard additions)		*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*

Remarks: The 0-50 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis

Date Analyzed: 4-Jun-99 **Verified by:**

Analyst: Dom De luca **Date:**

File:

Tetris NH3 an060499

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Marlene	REPORT TO:	Marlene
DATE SUBMITTED:	8-Jun-99	ADDRESS:	Tetres
DATE SAMPLED:	8-Jun-99		
SAMPLED BY:	Marlene	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Samples
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	**NH3-N**				
1	SB-Cont1	08-Jun-99	1.3				
2	SB-Cont2	08-Jun-99	1.0				
3	SB-1	08-Jun-99	3.6				
4	SB-2	08-Jun-99	5.8				
5	SB-4	08-Jun-99	8.1				
6	SA-8	08-Jun-99	10.0				
7	SB1-8	08-Jun-99	11.0				
8	SB2-8	08-Jun-99	11.1				
9	SB3-8	08-Jun-99	11.1				
10	SC-8	08-Jun-99	4.8				
11	SB-15	08-Jun-99	13.4				
12	WB-Cont1	08-Jun-99	1.6				
13	WB-Cont2	08-Jun-99	1.0				
14	WB-1	08-Jun-99	3.9				
15	WB-2	08-Jun-99	5.6				
16	WA-4	08-Jun-99	5.7				
17	WB1-4	08-Jun-99	7.4				
18	WB2-4	08-Jun-99	7.7				
19	WB3-4	08-Jun-99	7.7				
20	WC-4	08-Jun-99	5.0				
21	WA-8	08-Jun-99	9.1				
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
	QC data: (verification stds.)						
	QC data: (standard additions)		*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*
	WA-8 + 5.0 ppm NH3-N		*104*				
	WA-8 + 10.0 ppm NH3-N		*98*				

Remarks: The 0-50 ppm range (w/ 1/4 dil'n loop) was used for this NH3 analysis

Date Analyzed: 8-Jun-99

Verified by:

Analyst: Dom De luca

Date:

File:

Tetris NH3 an060899

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Marlene	REPORT TO:	Marlene
DATE SUBMITTED:	June 10,1999	ADDRESS:	Tetres
DATE SAMPLED:	June 10,1999		
SAMPLED BY:	Marlene	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River water samples
LOCATION:	
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	NH3-N				
1	SA-E-CONTROL	10-Jun-99	22.3				
2	SA-E -.5	10-Jun-99	1.3				
3	SA-E -1	10-Jun-99	2.2				
4	SA-E -2	10-Jun-99	2.8				
5	SA-E -4	10-Jun-99	4.9				
6	SA-E -8	10-Jun-99	7.2				
7	SA-E -16	10-Jun-99	9.5				
8	SA-E -32	10-Jun-99	27.1				
9	SB-E-CONTROL	10-Jun-99	22.5				
10	SB-E -.5	10-Jun-99	1.4				
11	SB-E -1	10-Jun-99	1.8				
12	SB-E -2	10-Jun-99	2.4				
13	SB-E -4	10-Jun-99	4.2				
14	SB1-E-8	10-Jun-99	7.0				
15	SB2-E-8	10-Jun-99	7.0				
16	SB-E -16	10-Jun-99	12.3				
17	SB-E -32	10-Jun-99	27.1				
18	SC-RW-CONTROL	10-Jun-99	<1.0				
19	SC-RW -.5	10-Jun-99	1.2				
20	SC-RW -1	10-Jun-99	2.2				
21	SC-RW -2	10-Jun-99	3.2				
22	SC-RW -4	10-Jun-99	5.2				
23	SC-RW -8	10-Jun-99	6.7				
24	SC-RW -16	10-Jun-99	12.8				
25	SC-RW -32	10-Jun-99	18.0				
26	SD-RW-CONTROL	10-Jun-99	<1.0				
27	SD-RW -.5	10-Jun-99	1.8				
28	SD-RW -1	10-Jun-99	2.2				
29	SD-RW -2	10-Jun-99	3.2				
30	SD-RW -4	10-Jun-99	5.0				
31	SD1-RW-8	10-Jun-99	6.3				
32	SD2-RW-8	10-Jun-99	6.2				
33	SD-RW -16	10-Jun-99	8.7				
34	SD-RW -32	10-Jun-99	19.7				
35	SE-E-CONTROL	10-Jun-99	22.2				
36	SE-E -.5	10-Jun-99	<1.0				
37	SE-E -1	10-Jun-99	1.4				
38	SE-E -2	10-Jun-99	2.3				
39	SE-E -4	10-Jun-99	4.4				
40	SE-E -8	10-Jun-99	6.8				
	QC data: (verification stds.)						
	QC data: (standard additions)		*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis

… CONTINUED ON NEXT PAGE

Date Analyzed: 11-Jun-99 **Verified by:** ____________

Analyst: Dom De luca **Date:** ____________

File: ____________

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Marlene	REPORT TO:	Marlene
DATE SUBMITTED:	June 11,1999	ADDRESS:	Tetres
DATE SAMPLED:	June 11,1999		
SAMPLED BY:	Marlene	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Samples
LOCATION:	North end Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	**NH3-N**				
41	SE-E -16	10-Jun-99	11.0				
42	SE-E -32	10-Jun-99	26.7				
43	SF-RW-CONTROL	10-Jun-99	<1.0				
44	SF-RW -.5	10-Jun-99	<1.0				
45	SF-RW -1	10-Jun-99	<1.0				
46	SF-RW -2	10-Jun-99	<1.0				
47	SF-RW -4	10-Jun-99	<1.0				
48	SF-RW -8	10-Jun-99	<1.0				
49	SF-RW -16	10-Jun-99	7.9				
50	SF-RW -32	10-Jun-99	61.0				
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							
62							
63							
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73							
74							
75							
76							
77							
78							
79							
80							
	QC data: (verification stds.)						
	Hach verification standard *(10.0 mg/L NH3-N)*		10.1				
	Hach 10 mg/L		10.2				
	1.0 ppm std.		<1.0				
	QC data: (standard additions)		*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis

Date Analyzed: 11-Jun-99 **Verified by:**

Analyst: Dom De luca **Date:**

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Marlene	REPORT TO:	Marlene
DATE SUBMITTED:	June 11,1999	ADDRESS:	Tetres
DATE SAMPLED:	June 11,1999		
SAMPLED BY:	Marlene	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Samples
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	**NH3-N**				
1	SA-E-CONTROL	11-Jun-99	over range				
2	SA-E -0.5	11-Jun-99	1.1				
3	SA-E -1	11-Jun-99	1.6				
4	SA-E -2	11-Jun-99	2.9				
5	SA-E -4	11-Jun-99	4.5				
6	SA-E -8	11-Jun-99	7.4				
7	SA-E -16	11-Jun-99	15.4				
8	SA-E -32	11-Jun-99	36.5				
9	SB-E-CONTROL	11-Jun-99	over range				
10	SB-E -0.5	11-Jun-99	1.0				
11	SB-E -1	11-Jun-99	1.7				
12	SB-E -2	11-Jun-99	2.6				
13	SB-E -4	11-Jun-99	5.5				
14	SB1-E-8 -8	11-Jun-99	9.3				
15	SB2-E-8 -8	11-Jun-99	9.2				
16	SB-E -16	11-Jun-99	11.8				
17	EFFLUENT	11-Jun-99	28.4				
18	SC-RW-CONTROL	11-Jun-99	<0.5				
19	SC-RW -0.5	11-Jun-99	0.9				
20	SC-RW -1	11-Jun-99	1.3				
21	SC-RW -2	11-Jun-99	2.6				
22	SC-RW -4	11-Jun-99	3.7				
23	SC-RW -8	11-Jun-99	7.4				
24	EFFLUENT	11-Jun-99	28.9				
25	RIVER WATER	11-Jun-99	<0.5				
26	SD-RW-CONTROL	11-Jun-99	<0.5				
27	SD-RW -0.5	11-Jun-99	0.7				
28	SD-RW -1	11-Jun-99	1.4				
29	SD-RW -2	11-Jun-99	2.6				
30	SD-RW -4	11-Jun-99	4.6				
31	SD1-RW -8	11-Jun-99	8.4				
32	SD2-RW -8	11-Jun-99	8.4				
33	SD-RW -16	11-Jun-99	11.7				
34	RIVER WATER	11-Jun-99	<0.5				
35	SE-E-CONTROL	11-Jun-99	28.6				
36	SE-E -0.5	11-Jun-99	0.8				
37	SE-E -1	11-Jun-99	1.7				
38	SE-E -2	11-Jun-99	2.6				
39	SE-E -4	11-Jun-99	4.5				
40	SE-E -8	11-Jun-99	8.0				
	QC data: (verification stds.)						
	QC data: (standard additions)		*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis

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Date Analyzed: 11-Jun-99 **Verified by:** ____________

Analyst: Dom De luca **Date:** ____________

File: ____________

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Marlene	REPORT TO:	Marlene
DATE SUBMITTED:	June 11,1999	ADDRESS:	Tetres
DATE SAMPLED:	June 11,1999		
SAMPLED BY:	Marlene	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Samples
LOCATION:	North end Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

Sample		Concentration - mg/L				
Description	Date	**NH3-N**				
SE-E -16	11-Jun-99	15.1				
SE-E -32	11-Jun-99	37.0				
SF-RW-CONTROL	11-Jun-99	<0.5				
SF-RW 0.5	11-Jun-99	0.8				
SF-RW 1	11-Jun-99	1.8				
SF-RW 2	11-Jun-99	3.2				
SF-RW 4	11-Jun-99	6.7				
SF-RW 8	11-Jun-99	10.2				
EFFLUENT	11-Jun-99	29.2				
RIVER WATER	11-Jun-99	<0.5				
NF 06/11/99	11-Jun-99	29.1				
QC data: (verification stds.)						
Hach verification standard *(10.0 mg/L NH3-N)*		10.1				
Hach verification standard *(10.0 mg/L NH3-N)*		10.2				
1.0 ppm std.		0.7				
QC data: (standard additions)		*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis

Date Analyzed: 11-Jun-99 **Verified by:**

Analyst: Dom De luca **Date:**

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Marlene	REPORT TO:	Marlene
DATE SUBMITTED:	June 12,1999	ADDRESS:	Tetres
DATE SAMPLED:	June 12,1999		
SAMPLED BY:	Marlene	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Samples
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia mg/L

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	NH3-N				
1	SA-E-CONTROL	12-Jun-99	25.8				
2	SA-E- -.5	12-Jun-99	1.0				
3	SA-E- -1	12-Jun-99	1.3				
4	SA-E- -2	12-Jun-99	2.7				
5	SA-E- -4	12-Jun-99	3.6				
6	SA-E- -8	12-Jun-99	6.2				
7	SA-E- -16	12-Jun-99	13.0				
8	SA-E- -32	12-Jun-99	33.7				
9	SB-E-CONTROL	12-Jun-99	25.9				
10	SB-E- -0.5	12-Jun-99	1.0				
11	SB-E- -1	12-Jun-99	1.7				
12	SB-E- -2	12-Jun-99	2.6				
13	SB-E- -4	12-Jun-99	3.2				
14	SB-E- SB1-E-8	12-Jun-99	6.3				
15	SB-E- SB2-E-8	12-Jun-99	6.3				
17	SC-RW-CONTROL	12-Jun-99	0.7				
18	SC-RW- -0.5	12-Jun-99	0.9				
19	SC-RW- -1	12-Jun-99	1.2				
20	SC-RW- -2	12-Jun-99	1.7				
21	SC-RW- -4	12-Jun-99	2.8				
22	SC-RW- -8	12-Jun-99	4.6				
24	SD-RW-CONTROL	12-Jun-99	0.7				
25	SD-RW- -0.5	12-Jun-99	1.0				
26	SD-RW- -1	12-Jun-99	1.2				
27	SD-RW- -2	12-Jun-99	1.7				
28	SD-RW- -4	12-Jun-99	2.2				
29	SD-RW- SD1-RW-8	12-Jun-99	4.3				
30	SD-RW- SD2-RW-8	12-Jun-99	4.4				
31	SE-E-CONTROL	12-Jun-99	26.6				
32	SE-E- -0.5	12-Jun-99	1.2				
33	SE-E- -1	12-Jun-99	1.6				
34	SE-E- -2	12-Jun-99	2.5				
35	SE-E- -4	12-Jun-99	4.2				
36	SE-E- -8	12-Jun-99	7.9				
37	SE-E- -16	12-Jun-99	7.6				
38	SF-RW-CONTROL	12-Jun-99	0.7				
39	SF-RW -0.5	12-Jun-99	0.7				
40	SF-RW -1	12-Jun-99	0.9				
41	SF-RW -2	12-Jun-99	1.5				
42	SF-RW -4	12-Jun-99	2.8				
43	SF-RW -8	12-Jun-99	5.2				
44							
45							
46							
	QC data: (standard additions)		*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*
	+ 5.0 ppm NH3-N						
	+ 10.0 ppm NH3-N						
	Hach verification standard *(10.0 mg/L NH3-N)*	June 12,1999	9.7				

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis

Date Analyzed: 14-Jun-99

Verified by:

Analyst: Dom De luca

Date:

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Marlene	REPORT TO:	Marlene
DATE SUBMITTED:	June 13,1999	ADDRESS:	Tetres
DATE SAMPLED:	June 14,1999		
SAMPLED BY:	Marlene	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Samples
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	**NH3-N**				
1	SA-E-CONTROL	13-Jun-09	22.2				
2	SA-E -0.5	13-Jun-09	1.4				
3	SA-E -1	13-Jun-09	1.8				
4	SA-E -2	13-Jun-09	2.4				
5	SA-E -4	13-Jun-09	4.7				
6	SA-E -8	13-Jun-09	5.8				
7	SA-E -16	13-Jun-09	11.2				
8	SA-E -32	13-Jun-09	32.6				
9	SB-E-CONTROL	13-Jun-09	21.9				
10	SB-E -0.5	13-Jun-09	1.2				
11	SB-E -1	13-Jun-09	1.3				
12	SB-E -2	13-Jun-09	1.9				
13	SB-E -4	13-Jun-09	3.3				
14	SB1-E-8	13-Jun-09	6.2				
15	SB2-E-8	13-Jun-09	6.0				
16	SB-E -16	13-Jun-09	13.1				
17	SC-RW-CONTROL	13-Jun-09	<1.0				
18	SC-RW -0.5	13-Jun-09	1.0				
19	SC-RW -1	13-Jun-09	1.4				
20	SC-RW -2	13-Jun-09	1.8				
21	SC-RW -4	13-Jun-09	2.4				
22	SC-RW -8	13-Jun-09	4.8				
23	SD-RW-CONTROL	13-Jun-09	<1.0				
24	SD-RW -0.5	13-Jun-09	<1.0				
25	SD-RW -1	13-Jun-09	1.2				
26	SD-RW -2	13-Jun-09	1.8				
27	SD-RW -4	13-Jun-09	2.6				
28	SD1-RW -8	13-Jun-09	4.7				
29	SD2-RW -8	13-Jun-09	4.7				
30	SE-E-CONTROL	13-Jun-09	22.0				
31	SE-E -0.5	13-Jun-09	1.2				
32	SE-E -1	13-Jun-09	1.6				
33	SE-E -2	13-Jun-09	2.4				
34	SE-E -4	13-Jun-09	4.1				
35	SE-E -8	13-Jun-09	6.7				
36	SE-E -16	13-Jun-09	8.5				
37	SF-RW-CONTROL	13-Jun-09	<1.0				
38	SF-RW -0.5	13-Jun-09	<1.0				
39	SF-RW -1	13-Jun-09	<1.0				
40	SF-RW -2	13-Jun-09	1.2				
41	SF-RW -4	13-Jun-09	1.6				
42	SF-RW -8	13-Jun-09	2.6				
	QC data: (verification stds.)						
	Hach verification standard *(10.0 mg/L NH3-N)*		9.7				
	2.0 mg/L std		1.9				
	QC data: (standard additions)		*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*
	Riverwater Control + 5.0 ppm NH3-N		*81*				
	Riverwater Control + 10.0 ppm NH3-N		*73*				

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis

Date Analyzed: 14-Jun-99 **Verified by:**

Analyst: Dom Deluca, Ted Poniatowski **Date:**

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Marlene	REPORT TO:	Marlene
DATE SUBMITTED:	June 15,1999	ADDRESS:	Tetres
DATE SAMPLED:	June 15,1999		
SAMPLED BY:	Marlene	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Samples
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	NH3-N				
1	SA-RW-CONTROL	15-Jun-99	<1.0				
2	SA-RW -2	15-Jun-99	2.7				
3	SA-RW -4	15-Jun-99	4.5				
4	SA-RW -8	15-Jun-99	4.1				
5	SA-RW -16	15-Jun-99	6.3				
6	SA-RW -32	15-Jun-99	18.5				
7	SB-RW-CONTROL	15-Jun-99	<1.0				
8	SB-RW -2	15-Jun-99	3.7				
9	SB-RW -4	15-Jun-99	6.3				
10	SB-RW -8	15-Jun-99	7.0				
11	SB-RW -16	15-Jun-99	10.0				
12	SB-RW -32	15-Jun-99	20.8				
13	SC-RW-CONTROL	15-Jun-99	<1.0				
14	SC-RW -2	15-Jun-99	3.0				
15	SC-RW -4	15-Jun-99	4.3				
16	SC-RW -8	15-Jun-99	7.3				
17	SC-RW -16	15-Jun-99	10.1				
18	SC-RW -32	15-Jun-99	12.4				
19	SD-RW-CONTROL	15-Jun-99	<1.0				
20	SD-RW -2	15-Jun-99	3.6				
21	SD-RW -4	15-Jun-99	5.8				
22	SD-RW -8	15-Jun-99	9.0				
23	SD-RW -16	15-Jun-99	13.8				
24	SD-RW -32	15-Jun-99	14.6				
25	SA-E-CONTOL	15-Jun-99	26.6				
26	SA-E -2	15-Jun-99	2.6				
27	SA-E -4	15-Jun-99	4.1				
28	SA-E -8	15-Jun-99	5.7				
29	SA-E -16	15-Jun-99	8.8				
30	SA-E -32	15-Jun-99	51.0				
31	SB-E-CONTROL	15-Jun-99	26.5				
32	SB-E -2	15-Jun-99	3.3				
33	SB-E -4	15-Jun-99	5.1				
34	SB-E -8	15-Jun-99	6.8				
35	SB-E -16	15-Jun-99	12.6				
36	SB-E -32	15-Jun-99	32.6				
37	SC-E-CONTROL	15-Jun-99	26.8				
38	SC-E -2	15-Jun-99	2.4				
39	SC-E -4	15-Jun-99	3.3				
40	SC-E -8	15-Jun-99	5.6				
41	SC-E -16	15-Jun-99	12.6				
42	SC-E -32	15-Jun-99	31.3				
43	SA-RW- 0.5	15-Jun-99	1.7				
44	SB-RW- 0.5	15-Jun-99	1.5				
45	SC-RW- 0.5	15-Jun-99	1.5				
46	SA-RW- 1	15-Jun-99	2.0				
47	SB-RW- 1	15-Jun-99	2.9				
48	SC-RW- 1	15-Jun-99	2.0				
49	SA-E- 0.5	15-Jun-99	1.2				
50	SB-E- 0.5	15-Jun-99	1.2				
51	SC-E- 0.5	15-Jun-99	1.5				
52	SA-E- 1	15-Jun-99	1.2				
53	SB-E- 1	15-Jun-99	1.9				
54	SC-E- 1	15-Jun-99	2.8				
55							
	QC data: (verification stds.)						
	Hach verification standard *(10.0 mg/L NH3-N)*		9.5				
	QC data: (standard additions)		*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*
	NEWPCC Final Eff. + 10.0 ppm NH3-N		*103*				
	NEWPCC Final Eff. + 20.0 ppm NH3-N		*98*				

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis

Date Analyzed: 15-Jun-99

Verified by:

Analyst: Dom Deluca, Ted Poniatowski

Date:

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	June 16 1999	ADDRESS:	Tetres
DATE SAMPLED:	June 16 1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Samples
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	**NH3-N**				
1	SA-RW-CONTROL	June16,1999	<0.5				
2	SA-RW-.5	June16,1999	1.3				
3	SA-RW-1.0	June16,1999	1.8				
4	SA-RW-2	June16,1999	2.6				
5	SA-RW-4	June16,1999	4.6				
6	SA-RW-8	June16,1999	6.3				
7	SA-RW-16	June16,1999	8.2				
8	SB-RW-CONTROL	June16,1999	<0.5				
9	SB-RW-.5	June16,1999	1.9				
10	SB-RW-1.0	June16,1999	2.8				
11	SB-RW-2	June16,1999	3.4				
12	SB-RW-4	June16,1999	5.1				
13	SB-RW-8	June16,1999	7.4				
14	SB-RW-16	June16,1999	8.8				
15	SB-RW-32	June16,1999	9.6				
16	SC-RW-CONTROL	June16,1999	<0.5				
17	SC-RW-.5	June16,1999	2.2				
18	SC-RW-1.0	June16,1999	4.1				
19	SC-RW-2	June16,1999	6.4				
20	SC-RW-4	June16,1999	7.9				
21	SC-RW-8	June16,1999	10.6				
22	SC-RW-16	June16,1999	15.5				
23	SC-RW-32	June16,1999	17.0				
24	SA-E-CONTROL	June16,1999	34.9				
25	SA-E-0.5	June16,1999	1.4				
26	SA-E-1.0	June16,1999	2.2				
27	SA-E-2	June16,1999	3.1				
28	SA-E-4	June16,1999	4.4				
29	SA-E-8	June16,1999	7.5				
30	SA-E-16	June16,1999	15.6				
31	SA-E-32	June16,1999	18.1				
32	SB-E-CONTOL	June16,1999	44.0				
33	SB-E-.5	June16,1999	1.9				
34	SB-E-1.0	June16,1999	2.9				
35	SA-E-2	June16,1999	3.9				
36	SA-E-4	June16,1999	6.7				
37	SA-E-8	June16,1999	8.4				
38	SA-E-16	June16,1999	17.4				
39	SA-E-32	June16,1999	24.2				
	SC-E-CONTROL	June16,1999	44.2				
	SC-E-.5	June16,1999	1.5				
	SC-E-1.0	June16,1999	3.2				
	SC-E-2	June16,1999	3.0				
	SC-E-4	June16,1999	6.0				
	SC-E-8	June16,1999	8.5				
	SC-E-16	June16,1999	12.9				
	SC-E-32	June16,1999	21.5				
	(10.0 mg/L NH3-N)		10.3				
	0.0 ppm std. check		0.2				
	2.0 ppm std. check		1.9				
	5.0 ppm std. check		4.9				
	10.0 ppm std. check		10.0				
	20.0 ppm std. check		19.8				
	Standard additions:		*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*
	+ 5.0 ppm NH3-N						
	+ 10.0 ppm NH3-N		*100*				

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis

Date Analyzed: June 16, 1999

Verified by:

Analyst: Dom Deluca, Ted Poniatowski

Date:

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	June17,1999	ADDRESS:	Tetres
DATE SAMPLED:	June17,1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Samples
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	NH3-N				
1	SA-RW-CONTROL	June17,1999	<0.5				
2	SA-RW-.5	June17,1999	2.4				
3	SA-RW-1.0	June17,1999	3.2				
4	SA-RW-2	June17,1999	4.1				
5	SA-RW-4	June17,1999	5.5				
6	SA-RW-8	June17,1999	7.2				
7	SA-RW-16	June17,1999	7.0				
8	SB-RW-CONTROL	June17,1999	<0.5				
9	SB-RW-.5	June17,1999	1.1				
10	SB-RW-1.0	June17,1999	2.3				
11	SB-RW-2	June17,1999	3.4				
12	SB-RW-4	June17,1999	3.6				
13	SB-RW-8	June17,1999	5.4				
14	SB-RW-16	June17,1999	8.8				
15	SB-RW-32	June17,1999	19.8				
16	SC-RW-CONTROL	June17,1999	<0.5				
17	SC-RW-.5	June17,1999	1.3				
18	SC-RW-1.0	June17,1999	2.2				
19	SC-RW-2	June17,1999	3.5				
20	SC-RW-4	June17,1999	4.6				
21	SC-RW-8	June17,1999	7.1				
22	SC-RW-16	June17,1999	11.6				
23	SC-RW-32	June17,1999	24.7				
24	SA-E-CONTROL	June17,1999	35.4				
25	SA-E-0.5	June17,1999	1.1				
26	SA-E-1.0	June17,1999	1.6				
27	SA-E-2	June17,1999	2.6				
28	SA-E-4	June17,1999	3.8				
29	SA-E-8	June17,1999	5.8				
30	SA-E-16	June17,1999	9.8				
31	SA-E-32	June17,1999	33.4				
32	SB-E-CONTOL	June17,1999	35.5				
33	SB-E-.5	June17,1999	1.9				
34	SB-E-1.0	June17,1999	2.2				
35	SA-E-2	June17,1999	3.3				
36	SA-E-4	June17,1999	5.0				
37	SA-E-8	June17,1999	7.2				
38	SA-E-16	June17,1999	11.4				
39	SA-E-32	June17,1999	32.7				
	SC-E-CONTROL	June17,1999	34.9				
	SC-E-.5	June17,1999	1.2				
	SC-E-1.0	June17,1999	2.1				
	SC-E-2	June17,1999	3.5				
	SC-E-4	June17,1999	4.9				
	SC-E-8	June17,1999	7.2				
	SC-E-16	June17,1999	11.4				
	SC-E-32	June17,1999	32.9				
	(10.0 mg/L NH3-N)		9.9				
	0.0 ppm std. check		0.2				
	2.0 ppm std. check		1.9				
	5.0 ppm std. check		4.9				
	10.0 ppm std. check		10.0				
	20.0 ppm std. check		19.9				
Standard additions:			*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*
	+ 5.0 ppm NH3-N						
	+ 10.0 ppm NH3-N		*99*				

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis

Date Analyzed: June17,1999 **Verified by:**

Analyst: Dom Deluca **Date:**

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	June18,1999	ADDRESS:	Tetres
DATE SAMPLED:	June18,1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Samples
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	NH3-N				
1	SA-RW-CONTROL	June18,1999	<0.5				
2	SA-RW-.5	June18,1999	0.6				
3	SA-RW-1.0	June18,1999	1.0				
4	SA-RW-2	June18,1999	2.4				
5	SA-RW-4	June18,1999	3.4				
6	SA-RW-8	June18,1999	4.8				
7	SA-RW-16	June18,1999	12.2				
8	SB-RW-CONTROL	June18,1999	<0.5				
9	SB-RW-.5	June18,1999	1.8				
10	SB-RW-1.0	June18,1999	4.6				
11	SB-RW-2	June18,1999	4.9				
12	SB-RW-4	June18,1999	5.6				
13	SB-RW-8	June18,1999	9.3				
14	SB-RW-16	June18,1999	10.9				
15	SB-RW-32	June18,1999	16.4				
16	SC-RW-CONTROL	June18,1999	<0.5				
17	SC-RW-.5	June18,1999	0.9				
18	SC-RW-1.0	June18,1999	1.5				
19	SC-RW-2	June18,1999	3.3				
20	SC-RW-4	June18,1999	4.5				
21	SC-RW-8	June18,1999	6.7				
22	SC-RW-16	June18,1999	13.6				
24	SA-E-CONTROL	June18,1999	35.6				
25	SA-E-0.5	June18,1999	0.8				
26	SA-E-1.0	June18,1999	1.5				
27	SA-E-2	June18,1999	3.0				
28	SA-E-4	June18,1999	4.4				
29	SA-E-8	June18,1999	6.8				
30	SA-E-16	June18,1999	14.4				
31	SA-E-32	June18,1999	33.7				
32	SB-E-CONTOL	June18,1999	<0.5				
33	SB-E-.5	June18,1999	0.9				
34	SB-E-1.0	June18,1999	1.3				
35	SA-E-2	June18,1999	2.5				
36	SA-E-4	June18,1999	3.4				
37	SA-E-8	June18,1999	7.5				
38	SA-E-16	June18,1999	10.8				
39	SA-E-32	June18,1999	33.3				
	SC-E-CONTROL	June18,1999	35.5				
	SC-E-.5	June18,1999	1.2				
	SC-E-1.0	June18,1999	2.1				
	SC-E-2	June18,1999	3.0				
	SC-E-4	June18,1999	5.4				
	SC-E-8	June18,1999	9.2				
	SC-E-16	June18,1999	15.1				
	SC-E-32	June18,1999	33.2				
	(10.0 mg/L NH3-N)		10.0				
	0.0 ppm std. check		0.2				
	2.0 ppm std. check		1.9				
	5.0 ppm std. check		4.7				
	10.0 ppm std. check		10.1				
	20.0 ppm std. check		19.9				
	Standard additions:		*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*
	+ 5.0 ppm NH3-N						
	+ 10.0 ppm NH3-N		*108*				

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis

Date Analyzed: June18,1999

Verified by:

Analyst: Dom Deluca, Ted Poniatowski

Date:

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	June19,1999	ADDRESS:	Tetres
DATE SAMPLED:	June19,1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Samples
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	NH3-N				
1	SA-RW-CONTROL	June19,1999	<0.5				
2	SA-RW-.5	June19,1999	1.1				
3	SA-RW-1.0	June19,1999	0.9				
4	SA-RW-2	June19,1999	1.7				
5	SA-RW-4	June19,1999	2.1				
6	SA-RW-8	June19,1999	5.3				
7	SA-RW-16	June19,1999	3.7				
8	SB-RW-CONTROL	June19,1999	<0.5				
9	SB-RW-.5	June19,1999	1.0				
10	SB-RW-1.0	June19,1999	4.9				
11	SB-RW-2	June19,1999	5.3				
12	SB-RW-4	June19,1999	8.6				
13	SB-RW-8	June19,1999	8.3				
14	SB-RW-16	June19,1999	6.7				
15	SB-RW-32	June19,1999	20.2				
16	SC-RW-CONTROL	June19,1999	<0.5				
17	SC-RW-.5	June19,1999	1.1				
18	SC-RW-1.0	June19,1999	3.1				
19	SC-RW-2	June19,1999	4.3				
20	SC-RW-4	June19,1999	8.4				
21	SC-RW-8	June19,1999	6.9				
22	SC-RW-16	June19,1999	<0.5				
24	SA-E-CONTROL	June19,1999	40.2				
25	SA-E-0.5	June19,1999	0.8				
26	SA-E-1.0	June19,1999	1.0				
27	SA-E-2	June19,1999	2.1				
28	SA-E-4	June19,1999	3.7				
29	SA-E-8	June19,1999	6.4				
30	SA-E-16	June19,1999	9.3				
31	SA-E-32	June19,1999	33.8				
32	SB-E-CONTOL	June19,1999	40.2				
33	SB-E-.5	June19,1999	1.0				
34	SB-E-1.0	June19,1999	1.4				
35	SA-E-2	June19,1999	2.9				
36	SA-E-4	June19,1999	4.6				
37	SA-E-8	June19,1999	8.3				
38	SA-E-16	June19,1999	14.5				
39	SA-E-32	June19,1999	33.6				
	SC-E-CONTROL	June19,1999	39.9				
	SC-E-.5	June19,1999	0.9				
	SC-E-1.0	June19,1999	1.9				
	SC-E-2	June19,1999	2.3				
	SC-E-4	June19,1999	3.9				
	SC-E-8	June19,1999	7.0				
	SC-E-16	June19,1999	9.4				
	SC-E-32	June19,1999	33.7				
	(10.0 mg/L NH3-N)		9.9				
	0.0 ppm std. check		0.1				
	2.0 ppm std. check		1.8				
	5.0 ppm std. check		4.8				
	10.0 ppm std. check		9.9				
	20.0 ppm std. check		19.6				
Standard additions:			*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*
	+ 5.0 ppm NH3-N						
	+ 10.0 ppm NH3-N		*100*				

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis

Date Analyzed: June21,1999 **Verified by:**

Analyst: Dom Deluca, Ted Poniatowski **Date:**

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	June 20,1999	ADDRESS:	Tetres
DATE SAMPLED:	June 20,1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Samples
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	NH3-N				
1	SA-RW-CONTROL	June 20,1999	<0.5				
2	SA-RW-.5	June 20,1999	0.3				
3	SA-RW-1.0	June 20,1999	1.7				
4	SA-RW-2	June 20,1999	1.8				
5	SA-RW-4	June 20,1999	3.4				
6	SA-RW-8	June 20,1999	3.8				
7	SA-RW-16	June 20,1999	3.5				
8	SB-RW-CONTROL	June 20,1999	<0.5				
9	SB-RW-.5	June 20,1999	0.7				
10	SB-RW-1.0	June 20,1999	0.8				
11	SB-RW-2	June 20,1999	1.6				
12	SB-RW-4	June 20,1999	1.8				
13	SB-RW-8	June 20,1999	3.0				
14	SB-RW-16	June 20,1999	10.8				
16	SC-RW-CONTROL	June 20,1999	1.0				
17	SC-RW-.5	June 20,1999	<0.5				
18	SC-RW-1.0	June 20,1999	1.8				
19	SC-RW-2	June 20,1999	3.0				
20	SC-RW-4	June 20,1999	4.7				
21	SC-RW-8	June 20,1999	7.2				
22	SC-RW-16	June 20,1999	5.3				
24	SA-E-CONTROL	June 20,1999	34.6				
25	SA-E-0.5	June 20,1999	<0.5				
26	SA-E-1.0	June 20,1999	0.6				
27	SA-E-2	June 20,1999	1.2				
28	SA-E-4	June 20,1999	3.0				
29	SA-E-8	June 20,1999	8.2				
30	SA-E-16	June 20,1999	9.2				
31	SA-E-32	June 20,1999	35.3				
32	SB-E-CONTOL	June 20,1999	34.7				
33	SB-E-.5	June 20,1999	0.8				
34	SB-E-1.0	June 20,1999	1.7				
35	SA-E-2	June 20,1999	2.1				
36	SA-E-4	June 20,1999	4.6				
37	SA-E-8	June 20,1999	8.9				
38	SA-E-16	June 20,1999	13.4				
39	SA-E-32	June 20,1999	33.9				
	SC-E-CONTROL	June 20,1999	33.8				
	SC-E-.5	June 20,1999	1.0				
	SC-E-1.0	June 20,1999	1.8				
	SC-E-2	June 20,1999	1.6				
	SC-E-4	June 20,1999	2.7				
	SC-E-8	June 20,1999	6.6				
	SC-E-16	June 20,1999	10.0				
	SC-E-32	June 20,1999	34.2				
		June 20,1999					
	(10.0 mg/L NH3-N)		9.9				
	0.0 ppm std. check		0.1				
	2.0 ppm std. check		1.8				
	5.0 ppm std. check		4.8				
	10.0 ppm std. check		9.9				
	20.0 ppm std. check		19.6				
Standard additions:			*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*
	+ 5.0 ppm NH3-N						
	+ 10.0 ppm NH3-N		*100*				

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis

Date Analyzed: ______________________ **Verified by:** ______________________

Analyst: Dom Deluca, Ted Poniatowski **Date:** ______________________

File: ______________________

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	June 21,1999	ADDRESS:	Tetres
DATE SAMPLED:	June 21,1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Samples
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	NH3-N				
1	SA-RW-CONTROL	June 21,1999	<0.5				
2	SA-RW-.5	June 21,1999	<0.5				
3	SA-RW-1.0	June 21,1999	0.8				
4	SA-RW-2	June 21,1999	1.5				
5	SA-RW-4	June 21,1999	2.6				
6	SA-RW-8	June 21,1999	3.2				
7	SA-RW-16	June 21,1999	7.3				
8	SB-RW-CONTROL	June 21,1999	<0.5				
9	SB-RW-.5	June 21,1999	0.6				
10	SB-RW-1.0	June 21,1999	1.8				
11	SB-RW-2	June 21,1999	2.4				
12	SB-RW-4	June 21,1999	4.2				
13	SB-RW-8	June 21,1999	5.6				
14	SB-RW-16	June 21,1999	10.2				
16	SC-RW-CONTROL	June 21,1999	0.0				
17	SC-RW-.5	June 21,1999	<0.5				
18	SC-RW-1.0	June 21,1999	1.2				
19	SC-RW-2	June 21,1999	2.6				
20	SC-RW-4	June 21,1999	2.7				
21	SC-RW-8	June 21,1999	3.8				
22	SC-RW-16	June 21,1999	8.1				
24	SA-E-CONTROL	June 21,1999	30.3				
25	SA-E-0.5	June 21,1999	0.6				
26	SA-E-1.0	June 21,1999	0.8				
27	SA-E-2	June 21,1999	1.7				
28	SA-E-4	June 21,1999	1.3				
29	SA-E-8	June 21,1999	5.4				
30	SA-E-16	June 21,1999	10.1				
31	SA-E-32	June 21,1999	30.8				
32	SB-E-CONTOL	June 21,1999	29.3				
33	SB-E-.5	June 21,1999	0.5				
34	SB-E-1.0	June 21,1999	0.8				
35	SA-E-2	June 21,1999	1.9				
36	SA-E-4	June 21,1999	2.8				
37	SA-E-8	June 21,1999	6.6				
38	SA-E-16	June 21,1999	13.5				
39	SA-E-32	June 21,1999	30.8				
	SC-E-CONTROL	June 21,1999	29.7				
	SC-E-.5	June 21,1999	0.6				
	SC-E-1.0	June 21,1999	0.9				
	SC-E-2	June 21,1999	1.2				
	SC-E-4	June 21,1999	2.1				
	SC-E-8	June 21,1999	4.8				
	SC-E-16	June 21,1999	11.0				
	SC-E-32	June 21,1999	30.2				
	(10.0 mg/L NH3-N)		9.9				
	0.0 ppm std. check		0.2				
	2.0 ppm std. check		1.7				
	5.0 ppm std. check		4.7				
	10.0 ppm std. check		9.8				
	20.0 ppm std. check		19.7				
	Standard additions:		*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*
	+ 5.0 ppm NH3-N						
	+ 10.0 ppm NH3-N		*91*				

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis

Date Analyzed: June 22, 1999

Analyst: Dom Deluca, Ted Poniatowski

Verified by:

Date:

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	June 22,1999	ADDRESS:	Tetres
DATE SAMPLED:	June 22,1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Samples
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	NH3-N				
1	SA-RW-CONTROL	June 22,1999	<0.5				
2	SA-RW-.5	June 22,2000	0.3				
3	SA-RW-1.0	June 22,2001	0.8				
4	SA-RW-2	June 22,2002	1.7				
5	SA-RW-4	June 22,2003	2.8				
6	SA-RW-8	June 22,2004	5.8				
7	SA-RW-16	June 22,2005	10.7				
8	SB-RW-CONTROL	June 22,2006	<0.5				
9	SB-RW-.5	June 22,2007	0.7				
10	SB-RW-1.0	June 22,2008	1.2				
11	SB-RW-2	June 22,2009	2.3				
12	SB-RW-4	June 22,2010	3.5				
13	SB-RW-8	June 22,2011	7.6				
14	SB-RW-16	June 22,2012	13.3				
16	SC-RW-CONTROL	June 22,2013	0.0				
17	SC-RW-.5	June 22,2014	<0.5				
18	SC-RW-1.0	June 22,2015	1.1				
19	SC-RW-2	June 22,2016	2.3				
20	SC-RW-4	June 22,2017	5.0				
21	SC-RW-8	June 22,2018	5.4				
22	SC-RW-16	June 22,2019	8.2				
24	SA-E-CONTROL	June 22,2020	36.3				
25	SA-E-0.5	June 22,2021	0.8				
26	SA-E-1.0	June 22,2022	1.0				
27	SA-E-2	June 22,2023	2.7				
28	SA-E-4	June 22,2024	3.6				
29	SA-E-8	June 22,2025	7.0				
30	SA-E-16	June 22,2026	11.7				
31	SA-E-32	June 22,2027	32.6				
32	SB-E-CONTOL	June 22,2028	36.2				
33	SB-E-.5	June 22,2029	1.1				
34	SB-E-1.0	June 22,2030	1.9				
35	SA-E-2	June 22,2031	3.0				
36	SA-E-4	June 22,2032	5.0				
37	SA-E-8	June 22,2033	8.2				
38	SA-E-16	June 22,2034	14.5				
39	SA-E-32	June 22,2035	32.4				
	SC-E-CONTROL	June 22,2036	36.1				
	SC-E-.5	June 22,2037	1.2				
	SC-E-1.0	June 22,2038	1.9				
	SC-E-2	June 22,2039	3.7				
	SC-E-4	June 22,2040	4.2				
	SC-E-8	June 22,2041	5.3				
	SC-E-16	June 22,2042	10.8				
	SC-E-32	June 22,2043	31.9				
	(10.0 mg/L NH3-N)		9.9				
	0.0 ppm std. check		0.2				
	2.0 ppm std. check		1.7				
	5.0 ppm std. check		4.7				
	10.0 ppm std. check		9.8				
	20.0 ppm std. check		19.7				
Standard additions:			*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*
	+ 5.0 ppm NH3-N						
	+ 10.0 ppm NH3-N		*91*				

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis

Date Analyzed: ______________ **Verified by:** ______________

Analyst: Dom Deluca, Ted Poniatowski **Date:** ______________

File: ______________

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	June 23,1999	ADDRESS:	Tetres
DATE SAMPLED:	June 23,1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE(S):	River Water & NEWPCC Final Effluent
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

#	Sample			Concentration - mg/L				
	Description		Date	NH3-N				
1		SA-RW-CONTROL	23-Jun-99	< 0.4				
2		SA-RW-0.5	23-Jun-99	< 0.4				
3		SA-RW-1.0	23-Jun-99	0.4				
4		SA-RW-2	23-Jun-99	1.2				
5		SA-RW-4	23-Jun-99	2.9				
6		SA-RW-8	23-Jun-99	3.2				
7		SA-RW-16	23-Jun-99	9.0				
8		SB-RW-CONTROL	23-Jun-99	< 0.4				
9		SB-RW-0.5	23-Jun-99	< 0.4				
10		SB-RW-1.0	23-Jun-99	0.6				
11		SB-RW-2	23-Jun-99	1.6				
12		SB-RW-4	23-Jun-99	3.7				
13		SB-RW-8	23-Jun-99	6.2				
14		SB-RW-16	23-Jun-99	10.4				
16		SC-RW-CONTROL	23-Jun-99	< 0.4				
17		SC-RW-0.5	23-Jun-99	0.6				
18		SC-RW-1.0	23-Jun-99	1.5				
19		SC-RW-2	23-Jun-99	1.9				
20		SC-RW-4	23-Jun-99	3.1				
21		SC-RW-8	23-Jun-99	4.5				
22		SC-RW-16	23-Jun-99	7.3				
24		SA-E-CONTROL	23-Jun-99	15.9				
25		SA-E-0.5	23-Jun-99	0.5				
26		SA-E-1.0	23-Jun-99	0.5				
27		SA-E-2	23-Jun-99	1.8				
28		SA-E-4	23-Jun-99	3.4				
29		SA-E-8	23-Jun-99	5.3				
30		SA-E-16	23-Jun-99	9.1				
31		SA-E-32	23-Jun-99	30.4				
32		SB-E-CONTROL	23-Jun-99	15.3				
33		SB-E-0.5	23-Jun-99	0.6				
34		SB-E-1.0	23-Jun-99	1.0				
35		SB-E-2	23-Jun-99	2.2				
36		SB-E-4	23-Jun-99	4.0				
37		SB-E-8	23-Jun-99	7.3				
38		SB-E-16	23-Jun-99	12.8				
39		SB-E-32	23-Jun-99	29.9				
		SC-E-CONTROL	23-Jun-99	15.0				
		SC-E-0.5	23-Jun-99	0.7				
		SC-E-1.0	23-Jun-99	1.2				
		SC-E-2	23-Jun-99	2.0				
		SC-E-4	23-Jun-99	3.4				
		SC-E-8	23-Jun-99	6.8				
		SC-E-16	23-Jun-99	10.3				
		SC-E-32	23-Jun-99	30.0				
	QC data:							
	Hach Verification Standard	*(10.0 mg/L NH3-N)*		10.1				
		0.0 ppm std. check		0.2				
		2.0 ppm std. check		1.9				
		5.0 ppm std. check		5.1				
		10.0 ppm std. check		10.3				
		20.0 ppm std. check		20.2				
	Standard additions:			*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*
	NEWPCC Final Eff (24/6/99)	+ 10.0 ppm NH3-N		*96*				

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis; MDL: <0.4 mg/L NH3-N

Date Analyzed: June 24, 1999

Verified by: G. Gay

Analyst: Dom Deluca

Date: 30 June 99

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	June 24,1999	ADDRESS:	Tetres
DATE SAMPLED:	June 24,1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	River Water & NEWPCC Final Effluent
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	**NH3-N**				
1	SA-RW-CONTROL	24-Jun-99	< 0.4				
2	SA-RW-0.5	24-Jun-99	0.7				
3	SA-RW-1.0	24-Jun-99	1.1				
4	SA-RW-2	24-Jun-99	2.0				
5	SA-RW-4	24-Jun-99	3.9				
6	SA-RW-8	24-Jun-99	5.0				
7	SA-RW-16	24-Jun-99	8.0				
8	SB-RW-CONTROL	24-Jun-99	< 0.4				
9	SB-RW-0.5	24-Jun-99	1.0				
10	SB-RW-1.0	24-Jun-99	1.9				
11	SB-RW-2	24-Jun-99	3.1				
12	SB-RW-4	24-Jun-99	5.0				
13	SB-RW-8	24-Jun-99	7.0				
14	SB-RW-16	24-Jun-99	9.7				
16	SC-RW-CONTROL	24-Jun-99	< 0.4				
17	SC-RW-0.5	24-Jun-99	1.0				
18	SC-RW-1.0	24-Jun-99	1.7				
19	SC-RW-2	24-Jun-99	2.5				
20	SC-RW-4	24-Jun-99	5.0				
21	SC-RW-8	24-Jun-99	5.4				
22	SC-RW-16	24-Jun-99	7.7				
24	SA-E-CONTROL	24-Jun-99	22.3				
25	SA-E-0.5	24-Jun-99	0.9				
26	SA-E-1.0	24-Jun-99	1.6				
27	SA-E-2	24-Jun-99	2.7				
28	SA-E-4	24-Jun-99	4.3				
29	SA-E-8	24-Jun-99	5.1				
30	SA-E-16	24-Jun-99	9.4				
31	SA-E-32	24-Jun-99	30.2				
32	SB-E-CONTROL	24-Jun-99	22.1				
33	SB-E-0.5	24-Jun-99	1.5				
34	SB-E-1.0	24-Jun-99	2.1				
35	SB-E-2	24-Jun-99	3.7				
36	SB-E-4	24-Jun-99	5.5				
37	SB-E-8	24-Jun-99	8.2				
38	SB-E-16	24-Jun-99	12.9				
39	SB-E-32	24-Jun-99	30.0				
	SC-E-CONTROL	24-Jun-99	21.3				
	SC-E-0.5	24-Jun-99	1.2				
	SC-E-1.0	24-Jun-99	1.8				
	SC-E-2	24-Jun-99	3.6				
	SC-E-4	24-Jun-99	3.5				
	SC-E-8	24-Jun-99	5.6				
	SC-E-16	24-Jun-99	11.3				
	SC-E-32	24-Jun-99	30.1				
QC data:							
Hach Verification Standard	*(10.0 mg/L NH3-N)*		10.1				
	0.0 ppm std. check		0.2				
	2.0 ppm std. check		1.9				
	5.0 ppm std. check		5.1				
	10.0 ppm std. check		10.3				
	20.0 ppm std. check		20.2				
Standard additions:			*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*
NEWPCC Final Eff (24/6/99)	+ 10.0 ppm NH3-N		*96*				

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis; MDL: <0.4 mg/L NH3-N

Date Analyzed: June 24, 1999

Verified by: G. Gay

Analyst: Dom Deluca

Date: 30 June 99

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	June 26, 1999	ADDRESS:	Tetres
DATE SAMPLED:	June 26, 1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	NEWPCC Final Effluent
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	NH3-N				
1	FA-E-CONTROL	June 25, 1999	23.4				
2	FA-E-1	June 25, 1999	1.6				
3	FA-E-2	June 25, 1999	2.0				
4	FA-E-4	June 25, 1999	4.7				
5	FA-E-8	June 25, 1999	8.9				
6	FA-E-16	June 25, 1999	13.2				
7	FA-E-32	June 25, 1999	28.8				
8	FA-E-64	June 25, 1999	56.0				
9	FB-E-CONTROL	June 25, 1999	23.6				
10	FB-E-1	June 25, 1999	1.3				
11	FB-E-2	June 25, 1999	2.8				
12	FB-E-4	June 25, 1999	4.7				
13	FB-E-8	June 25, 1999	8.5				
14	FB-E-16	June 25, 1999	15.3				
16	FB-E-32	June 25, 1999	23.0				
17	FB-E-64	June 25, 1999	55.8				
18	FC-E-CONTROL	June 25, 1999	23.7				
19	FC-E-1	June 25, 1999	0.9				
20	FC-E-2	June 25, 1999	1.3				
21	FC-E-4	June 25, 1999	3.0				
22	FC-E-8	June 25, 1999	6.2				
24	FC-E-16	June 25, 1999	12.0				
25	FC-E-32	June 25, 1999	16.1				
26	FC-E-64	June 25, 1999	58.4				
27	SA-E-CONTROL	June 25, 1999	27.1				
28	SA-E-1	June 25, 1999	0.8				
29	SA-E-2	June 25, 1999	1.2				
30	SA-E-4	June 25, 1999	2.8				
31	SA-E-8	June 25, 1999	6.8				
32	SA-E-16	June 25, 1999	6.5				
33	SA-E-32	June 25, 1999	17.2				
34	SA-E-64	June 25, 1999	57.4				
35	SB-E-CONTROL	June 25, 1999	27.1				
36	SB-E-1	June 25, 1999	0.8				
37	SB-E-2	June 25, 1999	1.5				
38	SB-E-4	June 25, 1999	2.7				
39	SB-E-8	June 25, 1999	6.3				
40	SB-E-16	June 25, 1999	10.6				
41	SB-E-32	June 25, 1999	17.0				
42	SB-E-64	June 25, 1999	57.4				
43	SC-E-CONTROL	June 25, 1999	27.0				
44	SC-E-1	June 25, 1999	0.8				
45	SC-E-2	June 25, 1999	1.6				
46	SC-E-4	June 25, 1999	4.7				
47	SC-E-8	June 25, 1999	9.3				
48	SC-E-16	June 25, 1999	12.8				
49	SC-E-32	June 25, 1999	25.6				
50	*SC-E-64*	June 25, 1999	56.6				
	QC data:						
	Hach Verification Standard *(10.0 mg/L NH3-N)*		10.0				
	0.0 ppm std. check		0.1				
	2.0 ppm std. check		1.9				
	5.0 ppm std. check		4.8				
	10.0 ppm std. check		10.0				
	20.0 ppm std. check		19.7				
	Standard additions:		*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis; MDL: <0.4 mg/L NH3-N

Date Analyzed: June 28, 1999 **Verified by:** G. Gay

Analyst: Dom Deluca, Ted Poniatowski **Date:** 30 June 99

File: ______________________________

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	June 26, 1999	ADDRESS:	Tetres
DATE SAMPLED:	June 26, 1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	NEWPCC Final Effluent
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	NH3-N				
1	FA-E-CONTROL	June 26, 1999	8.2				
2	FA-E-1	June 26, 1999	1.0				
3	FA-E-2	June 26, 1999	2.7				
4	FA-E-4	June 26, 1999	4.4				
5	FA-E-8	June 26, 1999	9.2				
6	FA-E-16	June 26, 1999	12.7				
7	FA-E-32	June 26, 1999	23.5				
8	FA-E-64	June 26, 1999	54.6				
9	FB-E-CONTROL	June 26, 1999	8.3				
10	FB-E-1	June 26, 1999	0.9				
11	FB-E-2	June 26, 1999	1.3				
12	FB-E-4	June 26, 1999	3.3				
13	FB-E-8	June 26, 1999	5.8				
14	FB-E-16	June 26, 1999	23.3				
16	FB-E-32	June 26, 1999	39.3				
17	FC-E-CONTROL	June 26, 1999	8.1				
18	FC-E-1	June 26, 1999	1.2				
19	FC-E-2	June 26, 1999	2.2				
20	FC-E-4	June 26, 1999	3.9				
21	FC-E-8	June 26, 1999	6.5				
22	FC-E-16	June 26, 1999	13.0				
24	FC-E-32	June 26, 1999	24.5				
25	SA-E-1	June 26, 1999	1.1				
26	SA-E-2	June 26, 1999	1.6				
27	SA-E-4	June 26, 1999	3.1				
28	SA-E-8	June 26, 1999	7.2				
29	SA-E-16	June 26, 1999	10.5				
30	SA-E-32	June 26, 1999	20.2				
31	SA-E-64	June 26, 1999	55.7				
32	SB-E-CONTROL	June 26, 1999	8.4				
33	SB-E-1	June 26, 1999	1.0				
34	SB-E-2	June 26, 1999	1.8				
35	SB-E-4	June 26, 1999	4.1				
36	SB-E-8	June 26, 1999	7.8				
37	SB-E-16	June 26, 1999	13.6				
38	SB-E-32	June 26, 1999	23.6				
39	SB-E-64	June 26, 1999	55.4				
40	SC-E-CONTROL	June 26, 1999	7.0				
41	SC-E-1	June 26, 1999	0.7				
42	SC-E-2	June 26, 1999	2.1				
43	SC-E-4	June 26, 1999	3.4				
44	SC-E-8	June 26, 1999	6.4				
45	SC-E-16	June 26, 1999	9.6				
46	SC-E-32	June 26, 1999	18.5				
47	SC-E-64	June 26, 1999	53.6				
	QC data:						
	Hach Verification Standard *(10.0 mg/L NH3-N)*		10.0				
	0.0 ppm std. check		0.1				
	2.0 ppm std. check		1.9				
	5.0 ppm std. check		4.8				
	10.0 ppm std. check		10.0				
	20.0 ppm std. check		19.7				
	Standard additions:		*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis; MDL: <0.4 mg/L NH3-N

Date Analyzed: June 28, 1999

Verified by: G. Gay

Analyst: Dom Deluca, Ted Poniatowski

Date: 30 June 99

File: ____________________

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	June 27, 1999	ADDRESS:	Tetres
DATE SAMPLED:	June 27, 1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	NEWPCC Final Effluent
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

	Sample		Concentration - mg/L				
	Description	Date	**NH3-N**				
1	FA-E-CONTROl	June 27, 1999	17.7				
2	FA-E-1	June 27, 1999	0.5				
3	FA-E-2	June 27, 1999	0.7				
4	FA-E-4	June 27, 1999	2.2				
5	FA-E-8	June 27, 1999	5.1				
6	FA-E-16	June 27, 1999	15.0				
7	FA-E-32	June 27, 1999	23.2				
8	FA-E-64	June 27, 1999	55.3				
9	FB-E-CONTROL	June 27, 1999	18.3				
10	FB-E-1	June 27, 1999	0.9				
11	FB-E-2	June 27, 1999	0.9				
12	FB-E-4	June 27, 1999	3.8				
13	FB-E-8	June 27, 1999	7.6				
14	FB-E-16	June 27, 1999	10.0				
16	FB-E-32	June 27, 1999	18.5				
17	FB-E-64	June 27, 1999	55.9				
18	FC-E-CONTROL	June 27, 1999	17.4				
19	FC-E-1	June 27, 1999	0.7				
20	FC-E-2	June 27, 1999	1.5				
21	FC-E-4	June 27, 1999	1.7				
22	FC-E-8	June 27, 1999	9.4				
24	FC-E-16	June 27, 1999	10.3				
25	FC-E-32	June 27, 1999	30.9				
26	SA-E-CONTROL	June 27, 1999	18.4				
27	SA-E-1	June 27, 1999	1.3				
28	SA-E-2	June 27, 1999	1.7				
29	SA-E-4	June 27, 1999	4.0				
30	SA-E-8	June 27, 1999	8.5				
31	SA-E-16	June 27, 1999	15.8				
32	SA-E-32	June 27, 1999	22.6				
33	SA-E-64	June 27, 1999	60.1				
34	SB-E-CONTROL	June 27, 1999	21.2				
35	SB-E-1	June 27, 1999	1.7				
36	SB-E-2	June 27, 1999	2.2				
37	SB-E-4	June 27, 1999	4.6				
38	SB-E-8	June 27, 1999	9.7				
39	SB-E-16	June 27, 1999	15.7				
40	SB-E-32	June 27, 1999	24.5				
41	SB-E-64	June 27, 1999	58.3				
42	SC-E-CONTROL	June 27, 1999	19.0				
43	SC-E-1	June 27, 1999	1.6				
44	SC-E-2	June 27, 1999	2.9				
45	SC-E-4	June 27, 1999	6.3				
46	SC-E-8	June 27, 1999	5.5				
47	SC-E-16	June 27, 1999	14.6				
48	SC-E-32	June 27, 1999	22.2				
49	SC-E-64	June 27, 1999	55.7				
QC data:							
Hach Verification Standard	*(10.0 mg/L NH3-N)*		10.0				
	0.0 ppm std. check		0.1				
	2.0 ppm std. check		1.9				
	5.0 ppm std. check		4.8				
	10.0 ppm std. check		10.0				
	20.0 ppm std. check		19.7				
Standard additions:			*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis; MDL: <0.4 mg/L NH3-N

Date Analyzed: June 28, 1999

Verified by: G. Gay

Analyst: Dom Deluca, Ted Poniatowski

Date: 30 June 99

File: ______________________

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	June 28, 1999	ADDRESS:	Tetres
DATE SAMPLED:	June 28, 1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE # 942-2505

SAMPLE TYPE:	NEWPCC Final Effluent
LOCATION:	North End Plant
PROJECT:	Ammonia Study

PARAMETERS REQUESTED: Total Ammonia

RESULTS

No.	Sample Description	Date	Concentration - mg/L NH3-N				
1	FA-E-CONTROL	28-Jun-99	20.7				
2	FA-E-1	28-Jun-99	1.3				
3	FA-E-2	28-Jun-99	2.1				
4	FA-E-4	28-Jun-99	3.9				
5	FA-E-8	28-Jun-99	7.3				
6	FA-E-16	28-Jun-99	13.2				
7	FA-E-32	28-Jun-99	26.1				
8	FB-E-CONTROL	28-Jun-99	20.7				
9	FB-E-1	28-Jun-99	1.8				
10	FB-E-2	28-Jun-99	3.1				
11	FB-E-4	28-Jun-99	4.3				
12	FB-E-8	28-Jun-99	7.6				
13	FR-E-16	28-Jun-99	12.6				
14	FB-E-32	28-Jun-99	23.9				
16	FC-E-CONTROL	28-Jun-99	20.7				
17	FC-E-1	28-Jun-99	1.6				
18	FC-E-2	28-Jun-99	2.5				
19	FC-E-4	28-Jun-99	4.5				
20	FC-E-8	28-Jun-99	9.2				
21	FC-E-16	28-Jun-99	13.9				
22	FC-E-32	28-Jun-99	22.3				
24	SA-E-CONTROL	28-Jun-99	21.0				
25	SA-E-1	28-Jun-99	1.0				
26	SA-E-2	28-Jun-99	1.7				
27	SA-E-4	28-Jun-99	2.8				
28	SA-E-8	28-Jun-99	5.8				
29	SA-E-16	28-Jun-99	11.3				
30	SA-E-32	28-Jun-99	24.7				
31	SA-E-64	28-Jun-99	58.9				
32	SB-E-CONTROL	28-Jun-99	21.4				
33	SB-E-1	28-Jun-99	1.2				
34	SB-E-2	28-Jun-99	2.3				
35	SB-E-4	28-Jun-99	3.0				
36	SB-E-8	28-Jun-99	5.9				
37	SB-E-16	28-Jun-99	11.0				
38	SB-E-32	28-Jun-99	22.4				
39	SB-E-64	28-Jun-99	58.2				
	SC-E-CONTROL	28-Jun-99	21.5				
	SC-E-1	28-Jun-99	1.3				
	SC-E-2	28-Jun-99	1.8				
	SC-E-4	28-Jun-99	3.3				
	SC-E-8	28-Jun-99	7.4				
	SC-E-16	28-Jun-99	11.5				
	SC-E-32	28-Jun-99	18.0				
QC data:							
*(repeated analysis from **25 June run**)*	FC-E-16 (25 June 99)		11.9				
*(repeated analysis from **25 June run**)*	SA-E-16 (25 June 99)		6.6				
*(repeated analysis from **25 June run**)*	SA-E-32 (25 June 99)		17.6				
*(repeated analysis from **25 June run**)*	SB-E-16 (25 June 99)		10.9				
*(repeated analysis from **25 June run**)*	SB-E-32 (25 June 99)		16.8				
*(repeated analysis from **28 June run**)*	FA-E-32 (26 June 99)		22.5				
*(repeated analysis from **28 June run**)*	SA-E-16 (26 June 99)		10.4				
*(repeated analysis from **28 June run**)*	SA-E-32 (26 June 99)		19.9				
*(repeated analysis from **28 June run**)*	SC-E-16 (26 June 99)		9.6				
*(repeated analysis from **28 June run**)*	SC-E-32 (26 June 99)		18.7				
Hach Verification Standard	*(10.0 mg/L NH3-N)*		9.9				
	0.0 ppm std. check		0.2				
	2.0 ppm std. check		1.7				
	5.0 ppm std. check		4.6				
	10.0 ppm std. check		9.8				
	20.0 ppm std. check		19.7				
Standard additions:			*% recovery*	*% recovery*	*%recovery*	*% recovery*	*% recovery*
FA-E Control (28/6/99)	+ 10.0 ppm NH3-N		*91*				

Remarks: The 0-25 ppm NH3-N range (w/ 1/4 dil'n loop) was used for this analysis; MDL: <0.4 mg/L NH3-N

Date Analyzed: June 29,1999 **Verified by:** G. Gay

Analyst: Dom Deluca, Ted Poniatowski **Date:** 30 June 99

File: ______

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	14-Aug-99	ADDRESS:	Tetres
DATE SAMPLED:	13-Aug-99		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	Sampler/Submitter Remarks:
LOCATION:	North End Plant	
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

	check		check		check
Total Nitrate (NO_3/NO_2-N):	X	Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):					
Total Kjeldahl Nitrogen (TKN):	X	Total Phophorus (P)	X		

RESULTS

Sample		Concentration (mg/L)							
Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date	TKN	Analysis Date	P	Analysis Date
8/13/99 CLAMS INITIAL	13-Aug-99			2.76	17-Aug-99	34.6	30-Aug-99	2.99	30-Aug-99
8/13/1999 CLAMS 15:30	13-Aug-99			15.5	17-Aug-99	20.3	30-Aug-99	2.84	30-Aug-99
8/13/99 CLAMS 22:00	13-Aug-99			29	17-Aug-99	5.6	30-Aug-99	2.64	30-Aug-99
8/14/99 CLAMS FINAL	14-Aug-99			32	17-Aug-99	2.9	30-Aug-99	2.87	30-Aug-99
QC data:			*% recovery*		*% recovery*		*% recovery*		*% recovery*
Low-level Standard Check:									
N03-N std. check: 0.0 ppm				0.06					
N03-N std. check: 0.4 ppm				0.43					
N03-N std. check: 0.8 ppm				0.79					
N03-N std. check: 1.6 ppm				1.56					
Verification Standard: 1.00mg/L NO3-N)/ 0.25 P				0.96		5.4		0.25	
Verification Standard: (10.0 mg/L NH3-N)/ 5 mg/L TKN									
Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*

Analyst Remarks:

Date Reported: Sept8,1999 **Verified by:**

Analyst: T.Poniatowski, D.DeLuca **Date:**

File: __na081799/pt083099________________________________

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	13 Jul 99 - 16 Jul 99	ADDRESS:	Tetres
DATE SAMPLED:	13 Jul 99 - 16 Jul 99		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	Sampler/Submitter Remarks:
LOCATION:	North End Plant	
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

Parameter	check	Parameter	check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	x				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

	Sample		Concentration (mg/L)							
	Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
1	7/13/99-CONTROL	13-Jul-99	<0.4	16-Jul-99						
2	7/13/99-1.5	13-Jul-99	<0.4	16-Jul-99						
3	7/13/99-3.0	13-Jul-99	<0.4	16-Jul-99						
4	7/13/99-6.0	13-Jul-99	0.4	16-Jul-99						
5	7/13/99-12.0	13-Jul-99	0.9	16-Jul-99						
6	7/13/99-25.0	13-Jul-99	3.5	16-Jul-99						
7	7/13/99-100	13-Jul-99	20.9	16-Jul-99						
8	7/14/99-CONTROL	14-Jul-99	<0.4	16-Jul-99						
9	7/14/99-1.5	14-Jul-99	<0.4	16-Jul-99						
10	7/14/99-3.0	14-Jul-99	<0.4	16-Jul-99						
11	7/14/99-6.0	14-Jul-99	<0.4	16-Jul-99						
12	7/14/99-12.0	14-Jul-99	0.9	16-Jul-99						
13	7/14/99-25.0	14-Jul-99	4.1	16-Jul-99						
14	7/14/99-100	14-Jul-99	21.9	16-Jul-99						
15	7/15/99-CONTROL	15-Jul-99	<0.4	16-Jul-99						
16	7/15/99-1.5	15-Jul-99	<0.4	16-Jul-99						
17	7/15/99-3.0	15-Jul-99	<0.4	16-Jul-99						
18	7/15/99-6.0	15-Jul-99	0.4	16-Jul-99						
19	7/15/99-12.0	15-Jul-99	0.9	16-Jul-99						
20	7/15/99-25.0	15-Jul-99	4.2	16-Jul-99						
21	7/15/99-100	15-Jul-99	22.7	16-Jul-99						
22	7/16/99-CONTROL	16-Jul-99	<0.4	16-Jul-99						
23	7/16/99-1.5	16-Jul-99	<0.4	16-Jul-99						
24	7/16/99-3.0	16-Jul-99	<0.4	16-Jul-99						
25	7/16/99-6.0	16-Jul-99	<0.4	16-Jul-99						
26	7/16/99-12.0	16-Jul-99	0.4	16-Jul-99						
27	7/16/99-25.0	16-Jul-99	1.3	16-Jul-99						
28	7/16/99-100	16-Jul-99	9.5	16-Jul-99						
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
	QC data:			*% recovery*		*% recovery*		*%recovery*		*% recovery*
	Low-level Standard Check:		-							
	NH3-N std. check: 0.0 ppm		0.0							
	NH3-N std. check: 5.0 ppm		4.0	80						
	NH3-N std. check: 10.0 ppm		9.5	95						
	NH3-N std. check: 20.0 ppm		19.8	99						
	Verification Standard: (10.0 mg/L NH3-N)		9.6	96						
	Standard additions:			*% recovery*		*% recovery*		*%recovery*		*% recovery*
	none to report		-							

Analyst Remarks:

Date Reported: 29-Jul-99 **Verified by:**

Analyst: D. De Luca/ T. Poniatowski **Date:**

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	17 Jul 99 - 29 Jul 99	ADDRESS:	Tetres
DATE SAMPLED:	17 Jul 99 - 29 Jul 99		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	Sampler/Submitter Remarks:
LOCATION:	North End Plant	
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

Parameter	check	Parameter	check	Parameter	check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	X				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

	Sample		Concentration (mg/L)							
	Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
1	7/17/99 CONTROL	17-Jul-99	<0.2	26-Jul-99						
2	7/17/99 1.5	17-Jul-99	<0.2	26-Jul-99						
3	7/17/99 3	17-Jul-99	<0.2	26-Jul-99						
4	7/17/99 6	17-Jul-99	0.3	26-Jul-99						
5	7/17/99 12	17-Jul-99	0.6	26-Jul-99						
6	**7/17/99 25**	17-Jul-99	2.1	26-Jul-99						
7	7/17/99 100	17-Jul-99	13.8	26-Jul-99						
8	7/18/99 CONTROL	18-Jul-99	<0.2	26-Jul-99						
9	7/18/99 1.5	18-Jul-99	<0.2	26-Jul-99						
10	7/18/99 3	18-Jul-99	<0.2	26-Jul-99						
11	7/18/99 6	18-Jul-99	0.3	26-Jul-99						
12	7/18/99 12	18-Jul-99	0.6	26-Jul-99						
13	**7/18/99 25**	18-Jul-99	2.0	26-Jul-99						
14	7/18/99 100	18-Jul-99	14.7	26-Jul-99						
15	7/19/99 CONTROL	19-Jul-99	<0.2	26-Jul-99						
16	7/19/99 1.5	19-Jul-99	<0.2	26-Jul-99						
17	7/19/99 3	19-Jul-99	<0.2	26-Jul-99						
18	7/19/99 6	19-Jul-99	0.3	26-Jul-99						
19	7/19/99 12	19-Jul-99	0.6	26-Jul-99						
20	7/19/99 25	19-Jul-99	2.7	26-Jul-99						
21	7/19/99 100	19-Jul-99	16.0	26-Jul-99						
22	7/20/99 CONTROL	20-Jul-99	<0.2	26-Jul-99						
23	7/20/99 1.5	20-Jul-99	<0.2	26-Jul-99						
24	7/20/99 3	20-Jul-99	0.2	26-Jul-99						
25	7/20/99 6	20-Jul-99	0.4	26-Jul-99						
26	7/20/99 12	20-Jul-99	0.9	26-Jul-99						
27	7/20/99 25	20-Jul-99	3.5	26-Jul-99						
28	7/20/99 100	20-Jul-99	19.2	26-Jul-99						
29	7/21/99 CONTROL	21-Jul-99	<0.2	26-Jul-99						
30	7/21/99 1.5	21-Jul-99	<0.2	26-Jul-99						
31	7/21/99 3	21-Jul-99	0.2	26-Jul-99						
32	7/21/99 6	21-Jul-99	0.4	26-Jul-99						
33	7/21/99 12	21-Jul-99	0.9	26-Jul-99						
34	7/21/99 25	21-Jul-99	4.3	26-Jul-99						
35	7/21/99 100	21-Jul-99	20.1	26-Jul-99						
36	7/22/99 CONTROL	22-Jul-99	<0.2	26-Jul-99						
37	7/22/99 1.5	22-Jul-99	<0.2	26-Jul-99						
38	7/22/99 3.0	22-Jul-99	0.3	26-Jul-99						
39	7/22/99 6.0	22-Jul-99	0.6	26-Jul-99						
40	7/22/99 12	22-Jul-99	1.0	26-Jul-99						
41	7/22/99 25	22-Jul-99	5.0	26-Jul-99						
42	7/22/99 100	22-Jul-99	25.2	26-Jul-99						
43	7/23/99 CONTROL	23-Jul-99	<0.2	26-Jul-99						
44	7/23/99 1.5	23-Jul-99	<0.2	26-Jul-99						
45	7/23/99 3.0	23-Jul-99	0.3	26-Jul-99						
46	7/23/99 6.0	23-Jul-99	0.6	26-Jul-99						
47	7/23/99 12	23-Jul-99	1.0	26-Jul-99						
48	7/23/99 25	23-Jul-99	5.0	26-Jul-99						
49	7/23/99 100	23-Jul-99	26.1	26-Jul-99						

	Sample		Concentration (mg/L)							
	Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
50	7/24/99 CONTROL	24-Jul-99	<0.2	26-Jul-99						
51	7/24/99 1.5	24-Jul-99	<0.2	26-Jul-99						
52	7/24/99 3.0	24-Jul-99	0.3	26-Jul-99						
53	7/24/99 6.0	24-Jul-99	0.5	26-Jul-99						
54	7/24/99 12	24-Jul-99	1.0	26-Jul-99						
55	7/24/99 25	24-Jul-99	4.3	26-Jul-99						
56	7/24/99 100	24-Jul-99	22.4	26-Jul-99						
57	7/25/99 CONTROL	25-Jul-99	<0.2	26-Jul-99						
58	7/25/99 1.5	25-Jul-99	<0.2	26-Jul-99						
59	7/25/99 3.0	25-Jul-99	<0.2	26-Jul-99						
60	7/25/99 6.0	25-Jul-99	0.4	26-Jul-99						
61	7/25/99 12	25-Jul-99	0.7	26-Jul-99						
62	7/25/99 25	25-Jul-99	2.6	26-Jul-99						
63	7/25/99 100	25-Jul-99	14.3	26-Jul-99						
64	7/26/99 CONTROL	26-Jul-99	<0.2	26-Jul-99						
65	7/26/99 1.5	26-Jul-99	<0.2	26-Jul-99						
66	7/26/99 3	26-Jul-99	0.3	26-Jul-99						
67	7/26/99 6	26-Jul-99	0.6	26-Jul-99						
68	7/26/99 12	26-Jul-99	0.9	26-Jul-99						
69	7/26/99 25	26-Jul-99	2.8	26-Jul-99						
70	7/26/99 100	26-Jul-99	13.6	26-Jul-99						
71	7/27/99 CONTROL	27-Jul-99	<0.2	27-Jul-99						
72	7/27/99 1.5	27-Jul-99	0.3	27-Jul-99						
73	7/27/99 3	27-Jul-99	0.6	27-Jul-99						
74	7/27/99 6	27-Jul-99	0.9	27-Jul-99						
75	7/27/99 12	27-Jul-99	0.9	27-Jul-99						
76	7/27/99 25	27-Jul-99	4.9	27-Jul-99						
77	7/27/99 100	27-Jul-99	19.8	27-Jul-99						
78	7/28/99 CONTROL	28-Jul-99	<0.2	28-Jul-99						
79	7/28/99 1.5	28-Jul-99	0.4	28-Jul-99						
80	7/28/99 3	28-Jul-99	0.8	28-Jul-99						
81	7/28/99 6	28-Jul-99	1.5	28-Jul-99						
82	7/28/99 12	28-Jul-99	3.0	28-Jul-99						
83	7/28/99 25	28-Jul-99	6.0	28-Jul-99						
84	7/28/99 100	28-Jul-99	27.1	28-Jul-99						
85	7/29/99 CONTROL	29-Jul-99	<0.2	29-Jul-99						
86	7/29/99 1.5	29-Jul-99	<0.2	29-Jul-99						
87	7/29/99 3	29-Jul-99	0.6	29-Jul-99						
88	7/29/99 6	29-Jul-99	1.4	29-Jul-99						
89	7/29/99 12	29-Jul-99	2.8	29-Jul-99						
90	7/29/99 25	29-Jul-99	6.1	29-Jul-99						
91	7/29/99 100	29-Jul-99	28.8	29-Jul-99						
	QC data:			*% recovery*		*% recovery*		*% recovery*		*% recovery*
	Low-level Standard Check:		-	-						
	NH3-N std. check: 0.0 ppm		0.0							
	NH3-N std. check: 2.0 ppm		1.9	95						
	NH3-N std. check: 4.0 ppm		4.1	102						
	NH3-N std. check: 8.0 ppm		7.9	99						
	Verification Standard: (10.0 mg/L NH3-N)		10.0	100						
	Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*
	none to report		-							

Analyst Remarks:

Date Reported: 29-Jul-99 **Verified by:**

Analyst: D. De Luca/ T. Poniatowski **Date:**

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY: Amy Partridge
DATE SUBMITTED:
DATE SAMPLED:
SAMPLED BY: Amy Partridge

REPORT TO: Amy Partridge
ADDRESS: Tetres
POSTAL CODE: PHONE: 942-2505

SAMPLE TYPE: River Samples
LOCATION: North End Plant
PROJECT: Ammonia Study

Sampler/Submitter Remarks:

REQUESTED PARAMETER(S):

Parameter	check	Parameter	check
Total Nitrate (NO_3/NO_2-N):	X	Ortho-phosphate (PO_4-P)	
Total Ammonia (NH_3-N):	X		
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)	

RESULTS

	Sample			Concentration (mg/L)						
	Description / Identification		Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date	TKN	Analysis Date	
1	7/30/1999	Control	30-Jul-99	**0.3**	5-Aug-99	0.32	5-Aug-99			
2	7/30/1999	1.5%	30-Jul-99	**0.3**	5-Aug-99	0.33	5-Aug-99			
3	7/30/1999	3%	30-Jul-99	**0.4**	5-Aug-99	0.36	5-Aug-99			
4	7/30/1999	6%	30-Jul-99	**0.9**	5-Aug-99	0.42	5-Aug-99			
5	7/30/1999	12%	30-Jul-99	**2.3**	5-Aug-99	0.55	5-Aug-99			
6	7/30/1999	25%	30-Jul-99	**5.4**	5-Aug-99	0.80	5-Aug-99			
7	7/30/1999	100%	30-Jul-99	**25.8**	5-Aug-99	2.40	5-Aug-99			
8	A 100 % no air, no clams		30-Jul-99	**27.5**	5-Aug-99	**2.84**	5-Aug-99	**30.0**	10 Aug. 99	
9	B 100 % air, no clams		30-Jul-99	**24.5**	5-Aug-99	**2.76**	5-Aug-99	**29.0**	10 Aug. 99	
10	C 100% air, clams		30-Jul-99	**0.8**	5-Aug-99	**30.5**	5-Aug-99	**3.0**	10 Aug. 99	
11	7/31/1999	Control	31-Jul-99	**<0.3**	5-Aug-99	0.33	5-Aug-99			
12	7/31/1999	1.5%	31-Jul-99	**<0.3**	5-Aug-99	0.35	5-Aug-99			
13	7/31/1999	3%	31-Jul-99	**0.4**	5-Aug-99	0.38	5-Aug-99			
14	7/31/1999	6%	31-Jul-99	**0.8**	5-Aug-99	0.44	5-Aug-99			
15	7/31/1999	12%	31-Jul-99	**2.0**	5-Aug-99	0.56	5-Aug-99			
16	7/31/1999	25%	31-Jul-99	**5.0**	5-Aug-99	0.83	5-Aug-99			
17	7/31/1999	100%	31-Jul-99	**24.9**	5-Aug-99	2.32	5-Aug-99			
18	8/1/1999	Control	1-Aug-99	**<0.3**	5-Aug-99	0.23	5-Aug-99			
19	8/1/1999	1.5%	1-Aug-99	**<0.3**	5-Aug-99	0.32	5-Aug-99			
20	8/1/1999	3%	1-Aug-99	**<0.3**	5-Aug-99	1.24	5-Aug-99			
21	8/1/1999	6%	1-Aug-99	**0.7**	5-Aug-99	0.42	5-Aug-99			
22	8/1/1999	12%	1-Aug-99	**1.7**	5-Aug-99	0.63	5-Aug-99			
23	8/1/1999	25%	1-Aug-99	**4.7**	5-Aug-99	1.02	5-Aug-99			
24	8/1/1999	100%	1-Aug-99	**24.3**	5-Aug-99	3.46	5-Aug-99			
25	8/2/1999	Control	2-Aug-99	**<0.3**	5-Aug-99	0.22	5-Aug-99			
26	8/2/1999	1.5%	2-Aug-99	**<0.3**	5-Aug-99	0.28	5-Aug-99			
27	8/2/1999	3%	2-Aug-99	**0.3**	5-Aug-99	0.33	5-Aug-99			
28	8/2/1999	6%	2-Aug-99	**0.6**	5-Aug-99	0.45	5-Aug-99			
29	8/2/1999	12%	2-Aug-99	**1.4**	5-Aug-99	0.85	5-Aug-99			
30	8/2/1999	25%	2-Aug-99	**4.2**	5-Aug-99	1.11	5-Aug-99			
31	8/2/1999	100%	2-Aug-99	**21.8**	5-Aug-99	3.88	5-Aug-99			
32	8/3/1999	Control	3-Aug-99	**<0.3**	5-Aug-99	0.24	5-Aug-99			
33	8/3/1999	1.5%	3-Aug-99	**<0.3**	5-Aug-99	0.29	5-Aug-99			
34	8/3/1999	3%	3-Aug-99	**0.3**	5-Aug-99	0.34	5-Aug-99			
35	8/3/1999	6%	3-Aug-99	**0.6**	5-Aug-99	0.45	5-Aug-99			
36	8/3/1999	12%	3-Aug-99	**1.6**	5-Aug-99	0.68	5-Aug-99			
37	8/3/1999	25%	3-Aug-99	**4.1**	5-Aug-99	1.10	5-Aug-99			
38	8/3/1999	100%	3-Aug-99	**21.8**	5-Aug-99	3.77	5-Aug-99			
39	8/4/1999	Control	4-Aug-99	**<0.3**	5-Aug-99	0.22	5-Aug-99			
40	8/4/1999	1.5%	4-Aug-99	**<0.3**	5-Aug-99	0.27	5-Aug-99			
41	8/4/1999	3%	4-Aug-99	**0.4**	5-Aug-99	0.32	5-Aug-99			
42	8/4/1999	6%	4-Aug-99	**0.9**	5-Aug-99	0.41	5-Aug-99			
43	8/4/1999	12%	4-Aug-99	**2.2**	5-Aug-99	0.60	5-Aug-99			
44	8/4/1999	25%	4-Aug-99	**5.4**	5-Aug-99	0.96	5-Aug-99			
45	8/4/1999	100%	4-Aug-99	**25.2**	5-Aug-99	3.17	5-Aug-99			
46	8/5/1999	Control	5-Aug-99	**<0.3**	5-Aug-99	0.23	5-Aug-99			
47	8/5/1999	1.5%	5-Aug-99	**0.3**	5-Aug-99	0.28	5-Aug-99			
48	8/5/1999	3%	5-Aug-99	**0.6**	5-Aug-99	0.32	5-Aug-99			
49	8/5/1999	6%	5-Aug-99	**1.3**	5-Aug-99	0.41	5-Aug-99			
50	8/5/1999	12%	5-Aug-99	**2.7**	5-Aug-99	0.57	5-Aug-99			
51	8/5/1999	25%	5-Aug-99	**6.2**	5-Aug-99	0.93	5-Aug-99			
52	8/5/1999	100%	5-Aug-99	**17.2**	5-Aug-99	1.55	5-Aug-99			

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:		ADDRESS:	Tetres
DATE SAMPLED:			
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	Sampler/Submitter Remarks:
LOCATION:	North End Plant	
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

Parameter	check	Parameter	check
Total Nitrate (NO_3/NO_2-N):	X	Ortho-phosphate (PO_4-P)	
Total Ammonia (NH_3-N):	X		
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)	

RESULTS

Sample		Concentration (mg/L)						
Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date	TKN	Analysis Date	
QC data:	*conc.(mg/L-N)*	*conc.(mg/L-N)*	*% recovery*		*% recovery*		*% recovery*	
Low-level Standard Check: -		-	-					
(reagent water), 0.0 ppm NH3-N *std. check:*		<0.3	-					
1.0 ppm NH3-N, *std. check:*		0.9	90%					
2.0 ppm NH3-N, *std. check:*		1.9	95%					
4.0 ppm NH3-N, *std. check:*		4.0	100%					
8.0 ppm NH3-N, *std. check:*		8.1	101%					
Hach Verification Standard: (5.0 mg/L NH3-N)		5.0	99%	-	-			
Hach Verification Standard: (1.0 mg/L NO3-N)		-	-	0.92	92%			
Standard additions:					*% recovery*		*% recovery*	
07/31/99 - 25% repeat		5.0						
07/31/99 25% + 2.0mg/L NH3-N + 0.4 mg/L NO3-N		6.8	101%					
08/01/99 - 25% repeat		4.8						
08/01/99 25% + 2.0mg/L NH3-N + 0.4 mg/L NO3-N		6.6	100%					
08/02/99 - 25% repeat		4.2						
08/02/99 25% + 2.0mg/L NH3-N + 0.4 mg/L NO3-N		6.1	103%					

Analyst Remarks:

Date Reported: 16 Aug. 99 **Verified by:** G.Gay

Analyst: T. Poniatowski, D.Deluca **Date:** 16 Aug. 99

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	13-Aug-99	ADDRESS:	Tetres
DATE SAMPLED:	06-Aug-99 to 13-Aug-99		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	Sampler/Submitter Remarks:
LOCATION:	North End Plant	
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

Parameter	check	Parameter	check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	X				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

	Sample		Concentration (mg/L)							
	Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
1	8/6/1999 Control	8/6/1999	<0.3	13-Aug-99						
2	8/6/1999 1.5%	8/6/1999	<0.3	13-Aug-99						
3	8/6/1999 3%	8/6/1999	0.3	13-Aug-99						
4	8/6/1999 6%	8/6/1999	0.6	13-Aug-99						
5	8/6/1999 12%	8/6/1999	1.8	13-Aug-99						
6	8/6/1999 25%	8/6/1999	5.5	13-Aug-99						
7	8/6/1999 100%	8/6/1999	28.3	13-Aug-99						
8	8/7/1999 Control	8/7/1999	<0.3	13-Aug-99						
9	8/7/1999 1.5%	8/7/1999	<0.3	13-Aug-99						
10	8/7/1999 3%	8/7/1999	<0.3	13-Aug-99						
11	8/7/1999 6%	8/7/1999	<0.3	13-Aug-99						
12	8/7/1999 12%	8/7/1999	0.3	13-Aug-99						
13	8/7/1999 25%	8/7/1999	1.0	13-Aug-99						
14	8/7/1999 100%	8/7/1999	7.6	13-Aug-99						
15	8/8/1999 Control	8/8/1999	<0.3	13-Aug-99						
16	8/8/1999 1.5%	8/8/1999	<0.3	13-Aug-99						
17	8/8/1999 3%	8/8/1999	<0.3	13-Aug-99						
18	8/8/1999 6%	8/8/1999	<0.3	13-Aug-99						
19	8/8/1999 12%	8/8/1999	0.8	13-Aug-99						
20	8/8/1999 25%	8/8/1999	2.9	13-Aug-99						
21	8/8/1999 100%	8/8/1999	16.4	13-Aug-99						
22	8/9/1999 Control	8/9/1999	<0.3	13-Aug-99						
23	8/9/1999 1.5%	8/9/1999	<0.3	13-Aug-99						
24	8/9/1999 3%	8/9/1999	<0.3	13-Aug-99						
25	8/9/1999 6%	8/9/1999	0.3	13-Aug-99						
26	8/9/1999 12%	8/9/1999	1.0	13-Aug-99						
27	8/9/1999 25%	8/9/1999	3.2	13-Aug-99						
28	8/9/1999 100%	8/9/1999	18.7	13-Aug-99						
29	8/10/1999 Control	8/10/1999	<0.3	13-Aug-99						
30	8/10/1999 1.5%	8/10/1999	<0.3	13-Aug-99						
31	8/10/1999 3%	8/10/1999	<0.3	13-Aug-99						
32	8/10/1999 6%	8/10/1999	0.6	13-Aug-99						
33	8/10/1999 12%	8/10/1999	1.6	13-Aug-99						
34	8/10/1999 25%	8/10/1999	3.9	13-Aug-99						
35	8/10/1999 100%	8/10/1999	21.1	13-Aug-99						
36	8/11/1999 Control	8/11/1999	<0.3	13-Aug-99						
37	8/11/1999 1.5%	8/11/1999	<0.3	13-Aug-99						
38	8/11/1999 3%	8/11/1999	0.3	13-Aug-99						
39	8/11/1999 6%	8/11/1999	0.8	13-Aug-99						
40	8/11/1999 12%	8/11/1999	2.4	13-Aug-99						
41	8/11/1999 25%	8/11/1999	5.9	13-Aug-99						
42	8/11/1999 100%	8/11/1999	29.3	13-Aug-99						
43	8/12/1999 Control	8/12/1999	<0.3	13-Aug-99						
44	8/12/1999 1.5%	8/12/1999	<0.3	13-Aug-99						
45	8/12/1999 3%	8/12/1999	0.4	13-Aug-99						
46	8/12/1999 6%	8/12/1999	0.9	13-Aug-99						
47	8/12/1999 12%	8/12/1999	2.6	13-Aug-99						
48	8/12/1999 25%	8/12/1999	6.0	13-Aug-99						
49	8/12/1999 100%	8/12/1999	30.1	13-Aug-99						
50	8/13/1999 Control	8/13/1999	<0.3	13-Aug-99						
51	8/13/1999 1.5%	8/13/1999	<0.3	13-Aug-99						
52	8/13/1999 3%	8/13/1999	0.7	13-Aug-99						
53	8/13/1999 6%	8/13/1999	1.5	13-Aug-99						
54	8/13/1999 12%	8/13/1999	3.3	13-Aug-99						
55	8/13/1999 25%	8/13/1999	6.7	13-Aug-99						
56	8/13/1999 100%	8/13/1999	31.1	13-Aug-99						

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	13-Aug-99	ADDRESS:	Tetres
DATE SAMPLED:	06-Aug-99 to 13-Aug-99		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	Sampler/Submitter Remarks:
LOCATION:	North End Plant	
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

	check		check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	X				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)							
Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
QC data:	*theoretical value*	*recovered value*	*% recovery*		*% recovery*		*% recovery*		*% recovery*
0.0 ppm NH3-N std. check:		0.1	-						
1.0 ppm NH3-N std. check:		1.1	-						
2.0 ppm NH3-N std. check:		2.0	-						
4.0 ppm NH3-N std. check:		4.1	-						
8.0 ppm NH3-N std. check:		7.8	-						
Hach Verification Standard: (5.0 mg/L NH3-N)		5.0	-						
Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*
8/6/99 25% - repeat		5.5	-						
8/6/99 25%+3.0 mg/L NH3-N		7.8	85%						
8/7/99 25% - repeat		1.2	-						
8/7/99 25%+3.0 mg/L NH3-N		4.0	96%						
8/8/99 25% - repeat		3.0	-						
8/8/99 25% + 3.0 mg/L NH3-N		5.8	99%						

Analyst Remarks:

Date Reported: 16 Aug. 99 **Verified by:** G. Gay

Analyst: T. Poniatowski **Date:** 1 6 Aug. 99

File:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	AUG,23,1999	ADDRESS:	Tetres
DATE SAMPLED:	AUG 14 to 22,1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	Sampler/Submitter Remarks:
LOCATION:	North End Plant	
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

Parameter	check	Parameter	check	Parameter	check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	X				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

	Sample		Concentration (mg/L)							
	Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
1	8/14/99 CONTROL	AUG,14,1999	<0.04	AUG,23,1999						
2	8/14/99 1.5%	AUG,14,1999	0.28	AUG,23,1999						
3	8/14/99 3%	AUG,14,1999	0.40	AUG,23,1999						
4	8/14/99 6%	AUG,14,1999	0.76	AUG,23,1999						
5	8/14/99 12%	AUG,14,1999	2.51	AUG,23,1999						
6	8/14/99 25%	AUG,14,1999	6.39	AUG,23,1999						
7	8/14/99 100%	AUG,14,1999	32.3	AUG,23,1999						
8										
9	8/15/99 CONTROL	AUG,15,1999	<0.04	AUG,23,1999						
10	8/15/99 1.5%	AUG,15,1999	0.23	AUG,23,1999						
11	8/15/99 3%	AUG,15,1999	0.41	AUG,23,1999						
12	8/15/99 6%	AUG,15,1999	0.71	AUG,23,1999						
13	8/15/99 12%	AUG,15,1999	2.12	AUG,23,1999						
14	8/15/99 25%	AUG,15,1999	4.58	AUG,23,1999						
15	8/15/99 100%	AUG,15,1999	27.7	AUG,23,1999						
16										
17	8/16/1999 CONTROL	AUG16,1999	<0.04	AUG,23,1999						
18	8/16/1999 1.5%	AUG16,1999	0.19	AUG,23,1999						
19	8/16/1999 3%	AUG16,1999	0.37	AUG,23,1999						
20	8/16/1999 6%	AUG16,1999	0.68	AUG,23,1999						
21	8/16/1999 12%	AUG16,1999	0.8	AUG,23,1999						
22	8/16/1999 25%	AUG16,1999	2.4	AUG,23,1999						
23	8/16/1999 100%	AUG16,1999	15.2	AUG,23,1999						
24										
25	8/17/1999 CONTROL	AUG,17,1999	<0.4	AUG,23,1999						
26	8/17/1999 1.5%	AUG,17,1999	<0.4	AUG,23,1999						
27	8/17/1999 3%	AUG,17,1999	<0.4	AUG,23,1999						
28	8/17/1999 6%	AUG,17,1999	<0.4	AUG,23,1999						
29	8/17/1999 12%	AUG,17,1999	0.9	AUG,23,1999						
30	8/17/1999 25%	AUG,17,1999	2.6	AUG,23,1999						
31	8/17/1999 100%	AUG,17,1999	16.4	AUG,23,1999						
32										
33	8/18/1999 CONTROL	AUG,18,1999	<0.4	AUG,23,1999						
34	8/18/1999 1.5%	AUG,18,1999	<0.4	AUG,23,1999						
35	8/18/1999 3%	AUG,18,1999	<0.4	AUG,23,1999						
36	8/18/1999 6%	AUG,18,1999	<0.4	AUG,23,1999						
37	8/18/1999 12%	AUG,18,1999	0.4	AUG,23,1999						
38	8/18/1999 25%	AUG,18,1999	1.5	AUG,23,1999						
39	8/18/1999 100%	AUG,18,1999	11.7	AUG,23,1999						
40										
41	8/19/1999 CONTROL	AUG,19,1999	<0.4	AUG,23,1999						
42	8/19/1999 1.5%	AUG,19,1999	<0.4	AUG,23,1999						
43	8/19/1999 3%	AUG,19,1999	<0.4	AUG,23,1999						
44	8/19/1999 6%	AUG,19,1999	0.4	AUG,23,1999						
45	8/19/1999 12%	AUG,19,1999	1.2	AUG,23,1999						
46	8/19/1999 25%	AUG,19,1999	3.9	AUG,23,1999						
47	8/19/1999 100%	AUG,19,1999	19.6	AUG,23,1999						
48										
49	8/20/1999 CONTROL	AUG,20,1999	<0.4	AUG,23,1999						
50	8/20/1999 1.5%	AUG,20,1999	<0.4	AUG,23,1999						
51	8/20/1999 3%	AUG,20,1999	<0.4	AUG,23,1999						
52	8/20/1999 6%	AUG,20,1999	0.6	AUG,23,1999						
53	8/20/1999 12%	AUG,20,1999	1.8	AUG,23,1999						
54	8/20/1999 25%	AUG,20,1999	4.7	AUG,23,1999						
55	8/20/1999 100%	AUG,20,1999	23.9	AUG,23,1999						
56										

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	AUG,23,1999	ADDRESS:	Tetres
DATE SAMPLED:	AUG 14 to 22,1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	Sampler/Submitter Remarks:
LOCATION:	North End Plant	
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

Parameter	check	Parameter	check	Parameter	check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	X				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

	Sample		Concentration (mg/L)							
	Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
57	8/21/1999 CONTROL	AUG,21,1999	<0.04	AUG,23,1999						
58	8/21/1999 1.5%	AUG,21,1999	0.9	AUG,23,1999						
59	8/21/1999 3%	AUG,21,1999	0.2	AUG,23,1999						
60	8/21/1999 6%	AUG,21,1999	0.5	AUG,23,1999						
61	8/21/1999 12%	AUG,21,1999	1.7	AUG,23,1999						
62	8/21/1999 25%	AUG,21,1999	5.1	AUG,23,1999						
63	8/21/1999 100%	AUG,21,1999	19.3	AUG,23,1999						
64										
65	8/22/1999 CONTROL	AUG,22,1999	<0.4	AUG,23,1999						
66	8/22/1999 1.5%	AUG,22,1999	<0.4	AUG,23,1999						
67	8/22/1999 3%	AUG,22,1999	0.5	AUG,23,1999						
68	8/22/1999 6%	AUG,22,1999	1.5	AUG,23,1999						
69	8/22/1999 12%	AUG,22,1999	4.3	AUG,23,1999						
70	8/22/1999 25%	AUG,22,1999	9.1	AUG,23,1999						
71	8/22/1999 100%	AUG,22,1999	21.6	AUG,23,1999						
	QC data:			*% recovery*		*% recovery*		*% recovery*		*% recovery*
	Low-level Standard Check:									
	NH3-N std. check: 1.0 mg/l		0.9							
	NH3-N std. check: 2.0 mg/l		1.9							
	NH3-N std. check: 4.0 mg/l		3.9							
	NH3-N std. check: 8.0 mg/l		7.9							
	Verification Standard: (5.0 mg/L NH3-N)		5.0							
	Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*
	8/13/99 N-5-2 +4.0ppm			*96*						
	8/13/99 N-5-4 +4.0 ppm			*94*						

Analyst Remarks: Samples control to 6% was done by low level ammonia except samples Aug 17 to Aug 20 was done by mid level range.
Samples 12% to 100% was done by mid range ammonia

Date Reported: AUG,23,1999 **Verified by:** ______

Analyst: T.Poniatowski, D.DeLuca **Date:** ______

File: _____an08/16,23,99______________________________

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	01-Sep-99	ADDRESS:	Tetres
DATE SAMPLED:	\UG. 23 to SEPT 2		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	Sampler/Submitter Remarks:
LOCATION:	North End Plant	
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

	check		check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	*x*				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

	Sample		Concentration (mg/L)							
	Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
1	8/23/1999 CONTROL	AUG,23 1999	**0.09**	1-Sep-99						
2	8/23/1999 1.5%	AUG,23 1999	**0.10**	1-Sep-99						
3	8/23/1999 3%	AUG,23 1999	**0.12**	1-Sep-99						
4	8/23/1999 6%	AUG,23 1999	**0.25**	30-Aug-99						
5	8/23/1999 12%	AUG,23 1999	**0.68**	30-Aug-99						
6	8/23/1999 25%	AUG,23 1999	**1.73**	30-Aug-99						
7	8/23/1999 100%	AUG,23 1999	**11.8**	30-Aug-99						
8										
9	8/24/1999 CONTROL	AUG,24 1999	**0.25**	1-Sep-99						
10	8/24/1999 1.5%	AUG,24 1999	**0.32**	1-Sep-99						
11	8/24/1999 3%	AUG,24 1999	**0.24**	1-Sep-99						
12	8/24/1999 6%	AUG,24 1999	**1.29**	30-Aug-99						
13	8/24/1999 12%	AUG,24 1999	**3.14**	30-Aug-99						
14	8/24/1999 25%	AUG,24 1999	**7.53**	30-Aug-99						
15	8/24/1999 100%	AUG,24 1999	**17.5**	30-Aug-99						
16										
17	8/25/1999 CONTROL	AUG,25 1999	**0.49**	1-Sep-99						
18	8/25/1999 1.5%	AUG,25 1999	**0.57**	1-Sep-99						
19	8/25/1999 3%	AUG,25 1999	**0.49**	1-Sep-99						
20	8/25/1999 6%	AUG,25 1999	**0.57**	30-Aug-99						
21	8/25/1999 12%	AUG,25 1999	**1.24**	30-Aug-99						
22	8/25/1999 25%	AUG,25 1999	**3.47**	30-Aug-99						
23	8/25/1999 100%	AUG,25 1999	**17.8**	30-Aug-99						
24										
25	8/26/1999 CONTROL	AUG,26 1999	**0.80**	1-Sep-99						
26	8/26/1999 1.5%	AUG,26 1999	**0.79**	1-Sep-99						
27	8/26/1999 3%	AUG,26 1999	**0.65**	1-Sep-99						
28	8/26/1999 6%	AUG,26 1999	**0.66**	30-Aug-99						
29	8/26/1999 12%	AUG,26 1999	**1.50**	30-Aug-99						
30	8/26/1999 25%	AUG,26 1999	**3.87**	30-Aug-99						
31	8/26/1999 100%	AUG,26 1999	**17.8**	30-Aug-99						
32										
33	8/27/1999 CONTROL	AUG,27 1999	**<0.04**	1-Sep-99						
34	8/27/1999 1.5%	AUG,27 1999	**0.23**	1-Sep-99						
35	8/27/1999 3%	AUG,27 1999	**0.41**	1-Sep-99						
36	8/27/1999 6%	AUG,27 1999	**1.20**	30-Aug-99						
37	8/27/1999 12%	AUG,27 1999	**3.20**	30-Aug-99						
38	8/27/1999 25%	AUG,27 1999	**7.68**	30-Aug-99						
39	8/27/1999 100%	AUG,27 1999	**34.7**	30-Aug-99						

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	01-Sep-99	ADDRESS:	Tetres
DATE SAMPLED:	\UG. 23 to SEPT 2		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	Sampler/Submitter Remarks:
LOCATION:	North End Plant	
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

Parameter	check	Parameter	check	Parameter	check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	x				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

	Sample		Concentration (mg/L)							
	Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
40										
41	8/28/1999 CONTROL	AUG,28 1999	**<0.04**	1-Sep-99						
42	8/28/1999 1.5%	AUG,28 1999	**0.21**	1-Sep-99						
43	8/28/1999 3%	AUG,28 1999	**0.38**	1-Sep-99						
44	8/28/1999 6%	AUG,28 1999	**0.89**	30-Aug-99						
45	8/28/1999 12%	AUG,28 1999	**2.45**	30-Aug-99						
46	8/28/1999 25%	AUG,28 1999	**6.92**	30-Aug-99						
47	8/28/1999 100%	AUG,28 1999	**28.2**	30-Aug-99						
48										
49	8/29/1999 CONTROL	AUG,29 1999	**0.80**	1-Sep-99						
50	8/29/1999 1.5%	AUG,29 1999	**0.80**	1-Sep-99						
51	8/29/1999 3%	AUG,29 1999	**0.45**	1-Sep-99						
52	8/29/1999 6%	AUG,29 1999	**2.04**	30-Aug-99						
53	8/29/1999 12%	AUG,29 1999	**5.34**	30-Aug-99						
54	8/29/1999 25%	AUG,29 1999	**11.24**	30-Aug-99						
55	8/29/1999 100%	AUG,29 1999	**24.4**	30-Aug-99						
56										
57										
	QC data:			*% recovery*		*% recovery*		*% recovery*		*% recovery*
	Low-level Standard Check: 0.05 MG/L		0.05							
	NH3-N std. check: 1.0 mg/l		0.7							
	NH3-N std. check: 2.0 mg/l		1.8							
	NH3-N std. check: 4.0 mg/l		4.0							
	NH3-N std. check: 8.0 mg/l		8.1							
	Hach Verification Standard: (5.0 mg/L NH3-N)		5.0							
	Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*

Analyst Remarks:

Date Reported: ____________________ **Verified by:** ____________________

Analyst: T.Poniatowski, D.DeLuca **Date:** ____________________

File: ___an090299________________________________

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	Aug 30 to Sept 14, 1999	ADDRESS:	Tetres
DATE SAMPLED:	Aug 30 to Sept 14, 1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	**Sampler/Submitter Remarks:**
LOCATION:	North End Plant	
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

	check		check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	X				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

	Sample		Concentration (mg/L)							
	Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
1	8/30/1999 CONTROL	30-Aug-99	**<0.04**	2-Sep-99						
2	8/30/1999 1.5%	30-Aug-99	**0.07**	2-Sep-99						
3	8/30/1999 3%	30-Aug-99	**0.2**	2-Sep-99						
4	8/30/1999 6%	30-Aug-99	**0.5**	16-Sep-99						
5	8/30/1999 12%	30-Aug-99	**1.0**	16-Sep-99						
6	8/30/1999 25%	30-Aug-99	**3.6**	16-Sep-99						
7	8/30/1999 100%	30-Aug-99	**20.2**	16-Sep-99						
8										
9	8/31/1999 CONTROL	31-Aug-99	**<0.04**	2-Sep-99						
10	8/31/1999 1.5%	31-Aug-99	**0.15**	2-Sep-99						
11	8/31/1999 3%	31-Aug-99	**0.26**	2-Sep-99						
12	8/31/1999 6%	31-Aug-99	**0.7**	16-Sep-99						
13	8/31/1999 12%	31-Aug-99	**2.0**	16-Sep-99						
14	8/31/1999 25%	31-Aug-99	**5.3**	16-Sep-99						
15	8/31/1999 100%	31-Aug-99	**27.1**	16-Sep-99						
16										
17	9/1/1999 CONTROL	1-Sep-99	**<0.04**	2-Sep-99						
18	9/1/1999 1.5%	1-Sep-99	**0.18**	2-Sep-99						
19	9/1/1999 3%	1-Sep-99	**0.38**	2-Sep-99						
20	9/1/1999 6%	1-Sep-99	**0.6**	16-Sep-99						
21	9/1/1999 12%	1-Sep-99	**2.0**	16-Sep-99						
22	9/1/1999 25%	1-Sep-99	**4.8**	16-Sep-99						
23	9/1/1999 100%	1-Sep-99	**25.9**	16-Sep-99						
24										
25	9/2/1999 CONTROL	2-Sep-99	**na**	-						
26	9/2/1999 1.5%	2-Sep-99	**na**	-						
27	9/2/1999 3%	2-Sep-99	**na**	-						
28	9/2/1999 6%	2-Sep-99	**0.8**	16-Sep-99						
29	9/2/1999 12%	2-Sep-99	**2.0**	16-Sep-99						
30	9/2/1999 25%	2-Sep-99	**5.4**	16-Sep-99						
31	9/2/1999 100%	2-Sep-99	**27.4**	16-Sep-99						
32										
33	9/3/1999 CONTROL	3-Sep-99	**<0.3**	16-Sep-99						
34	9/3/1999 1.5%	3-Sep-99	**<0.3**	16-Sep-99						
35	9/3/1999 3%	3-Sep-99	**0.4**	16-Sep-99						
36	9/3/1999 6%	3-Sep-99	**0.6**	16-Sep-99						
37	9/3/1999 12%	3-Sep-99	**2.1**	16-Sep-99						
38	9/3/1999 25%	3-Sep-99	**5.5**	16-Sep-99						
39	9/3/1999 100%	3-Sep-99	**28.0**	16-Sep-99						
40										
41	9/4/1999 CONTROL	4-Sep-99	**<0.3**	16-Sep-99						
42	9/4/1999 1.5%	4-Sep-99	**<0.3**	16-Sep-99						
43	9/4/1999 3%	4-Sep-99	**0.4**	16-Sep-99						
44	9/4/1999 6%	4-Sep-99	**0.7**	16-Sep-99						
45	9/4/1999 12%	4-Sep-99	**2.2**	16-Sep-99						
46	9/4/1999 25%	4-Sep-99	**6.0**	16-Sep-99						
47	9/4/1999 100%	4-Sep-99	**28.4**	16-Sep-99						
48										

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	Aug 30 to Sept 14, 1999	ADDRESS:	Tetres
DATE SAMPLED:	Aug 30 to Sept 14, 1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	**Sampler/Submitter Remarks:**
LOCATION:	North End Plant	
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

Parameter	*check*	Parameter	*check*		*check*
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	*X*				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)							
Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
9/5/1999 CONTROL	5-Sep-99	**<0.3**	16-Sep-99						
9/5/1999 1.5%	5-Sep-99	**<0.3**	16-Sep-99						
9/5/1999 3%	5-Sep-99	**<0.3**	16-Sep-99						
9/5/1999 6%	5-Sep-99	**0.3**	16-Sep-99						
9/5/1999 12%	5-Sep-99	**0.4**	16-Sep-99						
9/5/1999 25%	5-Sep-99	**0.7**	16-Sep-99						
9/5/1999 100%	5-Sep-99	**5.8**	16-Sep-99						
9/6/1999 CONTROL	6-Sep-99	**<0.3**	16-Sep-99						
9/6/1999 1.5%	6-Sep-99	**<0.3**	16-Sep-99						
9/6/1999 3%	6-Sep-99	**0.4**	16-Sep-99						
9/6/1999 6%	6-Sep-99	**0.6**	16-Sep-99						
9/6/1999 12%	6-Sep-99	**1.4**	16-Sep-99						
9/6/1999 25%	6-Sep-99	**3.4**	16-Sep-99						
9/6/1999 100%	6-Sep-99	**12.5**	16-Sep-99						
9/7/1999 CONTROL	7-Sep-99	**<0.3**	16-Sep-99						
9/7/1999 1.5%	7-Sep-99	**<0.3**	16-Sep-99						
9/7/1999 3%	7-Sep-99	**<0.3**	16-Sep-99						
9/7/1999 6%	7-Sep-99	**0.4**	16-Sep-99						
9/7/1999 12%	7-Sep-99	**0.7**	16-Sep-99						
9/7/1999 25%	7-Sep-99	**2.4**	16-Sep-99						
9/7/1999 100%	7-Sep-99	**15.0**	16-Sep-99						
9/8/1999 CONTROL	8-Sep-99	**<0.3**	16-Sep-99						
9/8/1999 1.5%	8-Sep-99	**<0.3**	16-Sep-99						
9/8/1999 3%	8-Sep-99	**<0.3**	16-Sep-99						
9/8/1999 6%	8-Sep-99	**0.5**	16-Sep-99						
9/8/1999 12%	8-Sep-99	**1.2**	16-Sep-99						
9/8/1999 25%	8-Sep-99	**3.3**	16-Sep-99						
9/8/1999 100%	8-Sep-99	**20.0**	16-Sep-99						
9/9/1999 CONTROL	9-Sep-99	**<0.3**	16-Sep-99						
9/9/1999 1.5%	9-Sep-99	**<0.3**	16-Sep-99						
9/9/1999 3%	9-Sep-99	**0.3**	16-Sep-99						
9/9/1999 6%	9-Sep-99	**0.7**	16-Sep-99						
9/9/1999 12%	9-Sep-99	**1.8**	16-Sep-99						
9/9/1999 25%	9-Sep-99	**5.5**	16-Sep-99						
9/9/1999 100%	9-Sep-99	**27.8**	16-Sep-99						
9/10/1999 CONTROL	10-Sep-99	**<0.3**	16-Sep-99						
9/10/1999 1.5%	10-Sep-99	**<0.3**	16-Sep-99						
9/10/1999 3%	10-Sep-99	**0.4**	16-Sep-99						
9/10/1999 6%	10-Sep-99	**0.7**	16-Sep-99						
9/10/1999 12%	10-Sep-99	**3.5**	16-Sep-99						
9/10/1999 25%	10-Sep-99	**5.1**	16-Sep-99						
9/10/1999 100%	10-Sep-99	**26.8**	16-Sep-99						

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	Aug 30 to Sept 14, 1999	ADDRESS:	Tetres
DATE SAMPLED:	Aug 30 to Sept 14, 1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	**Sampler/Submitter Remarks:**
LOCATION:	North End Plant	
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

	check		check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	X				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)							
Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
9/11/1999 CONTROL	11-Sep-99	**<0.3**	16-Sep-99						
9/11/1999 1.5%	11-Sep-99	**0.3**	16-Sep-99						
9/11/1999 3%	11-Sep-99	**0.4**	16-Sep-99						
9/11/1999 6%	11-Sep-99	**0.8**	16-Sep-99						
9/11/1999 12%	11-Sep-99	**0.9**	16-Sep-99						
9/11/1999 25%	11-Sep-99	**4.7**	16-Sep-99						
9/11/1999 100%	11-Sep-99	**25.3**	16-Sep-99						
9/12/1999 CONTROL	12-Sep-99	**<0.3**	16-Sep-99						
9/12/1999 1.5%	12-Sep-99	**<0.3**	16-Sep-99						
9/12/1999 3%	12-Sep-99	**0.3**	16-Sep-99						
9/12/1999 6%	12-Sep-99	**0.5**	16-Sep-99						
9/12/1999 12%	12-Sep-99	**0.9**	16-Sep-99						
9/12/1999 25%	12-Sep-99	**2.3**	16-Sep-99						
9/12/1999 100%	12-Sep-99	**13.1**	16-Sep-99						
9/13/1999 CONTROL	13-Sep-99	**<0.3**	16-Sep-99						
9/13/1999 1.5%	13-Sep-99	**<0.3**	16-Sep-99						
9/13/1999 3%	13-Sep-99	**<0.3**	16-Sep-99						
9/13/1999 6%	13-Sep-99	**0.3**	16-Sep-99						
9/13/1999 12%	13-Sep-99	**0.6**	16-Sep-99						
9/13/1999 25%	13-Sep-99	**1.6**	16-Sep-99						
9/13/1999 100%	13-Sep-99	**8.8**	16-Sep-99						
9/14/1999 CONTROL	14-Sep-99	**<0.3**	16-Sep-99						
9/14/1999 1.5%	14-Sep-99	**<0.3**	16-Sep-99						
9/14/1999 3%	14-Sep-99	**0.3**	16-Sep-99						
9/14/1999 6%	14-Sep-99	**0.7**	16-Sep-99						
9/14/1999 12%	14-Sep-99	**0.1**	16-Sep-99						
9/14/1999 25%	14-Sep-99	**2.8**	16-Sep-99						
9/14/1999 100%	14-Sep-99	**23.8**	16-Sep-99						
QC data:			*% recovery*		*% recovery*		*% recovery*		*% recovery*
Low-level Standard Check: -		**-**	-						
end of run Std. check: *1.0 ppm NH3-N*		**0.8**							
end of run Std. check: *2.0 ppm NH3-N*		**1.8**							
end of run Std. check: *4.0 ppm NH3-N*		**3.9**							
end of run Std. check: *8.0 ppm NH3-N*		**8.0**							
Verification Standard (HACH): (5.0 mg/L NH3-N)		**4.9**	98						
Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*
9/10/99 12% repeat		***3.4***	-						
9/10/99 12% + 5.0 NH3-N		**-**	*101*						
9/11/99 12% repeat		***1.8***	-						
9/11/99 12% + 5.0 NH3-N		**-**	*100*						
F08/30/99 E-4		***2.6***							
F08/30/99 E-4 + 5.0 ppm NH3-N		**-**	*100*						
F08/30/99 E-8		***7.0***							
F08/30/99 E-8 + 5.0 ppm NH3-N *		**-**	*51 **						

Analyst Remarks: * possible error in preparing F08/30/99 E-8 spike.

Date Reported: 16-Sep-99 **Verified by:** ______________________

Analyst: T.Poniatowski, D.DeLuca **Date:** ______________________

File: ______________________

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	Sept 15 and Sept 16, 1999	ADDRESS:	Tetres
DATE SAMPLED:	Sept 15 and Sept 16, 1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	Effluent-spiked riverwater	*Sampler/Submitter Remarks:*
LOCATION:	North End Plant	
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

Parameter	check	Parameter	check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	X				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	PO_4-P	Analysis Date	Total P	Analysis Date
09/2/99 RW CONT	02-Sep-99	**<0.3**	20-Sep-99								
09/2/99 1.5%	02-Sep-99	**<0.3**	20-Sep-99								
09/2/99 3%	02-Sep-99	**<0.3**	20-Sep-99								
09/15/99 R. W.	15-Sep-99	**<0.3**	20-Sep-99								
09/15/99 1.5%	15-Sep-99	**<0.3**	20-Sep-99								
09/15/99 3%	15-Sep-99	**0.3**	20-Sep-99								
09/15/99 6%	15-Sep-99	**0.7**	20-Sep-99								
09/15/99 12%	15-Sep-99	**1.4**	20-Sep-99								
09/15/99 25%	15-Sep-99	**3.9**	20-Sep-99								
09/15/99 100%	15-Sep-99	**21.4**	20-Sep-99								
09/16/99 R.W. C	16-Sep-99	**<0.3**	20-Sep-99								
09/16/99 1.5%	16-Sep-99	**<0.3**	20-Sep-99								
09/16/99 3%	16-Sep-99	**0.5**	20-Sep-99								
09/16/99 6%	16-Sep-99	**0.9**	20-Sep-99								
09/16/99 12%	16-Sep-99	**1.9**	20-Sep-99								
09/16/99 25%	16-Sep-99	**4.9**	20-Sep-99								
09/16/99 100%	16-Sep-99	**27.1**	20-Sep-99								
34											
40											

QC data:			% recovery		% recovery				% recovery		% recovery
Low-level Std. check:	*0.5 mg/L NH3-N*	0.5									
end of run std. check:	*1.0 mg/L NH3-N*	0.9									
end of run std. check:	*2.0 mg/L NH3-N*	1.9									
end of run std. check:	*4.0 mg/L NH3-N*	3.9									
end of run std. check:	*8.0 mg/L NH3-N*	8.0									
Verification Std.(HACH):	*5.0 mg/L NH3-N*	5.1	102								
Standard additions:			% recovery		% recovery		% recovery		% recovery		% recovery
09/15/99 3% - repeated		*0.3*	-								
09/15/99 3% + 5.0 ppm		*4.7*	88								
09/16/99 3% - repeated		*0.5*	-								
09/16/99 3% + 5.0 ppm		-	83								

Analyst Remarks:

Date Reported: Sept. 20, 1999 **Verified by:**

Analyst: T.Poniatowski, D.DeLuca **Date:**

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	16-Aug-99	ADDRESS:	Tetres
DATE SAMPLED:	Aug 13 to 16 1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	Sampler/Submitter Remarks:
LOCATION:	North End Plant	
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

Parameter	check	Parameter	check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	x				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

	Sample		Concentration (mg/L)							
	Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
1	8/13/1999 fish(f) RW	13-Aug-99	0.18	16-Aug-99						
2										
3	f 8/13/99 Control	13-Aug-99	30.9	24-Aug-99						
4	f 8/13/99 E1	13-Aug-99	0.7	24-Aug-99						
5	f 8/13/99 E2	13-Aug-99	1.4	24-Aug-99						
6	f 8/13/99 E4	13-Aug-99	3.2	24-Aug-99						
7	f 8/13/99 E8	13-Aug-99	7.3	24-Aug-99						
8	f 8/13/99 E16	13-Aug-99	16.8	24-Aug-99						
9	f 8/13/99 E32	13-Aug-99	32.3	24-Aug-99						
10	f 8/13/99 RW 1mg/L	13-Aug-99	0.4	24-Aug-99						
11	f 8/13/99 RW 2mg/L	13-Aug-99	0.8	24-Aug-99						
12	f 8/13/99 RW 4mg/L	13-Aug-99	2.3	24-Aug-99						
13	f 8/13/99 RW 8mg/L	13-Aug-99	5.7	24-Aug-99						
14	f 8/13/99 RW 16mg/L	13-Aug-99	14.6	24-Aug-99						
15	f 8/13/99 RW 32 mg/L	13-Aug-99	28.9	24-Aug-99						
16										
17	f 8/14/99 E1	14-Aug-99	0.5	24-Aug-99						
18	f 8/14/99 E2	14-Aug-99	1.0	24-Aug-99						
19	f 8/14/99 E4	14-Aug-99	3.0	24-Aug-99						
20	f 8/14/99 E8	14-Aug-99	7.3	24-Aug-99						
21	f 8/14/99 E16	14-Aug-99	18.1	24-Aug-99						
23	f 8/14/99 RW 1mg/L	14-Aug-99	0.3	24-Aug-99						
24	f 8/14/99 RW 2mg/L	14-Aug-99	0.6	24-Aug-99						
25	f 8/14/99 RW 4mg/L	14-Aug-99	2.2	24-Aug-99						
26	f 8/14/99 RW 8mg/L	14-Aug-99	6.0	24-Aug-99						
27	f 8/14/99 RW 16mg/L	14-Aug-99	15.5	24-Aug-99						
28										
29	f 8/15/99 E1	15-Aug-99	0.5	24-Aug-99						
30	f 8/15/99 E2	15-Aug-99	0.8	24-Aug-99						
31	f 8/15/99 E4	15-Aug-99	2.2	24-Aug-99						
32	f 8/15/99 E8	15-Aug-99	6.1	24-Aug-99						
33	f 8/15/99 RW 1mg/L	15-Aug-99	0.4	24-Aug-99						
34	f 8/15/99 RW 2mg/L	15-Aug-99	0.7	24-Aug-99						
35	f 8/15/99 RW 4mg/L	15-Aug-99	2.3	24-Aug-99						
36	f 8/15/99 RW 8mg/L	15-Aug-99	6.3	24-Aug-99						
37										
38	f 8/16/99 E1	16-Aug-99	0.3	24-Aug-99						
39	f 8/16/99 E2	16-Aug-99	0.9	24-Aug-99						
40	f 8/16/99 E4	16-Aug-99	2.7	24-Aug-99						
41	f 8/16/99 E8	16-Aug-99	6.6	24-Aug-99						
42	f 8/16/99 RW 1mg/L	16-Aug-99	0.5	24-Aug-99						
43	f 8/16/99 RW 2mg/L	16-Aug-99	1.3	24-Aug-99						
44	f 8/16/99 RW 4mg/L	16-Aug-99	3.2	24-Aug-99						
45	f 8/16/99 RW 8mg/L	16-Aug-99	7.2	24-Aug-99						
46										
47										
	QC data:			*% recovery*		*% recovery*		*% recovery*		*% recovery*
	Low-level Standard Check: 0.5 mg/L		0.41							
	NH3-N std. check: 1.0		0.8							
	NH3-N std. check: 2.0		2.0							
	NH3-N std. check: 4.0		4.0							
	NH3-N std. check: 8.0		8.0							
	Verification Standard: (5.0 mg/L NH3-N)		5.2							
	Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*
	f 8/13/99 E1 + 2.0 mg/L			*98*						
	f 8/13/99 E2 + 2.0 mg/L			*97*						
	f 8/13/99 E2 + 2.0 mg/L			*95*						

Analyst Remarks:

Date Reported: 24-Aug-99 **Verified by:**

Analyst: T.Poniatowski, D.DeLuca **Date:**

File: __an082499________________________________

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY: Amy Partridge	REPORT TO: Amy Partridge
DATE SUBMITTED: Oct 23-25, 1999	ADDRESS: Tetres
DATE SAMPLED: Oct 23-25, 1999	
SAMPLED BY: Amy Partridge	POSTAL CODE: PHONE:

SAMPLE TYPE: River Samples	*Sampler/Submitter Remarks:*
LOCATION: N. Main	
PROJECT: Toxicity	

REQUESTED PARAMETER(S):

Parameter	*check*	Parameter	*check*		*check*
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	*X*				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
10/23/99 RW CONTROL	23-Oct-99	**0.1**	26-Oct-99								
10/23/99 0.5	23-Oct-99	**0.3**	26-Oct-99								
10/23/99 1.0	23-Oct-99	**0.5**	26-Oct-99								
10/23/99 2.0	23-Oct-99	**1.0**	26-Oct-99								
10/23/99 4.0	23-Oct-99	**7.5**	26-Oct-99								
10/23/99 8.0	23-Oct-99	**12.1**	26-Oct-99								
10/23/99 16 CC	23-Oct-99	**23.8**	26-Oct-99								
10/23/99 16.0 FFM	23-Oct-99	**23.5**	26-Oct-99								
10/23/99 16.0 LFM	23-Oct-99	**23.6**	26-Oct-99								
10/23/99 58.0	23-Oct-99	**79.7**	26-Oct-99								
10/24/99 RW CONTROL	24-Oct-99	**0.2**	26-Oct-99								
10/24/99 0.5	24-Oct-99	**0.8**	26-Oct-99								
10/24/99 1.0	24-Oct-99	**0.7**	26-Oct-99								
10/24/99 2.0	24-Oct-99	**0.5**	26-Oct-99								
10/24/99 4.0	24-Oct-99	**2.7**	26-Oct-99								
10/24/99 8.0 CC	24-Oct-99	**9.1**	26-Oct-99								
10/24/99 8.0 FFM	24-Oct-99	**5.0**	26-Oct-99								
10/24/99 8.0 LFM	24-Oct-99	**9.5**	26-Oct-99								
10/24/99 16.0	24-Oct-99	**8.9**	26-Oct-99								
10/24/99 58	24-Oct-99	**75.3**	26-Oct-99								
10/25/99 RW CONTROL	25-Oct-99	**0.1**	26-Oct-99								
10/25/99 0.5	25-Oct-99	**0.2**	26-Oct-99								
10/25/99 1.0	25-Oct-99	**0.4**	26-Oct-99								
10/25/99 2.0	25-Oct-99	**0.6**	26-Oct-99								
10/25/99 4.0	25-Oct-99	**2.0**	26-Oct-99								
10/25/99 8.0 CC-A	25-Oct-99	**5.9**	26-Oct-99								
10/25/99 8.0FFM-A	25-Oct-99	**5.8**	26-Oct-99								
10/25/99 8.0 LEM-A	25-Oct-99	**6.3**	26-Oct-99								
10/25/99 16.0	25-Oct-99	**15.6**	26-Oct-99								
10/25/99 58.0	25-Oct-99	**60.8**	26-Oct-99								
QC data:			*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check: *0.0 mg/L NH3*		0.09									
end of run std. check: *1.0 mg/L NH3*		0.96									
end of run std. check: *2.0 mg/L NH3*		2.04									
end of run std. check: *4.0 mg/L NH3*		4.04									
end of run std. check: *8.0 mg/L NH3*		8.14									
Verification Std.(HACH): *5.0 PPM NH3*		5.04									
Verification Std.(HACH): *0.5 PPM NH3*		0.52									
Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*		*% recovery*
											-
10/23/99 2.0 repeat		*1.0*									
10/23/99 2.0 +0.4 ppm NH3			*106*								
10/24/99 2.0 repeat		*0.4*									
10/24/99 2.0 +ppm NH3			93								

Analyst Remarks:

Date Reported: 26-Oct-99 **Verified by:**

Analyst: T. Poniatowski, D. Deluca **Date:**

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	Oct 26 TO NOV 1, 1999	ADDRESS:	Tetres
DATE SAMPLED:	Oct 26 TO NOV 1, 1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	River Samples	*Sampler/Submitter Remarks:*
LOCATION:	N. Main	
PROJECT:	Toxicity	

REQUESTED PARAMETER(S):

Parameter	*check*	Parameter	*check*		*check*
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	X				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
10/26/99 RW CONTROL	10/26/99	**0.2**	2-Nov-99								
10/26/99 0.5	10/26/99	**28.4**	2-Nov-99								
10/26/99 1	10/26/99	**0.5**	2-Nov-99								
10/26/99 2	10/26/99	**2.0**	2-Nov-99								
10/26/99 4	10/26/99	**1.7**	2-Nov-99								
10/26/99 8-CC	10/26/99	**6.5**	2-Nov-99								
10/26/99 8-FFM	10/26/99	**6.8**	2-Nov-99								
10/26/99 8 LFM	10/26/99	**6.5**	2-Nov-99								
10/26/99 16	10/26/99	**12.1**	2-Nov-99								
10/26/99 58		**63.0**									
10/27/99 RW CONTROL	10/27/99	**0.1**	2-Nov-99								
10/27/99 0.5	10/27/99	**0.3**	2-Nov-99								
10/27/99 1	10/27/99	**0.3**	2-Nov-99								
10/27/99 2	10/27/99	**1.6**	2-Nov-99								
10/27/99 4	10/27/99	**0.3**	2-Nov-99								
10/27/99 8-CC	10/27/99	**2.7**	2-Nov-99								
10/27/99 8-FFM-A	10/27/99	**2.7**	2-Nov-99								
10/27/99 8 LFM-A	10/27/99	**2.4**	2-Nov-99								
10/27/99 16	10/27/99	**5.3**	2-Nov-99								
10/27/99 58	10/27/99	**62.0**	2-Nov-99								
10/28/99 RW CONTROL	10/28/99	**0.1**	2-Nov-99								
10/28/99 0.5	10/28/99	**0.2**	2-Nov-99								
10/28/99 1	10/28/99	**0.3**	2-Nov-99								
10/28/99 2	10/28/99	**3.7**	2-Nov-99								
10/28/99 4	10/28/99	**1.0**	2-Nov-99								
10/28/99 8-CC	10/28/99	**3.0**	2-Nov-99								
10/28/99 8-FFM	10/28/99	**2.6**	2-Nov-99								
10/28/99 8 LFM	10/28/99	**3.5**	2-Nov-99								
10/28/99 16	10/28/99	**13.3**	2-Nov-99								
10/28/99 58	10/28/99	**52.8**	2-Nov-99								
10/29/99 RW CONTROL	10/29/99	**0.1**	2-Nov-99								
10/29/99 0.5	10/29/99	**0.3**	2-Nov-99								
10/29/99 1	10/29/99	**0.4**	2-Nov-99								
10/29/99 2	10/29/99	**0.4**	2-Nov-99								
10/29/99 4	10/29/99	**3.0**	2-Nov-99								
10/29/99 8-CC	10/29/99	**5.2**	2-Nov-99								
10/29/99 8-FFM	10/29/99	**5.9**	2-Nov-99								
10/29/99 8 LFM	10/29/99	**5.3**	2-Nov-99								
10/29/99 16	10/29/99	**12.8**	2-Nov-99								
10/29/99 58	10/29/99	**63.0**	2-Nov-99								
10/30/99 RW CONTROL	10/30/99	**0.2**	2-Nov-99								
10/30/99 0.5	10/30/99	**0.3**	2-Nov-99								
10/30/99 1	10/30/99	**0.4**	2-Nov-99								
10/30/99 2	10/30/99	**0.3**	2-Nov-99								
10/30/99 4	10/30/99	**2.7**	2-Nov-99								
10/30/99 8-CC	10/30/99	**5.9**	2-Nov-99								
10/30/99 8-FFM	10/30/99	**5.7**	2-Nov-99								
10/30/99 8 LFM	10/30/99	**5.9**	2-Nov-99								
10/30/99 16	10/30/99	**13.2**	2-Nov-99								
10/30/99 58	10/30/99	**57.2**	2-Nov-99								

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY: Amy Partridge
DATE SUBMITTED: Oct 26 TO NOV 1, 1999
DATE SAMPLED: Oct 26 TO NOV 1, 1999
SAMPLED BY: Amy Partridge

REPORT TO: Amy Partridge
ADDRESS: Tetres
POSTAL CODE:
PHONE:

SAMPLE TYPE: River Samples
LOCATION: N. Main
PROJECT: Toxicity

Sampler/Submitter Remarks:

REQUESTED PARAMETER(S):

	check		check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	X				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
10/31/99 RW CONTROL	10/31/99	**0.1**	2-Nov-99								
10/31/99 0.5	10/31/99	**2.7**	2-Nov-99								
10/31/99 1	10/31/99	**1.3**	2-Nov-99								
10/31/99 2	10/31/99	**3.2**	2-Nov-99								
10/31/99 4	10/31/99	**1.7**	2-Nov-99								
10/31/99 8-CC	10/31/99	**8.1**	2-Nov-99								
10/31/99 8-FFM	10/31/99	**4.7**	2-Nov-99								
10/31/99 8 LFM	10/31/99	**8.3**	2-Nov-99								
10/31/99 16	10/31/99	**23.3**	2-Nov-99								
10/31/99 58	10/31/99	**89.8**	2-Nov-99								
11/01/99 RW CONTROL	11/01/99	**0.1**	2-Nov-99								
11/01/99 0.5	11/01/99	**0.2**	2-Nov-99								
11/01/99 1	11/01/99	**0.4**	2-Nov-99								
11/01/99 2	11/01/99	**0.1**	2-Nov-99								
11/01/99 4	11/01/99	**2.4**	2-Nov-99								
11/01/99 8-CC	11/01/99	**1.3**	2-Nov-99								
11/01/99 8-FFM	11/01/99	**1.0**	2-Nov-99								
11/01/99 8 LFM	11/01/99	**1.1**	2-Nov-99								
11/01/99 16	11/01/99	**13.8**	2-Nov-99								
11/01/99 58	11/01/99	**44.5**	2-Nov-99								
QC data:			*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check: *0.0 mg/L NH3*		0.10									
end of run std. check: *1.0 mg/L NH3*		0.92									
end of run std. check: *2.0 mg/L NH3*		1.90									
end of run std. check: *4.0 mg/L NH3*		4.02									
end of run std. check: *8.0 mg/L NH3*		8.02									
Verification Std.(HACH): *5.0 PPM NH3*		5.10									
Verification Std.(HACH): *0.5 PPM NH3*		0.60									
Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*		*% recovery*
											-
10/26/99 2.0 repeat		*1.9*									
10/26/99 2.0 +4.0 ppm NH3			*101*								
10/26/994.0 repeat		*1.7*									
10/264/99 4.0 + 4.0ppm NH3			100								

Analyst Remarks:

Date Reported: 02-Nov-99

Verified by:

Analyst: T. Poniatowski, D. Deluca

Date:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY: Amy Partridge	REPORT TO: Amy Partridge
DATE SUBMITTED: NOV. 2-7/99	ADDRESS: Tetres
DATE SAMPLED: NOV. 2- 7/99	
SAMPLED BY: Amy Partridge	POSTAL CODE: PHONE:

SAMPLE TYPE: River Samples	*Sampler/Submitter Remarks:*
LOCATION: N. Main	
PROJECT: Toxicity	

REQUESTED PARAMETER(S):

Parameter	*check*	Parameter	*check*	Parameter	*check*
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	*X*				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	**NH_3-N**	Analysis Date	**NO_3-N**	Analysis Date	**TKN**	Analysis Date	**P**	Analysis Date	**Ortho PO_4-P**	Analysis Date
11/02/99 RW CONTROL	11/02/99	**<0.3**	8-Nov-99								
11/02/99 0.5	11/02/99	**<0.3**	8-Nov-99								
11/02/99 1	11/02/99	**<0.3**	8-Nov-99								
11/02/99 2	11/02/99	**0.5**	8-Nov-99								
11/02/99 4	11/02/99	**3.5**	8-Nov-99								
11/02/99 8-CC	11/02/99	**5.7**	8-Nov-99								
11/02/99 8-FFM	11/02/99	**5.3**	8-Nov-99								
11/02/99 8 LFM	11/02/99	**5.7**	8-Nov-99								
11/02/99 16	11/02/99	**8.3**	8-Nov-99								
11/02/99 58	11/02/99	**20.3**	8-Nov-99								
11/03/99 RW CONTROL	11/03/99	**<0.3**	8-Nov-99								
11/03/99 0.5	11/03/99	**0.3**	8-Nov-99								
11/03/99 1	11/03/99	**0.3**	8-Nov-99								
11/03/99 2	11/03/99	**<0.3**	8-Nov-99								
11/03/99 4	11/03/99	**2.2**	8-Nov-99								
11/03/99 8-CC	11/03/99	**3.4**	8-Nov-99								
11/03/99 8-FFM-A	11/03/99	**4.5**	8-Nov-99								
11/03/99 8 LFM-A	11/03/99	**3.2**	8-Nov-99								
11/03/99 16	11/03/99	**9.3**	8-Nov-99								
11/03/99 58	11/03/99	**51.7**	8-Nov-99								
11/04/99 1	11/04/99	**0.3**	8-Nov-99								
11/04/99 8	11/04/99	**5.5**	8-Nov-99								
11/04/99 58	11/04/99	**59.9**	8-Nov-99								
11/05/99 RW CONTROL	11/05/99	**<0.3**	8-Nov-99								
11/05/99 0.5	11/05/99	**<0.3**	8-Nov-99								
11/05/99 1	11/05/99	**0.3**	8-Nov-99								
11/05/99 2	11/05/99	**0.7**	8-Nov-99								
11/05/99 4	11/05/99	**4.1**	8-Nov-99								
11/05/99 8-CC	11/05/99	**4.8**	8-Nov-99								
11/05/99 8-FFM	11/05/99	**5.2**	8-Nov-99								
11/05/99 8 LFM	11/05/99	**4.8**	8-Nov-99								
11/05/99 16	11/05/99	**13.6**	8-Nov-99								
11/05/99 58	11/05/99	**56.3**	8-Nov-99								
11/06/99 RW CONTROL	11/06/99	**<0.3**	8-Nov-99								
11/06/99 0.5	11/06/99	**<0.3**	8-Nov-99								
11/06/99 1	11/06/99	**0.4**	8-Nov-99								
11/06/99 2	11/06/99	**0.4**	8-Nov-99								
11/06/99 4	11/06/99	**2.7**	8-Nov-99								
11/06/99 8-CC	11/06/99	**9.5**	8-Nov-99								
11/06/99 8-FFM	11/06/99	**6.8**	8-Nov-99								
11/06/99 8 LFM	11/06/99	**6.8**	8-Nov-99								
11/06/99 16	11/06/99	**10.4**	8-Nov-99								
11/06/99 58	11/06/99	**59.1**	8-Nov-99								

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
11/07/99 RW CONTROL	11/07/99	**<0.3**	8-Nov-99								
11/07/99 0.5	11/07/99	**<0.3**	8-Nov-99								
11/07/99 1	11/07/99	**0.4**	8-Nov-99								
11/07/99 2	11/07/99	**0.5**	8-Nov-99								
11/07/99 4	11/07/99	**0.6**	8-Nov-99								
11/07/99 8-CC	11/07/99	**3.3**	8-Nov-99								
11/07/99 8-FFM	11/07/99	**10.8**	8-Nov-99								
11/07/99 8 LFM	11/07/99	**6.9**	8-Nov-99								
11/07/99 16	11/07/99	**37.0**	8-Nov-99								
11/07/99 58	11/07/99	**58.5**	8-Nov-99								
QC data:			*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check: *0.0 mg/L NH3*		0.1									
end of run std. check: *1.0 mg/L NH3*		0.9									
end of run std. check: *2.0 mg/L NH3*		1.9									
end of run std. check: *4.0 mg/L NH3*		4.0									
end of run std. check: *8.0 mg/L NH3*		8.1									
Verification Std.(HACH): *5.0 PPM NH3*		5.1	*102%*								
Verification Std.(HACH): *0.5 PPM NH3*		0.5	*106%*								
Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*		*% recovery*
11/02/99 2.0 repeat		0.7	*134%*								
11/02/99 2.0 +4.0 ppm NH3		-	*88%*								
11/03/99 2.0 repeat		0.3	-								
11/03/99 2.0 +4.0 ppm NH3		-	*97%*								

Analyst Remarks:

Date Reported: 08-Nov-99 **Verified by:** G. Gay

Analyst: T. Poniatowski, D. Deluca **Date:** 10-Nov-99

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	NOV.8-15/99	ADDRESS:	Tetres
DATE SAMPLED:	NOV.8-15/99		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	River Samples	*Sampler/Submitter Remarks:*
LOCATION:	N. Main	
PROJECT:	Toxicity	

REQUESTED PARAMETER(S):

Parameter	*check*	Parameter	*check*		*check*
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	*X*				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	**NH_3-N**	Analysis Date	**NO_3-N**	Analysis Date	**TKN**	Analysis Date	**P**	Analysis Date	**Ortho PO_4-P**	Analysis Date
11/8/99 RW CONTROL	11/8/99	**<0.3**	15-Nov-99								
11/8/99 0.5	11/8/99	**0.3**	15-Nov-99								
11/8/99 1	11/8/99	**0.4**	15-Nov-99								
11/8/99 2	11/8/99	**0.6**	15-Nov-99								
11/8/99 4	11/8/99	**2.9**	15-Nov-99								
11/8/99 8-CC	11/8/99	**6.3**	15-Nov-99								
11/8/99 8-FFM	11/8/99	**5.9**	15-Nov-99								
11/8/99 8 LFM	11/8/99	**5.3**	15-Nov-99								
11/8/99 16	11/8/99	**13.4**	15-Nov-99								
11/8/99 58	11/8/99	**63**	15-Nov-99								
11/09/99 RW CONTROL	11/09/99	**<0.3**	15-Nov-99								
11/09/99 0.5	11/09/99	**<0.3**	15-Nov-99								
11/09/99 1	11/09/99	**0.3**	15-Nov-99								
11/09/99 2	11/09/99	**1.0**	15-Nov-99								
11/09/99 4	11/09/99	**3.8**	15-Nov-99								
11/09/99 8-CC	11/09/99	**6.0**	15-Nov-99								
11/09/99 8-FFM	11/09/99	**6.3**	15-Nov-99								
11/09/99 8 LFM	11/09/99	**6.0**	15-Nov-99								
11/09/99 16	11/09/99	**16.5**	15-Nov-99								
11/09/99 58	11/09/99	**63**	15-Nov-99								
11/10/99 RW CONTROL	11/10/99	**<0.3**	15-Nov-99								
11/10/99 0.5	11/10/99	**0.4**	15-Nov-99								
11/10/99 1	11/10/99	**0.3**	15-Nov-99								
11/10/99 2	11/10/99	**1.1**	15-Nov-99								
11/10/99 4	11/10/99	**6.5**	15-Nov-99								
11/10/99 8-CC	11/10/99	**8.7**	15-Nov-99								
11/10/99 8-FFM	11/10/99	**9.3**	15-Nov-99								
11/10/99 8 LFM	11/10/99	**8.9**	15-Nov-99								
11/10/99 16	11/10/99	**28.6**	15-Nov-99								
11/10/99 58	11/10/99	**61**	15-Nov-99								
11/11/99 RW CONTROL	11/11/99	**0.3**	15-Nov-99								
11/11/99 0.5	11/11/99	**<0.3**	15-Nov-99								
11/11/99 1	11/11/99	**<0.3**	15-Nov-99								
11/11/99 2	11/11/99	**1.0**	15-Nov-99								
11/11/99 4	11/11/99	**6.0**	15-Nov-99								
11/11/99 8-CC	11/11/99	**9.2**	15-Nov-99								
11/11/99 8-FFM	11/11/99	**8.1**	15-Nov-99								
11/11/99 8 LFM	11/11/99	**9.3**	15-Nov-99								
11/11/99 16	11/11/99	**24.6**	15-Nov-99								
11/11/99 58	11/11/99	**65**	15-Nov-99								
11/12/99 RW CONTROL	11/12/99	**<0.3**	15-Nov-99								
11/12/99 0.5	11/12/99	**<0.3**	15-Nov-99								
11/12/99 1	11/12/99	**0.6**	15-Nov-99								
11/12/99 2	11/12/99	**0.3**	15-Nov-99								
11/12/99 4	11/12/99	**3.2**	15-Nov-99								
11/12/99 8-CC-A	11/12/99	**9.0**	15-Nov-99								
11/12/99 8-FFM-A	11/12/99	**8.7**	15-Nov-99								
11/12/99 8 LFM-A	11/12/99	**5.4**	15-Nov-99								
11/12/99 16	11/12/99	**12.4**	15-Nov-99								
11/12/99 58	11/12/99	**48**	15-Nov-99								

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
11/13/99 RW CONTROL	11/13/99	**<0.3**	15-Nov-99								
11/13/99 0.5	11/13/99	**<0.3**	15-Nov-99								
11/13/99 1	11/13/99	**<0.3**	15-Nov-99								
11/13/99 2	11/13/99	**0.6**	15-Nov-99								
11/13/99 4	11/13/99	**6.6**	15-Nov-99								
11/13/99 8-CC	11/13/99	**5.4**	15-Nov-99								
11/13/99 8-FFM	11/13/99	**5.4**	15-Nov-99								
11/13/99 8 LFM	11/13/99	**6.8**	15-Nov-99								
11/13/99 16	11/13/99	**11.3**	15-Nov-99								
11/13/99 58	11/13/99	**57**	15-Nov-99								
11/14/99 RW CONTROL	11/14/99	**<0.3**	15-Nov-99								
11/14/99 0.5	11/14/99	**<0.3**	15-Nov-99								
11/14/99 1	11/14/99	**0.3**	15-Nov-99								
11/14/99 2	11/14/99	**0.5**	15-Nov-99								
11/14/99 4	11/14/99	**4.5**	15-Nov-99								
11/14/99 8-CC	11/14/99	**5.9**	15-Nov-99								
11/14/99 8-FFM	11/14/99	**6.2**	15-Nov-99								
11/14/99 8 LFM	11/14/99	**6.0**	15-Nov-99								
11/14/99 16	11/14/99	**10.1**	15-Nov-99								
11/14/99 58	11/14/99	**31**	15-Nov-99								
QC data:			*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check: *0.0 mg/L NH3*		0.0									
end of run std. check: *1.0 mg/L NH3*		0.8									
end of run std. check: *2.0 mg/L NH3*		1.8									
end of run std. check: *4.0 mg/L NH3*		3.8									
end of run std. check: *8.0 mg/L NH3*		7.6									
Verification Std.(HACH): *5.0 PPM NH3*		5.0	*101%*								
Verification Std.(HACH): *0.5 PPM NH3*		0.6	*112%*								
Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*		*% recovery*
11/08/99 2.0 repeat		0.6	*100%*								
11/08/99 2.0 +4.0 ppm NH3		-	*97%*								
11/09/99 2.0 repeat		1.1	*113%*								
11/09/99 2.0 +4.0 ppm NH3		-	*96%*								

Analyst Remarks:

Date Reported: 15-Nov-99 **Verified by:**

Analyst: T. Poniatowski, D. Deluca **Date:** 16-Nov-99

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	NOV.15-21/99	ADDRESS:	Tetres
DATE SAMPLED:	NOV.15-21/99		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	River Samples	*Sampler/Submitter Remarks:*
LOCATION:	N. Main	
PROJECT:	Toxicity	

REQUESTED PARAMETER(S):

	check		*check*		*check*
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	*X*				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
11/15/99 RW CONTROL	11/15/99	**<0.3**	22-Nov-99								
11/15/99 0.5	11/15/99	**<0.3**	22-Nov-99								
11/15/99 1	11/15/99	**<0.3**	22-Nov-99								
11/15/99 2	11/15/99	**0.6**	22-Nov-99								
11/15/99 4	11/15/99	**2.9**	22-Nov-99								
11/15/99 8-CC	11/15/99	**5.8**	22-Nov-99								
11/15/99 8-FFM	11/15/99	**5.2**	22-Nov-99								
11/15/99 8 LFM	11/15/99	**5.8**	22-Nov-99								
11/15/99 16	11/15/99	**9.0**	22-Nov-99								
11/15/99 58	11/15/99	**63**	22-Nov-99								
11/16/99 RW CONTROL	11/16/99	**<0.3**	22-Nov-99								
11/16/99 0.5	11/16/99	**<0.3**	22-Nov-99								
11/16/99 1	11/16/99	**0.4**	22-Nov-99								
11/16/99 2	11/16/99	**0.4**	22-Nov-99								
11/16/99 4	11/16/99	**2.0**	22-Nov-99								
11/16/99 8-CC	11/16/99	**5.2**	22-Nov-99								
11/16/99 8-FFM	11/16/99	**5.2**	22-Nov-99								
11/16/99 8 LFM	11/16/99	**5.3**	22-Nov-99								
11/16/99 16	11/16/99	**12.0**	22-Nov-99								
11/16/99 58	11/16/99	**50**	22-Nov-99								
11/17/99 RW CONTROL	11/17/99	**17.0**	22-Nov-99								
11/17/99 0.5	11/17/99	**0.4**	22-Nov-99								
11/17/99 1	11/17/99	**0.4**	22-Nov-99								
11/17/99 2	11/17/99	**0.5**	22-Nov-99								
11/17/99 4	11/17/99	**2.7**	22-Nov-99								
11/17/99 8-CC	11/17/99	**3.6**	22-Nov-99								
11/17/99 8-FFM	11/17/99	**6.4**	22-Nov-99								
11/17/99 8 LFM	11/17/99	**5.0**	22-Nov-99								
11/17/99 16	11/17/99	**9.5**	22-Nov-99								
11/17/99 58	11/17/99	**41**	22-Nov-99								
11/18/99 RW CONTROL	11/18/99	**<0.3**	22-Nov-99								
11/18/99 0.5	11/18/99	**<0.3**	22-Nov-99								
11/18/99 1	11/18/99	**<0.3**	22-Nov-99								
11/18/99 2	11/18/99	**1.0**	22-Nov-99								
11/18/99 4	11/18/99	**1.6**	22-Nov-99								
11/18/99 8-CC	11/18/99	**3.3**	22-Nov-99								
11/18/99 8-FFM	11/18/99	**3.4**	22-Nov-99								
11/18/99 8 LFM	11/18/99	**3.6**	22-Nov-99								
11/18/99 16	11/18/99	**11.3**	22-Nov-99								
11/18/99 58	11/18/99	**54**	22-Nov-99								

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
11/19/99 RW CONTROL	11/19/99	**<0.3**	22-Nov-99								
11/19/99 0.5	11/19/99	**<0.3**	22-Nov-99								
11/19/99 1	11/19/99	**0.4**	22-Nov-99								
11/19/99 2	11/19/99	**0.2**	22-Nov-99								
11/19/99 4	11/19/99	**1.4**	22-Nov-99								
11/19/99 8-CC	11/19/99	**4.7**	22-Nov-99								
11/19/99 8-FFM	11/19/99	**5.1**	22-Nov-99								
11/19/99 8 LFM	11/19/99	**4.7**	22-Nov-99								
11/19/99 16	11/19/99	**12.0**	22-Nov-99								
11/19/99 58	11/19/99	**57**	22-Nov-99								
11/20/99 RW CONTROL	11/20/99	**<0.3**	22-Nov-99								
11/20/99 0.5	11/20/99	**0.3**	22-Nov-99								
11/20/99 1	11/20/99	**0.4**	22-Nov-99								
11/20/99 2	11/20/99	**0.7**	22-Nov-99								
11/20/99 4	11/20/99	**2.3**	22-Nov-99								
11/20/99 8-CC	11/20/99	**5.3**	22-Nov-99								
11/20/99 8-FFM	11/20/99	**5.1**	22-Nov-99								
11/20/99 8 LFM	11/20/99	**4.8**	22-Nov-99								
11/20/99 16	11/20/99	**9.6**	22-Nov-99								
11/20/99 58	11/20/99	**56**	22-Nov-99								
11/21/99 RW CONTROL	11/21/99	**<0.3**	22-Nov-99								
11/21/99 0.5	11/21/99	**<0.3**	22-Nov-99								
11/21/99 1	11/21/99	**<0.3**	22-Nov-99								
11/21/99 2	11/21/99	**0.6**	22-Nov-99								
11/21/99 4	11/21/99	**0.8**	22-Nov-99								
11/21/99 8-CC	11/21/99	**2.7**	22-Nov-99								
11/21/99 8-FFM	11/21/99	**2.2**	22-Nov-99								
11/21/99 8 LFM	11/21/99	**1.7**	22-Nov-99								
11/21/99 16	11/21/99	**9.5**	22-Nov-99								
11/21/99 58	11/21/99	**31**	22-Nov-99								
QC data:			*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check: *0.0 mg/L NH3*		0.0									
end of run std. check: *1.0 mg/L NH3*		0.9									
end of run std. check: *2.0 mg/L NH3*		2.0									
end of run std. check: *4.0 mg/L NH3*		4.2									
end of run std. check: *8.0 mg/L NH3*		7.9									
Verification Std.(HACH): *5.0 PPM NH3*											
Verification Std.(HACH): *0.5 PPM NH3*											
Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*		*% recovery*
11/15/99 2.0 repeat		0.7									
11/15/99 2.0 +4.0 ppm NH3			*105%*								
11/15/99 4.0 repeat		3.1									
11/15/99 4.0 +4.0 ppm NH3			*101%*								

Analyst Remarks:

Date Reported: 22-Nov-99 **Verified by:**

Analyst: T. Poniatowski, D. Deluca **Date:** 16-Nov-99

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	22-25 Nov 99	ADDRESS:	Tetres
DATE SAMPLED:	22-25 Nov 99		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	River Samples	*Sampler/Submitter Remarks:*
LOCATION:	2230 Main	
PROJECT:	Toxicity	

REQUESTED PARAMETER(S):	check		check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	*X*				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	**NH_3-N**	Analysis Date	**NO_3-N**	Analysis Date	**TKN**	Analysis Date	**P**	Analysis Date	**Ortho PO_4-P**	Analysis Date
11/22/99 RW CONTROL	11/22/99	**<0.3**	26-Nov-99								
11/22/99 0.5	11/22/99	**<0.3**	26-Nov-99								
11/22/99 1	11/22/99	**<0.3**	26-Nov-99								
11/22/99 2	11/22/99	**0.5**	26-Nov-99								
11/22/99 4	11/22/99	**1.3**	26-Nov-99								
11/22/99 8	11/22/99	**3.5**	26-Nov-99								
11/22/99 16	11/22/99	**11.3**	26-Nov-99								
11/22/99 58	11/22/99	**72**	26-Nov-99								
11/23/99 RW CONTROL	11/23/99	**<0.3**	26-Nov-99								
11/23/99 0.5	11/23/99	**<0.3**	26-Nov-99								
11/23/99 1	11/23/99	**0.4**	26-Nov-99								
11/23/99 2	11/23/99	**0.6**	26-Nov-99								
11/23/99 4	11/23/99	**2.4**	26-Nov-99								
11/23/99 8	11/23/99	**5.4**	26-Nov-99								
11/23/99 58	11/23/99	**65**	26-Nov-99								
11/24/99 RW CONTROL	11/24/99	**<0.3**	26-Nov-99								
11/24/99 0.5	11/24/99	**<0.3**	26-Nov-99								
11/24/99 1	11/24/99	**0.3**	26-Nov-99								
11/24/99 2	11/24/99	**0.8**	26-Nov-99								
11/24/99 4	11/24/99	**2.3**	26-Nov-99								
11/24/99 8	11/24/99	**5.3**	26-Nov-99								
11/24/99 58	11/24/99	**47**	26-Nov-99								
11/25/99 RW CONTROL	11/25/99	**<0.3**	26-Nov-99								
11/25/99 0.5	11/25/99	**<0.3**	26-Nov-99								
11/25/99 1	11/25/99	**0.3**	26-Nov-99								
11/25/99 2	11/25/99	**0.7**	26-Nov-99								
11/25/99 4	11/25/99	**2.4**	26-Nov-99								
11/25/99 8	11/25/99	**3.9**	26-Nov-99								
11/25/99 58	11/25/99	**66**	26-Nov-99								
QC data:			*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check: *0.0 mg/L NH3*		0.0									
end of run std. check: *1.0 mg/L NH3*		0.9									
end of run std. check: *2.0 mg/L NH3*		1.9									
end of run std. check: *4.0 mg/L NH3*		4.1									
end of run std. check: *8.0 mg/L NH3*		8.0									
Verification Std.(HACH): *5.0 PPM NH3*		5.0	*101%*								
Verification Std.(HACH): *0.5 PPM NH3*		0.5	*96%*								
Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*		*% recovery*
11/22/99 2.0 repeat		0.6	119%								
11/22/99 2.0 +4.0 ppm NH3		-	89%								
11/22/99 4.0 repeat		1.6	116%								
11/22/99 4.0 +4.0 ppm NH3		-	92%								

Analyst Remarks:

Date Reported: 26-Nov-99 **Verified by:** G.Gay

Analyst: T. Poniatowski, D. Deluca **Date:** 26 Nov 99

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	AUG,27,1999	ADDRESS:	Tetres
DATE SAMPLED:	AUG, 4 to 11 , 1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	Sampler/Submitter Remarks:	
LOCATION:	North End Plant		**Daphnia Report**
PROJECT:	Ammonia Study		

REQUESTED PARAMETER(S):

	check		check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	x				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)							
Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
RW-NEW-0-US	4-Aug-99	**<0.04**	AUG,27,1999						
RW-NEW-0-2	4-Aug-99	**2.0**	AUG,27,1999						
RW-NEW-0-4	4-Aug-99	**4.2**	AUG,27,1999						
RW-NEW-0-8	4-Aug-99	**7.5**	AUG,27,1999						
RW-NEW-0-16	4-Aug-99	**14.7**	AUG,27,1999						
RW-NEW-0-32	4-Aug-99	**30.7**	AUG,27,1999						
RW-NEW-0-64	4-Aug-99	**62.0**	AUG,27,1999						
RW-OLD-1-US	5-Aug-99	**<0.04**	AUG,27,1999						
RW-OLD-1-0-2	5-Aug-99	**2.0**	AUG,27,1999						
RW-OLD-1-0-4	5-Aug-99	**3.8**	AUG,27,1999						
RW-OLD-1-0-8	5-Aug-99	**6.0**	AUG,27,1999						
RW-OLD-1-0-16	5-Aug-99	**11.0**	AUG,27,1999						
RW-OLD-1-0-32	5-Aug-99	**23.9**	AUG,27,1999						
RW-OLD-1-0-64	5-Aug-99	**51.5**	AUG,27,1999						
RW-NEW-1-0-US	5-Aug-99	**<0.04**	AUG,27,1999						
RW-NEW-1-0-2	5-Aug-99	**1.6**	AUG,27,1999						
RW-NEW-1-0-4	5-Aug-99	**3.8**	AUG,27,1999						
RW-NEW-1-0-8	5-Aug-99	**7.7**	AUG,27,1999						
RW-NEW-1-0-16	5-Aug-99	**14.5**	AUG,27,1999						
RW-NEW-1-0-32	5-Aug-99	**27.5**	AUG,27,1999						
RW-NEW-1-0-64	5-Aug-99	**57.7**	AUG,27,1999						
RW-OLD-2-US	6-Aug-99	**<0.04**	AUG,27,1999						
RW-OLD-2-2	6-Aug-99	**1.8**	AUG,27,1999						
RW-OLD-2-4	6-Aug-99	**3.7**	AUG,27,1999						
RW-OLD-2-8	6-Aug-99	**7.0**	AUG,27,1999						
RW-OLD-2-16	6-Aug-99	**11.7**	AUG,27,1999						
RW-OLD-2-32	6-Aug-99	**22.1**	AUG,27,1999						
RW-NEW-2-US	6-Aug-99	**<0.04**	AUG,27,1999						
RW-NEW-2-2	6-Aug-99	**1.8**	AUG,27,1999						
RW-NEW-2-4	6-Aug-99	**3.9**	AUG,27,1999						
RW-NEW-2-8	6-Aug-99	**8.0**	AUG,27,1999						
RW-NEW-2-16	6-Aug-99	**13.7**	AUG,27,1999						
RW-NEW-2-32	6-Aug-99	**29.4**	AUG,27,1999						
RW-OLD-3-US	7-Aug-99	**<0.04**	AUG,27,1999						
RW-OLD-3-2	7-Aug-99	**2.1**	AUG,27,1999						
RW-OLD-3-4	7-Aug-99	**4.0**	AUG,27,1999						
RW-OLD-3-8	7-Aug-99	**7.5**	AUG,27,1999						
RW-OLD-3-16	7-Aug-99	**13.0**	AUG,27,1999						
RW-OLD-3-32	7-Aug-99	**24.4**	AUG,27,1999						
RW-NEW-3-US	7-Aug-99	**<0.04**	AUG,27,1999						
RW-NEW-3-2	7-Aug-99	**1.7**	AUG,27,1999						
RW-NEW-3-4	7-Aug-99	**4.0**	AUG,27,1999						
RW-NEW-3-8	7-Aug-99	**8.2**	AUG,27,1999						
RW-NEW-3-16	7-Aug-99	**13.9**	AUG,27,1999						
RW-NEW-3-32	7-Aug-99	**30.8**	AUG,27,1999						
RW-OLD-4-US	8-Aug-99	**<0.04**	AUG,27,1999						
RW-OLD-4-2	8-Aug-99	**2.2**	AUG,27,1999						
RW-OLD-4-4	8-Aug-99	**4.0**	AUG,27,1999						
RW-OLD-4-8	8-Aug-99	**7.6**	AUG,27,1999						
RW-OLD-4-16	8-Aug-99	**13.4**	AUG,27,1999						
RW-OLD-4-32	8-Aug-99	**24.6**	AUG,27,1999						

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	AUG,27,1999	ADDRESS:	Tetres
DATE SAMPLED:	AUG, 4 to 11 , 1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	Sampler/Submitter Remarks:
LOCATION:	North End Plant	**Daphnia Report**
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):		check		check		check
	Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
	Total Ammonia (NH_3-N):	X				
	Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)							
Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
RW-NEW-4-US	8-Aug-99	**<0.04**	AUG,27,1999						
RW-NEW-4-2	8-Aug-99	**1.7**	AUG,27,1999						
RW-NEW-4-4	8-Aug-99	**3.9**	AUG,27,1999						
RW-NEW-4-8	8-Aug-99	**8.0**	AUG,27,1999						
RW-NEW-4-16	8-Aug-99	**14.1**	AUG,27,1999						
RW-NEW-4-32	8-Aug-99	**30.7**	AUG,27,1999						
RW-OLD-5-US	9-Aug-99	**<0.04**	AUG,27,1999						
RW-OLD-5-2	9-Aug-99	**2.1**	AUG,27,1999						
RW-OLD-5-4	9-Aug-99	**4.2**	AUG,27,1999						
RW-OLD-5-8	9-Aug-99	**7.5**	AUG,27,1999						
RW-OLD-5-16	9-Aug-99	**12.3**	AUG,27,1999						
RW-NEW-5-US	9-Aug-99	**<0.04**	AUG,27,1999						
RW-NEW-5-2	9-Aug-99	**1.8**	AUG,27,1999						
RW-NEW-5-4	9-Aug-99	**4.1**	AUG,27,1999						
RW -NEW-5-8	9-Aug-99	**8.1**	AUG,27,1999						
RW-NEW-5-16	9-Aug-99	**15.0**	AUG,27,1999						
RW-OLD-6-US	10-Aug-99	**<0.04**	AUG,27,1999						
RW-OLD-6-2	10-Aug-99	**2.2**	AUG,27,1999						
RW-OLD-6-4	10-Aug-99	**4.1**	AUG,27,1999						
RW-OLD-6-8	10-Aug-99	**7.5**	AUG,27,1999						
RW-OLD-6-16	10-Aug-99	**12.1**	AUG,27,1999						
RW-NEW-6-US	10-Aug-99	**<0.04**	AUG,27,1999						
RW-NEW-6-2	10-Aug-99	**1.8**	AUG,27,1999						
RW-NEW-6-4	10-Aug-99	**4.0**	AUG,27,1999						
RW-NEW-6-8	10-Aug-99	**8.2**	AUG,27,1999						
RW-NEW-6-16	10-Aug-99	**14.6**	AUG,27,1999						
RW-OLD-7-US	11-Aug-99	**<0.04**	AUG,27,1999						
RW-OLD-7-2	11-Aug-99	**2.4**	AUG,27,1999						
RW-OLD-7-4	11-Aug-99	**4.4**	AUG,27,1999						
RW-OLD-7-8	11-Aug-99	**7.9**	AUG,27,1999						
RW-OLD-7-16	11-Aug-99	**14.0**	AUG,27,1999						
E-NEW-0-2	4-Aug-99	**2.2**	AUG,27,1999						
E-NEW-0-4	4-Aug-99	**4.5**	AUG,27,1999						
E-NEW-0-8	4-Aug-99	**8.6**	AUG,27,1999						
E-NEW-0-16	4-Aug-99	**16.4**	AUG,27,1999						
E-NEW-0-US	4-Aug-99	**22.5**	AUG,27,1999						
E-NEW-0-32	4-Aug-99	**3.4**	AUG,27,1999						
E-NEW-0-64	4-Aug-99	**6.5**	AUG,27,1999						

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	AUG,27,1999	ADDRESS:	Tetres
DATE SAMPLED:	AUG, 4 to 11 , 1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	Sampler/Submitter Remarks:
LOCATION:	North End Plant	**Daphnia Report**
PROJECT:	Ammonia Study	

		check		check		check
REQUESTED PARAMETER(S):	Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
	Total Ammonia (NH_3-N):	x				
	Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)							
Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
E-OLD-1-2	5-Aug-99	2.4	AUG,27,1999						
E-OLD-1-4	5-Aug-99	4.3	AUG,27,1999						
E-OLD-1-8	5-Aug-99	7.8	AUG,27,1999						
E-OLD-1-16	5-Aug-99	14.7	AUG,27,1999						
E-OLD-1-US	5-Aug-99	<0.4	AUG,27,1999						
E-OLD-1-32	5-Aug-99	29.4	AUG,27,1999						
E-OLD-1-64	5-Aug-99	61.8	AUG,27,1999						
E-NEW--1-2	5-Aug-99	2.2	AUG,27,1999						
E-NEW--1-4	5-Aug-99	4.1	AUG,27,1999						
E-NEW--1-8	5-Aug-99	8.4	AUG,27,1999						
E-NEW--1-16	5-Aug-99	15.0	AUG,27,1999						
E-NEW--1-US	5-Aug-99	21.3	AUG,27,1999						
E-NEW--1-32	5-Aug-99	32.2	AUG,27,1999						
E-NEW--1-64	5-Aug-99	63.4	AUG,27,1999						
E-OLD-2-2	6-Aug-99	2.4	AUG,27,1999						
E-OLD-2-4	6-Aug-99	4.3	AUG,27,1999						
E-OLD-2-8	6-Aug-99	8.0	AUG,27,1999						
E-OLD-2-16	6-Aug-99	15.6	AUG,27,1999						
E-OLD-2-US	6-Aug-99	24.9	AUG,27,1999						
E-OLD-2-32	6-Aug-99	29.5	AUG,27,1999						
E-OLD-2-64	6-Aug-99	59.0	AUG,27,1999						
E-NEW-2-2	6-Aug-99	2.1	AUG,27,1999						
E-NEW-2-4	6-Aug-99	4.2	AUG,27,1999						
E-NEW-2-8	6-Aug-99	8.0	AUG,27,1999						
E-NEW-2-16	6-Aug-99	16.0	AUG,27,1999						
E-NEW-2-32	6-Aug-99	31.4	AUG,27,1999						
E-NEW-2-64	6-Aug-99	61.2	AUG,27,1999						
E-OLD-3-2	7-Aug-99	2.3	AUG,27,1999						
E-OLD-3-4	7-Aug-99	4.3	AUG,27,1999						
E-OLD-3-8	7-Aug-99	7.7	AUG,27,1999						
E-OLD-3-16	7-Aug-99	14.5	AUG,27,1999						
E-OLD-3-US	7-Aug-99	27.8	AUG,27,1999						
E-OLD-3-32	7-Aug-99	27.4	AUG,27,1999						
E-OLD-3-64	7-Aug-99	56.9	AUG,27,1999						
E-NEW-3-2	7-Aug-99	2.1	AUG,27,1999						
E-NEW-3-4	7-Aug-99	4.3	AUG,27,1999						
E-NEW-3-8	7-Aug-99	8.4	AUG,27,1999						
E-NEW-3-16	7-Aug-99	15.9	AUG,27,1999						
E-NEW-3-US	7-Aug-99	32.0	AUG,27,1999						
E-NEW-3-32	7-Aug-99	32.9	AUG,27,1999						
E-NEW-3-64	7-Aug-99	66.3	AUG,27,1999						
E-OLD-4-2	8-Aug-99	2.4	AUG,27,1999						
E-OLD-4-4	8-Aug-99	4.4	AUG,27,1999						
E-OLD-4-8	8-Aug-99	8.0	AUG,27,1999						
E-OLD-4-16	8-Aug-99	15.9	AUG,27,1999						
E-OLD-4-US	8-Aug-99	27.9	AUG,27,1999						
E-OLD-4-32	8-Aug-99	30.1	AUG,27,1999						
E-OLD-4-64	8-Aug-99	59.9	AUG,27,1999						

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	AUG,27,1999	ADDRESS:	Tetres
DATE SAMPLED:	AUG, 4 to 11 , 1999		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE: 942-2505

SAMPLE TYPE:	River Samples	Sampler/Submitter Remarks:
LOCATION:	North End Plant	**Daphnia Report**
PROJECT:	Ammonia Study	

REQUESTED PARAMETER(S):

Parameter	check	Parameter	check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	x				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

	Sample		Concentration (mg/L)							
	Description / Identification	Date	NH_3-N	Analysis Date	NO_3/NO_2-N	Analysis Date		Analysis Date		Analysis Date
	E-NEW-4-2	8-Aug-99	**2.2**	AUG,27,1999						
	E-NEW-4-4	8-Aug-99	**4.4**	AUG,27,1999						
	E-NEW-4-8	8-Aug-99	**8.6**	AUG,27,1999						
	E-NEW-4-16	8-Aug-99	**17.6**	AUG,27,1999						
	E-NEW-4-US	8-Aug-99	**31.6**	AUG,27,1999						
	E-NEW-4-32	8-Aug-99	**34.4**	AUG,27,1999						
	E-OLD-5-2	9-Aug-99	**2.6**	AUG,27,1999						
	E-OLD-5-4	9-Aug-99	**4.5**	AUG,27,1999						
	E-OLD-5-8	9-Aug-99	**8.0**	AUG,27,1999						
1	E-OLD-5-16	9-Aug-99	16.3	AUG,27,1999						
2	E-OLD-5-US	9-Aug-99	26.9	AUG,27,1999						
3	E-OLD-5-32	9-Aug-99	29.0	AUG,27,1999						
6	E-NEW-5-2	9-Aug-99	2.1	AUG,27,1999						
7	E-NEW-5-4	9-Aug-99	4.4	AUG,27,1999						
8	E-NEW-5-8	9-Aug-99	8.4	AUG,27,1999						
9	E-NEW-5-16	9-Aug-99	16.3	AUG,27,1999						
10	E-NEW-5-US	9-Aug-99	31.6	AUG,27,1999						
11	E-NEW-5-32	9-Aug-99	35.0	AUG,27,1999						
14	E-OLD-6-2	10-Aug-99	2.6	AUG,27,1999						
15	E-OLD-6-4	10-Aug-99	4.6	AUG,27,1999						
16	E-OLD-6-8	10-Aug-99	8.2	AUG,27,1999						
17	E-OLD-6-16	10-Aug-99	16.1	AUG,27,1999						
18	E-OLD-6-US	10-Aug-99	28.5	AUG,27,1999						
19	E-OLD-6-32	10-Aug-99	31.0	AUG,27,1999						
22	E-NEW-6-2	10-Aug-99	2.0	AUG,27,1999						
23	E-NEW-6-4	10-Aug-99	4.1	AUG,27,1999						
24	E-NEW-6-8	10-Aug-99	8.0	AUG,27,1999						
25	E-NEW-6-US	10-Aug-99	21.3	AUG,27,1999						
26	E-NEW-6-16	10-Aug-99	30.4	AUG,27,1999						
27	E-NEW-6-32	10-Aug-99	31.7	AUG,27,1999						
30	E-OLD-7-2	11-Aug-99	2.4	AUG,27,1999						
31	E-OLD-7-4	11-Aug-99	4.3	AUG,27,1999						
32	E-OLD-7-8	11-Aug-99	7.7	AUG,27,1999						
33	E-OLD-7-US	11-Aug-99	19.2	AUG,27,1999						
34	E-OLD-7-16	11-Aug-99	14.2	AUG,27,1999						
35	E-OLD-7-32	11-Aug-99	27.6	AUG,27,1999						
36										
37										
38										
39										
40										
	QC data:			*% recovery*		*% recovery*		*% recovery*		*% recovery*
	Low-level Standard Check:									
	NH3-N std. check: blank check		0.4							
	16.0mg/L NH3-N std. check:		16.0							
	NH3-N std. check:									
	NH3-N std. check:									
	Verification Standard: 5.0 mg/L NH3-N		5.20							
	Verification Standard: 0.05 mg/L NH3-N		0.05	*% recovery*		*% recovery*		*% recovery*		*% recovery*

Analyst Remarks: The RW-US's series was done by low level ammonia : detection limit is <0.04
The other series was done by mid level ammonia: detection limit is 0.4

Date Reported: 27-Aug-99 **Verified by:** ____________

Analyst: T.Poniatowski, D.DeLuca **Date:** ____________

File: __an082799________________________________

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	09-May-00	ADDRESS:	Tetres
DATE SAMPLED:	09-May-20		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	River water	*Sampler/Submitter Remarks:*
LOCATION:		
PROJECT:	NH3 - Toxicity	

REQUESTED PARAMETER(S):

Parameter	check	Parameter	check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	X				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
05/09/00 CONT-FM-A	09-May-00	**<0.3**	12-May-00								
05/09/00 0.5-FM-A	09-May-00	**0.6**	12-May-00								
05/09/00 1.0 FM-C	09-May-00	**1.0**	12-May-00								
05/09/00 2.0-FM-D	09-May-00	**3.0**	12-May-00								
05/09/00 4.0-FM-B	09-May-00	**3.5**	12-May-00								
05/09/00 6.0-FM-D	09-May-00	**7.2**	12-May-00								
05/09/00 8.0-FM-B	09-May-00	**9.9**	12-May-00								
05/09/00 29.0 ppm	09-May-00	**34.0**	12-May-00								
05/10/00 CONT-FM-B	10-May-00	**<0.3**	12-May-00								
05/10/00 0.5 FM-B	10-May-00	**0.6**	12-May-00								
05/10/00 1.0-FM-A	10-May-00	**0.9**	12-May-00								
05/10/00 2.0-FM-A	10-May-00	**2.1**	12-May-00								
05/10/00 4.0-FM-C	10-May-00	**4.3**	12-May-00								
05/10/00 6.0 FM-A	10-May-00	**6.7**	12-May-00								
05/10/00 8.0 FM-A	10-May-00	**8.7**	12-May-00								
05/10/00 29 ppm	10-May-00	**31.8**	12-May-00								
05/11/00 CONT-FM-A	11-May-00	**<0.3**	12-May-00								
05/11/00 0.5-FM-D	11-May-00	**0.5**	12-May-00								
05/11/00 1.0-FM-C	11-May-00	**1.0**	12-May-00								
05/11/00 2.0-FM-D	11-May-00	**2.1**	12-May-00								
05/11/00 4.0-FM-B	11-May-00	**4.3**	12-May-00								
05/11/00 6.0-FM-B	11-May-00	**6.6**	12-May-00								
05/11/00 8.0 FM-B	11-May-00	**8.6**	12-May-00								
05/11/00 29 ppm	11-May-00	**34.5**	12-May-00								
QC data:			*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check: *0.0 mg/L NH3*		0.00									
end of run std. check: *1.0 mg/L NH3*		0.91	91%								
end of run std. check: *2.0 mg/L NH3*		2.03	102%								
end of run std. check: *4.0 mg/L NH3*		3.97	99%								
end of run std. check: *8.0 mg/L NH3*		8.07	101%								
Verification Std.(HACH): *5.0 PPM NH3*		5.00	100%								
Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*		*% recovery*
											-
05/09/00 2.0-FM-D		2.8	96%								
05/09/00 2.0-FM-D+3.0 mg/L NH3		6.0	107%								

Analyst Remarks:

Date Reported: 12-May-00 **Verified by:** G. GAY

Analyst: T. Poniatowski, D. Deluca **Date:** 19-May-00

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	12-May-00	ADDRESS:	Tetres
DATE SAMPLED:	12-May-00		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	River water	*Sampler/Submitter Remarks:*
LOCATION:		
PROJECT:	NH3 - Toxicity	

REQUESTED PARAMETER(S):

Parameter	check	Parameter	check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	*X*				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
5/12/00 CONT.WF	12-May-00	**<0.3**	15-May-00								
5/12/00 0.5WF-C	12-May-00	**0.7**	15-May-00								
5/12/00 1.0WF-D	12-May-00	**1.1**	15-May-00								
5/12/00 2 WF-B	12-May-00	**2.3**	15-May-00								
5/12/00 4.0WF-B	12-May-00	**4.3**	15-May-00								
5/12/00 6.0WF-A	12-May-00	**6.3**	15-May-00								
5/12/00 8.0WF-A	12-May-00	**8.6**	15-May-00								
5/12/00 29.0	12-May-00	**26.9**	15-May-00								
5/13/00 CONT.WF	13-May-00	**0.4**	15-May-00								
5/13/00 0.5WF-C	13-May-00	**0.7**	15-May-00								
5/13/00 1.0WF-B	13-May-00	**1.4**	15-May-00								
5/13/00 2.0WF-C	13-May-00	**2.5**	15-May-00								
5/13/00 4.0WF-B	13-May-00	**4.2**	15-May-00								
5/13/00 6.0WF-D	13-May-00	**6.5**	15-May-00								
5/13/00 8.0WF-A	13-May-00	**8.3**	15-May-00								
5/13/00 29.0	13-May-00	**28.2**	15-May-00								
5/14/00 CONT.WF	14-May-00	**0.4**	15-May-00								
5/14/00 0.5WF-C	14-May-00	**1.1**	15-May-00								
5/14/00 1.0WF-B	14-May-00	**1.1**	15-May-00								
5/14/00 2.0WF-A	14-May-00	**2.6**	15-May-00								
5/14/00 4.0WF-A	14-May-00	**4.0**	15-May-00								
5/14/00 6.0WF-B	14-May-00	**6.6**	15-May-00								
5/14/00 8.0WF-A	14-May-00	**9.0**	15-May-00								
5/14/00 29.0	14-May-00	**29.4**	15-May-00								
QC data:			*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check: *0.0 mg/L NH3*		0.00	-								
end of run std. check: *1.0 mg/L NH3*		1.10	110%								
end of run std. check: *2.0 mg/L NH3*		2.05	102%								
end of run std. check: *4.0 mg/L NH3*		4.12	103%								
end of run std. check: *8.0 mg/L NH3*		7.95	99%								
Verification Std.(HACH): *5.0 PPM NH3*		5.27	105%								
Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*		*% recovery*
											-
05/12/00 2.0-WF-B		2.6	112%								
05/12/00 2.0-WF-B+3.0 mg/L NH3			102%								

Analyst Remarks:

Date Reported: 15-May-00 **Verified by:** G.Gay

Analyst: T. Poniatowski, D. Deluca **Date:** 19 May 00

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	5/15/2000 - 5/17/2000	ADDRESS:	Tetres
DATE SAMPLED:	5/15/2000 - 5/17/2000		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	river water	*Sampler/Submitter Remarks:*
LOCATION:		
PROJECT:	NH3 - Toxicity	

REQUESTED PARAMETER(S):

	check		*check*		*check*
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	***X***				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	**NH_3-N**	Analysis Date	**NO_3-N**	Analysis Date	**TKN**	Analysis Date	**P**	Analysis Date	**Ortho PO_4-P**	Analysis Date
05/15/00 CONT.-WF-D	15-May-00	**<0.3**	18-May-00								
05/15/00 -0.5 WF-C	15-May-00	**0.5**	18-May-00								
05/15/00 -1 WF-A	15-May-00	**1.0**	18-May-00								
05/15/00 -2 WF-A	15-May-00	**1.9**	18-May-00								
05/15/00 4-WF-D	15-May-00	**3.9**	18-May-00								
05/15/00 6-WF-A	15-May-00	**6.4**	18-May-00								
05/15/00 -8 WF-C	15-May-00	**7.6**	18-May-00								
05/15/00 29 ppm	15-May-00	**28.0**	18-May-00								
05/16/00 -CONT WF-C	16-May-00	**0.3**	18-May-00								
05/16/00 -0.5 WF-D	16-May-00	**0.5**	18-May-00								
05/16/00 -1 WF-A	16-May-00	**1.1**	18-May-00								
05/16/00 -2 WF-A	16-May-00	**2.4**	18-May-00								
05/16/00 -4 WF-A	16-May-00	**3.8**	18-May-00								
05/16/00 -4 WFT-A	16-May-00	**3.7**	18-May-00								
05/16/00 -6 WF-A	16-May-00	**6.4**	18-May-00								
05/16/00 -8WFT-B	16-May-00	**7.9**	18-May-00								
05/16/00 -29 PPM	16-May-00	**28.1**	18-May-00								
05/17/00 -CONT-WF-D	17-May-00	**<0.3**	18-May-00								
05/17/00 -0.5 WF-A	17-May-00	**0.5**	18-May-00								
05/17/00 -1 WF-C	17-May-00	**1.2**	18-May-00								
05/17/00 -2 WF-B	17-May-00	**3.0**	18-May-00								
05/17/00 -4-WFT-D	17-May-00	**3.6**	18-May-00								
05/17/00 -4WF-B	17-May-00	**3.7**	18-May-00								
05/17/00 -6-WF-A	17-May-00	**6.4**	18-May-00								
05/17/00 -8WF-T-B	17-May-00	**7.1**	18-May-00								
05/17/00 29 PPM	17-May-00	**25.4**	18-May-00								
QC data:			*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check: *0.0 mg/L NH3*		0.02	-								
end of run std. check: *1.0 mg/L NH3*		0.92	92%								
end of run std. check: *2.0 mg/L NH3*		1.97	99%								
end of run std. check: *4.0 mg/L NH3*		3.95	99%								
end of run std. check: *8.0 mg/L NH3*		8.10	101%								
Verification Std.(HACH): *5.0 PPM NH3*		5.25	105%								
Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*		*% recovery*
											-
05/15/00 -2 WF-A Repeat		1.98	106%								
05/15/00 -2 WF-A + 3.0 mg/L NH3			107%								

Analyst Remarks:

Date Reported: 18-May-00 **Verified by:** G. GAY

Analyst: T. Poniatowski, D. Deluca **Date:**

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY: Amy Partridge
DATE SUBMITTED: 5/19/2000 - 5/22/2000
DATE SAMPLED: 5/19/2000 - 5/22/2000
SAMPLED BY: Amy Partridge

REPORT TO: Amy Partridge
ADDRESS: Tetres
POSTAL CODE: PHONE:

SAMPLE TYPE: river water
LOCATION:
PROJECT: NH3 - Toxicity

Sampler/Submitter Remarks:

REQUESTED PARAMETER(S):

	check		check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	*X*				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample			Concentration (mg/L)									
Description / Identification		Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
5/19/00 CONT Y2K-3WF(+)		19-May-00	**<0.3**	23-May-00								
5/19/00 0.5 Y2K-3WF(+)		19-May-00	**0.6**	23-May-00								
5/19/00 1.0 Y2K-3WF(+)		19-May-00	**1.1**	23-May-00								
5/19/00 2.0 Y2K-3WF(+)		19-May-00	**2.2**	23-May-00								
5/19/00 4.0 Y2K-3WF(+)		19-May-00	**4.0**	23-May-00								
5/19/00 6.0 Y2K-3WF(+)		19-May-00	**6.1**	23-May-00								
5/19/00 8.0 Y2K-3WF(+)		19-May-00	**8.7**	23-May-00								
5/19/00 29.0 ppm		19-May-00	**30.0**	23-May-00								
5/20/00 CONT Y2K-4FM		20-May-00	**<0.3**	23-May-00								
5/20/00 0.5 Y2K-3WF		20-May-00	**0.6**	23-May-00								
5/20/00 1.0 Y2K-4 FM		20-May-00	**0.8**	23-May-00								
5/20/00 2.0 Y2K-4 FM		20-May-00	**1.8**	23-May-00								
5/20/00 4.0 Y2K-3 WP		20-May-00	**3.7**	23-May-00								
5/20/00 6.0 Y2K-4 FM		20-May-00	**5.8**	23-May-00								
5/20/00 8.0 Y2K-3 WF		20-May-00	**8.4**	23-May-00								
05/20/00 29 ppm		20-May-00	**29.8**	23-May-00								
5/20/00 CONT. Y2K-3 WF		20-May-00	**<0.3**	23-May-00								
5/20/00 0.5 Y2K-4 FM		20-May-00	**0.6**	23-May-00								
5/20/00 1.0 Y2K-3 WF		20-May-00	**1.1**	23-May-00								
5/20/00 2.0 Y2K-3 WF		20-May-00	**1.9**	23-May-00								
5/20/00 4.0 Y2K -4 FM		20-May-00	**3.5**	23-May-00								
5/20/00 6.0 Y2K-3 WF		20-May-00	**5.6**	23-May-00								
5/20/00 8.0 Y2K-4 FM		20-May-00	**8.1**	23-May-00								
05/21/00 CONT-FM-B		21-May-00	**<0.3**	23-May-00								
05/21/00 0.5-FM-B		21-May-00	**0.5**	23-May-00								
05/21/00 1.0-FM-C		21-May-00	**1.0**	23-May-00								
05/21/00 2-FM-C		21-May-00	**2.0**	23-May-00								
05/21/00 4.0-WFT-A		21-May-00	**3.6**	23-May-00								
05/21/00 4-FM-C		21-May-00	**3.5**	23-May-00								
05/21/00 6-FM-A		21-May-00	**5.9**	23-May-00								
05/21/00 8-FM-A		21-May-00	**8.1**	23-May-00								
05/21/00 29ppm		21-May-00	**27.0**	23-May-00								
05/22/00 CONT FM-C		22-May-00	**<0.3**	23-May-00								
05/22/00 0.5 FM-A		22-May-00	**0.5**	23-May-00								
05/22/00 1 FM-B		22-May-00	**0.9**	23-May-00								
05/22/00 2 FM-C		22-May-00	**2.0**	23-May-00								
05/22/00 4 FM-D		22-May-00	**3.5**	23-May-00								
05/22/00 4 WFT-A		22-May-00	**3.3**	23-May-00								
05/22/00 6 FM-A		22-May-00	**5.9**	23-May-00								
05/22/00 8 FM-B		22-May-00	**8.1**	23-May-00								
05/22/00 29 ppm		22-May-00	**25.8**	23-May-00								
QC data:				*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check:	*0.0 mg/L NH3*		0.08	-								
end of run std. check:	*1.0 mg/L NH3*		0.87	87%								
end of run std. check:	*2.0 mg/L NH3*		1.83	92%								
end of run std. check:	*4.0 mg/L NH3*		3.97	99%								
end of run std. check:	*8.0 mg/L NH3*		7.76	97%								
Verification Std.(HACH):	*5.0 PPM NH3*		4.89	98%								
Standard additions:				*% recovery*		*% recovery*		*% recovery*		*% recovery*		*% recovery*
												-
5/19/00 2.0 Y2K-3WF(+) Repeat			2.06	95%								
5/19/00 2.0 Y2K-3WF(+) + 3.0 mg/L NH3				96%								

Analyst Remarks:

Date Reported: 18-May-00

Verified by: G. GAY

Analyst: T. Poniatowski, D. Deluca

Date:

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY: Amy Partridge	REPORT TO: Amy Partridge
DATE SUBMITTED: 5/23/2000 - 5/28/2000	ADDRESS: Tetres
DATE SAMPLED: 5/23/2000 - 5/28/2000	
SAMPLED BY: Amy Partridge	POSTAL CODE: PHONE:

SAMPLE TYPE: river water	*Sampler/Submitter Remarks:*
LOCATION:	
PROJECT: NH3 - Toxicity	

REQUESTED PARAMETER(S):		check		check		check
	Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
	Total Ammonia (NH_3-N):	X				
	Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
05/23/00 CONT. FM-A	23-May-00	**<0.3**	29-May-00								
05/23/00 0.5 FM-C	23-May-00	**0.4**	29-May-00								
05/23/00 1 FM-B	23-May-00	**0.9**	29-May-00								
05/23/00 2-FM-A	23-May-00	**2.0**	29-May-00								
05/23/00 4-FM-A	23-May-00	**3.6**	29-May-00								
05/23/00 4-WFT-C	23-May-00	**3.4**	29-May-00								
05/23/00 6-FM-C	23-May-00	**6.0**	29-May-00								
05/23/00 8-FM-A	23-May-00	**7.9**	29-May-00								
05/23/00 29.0 ppm	23-May-00	**27.7**	29-May-00								
05/24/00 CONT. FM-C	24-May-00	**<0.3**	29-May-00								
05/24/00 0.5 FM-D	24-May-00	**0.5**	29-May-00								
05/24/00 1.0 FM-B	24-May-00	**0.9**	29-May-00								
05/24/00 2 FM-D	24-May-00	**1.8**	29-May-00								
05/24/00 4-WE-C	24-May-00	**3.3**	29-May-00								
05/24/00 4 NP-C	24-May-00	**3.4**	29-May-00								
05/24/00 4-WPT-B	24-May-00	**3.3**	29-May-00								
05/24/00 4 FM-D	24-May-00	**3.4**	29-May-00								
05/24/00 6 FM-C	24-May-00	**5.7**	29-May-00								
05/24/00 8 FM-B	24-May-00	**7.5**	29-May-00								
05/24/00 29ppm	24-May-00	**27.1**	29-May-00								
05/25/00 CONT. A Y2K-4-FM	25-May-00	**<0.3**	29-May-00								
05/25/000.5 B Y2K-4-FM	25-May-00	**0.4**	29-May-00								
05/25/00 1.0 B Y2K-4-FM	25-May-00	**0.8**	29-May-00								
05/25/00 2.0 B Y2K-4-FM	25-May-00	**1.8**	29-May-00								
05/25/00 4.0 C Y2K-6NP	25-May-00	**4.4**	29-May-00								
05/25/00 4.0 C Y2K-5WE	25-May-00	**3.4**	29-May-00								
05/25/00 4.0 A Y2K-4-FM	25-May-00	**3.1**	29-May-00								
05/25/00 4.0A Y2K-3WF	25-May-00	**3.1**	29-May-00								
05/25/00 6.0 B Y2K-4-FM	25-May-00	**5.5**	29-May-00								
05/25/00 8.0 A Y2K-4-FM	25-May-00	**8.2**	29-May-00								
05/25/00 8.0 A Y2K-4-FM	25-May-00	**27.8**	29-May-00								
05/26/00 -CONT. FM-A	26-May-00	**<0.3**	29-May-00								
05/26/00 -0.5 FM-A	26-May-00	**0.4**	29-May-00								
05/26/00 -1 FM-D	26-May-00	**0.8**	29-May-00								
05/26/00 -2 NP-D	26-May-00	**2.0**	29-May-00								
05/26/00 -2 FM-C	26-May-00	**1.9**	29-May-00								
05/26/00 -4 FM-C	26-May-00	**3.1**	29-May-00								
05/26/00 -6 FM-D	26-May-00	**5.6**	29-May-00								
05/26/00 -8 FM-A	26-May-00	**7.4**	29-May-00								
05/26/00 -29 ppm	26-May-00	**25.8**	29-May-00								
05/27/00 -CONT.Y2K-4	27-May-00	**<0.3**	29-May-00								
05/27/00 -0.5D Y2K-3	27-May-00	**0.4**	29-May-00								
05/27/00 -0.5 D Y2K-4	27-May-00	**0.4**	29-May-00								
05/27/00 -0.5 B Y2K-6	27-May-00	**0.4**	29-May-00								
05/27/00 -1.0 C Y2K-4	27-May-00	**0.8**	29-May-00								
05/27/00 -2.0 C Y2K-4	27-May-00	**1.5**	29-May-00								
05/27/00 -6.0 B Y2K-4	27-May-00	**3.8**	29-May-00								
05/27/00 -6.0 Y2K-4	27-May-00	**4.9**	29-May-00								
05/27/00 -8.0 Y2K-4	27-May-00	**6.5**	29-May-00								
05/27/00 29.0 ppm	27-May-00	**25.6**	29-May-00								
05/28/00 CONT. -N-P-C	28-May-00	**<0.3**	29-May-00								
05/28/00 0.5 NP-A	28-May-00	**0.7**	29-May-00								
05/28/00 1 WF-B	28-May-00	**1.0**	29-May-00								
05/28/00 1 NP-A	28-May-00	**1.0**	29-May-00								
05/28/00 2 NP-D	28-May-00	**1.9**	29-May-00								
05/28/00 4 NP-C	28-May-00	**3.0**	29-May-00								
05/28/00 6 NP-C	28-May-00	**6.2**	29-May-00								
05/28/00 8 NP-D	28-May-00	**7.5**	29-May-00								
05/28/00 29 ppm	28-May-00	**26.7**	29-May-00								
QC data:			*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check: *0.0 mg/L NH3*		0.00	-								
end of run std. check: *1.0 mg/L NH3*		0.89	89%								
end of run std. check: *2.0 mg/L NH3*		1.87	94%								
end of run std. check: *4.0 mg/L NH3*		3.96	99%								
end of run std. check: *8.0 mg/L NH3*		8.06	101%								
Verification Std.(HACH): *5.0 PPM NH3*		5.07	101%								
Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*		*% recovery*
05/23/00 1-FM-B		0.89	102%								
05/23/00 1-FM-B +0.3 mg/L NH3		-	98%								
05/23/00 2-FM-A		1.79	89%								
05/23/00 2-FM-A+0.3 mg/L NH3		-	101%								

Analyst Remarks:

Date Reported: 29-May-00 **Verified by:** G. GAY

Analyst: T. Poniatowski, D. Deluca **Date:** 29-May-00

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	5/29/2000 - 06/04/00	ADDRESS:	Tetres
DATE SAMPLED:	5/29/2000 - 06/04/00		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	river water	*Sampler/Submitter Remarks:*
LOCATION:		
PROJECT:	NH3 - Toxicity	

REQUESTED PARAMETER(S):		check		check		check
	Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
	Total Ammonia (NH_3-N):	*X*				
	Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
5/29/00 CONT. NP-A	29-May-00	**0.3**	5-Jun-00								
5/29/00 -0.5 NP-D	29-May-00	**0.8**	5-Jun-00								
5/29/00 -1-NP-C	29-May-00	**1.0**	5-Jun-00								
5/29/00 -2-NP-B	29-May-00	**2.2**	5-Jun-00								
5/29/00 -4-NP-A	29-May-00	**4.3**	5-Jun-00								
5/29/00 -6 NP-D	29-May-00	**6.7**	5-Jun-00								
5/29/00 -8 NP-D	29-May-00	**8.3**	5-Jun-00								
5/29/00 29 ppm	29-May-00	**28.9**	5-Jun-00								
5/30/00 -CONT.NP-C	30-May-00	**<0.3**	5-Jun-00								
5/30/00 -0.5 NP-D	30-May-00	**1.0**	5-Jun-00								
5/3000 -1 NP-D	30-May-00	**1.6**	5-Jun-00								
5/30/00 -2 NP-C	30-May-00	**2.1**	5-Jun-00								
5/30/00 -4 WE-D	30-May-00	**3.9**	5-Jun-00								
5/30/00 -4-NP-D	30-May-00	**4.4**	5-Jun-00								
5/30/00 -6-NP-A	30-May-00	**6.2**	5-Jun-00								
5/30/00 -8-NP-C	30-May-00	**8.1**	5-Jun-00								
5/30/00 -29 ppm	30-May-00	**27.6**	5-Jun-00								
5/31/00 -CONT.NP-B	31-May-00	**<0.3**	5-Jun-00								
5/31/00 -0.5NP-A	31-May-00	**0.3**	5-Jun-00								
5/31/00 -1.0 NP-C	31-May-00	**0.9**	5-Jun-00								
5/31/00 -2.0 NP-A	31-May-00	**1.9**	5-Jun-00								
5/31/00 -4.0 NP-B	31-May-00	**3.8**	5-Jun-00								
5/31/00 6-NP-D	31-May-00	**5.8**	5-Jun-00								
5/31/00 8 NP-B	31-May-00	**7.6**	5-Jun-00								
05/31/00 29 ppm	31-May-00	**26.0**	5-Jun-00								
06/01/00 -CONT NP-D	01-Jun-00	**0.4**	5-Jun-00								
06/01/00 -0.5 NP-A	01-Jun-00	**0.5**	5-Jun-00								
06/01/00 -1NP-C	01-Jun-00	**1.2**	5-Jun-00								
06/01/00 -2 NP-B	01-Jun-00	**2.0**	5-Jun-00								
06/01/00 -4NP-B	01-Jun-00	**5.0**	5-Jun-00								
06/01/00 -6NP-A	01-Jun-00	**5.8**	5-Jun-00								
06/01/00 -8NP-B	01-Jun-00	**8.5**	5-Jun-00								
06/01/00 -29 ppm	01-Jun-00	**26.5**	5-Jun-00								
06/02/00-CONT-NP-D	02-Jun-00	**0.5**	5-Jun-00								
06/02/00-0.5NP-A	02-Jun-00	**1.1**	5-Jun-00								
06/02/00-1 NP-B	02-Jun-00	**1.5**	5-Jun-00								
06/02/00-2 NP-A	02-Jun-00	**2.0**	5-Jun-00								
06/02/00-4NP-B	02-Jun-00	**3.9**	5-Jun-00								
06/02/00-6NP-C	02-Jun-00	**6.0**	5-Jun-00								
06/02/00-8NP-D	02-Jun-00	**8.0**	5-Jun-00								
06/02/00-29 ppm	02-Jun-00	**25.8**	5-Jun-00								
05/03/00-CONT.NP-A	03-Jun-00	**0.3**	5-Jun-00								
05/03/00-0.5NP-D	03-Jun-00	**0.6**	5-Jun-00								
05/03/00-1.0 NP-C	03-Jun-00	**1.3**	5-Jun-00								
05/03/00-2.0 NP-C	03-Jun-00	**2.1**	5-Jun-00								
05/03/00-4 NP-B	03-Jun-00	**4.2**	5-Jun-00								
05/03/00-6 NP-C	03-Jun-00	**5.4**	5-Jun-00								
05/03/00-8NP-A	03-Jun-00	**7.0**	5-Jun-00								
05/03/00-29 ppm	03-Jun-00	**24.0**	5-Jun-00								
06/04/00-CONT.-NP-A	04-Jun-00	**0.3**	5-Jun-00								
06/04/00-0.5 NP-D	04-Jun-00	**0.5**	5-Jun-00								
06/04/00-1.0 NP-B	04-Jun-00	**1.3**	5-Jun-00								
06/04/00-2 NP-A	04-Jun-00	**2.0**	5-Jun-00								
06/04/00-4 LTA	04-Jun-00	**3.6**	5-Jun-00								
06/04/00 NP-A	04-Jun-00	**4.1**	5-Jun-00								
06/04/00-6NP-C	04-Jun-00	**6.3**	5-Jun-00								
06/04/00-8 LT-C	04-Jun-00	**7.9**	5-Jun-00								
06/04/00-29 ppm	04-Jun-00	**25.7**	5-Jun-00								

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	5/29/2000 - 06/04/00	ADDRESS:	Tetres
DATE SAMPLED:	5/29/2000 - 06/04/00		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	river water	*Sampler/Submitter Remarks:*
LOCATION:		
PROJECT:	NH3 - Toxicity	

REQUESTED PARAMETER(S):

	check		check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	*X*				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample			Concentration (mg/L)									
Description / Identification		Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
QC data:				*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check:	*0.0 mg/L NH3*		0.1	-								
end of run std. check:	*1.0 mg/L NH3*		0.9	95%								
end of run std. check:	*2.0 mg/L NH3*		2.0	102%								
end of run std. check:	*4.0 mg/L NH3*		4.1	101%								
end of run std. check:	*8.0 mg/L NH3*		8.0	100%								
Verification Std.(HACH):	*5.0 PPM NH3*											
Standard additions:						*% recovery*		*% recovery*		*% recovery*		*% recovery*
05/29/00 2-NP-B			2.2	100%								
05/29/00 2-NP-B+0.3 mg/L NH3				100%								
05/30/00 2-NP-C			2.2	103%								
05/30/00 2-NP-C+0.3 mg/L NH3				101%								

Analyst Remarks:

Date Reported: 05-Jun-00 **Verified by:** G. GAY

Analyst: T. Poniatowski, D. Deluca **Date:** 5-Jun-00

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	06/05/00 - 06/11/00	ADDRESS:	Tetres
DATE SAMPLED:	06/05/00 - 06/11/00		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	river water	*Sampler/Submitter Remarks:*	
LOCATION:			
PROJECT:	NH3 - Toxicity		

REQUESTED PARAMETER(S):		*check*		*check*		*check*
	Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
	Total Ammonia (NH_3-N):	*X*				
	Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
06/5/00 CONTROL	05-Jun-00	<0.2	12-Jun-00								
06/5/00 0.5-LTC	05-Jun-00	0.4	12-Jun-00								
06/5/00 1.0-LTD	05-Jun-00	0.8	12-Jun-00								
06/5/00 2.0-LTA	05-Jun-00	1.7	12-Jun-00								
06/5/00 4.0-LTB	05-Jun-00	3.3	12-Jun-00								
06/5/00 6-LTB	05-Jun-00	5.6	12-Jun-00								
06/5/00 8.0-LTA	05-Jun-00	7.5	12-Jun-00								
29ppm	05-Jun-00	23.7	12-Jun-00								
06/06/00 CONT-LTC	06-Jun-00	0.2	12-Jun-00								
06/06/00 0.5 LTC	06-Jun-00	0.3	12-Jun-00								
06/06/00 1.0 LTA	06-Jun-00	0.9	12-Jun-00								
06/06/00 2.0 LTC	06-Jun-00	1.8	12-Jun-00								
06/06/00 4.0 LTB	06-Jun-00	3.7	12-Jun-00								
06/06/00 6.0 LTA	06-Jun-00	5.9	12-Jun-00								
06/06/00 8.0 LTA	06-Jun-00	7.8	12-Jun-00								
29 ppm	06-Jun-00	22.9	12-Jun-00								
06/07/00 CONT ALT	07-Jun-00	0.2	12-Jun-00								
06/07/00 0.5 DLT	07-Jun-00	0.3	12-Jun-00								
06/07/00 1.0 CLT	07-Jun-00	0.8	12-Jun-00								
06/07/00 2.0 ALT	07-Jun-00	2.0	12-Jun-00								
06/07/00 4.0 BLT	07-Jun-00	3.8	12-Jun-00								
06/07/00 6.0 BLT	07-Jun-00	6.2	12-Jun-00								
06/07/00 8 DLT	07-Jun-00	7.6	12-Jun-00								
29 ppm	07-Jun-00	23.0	12-Jun-00								
06/08/00 CONT LTB	08-Jun-00	0.2	12-Jun-00								
06/08/00 0.5-LTA	08-Jun-00	0.2	12-Jun-00								
06/08/00 1.0-LTA	08-Jun-00	0.7	12-Jun-00								
06/08/00 2.0-LTA	08-Jun-00	1.8	12-Jun-00								
06/08/00 4.0-LTB	08-Jun-00	3.8	12-Jun-00								
06/08/00 6.0-LTC	08-Jun-00	5.4	12-Jun-00								
06/08/00 6.0 WEA	08-Jun-00	5.5	12-Jun-00								
06/08/00 8.0 LTB	08-Jun-00	7.4	12-Jun-00								
29 ppm	08-Jun-00	25.7	12-Jun-00								
06/09/00 CONT-WE-C	09-Jun-00	0.2	12-Jun-00								
06/09/00 0.5 WE-C	09-Jun-00	0.2	12-Jun-00								
6/09/00 1.0 WE-B	09-Jun-00	0.7	12-Jun-00								
6/09/00 2.0 WE-A	09-Jun-00	1.6	12-Jun-00								
6/09/00 4.0 LT-C	09-Jun-00	3.5	12-Jun-00								
6/09/00 4.0 WE-A	09-Jun-00	3.6	12-Jun-00								
6/09/00 6.0 WE-C	09-Jun-00	5.4	12-Jun-00								
6/09/00 8.0 LT-B	09-Jun-00	7.5	12-Jun-00								
29 ppm	09-Jun-00	30.2	12-Jun-00								
06/10/00 CONTROL B-WE	10-Jun-00	0.3	12-Jun-00								
06/10/00 0.5-C-WE	10-Jun-00	0.5	12-Jun-00								
06/10/00 1.0 A-WE	10-Jun-00	1.0	12-Jun-00								
06/10/00 2.0-B-WE	10-Jun-00	2.2	12-Jun-00								
06/10/00 4.0-B-LT	10-Jun-00	3.8	12-Jun-00								
06/10/00 4.0-C-WE	10-Jun-00	3.8	12-Jun-00								
06/10/00 6.0-B-WE	10-Jun-00	5.7	12-Jun-00								
06/10/00 8.0-C-LT	10-Jun-00	7.2	12-Jun-00								
06/10/00 29.0 p	10-Jun-00	32.4	12-Jun-00								
06/11/00 CONTROL B-WE	11-Jun-00	0.3	12-Jun-00								
06/11/00 0.5 B-WE	11-Jun-00	0.5	12-Jun-00								
06/11/00 1.0 C-WE	11-Jun-00	0.9	12-Jun-00								
06/11/00 1.0 C-LT	11-Jun-00	0.8	12-Jun-00								
06/11/00 2.0 C-WE	11-Jun-00	1.8	12-Jun-00								
06/11/00 4.0 B-WE	11-Jun-00	3.7	12-Jun-00								
06/11/00 A-WE	11-Jun-00	5.2	12-Jun-00								
06/11/00 8.0 B-LT	11-Jun-00	7.1	12-Jun-00								
06/11/00 29ppm	11-Jun-00	28.3	12-Jun-00								

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	06/05/00 - 06/11/00	ADDRESS:	Tetres
DATE SAMPLED:	06/05/00 - 06/11/00		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	river water	*Sampler/Submitter Remarks:*
LOCATION:		
PROJECT:	NH3 - Toxicity	

		check		check		check
REQUESTED PARAMETER(S):	Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
	Total Ammonia (NH_3-N):	*X*				
	Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample			Concentration (mg/L)									
Description / Identification		Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
QC data:				*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check:	*0.0 mg/L NH3*		0.0	-								
end of run std. check:	*1.0 mg/L NH3*		1.3	**130%**								
end of run std. check:	*2.0 mg/L NH3*		1.9	95%								
end of run std. check:	*4.0 mg/L NH3*		4.0	100%								
end of run std. check:	*8.0 mg/L NH3*		8.0	100%								
Verification Std.(HACH):	*5.0 PPM NH3*											
Standard additions:						*% recovery*		*% recovery*		*% recovery*		*% recovery*
06/05/00 2.0 LTA			1.7	98%								
06/05/00 2.0 LTA+0.3 mg/L NH3				102%								
06/06/00 2.0-LTC			1.8	99%								
06/06/00 2.0-LTC+0.3 mg/L NH3				102%								

Analyst Remarks:

Date Reported: 12-Jun-00 **Verified by:** G. GAY

Analyst: T. Poniatowski, D. Deluca **Date:** 5-Jun-00

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	06/12/00 - 06/19/00	ADDRESS:	Tetres
DATE SAMPLED:	06/12/00 - 06/19/00		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	river water	*Sampler/Submitter Remarks:*
LOCATION:		
PROJECT:	NH3 - Toxicity	

REQUESTED PARAMETER(S):		check		check		check
	Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
	Total Ammonia (NH_3-N):	X				
	Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
06/12/00-CONT.WE-B	12-Jun-00	<0.3	20-Jun-00								
06/12/00-0.5 WE-C	12-Jun-00	0.4	20-Jun-00								
06/12/00-1.0 WE-C	12-Jun-00	0.9	20-Jun-00								
06/12/00-2.0 WE-A	12-Jun-00	1.8	20-Jun-00								
06/12/00- 2.0 LT-A	12-Jun-00	1.8	20-Jun-00								
06/12/00-4 WE-C	12-Jun-00	3.6	20-Jun-00								
06/12/00-6.0 WE-B	12-Jun-00	5.5	20-Jun-00								
06/12/00-8-LT-A	12-Jun-00	7.7	20-Jun-00								
06/12/00-29 PPM	12-Jun-00	25.4	20-Jun-00								
06/13/00 CONT. WE-C	13-Jun-00	<0.3	20-Jun-00								
06/13/00 0.5 WE-B	13-Jun-00	0.4	20-Jun-00								
06/13/00 1.0 WE-A	13-Jun-00	0.9	20-Jun-00								
06/13/00 2.0 WE-B	13-Jun-00	1.7	20-Jun-00								
06/13/00 4.0 LT-B	13-Jun-00	3.1	20-Jun-00								
06/13/00 4.0 WE-B	13-Jun-00	3.2	20-Jun-00								
06/13/00 6.0 WE-B	13-Jun-00	5.8	20-Jun-00								
06/13/00 8.0 LT-A	13-Jun-00	6.8	20-Jun-00								
06/13/00 29 PPM	13-Jun-00	25.6	20-Jun-00								
06/14/00 CONT-WE-B	14-Jun-00	<0.3	20-Jun-00								
06/14/00 0.5 WE-A	14-Jun-00	0.4	20-Jun-00								
06/14/00 1.0 WE-C	14-Jun-00	0.8	20-Jun-00								
06/14/00 2.0 WE-B	14-Jun-00	1.8	20-Jun-00								
06/14/00 4.0 WE-A	14-Jun-00	3.5	20-Jun-00								
06/14/00 6.0 LT-A	14-Jun-00	5.8	20-Jun-00								
06/14/00 6 WE-C	14-Jun-00	5.9	20-Jun-00								
06/14/00 8.0 LT-B	14-Jun-00	7.6	20-Jun-00								
06/14/00 29 PPM	14-Jun-00	31.2	20-Jun-00								
06/15/00 CONT B-LT	15-Jun-00	<0.3	20-Jun-00								
06/15/00 CONT.C-WE	15-Jun-00	<0.3	20-Jun-00								
06/15/00 0.5 C-WE	15-Jun-00	0.5	20-Jun-00								
06/15/00 1.0 B-WE	15-Jun-00	1.0	20-Jun-00								
06/15/00 2.0 A-WE	15-Jun-00	2.2	20-Jun-00								
06/15/00 4.0 A-WE	15-Jun-00	3.4	20-Jun-00								
06/15/00 6.0 C-WE	15-Jun-00	6.1	20-Jun-00								
06/15/00 8.0 B-WE	15-Jun-00	8.0	20-Jun-00								
06/15/00 29 PPM	15-Jun-00	26.7	20-Jun-00								
06/16/00 CONT.WE-B	16-Jun-00	<0.3	20-Jun-00								
06/16/00 0.5 LT-B	16-Jun-00	<0.3	20-Jun-00								
06/16/00 0.5 WE-B	16-Jun-00	<0.3	20-Jun-00								
06/16/00 1-WE-A	16-Jun-00	<0.3	20-Jun-00								
06/16/00 2-WE-B	16-Jun-00	<0.3	20-Jun-00								
06/16/00 4-WE-C	16-Jun-00	<0.3	20-Jun-00								
06/16/00 6-WE-A	16-Jun-00	0.6	20-Jun-00								
06/16/00 8-LT-B	16-Jun-00	0.3	20-Jun-00								
06/16/00 22 PPM	16-Jun-00	20.9	20-Jun-00								
06/17/00 CONT.WE-A	17-Jun-00	<0.3	20-Jun-00								
06/17/00 0.5 WE-A	17-Jun-00	0.8	20-Jun-00								
06/17/00 1.0 WE-C	17-Jun-00	1.1	20-Jun-00								
06/17/00 2.0 WE-A	17-Jun-00	2.1	20-Jun-00								
06/17/00 4.0 WE-C	17-Jun-00	4.6	20-Jun-00								
06/17/00 6.0 WE-C	17-Jun-00	5.7	20-Jun-00								
06/17/00 6.0 LT-B	17-Jun-00	5.8	20-Jun-00								
06/18/00 CONT. B-WE	18-Jun-00	<0.3	20-Jun-00								
06/18/00 0.5 C-WE	18-Jun-00	0.6	20-Jun-00								
06/18/00 1.0 A-WE	18-Jun-00	1.2	20-Jun-00								
06/18/00 2.0C-LT	18-Jun-00	2.2	20-Jun-00								
06/18/00 2.0 B-WE	18-Jun-00	4.4	20-Jun-00								
06/18/00 4.0 C-WE	18-Jun-00	2.3	20-Jun-00								
06/18/00 6.0 A-WE	18-Jun-00	6.0	20-Jun-00								
06/18/00 22 PPM	18-Jun-00	28.2	20-Jun-00								
06/19/00 CONT-LTA	19-Jun-00	0.4	20-Jun-00								
06/19/00 CONT-WE-C	19-Jun-00	0.3	20-Jun-00								
06/19/00 0.5 WE-B	19-Jun-00	0.7	20-Jun-00								
06/19/00 1.0 WE-A	19-Jun-00	1.4	20-Jun-00								
06/19/00 2.0 WE-B	19-Jun-00	2.2	20-Jun-00								
06/19/00 4.0 WE-A	19-Jun-00	4.7	20-Jun-00								
06/19/00 6.0 WE-B	19-Jun-00	6.2	20-Jun-00								
06/19/00 22 PPM	19-Jun-00	22.3	20-Jun-00								

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	06/12/00 - 06/19/00	ADDRESS:	Tetres
DATE SAMPLED:	06/12/00 - 06/19/00		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	river water	*Sampler/Submitter Remarks:*
LOCATION:		
PROJECT:	NH3 - Toxicity	

REQUESTED PARAMETER(S):		check		check		check
	Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
	Total Ammonia (NH_3-N):	*X*				
	Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample			Concentration (mg/L)									
Description / Identification		Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
QC data:				*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check:	*0.0 mg/L NH3*		0.14	-								
end of run std. check:	*1.0 mg/L NH3*		0.98	**98%**								
end of run std. check:	*2.0 mg/L NH3*		1.98	99%								
end of run std. check:	*4.0 mg/L NH3*		4.05	101%								
end of run std. check:	*8.0 mg/L NH3*		8.02	100%								
Verification Std.(HACH):	*5.0 PPM NH3*		5.00	100%								
Standard additions:						*% recovery*		*% recovery*		*% recovery*		*% recovery*
06/12/00 2.0 WE-A			1.7									
06/12/00 2.0 WE-A+0.3 mg/L NH3				102%								
06/13/00 2.0- WE-B			1.8									
06/13/00 2.0-WE-B+0.3 mg/L NH3				98%								

Analyst Remarks: Shaded values for 2.0 B-WE and 20 C-WE are suspect due to possibly switched samples.

Date Reported: 20-Jun-00 **Verified by:** G. GAY

Analyst: T. Poniatowski, D. Deluca **Date:** 21-Jun-00

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	06/20/00 - 06/26/00	ADDRESS:	Tetres
DATE SAMPLED:	06/20/00 - 06/26/00		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	river water	*Sampler/Submitter Remarks:*
LOCATION:		
PROJECT:	NH3 - Toxicity	

REQUESTED PARAMETER(S):

Parameter	check	Parameter	check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	*X*				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
06/20/00-CONT.WE-C	20-Jun-00	**0.2**	27-Jun-00								
06/20/00-0.5 WE-A	20-Jun-00	**0.7**	27-Jun-00								
06/20/00-1.0 WE-A	20-Jun-00	**0.9**	27-Jun-00								
06/20/00-2.0 WE-B	20-Jun-00	**1.6**	27-Jun-00								
06/20/00- 2.0 LT-B	20-Jun-00	**1.6**	27-Jun-00								
06/20/00-4 WE-A	20-Jun-00	**3.5**	27-Jun-00								
06/20/00-6.0 WE-B	20-Jun-00	**4.7**	27-Jun-00								
06/20/00-22 PPM	20-Jun-00	**21.7**	27-Jun-00								
06/21/00 CONT. WE-B	21-Jun-00	**0.1**	27-Jun-00								
06/21/00 0.5 WE-A	21-Jun-00	**0.4**	27-Jun-00								
06/21/00 1.0 WE-B	21-Jun-00	**1.2**	27-Jun-00								
06/21/00 2.0 WE-A	21-Jun-00	**1.7**	27-Jun-00								
06/21/00 4.0 WE-A	21-Jun-00	**3.9**	27-Jun-00								
06/21/00 4.0 LT-C	21-Jun-00	**3.9**	27-Jun-00								
06/21/00 6.0 WE-A	21-Jun-00	**5.7**	27-Jun-00								
06/21/00 22 PPM	21-Jun-00	**21.5**	27-Jun-00								
06/22/00 CONT-WE-A	22-Jun-00	**0.2**	27-Jun-00								
06/22/00 0.5 WE-C	22-Jun-00	**0.5**	27-Jun-00								
06/22/00 1.0 WE-A	22-Jun-00	**1.0**	27-Jun-00								
06/22/00 2.0 WE-B	22-Jun-00	**1.8**	27-Jun-00								
06/22/00 2.0 LT-B	22-Jun-00	**1.8**	27-Jun-00								
06/22/00 4-WE-A	22-Jun-00	**3.8**	27-Jun-00								
06/22/00 6 WE-A	22-Jun-00	**5.1**	27-Jun-00								
06/22/00 22 PPM	22-Jun-00	**31.7**	27-Jun-00								
06/23/00 CONT.WE-B	23-Jun-00	**0.1**	27-Jun-00								
06/23/00 0.5 WE-B	23-Jun-00	**0.4**	27-Jun-00								
06/23/00 1.0 WE-C	23-Jun-00	**0.9**	27-Jun-00								
06/23/00 2.0 WE-B	23-Jun-00	**1.7**	27-Jun-00								
06/23/00 4.0 WE-C	23-Jun-00	**3.8**	27-Jun-00								
06/23/00 6.0 WE-B	23-Jun-00	**5.3**	27-Jun-00								
06/23/00 6 LT-A	23-Jun-00	**5.1**	27-Jun-00								
06/23/00 22 PPM	23-Jun-00	**24.0**	27-Jun-00								
06/24/00 CONT.WE-A	24-Jun-00	**0.2**	27-Jun-00								
06/24/00 0.5 WE-B	24-Jun-00	**0.4**	27-Jun-00								
06/24/00 1 LT-A	24-Jun-00	**0.9**	27-Jun-00								
06/24/00 1-WE-A	24-Jun-00	**1.0**	27-Jun-00								
06/24/00 2-WE-B	24-Jun-00	**1.5**	27-Jun-00								
06/24/00 4-WE-A	24-Jun-00	**3.5**	27-Jun-00								
06/24/00 6-WE-A	24-Jun-00	**5.1**	27-Jun-00								
06/24/00 22 PPM	24-Jun-00	**23.0**	27-Jun-00								
06/25/00 CONT.WE-B	25-Jun-00	**0.2**	27-Jun-00								
06/25/00 0.5 WE-C	25-Jun-00	**0.5**	27-Jun-00								
06/25/00 1.0 WE-A	25-Jun-00	**0.9**	27-Jun-00								
06/25/00 2.0 WE-C	25-Jun-00	**1.6**	27-Jun-00								
06/25/00 2.0 LT-A	25-Jun-00	**1.6**	27-Jun-00								
06/25/00 4.0 WE-C	25-Jun-00	**3.5**	27-Jun-00								
06/25/00 6.0 WE-B	25-Jun-00	**5.1**	27-Jun-00								
06/25/00 22 PPM	25-Jun-00	**26.7**	27-Jun-00								

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	06/20/00 - 06/26/00	ADDRESS:	Tetres
DATE SAMPLED:	06/20/00 - 06/26/00		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	river water	*Sampler/Submitter Remarks:*
LOCATION:		
PROJECT:	NH3 - Toxicity	

REQUESTED PARAMETER(S):

	check		check		check
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	*X*				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	**NH_3-N**	Analysis Date	**NO_3-N**	Analysis Date	**TKN**	Analysis Date	**P**	Analysis Date	**Ortho PO_4-P**	Analysis Date
06/26/00 CONT. WE-A	26-Jun-00	**0.4**	27-Jun-00								
06/26/00 0.5WE-B	26-Jun-00	**0.6**	27-Jun-00								
06/26/00 1.0 WE-A	26-Jun-00	**1.0**	27-Jun-00								
06/26/00 2.0 WE-B	26-Jun-00	**1.6**	27-Jun-00								
06/26/00 4.0 WE-A	26-Jun-00	**3.6**	27-Jun-00								
06/26/00 6.0 WE-C	26-Jun-00	**5.0**	27-Jun-00								
06/26/00 6.0 C-LT	26-Jun-00	**5.3**	27-Jun-00								
06/26/00 22 PPM	26-Jun-00	**26.0**	27-Jun-00								
QC data:			*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check: 0.0 mg/L NH3		0.03									
end of run std. check: 1.0 mg/L NH3		1.06	**106%**								
end of run std. check: 2.0 mg/L NH3		-	-								
end of run std. check: 4.0 mg/L NH3		4.02	100%								
end of run std. check: 8.0 mg/L NH3		8.18	102%								
Verification Std.(HACH): *5.0 PPM NH3*		4.97	99%								
Standard additions:					*% recovery*		*% recovery*		*% recovery*		*% recovery*
06/20/00 2.0 WE-B		1.6	101%								
06/20/00 2.0 WE-B+ 5.0 mg/L NH3			107%								
06/20/00 2.0-LT-B		1.7	102%								
06/20/00 2.0-LT-B+ 5.0 mg/L NH3			106%								

Analyst Remarks:

Date Reported: ______________________ **Verified by:** G. GAY

Analyst: T. Poniatowski, D. Deluca **Date:** ______________________

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	06/27/00 - 07/03/00	ADDRESS:	Tetres
DATE SAMPLED:	06/27/00 - 07/03/00		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	river water	*Sampler/Submitter Remarks:*	
LOCATION:			
PROJECT:	NH3 - Toxicity		

		check		check		check
REQUESTED PARAMETER(S):	Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
	Total Ammonia (NH_3-N):	*X*				
	Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	NH_3-N	Analysis Date	NO_3-N	Analysis Date	TKN	Analysis Date	P	Analysis Date	Ortho PO_4-P	Analysis Date
06/27/00-CONT.WE-A	27-Jun-00	**<0.3**	4-Jul-00								
06/27/00-0.5 WE-C	27-Jun-00	**0.5**	4-Jul-00								
06/27/00-1.0 WE-C	27-Jun-00	**0.7**	4-Jul-00								
06/27/00-2.0 WE-A	27-Jun-00	**1.5**	4-Jul-00								
06/27/00- 2.0 LT-A	27-Jun-00	**3.5**	4-Jul-00								
06/27/00-4 WE-A	27-Jun-00	**3.4**	4-Jul-00								
06/27/00-6.0 WE-A	27-Jun-00	**5.0**	4-Jul-00								
06/27/00-22 PPM	27-Jun-00	**35.7**	4-Jul-00								
06/28/00 CONT. WE-C	28-Jun-00	**<0.3**	4-Jul-00								
06/28/00 0.5 WE-B	28-Jun-00	**0.4**	4-Jul-00								
06/28/00 1.0 WE-A	28-Jun-00	**0.7**	4-Jul-00								
06/28/00 2.0 LT-C	28-Jun-00	**1.5**	4-Jul-00								
06/28/00 2.0 WE-B	28-Jun-00	**1.5**	4-Jul-00								
06/28/00 4.0WE-B	28-Jun-00	**3.5**	4-Jul-00								
06/28/00 6.0 WE-A	28-Jun-00	**4.6**	4-Jul-00								
06/28/00 22 PPM	28-Jun-00	**24.7**	4-Jul-00								
06/29/00 CONT-WE-A	29-Jun-00	**<0.3**	4-Jul-00								
06/29/00 0.5 WE-C	29-Jun-00	**0.4**	4-Jul-00								
06/29/00 1.0 WE-B	29-Jun-00	**0.8**	4-Jul-00								
06/29/00 2.0 WE-C	29-Jun-00	**1.1**	4-Jul-00								
06/29/00 4-WE-C	29-Jun-00	**3.3**	4-Jul-00								
06/29/00 6 LT-C	29-Jun-00	**4.7**	4-Jul-00								
06/29/00 6 WE-A	29-Jun-00	**4.3**	4-Jul-00								
06/29/00 22 PPM	29-Jun-00	**21.5**	4-Jul-00								
06/30/00 CONT.WE-C	30-Jun-00	**<0.3**	4-Jul-00								
06/30/00 0.5 WE-A	30-Jun-00	**0.4**	4-Jul-00								
06/30/00 1.0 WE-B	30-Jun-00	**0.9**	4-Jul-00								
06/30/00 2.0 WE-B	30-Jun-00	**1.6**	4-Jul-00								
06/30/00 4.0 WE-C	30-Jun-00	**3.5**	4-Jul-00								
06/30/004-LT-B	30-Jun-00	**3.6**	4-Jul-00								
06/30/00 6 WE-B	30-Jun-00	**5.1**	4-Jul-00								
06/30/00 22 PPM	30-Jun-00	**20.6**	4-Jul-00								
07/01/00 CONT.WE-A	01-Jul-00	**<0.3**	4-Jul-00								
07/01/00 0.5 WE-B	01-Jul-00	**0.4**	4-Jul-00								
07/01/00 1 WE-A	01-Jul-00	**0.9**	4-Jul-00								
07/01/00 1-LT-B	01-Jul-00	**0.9**	4-Jul-00								
07/01/00 2-WE-B	01-Jul-00	**1.5**	4-Jul-00								
07/01/00 4-WE-B	01-Jul-00	**3.3**	4-Jul-00								
07/01/00 6-WE-C	01-Jul-00	**4.6**	4-Jul-00								
07/01/00 22 PPM	01-Jul-00	**24.1**	4-Jul-00								
07/02/00 CONT.WE-A	02-Jul-00	**<0.3**	4-Jul-00								
07/02/00 0.5 WE-C	02-Jul-00	**0.8**	4-Jul-00								
07/02/00 1.0 WE-C	02-Jul-00	**1.1**	4-Jul-00								
07/02/00 2.0 WE-A	02-Jul-00	**1.8**	4-Jul-00								
07/02/00 4.0 -WE-C	02-Jul-00	**3.7**	4-Jul-00								
07/02/00 4.0 LT-B	02-Jul-00	**3.7**	4-Jul-00								
07/02/00 6.0 WE-B	02-Jul-00	**5.4**	4-Jul-00								
07/02/00 22 PPM	02-Jul-00	**21.0**	4-Jul-00								

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	06/27/00 - 07/03/00	ADDRESS:	Tetres
DATE SAMPLED:	06/27/00 - 07/03/00		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	river water	*Sampler/Submitter Remarks:*
LOCATION:		
PROJECT:	NH3 - Toxicity	

		check		check		check
REQUESTED PARAMETER(S):	Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
	Total Ammonia (NH_3-N):	***X***				
	Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample			Concentration (mg/L)									
Description / Identification		Date	**NH_3-N**	Analysis Date	**NO_3-N**	Analysis Date	**TKN**	Analysis Date	**P**	Analysis Date	**Ortho PO_4-P**	Analysis Date
07/03/00 CONT. WE-C		03-Jul-00	**0.4**	4-Jul-00								
07/03/00 0.5 WE-C		03-Jul-00	**0.6**	4-Jul-00								
07/03/00 1.0 WE-C		03-Jul-00	**1.0**	4-Jul-00								
07/03/00 2.0 WE-A		03-Jul-00	**1.9**	4-Jul-00								
07/03/00 2.0 LT-C		03-Jul-00	**2.1**	4-Jul-00								
07/03/00 4.0 WE-B		03-Jul-00	**3.9**	4-Jul-00								
07/03/00 6.0 WE-C		03-Jul-00	**5.2**	4-Jul-00								
07/03/00 22 PPM		03-Jul-00	**22.0**	4-Jul-00								
QC data:				*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check:	0.0 mg/L NH3		0.07	-								
end of run std. check:	1.0 mg/L NH3		0.89	89%								
end of run std. check:	2.0 mg/L NH3		1.98	99%								
end of run std. check:	4.0 mg/L NH3		4.08	102%								
end of run std. check:	8.0 mg/L NH3		7.91	99%								
Verification Std.(HACH):	*5.0 PPM NH3*		5.09	102%								
Standard additions:						*% recovery*		*% recovery*		*% recovery*		*% recovery*
06/27/00 2.0 WE-B			1.6	107%								
06/27/00 2.0 WE-B+ 5.0 mg/L NH3				109%								
06/20/00 2.0-LT-B			1.7	117%								
06/20/00 2.0-LT-B+ 5.0 mg/L NH3				105%								

Analyst Remarks:

Date Reported: 05-Jul-00 **Verified by:** G. GAY/ Gerry Levesque

Analyst: T. Poniatowski, D. Deluca **Date:**

City of Winnipeg
Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	07/04 - 07/07/00	ADDRESS:	Tetres
DATE SAMPLED:	07/04 - 07/07/00		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	river water	*Sampler/Submitter Remarks:*	
LOCATION:			
PROJECT:	NH3 - Toxicity		

REQUESTED PARAMETER(S):		*check*		*check*		*check*
	Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
	Total Ammonia (NH_3-N):	*X*				
	Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	**NH_3-N**	Analysis Date	**NO_3-N**	Analysis Date	**TKN**	Analysis Date	**P**	Analysis Date	**Ortho PO_4-P**	Analysis Date
0704/00-CONT.WE-C	04-Jul-00	**0.2**	7-Jul-00								
0704/00-0.5 WE-C	04-Jul-00	**0.5**	7-Jul-00								
0704/00-1.0 WE-A	04-Jul-00	**1.0**	7-Jul-00								
0704/00-2.0 WE-B	04-Jul-00	**1.8**	7-Jul-00								
0704/00-4 WE-A	04-Jul-00	**3.5**	7-Jul-00								
0704/00-6.0 WE-C	04-Jul-00	**5.0**	7-Jul-00								
0704/00-22 PPM	04-Jul-00	**24.5**	7-Jul-00								
0705/00 CONT. WE-B	05-Jul-00	**0.2**	7-Jul-00								
0705/00 0.5 WE-B	05-Jul-00	**0.5**	7-Jul-00								
0705/00 1.0 WE-A	05-Jul-00	**1.1**	7-Jul-00								
0705/00 2.0 WE-A	05-Jul-00	**1.9**	7-Jul-00								
0705/00 4.0 WE-B	05-Jul-00	**4.3**	7-Jul-00								
0705/00 6.0 WE-C	05-Jul-00	**5.4**	7-Jul-00								
0705/00 22 PPM	05-Jul-00	**22.4**	7-Jul-00								
0706/00 CONT-WE-A	06-Jul-00	**0.2**	7-Jul-00								
0706/00 0.5 WE-B	06-Jul-00	**0.5**	7-Jul-00								
0706/00 1.0 WE-B	06-Jul-00	**1.1**	7-Jul-00								
0706/00 2.0 WE-C	06-Jul-00	**2.2**	7-Jul-00								
0706/00 4-WE-C	06-Jul-00	**4.0**	7-Jul-00								
0706/00 6 WE-B	06-Jul-00	**5.3**	7-Jul-00								
0706/00 22 PPM	06-Jul-00	**22.5**	7-Jul-00								
0707/00 CONT.WE-B	07-Jul-00	**0.4**	7-Jul-00								
0707/00 0.5 WE-B	07-Jul-00	**0.6**	7-Jul-00								
0707/00 1.0 WE-B	07-Jul-00	**1.1**	7-Jul-00								
0707/00 2.0 WE-B	07-Jul-00	**2.1**	7-Jul-00								
0707/00 4.0 WE-B	07-Jul-00	**4.2**	7-Jul-00								
0707/00 6 WE-A	07-Jul-00	**5.2**	7-Jul-00								
0707/00 22 PPM	07-Jul-00	**20.2**	7-Jul-00								
QC data:			*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check: 0.0 mg/L NH3		0.01									
end of run std. check: 1.0 mg/L NH3		0.90	90%								
end of run std. check: 2.0 mg/L NH3		1.93	97%								
end of run std. check: 4.0 mg/L NH3		4.06	101%								
end of run std. check: 8.0 mg/L NH3		8.20	100%								
Verification Std.(HACH): *5.0 PPM NH3*		-									
Standard additions:					*% recovery*		*% recovery*		*% recovery*		*% recovery*
07/04/00 2.0 WE-B		1.7	103%								
07/04/00 2.0 WE-B+ 5.0 mg/L NH3			106%								
07/05/00 2.0 WE-A		1.9	100%								
07/05/00 2.0 WE-A+ 5.0 mg/L NH3			106%								

Analyst Remarks:

Date Reported: 07-Jul-00 **Verified by:** Gerry Levesque

Analyst: D. Deluca **Date:**

City of Winnipeg

Laboratory Services Division

Analytical Report

SAMPLES SUBMITTED BY:	Amy Partridge	REPORT TO:	Amy Partridge
DATE SUBMITTED:	01-Aug-00	ADDRESS:	
DATE SAMPLED:	JUNE/JULY, 2000		
SAMPLED BY:	Amy Partridge	POSTAL CODE:	PHONE:

SAMPLE TYPE:	RIVER SAMPLES	*Sampler/Submitter Remarks:*
LOCATION:		
PROJECT:		

REQUESTED PARAMETER(S):

Parameter	*check*	Parameter	*check*		*check*
Total Nitrate (NO_3/NO_2-N):		Ortho-phosphate (PO_4-P)			
Total Ammonia (NH_3-N):	*X*				
Total Kjeldahl Nitrogen (TKN):		Total Phophorus (P)			

RESULTS

Sample		Concentration (mg/L)									
Description / Identification	Date	**NH_3-N**	Analysis Date	**NO_3-N**	Analysis Date	**TKN**	Analysis Date	**Total P**	Analysis Date	**Ortho PO_4-P**	Analysis Date
JN16-8		**8.0**	1-Aug-00								
JN19-8	19-Jun-00	**7.8**	1-Aug-00								
JN23-8	23-Jun-00	**8.0**	1-Aug-00								
JN26-8	26-Jun-00	**7.9**	1-Aug-00								
JN30-8	30-Jun-00	**8.0**	1-Aug-00								
JL04-8	04-Jul-00	**7.8**	1-Aug-00								
JL07-8	07-Jul-00	**7.8**	1-Aug-00								
JL10-8	10-Jul-00	**8.0**	1-Aug-00								
JL14-8	14-Jul-00	**7.9**	1-Aug-00								
JL24-8		**6.0**	1-Aug-00								
JL24-15	24-Jul-00	**11.8**	1-Aug-00								
JL24-30	24-Jul-00	**24.0**	1-Aug-00								
QC data:			*% recovery*		*% recovery*				*% recovery*		*% recovery*
end of run std. check: *0.0MG/L NH3*		0.01	-								
end of run std. check: *1.0MG/L NH3*		0.97	*97%*								
end of run std. check: *2.0MG/L NH3*		1.98	*99%*								
end of run std. check: *4.0MG/L NH3*		3.94	*99%*								
end of run std. check: *8.0MG/L NH3*		7.96	*100%*								
Digested Blank											
Digested std.											
Verification Std.(HACH):		4.5	*89%*								
Standard additions:			*% recovery*		*% recovery*		*% recovery*		*% recovery*		*% recovery*
		7.9	*99%*								
JN19											
JN19+3.0 mg/L NH3			*102%*								

Analyst Remarks:

Date Reported: 01-Aug-00 **Verified by:** G.GAY

Analyst: T. Poniatowski D. De Luca **Date:**

APPENDIX E

AVERAGE NH_3 CONCENTRATIONS: CALCULATIONS AND RESULTS

NH_3 concentrations were derived using *daily* temperature, pH and NH_3-N concentration measurements to account for potential variation in test-conditions from the beginning to the end of each test. Average NH_3 concentrations were used to generate all $LC_{50/20}$ and $EC_{50/20}$ values using the linear interpolation method and the ICPIN program. Data used to derive average NH_3 concentrations are reported as follows:

Appendix No.	Table No.	Test Duration	Test Organism Type
E-1	E-1 - E-10	acute	fish
E-2	E-11 – E-21	chronic	fish
E-3	E-22 – E-25	acute or chronic	invertebrate

For presentational purposes, only average test-temperature, test-pH and test-NH_3-N-concentration measurements for these tests are reported. The following is a sample calculation of NH_3 derivation for T1A – control-group.

1. Determine pK for Day 1 of the test according to the equation:

$$pK = 0.09018 + \frac{2729.92}{273.2 + t}$$

where $pK = -\log_{10}K$
(K is the equilibrium constant of ionized or unionized ammonia in aqueous solutions)
t = temperature in °C

Note: When more than one temperature was measured daily, the average daily-temperature was used. In this example, three measurements were collected (one for each replicate). Therefore, t=(15.5°C + 15.0°C + 15.0°C)/3 = 15.17°C

(e.g., $pK = 0.09018 + \frac{2729.92}{273.2 + 15.17} = 9.557$)

2. Determine the fraction of unionized ammonia in total ammonia according to the equation:

$$f_{NH3} = \frac{1}{1 + 10^{pK - pH}}$$

where f_{NH3} = the fraction of unionized ammonia
$pK = -\log_{10}K$
$pH = -\log_{10}[H^+]$

Note: When more than one pH measurement was obtained on a given day, the average pH value was used. In this example, three pHs were measured on Day 1, (one for each replicate). Therefore, pH = (8.3 + 8.4 + 8.4)/3 = 8.367

(e.g., $f_{NH3} = \frac{1}{1 + 10^{9.557 - 8.367}} = 0.0606$)

3. Determine the actual concentration of NH_3 by multiplying the fraction obtained in 2 by the average total-ammonia for Day 1.

   (e.g., 0.0606 x 0.61 mg/L = 0.037 mg/L)

4. Repeat steps 1, 2, and 3 using measurements collected for each day of the test.

5. Sum the NH_3 concentrations determined in steps 1-4 and divide by *n*, the number of days in the test. For T1A and T1B, total ammonia concentrations were only measured on the first and last days of the test, therefore, two NH_3 concentrations were calculated and averaged.

   (e.g., $\frac{0.037 + 0.082}{2}$ = 0.059 mg/L) (c.f. Appendix E-1, Table E-1)

This five-step process was repeated for all exposure-concentrations of each test, except for T5A/T5B. For these tests, the toxicant of interest was treated effluent and nominal concentrations of 100%, 25%, 12.5%, 6.25%, 3.125% and 1.56% were used during derivation of $LC_{50/20}$ and $EC_{50/20}$ values.

APPENDIX E-1

DATA USED TO CALCULATE NH_3 CONCENTRATIONS FOR ACUTE-EXPOSURE TESTS CONDUCTED ON FISH

TABLE E-1: Data Used to Calculate Unionized Ammonia Concentrations for T1A

Test-Description: 96 hr acute-exposure test; static
Test-Treatment: River water spiked with ammonia
Test-Species: walleye fry

	Avg. Temp.(^oC)			Avg. pH			Avg. total-ammonia	Avg. NH_3
	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	(mg/L)	(mg/L)
control	16.1	15.4	16.0	8.3	8.3	8.3	1.09	0.059
conc.1	16.0	15.2	16.0	8.4	8.4	8.3	3.40	0.169
conc.2	16.0	15.4	16.0	8.3	8.3	8.3	5.84	0.278
conc.3	16.0	15.4	16.0	8.3	8.3	8.4	8.15	0.396
conc.4	16.0	15.1	16.0	8.4	8.4	8.4	12.65	0.580
conc.5	16.0	15.1	16.0	8.4	8.4	8.4	17.51	0.720
conc.6	15.2	15.0	15.0	8.5	8.3	8.4	31.61	1.284
conc.7	15.0	15.2	15.2	8.5	8.3	8.4	40.37	1.345
conc.8	15.0	15.3	15.0	8.3	8.3	8.2	74.29	2.327

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurem
were used to calculate the reported average NH_3 concentrations.

TABLE E-2: Data Used to Calculate Unionized Ammonia Concentrations for T1B

Test-Description: 96 hr acute-exposure test; static
Test-Treatment: River water spiked with ammonia
Test-Species: white sucker fry

	Avg. Temp.(^oC)			Avg. pH			Avg. total-ammonia	Avg. NH_3
	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	(mg/L)	(mg/L)
control	16.1	15.5	15.4	8.4	8.3	8.3	0.97	0.055
conc.1	15.9	15.4	15.4	8.4	8.4	8.4	3.53	0.190
conc.2	16.0	15.4	15.4	8.4	8.4	8.4	6.32	0.324
conc.3	16.0	15.4	15.4	8.4	8.4	8.3	9.00	0.431
conc.4	16.0	15.4	15.4	8.3	8.3	8.3	11.67	0.502
conc.5	16.0	15.2	15.4	8.3	8.4	8.3	20.18	0.793
conc.6	15.0	15.0	15.0	8.3	8.5	8.4	28.70	1.109
conc.7	15.0	15.0	15.0	8.4	8.4	8.3	35.38	1.179
conc.8	15.0	15.0	15.0	8.3	8.3	8.3	76.84	2.048

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurem
were used to calculate the reported average NH_3 concentrations.

TABLE E-3: Data Used to Calculate Unionized Ammonia Concentrations for T2A

Test-Description: 96 hr acute-exposure test; semi-static
Test-Treatment: River water spiked with ammonia
Test-Species: white sucker fry

	Avg. Temp.(^oC)			Avg. pH			Avg. total-ammonia (mg/L)			Avg. NH_3
	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	(mg/L)
control	15.5	15.4	15.4	8.1	8.2	8.2	0.61	0.61	0.61	0.024
conc.1	15.5	15.4	15.4	8.2	8.2	8.2	1.22	1.22	0.85	0.047
conc.2	15.5	15.4	15.4	8.2	8.2	8.2	1.82	1.82	1.34	0.074
conc.3	15.5	15.4	15.4	8.2	8.2	8.2	2.80	2.80	2.43	0.108
conc.4	15.5	15.4	15.4	8.2	8.2	8.2	4.26	4.38	4.50	0.178
conc.5	15.5	15.4	15.4	8.2	8.2	8.2	7.17	7.17	7.30	0.273
conc.6	17.0	15.3	16.5	8.1	8.2	8.1	15.56	12.40		0.521
conc.7	17.0	16.5	16.5	8.0	8.0	8.0	21.89	23.95		0.690

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-4: Data Used to Calculate Unionized Ammonia Concentrations for T2B

Test-Description: 96 hr acute-exposure test; semi-static
Test-Treatment: Treated effluent spiked with ammonia
Test Species: white sucker fry

	Avg. Temp.(^oC)			Avg. pH			Avg. total-ammonia (mg/L)			Avg. NH_3
	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	(mg/L)
control	15.5	15.4	15.4	8.1	8.2	8.2	0.61	0.61	0.61	0.024
conc.1	15.5	15.4	15.5	8.1	8.1	8.1	1.46	1.46	1.09	0.045
conc.2	15.5	15.4	15.5	8.1	8.1	8.1	2.07	1.95	1.95	0.068
conc.3	15.5	15.4	15.5	8.1	8.1	8.1	3.28	2.92	2.92	0.091
conc.4	15.5	15.4	15.5	8.0	8.0	8.0	5.35	4.86	5.23	0.124
conc.5	15.5	15.4	15.5	7.9	7.9	7.9	8.15	8.75	8.88	0.159
conc.6	15.5	15.4	15.5	7.7	7.7	7.8	14.96	15.08	12.89	0.186
conc.7	15.5	16.5	15.5	7.3	7.3	7.4	39.52	32.95	38.67	0.233

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-5: Data Used to Calculate Unionized Ammonia Concentrations for T3A-96 hr
Test-Description: 96 hr acute-exposure test; semi-static
Test-Treatment: River water spiked with ammonia
Test Species: white sucker fry

	Avg. Temp.(^oC)			Avg. pH			Avg. total-ammonia (mg/L)			Avg. NH_3
	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	(mg/L)
control	17.5	17.5	17.5	8.2	8.2	8.2	0.36	0.36	0.36	0.016
conc.1	17.5	17.5	17.5	8.2	8.2	8.2	1.70	1.82	1.70	0.093
conc.2	17.5	17.5	17.5	8.2	8.3	8.2	2.19	4.26	3.16	0.178
conc.3	17.5	17.5	17.5	8.2	8.2	8.2	3.28	4.99	4.99	0.233
conc.4	17.5	17.5	17.5	8.2	8.2	8.2	4.86	7.05	7.17	0.318
conc.5	17.5	17.5	17.5	8.2	8.2	8.2	6.69	9.12	9.36	0.413
conc.6	17.5	17.5	17.5	8.2	8.2	8.1	9.12	10.94	15.44	0.532
conc.7	16.3	17.5	17.6	8.2	8.1	8.1	22.49	21.16	21.89	0.868

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-6: Data Used to Calculate Unionized Ammonia Concentrations for T3B-96 hr
Test-Description: 96 hr acute-exposure test; semi-static
Test-Treatment: Treated effluent spiked with ammonia
Test-Species: white sucker fry

	Avg. Temp.(^oC)			Avg. pH			Avg. total-ammonia (mg/L)			Avg. NH_3
	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	(mg/L)
control	17.5	17.5	17.5	8.2	8.2	8.2	0.36	0.36	0.36	0.016
conc.1	16.7	16.7	16.7	8.0	8.1	8.1	1.34	1.70	1.58	0.055
conc.2	16.7	16.7	16.7	8.2	8.1	8.2	1.82	2.31	2.92	0.100
conc.3	16.7	16.7	16.7	8.1	8.1	8.1	3.28	3.89	3.40	0.135
conc.4	16.7	16.7	16.7	8.1	8.0	8.0	4.99	6.08	5.71	0.180
conc.5	16.7	16.7	16.7	8.0	7.9	7.9	7.78	9.24	9.12	0.233
conc.6	16.7	16.7	16.7	7.9	7.7	7.7	14.10	16.17	14.96	0.282
conc.7	16.7	16.7	16.7	7.4	7.4	7.4	37.94	38.06	37.08	0.331

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-7: Data Used to Calculate Unionized Ammonia Concentrations for T4A
Test-Description: 96 hr acute-exposure test; semi-static
Test-Treatment: Treated effluent spiked with ammonia
Test-Species: white sucker fry

	Avg. Temp.(^oC)			Avg. pH			Avg. total-ammonia (mg/L)			Avg. NH_3
	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	(mg/L)
control	18.2	18.2	18.2	8.2	8.2	8.3	1.34	1.46	1.34	0.078
conc.1	18.2	18.2	18.2	8.2	8.2	8.2	1.95	2.43	2.55	0.126
conc.2	18.2	18.2	18.2	8.2	8.2	8.1	3.89	4.38	5.35	0.222
conc.3	18.2	18.2	18.2	8.1	8.0	8.0	8.63	9.00	8.75	0.322
conc.4	18.2	18.2	18.2	8.0	7.9	7.9	13.37	15.44	14.71	0.415
conc.5	18.2	18.2	18.2	7.7	7.8	7.7	25.78	26.63	25.66	0.479
conc.6	18.2	18.2	18.2	7.3	7.3	7.2	70.52	69.67	67.24	0.423

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-8: Data Used to Calculate Unionized Ammonia Concentrations for T4B
Test-Description: 96 hr acute-exposure test; semi-static
Test-Treatment: Treated effluent spiked with ammonia
Test Species: fathead minnow fry

	Avg. Temp.(^oC)			Avg. pH			Avg. total-ammonia (mg/L)			Avg. NH_3
	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	(mg/L)
control	18.3	18.3	18.3	8.2	8.2	8.2	1.34	1.46	1.34	0.075
conc.1	18.3	18.3	18.3	8.1	8.2	8.1	2.31	2.43	2.31	0.116
conc.2	18.3	18.3	18.3	8.1	8.1	8.1	4.62	4.86	4.01	0.204
conc.3	18.3	18.3	18.3	8.0	8.0	8.0	9.24	9.00	9.48	0.338
conc.4	18.3	18.3	18.3	7.9	7.9	7.9	16.41	18.60	14.96	0.443
conc.5	18.3	18.3	18.3	7.6	7.7	7.7	30.88	31.86	28.57	0.524
conc.6	18.2	18.2	18.0	7.3	7.2	7.3	67.24	67.97	71.01	0.440

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-9: Data Used to Calculate Unionized Ammonia Concentrations for T6A
Test-Description: 72 hr acute-exposure test; semi-static
Test-Treatment: River water spiked with ammonia
Test-Species: fathead minnow fry

	Avg. Temp.(^{o}C)				Avg. pH				Avg. total-ammonia	Avg. NH_3
	Rep.A	Rep.B	Rep.C	Rep.D	Rep.A	Rep.B	Rep.C	Rep.D	(mg/L)	(mg/L)
control	20.9	20.9	20.9	20.9	8.6	8.7	8.6	8.6	0.12	0.010
conc.1	20.9	20.9	20.9	20.9	8.7	8.6	8.7	8.7	0.49	0.077
conc.2	20.9	20.9	20.9	20.9	8.7	8.6	8.7	8.7	0.85	0.139
conc.3	20.9	20.9	20.9	20.9	8.6	8.6	8.6	8.6	2.80	0.426
conc.4	20.9	20.8	20.9	20.9	8.6	8.6	8.6	8.5	7.30	1.000
conc.5	20.8	20.8	20.8	20.8	8.5	8.5	8.5	8.5	18.36	2.150
conc.6	20.8	20.8	20.8	20.8	8.4	8.4	8.4	8.4	35.14	3.361

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-10: Data Used to Calculate Unionized Ammonia Concentrations for T6B
Test-Description: 72 hr acute-exposure test; semi-static
Test-Treatment: Treated effluent spiked with ammonia
Test-Species: fathead minnow fry

	Avg. Temp.(^{o}C)				Avg. pH				Avg. total-ammonia	Avg. NH_3
	Rep.A	Rep.B	Rep.C	Rep.D	Rep.A	Rep.B	Rep.C	Rep.D	(mg/L)	(mg/L)
control	20.9	20.9	20.9	20.9	8.6	8.7	8.6	8.6	0.12	0.010
conc.1	20.9	20.9	20.9	20.9	8.5	8.5	8.5	8.6	0.73	0.085
conc.2	20.9	20.9	20.9	20.9	8.4	8.4	8.4	8.5	1.34	0.128
conc.3	20.9	20.9	20.9	20.9	8.2	8.2	8.2	8.2	3.40	0.211
conc.4	20.8	20.9	20.8	20.9	8.0	8.0	8.0	8.0	8.39	0.363
conc.5	20.8	20.8	20.8	20.8	7.3	7.5	7.5	7.3	21.28	0.219
conc.6	20.8	20.8	20.8	20.8	7.2	7.2	7.2	7.2	39.27	0.260

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

APPENDIX E-2

DATA USED TO CALCULATE NH_3 CONCENTRATIONS FOR CHRONIC-EXPOSURE TESTS CONDUCTED ON FISH

TABLE E-11: Data Used to Calculate Unionized Ammonia Concentrations for T3A-10 day
Test-Description: 10 day chronic-exposure test; semi-static
Test-Treatment: River water spiked with ammonia
Test-Species: white sucker fry

	Avg. Temp.(^oC)			Avg. pH			Avg. total-ammonia (mg/L)			Avg. NH_3
	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	(mg/L)
control	17.5	17.5	17.5	8.2	8.2	8.2	0.24	0.24	0.36	0.015
conc.1	17.5	17.5	17.5	8.2	8.2	8.2	1.09	1.34	1.09	0.060
conc.2	17.5	17.5	17.5	8.2	8.2	8.2	1.70	2.92	2.43	0.129
conc.3	17.5	17.5	17.5	8.2	8.2	8.2	2.67	3.89	4.01	0.183
conc.4	17.5	17.5	17.5	8.2	8.1	8.2	4.38	5.71	6.08	0.267
conc.5	17.5	17.5	17.5	8.2	8.1	8.2	5.96	8.15	7.90	0.351
conc.6	17.5	17.5	17.5	8.2	8.1	8.1	9.24	12.16	11.79	0.505
conc.7	16.3	17.4	17.6	8.2	8.1	8.1	22.49	21.16	21.89	0.868

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-12: Data Used to Calculate Unionized Ammonia Concentrations for T3B-10 day
Test-Description: 10 day chronic-exposure test; semi-static
Test-Treatment: Treated effluent spiked with ammonia
Test-Species: white sucker fry

	Avg. Temp.(^oC)			Avg. pH			Avg. total-ammonia (mg/L)			Avg. NH_3
	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	Rep.A	Rep.B	Rep.C	(mg/L)
control	17.5	17.5	17.5	8.2	8.2	8.2	0.24	0.24	0.36	0.015
conc.1	16.9	16.9	16.9	8.1	8.1	8.1	0.97	1.34	1.34	0.049
conc.2	16.9	16.9	16.9	8.2	8.1	8.1	1.46	2.07	2.43	0.084
conc.3	16.9	16.9	16.9	8.1	8.1	8.1	2.92	3.53	3.16	0.124
conc.4	16.9	16.9	16.9	8.1	8.0	8.0	4.38	5.71	4.74	0.167
conc.5	16.9	16.9	16.9	8.0	7.9	7.9	7.66	9.36	8.15	0.222
conc.6	16.9	16.9	16.9	7.8	7.7	7.7	13.01	16.29	13.98	0.263
conc.7	16.9	16.9	16.9	7.4	7.4	7.4	38.30	38.06	37.57	0.293

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-13: Data Used to Calculate Unionized Ammonia Concentrations for T8

Test-Description: 30 day chronic-exposure test; flow-through
Test-Treatment: River water spiked with ammonia
Test-Species: juvenile channel catfish

	Avg. Temp. (^oC)	Avg. pH	Avg. total-ammonia (mg/L)	Avg. NH_3 (mg/L)
control	8.8	8.4	0.14	0.007
conc.1		8.4	0.39	0.021
conc.2		8.4	0.71	0.039
conc.3	8.5	8.4	1.11	0.059
conc.4		8.4	4.15	0.205
conc.5		8.4	7.05	0.326
conc.6	8.7	8.4	13.91	0.616

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-14: Data Used to Calculate Unionized Ammonia Concentrations for T9

Test-Description: 30 day chronic-exposure test; flow-through
Test-Treatment: River water spiked with ammonia
Test-Species: juvenile (3-month-old) fathead minnow

	Avg. Temp. (^oC)	Avg. pH	Avg. total-ammonia (mg/L)	Avg. NH_3 (mg/L)
control	8.4	8.4	0.14	0.007
conc.1		8.4	0.39	0.022
conc.2		8.5	0.71	0.039
conc.3	7.9	8.4	1.11	0.061
conc.4		8.4	4.15	0.198
conc.5		8.4	7.04	0.310
conc.6	8.5	8.3	13.91	0.575

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-15: Data Used to Calculate Unionized Ammonia Concentrations for T11

Test-Description: 30 day chronic-exposure test; flow-through
Test-Treatment: River water spiked with ammonia
Test-Species: juvenile (1-month-old) fathead minnow

	Avg. Temp. (^oC)	Avg. pH	Avg. total-ammonia (mg/L)	Avg. NH_3 (mg/L)
control	7.6	8.4	0.16	0.006
conc.1		8.5	0.44	0.019
conc.2	7.0	8.5	0.84	0.036
conc.3		8.5	1.31	0.057
conc.4		8.4	4.94	0.193
conc.5	6.8	8.4	8.04	0.303

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-16: Data Used to Calculate Unionized Ammonia Concentrations for T14

Test-Description: 5 day chronic-exposure test; flow-through
Test-Treatment: River water spiked with ammonia
Test-Species: lake whitefish fry - disease-free

	Avg. Temp. (^oC)	Avg. pH	Avg. total-ammonia (mg/L)	Avg. NH_3 (mg/L)
control	14.4	8.5	0.31	0.026
conc.1	14.6	8.4	0.81	0.052
conc.2	14.2	8.5	1.40	0.101
conc.3	14.6	8.4	2.98	0.186
conc.4	14.1	8.4	4.84	0.316
conc.5	14.1	8.4	7.82	0.495
conc.6	14.1	8.4	10.18	0.581

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-17: Data Used to Calculate Unionized Ammonia Concentrations for T15 (5-day analysis)

Test-Description: 5 day chronic-exposure test; flow-through
Test-Treatment: River water spiked with ammonia
Test-Species: lake whitefish fry - treated for a fungal infection prior to test-start

	Avg. Temp. (^oC)	Avg. pH	Avg. total-ammonia (mg/L)	Avg. NH_3 (mg/L)
control	15.7	8.5	0.22	0.018
conc.1	15.6	8.5	0.71	0.060
conc.2	15.7	8.5	1.39	0.114
conc.3				
conc.4	15.7	8.4	4.67	0.345
conc.5	16.2	8.4	7.59	0.496
conc.6	15.9	8.4	9.99	0.720

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-18: Data Used to Calculate Unionized Ammonia Concentrations for T15 (13-day analysis)

Test-Description: 5 day chronic-exposure test; flow-through
Test-Treatment: River water spiked with ammonia
Test-Species: lake whitefish fry - treated for a fungal infection prior to test-start

	Avg. Temp. (^oC)	Avg. pH	Avg. total-ammonia (mg/L)	Avg. NH_3 (mg/L)
control	16.1	8.5	0.20	0.018
conc.1	16.1	8.5	0.63	0.055
conc.2	16.1	8.5	1.20	0.102
conc.3				
conc.4	16.2	8.4	4.28	0.316
conc.5	16.3	8.4	7.19	0.524
conc.6	15.9	8.4	9.99	0.720

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-19: Data Used to Calculate Unionized Ammonia Concentrations for T18

Test-Description: 12 day chronic-exposure test; flow-through
Test-Treatment: River water spiked with ammonia
Test-Species: northern pike fry

	Avg. Temp. (^{o}C)	Avg. pH	Avg. total-ammonia (mg/L)	Avg. NH_3 (mg/L)
control	16.8	8.6	0.30	0.030
conc.1	16.7	8.5	0.73	0.072
conc.2	16.7	8.5	1.33	0.127
conc.3	16.7	8.5	2.36	0.210
conc.4	16.7	8.5	4.80	0.410
conc.5	16.8	8.5	7.10	0.588
conc.6	16.9	8.4	9.37	0.661

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-20: Data Used to Calculate Unionized Ammonia Concentrations for T20

Test-Description: 30 day chronic-exposure test; flow-through
Test-Treatment: River water spiked with ammonia
Test-Species: juvenile lake trout

	Avg. Temp. (^{o}C)	Avg. pH	Avg. total-ammonia (mg/L)	Avg. NH_3 (mg/L)
control	17.7	8.2	0.24	0.014
conc.1	17.6	8.2	0.56	0.028
conc.2	17.6	8.2	1.11	0.056
conc.3	17.6	8.1	2.09	0.106
conc.4	17.7	8.1	4.36	0.212
conc.5	17.8	8.1	6.41	0.298

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-21: Data Used to Calculate Unionized Ammonia Concentrations for T21

Test-Description: 30 day chronic-exposure test; flow-through
Test-Treatment: River water spiked with ammonia
Test-Species: juvenile walleye

	Avg. Temp. (^oC)	Avg. pH	Avg. total-ammonia (mg/L)	Avg. NH_3 (mg/L)
control	17.8	8.1	0.25	0.012
conc.1	17.8	8.1	0.59	0.025
conc.2	17.9	8.1	1.14	0.048
conc.3	17.8	8.1	2.11	0.089
conc.4	17.8	8.1	4.40	0.177
conc.5	17.9	8.0	6.27	0.243

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

APPENDIX E-3

DATA USED TO CALCULATE NH_3 CONCENTRATIONS FOR TESTS CONDUCTED ON *Ceriodaphnia dubia* AND *Hyalella azteca*

TABLE E-22: Data Used to Calculate Unionized Ammonia Concentrations for T12A

Test-Description: 7 day chronic-exposure test; semi-static
Test-Treatment: River water spiked with ammonia
Test-Species: *Ceriodaphnia dubia* neonates

	Avg. Temp. (^oC)	Avg. pH	Avg. total-ammonia (mg/L)	Avg. NH_3 (mg/L)
control	24.0	8.4	0.02	0.003
conc.1	24.0	8.4	2.31	0.274
conc.2	24.0	8.4	4.86	0.558
conc.3	24.0	8.4	9.24	1.046
conc.4	24.0	8.4	16.29	1.684
conc.5	24.0	8.3	32.95	2.951
conc.6	24.0	8.1	69.43	5.443

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-23: Data Used to Calculate Unionized-Ammonia Concentrations for T12B

Test-Description: 7 day chronic-exposure test; semi-static
Test-Treatment: Effluent spiked with ammonia
Test-Species: *Ceriodaphnia dubia* neonates

	Avg. Temp. (^oC)	Avg. pH	Avg. total-ammonia (mg/L)	Avg. NH_3 (mg/L)
control	24.0	8.4	0.02	0.003
conc.1	24.0	8.4	2.80	0.326
conc.2	24.0	8.4	5.23	0.567
conc.3	24.0	8.3	9.95	0.975
conc.4	24.0	8.3	19.09	1.292
conc.5	24.0	8.0	37.57	2.317
conc.6	24.0	7.6	74.41	2.594

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-24: Data Used to Calculate Unionized Ammonia Concentrations for T22

Test-Description: 28 day chronic-exposure test; semi-static
Test-Treatment: River water spiked with ammonia
Test-Species: *Hyalella azteca* adults

	Avg. Temp. (^oC)	Avg. pH	Avg. total-ammonia (mg/L)	Avg. NH_3 (mg/L)
control	23.9	8.3	0.25	0.023
conc.1	23.9	8.3	0.61	0.058
conc.2	23.9	8.3	1.22	0.111
conc.3	23.9	8.3	2.43	0.243
conc.4	23.9	8.3	4.86	0.463
conc.5	23.9	8.2	9.73	0.783

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

TABLE E-25: Data Used to Calculate Unionized Ammonia Concentrations for T23

Test-Description: 96 hour acute-exposure test; semi-static
Test-Treatment: River water spiked with ammonia
Test-Species: *Hyalella azteca* adults

	Avg. Temp. (^oC)	Avg. pH	Avg. total-ammonia (mg/L)	Avg. NH_3 (mg/L)
control	24.2	8.1	0.24	0.015
conc.1	24.3	8.2	2.28	0.171
conc.2	24.4	8.2	4.56	0.325
conc.3	24.4	8.2	9.12	0.686
conc.4	24.3	8.2	18.24	1.368
conc.5	24.2	8.1	36.48	2.446
conc.6	24.3	8.0	72.95	3.742

Note: Average test temperaures, pHs, and total ammonia concentrations are reported here but *daily* measurements were used to calculate the reported average NH_3 concentrations.

APPENDIX F

STATISTICAL ANALYSES OF ALL TOXICITY-TESTS: EXPLANATION AND CALCULATIONS

Derivation of $LC_{50/20}$ and $EC_{50/20}$ values:

Average stressor-concentrations (i.e., NH_3 or treated effluent), average test-organism responses expressed quantitatively (i.e., percent-mortality, percent-growth inhibition or percent-reproduction inhibition) and corresponding lethal and/or effective stressor-concentrations affecting 20% and 50% of the test-populations are reported here and organized as follows:

Appendix No.	Table No.	Graph No.	Test-Exposure	Test Organism Type
F-1	F-1 – F-10	F-1 – F-10	Acute	fish
F-2	F-11 – F-29	F-11 – F-29	Chronic	fish
F-3	F-30 – F-37	F-30 - F-37	Acute or Chronic	invertebrate

Data were analysed via linear interpolation using a computer-based statistical program called ICPIN (version 2.0). This program calculates lethal or inhibitory-concentrations (i.e., LC or EC) of a stressor affecting x% of the test-population by comparing pairs of adjacent toxicant concentrations with their corresponding response-means as described in USEPA (1994). In brief, the pairs of exposure-concentrations and response-means that bracket the expected response (i.e., 20% or 50% of the test-populations) are used to estimate the lethal or inhibitory toxicant concentration according to the following equation:

$$ICP = C_J + [M_1(1-p/100)-M_J]\,\frac{(C_{J+1} - C_J)}{(M_{J+1} - M_J)}$$

Where: ICP = inhibitory (or lethal) estimated concentration of a toxicant that produces a percent-reduction in growth, reproduction or survival that is quantitatively different from the control-group

C_J = exposure-concentration whose observed mean-response is > $M_1(1-p/100)$

C_{J+1} = exposure-concentration whose observed response mean is < $M_1(1-p/100)$

M_1 = smoothed response mean for the control

M_J = smoothed response mean for concentration J

M_{J+1} = smoothed mean response for concentration J+1

p = percent reduction in growth, reproduction or survival response of exposed organisms relative to the response of control organisms

The ICPIN program assumes that the response means of all replicate-exposure data are monotonically non-increasing, where the mean response for each higher concentration is less than or equal to the mean response for the previous concentration. If the data are not monotonically non-increasing, they are ‘smoothed’ by replacing adjacent response means with their average (described in USEPA 1994).

For presentational purposes, smoothed data have been adjusted for control mortality using Abbott’s formula and plotted on the appropriate graphs in Appendices F-1, F-2, and F-3. The adjustment simulates the portion of the ICPIN equation $M_1(1\text{-}p/100)$, and takes the form:

$$p_i^a = (p_i^s - p_o^s)/(1 - p_o^s)$$

where: p_i^a = adjusted percent-mortality at concentration i
i = stressor concentration
p_i^s = the smoothed percent-mortality at concentration i
p_o^s = the smoothed percent-mortality for the control

sample calculation for T1A (Appendix F-1, Table F-1)

p_i^s = .400
p_o^s = .233

p_i^a = (0.400-0.233)/(1-.233)
= .217 or 21.7%

Input data used during ICPIN analysis for all toxicity tests varied as a function of stressor type and endpoint of interest as tabulated below:

Tests	**Toxicant**	**Input data: Toxicant**	**Endpoint**	**Input data: Endpoint**
All tests with fish (acute and chronic-exposure)	NH_3 with or without treated effluent	[NH_3] in mg/L	Survival	Average % of survivors in each exposure-concentration at EOT[a]
All chronic-exposure tests with fish	NH_3 with or without treated effluent	[NH_3] in mg/L	Growth	Dry-weight per organism in each exposure concentration
All bivalve tests (i.e., floater mussels and fingernail clams)	Treated effluent	% effluent	Survival	Average % of survivors in each exposure-concentration at EOT[a]
66-day, floater mussel test	Treated effluent	% effluent	Growth	Net change in WAWW[b] from BOT[c] to EOT[a]
Ceriodaphnia dubia and *Hyalella azteca* tests	NH_3 with or without treated effluent	[NH_3] in mg/L	Reproduction and/or Survival	Number of neonates produced at EOT[a] Average % of survivors in each exposure concentration at EOT[a]

Notes:

1) [a]EOT = end of test
2) [b]WAWW = whole-animal wet-weight
3) [c]BOT = beginning of test

Printouts of the results are included in this appendix following the table or graph of each corresponding test. All inhibitory-concentration-percent-estimates (ICP) produced by the ICPIN are plotted on the appropriate graphs.

APPENDIX F-1

ACUTE-EXPOSURE TESTS CONDUCTED ON FISH: RAW DATA AND RESULTS

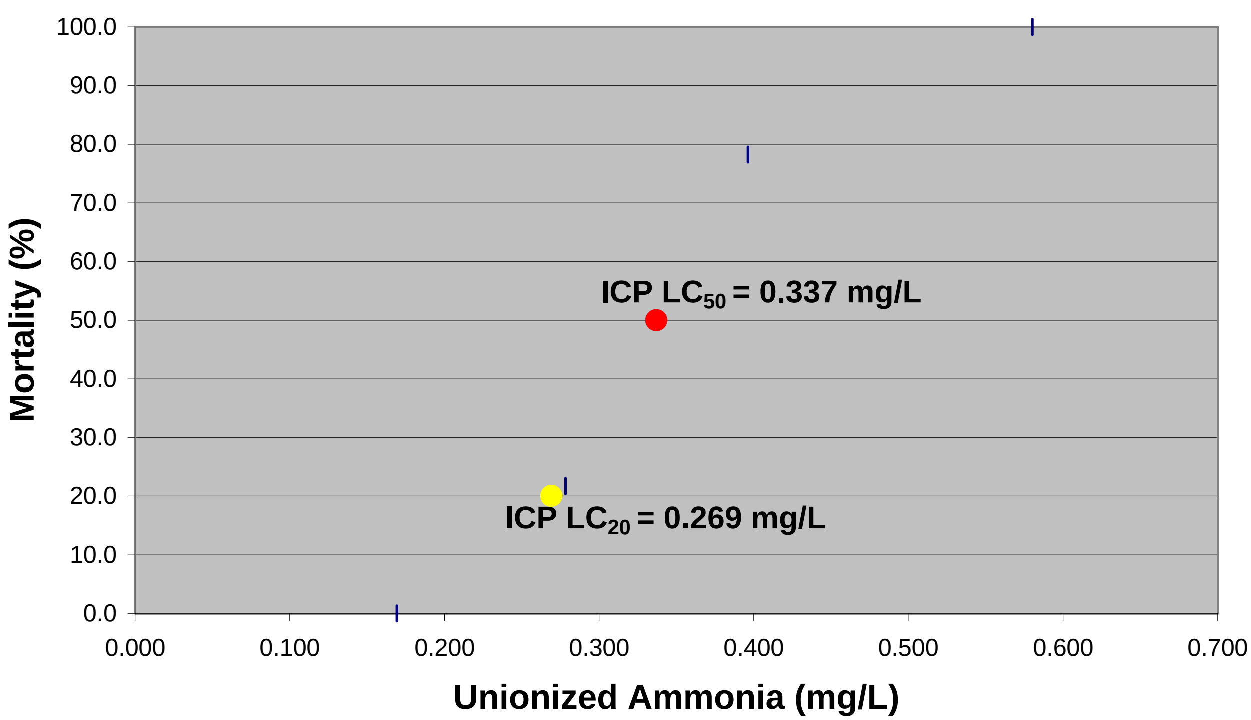
TABLE F-1: MORTALITY OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T1A)

Test-Description: 96 hr acute-exposure test; static
Test-Species: walleye fry

	Avg. NH_3	Mortality (%)			Avg. Mortality	SD of %	Smoothed	Adjusted
	(mg/L)	Rep.A	Rep.B	Rep.C	(%)	Mortality	% Mortality	% Mortality
control	0.059	30.0	30.0	30.0	30.0	0.0	23.3	0.0
conc.1	**0.169**	10.0	0.0	40.0	16.7	20.8	23.3	**0.0**
conc.2	**0.278**	40.0	40.0	40.0	40.0	0.0	40.0	**21.7**
conc.3	**0.396**	80.0	100.0	70.0	83.3	15.3	83.3	**78.2**
conc.4	**0.580**	100.0	100.0	100.0	100.0	0.0	100.0	**100.0**
conc.5	0.720	100.0	100.0	100.0	100.0	0.0	100.0	100.0
conc.6	1.284	100.0	100.0	100.0	100.0	0.0	100.0	100.0
conc.7	1.345	100.0	100.0	100.0	100.0	0.0	100.0	100.0
conc.8	2.327	100.0	100.0	100.0	100.0	0.0	100.0	100.0

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-1, Appendix E-1.
2. (a) Test-Temperature (mean) = 15.6^{o}C (b) Test-pH (min-max): 8.0-8.5
3. SD = standard deviation
4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
6. Data plotted on Graph F-1 are highlighed in bold-type.

Graph F-1: Mortality Curve for Fish Exposed to River Water Spiked with Ammonia (T1A)



<u>ICPIN PRINTOUT FOR T1A</u> – survival data

Test-Description: 96 hr acute-exposure test; static
Test-Treatment: RW spiked with NH_3
Test-Species: walleye fry

LC_{50}

DATA FILE: T1Asurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.059	70.000	0.000	76.667
2	3	0.169	83.333	20.817	76.667
3	3	0.278	60.000	0.000	60.000
4	3	0.396	16.667	15.275	16.667
5	3	0.580	0.000	0.000	0.000
6	3	0.720	0.000	0.000	0.000
7	3	1.284	0.000	0.000	0.000
8	3	1.345	0.000	0.000	0.000
9	3	2.327	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.3370 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.3381 Standard Deviation: 0.0118
Original Confidence Limits: Lower: 0.3193 Upper: 0.3585
Expanded Confidence Limits: Lower: 0.2998 Upper: 0.3821
Resampling time in Seconds: 0.06 Random_Seed: -586264792

LC_{20}

DATA FILE: T1Asurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.059	70.000	0.000	76.667
2	3	0.169	83.333	20.817	76.667
3	3	0.278	60.000	0.000	60.000
4	3	0.396	16.667	15.275	16.667
5	3	0.580	0.000	0.000	0.000
6	3	0.720	0.000	0.000	0.000
7	3	1.284	0.000	0.000	0.000
8	3	1.345	0.000	0.000	0.000
9	3	2.327	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.2693 Entered P Value: 20

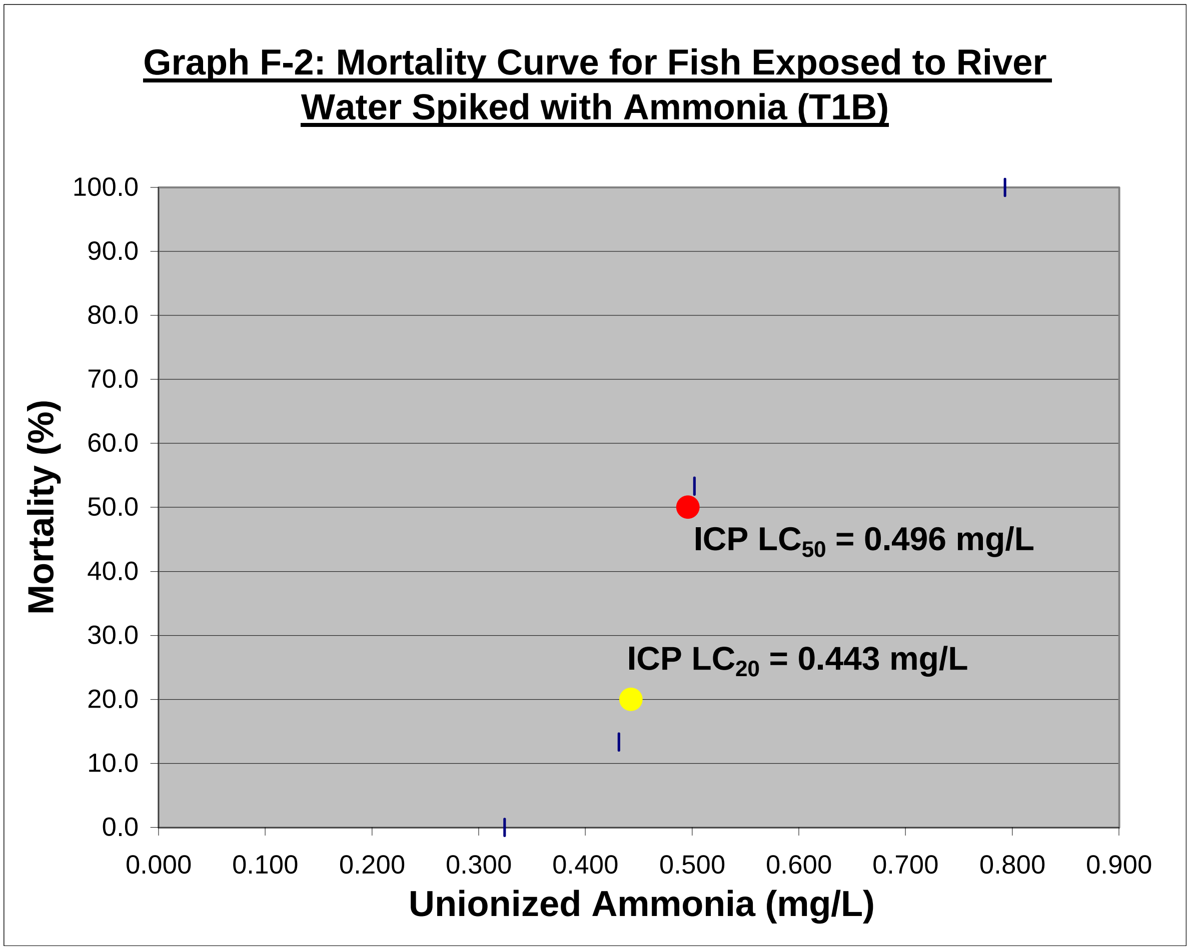
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.2696 Standard Deviation: 0.0153
Original Confidence Limits: Lower: 0.2469 Upper: 0.2922
Expanded Confidence Limits: Lower: 0.2222 Upper: 0.3173
Resampling time in Seconds: 0.06 Random_Seed: -1998030664

TABLE F-2: MORTALITY OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T1B)

Test-Description: 96 hr acute-exposure test; static
Test-Species: white sucker fry

	Avg. NH_3 (mg/L)	Mortality (%) Rep.A	Rep.B	Rep.C	Avg. Mortality (%)	SD of % Mortality
control	0.055	0.0	0.0	0.0	0.0	0.0
conc.1	0.190	0.0	0.0	0.0	0.0	0.0
conc.2	**0.324**	0.0	0.0	0.0	**0.0**	0.0
conc.3	**0.431**	0.0	40.0	0.0	**13.3**	23.1
conc.4	**0.502**	60.0	100.0	0.0	**53.3**	50.3
conc.5	**0.793**	100.0	100.0	100.0	**100.0**	0.0
conc.6	1.109	100.0	100.0	100.0	100.0	0.0
conc.7	1.179	100.0	100.0	100.0	100.0	0.0
conc.8	2.048	100.0	100.0	100.0	100.0	0.0

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-2, Appendix E-1.
2. (a) Test-Temperature (mean) = 15.5°C (b) Test-pH (min-max): 8.0-8.5
3. SD = standard deviation
4. Data plotted on Graph F-2 are highlighed in bold-type.



<u>ICPIN PRINTOUT FOR T1B</u> – survival data

Test-Description: 96 hr acute-exposure test; static
Test-Treatment: RW spiked with NH_3
Test-Species: white sucker fry

LC_{50}

DATA FILE: T1Bsurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.055	100.000	0.000	100.000
2	3	0.190	100.000	0.000	100.000
3	3	0.324	100.000	0.000	100.000
4	3	0.431	86.667	23.094	86.667
5	3	0.502	46.667	50.332	46.667
6	3	0.793	0.000	0.000	0.000
7	3	1.109	0.000	0.000	0.000
8	3	1.179	0.000	0.000	0.000
9	3	2.048	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.4961 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.5149 Standard Deviation: 0.0493
Original Confidence Limits: Lower: 0.4586 Upper: 0.6111
Expanded Confidence Limits: Lower: 0.4174 Upper: 0.7377
Resampling time in Seconds: 0.06 Random_Seed: -288422400

LC_{20}

DATA FILE: T1Bsurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.055	100.000	0.000	100.000
2	3	0.190	100.000	0.000	100.000
3	3	0.324	100.000	0.000	100.000
4	3	0.431	86.667	23.094	86.667
5	3	0.502	46.667	50.332	46.667
6	3	0.793	0.000	0.000	0.000
7	3	1.109	0.000	0.000	0.000
8	3	1.179	0.000	0.000	0.000
9	3	2.048	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.4428 Entered P Value: 20

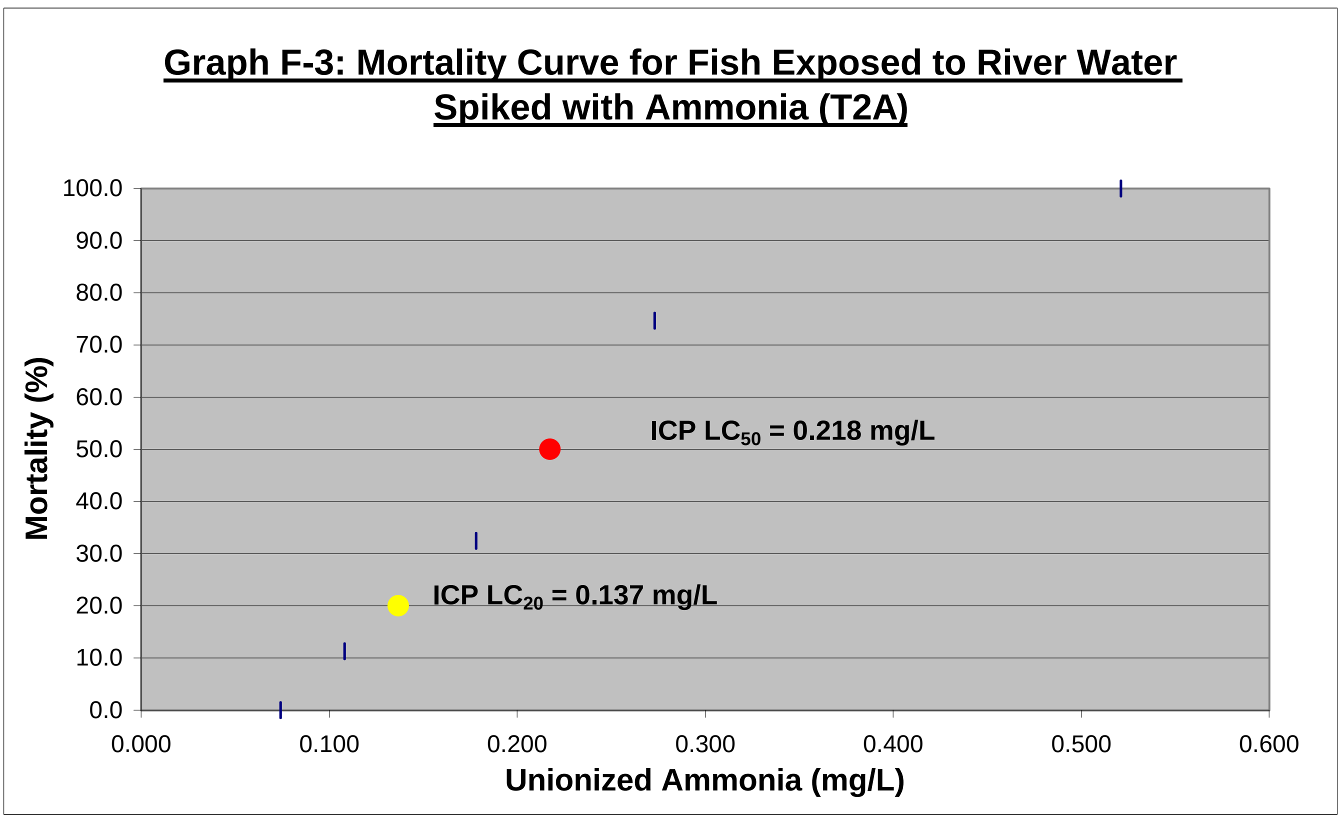
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.4437 Standard Deviation: 0.0365
Original Confidence Limits: Lower: 0.3775 Upper: 0.5436
Expanded Confidence Limits: Lower: 0.3056 Upper: 0.6544
Resampling time in Seconds: 0.00 Random_Seed: 293680528

TABLE F-3: MORTALITY OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T2A)

Test-Description: 96 hr acute-exposure test; semi-static
Test-Species: white sucker fry

	Avg. NH_3 (mg/L)	Mortality (%)			Avg. Mortality (%)	SD of % Mortality	Smoothed % Mortality	Adjusted % Mortality
		Rep.A	Rep.B	Rep.C				
control	0.024	30.0	20.0	20.0	23.3	5.8	21.1	0.0
conc.1	0.047	60.0	0.0	10.0	23.3	32.1	21.1	0.0
conc.2	**0.074**	40.0	10.0	0.0	16.7	20.8	21.1	**0.0**
conc.3	**0.108**	70.0	20.0	0.0	30.0	36.1	30.0	**11.3**
conc.4	**0.178**	40.0	60.0	40.0	46.7	11.5	46.7	**32.4**
conc.5	**0.273**	80.0	70.0	90.0	80.0	10.0	80.0	**74.6**
conc.6	**0.521**	100.0	100.0	100.0	100.0	0.0	100.0	**100.0**
conc.7	0.690	100.0	100.0	100.0	100.0	0.0	100.0	100.0

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-3, Appendix E-1.
2. (a) Test-Temperature (mean) = 15.5^{o}C (b) Test-pH (min-max): 8.0-8.4
3. SD = standard deviation
4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
6. Data plotted on Graph F-3 are highlighed in bold-type.



<u>ICPIN PRINTOUT FOR T2A</u> – survival data

Test-Description: 96 hr acute-exposure test; semi-static
Test-Treatment: RW spiked with NH_3
Test-Species: white sucker fry

LC_{50}

DATA FILE: T2Asurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.024	76.667	5.774	78.889
2	3	0.047	76.667	32.146	78.889
3	3	0.074	83.333	20.817	78.889
4	3	0.108	70.000	36.056	70.000
5	3	0.178	53.333	11.547	53.333
6	3	0.273	20.000	10.000	20.000
7	3	0.521	0.000	0.000	0.000
8	3	0.690	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.2176 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.2160 Standard Deviation: 0.0129
Original Confidence Limits: Lower: 0.1928 Upper: 0.2374
Expanded Confidence Limits: Lower: 0.1656 Upper: 0.2591
Resampling time in Seconds: 0.00 Random_Seed: 7842960

LC_{20}

DATA FILE: T2Asurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.024	76.667	5.774	78.889
2	3	0.047	76.667	32.146	78.889
3	3	0.074	83.333	20.817	78.889
4	3	0.108	70.000	36.056	70.000
5	3	0.178	53.333	11.547	53.333
6	3	0.273	20.000	10.000	20.000
7	3	0.521	0.000	0.000	0.000
8	3	0.690	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.1369 Entered P Value: 20

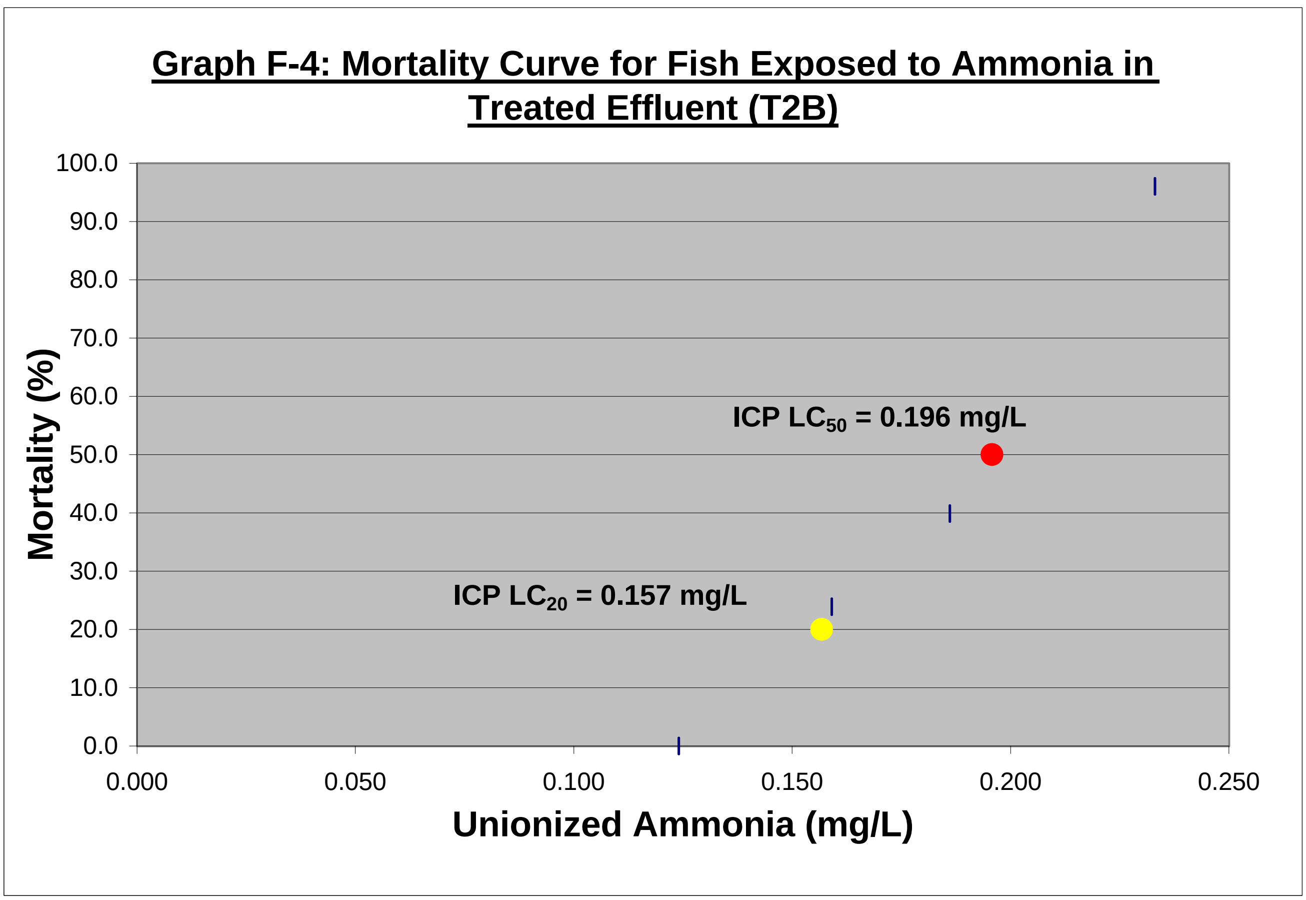
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.1226 Standard Deviation: 0.0295
Original Confidence Limits: Lower: 0.0740 Upper: 0.1624
Expanded Confidence Limits: Lower: 0.0048 Upper: 0.1905
Resampling time in Seconds: 0.00 Random_Seed: 930903312

TABLE F-4: MORTALITY OF FISH EXPOSED TO AMMONIA IN TREATED EFFLUENT (T2B)

Test-Description: 96 hr acute-exposure test; semi-static
Test-Species: white sucker fry

	Avg. NH_3	Mortality (%)			Avg. Mortality	SD of %	Smoothed	Adjusted
	(mg/L)	Rep.A	Rep.B	Rep.C	(%)	Mortality	% Mortality	% Mortality
control	0.024	30.0	20.0	20.0	23.3	5.8	16.8	0.0
conc.1	0.045	0.0	22.2	22.2	14.8	12.8	16.8	0.0
conc.2	0.068	20.0	40.0	20.0	26.7	11.5	16.8	0.0
conc.3	0.091	0.0	20.0	0.0	6.7	11.5	16.8	0.0
conc.4	**0.124**	18.2	0.0	20.0	12.7	11.1	16.8	**0.0**
conc.5	**0.159**	10.0	50.0	50.0	36.7	23.1	36.7	**23.9**
conc.6	**0.186**	50.0	60.0	40.0	50.0	10.0	50.0	**39.9**
conc.7	**0.233**	90.0	100.0	100.0	96.7	5.8	96.7	**96.0**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-4, Appendix E-1.
2. (a) Test-Temperature (mean) = 15.5^{o}C (b) Test-pH (min-max): 7.1-8.3
3. SD = standard deviation
4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
6. Data plotted on Graph F-4 are highlighed in bold-type.



ICPIN PRINTOUT FOR T2B - survival data

Test-Description: 96 hr acute-exposure test; semi-static
Test-Treatment: E spiked with NH_3
Test-Species: white sucker fry

LC_{50}

DATA FILE: T2Bsurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.024	63.333	5.774	80.493
2	3	0.045	85.200	12.817	80.493
3	3	0.068	73.333	11.547	80.493
4	3	0.091	93.333	11.547	80.493
5	3	0.124	87.267	11.064	80.493
6	3	0.159	63.333	23.094	63.333
7	3	0.186	50.000	10.000	50.000
8	3	0.233	3.333	5.774	3.333

The Linear Interpolation Estimate: 0.1958 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.1948 Standard Deviation: 0.0041
Original Confidence Limits: Lower: 0.1858 Upper: 0.2028
Expanded Confidence Limits: Lower: 0.1747 Upper: 0.2104
Resampling time in Seconds: 0.05 Random_Seed: 497193680

LC_{20}

DATA FILE: T2Bsurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.024	63.333	5.774	80.493
2	3	0.045	85.200	12.817	80.493
3	3	0.068	73.333	11.547	80.493
4	3	0.091	93.333	11.547	80.493
5	3	0.124	87.267	11.064	80.493
6	3	0.159	63.333	23.094	63.333
7	3	0.186	50.000	10.000	50.000
8	3	0.233	3.333	5.774	3.333

The Linear Interpolation Estimate: 0.1568 Entered P Value: 20

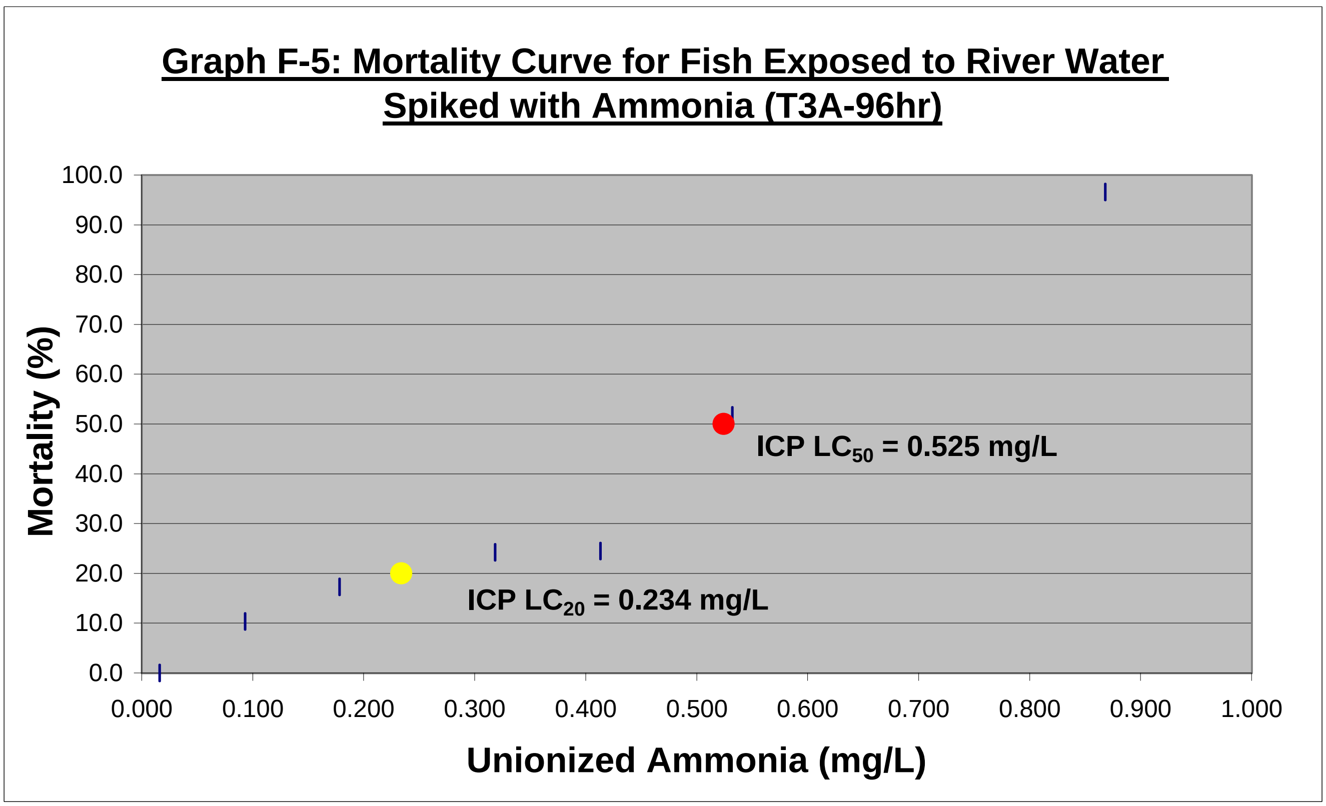
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.1580 Standard Deviation: 0.0106
Original Confidence Limits: Lower: 0.1420 Upper: 0.1750
Expanded Confidence Limits: Lower: 0.1258 Upper: 0.1949
Resampling time in Seconds: 0.06 Random_Seed: 1952176976

TABLE F-5: MORTALITY OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T3A-96 hr)

Test-Description: 96 hr acute-exposure test; semi-static
Test-Species: white sucker fry

	Avg. NH_3 (mg/L)	Mortality (%) Rep.A	Rep.B	Rep.C	Avg. Mortality (%)	SD of % Mortality	Smoothed % Mortality	Adjusted % Mortality
control	**0.016**	10.0	0.0	0.0	3.3	5.8	3.3	**0.0**
conc.1	**0.093**	0.0	10.0	30.0	13.3	15.3	13.3	**10.3**
conc.2	**0.178**	10.0	30.0	20.0	20.0	10.0	20.0	**17.3**
conc.4	**0.318**	10.0	40.0	30.0	26.7	15.3	26.7	**24.2**
conc.5	**0.413**	11.1	50.0	20.0	27.0	20.4	27.0	**24.5**
conc.6	**0.532**	20.0	80.0	60.0	53.3	30.6	53.3	**51.7**
conc.7	**0.868**	100.0	90.0	100.0	96.7	5.8	96.7	**96.6**
conc.3	0.233	10.0	0.0	0.0	3.3	5.8		

Notes: 1. Concentration 3 was removed from dataset because the observed response did not follow the response-gradient.
2. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-5, Appendix E-1.
3. (a) Test-Temperature (mean) = 17.5^oC (b) Test-pH (min-max): 7.9-8.3
4. SD = standard deviation
5. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
6. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
7. Data plotted on Graph F-5 are highlighed in bold-type.



ICPIN PRINTOUT FOR T3A-96hr – survival data

Test-Description: 96 hr acute-exposure test; semi-static
Test-Treatment: RW spiked with NH_3
Test-Species: white sucker fry

LC_{50}

DATA FILE: T3A96sur.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.016	96.667	5.774	96.667
2	3	0.093	86.667	15.275	86.667
3	3	0.178	80.000	10.000	80.000
4	3	0.318	73.333	15.275	73.333
5	3	0.413	72.967	20.381	72.967
6	3	0.532	46.667	30.551	46.667
7	3	0.868	3.333	5.774	3.333

The Linear Interpolation Estimate: 0.5245 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.5290 Standard Deviation: 0.0587
Original Confidence Limits: Lower: 0.4610 Upper: 0.6377
Expanded Confidence Limits: Lower: 0.3911 Upper: 0.7622
Resampling time in Seconds: 0.05 Random_Seed: -1604060736

LC_{20}

DATA FILE: T3A96sur.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.016	96.667	5.774	96.667
2	3	0.093	86.667	15.275	86.667
3	3	0.178	80.000	10.000	80.000
4	3	0.318	73.333	15.275	73.333
5	3	0.413	72.967	20.381	72.967
6	3	0.532	46.667	30.551	46.667
7	3	0.868	3.333	5.774	3.333

The Linear Interpolation Estimate: 0.2340 Entered P Value: 20

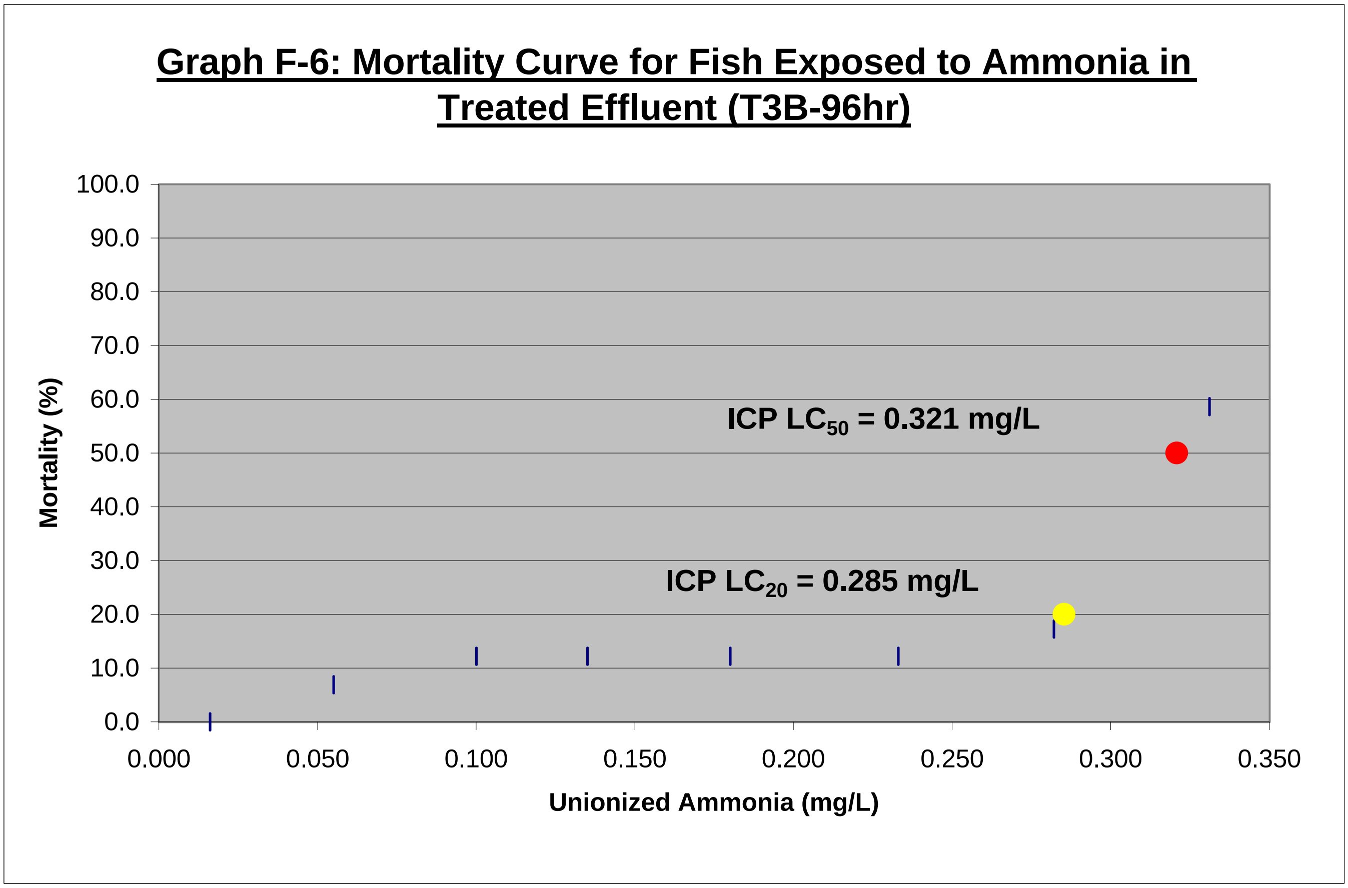
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.2639 Standard Deviation: 0.1043
Original Confidence Limits: Lower: 0.0930 Upper: 0.4313
Expanded Confidence Limits: Lower: -0.0621 Upper: 0.6482
Resampling time in Seconds: 0.06 Random_Seed: -1272838064

TABLE F-6: MORTALITY OF FISH EXPOSED TO AMMONIA IN TREATED EFFLUENT (T3B-96hr)

Test-Description: 96 hr acute-exposure test; semi-static
Test-Species: white sucker fry

	Avg. NH_3 (mg/L)	Mortality (%) Rep.A	Rep.B	Rep.C	Avg. Mortality (%)	SD of % Mortality	Smoothed % Mortality	Adjusted % Mortality
control	**0.016**	10.0	0.0	0.0	3.3	5.8	3.3	**0.0**
conc.1	**0.055**	0.0	30.0	0.0	10.0	17.3	10.0	**6.9**
conc.2	**0.100**	30.0	20.0	0.0	16.7	15.3	15.1	**12.2**
conc.3	**0.135**	10.0	10.0	20.0	13.3	5.8	15.1	**12.2**
conc.4	**0.180**	20.0	10.0	20.0	16.7	5.8	15.1	**12.2**
conc.5	**0.233**	11.1	0.0	30.0	13.7	15.2	15.1	**12.2**
conc.6	**0.282**	10.0	30.0	20.0	20.0	10.0	20.0	**17.3**
conc.7	**0.331**	70.0	50.0	60.0	60.0	10.0	60.0	**58.6**

Notes: 1. Raw data used to calculate average final NH_3 are tabulated in Table E-6, Appendix E-1.
2. (a) Test-Temperature (mean) = 16.8^{o}C (b) Test-pH (min-max): 7.2-8.3
3. SD = standard deviation
4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
6. Data plotted on Graph F-6 are highlighed in bold-type.



<u>ICPIN PRINTOUT FOR T3B-96hr</u> – survival data

Test-Description: 96 hr acute-exposure test; semi-static
Test-Treatment: E spiked with NH_3
Test-Species: white sucker fry

LC_{50}

DATA FILE: T3B96sur.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.016	96.667	5.774	96.667
2	3	0.055	90.000	17.321	90.000
3	3	0.100	83.333	15.275	85.000
4	3	0.135	86.667	5.774	85.000
5	3	0.180	83.333	5.774	84.817
6	3	0.233	86.300	15.168	84.817
7	3	0.282	80.000	10.000	80.000
8	3	0.331	40.000	10.000	40.000

The Linear Interpolation Estimate: 0.3208 Entered P Value: 50

Number of Resamplings: 80 77 Resamples Generated
Those resamples not used had estimates
above the highest concentration/ %Effluent.
The Bootstrap Estimates Mean: 0.3203 Standard Deviation: 0.0048

No Confidence Limits can be produced since the number of resamples
generated is not a multiple of 40.
Resampling time in Seconds: 0.00 Random_Seed: -410076339

LC_{20}

DATA FILE: T3B96sur.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.016	96.667	5.774	96.667
2	3	0.055	90.000	17.321	90.000
3	3	0.100	83.333	15.275	85.000
4	3	0.135	86.667	5.774	85.000
5	3	0.180	83.333	5.774	84.817
6	3	0.233	86.300	15.168	84.817
7	3	0.282	80.000	10.000	80.000
8	3	0.331	40.000	10.000	40.000

The Linear Interpolation Estimate: 0.2853 Entered P Value: 20

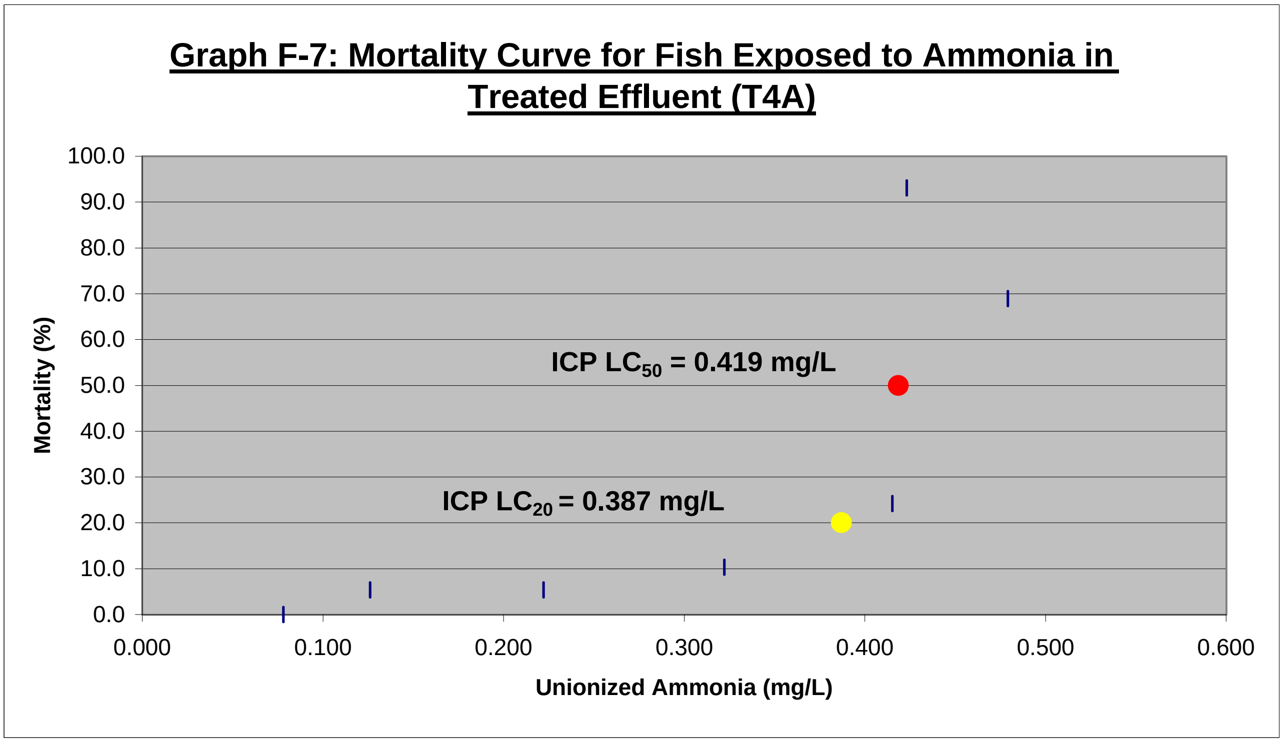
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.2760 Standard Deviation: 0.0220
Original Confidence Limits: Lower: 0.2012 Upper: 0.2936
Expanded Confidence Limits: Lower: 0.1087 Upper: 0.3027
Resampling time in Seconds: 0.05 Random_Seed: -1485890099

TABLE F-7: MORTALITY OF FISH EXPOSED TO AMMONIA IN TREATED EFFLUENT (T4A)

Test-Description: 96 hr acute-exposure test; semi-static
Test-Species: white sucker fry

	Avg. NH_3 (mg/L)	Mortality (%) Rep.A	Rep.B	Rep.C	Avg. Mortality (%)	SD of % Mortality	Smoothed % Mortality	Adjusted % Mortality
control	**0.078**	0.0	0.0	10.0	3.3	5.8	3.3	**0.0**
conc.1	**0.126**	11.1	30.0	0.0	13.7	15.2	8.5	**5.4**
conc.2	**0.222**	10.0	0.0	0.0	3.3	5.8	8.5	**5.4**
conc.3	**0.322**	10.0	10.0	20.0	13.3	5.8	13.3	**10.3**
conc.4	**0.415**	20.0	40.0	20.0	26.7	11.5	26.7	**24.2**
conc.5	**0.479**	70.0	70.0	70.0	70.0	0.0	70.0	**69.0**
conc.6	**0.423**	90.0	90.0	100.0	93.3	5.8	93.3	**93.1**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-7, Appendix E-1.
2. (a) Test-Temperature (mean) = 18.2^{o}C (b) Test-pH (min-max): 7.1-8.4
3. SD = standard deviation
4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
6. Data plotted on Graph F-7 are highlighed in bold-type.



<u>ICPIN PRINTOUT FOR T4A</u> – survival data

Test-Description: 96 hr acute-exposure test; semi-static
Test-Treatment: E spiked with NH_3
Test-Species: white sucker fry

LC_{50}

DATA FILE: T4Asurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.078	96.667	5.774	96.667
2	3	0.126	86.300	15.168	91.483
3	3	0.222	96.667	5.774	91.483
4	3	0.322	86.667	5.774	86.667
5	3	0.415	73.333	11.547	73.333
6	3	0.423	6.667	5.774	18.333
7	3	0.479	30.000	0.000	18.333

The Linear Interpolation Estimate: 0.4186 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.4186 Standard Deviation: 0.0005
Original Confidence Limits: Lower: 0.4178 Upper: 0.4193
Expanded Confidence Limits: Lower: 0.4168 Upper: 0.4201
Resampling time in Seconds: 0.06 Random_Seed: -25932201

LC_{20}

DATA FILE: T4Asurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.078	96.667	5.774	96.667
2	3	0.126	86.300	15.168	91.483
3	3	0.222	96.667	5.774	91.483
4	3	0.322	86.667	5.774	86.667
5	3	0.415	73.333	11.547	73.333
6	3	0.423	6.667	5.774	18.333
7	3	0.479	30.000	0.000	18.333

The Linear Interpolation Estimate: 0.3871 Entered P Value: 20

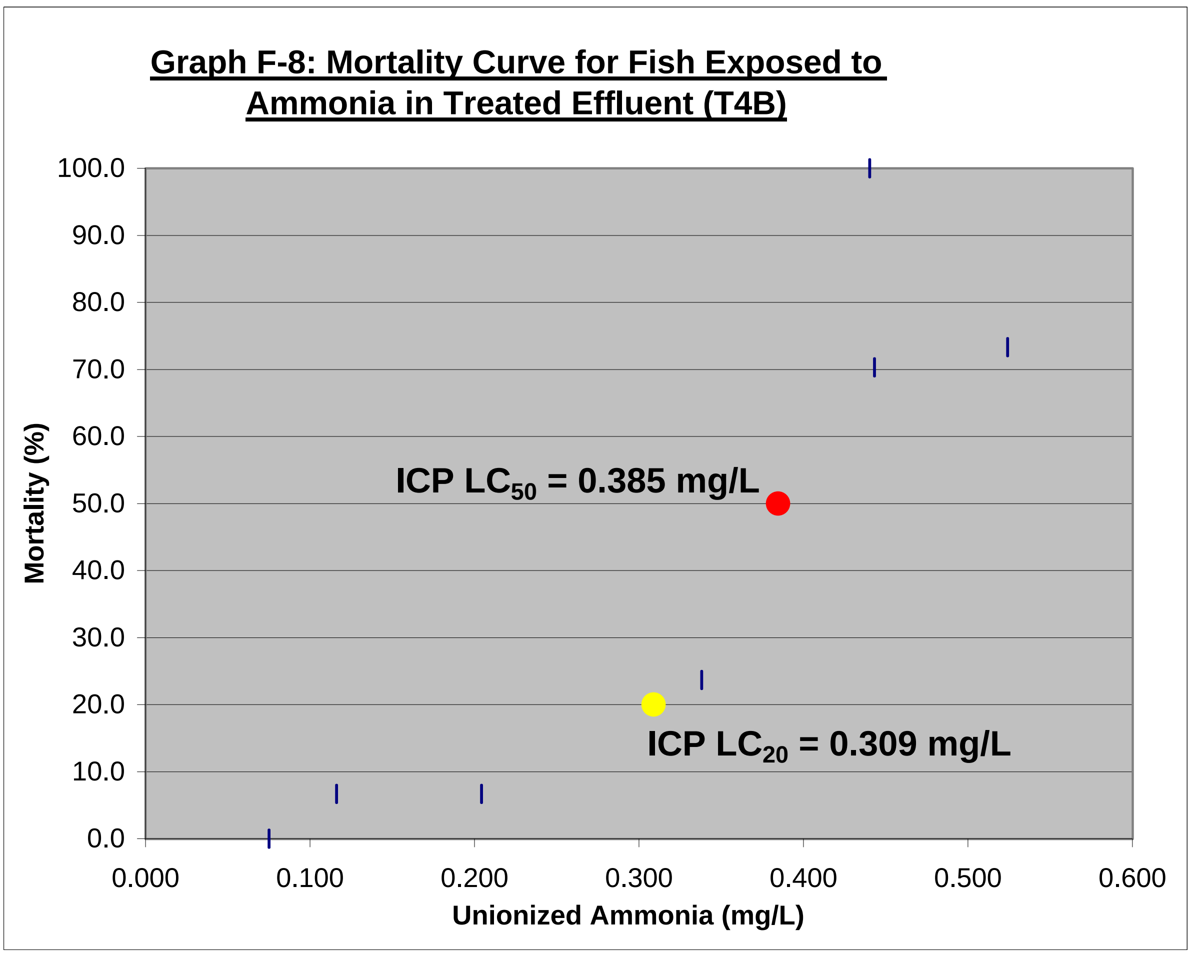
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.3915 Standard Deviation: 0.0232
Original Confidence Limits: Lower: 0.3406 Upper: 0.4157
Expanded Confidence Limits: Lower: 0.2895 Upper: 0.4471
Resampling time in Seconds: 0.06 Random_Seed: 1258887175

TABLE F-8: MORTALITY OF FISH EXPOSED TO AMMONIA IN TREATED EFFLUENT (T4B)

Test-Description: 96 hr acute-exposure test; semi-static
Test-Species: fathead minnow fry

	Avg. NH_3 (mg/L)	Mortality (%)			Avg. Mortality (%)	SD of % Mortality
		Rep.A	Rep.B	Rep.C		
control	**0.075**	0.0	0.0	0.0	**0.0**	0.0
conc.1	**0.116**	10.0	0.0	10.0	**6.7**	5.8
conc.2	**0.204**	20.0	0.0	0.0	**6.7**	11.5
conc.3	**0.338**	11.0	30.0	30.0	**23.7**	11.0
conc.4	**0.443**	90.9	70.0	50.0	**70.3**	20.5
conc.5	**0.524**	90.0	60.0	70.0	**73.3**	15.3
conc.6	**0.440**	100.0	100.0	100.0	**100.0**	0.0

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-8, Appendix E-1.
2. (a) Test-Temperature (mean) = 18.3°C (b) Test-pH (min-max): 7.1-8.3
3. SD = standard deviation
4. Data plotted on Graph F-8 are highlighed in bold-type.



<u>ICPIN PRINTOUT FOR T4B</u> – survival data

Test-Description: 96 hr acute-exposure test; semi-static
Test-Treatment: E spiked with NH_3
Test-Species: fathead minnow fry

LC_{50}

DATA FILE: T4Bsurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.075	100.000	0.000	100.000
2	3	0.116	93.333	5.774	93.333
3	3	0.204	93.333	11.547	93.333
4	3	0.338	76.300	10.912	76.300
5	3	0.440	0.000	0.000	18.789
6	3	0.443	29.700	20.452	18.789
7	3	0.524	26.667	15.275	18.789

The Linear Interpolation Estimate: 0.3846 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.3844 Standard Deviation: 0.0057
Original Confidence Limits: Lower: 0.3732 Upper: 0.3963
Expanded Confidence Limits: Lower: 0.3606 Upper: 0.4091
Resampling time in Seconds: 0.00 Random_Seed: 412138314

LC_{20}

DATA FILE: T4Bsurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.075	100.000	0.000	100.000
2	3	0.116	93.333	5.774	93.333
3	3	0.204	93.333	11.547	93.333
4	3	0.338	76.300	10.912	76.300
5	3	0.440	0.000	0.000	18.789
6	3	0.443	29.700	20.452	18.789
7	3	0.524	26.667	15.275	18.789

The Linear Interpolation Estimate: 0.3089 Entered P Value: 20

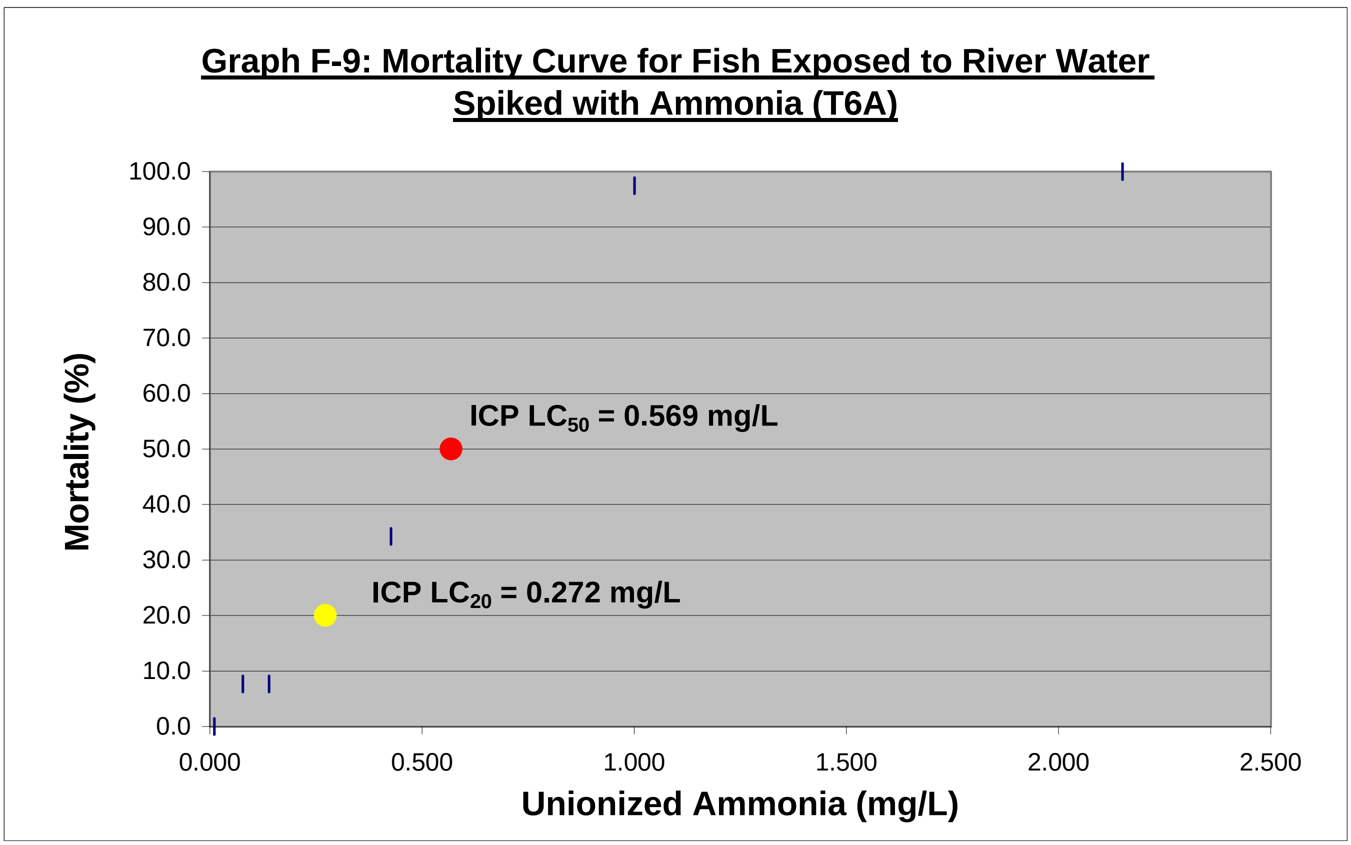
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.3123 Standard Deviation: 0.0257
Original Confidence Limits: Lower: 0.2576 Upper: 0.3509
Expanded Confidence Limits: Lower: 0.2012 Upper: 0.3970
Resampling time in Seconds: 0.00 Random_Seed: -1508251078

TABLE F-9: MORTALITY OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T6A)

Test-Description: 72 hr acute-exposure test; semi-static
Test-Species: fathead minnow fry

	Avg. NH_3 (mg/L)	Mortality (%)				Avg. Mortality (%)	SD of % Mortality	Smoothed % Mortality	Adjusted % Mortality
		Rep.A	Rep.B	Rep.C	Rep.D				
control	**0.010**	0.0	0.0	10.0	0.0	2.5	5.0	2.5	**0.0**
conc.1	**0.077**	10.0	20.0	10.0	10.0	12.5	5.0	10.0	**7.7**
conc.2	**0.139**	0.0	10.0	20.0	0.0	7.5	9.6	10.0	**7.7**
conc.3	**0.426**	63.6	40.0	20.0	20.0	35.9	20.7	35.9	**34.3**
conc.4	**1.000**	100.0	100.0	100.0	90.0	97.5	5.0	97.5	**97.4**
conc.5	**2.150**	100.0	100.0	100.0	100.0	100.0	0.0	100.0	**100.0**
conc.6	3.361	100.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-9, Appendix E-1.
2. (a) Test-Temperature (mean) = 20.9°C (b) Test-pH (min-max): 8.4-8.8
3. SD = standard deviation
4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
6. Data plotted on Graph F-9 are highlighed in bold-type.



ICPIN PRINTOUT FOR T6A – survival data

Test-Description: 72 hr acute-exposure test; semi-static
Test-Treatment: RW spiked with NH_3
Test-Species: fathead minnow fry

LC_{50}

DATA FILE: T6Asurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.010	97.500	5.000	97.500
2	4	0.077	87.500	5.000	90.000
3	4	0.139	92.500	9.574	90.000
4	4	0.426	64.100	20.734	64.100
5	4	1.000	2.500	5.000	2.500
6	4	2.150	0.000	0.000	0.000
7	4	3.361	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.5690 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.5578 Standard Deviation: 0.0740
Original Confidence Limits: Lower: 0.3963 Upper: 0.6575
Expanded Confidence Limits: Lower: 0.2926 Upper: 0.7105
Resampling time in Seconds: 0.00 Random_Seed: -164439840

LC_{20}

DATA FILE: T6Asurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.010	97.500	5.000	97.500
2	4	0.077	87.500	5.000	90.000
3	4	0.139	92.500	9.574	90.000
4	4	0.426	64.100	20.734	64.100
5	4	1.000	2.500	5.000	2.500
6	4	2.150	0.000	0.000	0.000
7	4	3.361	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.2720 Entered P Value: 20

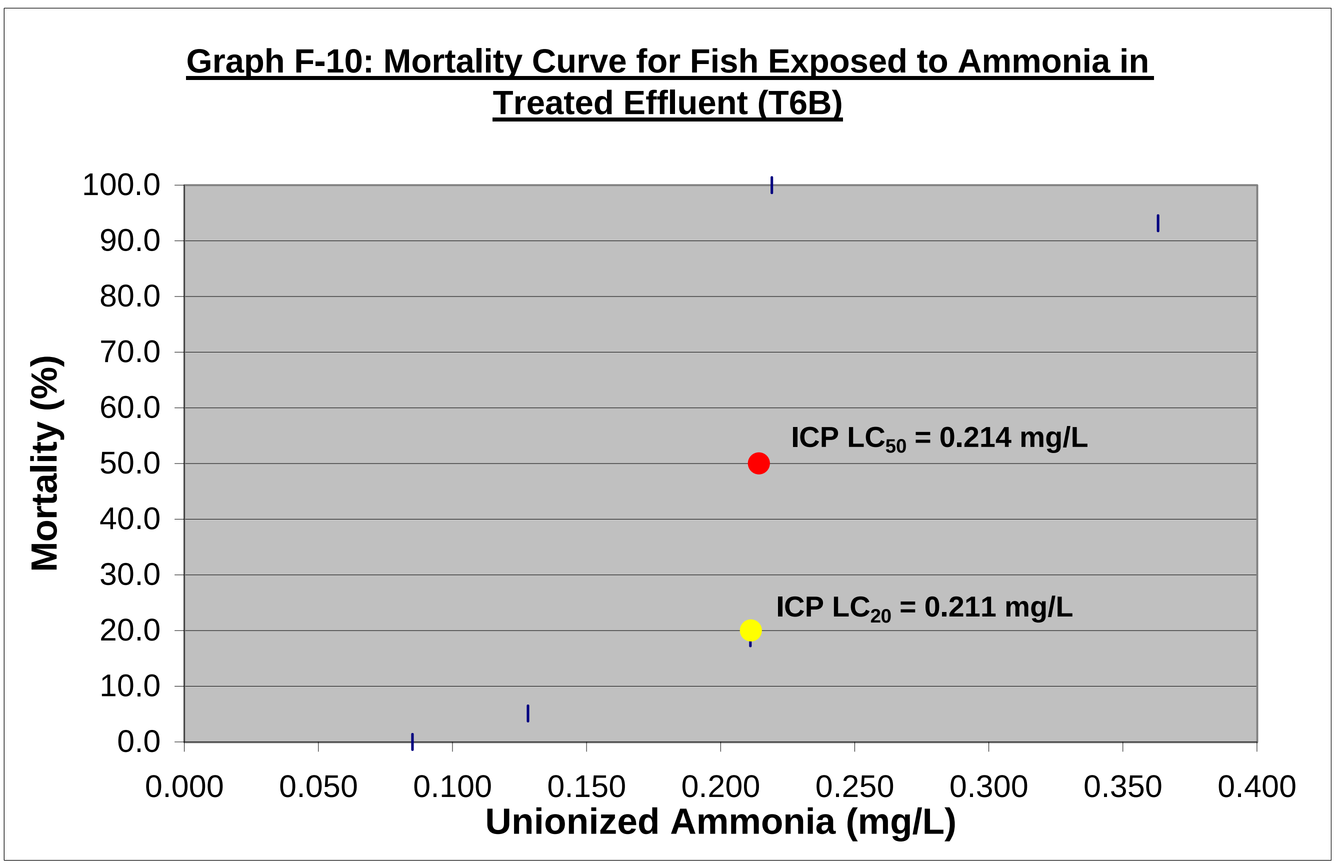
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.2986 Standard Deviation: 0.0663
Original Confidence Limits: Lower: 0.2084 Upper: 0.4404
Expanded Confidence Limits: Lower: 0.1702 Upper: 0.5414
Resampling time in Seconds: 0.06 Random_Seed: -416806880

TABLE F-10: MORTALITY OF FISH EXPOSED TO AMMONIA IN TREATED EFFLUENT (T6B)

Test-Description: 72 hr acute-exposure test; semi-static
Test-Species: fathead minnow fry

	Avg. NH_3 (mg/L)	Mortality (%)				Avg. Mortality (%)	SD of % Mortality	Smoothed % Mortality	Adjusted % Mortality
		Rep.A	Rep.B	Rep.C	Rep.D				
control	0.010	0.0	0.0	10.0	0.0	3.3	5.0	1.7	0.0
conc.1	**0.085**	0.0	0.0	0.0	0.0	0.0	0.0	1.7	**0.0**
conc.2	**0.128**	0.0	0.0	10.0	10.0	6.7	5.8	6.7	**5.1**
conc.3	**0.211**	10.0	10.0	20.0	30.0	20.0	9.6	20.0	**18.6**
conc.4	**0.363**	100.0	90.0	100.0	90.0	93.3	5.8	93.3	**93.2**
conc.5	**0.219**	100.0	100.0	100.0	100.0	100.0	0.0	100.0	**100.0**
conc.6	0.260	100.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-10, Appendix E-1.
2. (a) Test-Temperature (mean) = 20.9^oC (b) Test-pH (min-max): 7.2-8.8
3. SD = standard deviation
4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
6. Data plotted on Graph F-10 are highlighed in bold-type.



ICPIN PRINTOUT FOR T6B – survival data

Test-Description: 72 hr acute-exposure test; semi-static
Test-Treatment: E spiked with NH_3
Test-Species: fathead minnow fry

LC_{50}

DATA FILE: T6Bsurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.010	97.500	5.000	98.750
2	4	0.085	100.000	0.000	98.750
3	4	0.128	95.000	5.774	95.000
4	4	0.211	82.500	9.574	82.500
5	4	0.219	0.000	0.000	1.667
6	4	0.260	0.000	0.000	1.667
7	4	0.363	5.000	5.774	1.667

The Linear Interpolation Estimate: 0.2143 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.2143 Standard Deviation: 0.0002
Original Confidence Limits: Lower: 0.2138 Upper: 0.2147
Expanded Confidence Limits: Lower: 0.2136 Upper: 0.2149
Resampling time in Seconds: 0.00 Random_Seed: 274276020

LC_{20}

DATA FILE: T6Bsurv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.010	97.500	5.000	98.750
2	4	0.085	100.000	0.000	98.750
3	4	0.128	95.000	5.774	95.000
4	4	0.211	82.500	9.574	82.500
5	4	0.219	0.000	0.000	1.667
6	4	0.260	0.000	0.000	1.667
7	4	0.363	5.000	5.774	1.667

The Linear Interpolation Estimate: 0.2113 Entered P Value: 20

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.2078 Standard Deviation: 0.0078
Original Confidence Limits: Lower: 0.1861 Upper: 0.2120
Expanded Confidence Limits: Lower: 0.1710 Upper: 0.2124
Resampling time in Seconds: 0.05 Random_Seed: 950129140

APPENDIX F-2

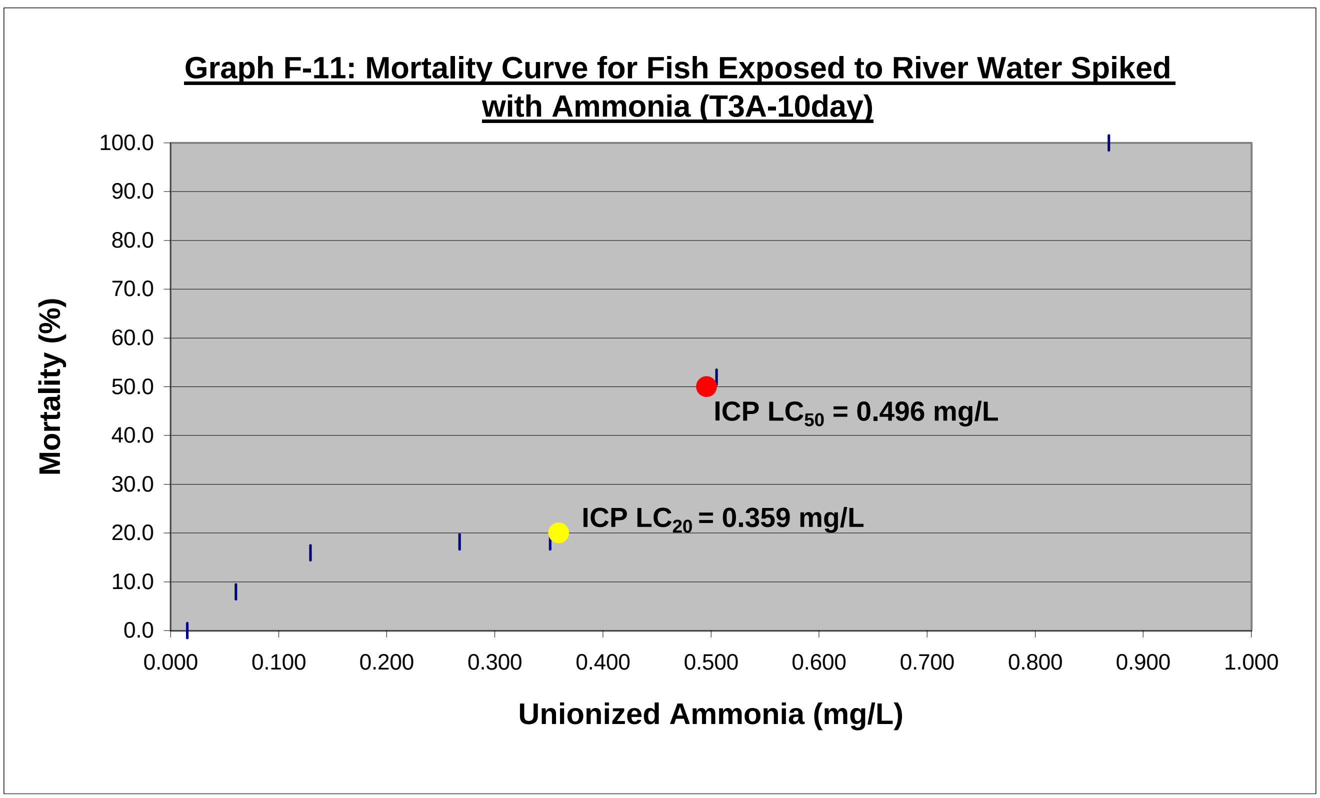
CHRONIC-EXPOSURE TESTS CONDUCTED ON FISH: RAW DATA AND RESULTS

TABLE F-11: MORTALITY OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T3A-10day)

Test-Description: 10 day chronic-exposure test; semi-static
Test-Species: white sucker fry

	Avg. NH_3 (mg/L)	Mortality (%)			Avg. Mortality (%)	SD of % Mortality	Smoothed %-Mortality	Adjusted %-Mortality
		Rep.A	Rep.B	Rep.C				
control	**0.015**	40.0	0.0	10.0	16.7	20.8	16.7	**0.0**
conc.1	**0.060**	20.0	10.0	40.0	23.3	15.3	23.3	**7.9**
conc.2	**0.129**	10.0	30.0	50.0	30.0	20.0	30.0	**16.0**
conc.4	**0.267**	30.0	40.0	30.0	33.3	5.8	31.9	**18.2**
conc.5	**0.351**	11.1	50.0	30.0	30.4	19.5	31.9	**18.2**
conc.6	**0.505**	20.0	90.0	70.0	60.0	36.1	60.0	**52.0**
conc.7	**0.868**	100.0	100.0	100.0	100.0	0.0	100.0	**100.0**
conc.3	0.183	20.0	0.0	10.0	10.0	10.0		

Notes: 1. Concentration 3 was removed from dataset because the observed response did not follow the response-gradient.
2. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-11, Appendix E-2.
3. (a) Test-Temperature (mean) = 17.4^{o}C (b) Test-pH (min-max): 7.7-8.4
4. SD = standard deviation
5. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
6. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
7. Data plotted on Graph F-11 are highlighted in bold-type.



<u>ICPIN PRINTOUT FOR T3A-10day</u> – survival data

Test-Description: 10 day chronic-exposure test; semi-static
Test-Treatment: RW spiked with NH_3
Test-Species: white sucker fry

LC_{50}

DATA FILE: T3a10sur.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.015	83.333	20.817	83.333
2	3	0.060	76.667	15.275	76.667
3	3	0.129	70.000	20.000	70.000
4	3	0.267	66.667	5.774	68.150
5	3	0.351	69.633	19.453	68.150
6	3	0.505	40.000	36.056	40.000
7	3	0.868	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.4959 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.5113 Standard Deviation: 0.0725
Original Confidence Limits: Lower: 0.4142 Upper: 0.6582
Expanded Confidence Limits: Lower: 0.3244 Upper: 0.8368
Resampling time in Seconds: 0.05 Random_Seed: 321553980

LC_{20}

DATA FILE: T3a10sur.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.015	83.333	20.817	83.333
2	3	0.060	76.667	15.275	76.667
3	3	0.129	70.000	20.000	70.000
4	3	0.267	66.667	5.774	68.150
5	3	0.351	69.633	19.453	68.150
6	3	0.505	40.000	36.056	40.000
7	3	0.868	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.3591 Entered P Value: 20

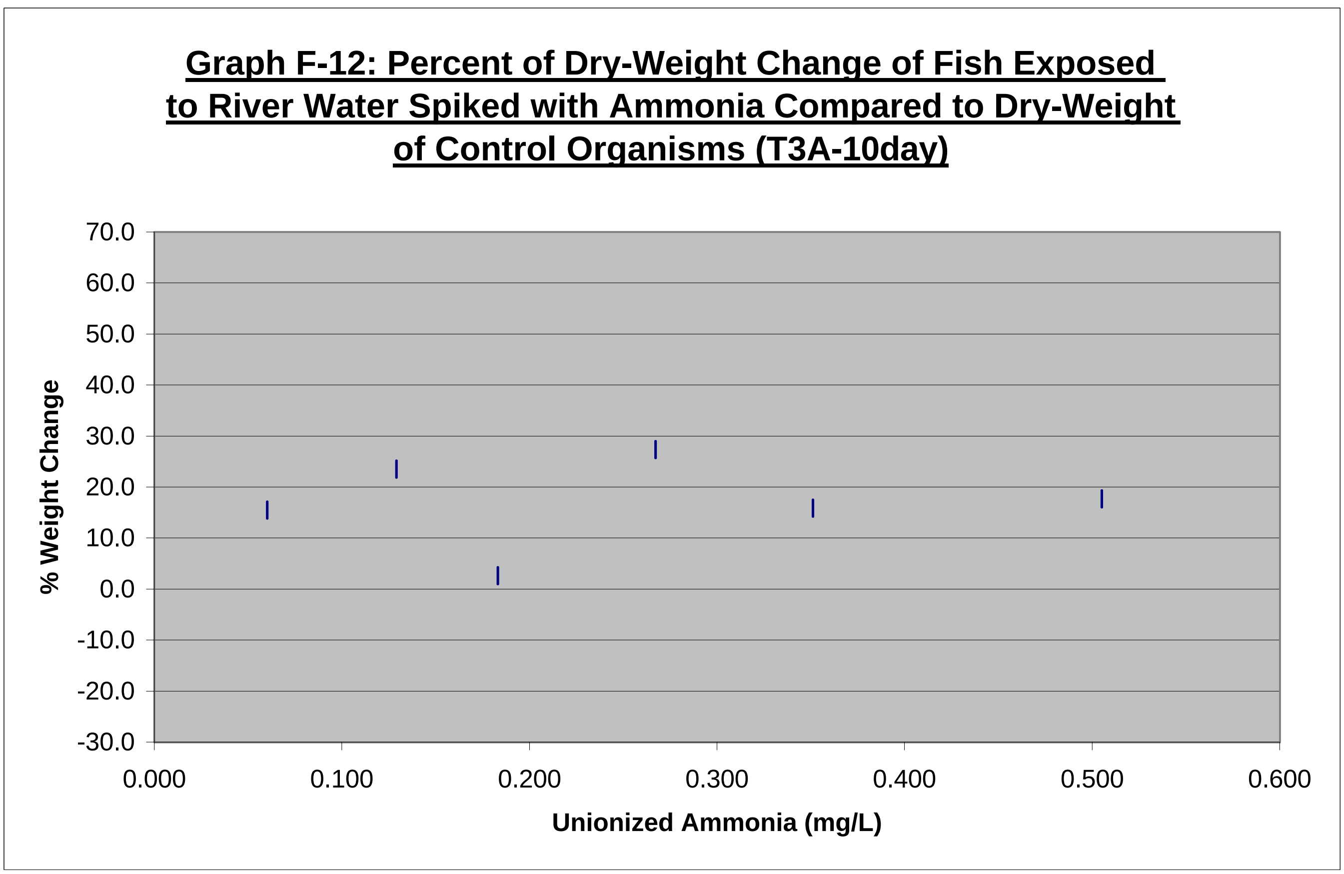
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.2771 Standard Deviation: 0.1515
Original Confidence Limits: Lower: 0.0510 Upper: 0.5245
Expanded Confidence Limits: Lower: -0.2879 Upper: 0.7063
Resampling time in Seconds: 0.06 Random_Seed: -5094228

TABLE F-12: WEIGHT OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T3A-10day)

Test-Description: 10 day chronic-exposure test; semi-static
Test-Species: white sucker fry

	Avg. NH_3 (mg/L)	Dry-weight per fish (mg) Rep.A	Rep.B	Rep.C	Avg.dry- weight per fish (mg)	SD of Weight (mg)	% weight change compared to controls
control	0.015	1.67	1.39	1.92	1.66	0.27	
conc.1	**0.060**	2.06	1.81	1.88	1.92	0.13	**15.5**
conc.2	**0.129**	1.71	1.80	2.64	2.05	0.51	**23.5**
conc.3	**0.183**	1.53	1.81	1.77	1.70	0.15	**2.6**
conc.4	**0.267**	2.00	2.03	2.31	2.11	0.17	**27.3**
conc.5	**0.351**	1.66	2.24	1.87	1.92	0.29	**15.9**
conc.6	**0.505**	1.83	1.20	2.83	1.95	0.82	**17.7**
conc.7	0.868						

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-11, Appendix E-2.
2. (a) Test-Temperature (mean) = 17.4^{o}C (b) Test-pH (min-max): 7.7-8.4
3. SD = standard deviation
4. Data plotted on Graph F-12 are highlighted in bold-type.



ICPIN PRINTOUT FOR T3A-10day – growth data based on final dry weights/fish

Test-Description: 10 day chronic-exposure test; semi-static
Test-Treatment: RW spiked with NH_3
Test-Species: white sucker fry

EC_{50}

DATA FILE: T3A10grw.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.015	1.660	0.266	1.903
2	3	0.060	1.919	0.129	1.903
3	3	0.129	2.050	0.513	1.903
4	3	0.183	1.701	0.154	1.903
5	3	0.267	2.116	0.173	1.903
6	3	0.351	1.925	0.292	1.903
7	3	0.505	1.953	0.824	1.903

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 50% of the control response mean.

EC_{20}

DATA FILE: T3A10grw.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.015	1.660	0.266	1.903
2	3	0.060	1.919	0.129	1.903
3	3	0.129	2.050	0.513	1.903
4	3	0.183	1.701	0.154	1.903
5	3	0.267	2.116	0.173	1.903
6	3	0.351	1.925	0.292	1.903
7	3	0.505	1.953	0.824	1.903

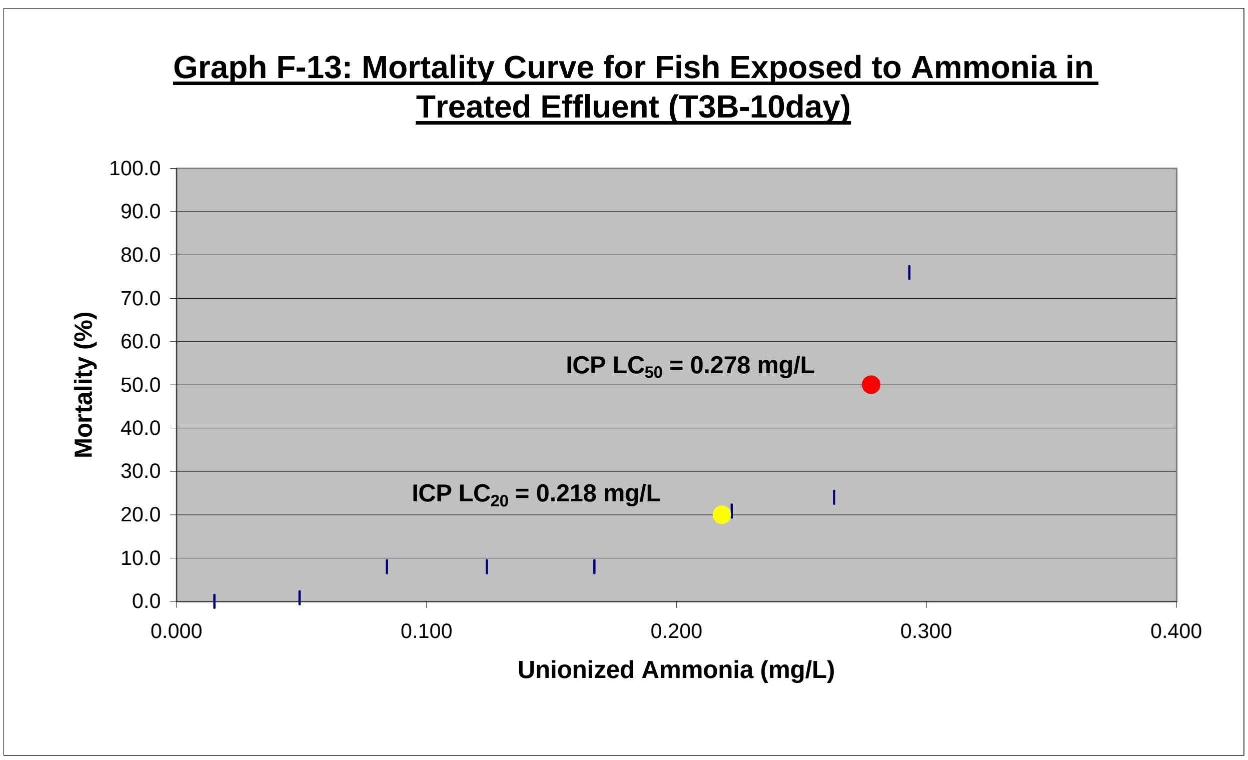
*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 80% of the control response mean.

TABLE F-13: MORTALITY OF FISH EXPOSED TO AMMONIA IN TREATED EFFLUENT (T3B-10day)

Test-Description: 10 day chronic-exposure test; semi-static
Test-Species: white sucker fry

	Avg. NH_3 (mg/L)	Mortality (%) Rep.A	Rep.B	Rep.C	Avg. Mortality (%)	SD of % Mortality	Smoothed %-Mortality	Adjusted %-Mortality
control	**0.015**	40.0	0.0	10.0	16.7	20.8	16.7	**0.0**
conc.1	**0.049**	0.0	30.0	22.2	17.4	15.6	17.4	**0.8**
conc.2	**0.084**	50.0	40.0	0.0	30.0	26.5	23.3	**8.0**
conc.3	**0.124**	20.0	20.0	20.0	20.0	0.0	23.3	**8.0**
conc.4	**0.167**	20.0	10.0	30.0	20.0	10.0	23.3	**8.0**
conc.5	**0.222**	22.2	20.0	60.0	34.1	22.5	34.1	**20.9**
conc.6	**0.263**	40.0	30.0	40.0	36.7	5.8	36.7	**24.0**
conc.7	**0.293**	80.0	80.0	80.0	80.0	0.0	80.0	**76.0**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-12, Appendix E-2.
2. (a) Test-Temperature (mean) = 16.9^oC (b) Test-pH (min-max): 6.9-8.4
3. SD = standard deviation
4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
6. Data plotted on Graph F-13 are highlighted in bold-type.



ICPIN PRINTOUT FOR T3B-10day – survival data

Test-Description: 10 day chronic-exposure test; semi-static
Test-Treatment: E spiked with NH_3
Test-Species: white sucker fry

LC_{50}

DATA FILE: T3B10sur.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.015	83.333	20.817	83.333
2	3	0.049	82.600	15.565	82.600
3	3	0.084	70.000	26.458	76.667
4	3	0.124	80.000	0.000	76.667
5	3	0.167	80.000	10.000	76.667
6	3	0.222	65.933	22.486	65.933
7	3	0.263	63.333	5.774	63.333
8	3	0.293	20.000	0.000	20.000

The Linear Interpolation Estimate: 0.2780 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.2761 Standard Deviation: 0.0028
Original Confidence Limits: Lower: 0.2708 Upper: 0.2805
Expanded Confidence Limits: Lower: 0.2629 Upper: 0.2833
Resampling time in Seconds: 0.05 Random_Seed: 188068185

LC_{20}

DATA FILE: T3B10sur.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.015	83.333	20.817	83.333
2	3	0.049	82.600	15.565	82.600
3	3	0.084	70.000	26.458	76.667
4	3	0.124	80.000	0.000	76.667
5	3	0.167	80.000	10.000	76.667
6	3	0.222	65.933	22.486	65.933
7	3	0.263	63.333	5.774	63.333
8	3	0.293	20.000	0.000	20.000

The Linear Interpolation Estimate: 0.2182 Entered P Value: 20

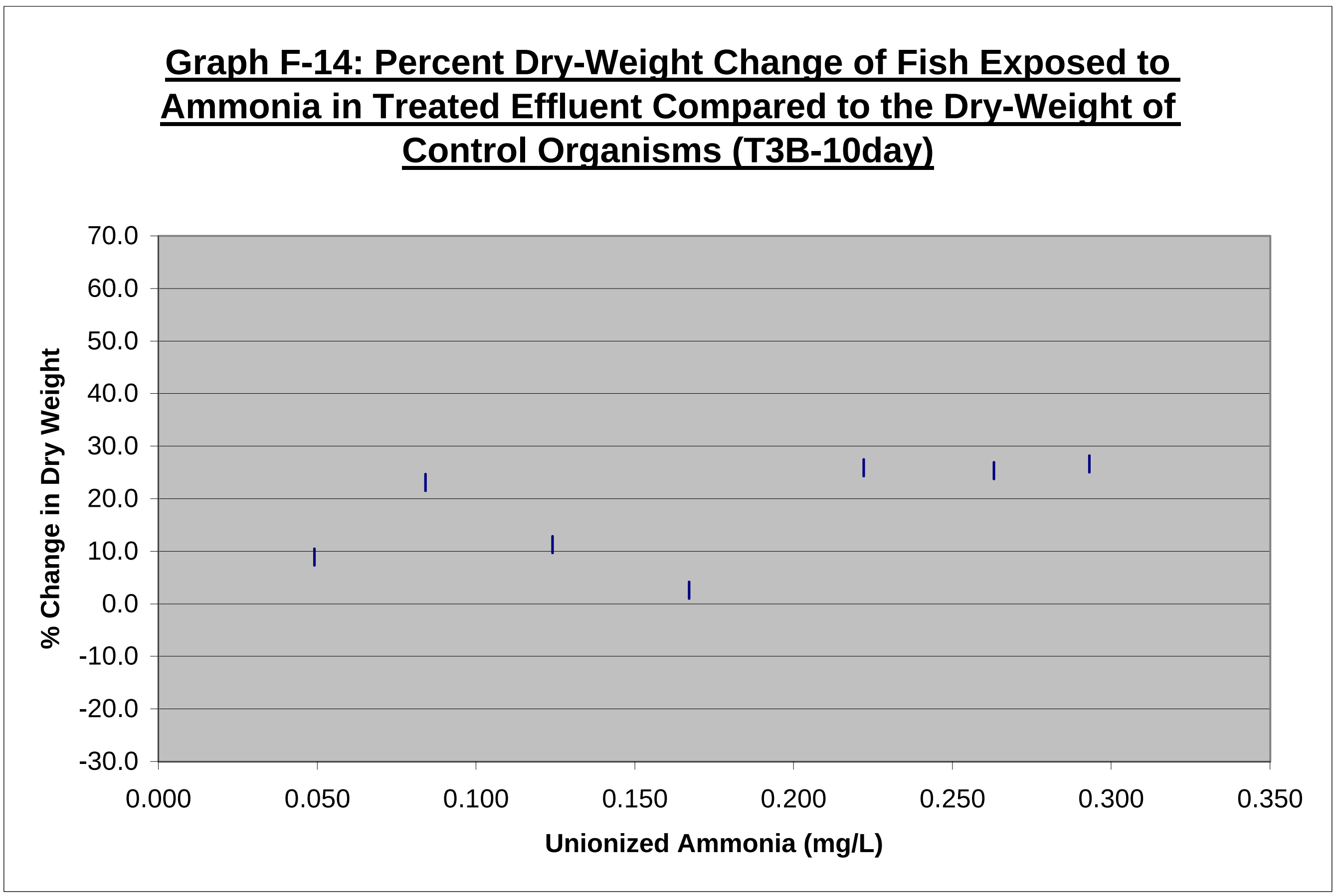
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.2036 Standard Deviation: 0.0598
Original Confidence Limits: Lower: 0.0597 Upper: 0.2672
Expanded Confidence Limits: Lower: -0.1146 Upper: 0.3211
Resampling time in Seconds: 0.00 Random_Seed: 1420405721

TABLE F-14: WEIGHT OF FISH EXPOSED TO AMMONIA IN TREATED EFFLUENT (T3B-10day)

Test-Description: 10 day chronic-exposure test; semi-static
Test-Species: white sucker fry

	Avg. NH_3 (mg/L)	Dry-weight per fish (mg)			Avg.dry- weight per fish (mg)	SD of Weight (mg)	% weight change compared to controls
		Rep.A	Rep.B	Rep.C			
control	0.015	2.28	1.30	1.83	1.80	0.49	
conc.1	**0.049**	1.63	1.70	2.56	1.96	0.52	**8.9**
conc.2	**0.084**	2.72	2.30	1.64	2.22	0.54	**23.1**
conc.3	**0.124**	1.86	2.26	1.90	2.01	0.22	**11.3**
conc.4	**0.167**	1.80	1.84	1.91	1.85	0.06	**2.6**
conc.5	**0.222**	2.15	1.78	2.88	2.27	0.56	**25.9**
conc.6	**0.263**	1.78	2.33	2.67	2.26	0.45	**25.3**
conc.7	**0.293**	2.45	2.05	2.35	2.28	0.21	**26.6**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-12, Appendix E-2.
2. (a) Test-Temperature (mean) = 16.9°C (b) Test-pH (min-max): 6.9-8.4
3. SD = standard deviation
4. Data plotted on Graph F-14 are highlighted in bold-type.



ICPIN PRINTOUT FOR T3B-10day – growth data based on final dry weights/fish

Test-Description: 10 day chronic-exposure test; semi-static
Test-Treatment: E spiked with NH_3
Test-Species: white sucker fry

EC_{50}

DATA FILE: T3B10grw.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.015	1.660	0.266	2.047
2	3	0.049	1.962	0.516	2.047
3	3	0.084	2.220	0.544	2.047
4	3	0.124	2.008	0.221	2.047
5	3	0.167	1.853	0.058	2.047
6	3	0.222	2.267	0.559	2.047
7	3	0.263	2.126	0.299	2.047
8	3	0.293	2.283	0.208	2.047

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 50% of the control response mean.

EC_{20}

DATA FILE: T3B10grw.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.015	1.660	0.266	2.047
2	3	0.049	1.962	0.516	2.047
3	3	0.084	2.220	0.544	2.047
4	3	0.124	2.008	0.221	2.047
5	3	0.167	1.853	0.058	2.047
6	3	0.222	2.267	0.559	2.047
7	3	0.263	2.126	0.299	2.047
8	3	0.293	2.283	0.208	2.047

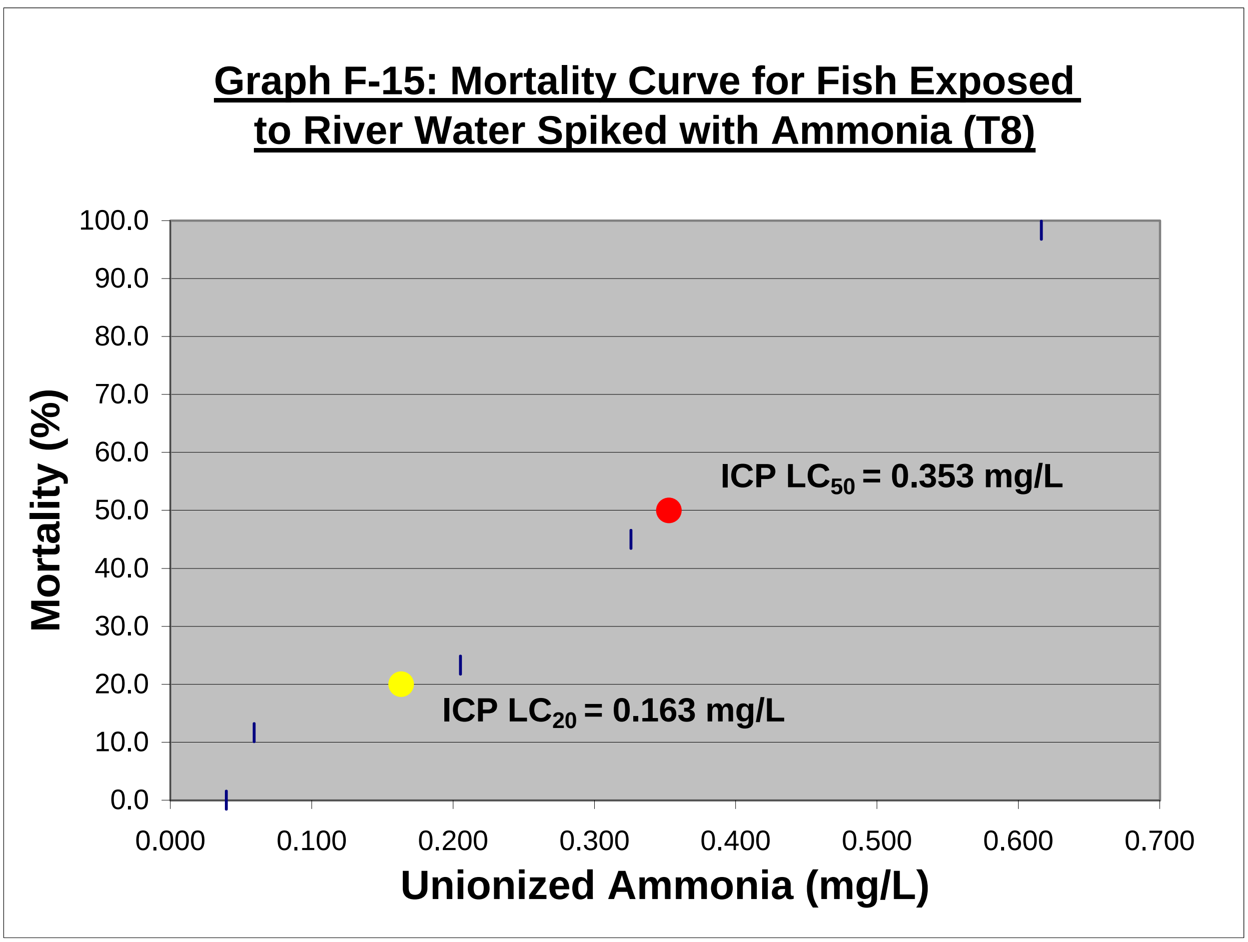
*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 80% of the control response mean.

TABLE F-15: MORTALITY OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T8)

Test-Description: 30 day chronic-exposure test; flow-through
Test-Species: juvenile channel catfish

	Avg. NH_3 (mg/L)	Mortality (%) Rep.A	Rep.B	Rep.C	Rep.D	Avg. Mortality (%)	SD of % Mortality
control	0.007	0.0	0.0	0.0	0.0	0.0	0.0
conc.1	0.021	0.0	0.0	0.0	0.0	0.0	0.0
conc.2	**0.039**	0.0	0.0	0.0	0.0	**0.0**	0.0
conc.3	**0.059**	0.0	0.0	20.0	26.7	**11.7**	13.8
conc.4	**0.205**	13.3	40.0	6.7	33.3	**23.3**	15.9
conc.5	**0.326**	20.0	46.7	40.0	73.3	**45.0**	22.0
conc.6	**0.616**	93.3	100.0	100.0	100.0	**98.3**	3.3

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-13, Appendix E-2.
2. (a) Test-Temperature (mean) = 8.6°C (b) Test-pH (min-max): 7.9-8.7
3. SD = standard deviation
4. Data plotted on Graph F-15 are highlighted in bold-type.



<u>ICPIN PRINTOUT FOR T8</u> – survival data

Test-Description: 30 day chronic-exposure test; flow-through
Test-Treatment: RW spiked with NH_3
Test-Species: juvenile channel catfish

LC_{50}

DATA FILE: T8surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.007	100.000	0.000	100.000
2	4	0.021	100.000	0.000	100.000
3	4	0.039	100.000	0.000	100.000
4	4	0.059	88.325	13.756	88.325
5	4	0.205	76.675	15.858	76.675
6	4	0.326	55.000	22.013	55.000
7	4	0.616	1.675	3.350	1.675

The Linear Interpolation Estimate: 0.3529 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.3519 Standard Deviation: 0.0348
Original Confidence Limits: Lower: 0.2870 Upper: 0.4076
Expanded Confidence Limits: Lower: 0.2475 Upper: 0.4404
Resampling time in Seconds: 0.05 Random_Seed: 307455177

LC_{20}

DATA FILE: T8surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.007	100.000	0.000	100.000
2	4	0.021	100.000	0.000	100.000
3	4	0.039	100.000	0.000	100.000
4	4	0.059	88.325	13.756	88.325
5	4	0.205	76.675	15.858	76.675
6	4	0.326	55.000	22.013	55.000
7	4	0.616	1.675	3.350	1.675

The Linear Interpolation Estimate: 0.1634 Entered P Value: 20

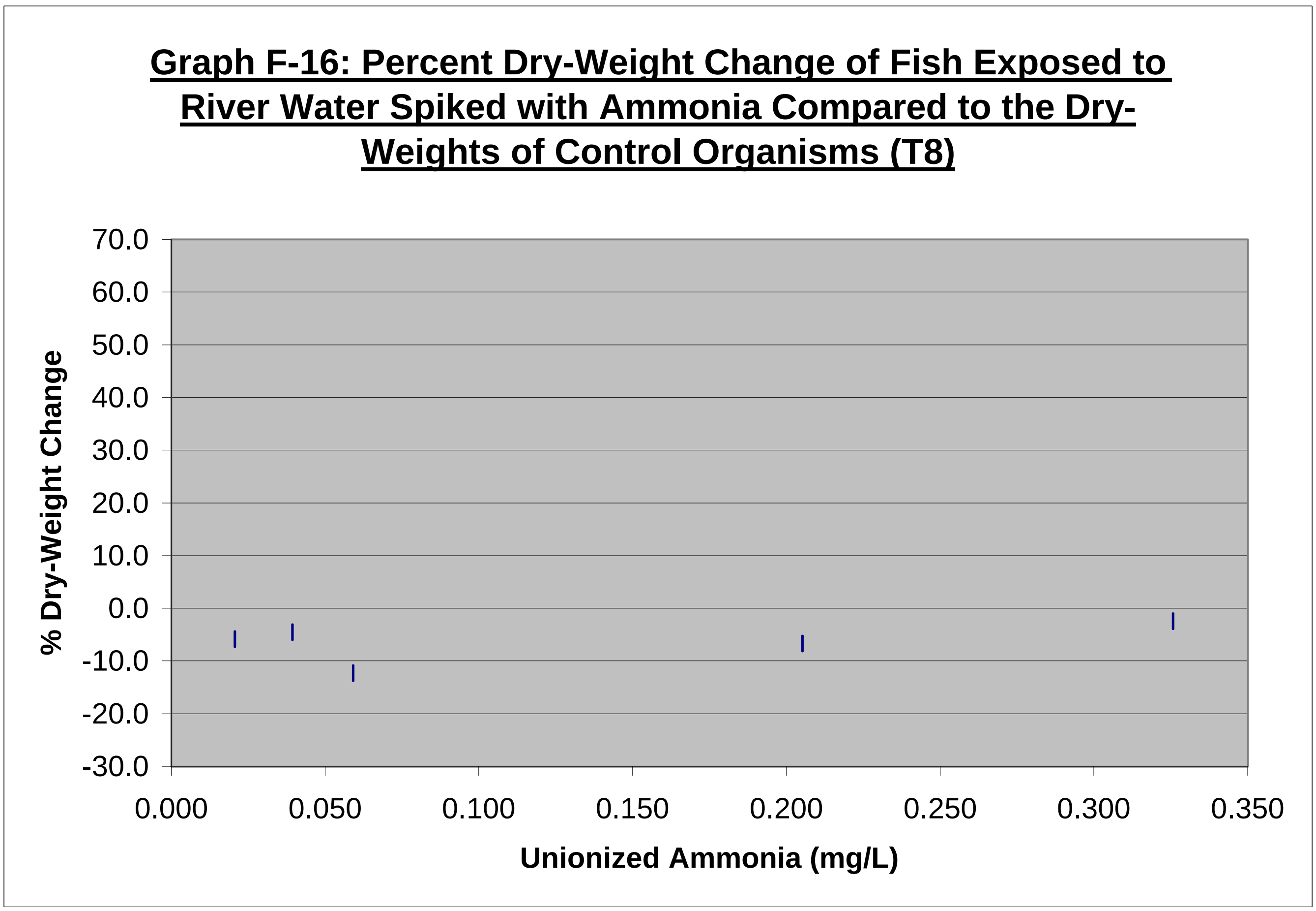
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.1620 Standard Deviation: 0.0537
Original Confidence Limits: Lower: 0.0562 Upper: 0.2418
Expanded Confidence Limits: Lower: -0.0081 Upper: 0.2888
Resampling time in Seconds: 0.00 Random_Seed: 1358633225

TABLE F-16: WEIGHT OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T8)

Test-Description: 30 day chronic-exposure test; flow-through
Test-Species: juvenile channel catfish

	Avg. NH_3 (mg/L)	Dry-weight per fish (mg)				Avg.dry- weight per fish (mg)	SD of Weight (mg)	% weight change compared to controls
		Rep.A	Rep.B	Rep.C	Rep.D			
control	0.007	938	1232	1104	1030	1076	124.4	
conc.1	**0.021**	849	1097	1018	1088	1013	115.0	**-5.9**
conc.2	**0.039**	1003	1072	1019	1015	1027	30.6	**-4.5**
conc.3	**0.059**	963	1110	917	784	943	134.3	**-12.3**
conc.4	**0.205**	977	942	999	1098	1004	66.9	**-6.7**
conc.5	**0.326**	916	1111	1132	1040	1050	97.3	**-2.4**
conc.6	0.616	1514				1514		40.7

Notes: 1. Concentration 6 was removed from the dataset because the observed response was an outlier.
2. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-13, Appendix E-2.
3. (a) Test-Temperature (mean) = 8.6^{o}C (b) Test-pH (min-max): 7.9-8.7
4. SD = standard deviation
5. Data plotted on Graph F-16 are highlighted in bold-type.



ICPIN PRINTOUT FOR T8 - growth data based on final dry weights/fish

Test-Description: 30 day chronic-exposure test; flow-through
Test-Treatment: RW spiked with NH_3
Test-Species: juvenile channel catfish

EC_{50}

DATA FILE: T8grow.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.007	1075.950	124.411	1075.950
2	4	0.021	1012.750	114.955	1020.075
3	4	0.039	1027.400	30.625	1020.075
4	4	0.059	943.375	134.287	973.613
5	4	0.205	1003.850	66.916	973.613
6	4	0.326	1039.900	100.556	995.708

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 50% of the control response mean.

EC_{20}

DATA FILE: T8grow.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.007	1075.950	124.411	1075.950
2	4	0.021	1012.750	114.955	1020.075
3	4	0.039	1027.400	30.625	1020.075
4	4	0.059	943.375	134.287	995.708
5	4	0.205	1003.850	66.916	995.708
6	4	0.326	1039.900	100.556	995.708

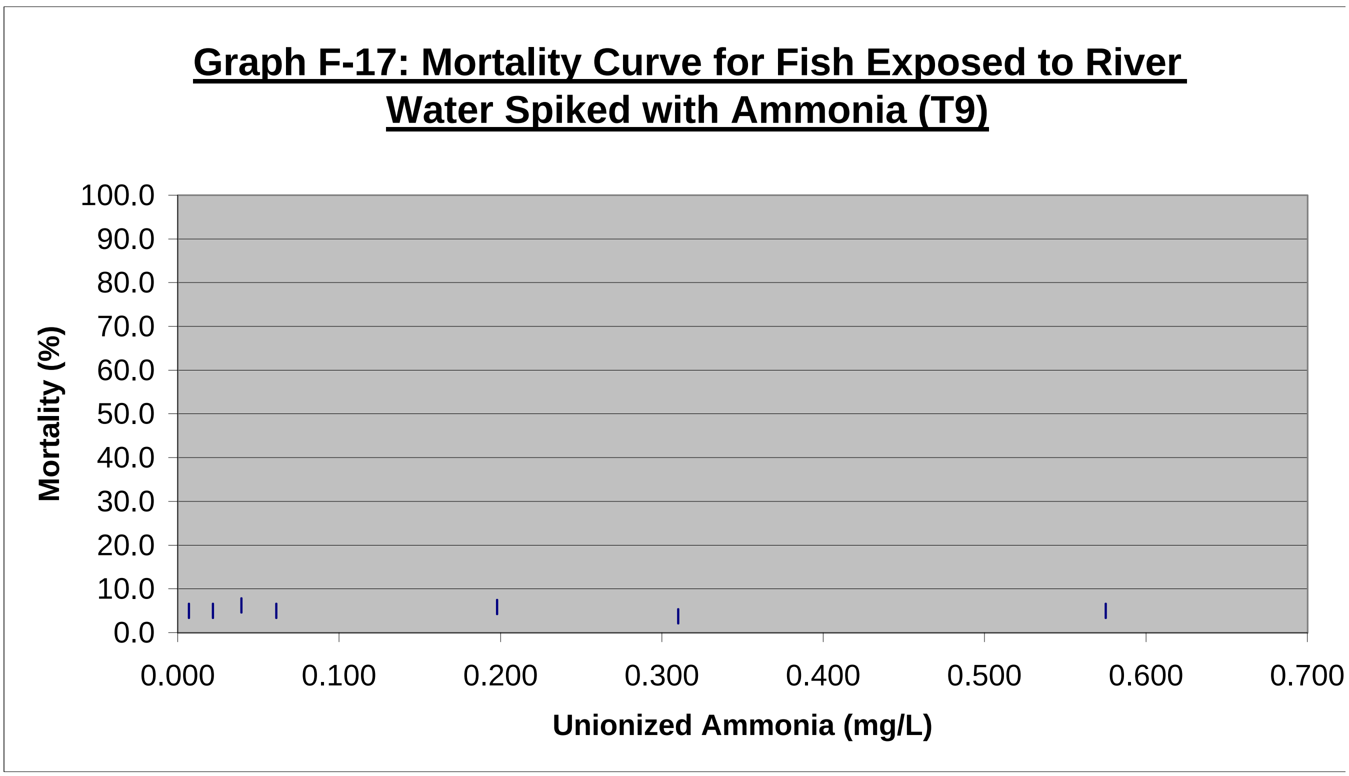
*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 80% of the control response mean.

TABLE F-17: MORTALITY OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T9)

Test-Description: 30 day chronic-exposure test; flow-through
Test-Species: juvenile (three-month-old) fathead minnow

	Avg. NH_3 (mg/L)	Percent Mortality				Avg. Mortality (%)	SD of % Mortality	Smoothed %-Mortality	Adjusted %-Mortality
		Rep.A	Rep.B	Rep.C	Rep.D				
control	**0.007**	0.0	10.0	0.0	10.0	**5.0**	5.8	5.0	0.0
conc.1	**0.022**	*	5.0	5.0	5.0	**5.0**	0.0	5.0	0.0
conc.2	**0.039**	5.0	5.0	10.0	5.0	**6.3**	2.5	5.2	0.2
conc.3	**0.061**	10.0	0.0	10.0	0.0	**5.0**	5.8	5.2	0.2
conc.4	**0.198**	0.0	5.0	5.0	13.3	**5.8**	5.5	5.2	0.2
conc.5	**0.310**	5.0	0.0	5.0	5.0	**3.8**	2.5	5.2	0.2
conc.6	**0.575**	0.0	10.0	10.0	0.0	**5.0**	5.8	5.2	0.2

Notes: 1. * Removed from dataset because of accidental ammonia spike in test-solution.
2. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-14, Appendix E-2.
3. (a) Test-Temperature (mean) = 8.3^{o}C (b) Test-pH (min-max): 7.9-8.6
4. SD = standard deviation
5. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
6. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
7. Data plotted on Graph F-17 are highlighted in bold-type.



ICPIN PRINTOUT FOR T9 – survival data

Test-Description: 30 day chronic-exposure test; flow-through
Test-Treatment: RW spiked with NH_3
Test-Species: juvenile (three-month-old) fathead minnow

LC_{50}

DATA FILE: T9surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.007	95.000	5.774	95.000
2	3	0.022	95.000	0.000	95.000
3	4	0.039	93.750	2.500	94.835
4	4	0.061	95.000	5.774	94.835
5	4	0.198	94.175	5.513	94.835
6	4	0.310	96.250	2.500	94.835
7	4	0.575	95.000	5.774	94.835

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 50% of the control response mean.

LC_{20}

DATA FILE: T9surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.007	95.000	5.774	95.000
2	3	0.022	95.000	0.000	95.000
3	4	0.039	93.750	2.500	94.835
4	4	0.061	95.000	5.774	94.835
5	4	0.198	94.175	5.513	94.835
6	4	0.310	96.250	2.500	94.835
7	4	0.575	95.000	5.774	94.835

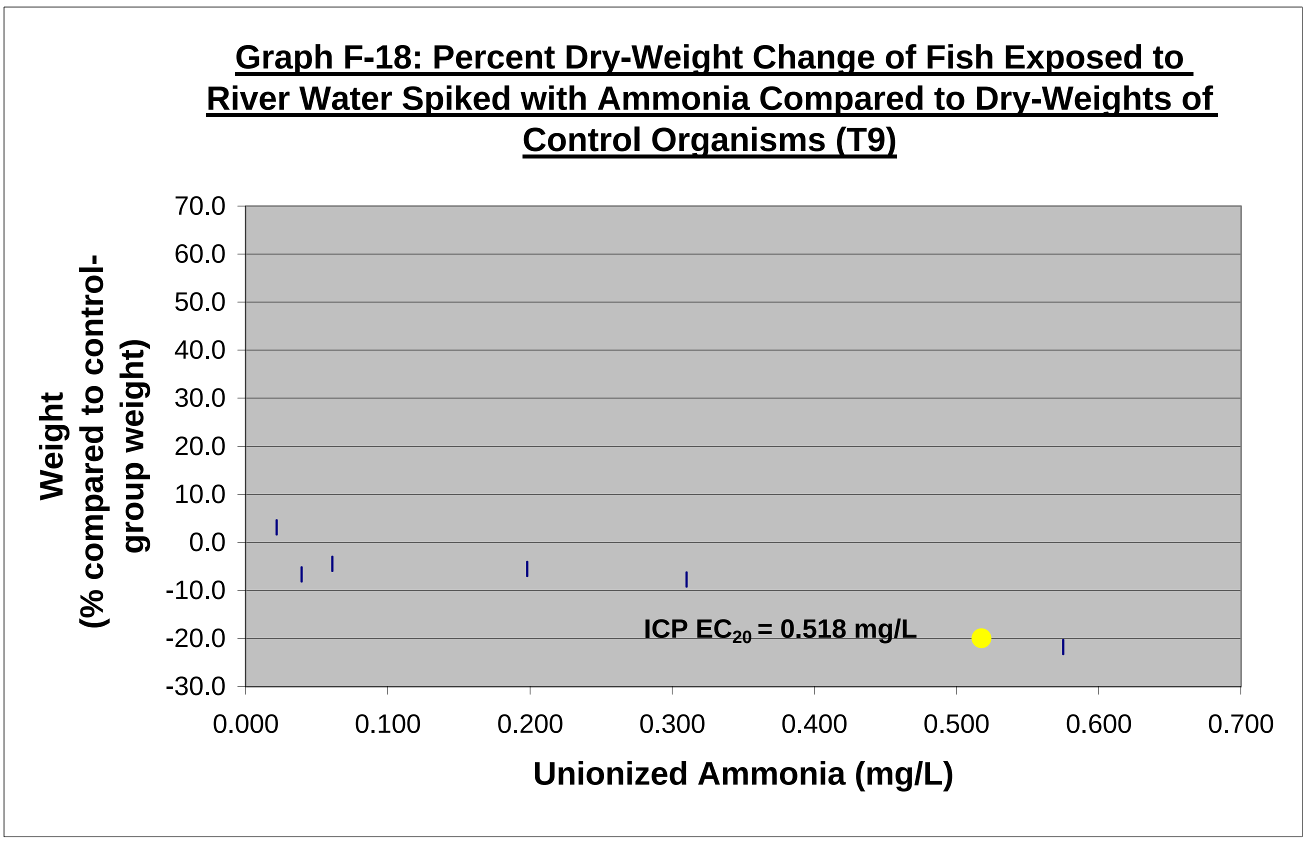
*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 80% of the control response mean.

TABLE F-18: WEIGHT OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T9)

Test-Description: 30 day chronic-exposure test; flow-through
Test-Species: juvenile (three-month-old) fathead minnow

	Avg. NH_3 (mg/L)	Dry-weight per fish (mg)				Avg.dry- weight per fish (mg)	SD of Weight (mg)	% weight change compared to controls
		Rep.A	Rep.B	Rep.C	Rep.D			
control	**0.007**	330	305	307	326	317	13.0	
conc.1	**0.022**	312	331	300	364	327	27.7	**3.1**
conc.2	**0.039**	304	284	307	289	296	11.3	**-6.7**
conc.3	**0.061**	272	320	297	322	303	23.5	**-4.5**
conc.4	**0.198**	290	317	302	290	300	12.7	**-5.5**
conc.5	**0.310**	284	314	295	277	292	16.3	**-7.8**
conc.6	**0.575**	243	235	235	279	248	20.7	**-21.8**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-14, Appendix E-2.
2. (a) Test-Temperature (mean) = 8.3°C (b) Test-pH (min-max): 7.9-8.6
3. SD = standard deviation
4. Smoothed means that any adjacent pair of 'dry-weight' data that did not decrease monotonically were replaced with their average.
5. Data plotted on Graph F-18 are highlighted in bold-type.



ICPIN PRINTOUT FOR T9 – growth data based on final dry weights/fish

Test-Description: 30 day chronic-exposure test; flow-through
Test-Treatment: River water spiked with ammonia
Test-Species: juvenile fathead minnow (three-month old)

EC_{50}

DATA FILE: T9grow.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.007	317.050	13.044	321.938
2	4	0.022	326.825	27.664	321.938
3	4	0.039	295.825	11.346	299.400
4	4	0.061	302.850	23.501	299.400
5	4	0.198	299.525	12.670	299.400
6	4	0.310	292.475	16.271	292.475
7	4	0.575	247.925	20.742	247.925

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 50% of the control response mean.

EC_{20}

DATA FILE: T9grow.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.007	317.050	13.044	321.938
2	4	0.022	326.825	27.664	321.938
3	4	0.039	295.825	11.346	299.400
4	4	0.061	302.850	23.501	299.400
5	4	0.198	299.525	12.670	299.400
6	4	0.310	292.475	16.271	292.475
7	4	0.575	247.925	20.742	247.925

The Linear Interpolation Estimate: 0.5176 Entered P Value: 20

Number of Resamplings: 80 70 Resamples Generated
Those resamples not used had estimates
above the highest concentration/ %Effluent.
The Bootstrap Estimates Mean: 0.4917 Standard Deviation: 0.0350

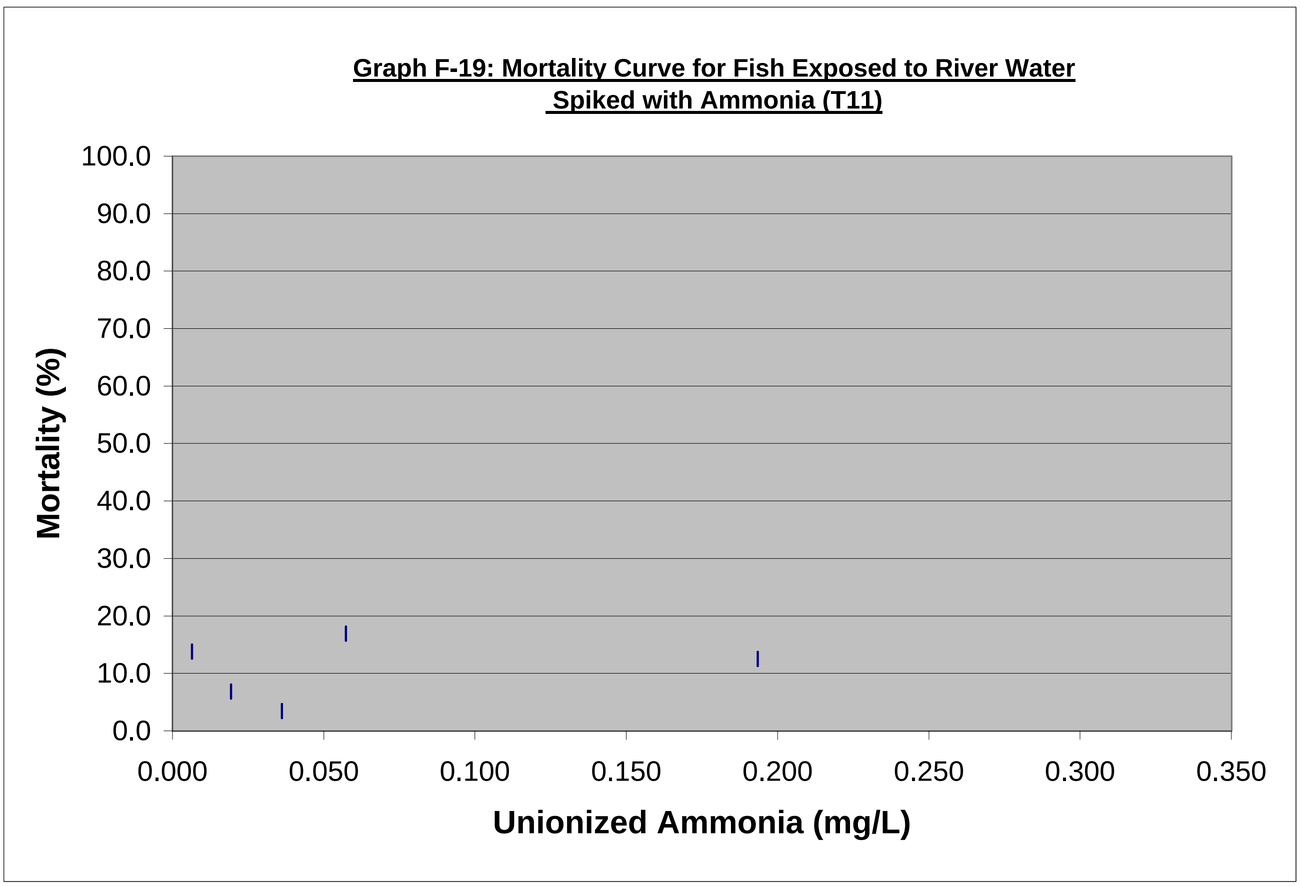
No Confidence Limits can be produced since the number of resamples generated is not a multiple of 40.
Resampling time in Seconds: 0.00 Random_Seed: -216123574

TABLE F-19: MORTALITY OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T11)

Test-Description: 29 day chronic-exposure test; flow-through
Test Species: juvenile (one-month-old) fathead minnow

	Avg. NH_3 (mg/L)	Percent Mortality Rep.A	Rep.B	Rep.C	Rep.D	Avg. Percent Mortality	SD of % Mortality	Smoothed %-Mortality	Adjusted %-Mortality
control	**0.006**	21.4	0.0	7.1	26.7	**13.8**	12.4	8.0	0.0
conc.1	**0.019**	*	7.1	6.7	6.7	**6.8**	0.3	8.0	0.0
conc.2	**0.036**	7.1	0.0	0.0	6.7	**3.5**	4.0	8.0	0.0
conc.3	**0.057**	6.7	0.0	14.3	46.7	**16.9**	20.7	12.0	4.3
conc.4	**0.193**	13.3	13.3	6.7	16.7	**12.5**	4.2	12.0	4.3
conc.5	**0.303**	13.3	6.7	6.7	0.0	**6.7**	5.4	12.0	4.3

Notes: 1. * Removed from dataset because of accidental ammonia spike in test-solution.
2. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-15, Appendix E-2.
3. (a) Test-Temperature (mean) = 7.1^{o}C (b) Test-pH (min-max): 8.3-8.6
4. SD = standard deviation
5. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
6. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
7. Data plotted on Graph F-19 are highlighted in bold-type.



<u>ICPIN PRINTOUT FOR T11</u> – survival data

Test-Description: 29 day chronic-exposure test; flow-through
Test-Treatment: RW spiked with NH_3
Test-Species: juvenile (one-month-old) fathead minnow

LC_{50}

DATA FILE: T11surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.006	86.200	12.376	91.864
2	3	0.019	93.167	0.231	91.864
3	4	0.036	96.550	3.987	91.864
4	4	0.057	83.075	20.692	87.967
5	4	0.193	87.500	4.186	87.967
6	4	0.303	93.325	5.430	87.967

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 50% of the control response mean.

LC_{20}

DATA FILE: T11surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.006	86.200	12.376	91.864
2	3	0.019	93.167	0.231	91.864
3	4	0.036	96.550	3.987	91.864
4	4	0.057	83.075	20.692	87.967
5	4	0.193	87.500	4.186	87.967
6	4	0.303	93.325	5.430	87.967

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 80% of the control response mean.

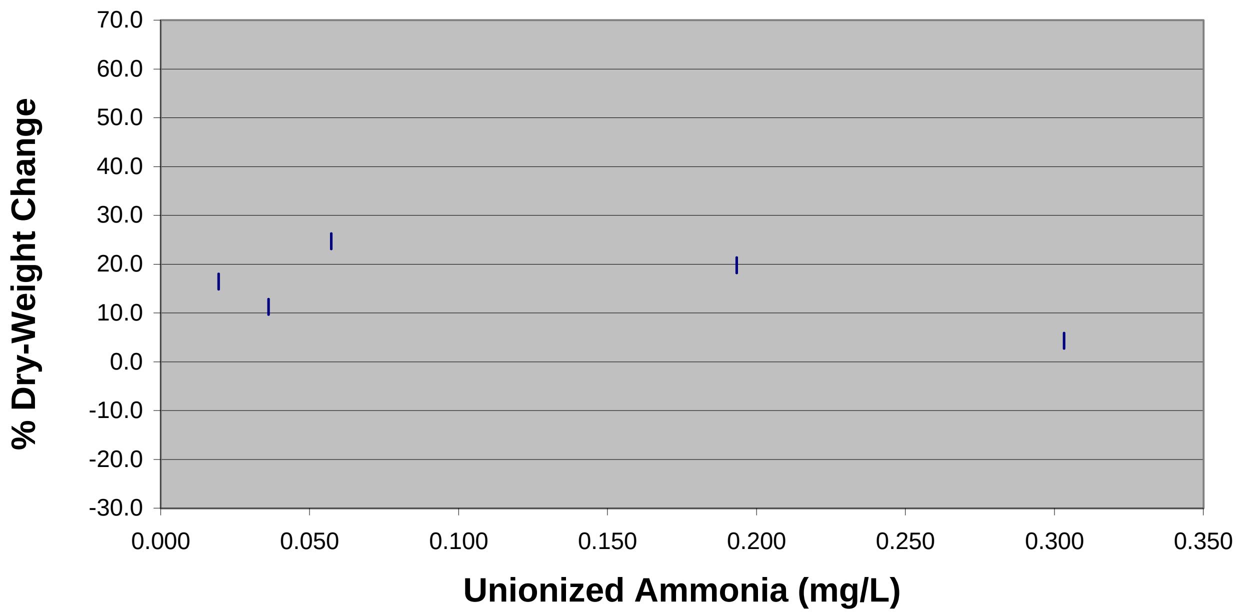
TABLE F-20: WEIGHT OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T11)

Test-Description: 29 day chronic-exposure test; flow-through
Test Species: juvenile (one-month-old) fathead minnow

	Avg. NH_3 (mg/L)	Dry-weight per fish (mg)				Avg.dry- weight per fish (mg)	SD of Weight (mg)	% weight change compared to controls
		Rep.A	Rep.B	Rep.C	Rep.D			
control	0.006	8.3	11.1	10.9	14.2	11.1	2.4	
conc.1	**0.019**	10.5	12.8	11.5	17.0	13.0	2.9	**16.4**
conc.2	**0.036**	11.2	11.2	12.4	14.7	12.4	1.7	**11.2**
conc.3	**0.057**	12.0	8.6	14.3	20.6	13.9	5.1	**24.7**
conc.4	**0.193**	11.5	13.5	14.1	14.2	13.3	1.3	**19.8**
conc.5	**0.303**	9.4	14.8	10.3	11.9	11.6	2.4	**4.3**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-15, Appendix E-2.
2. (a) Test-Temperature (mean) = 7.1^{o}C (b) Test-pH (min-max): 8.3-8.6
3. SD = standard deviation
4. Data plotted on Graph F-20 are highlighted in bold-type.

Graph F-20: Percent Dry-Weight Change of Fish Exposed to River Water Spiked with Ammonia Compared to Dry-Weights of Control Organisms (T11)



<u>ICPIN PRINTOUT FOR T11</u> – growth data based on final dry weights/fish

Test-Description: 29 day chronic-exposure test; flow-through
Test-Treatment: RW spiked with NH_3
Test-Species: juvenile (one-month-old) fathead minnow

EC_{50}

DATA FILE: T11grow.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.006	11.125	2.414	12.730
2	4	0.019	12.950	2.859	12.730
3	4	0.036	12.375	1.650	12.730
4	4	0.057	13.875	5.058	12.730
5	4	0.193	13.325	1.255	12.730
6	4	0.303	11.600	2.371	11.600

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 50% of the control response mean.

EC_{20}

DATA FILE: T11grow.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.006	11.125	2.414	12.730
2	4	0.019	12.950	2.859	12.730
3	4	0.036	12.375	1.650	12.730
4	4	0.057	13.875	5.058	12.730
5	4	0.193	13.325	1.255	12.730
6	4	0.303	11.600	2.371	11.600

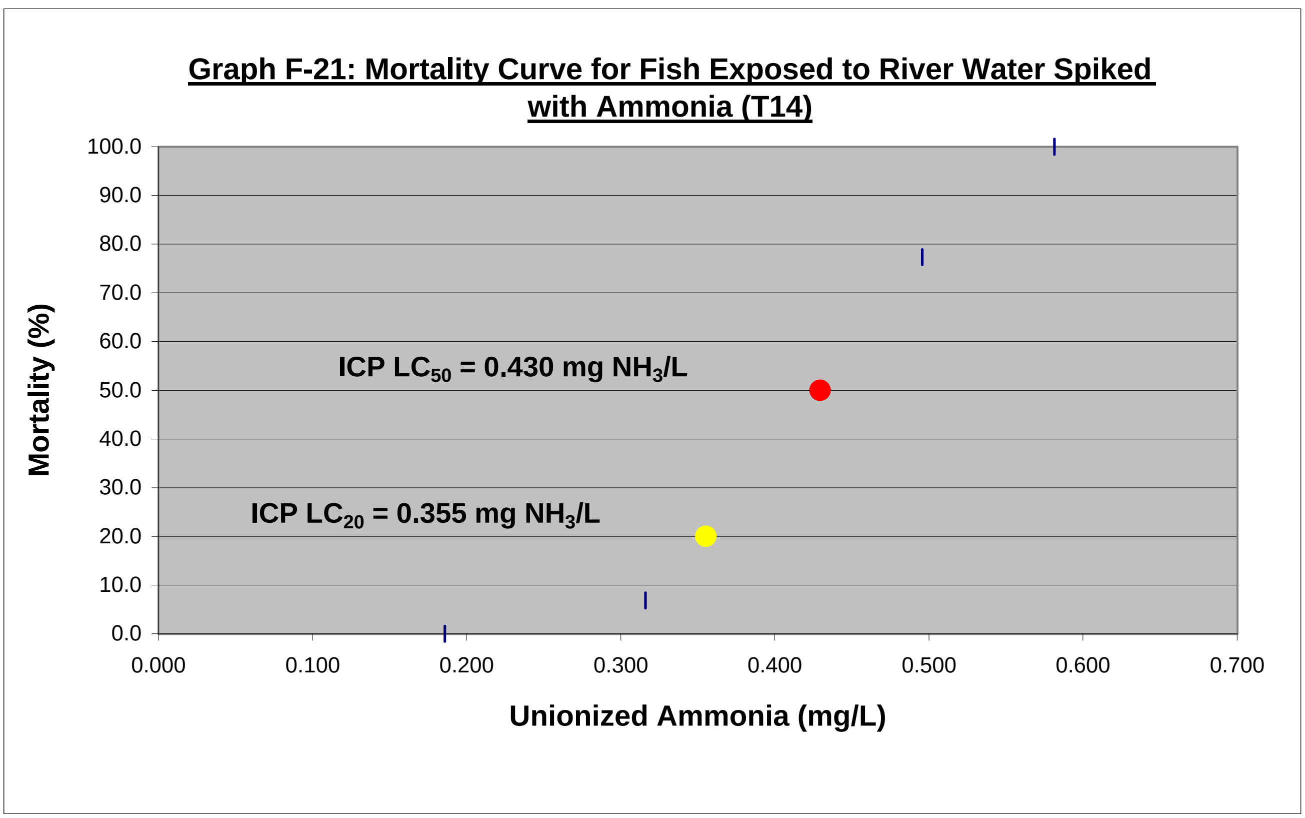
*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 80% of the control response mean.

TABLE F-21: MORTALITY OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T14 - 5 day)

Test-Description: 5 day chronic-exposure test; flow-through
Test-Species: lake whitefish - disease-free

	Avg. NH_3 (mg/L)	Mortality (%)				Avg. Mortality (%)	SD of % Mortality	Smoothed %-Mortality	Adjusted %-Mortality
		Rep.A	Rep.B	Rep.C	Rep.D				
control	0.026		0.0	16.7	8.3	8.3	8.4	8.3	0.0
conc.1	0.052	8.3	16.7	16.7	16.7	14.6	4.2	8.3	0.0
conc.2	0.101	8.3	0.0	0.0	8.3	4.2	4.8	8.3	0.0
conc.3	**0.186**	8.3	8.3	8.3	0.0	6.2	4.2	8.3	**0.0**
conc.4	**0.316**	0.0	25.0	25.0	8.3	14.6	12.5	14.6	**6.8**
conc.5	**0.495**	75.0	91.7	75.0	75.0	79.2	8.3	79.2	**77.3**
conc.6	**0.581**	100.0	100.0	100.0	100.0	100.0	0.0	100.0	**100.0**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-16, Appendix E-2.
2. (a) Test-Temperature (mean) = 14.3°C (b) Test-pH (min-max): 8.2-8.6
3. SD = standard deviation
4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
6. Data plotted on Graph F-21 are highlighted in bold-type.



Graph F-21: Mortality Curve for Fish Exposed to River Water Spiked with Ammonia (T14)

<u>ICPIN PRINTOUT FOR T14</u> – survival data

Test-Description: 5-day chronic-exposure test; flow-through
Test-Treatment: RW spiked with NH_3
Test-Species: lake whitefish fry, disease-free

LC_{50}

DATA FILE: Y2K2surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.026	81.250	21.921	89.069
2	4	0.052	85.400	4.200	89.069
3	4	0.101	95.850	4.792	89.069
4	4	0.186	93.775	4.150	89.069
5	4	0.316	85.425	12.506	85.425
6	4	0.495	20.825	8.350	20.825
7	4	0.581	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.4295 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.4280 Standard Deviation: 0.0081
Original Confidence Limits: Lower: 0.4120 Upper: 0.4413
Expanded Confidence Limits: Lower: 0.4015 Upper: 0.4484
Resampling time in Seconds: 0.00 Random_Seed: 1918889093

LC_{20}

DATA FILE: Y2K2surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.026	81.250	21.921	89.069
2	4	0.052	85.400	4.200	89.069
3	4	0.101	95.850	4.792	89.069
4	4	0.186	93.775	4.150	89.069
5	4	0.316	85.425	12.506	85.425
6	4	0.495	20.825	8.350	20.825
7	4	0.581	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.3552 Entered P Value: 20

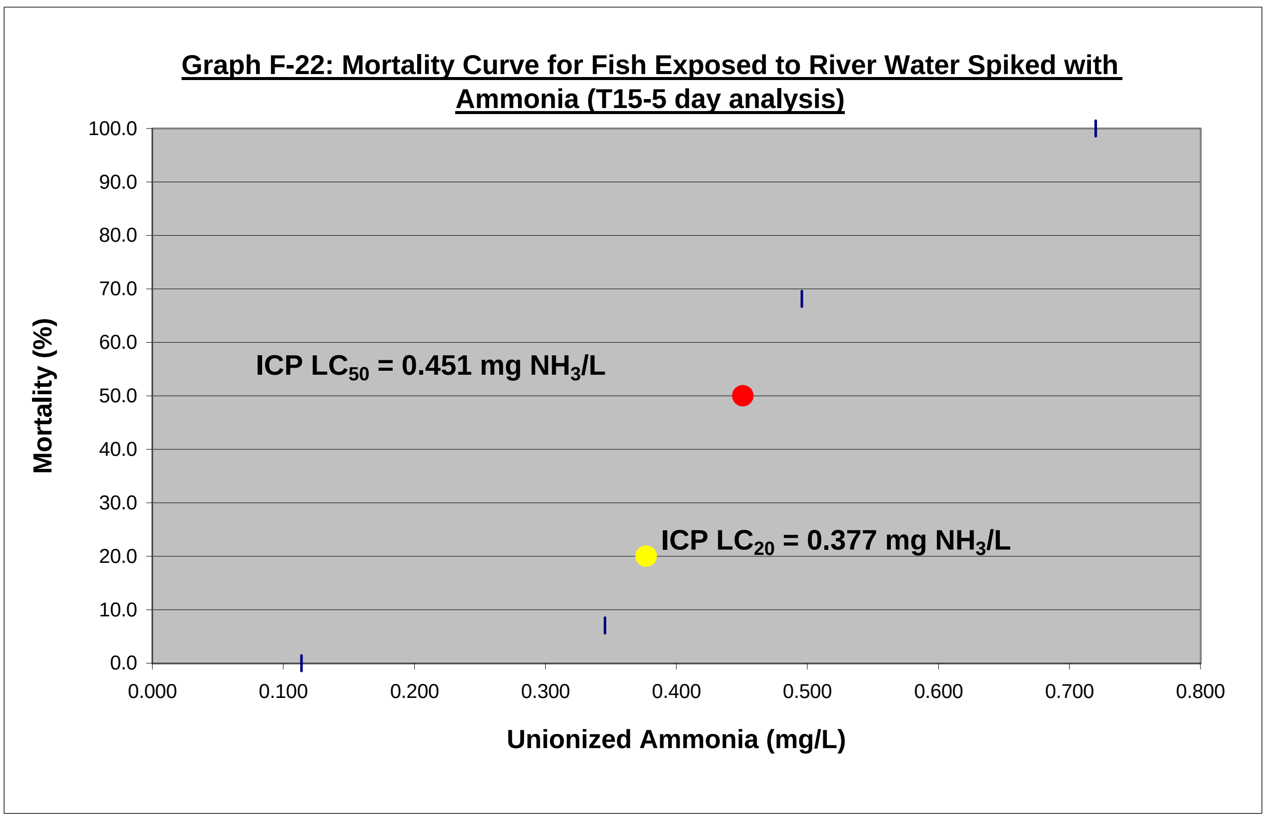
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.3518 Standard Deviation: 0.0121
Original Confidence Limits: Lower: 0.3230 Upper: 0.3658
Expanded Confidence Limits: Lower: 0.3036 Upper: 0.3722
Resampling time in Seconds: 0.00 Random_Seed: -1801475003

TABLE F-22: MORTALITY OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T15 - 5 day)

Test-Description: 5 day chronic-exposure test; flow-through
Test-Species: lake whitefish - treated for a fungal infection prior to test-start

	Avg. NH_3	Mortality (%)				Avg. Mortality	SD of %	Smoothed	Adjusted
	(mg/L)	Rep.A	Rep.B	Rep.C	Rep.D	(%)	Mortality	%-Mortality	%-Mortality
control	0.018	0.0	15.0	10.0	0.0	6.3	7.5	5.8	0.0
conc.1	0.060	0.0	10.0	15.0	0.0	6.3	7.5	5.8	0.0
conc.2	**0.114**	5.0	10.0	5.0	0.0	5.0	4.1	5.8	**0.0**
conc.3	**0.345**	5.0	15.0	25.0	5.0	12.5	9.6	12.5	**7.1**
conc.4	**0.496**	80.0	70.0	65.0	65.0	70.0	7.1	70.0	**68.1**
conc.5	**0.720**	100.0	100.0	100.0	100.0	100.0	0.0	100.0	**100.0**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-17, Appendix E-2.
2. (a) Test-Temperature (mean) = 15.8^{o}C (b) Test-pH (min-max): 8.2-8.6
3. SD = standard deviation
4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
6. Data plotted on Graph F-22 are highlighted in bold-type.



<u>ICPIN PRINTOUT FOR T15-5 day</u> – survival data

Test-Description: 5-day chronic-exposure test; flow-through
Test-Treatment: RW spiked with NH_3
Test-Species: lake whitefish fry, treated for a fungal infection prior to test-start

LC_{50}

DATA FILE: Y2K3srv2.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.018	93.750	7.500	94.167
2	4	0.060	93.750	7.500	94.167
3	4	0.114	95.000	4.082	94.167
4	4	0.345	87.500	9.574	87.500
5	4	0.496	30.000	7.071	30.000
6	4	0.720	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.4509 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.4498 Standard Deviation: 0.0071
Original Confidence Limits: Lower: 0.4381 Upper: 0.4636
Expanded Confidence Limits: Lower: 0.4305 Upper: 0.4712
Resampling time in Seconds: 0.05 Random_Seed: 494404128

LC_{20}

DATA FILE: Y2K3srv2.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.018	93.750	7.500	94.167
2	4	0.060	93.750	7.500	94.167
3	4	0.114	95.000	4.082	94.167
4	4	0.345	87.500	9.574	87.500
5	4	0.496	30.000	7.071	30.000
6	4	0.720	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.3770 Entered P Value: 20

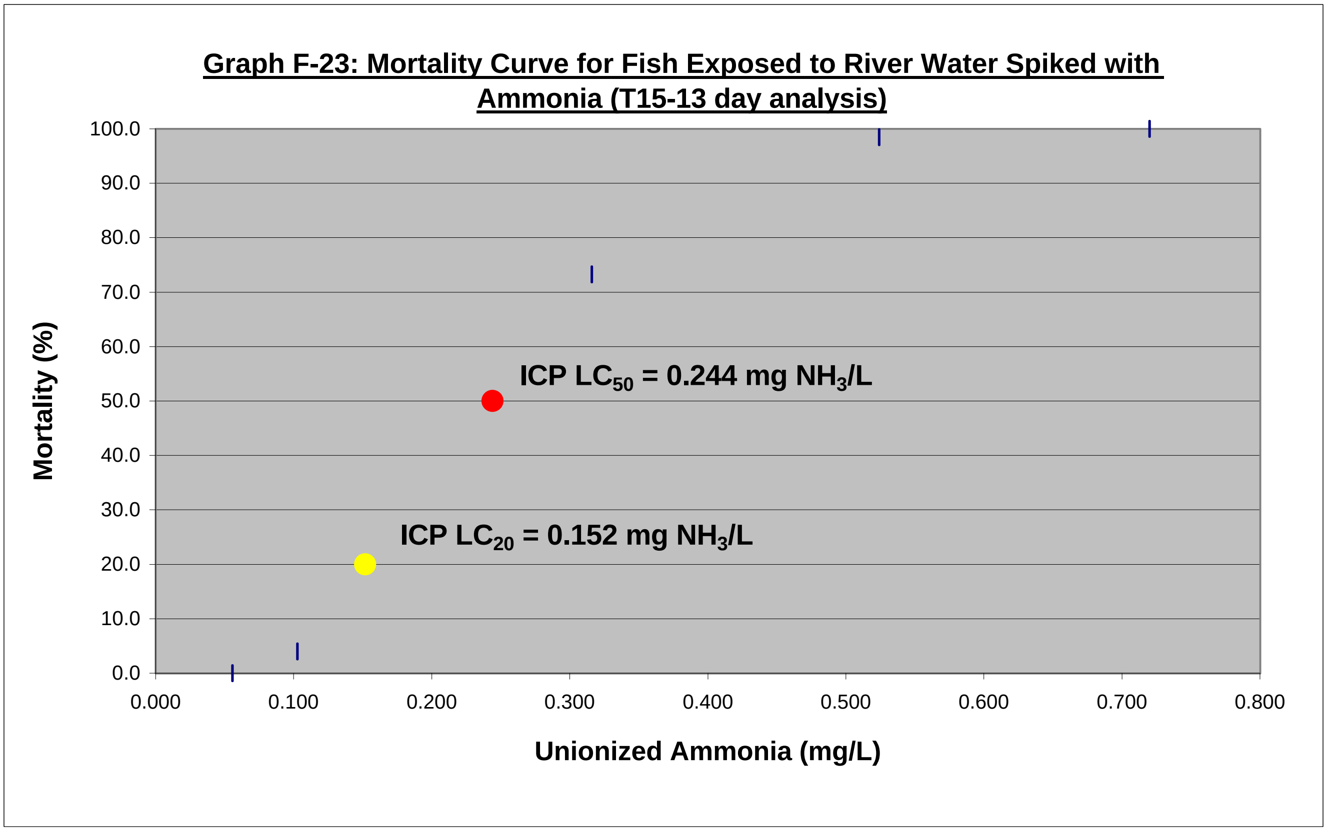
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.3757 Standard Deviation: 0.0088
Original Confidence Limits: Lower: 0.3578 Upper: 0.3919
Expanded Confidence Limits: Lower: 0.3463 Upper: 0.4008
Resampling time in Seconds: 0.05 Random_Seed: 690088608

TABLE F-23: MORTALITY OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T15 - 13 day)

Test-Description: 13 day chronic-exposure test; flow-through
Test-Species: lake whitefish - treated for a fungal infection prior to test-start

	Avg. NH_3 (mg/L)	Mortality (%)				Avg. Mortality (%)	SD of % Mortality	Smoothed %-Mortality	Adjusted %-Mortality
		Rep.A	Rep.B	Rep.C	Rep.D				
control	0.018	10.0	30.0	20.0	30.0	22.5	9.6	20.6	0.0
conc.1	**0.055**	10.0	20.0	35.0	10.0	18.8	11.8	20.6	**0.0**
conc.2	**0.102**	20.0	15.0	30.0	30.0	23.8	7.5	23.8	**4.0**
conc.3	**0.316**	85.0	80.0	65.0	85.0	78.8	9.5	78.8	**73.3**
conc.4	**0.524**	100.0	100.0	100.0	95.0	98.8	2.5	98.8	**98.5**
conc.5	**0.720**	100.0	100.0	100.0	100.0	100.0	0.0	100.0	**100.0**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-18, Appendix E-2.
2. (a) Test-Temperature (mean) = 16.1°C (b) Test-pH (min-max): 8.0-8.6
3. SD = standard deviation
4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
6. Data plotted on Graph F-23 are highlighted in bold-type.



ICPIN PRINTOUT FOR T15-13 day – survival data

Test-Description: 13-day chronic-exposure test; flow-through
Test-Treatment: RW spiked with NH_3
Test-Species: lake whitefish fry, treated for a fungal infection prior to test-start

LC_{50}

DATA FILE: Y2K3surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.018	77.500	9.574	79.375
2	4	0.055	81.250	11.815	79.375
3	4	0.102	76.250	7.500	76.250
4	4	0.316	21.250	9.465	21.250
5	4	0.524	1.250	2.500	1.250
6	4	0.720	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.2442 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.2420 Standard Deviation: 0.0108
Original Confidence Limits: Lower: 0.2165 Upper: 0.2645
Expanded Confidence Limits: Lower: 0.1999 Upper: 0.2767
Resampling time in Seconds: 0.00 Random_Seed: -364096775

LC_{20}

DATA FILE: Y2K3surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.018	77.500	9.574	79.375
2	4	0.055	81.250	11.815	79.375
3	4	0.102	76.250	7.500	76.250
4	4	0.316	21.250	9.465	21.250
5	4	0.524	1.250	2.500	1.250
6	4	0.720	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.1518 Entered P Value: 20

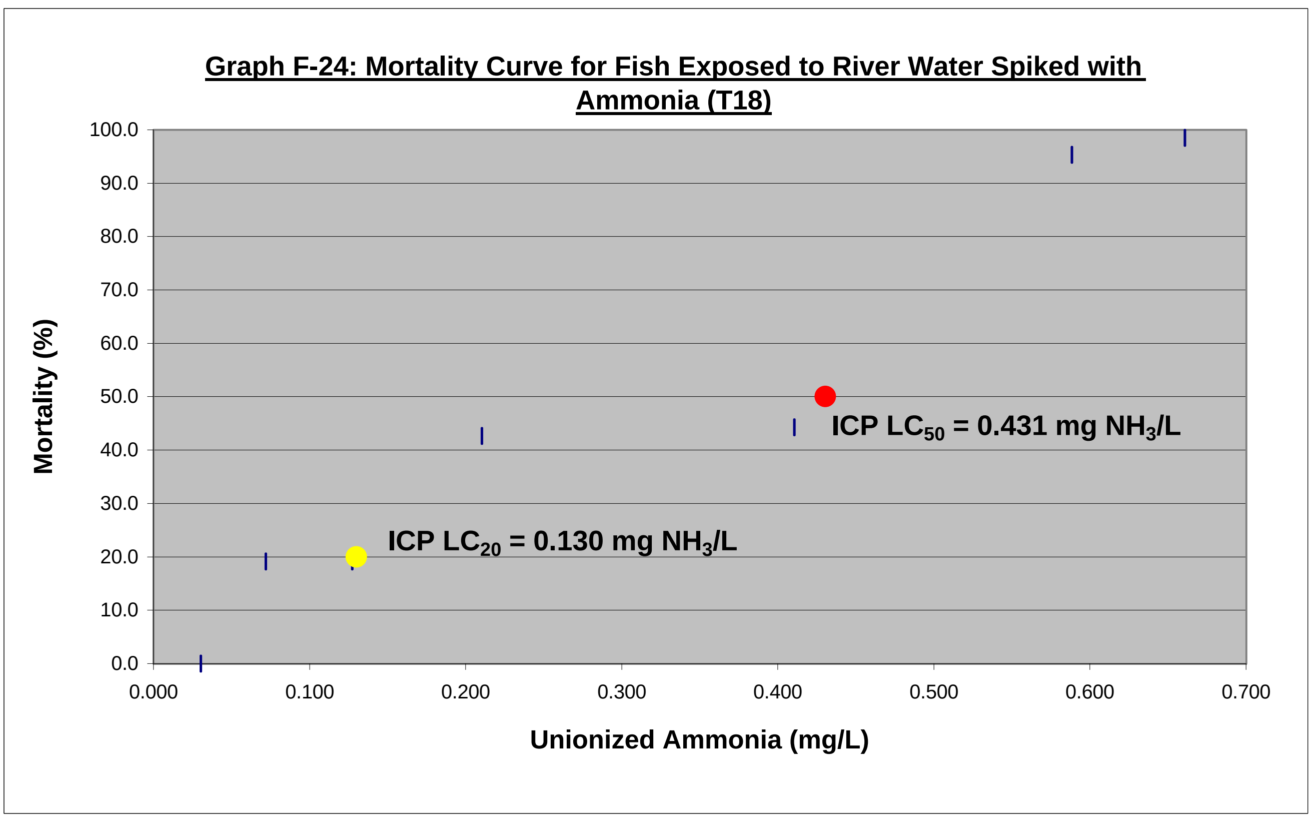
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.1497 Standard Deviation: 0.0125
Original Confidence Limits: Lower: 0.1237 Upper: 0.1698
Expanded Confidence Limits: Lower: 0.1069 Upper: 0.1806
Resampling time in Seconds: 0.05 Random_Seed: 1191677305

TABLE F-24: MORTALITY OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T18)

Test-Description: 12 day chronic-exposure test; flow-through
Test-Species: northern pike fry

	Avg. NH_3 (mg/L)	Mortality (%)				Avg. Mortality (%)	SD of % Mortality	Smoothed %-Mortality	Adjusted %-Mortality
		Rep.A	Rep.B	Rep.C	Rep.D				
control	**0.030**	15.0	18.8		27.8	20.5	6.6	20.5	**0.0**
conc.1	**0.072**	14.3	52.9	53.8	29.4	37.6	19.2	35.7	**19.2**
conc.2	**0.127**	26.3	15.8	60.0	33.3	33.9	18.9	35.7	**19.2**
conc.3	**0.210**	21.1	65.0	55.0	76.5	54.4	23.9	54.4	**42.6**
conc.4	**0.410**	65.0	52.6	45.0	60.0	55.7	8.7	55.7	**44.3**
conc.5	**0.588**	95.0	95.0	95.0	100.0	96.3	2.5	96.3	**95.3**
conc.6	**0.661**	100.0	95.0	100.0	100.0	98.8	2.5	98.8	**98.5**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-19, Appendix E-2.
2. (a) Test-Temperature (mean) = 16.7^oC (b) Test-pH (min-max): 7.8-8.6
3. SD = standard deviation
4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
6. Data plotted on Graph F-24 are highlighted in bold-type.



ICPIN PRINTOUT FOR T18 – survival data

Test-Description: 12-day chronic-exposure test; flow-through
Test-Treatment: RW spiked with NH_3
Test-Species: northern pike fry

LC_{50}

DATA FILE: Y2K6surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.030	79.500	6.587	79.500
2	4	0.072	62.400	19.206	64.275
3	4	0.127	66.150	18.859	64.275
4	4	0.210	45.600	23.875	45.600
5	4	0.410	44.350	8.738	44.350
6	4	0.588	3.750	2.500	3.750
7	4	0.661	1.250	2.500	1.250

The Linear Interpolation Estimate: 0.4306 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.3839 Standard Deviation: 0.0883
Original Confidence Limits: Lower: 0.1935 Upper: 0.4514
Expanded Confidence Limits: Lower: 0.0512 Upper: 0.4639
Resampling time in Seconds: 0.00 Random_Seed: -8215220

LC_{20}

DATA FILE: Y2K6surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.030	79.500	6.587	79.500
2	4	0.072	62.400	19.206	64.275
3	4	0.127	66.150	18.859	64.275
4	4	0.210	45.600	23.875	45.600
5	4	0.410	44.350	8.738	44.350
6	4	0.588	3.750	2.500	3.750
7	4	0.661	1.250	2.500	1.250

The Linear Interpolation Estimate: 0.1301 Entered P Value: 20

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.1108 Standard Deviation: 0.0443
Original Confidence Limits: Lower: 0.0567 Upper: 0.1688
Expanded Confidence Limits: Lower: 0.0126 Upper: 0.1920
Resampling time in Seconds: 0.00 Random_Seed: -255193124

TABLE F-25: WEIGHT OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T18)

Test-Description: 12 day chronic-exposure test; flow-through
Test-Species: northern pike fry

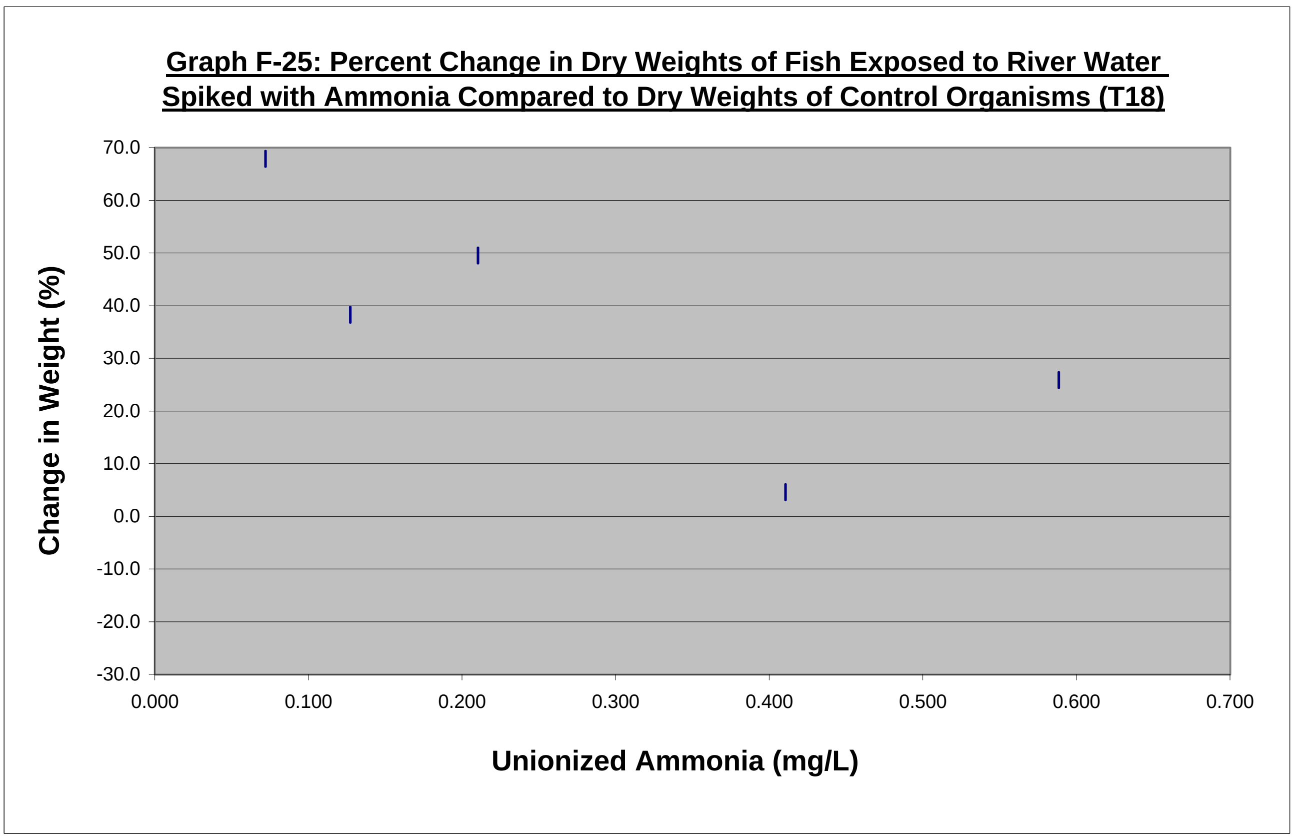
	Avg. NH_3 (mg/L)	Avg. dry weight per organism (mg)				Avg. dry weight per fish (mg)	SD of Weight (mg)	% change in weight compared to controls
		Rep.A	Rep.B	Rep.C	Rep.D			
control	0.030	3.6	5.9		5.2	4.9	1.2	
conc.1	**0.072**	6.9	8.5	8.3	9.2	8.2	1.0	**67.9**
conc.2	**0.127**	6	8.1	7.1	5.9	6.8	1.0	**38.3**
conc.3	**0.210**	5.7	5.4	6.3	11.9	7.3	3.1	**49.5**
conc.4	**0.410**	5.4	5.2	4.6	5.3	5.1	0.4	**4.6**
conc.5	**0.588**	1.8	6.8	9.9		6.2	4.1	**25.9**
conc.6	0.661							

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-19, Appendix E-2.

2. (a) Test-Temperature (mean) = 16.7°C (b) Test-pH (min-max): 7.8-8.6

3. SD = standard deviation

4. Data plotted on Graph F-25 are highlighted in bold-type.



<u>ICPIN PRINTOUT FOR T18</u> – growth data based on average dry weights/fish at test-termination

Test-Description: 12-day chronic-exposure test; flow-through
Test-Treatment: RW spiked with NH_3
Test-Species: northern pike fry

EC_{50}

DATA FILE: Y2K6grow.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.030	0.005	0.001	0.007
2	4	0.072	0.008	0.001	0.007
3	4	0.127	0.007	0.001	0.007
4	4	0.210	0.007	0.003	0.007
5	4	0.410	0.005	0.000	0.006
6	3	0.588	0.006	0.004	0.006

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 50% of the control response mean.

EC_{20}

DATA FILE: Y2K6grow.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.030	0.005	0.001	0.007
2	4	0.072	0.008	0.001	0.007
3	4	0.127	0.007	0.001	0.007
4	4	0.210	0.007	0.003	0.007
5	4	0.410	0.005	0.000	0.006
6	3	0.588	0.006	0.004	0.006

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 80% of the control response mean.

TABLE F-26: MORTALITY OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T20)

Test-Description: 30 day chronic-exposure test; flow-through
Test-Species: juvenile lake trout

	Avg. NH_3 (mg/L)	Mortality (%)			Avg. Mortality (%)	SD of % Mortality	Smoothed %-Mortality	Adjusted %-Mortality
		Rep.A	Rep.B	Rep.C				
control	**0.014**	10.0	15.4	5.3	10.2	5.1	10.2	**0.0**
conc.1	**0.028**	18.5	46.2	26.9	30.5	14.2	29.9	**22.0**
conc.2	**0.056**	24.0	46.2	44.4	38.2	12.3	29.9	**22.0**
conc.3	**0.106**	11.1	24.2	28.0	21.1	8.9	29.9	**22.0**
conc.4	**0.212**	44.4	51.9	19.2	38.5	17.1	38.5	**31.5**
conc.5	**0.298**	84.6	64.7	64.7	71.3	11.5	71.3	**68.0**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-20, Appendix E-2.

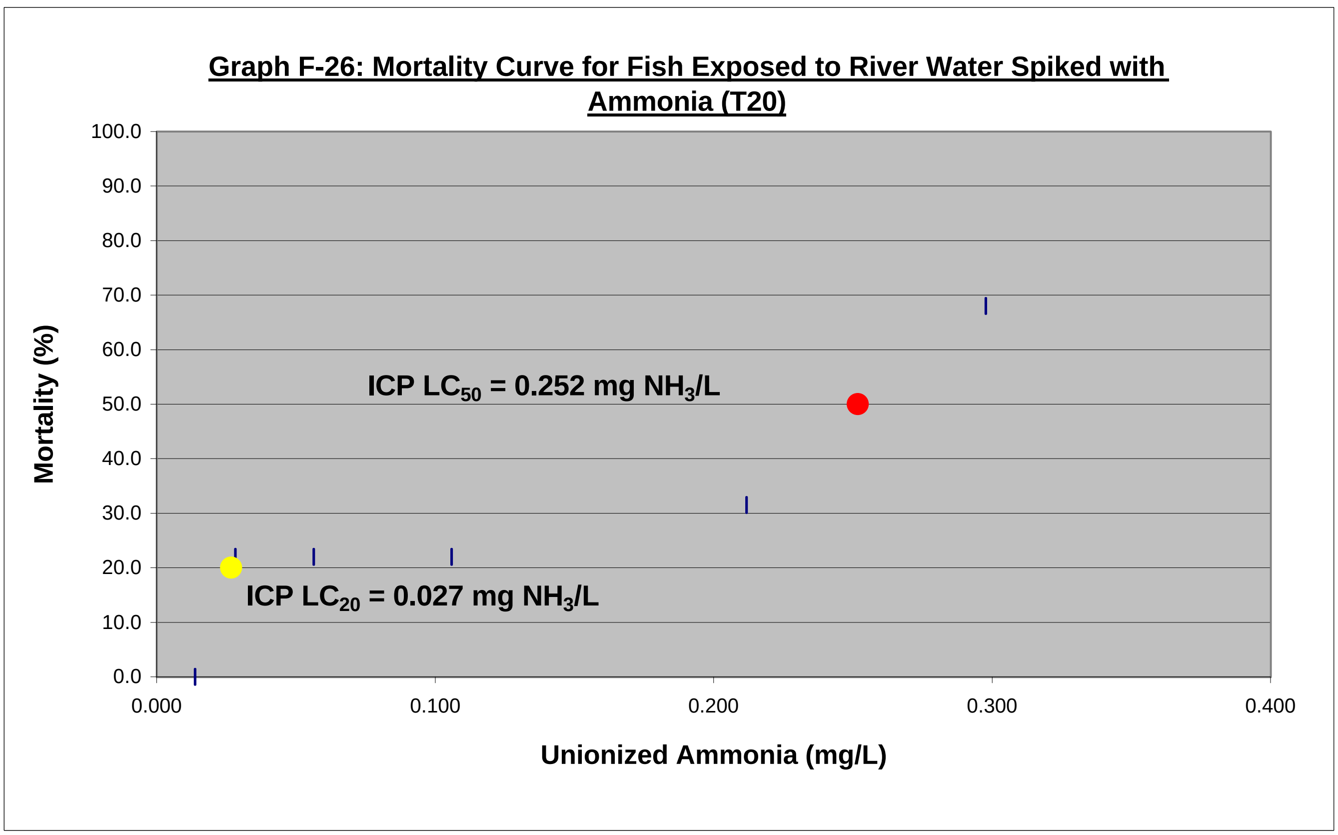
2. (a) Test-Temperature (mean) = 17.7^oC (b) Test-pH (min-max): 7.7-8.6

3. SD = standard deviation

4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.

5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.

6. Data plotted on Graph F-26 are highlighted in bold-type.



<u>ICPIN PRINTOUT FOR T20</u> – survival data

Test-Description: 30-day chronic-exposure test; flow-through
Test-Treatment: RW spiked with NH_3
Test-Species: juvenile lake trout

LC_{50}

DATA FILE: Y2K8surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.014	89.767	5.054	89.767
2	3	0.028	69.467	14.203	70.056
3	3	0.056	61.800	12.330	70.056
4	3	0.106	78.900	8.866	70.056
5	3	0.212	61.500	17.130	61.500
6	3	0.298	25.867	9.990	25.867

The Linear Interpolation Estimate: 0.2518 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.2483 Standard Deviation: 0.0127
Original Confidence Limits: Lower: 0.2251 Upper: 0.2690
Expanded Confidence Limits: Lower: 0.1957 Upper: 0.2879
Resampling time in Seconds: 0.00 Random_Seed: 445212196

LC_{20}

DATA FILE: Y2K8surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.014	89.767	5.054	89.767
2	3	0.028	69.467	14.203	70.056
3	3	0.056	61.800	12.330	70.056
4	3	0.106	78.900	8.866	70.056
5	3	0.212	61.500	17.130	61.500
6	3	0.298	25.867	9.990	25.867

The Linear Interpolation Estimate: 0.0268 Entered P Value: 20

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.0549 Standard Deviation: 0.0494
Original Confidence Limits: Lower: 0.0235 Upper: 0.2124
Expanded Confidence Limits: Lower: 0.0198 Upper: 0.4165
Resampling time in Seconds: 0.00 Random_Seed: -939515260

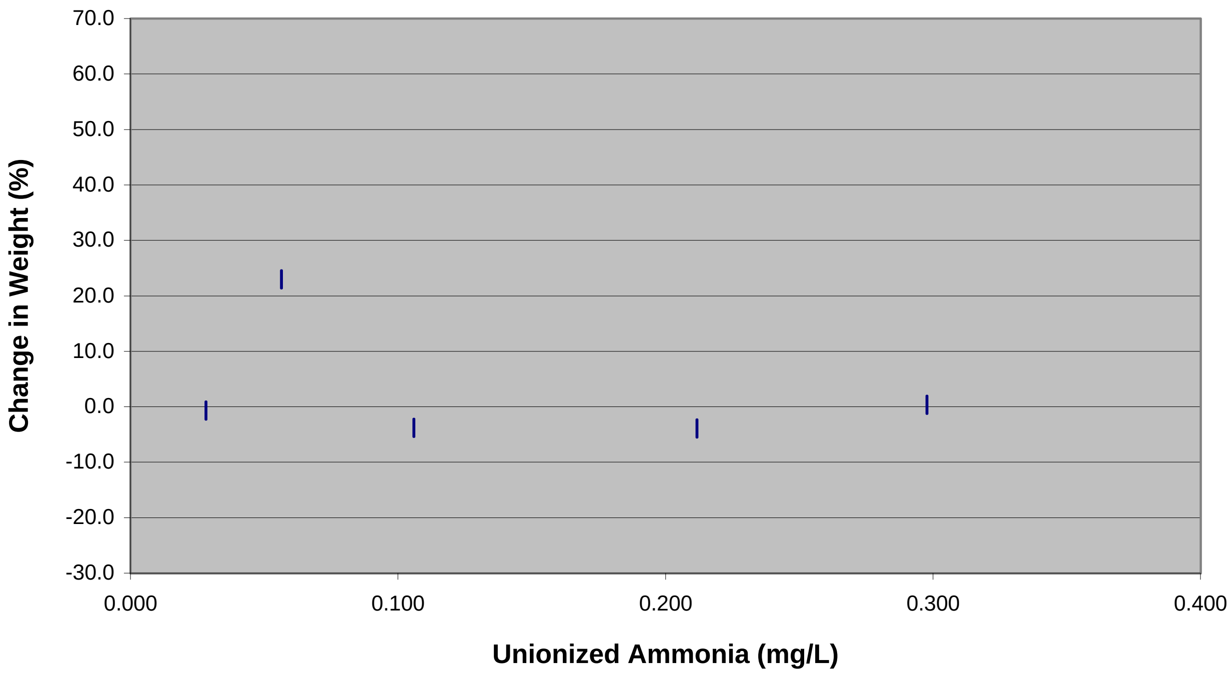
TABLE F-27: WEIGHT OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T20)

Test-Description: 30 day chronic-exposure test; flow-through
Test-Species: juvenile lake trout

	Avg. NH_3 (mg/L)	Avg. dry weight per organis			Avg. dry weight per fish (mg)	SD of Weight (mg)	% change in weight compared to controls
		Rep.A	Rep.B	Rep.C			
control	0.014	172.9	166.9	165.8	168.5	3.8	
conc.1	**0.028**	172.2	164.8	165.2	167.4	4.2	**-0.7**
conc.2	**0.056**	175.1	246.1	200.5	207.2	36.0	**23.0**
conc.3	**0.106**	183.0	159.6	143.8	162.1	19.7	**-3.8**
conc.4	**0.212**	155.0	169.3	161.4	161.9	7.2	**-3.9**
conc.5	**0.298**	130.1	167.3	210.0	169.1	40.0	**0.4**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-20, Appendix E-2.
2. (a) Test-Temperature (mean) = 17.7°C (b) Test-pH (min-max): 7.7-8.6
3. SD = standard deviation
4. Data plotted on Graph F-27 are highlighted in bold-type.

Graph F-27: Percent Change in Dry Weights of Fish Exposed to River Water Spiked with Ammonia Compared to Dry Weights of Control Organisms (T20)



<u>ICPIN PRINTOUT FOR T20</u> – growth data based on average dry weights/fish at test-termination

Test-Description: 30-day chronic-exposure test; flow-through
Test-Treatment: RW spiked with NH_3
Test-Species: juvenile lake trout

EC_{50}

DATA FILE: Y2K8grow.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.014	0.169	0.004	0.181
2	3	0.028	0.167	0.004	0.181
3	3	0.056	0.207	0.036	0.181
4	3	0.106	0.162	0.020	0.164
5	3	0.212	0.162	0.007	0.164
6	3	0.298	0.169	0.040	0.164

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 50% of the control response mean.

EC_{20}

DATA FILE: Y2K8grow.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.014	0.169	0.004	0.181
2	3	0.028	0.167	0.004	0.181
3	3	0.056	0.207	0.036	0.181
4	3	0.106	0.162	0.020	0.164
5	3	0.212	0.162	0.007	0.164
6	3	0.298	0.169	0.040	0.164

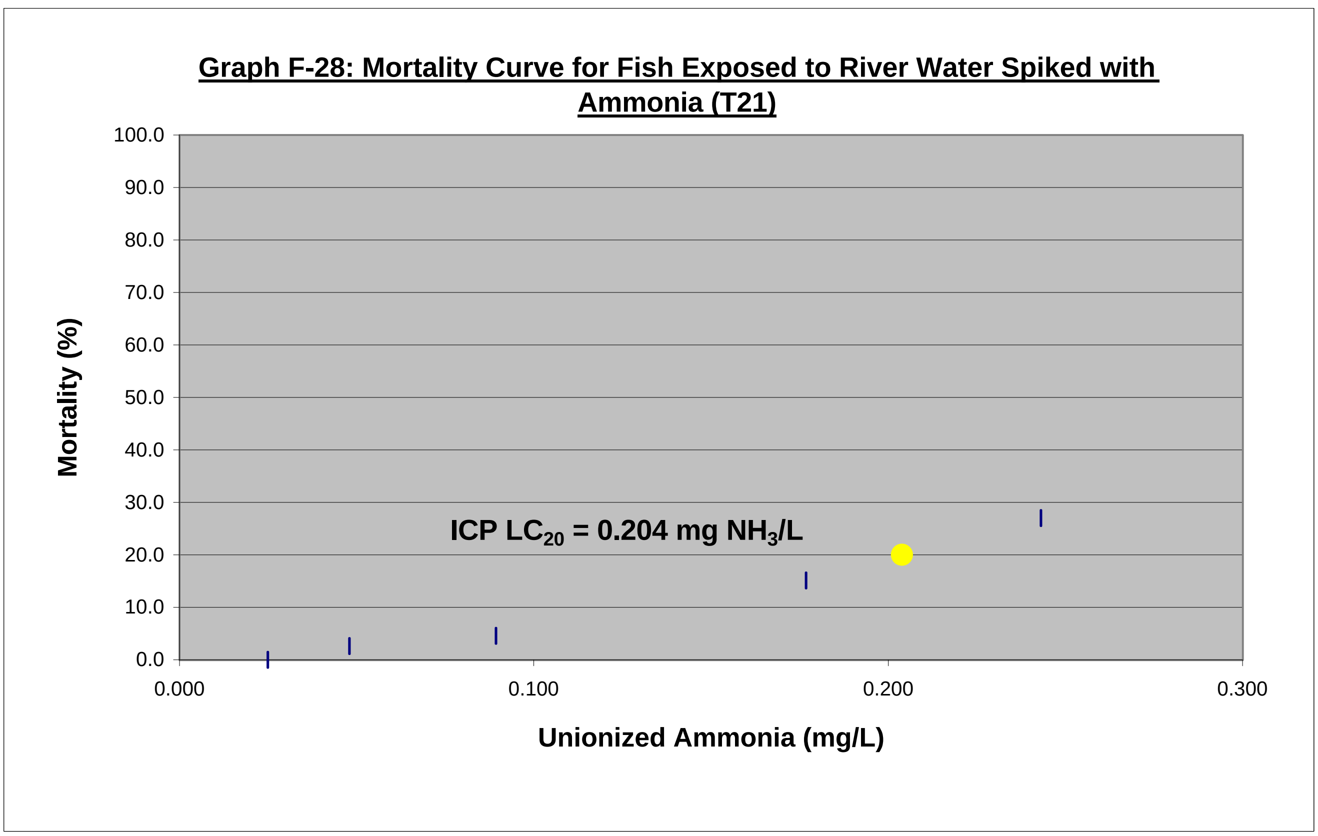
*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 80% of the control response mean.

TABLE F-28: MORTALITY OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T21)

Test-Description: 30 day chronic-exposure test; flow-through
Test-Species: juvenile walleye

	Avg. NH_3 (mg/L)	Mortality (%)			Avg. Mortality (%)	SD of % Mortality	Smoothed %-Mortality	Adjusted %-Mortality
		Rep.A	Rep.B	Rep.C				
control	0.012	11.8	20.0	16.7	16.2	4.1	12.8	0.0
conc.1	**0.025**	5.6	5.3	17.6	9.5	7.0	12.8	**0.0**
conc.2	**0.048**	14.3		15.8	15.1	1.1	15.1	**2.6**
conc.3	**0.089**	15.8	11.1	23.5	16.8	6.3	16.8	**4.6**
conc.4	**0.177**	26.7	38.9	12.5	26.0	13.2	26.0	**15.1**
conc.5	**0.243**	50.0	31.3	27.8	36.4	11.9	36.4	**27.0**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-21, Appendix E-2.
2. (a) Test-Temperature (mean) = 17.8^{o}C (b) Test-pH (min-max): 7.7-8.5
3. SD = standard deviation
4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
6. Data plotted on Graph F-28 are highlighted in bold-type.



<u>ICPIN PRINTOUT FOR T21</u> – survival data

Test-Description: 30-day chronic-exposure test; flow-through
Test-Treatment: RW spiked with NH_3
Test-Species: juvenile walleye

LC_{50}

DATA FILE: Y2K9surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.012	83.833	4.126	87.167
2	3	0.025	90.500	7.016	87.167
3	2	0.048	84.950	1.061	84.950
4	3	0.089	83.200	6.260	83.200
5	3	0.177	73.967	13.213	73.967
6	3	0.243	63.667	11.957	63.667

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 50% of the control response mean.

LC_{20}

DATA FILE: Y2K9surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.012	83.833	4.126	87.167
2	3	0.025	90.500	7.016	87.167
3	2	0.048	84.950	1.061	84.950
4	3	0.089	83.200	6.260	83.200
5	3	0.177	73.967	13.213	73.967
6	3	0.243	63.667	11.957	63.667

The Linear Interpolation Estimate: 0.2039 Entered P Value: 20

Number of Resamplings: 80 64 Resamples Generated
Those resamples not used had estimates
above the highest concentration/ %Effluent.
The Bootstrap Estimates Mean: 0.1915 Standard Deviation: 0.0259

No Confidence Limits can be produced since the number of resamples generated is not a multiple of 40.
Resampling time in Seconds: 0.06 Random_Seed: -108782898

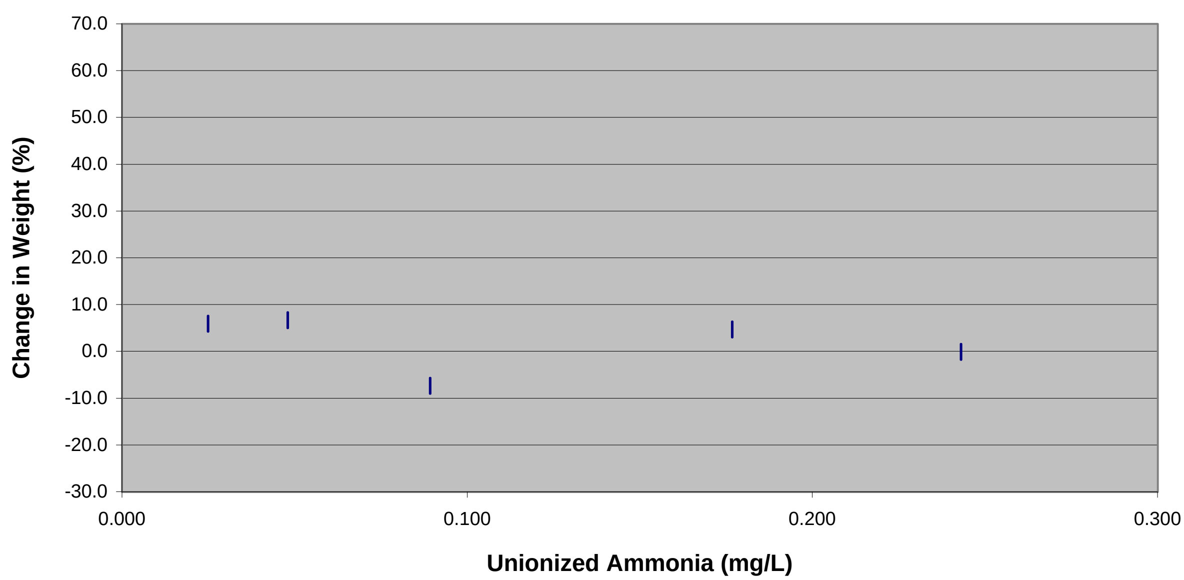
TABLE F-29: WEIGHT OF FISH EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T21)

Test-Description: 30 day chronic-exposure test; flow-through
Test-Species: juvenile walleye

	Avg. NH_3 (mg/L)	Avg. dry weight per organism (mg) Rep.A	Rep.B	Rep.C	Avg. dry weight per fish (mg)	SD of Weight (mg)	% change in weight compared to controls
control	0.012	35.7	34.6	34.5	34.9	0.7	
conc.1	**0.025**	40.0	31.6	39.4	37.0	4.7	**5.9**
conc.2	**0.048**	34.9		39.6	37.3	3.3	**6.6**
conc.3	**0.089**	28.9	35.3	32.9	32.4	3.2	**-7.3**
conc.4	**0.177**	40.9	38.3	30.5	36.6	5.4	**4.7**
conc.5	**0.243**	45.2	30.4	29.1	34.9	8.9	**-0.1**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-21, Appendix E-2.
2. (a) Test-Temperature (mean) = 17.8°C (b) Test-pH (min-max): 7.7-8.5
3. SD = standard deviation
4. Data plotted on Graph F-29 are highlighted in bold-type.

Graph F-29: Percent Change in Dry Weights of Fish Exposed to River Water Spiked with Ammonia Compared to Dry Weights of Control Organisms (T21)



<u>ICPIN PRINTOUT FOR T21</u> – growth data based on average dry weight/fish at test-termination

Test-Description: 30-day chronic-exposure test; flow-through
Test-Treatment: RW spiked with NH_3
Test-Species: walleye

EC_{50}

DATA FILE: Y2K9grow.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.012	0.035	0.001	0.036
2	3	0.025	0.037	0.005	0.036
3	2	0.048	0.037	0.003	0.036
4	3	0.089	0.032	0.003	0.035
5	3	0.177	0.037	0.005	0.035
6	3	0.243	0.035	0.009	0.035

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 50% of the control response mean.

EC_{20}

DATA FILE: Y2K9grow.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.012	0.035	0.001	0.036
2	3	0.025	0.037	0.005	0.036
3	2	0.048	0.037	0.003	0.036
4	3	0.089	0.032	0.003	0.035
5	3	0.177	0.037	0.005	0.035
6	3	0.243	0.035	0.009	0.035

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 80% of the control response mean.

APPENDIX F-3

TESTS CONDUCTED ON INVERTEBRATES: RAW DATA AND RESULTS

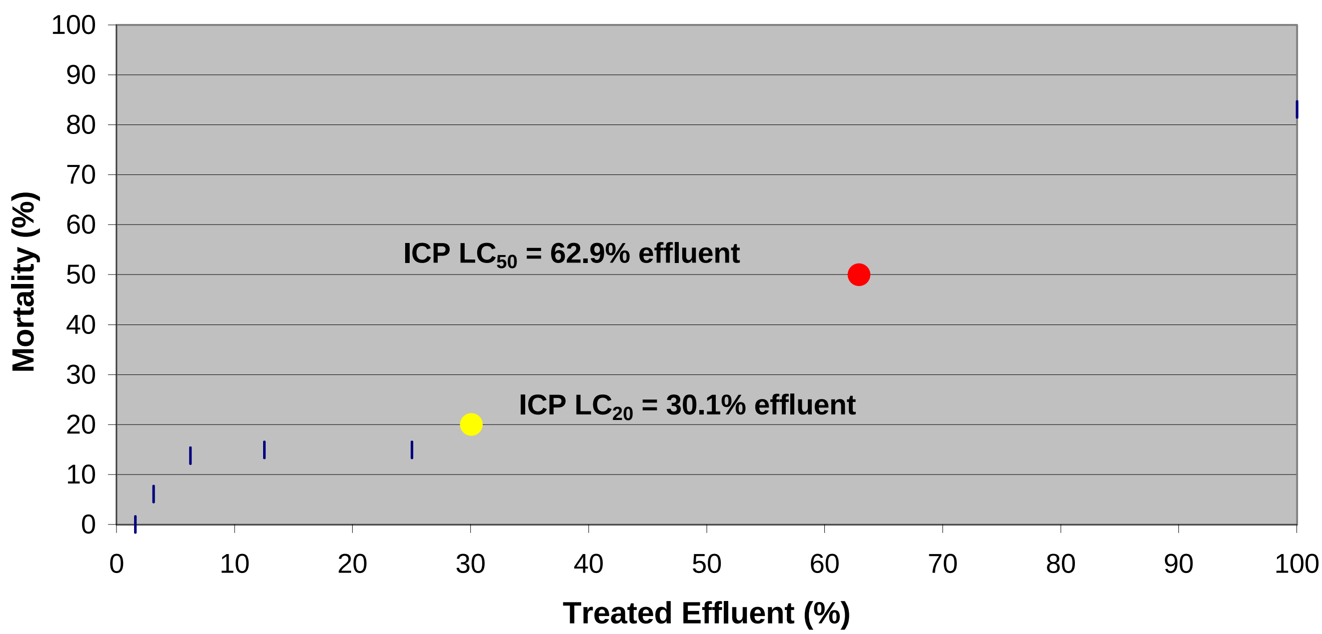
TABLE F-30: MORTALITY OF FLOATER MUSSELS EXPOSED TO TREATED EFFLUENT (T5A - 66 days).

Test-Description: 66-day chronic-exposure test; semi-static
Test-Species: floater mussels

	Avg. Final % Effluent	Mortality (%)			Avg. Mortality (%)	SD of % Mortality	Smoothed % Mortality	Adjusted % Mortality
		Rep.A	Rep.B	Rep.C				
control	0.00	42	50	26	39.3	12.2	34.8	0.0
conc.1	**1.56**	26	44	21	30.3	12.1	34.8	**0.0**
conc.2	**3.13**	47	32	37	38.7	7.6	38.7	**6.1**
conc.3	**6.25**	47	58	26	43.7	16.3	43.7	**13.8**
conc.4	**12.50**	58	58	39	51.7	11.0	44.9	**14.9**
conc.5	**25.00**	45	37	32	38.0	6.6	44.9	**14.9**
conc.6	**100.00**	74	100	95	89.7	13.8	89.7	**83.1**

Notes: 1. *Adjusted* means that percent-mortality values for test-organisms in exposure-vessels were corrected for control-group-mortality.
2. (a) Test-Temperature (mean) = 20.6°C (b) Test-pH (min-max): 7.1-8.8
3. SD = standard deviation
4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.
5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.
6. Data plotted on Graph F-30 are highlighted in bold-type.

Graph F-30: Mortality Curve for Floater Mussels After 66 Days of Exposure to Treated Effluent (T5A).



ICPIN PRINTOUT FOR T5A-66days – survival data

Test-Description: 66 day chronic-exposure test; semi-static
Toxicant: treated effluent
Test-Species: floater mussels

LC_{50}

DATA FILE: T5A66raw.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.000	60.750	9.979	65.125
2	4	1.560	69.500	9.883	65.125
3	4	3.130	61.250	6.238	61.250
4	4	6.250	56.250	13.276	56.250
5	4	12.500	48.250	8.958	55.125
6	4	25.000	62.000	5.354	55.125
7	4	100.000	10.500	11.269	10.500

The Linear Interpolation Estimate: 62.9202 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 62.4352 Standard Deviation: 4.8189
Original Confidence Limits: Lower: 54.8797 Upper: 72.9485
Expanded Confidence Limits: Lower: 50.0554 Upper: 78.9655
Resampling time in Seconds: 0.06 Random_Seed: -25860615

LC_{20}

DATA FILE: T5A66raw.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.000	60.750	9.979	65.125
2	4	1.560	69.500	9.883	65.125
3	4	3.130	61.250	6.238	61.250
4	4	6.250	56.250	13.276	56.250
5	4	12.500	48.250	8.958	55.125
6	4	25.000	62.000	5.354	55.125
7	4	100.000	10.500	11.269	10.500

The Linear Interpolation Estimate: 30.0840 Entered P Value: 20

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 25.6466 Standard Deviation: 10.4334
Original Confidence Limits: Lower: 5.2360 Upper: 37.8333
Expanded Confidence Limits: Lower: -9.6728 Upper: 42.4829
Resampling time in Seconds: 0.00 Random_Seed: -1834644935

TABLE F-31: GROWTH OF FLOATER MUSSELS EXPOSED TO TREATED EFFLUENT (T5A - 66 days).

Test-Description: 66-day chronic-exposure test; semi-static
Test-Species: floater mussel

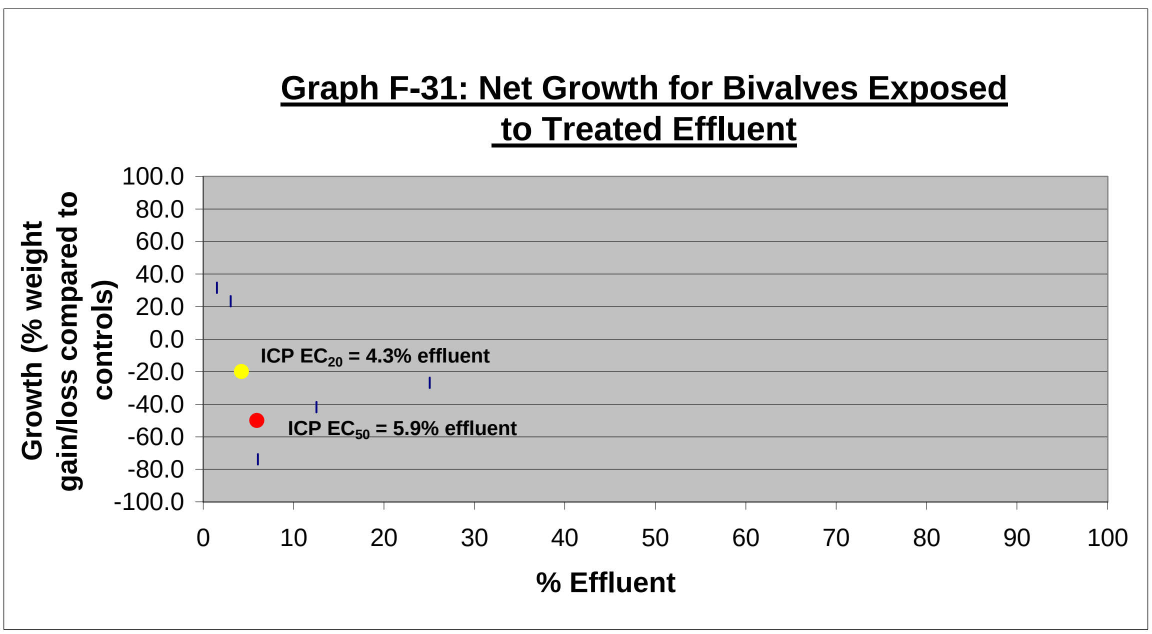
	Effluent Concentration (%)	Weight gain/loss per organism (mg)			Avg. weight gain/loss per organism (mg)	SD of net weight (mg)	% weight gain/loss compared to controls	Smoothed average net weight per organism (mg)
		Rep.A	Rep.B	Rep.C				
control	0.00	117	59	98	91	29.7		108.0
conc.1	**1.50**	136	96	129	120	21.5	**31.6**	108.0
conc.2	**3.00**	121	85	132	113	24.3	**23.3**	108.0
conc.3	**6.00**	-70	41	101	24	86.7	**-73.8**	48.0
conc.4	**12.50**	75	-6	91	53	52.1	**-41.8**	48.0
conc.5	**25.00**	4	48	149	67	74.2	**-26.9**	48.0
conc.6	100.00	-20		-210	-115	134.4	-225.8	0.0

Notes: 1. (a) Test-Temperature (mean) = 20.6°C (b) Test-pH (min-max): 7.1-8.8

2. SD = standard deviation

3. Smoothed means that any adjacent net weight means that did not decrease monotonically were replaced with their average.

4. Data plotted on Graph F-31 are highlighted in bold-type.



ICPIN PRINTOUT FOR T5A – growth data (based on net weights)
- nominal effluent concentrations used

Test-Description: 66-day chronic-exposure test, semi-static
Toxicant: Treated effluent
Test-Species: floater mussels

EC_{50}

DATA FILE: t5weinom.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.000	0.091	0.030	0.108
2	3	1.560	0.120	0.021	0.108
3	3	3.125	0.113	0.024	0.108
4	3	6.250	0.024	0.087	0.048
5	3	12.500	0.053	0.052	0.048
6	3	25.000	0.067	0.074	0.048
7	2	100.000	-0.115	0.134	0.000

The Linear Interpolation Estimate: 5.9350 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 16.9245 Standard Deviation: 15.2733
Original Confidence Limits: Lower: 4.8447 Upper: 53.0641
Expanded Confidence Limits: Lower: 3.6455 Upper: 104.9061
Resampling time in Seconds: 0.06 Random_Seed: 1215566101

EC_{20}

DATA FILE: t5weinom.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	3	0.000	0.091	0.030	0.108
2	3	1.560	0.120	0.021	0.108
3	3	3.125	0.113	0.024	0.108
4	3	6.250	0.024	0.087	0.048
5	3	12.500	0.053	0.052	0.048
6	3	25.000	0.067	0.074	0.048
7	2	100.000	-0.115	0.134	0.000

The Linear Interpolation Estimate: 4.2490 Entered P Value: 20

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 4.7878 Standard Deviation: 2.9671
Original Confidence Limits: Lower: 3.0652 Upper: 8.0669
Expanded Confidence Limits: Lower: 1.7631 Upper: 12.2666
Resampling time in Seconds: 0.05 Random_Seed: 334888021

TABLE F-32: MORTALITY OF FINGERNAIL CLAMS EXPOSED TO TREATED EFFLUENT FOR 8 DAYS (T5B).

Test-Description: 8-day chronic-exposure test; semi-static
Test-Species: fingernail clams

	Avg. Final % Effluent	Mortality (%)			Avg. Mortality (%)	SD of % Mortality	Smoothed % Mortality	Adjusted % Mortality
		Rep.A	Rep.B	Rep.C				
control	0.00	10	16	8	11.3	4.2	9.0	0.0
conc.1	1.56	12	6	8	8.7	3.1	9.0	0.0
conc.2	**3.13**	6	6	8	6.7	1.2	9.0	**0.0**
conc.3	**6.25**	33	12	16	20.3	11.2	18.5	**10.9**
conc.4	**12.50**	20	28	4	17.3	12.2	18.5	**10.9**
conc.5	**25.00**	44	13	31	29.3	15.6	30.0	**23.2**
conc.6	**100.00**	96	98	98	97.3	1.2	97.0	**96.7**

Notes: 1. *Adjusted* means that percent-mortality values for test-organisms in exposure-vessels were corrected for control-group-mortality.

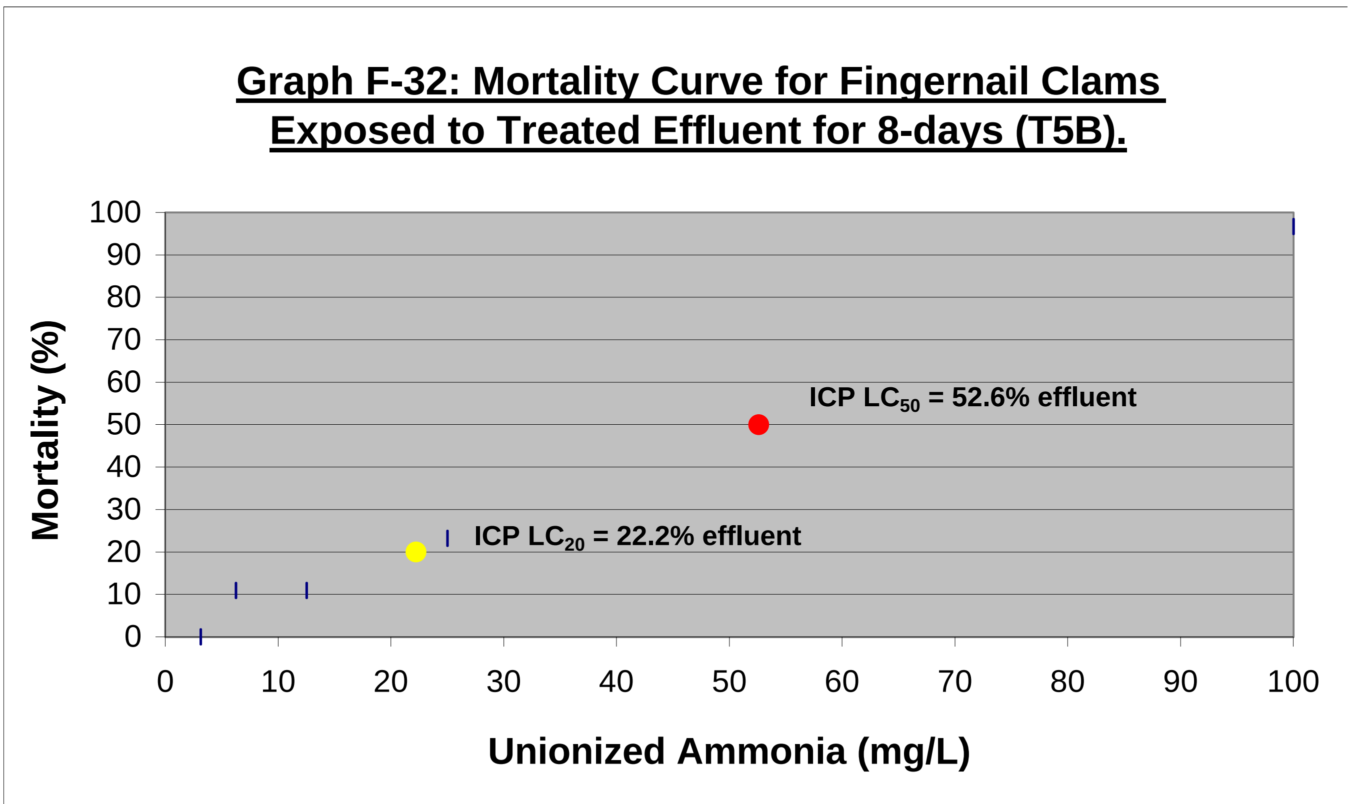
2. (a) Test-Temperature (mean) = 22.7^{o}C (b) Test-pH (min-max): 7.1-8.8

3. SD = standard deviation

4. Smoothed means that any adjacent %-mortality values that did not increase monotonically were replaced with their average.

5. Adjusted means that smoothed %-mortality data was corrected for control-group mortality using Abbott's formula.

6. Data plotted on Graph F-32 are highlighted in bold-type.



<u>ICPIN PRINTOUT FOR T5B-8 days</u> – survival data

Test-Description: 8 day chronic-exposure test; semi-static
Toxicant: treated effluent
Test-Species: fingernail clams

LC_{50}

DATA FILE: T5Braw.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.000	88.750	3.403	91.083
2	4	1.560	91.250	2.500	91.083
3	4	3.130	93.250	0.957	91.083
4	4	6.250	79.750	9.106	81.250
5	4	12.500	82.750	9.979	81.250
6	4	25.000	70.500	12.715	70.500
7	4	100.000	2.750	0.957	2.750

The Linear Interpolation Estimate: 52.6292 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 52.7393 Standard Deviation: 3.9448
Original Confidence Limits: Lower: 46.2343 Upper: 58.0592
Expanded Confidence Limits: Lower: 42.3974 Upper: 61.3172
Resampling time in Seconds: 0.00 Random_Seed: 22348734

LC_{20}

DATA FILE: T5Braw.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	4	0.000	88.750	3.403	91.083
2	4	1.560	91.250	2.500	91.083
3	4	3.130	93.250	0.957	91.083
4	4	6.250	79.750	9.106	81.250
5	4	12.500	82.750	9.979	81.250
6	4	25.000	70.500	12.715	70.500
7	4	100.000	2.750	0.957	2.750

The Linear Interpolation Estimate: 22.2481 Entered P Value: 20

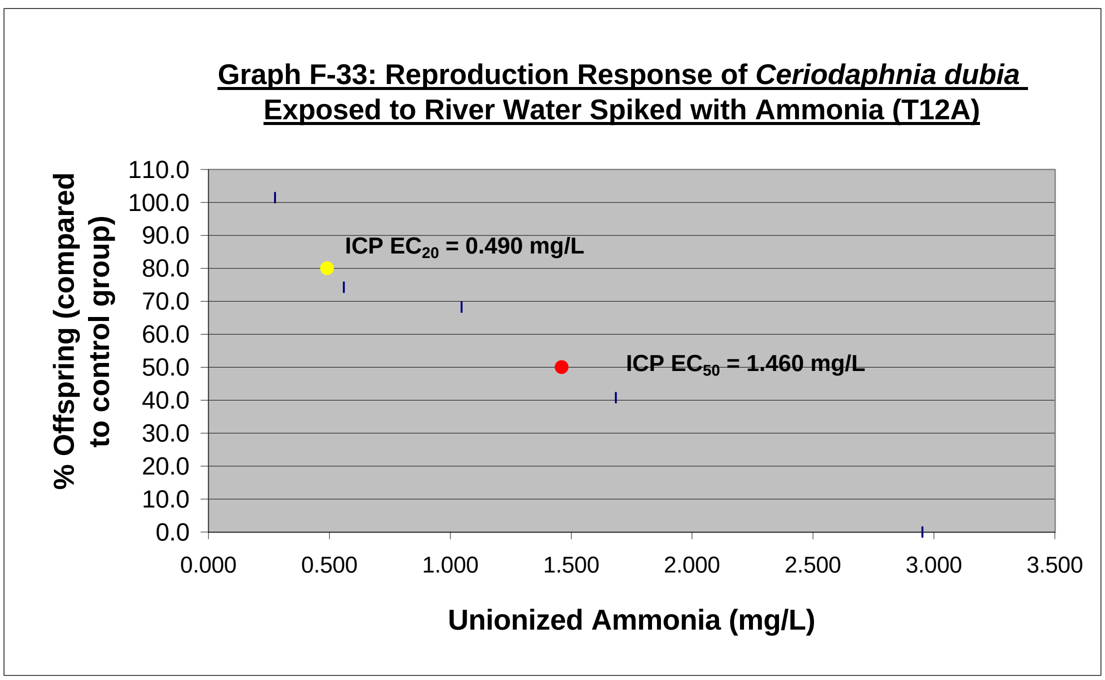
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 23.4907 Standard Deviation: 4.9591
Original Confidence Limits: Lower: 13.2911 Upper: 31.6216
Expanded Confidence Limits: Lower: 7.9170 Upper: 37.2458
Resampling time in Seconds: 0.00 Random_Seed: -120754626

<u>TABLE F-33: REPRODUCTION RESPONSE OF *Ceriodaphnia dubia* EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T12A)</u>

Test Description: 7 day chronic-exposure test; semi-static
Test Species: *Ceriodaphnia dubia* neonates

	Avg. NH_3 (mg/L)	Total No. Neonates (end of test) Rep.A	Rep.B	Rep.C	Rep.D	Rep.E	Rep.F	Rep.G	Rep.H	Rep.I	Rep.J	Avg. No. Neonates	SD of no. of neonates	% offspring compared to controls	Smoothed average number of neonates
control	0.003	39	34	32	10	40	36	40	39	38	38	34.6	9.0		34.9
conc.1	**0.274**	34	33	43	34	33	35	32	37	34	36	35.1	3.1	**101.4**	34.9
conc.2	**0.558**	14	30	30	15	20	18	36	27	36	31	25.7	8.3	**74.3**	25.7
conc.3	**1.046**	13	29	30	6	8	29	30	35	24	32	23.6	10.6	**68.2**	23.6
conc.4	**1.684**	15	19	15	13	17	3	22	13	14	10	14.1	5.2	**40.8**	14.1
conc.5	**2.951**	0	0	0	0	0	0	0	0	0	0	0.0	0.0	**0.0**	0.0
conc.6	**5.443**	0	0	0	0	0	0	0	0	0	0	0.0	0.0	**0.0**	0.0

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-22, Appendix E-3.
2. (a) Test-Temperature (mean) = 24.0°C (b) Test-pH (min-max): 8.0-8.5
3. SD = standard deviation
4. Smoothed means that any adjacent 'number-of-neonates' that did not decrease monotonically were replaced with their average.
5. Data plotted on Graph F-33 are highlighted in bold-type.



ICPIN PRINTOUT FOR 12A – reproduction data based on total numbers of neonates produced

Test-Description: 7-day chronic-exposure test, semi-static
Test-Treatment: River water spiked with ammonia
Test-Species: *Ceriodaphnia dubia* neonates

EC_{50}

DATA FILE: T12Arepr.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	10	0.003	34.600	9.033	34.850
2	10	0.274	35.100	3.143	34.850
3	10	0.558	25.700	8.314	25.700
4	10	1.046	23.600	10.575	23.600
5	10	1.683	14.100	5.152	14.100
6	10	2.950	0.000	0.000	0.000
7	10	5.443	0.000	0.000	0.000

The Linear Interpolation Estimate: 1.4604 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 1.4376 Standard Deviation: 0.1638
Original Confidence Limits: Lower: 0.9833 Upper: 1.6896
Resampling time in Seconds: 0.00 Random_Seed: -1395553311

EC_{20}

DATA FILE: T12Arepr.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	10	0.003	34.600	9.033	34.850
2	10	0.274	35.100	3.143	34.850
3	10	0.558	25.700	8.314	25.700
4	10	1.046	23.600	10.575	23.600
5	10	1.683	14.100	5.152	14.100
6	10	2.950	0.000	0.000	0.000
7	10	5.443	0.000	0.000	0.000

The Linear Interpolation Estimate: 0.4904 Entered P Value: 20

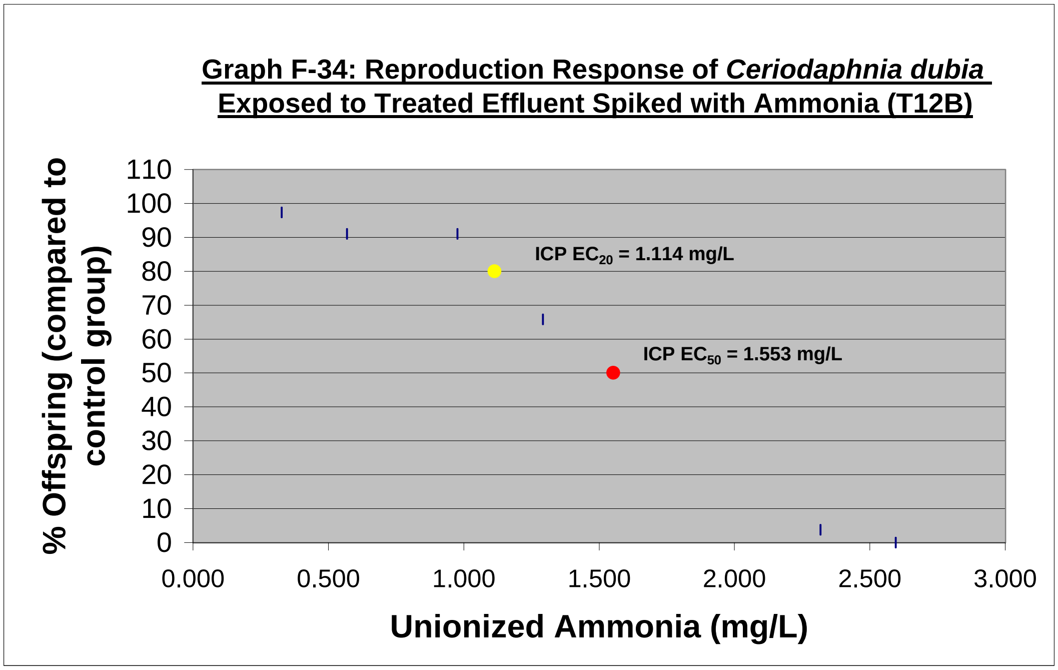
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 0.5365 Standard Deviation: 0.1739
Original Confidence Limits: Lower: 0.3663 Upper: 1.0904
Resampling time in Seconds: 0.06 Random_Seed: -2076200319

TABLE F-34: REPRODUCTION RESPONSE OF *Ceriodaphnia dubia* EXPOSED TO AMMONIA IN TREATED EFFLUENT (T12B)

Test-Description: 7 day chronic-exposure test; semi-static
Test-Species: *Ceriodaphnia dubia* neonates

	Avg. NH_3 (mg/L)	Total No. Neonates (end of test) Rep.A	Rep.B	Rep.C	Rep.D	Rep.E	Rep.F	Rep.G	Rep.H	Rep.I	Rep.J	Avg. No. Neonates	SD of no. of neonates	% offspring compared to controls	Smoothed average number of neonates
control	0.003	40	40	38	36	40	36	11	26	37	41	34.5	9.3		34.5
conc.1	**0.326**	32	36	36	41	31	34	35	17	41	33	33.6	6.7	**97.4**	33.6
conc.2	**0.567**	37	39	19	33	29	22	35	37	35	28	31.4	6.7	**91.0**	31.4
conc.3	**0.975**	32	33	21	33	26	37	36	28	32	36	31.4	5.0	**91.0**	31.4
conc.4	**1.292**	29	25	28	21	29	12	25	12	28	18	22.7	6.7	**65.8**	11.4
conc.5	**2.317**	6	0	2	0	0	5	0	0	0	0	1.3	2.3	**3.8**	11.4
conc.6	**2.594**	0	0	0	0	0	0	0	0	0	0	0.0	0.0	**0.0**	1.3

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-23, Appendix E-3.
2. (a) Test-Temperature (mean) = 24.0°C (b) Test-pH (min-max): 7.1-8.5
3. SD = standard deviation
4. Smoothed means that any adjacent 'number-of-neonates' that did not decrease monotonically were replaced with their average.
5. Data plotted on Graph F-34 are highlighted in bold-type.



ICPIN PRINTOUT FOR 12B – reproduction data based on total numbers of neonates produced

Test-Description: 7-day chronic-exposure test, semi-static
Test-Treatment: Effluent spiked with ammonia
Test-Species: *Ceriodaphnia dubia* neonates

EC_{50}

DATA FILE: T12Brepr.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	10	0.003	34.500	9.312	34.500
2	10	0.326	33.600	6.736	33.600
3	10	0.567	31.400	6.736	31.400
4	10	0.975	31.400	5.038	31.400
5	10	1.292	22.700	6.667	22.700
6	10	2.317	1.300	2.312	1.300
7	10	2.594	0.000	0.000	0.000

The Linear Interpolation Estimate: 1.5528 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 1.5300 Standard Deviation: 0.0844
Original Confidence Limits: Lower: 1.3090 Upper: 1.6654
Resampling time in Seconds: 0.06 Random_Seed: -127302672

EC_{20}

DATA FILE: T12Brepr.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	10	0.003	34.500	9.312	34.500
2	10	0.326	33.600	6.736	33.600
3	10	0.567	31.400	6.736	31.400
4	10	0.975	31.400	5.038	31.400
5	10	1.292	22.700	6.667	22.700
6	10	2.317	1.300	2.312	1.300
7	10	2.594	0.000	0.000	0.000

The Linear Interpolation Estimate: 1.1136 Entered P Value: 20

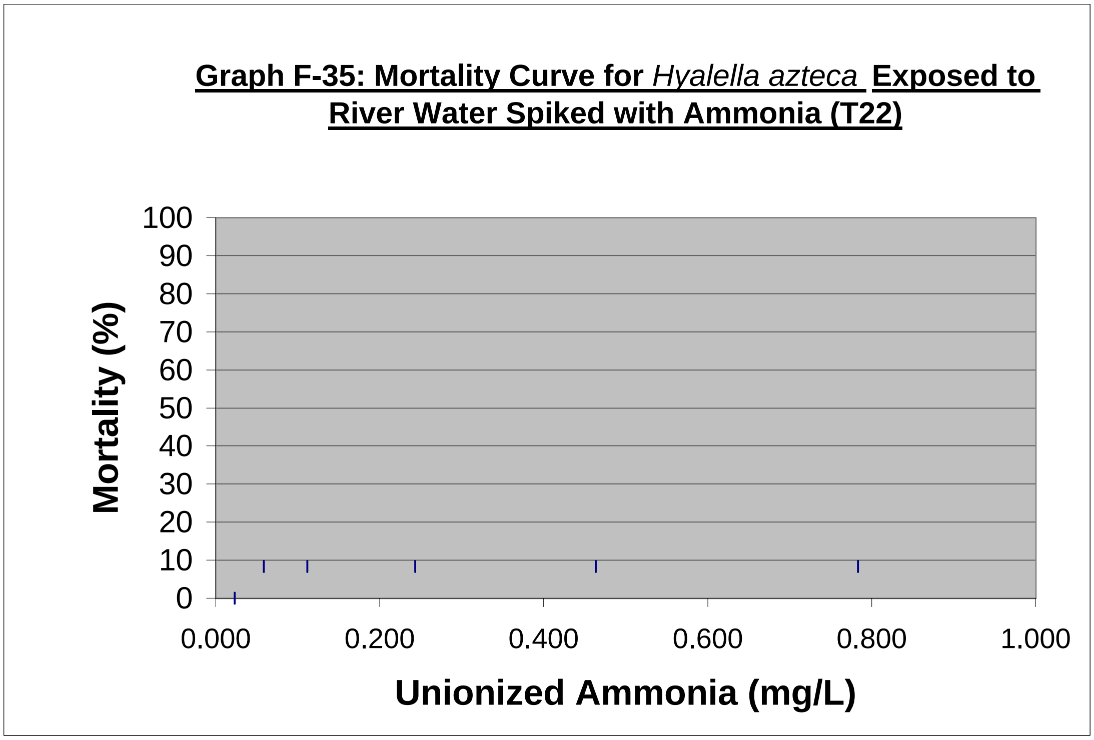
Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 1.0293 Standard Deviation: 0.1849
Original Confidence Limits: Lower: 0.5181 Upper: 1.2531
Resampling time in Seconds: 0.11 Random_Seed: -2067547632

TABLE F-35: MORTALITY OF *Hyalella azteca* EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T22)

Test-Description: 28 day chronic-exposure test; semi-static
Test-Species: *Hyalella azteca* neonates

	Avg. NH_3	Percent Mortality										Avg. %	SD of %	Smoothed	Adjusted
	(mg/L)	Rep.A	Rep.B	Rep.C	Rep.D	Rep.E	Rep.F	Rep.G	Rep.H	Rep.I	Rep.J	Mortality	Mortality	%-Mortality	%-Mortality
control	**0.023**	15	0	0	5	0	5	0	15	0	15	5.5	6.9	5.5	**0.0**
conc.1	**0.058**	10	5	15	35	20						17.0	11.5	13.4	**8.4**
conc.2	**0.111**	15	10	5	15	10						11.0	4.2	13.4	**8.4**
conc.3	**0.243**	5	25	0	40	20						18.0	16.0	13.4	**8.4**
conc.4	**0.463**	5	15	10	5	10						9.0	4.2	13.4	**8.4**
conc.5	**0.783**	5	0	20	30	5						12.0	12.5	13.4	**8.4**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-24, Appendix E-3.
2. (a) Test-Temperature (mean) = 23.9°C (b) Test-pH (min-max): 7.5-8.6
3. SD = standard deviation
4. Smoothed means that any adjacent percent-mortality values that did not increase monotonically were replaced with their average.
5. Adjusted means that smoothed percent-mortlality data was corrected for control-group mortality using Abbott's formula.
6. Data plotted on Graph F-35 are highlighted in bold-type.



ICPIN PRINTOUT FOR T22 – survival data

Test-Description: 28 day chronic-exposure test; semi-static
Toxicant: river water spiked with ammonia
Test-Species: *Hyalella azteca* adults

LC_{50}

DATA FILE: T22surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	10	0.023	94.500	6.852	94.500
2	5	0.058	83.000	11.511	86.600
3	5	0.111	89.000	4.183	86.600
4	5	0.243	82.000	16.047	86.600
5	5	0.463	91.000	4.183	86.600
6	5	0.783	88.000	12.550	86.600

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 50% of the control response mean.

LC_{20}

DATA FILE: T22surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	10	0.023	94.500	6.852	94.500
2	5	0.058	83.000	11.511	86.600
3	5	0.111	89.000	4.183	86.600
4	5	0.243	82.000	16.047	86.600
5	5	0.463	91.000	4.183	86.600
6	5	0.783	88.000	12.550	86.600

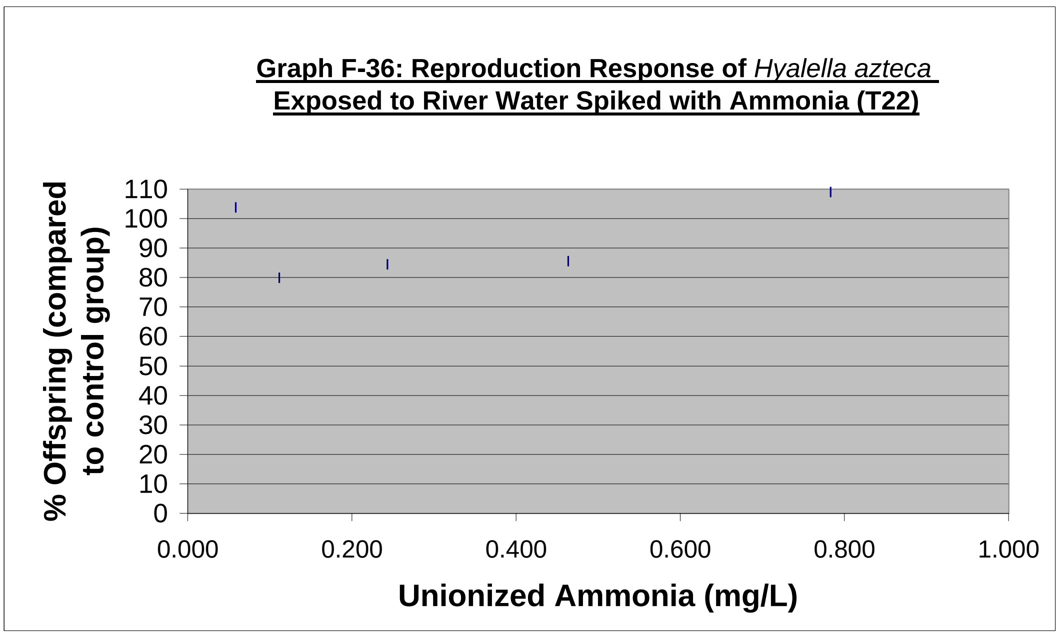
*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 80% of the control response mean.

TABLE F-36: REPRODUCTION RESPONSE OF *Hyalella azteca* EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T22)

Test-Description: 28 day chronic-exposure test; semi-static
Test-Species: *Hyalella azteca* adults

	Avg. NH_3 (mg/L)	Total No. Neonates (at end of test) Rep.A	Rep.B	Rep.C	Rep.D	Rep.E	Rep.F	Rep.G	Rep.H	Rep.I	Rep.J	Avg. No. Neonates	SD of No. of Neonates	% offspring compared to controls	Smoothed Average No. of Neonates
control	0.023	121	79	129	131	171	133	171	137	107	120	129.9	27.4		129.9
conc.1	**0.058**	151	115	158	138	112						134.8	20.8	**103.8**	120.2
conc.2	**0.111**	114	105	73	128	99						103.8	20.4	**79.9**	120.2
conc.3	**0.243**	115	67	131	88	148						109.8	32.6	**84.5**	120.2
conc.4	**0.463**	103	97	135	118	103						111.2	15.4	**85.6**	120.2
conc.5	**0.783**	128	121	166	74	219						141.6	54.2	**109.0**	120.2

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-24, Appendix E-3.
2. (a) Test-Temperature (mean) = 23.9°C (b) Test-pH (min-max): 7.5-8.6
3. SD = standard deviation
4. Smoothed means that any adjacent percent-mortality values that did not decrease monotonically were replaced with their average.
5. Data plotted on Graph F-36 are highlighted in bold-type.



ICPIN PRINTOUT FOR T22 – reproduction data based on total numbers of neonates produced

Test-Description: 28-day chronic-exposure test, semi-static
Test-Treatment: River water spiked with ammonia
Test-Species: *Hyalella azteca* adults

EC_{50}

DATA FILE: T22repro.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	10	0.023	129.900	27.351	131.533
2	5	0.058	134.800	20.753	131.533
3	5	0.112	103.800	20.389	116.600
4	5	0.243	109.800	32.568	116.600
5	5	0.463	111.200	15.401	116.600
6	5	0.783	141.600	54.234	116.600

*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 50% of the control response mean.

EC_{20}

DATA FILE: T22repro.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	10	0.023	129.900	27.351	131.533
2	5	0.058	134.800	20.753	131.533
3	5	0.112	103.800	20.389	116.600
4	5	0.243	109.800	32.568	116.600
5	5	0.463	111.200	15.401	116.600
6	5	0.783	141.600	54.234	116.600

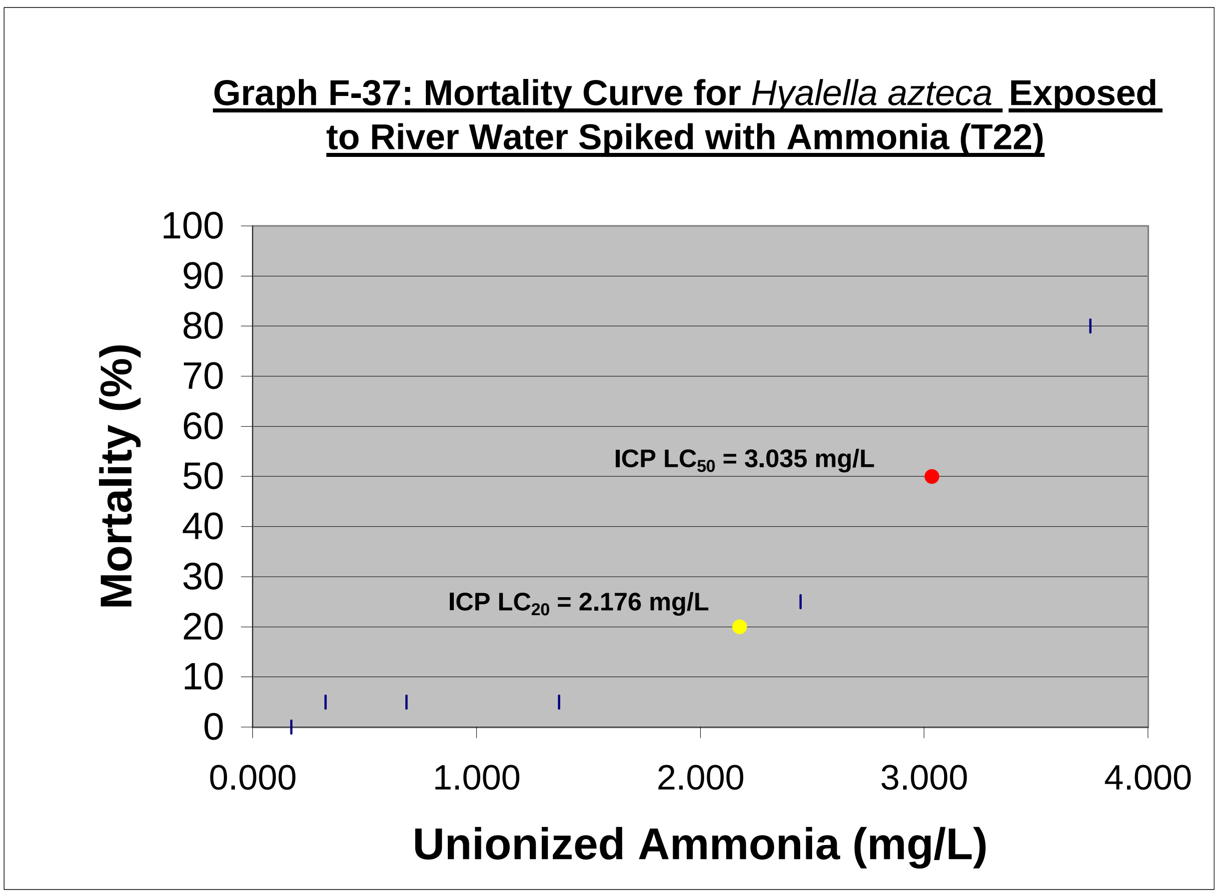
*** No Linear Interpolation Estimate can be calculated from the input data since none of the (possibly pooled) group response means were less than 80% of the control response mean.

TABLE F-37: MORTALITY OF *Hyalella azteca* EXPOSED TO RIVER WATER SPIKED WITH AMMONIA (T23)

Test-Description: 96 hour acute-exposure test; semi-static
Test-Species: *Hyalella azteca* adults

	Avg. NH_3 (mg/L)	Percent Mortality Rep.A	Percent Mortality Rep.B	Avg. % Mortality	SD of % Mortality	Smoothed % Mortality
control	0.015	0	0	0.0	0.0	0
conc.1	**0.171**	0	0	0.0	0.0	**0.0**
conc.2	**0.325**	20	0	10.0	14.1	**5.0**
conc.3	**0.686**	0	10	5.0	7.1	**5.0**
conc.4	**1.368**	0	0	0.0	0.0	**5.0**
conc.5	**2.446**	20	30	25.0	7.1	**25.0**
conc.6	**3.742**	90	70	80.0	14.1	**80.0**

Notes: 1. Raw data used to calculate average NH_3 concentrations are tabulated in Table E-25, Appendix E-3.
2. (a) Test-Temperature (mean) = 24.3^{o}C (b) Test-pH (min-max): 7.8-8.4
3. SD = standard deviation
4. Smoothed means that any adjacent percent-mortality values that did not decrease monotonically were replaced with their average.
5. Data plotted on Graph F-37 are highlighted in bold-type.



ICPIN PRINTOUT FOR T23 - survival data

Test-Description: 96 hr acute-exposure test, semi-static
Test-Treatment: River water spiked with ammonia
Test-Species: *Hyalella azteca* adults

LC_{50}

DATA FILE: t23surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Means
1	2	0.015	100.000	0.000	100.000
2	2	0.171	100.000	0.000	100.000
3	2	0.325	90.000	14.142	95.000
4	2	0.686	95.000	7.071	95.000
5	2	1.368	100.000	0.000	95.000
6	2	2.446	75.000	7.071	75.000
7	2	3.742	20.000	14.142	20.000

The Linear Interpolation Estimate: 3.0349 Entered P Value: 50

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 3.0392 Standard Deviation: 0.0830
Original Confidence Limits: Lower: 2.8778 Upper: 3.2233
Expanded Confidence Limits: Lower: 2.4066 Upper: 3.7887
Resampling time in Seconds: 0.06 Random_Seed: -1884520730

LC_{20}

DATA FILE: t23surv.icp

Conc. ID	Number Replicates	Concentration	Response Means	Std. Dev.	Pooled Response Mean
1	2	0.015	100.000	0.000	100.000
2	2	0.171	100.000	0.000	100.000
3	2	0.325	90.000	14.142	95.000
4	2	0.686	95.000	7.071	95.000
5	2	1.368	100.000	0.000	95.000
6	2	2.446	75.000	7.071	75.000
7	2	3.742	20.000	14.142	20.000

The Linear Interpolation Estimate: 2.1764 Entered P Value: 20

Number of Resamplings: 80 80 Resamples Generated
The Bootstrap Estimates Mean: 2.1833 Standard Deviation: 0.1718
Original Confidence Limits: Lower: 1.9484 Upper: 2.4459
Expanded Confidence Limits: Lower: 1.2642 Upper: 3.2544
Resampling time in Seconds: 0.06 Random_Seed: -1798847098

APPENDIX G

CALCULATION OF FLOW RATES AND THE NH_4Cl-STOCK CONCENTRATION FOR FLOW-THROUGH TESTS

Calculating Flow Rates to Diluters at Each Test-Table for 1999:

ASTM standard-method protocol (1996) states that a minimum daily replacement rate of five times per day should be used in flow-through exposure-systems and a ten-fold replacement rate is recommended. Each test-table in the toxicology-lab held twelve-10 L test-chambers (4 of which contained 1 L 'insert' containers for the one-month-old fathead minnows). Therefore, the minimum flow-rate required to pass through the diluters at each testing-table to replace the test-solutions ten times per day was 0.83 L/min.

Sample calculation:

$$12 \text{ test chambers} * \frac{10 \text{ L}}{\text{test-chamber}} * \frac{10 \text{ replacements}}{\text{day}} * \frac{1 \text{ day}}{1400 \text{ min}} = 0.83 \text{ L/min}$$

However, in order to maintain a sufficient flow-rate through the distribution manifold to supply all test chambers with an equal volume of test-solution, a flow-rate of 3.6 L/min was used (i.e. a rate four times greater than the minimum calculated-replacement rate).

Each diluter was supplied with a constant source of river water and NH_4Cl-stock. The flow rates of NH_4Cl-stock were arbitrarily chosen and are tabulated below. The river water flow rates were calculated by subtracting the corresponding NH_4Cl-stock flow rate at each exposure-concentration from the ideal measured flow rate to the diluter system (i.e., 3.6 L/min).

TABLE G-1: Flow rates of river water and NH_4Cl-stock entering each diluter.

Nominal [NH_3-N] (mg/L)	NH_4Cl-stock flow rate (ml/min)	River water flow rate (ml/min)	Total flow rate to diluter (ml/min)
Control	--	3600	3600
0.5	31	3569	3600
1	63	3537	3600
2	125	3475	3600
4	250	3350	3600
8	500	3100	3600
16	1000	2600	3600

Determining NH_4Cl-stock concentration in 1999:

An LMI™ 'dosing-pump' withdrew 10 ml of NH_4Cl-stock per minute (arbitrarily decided) or 14.4 L/day (i.e. 0.01 L/min * 60 min/hr * 24 hr/day) from an NH_4Cl-stock storage-container and deposited it into the ammonia-mixing chamber. River water from the river-water-distribution-chamber was also added to the ammonia-mixing chamber at a rate of 4650ml/min (i.e., a good working-flow-rate). Therefore, 4660 ml of solution (i.e., 4650 ml +10 ml) was added to the ammonia-mixing chamber every minute for the duration of the test.

The maximum NH_3-N concentration needed for the tests was 16 mg/L. In one minute, the total volume of test-solution entering a diluter was 3.6 L, 1.0 L (Table G-1) of which contained 57.6 mg of NH_3-N.

Sample Calculation: $\frac{16\ \text{mg}}{\text{L}} = \frac{x\ \text{mg}}{3.6\ \text{L}}$ $\quad x = 57.6$ mg

So, the NH_3-stock concentration in the ammonia-mixing chamber needed to be 57.6 mg/L. In one minute, 4.66 L of test-solution was received by the ammonia-mixing chamber, therefore 268.4 mg of NH_3-N had to be supplied by the 10 ml input of NH_4Cl-stock.

Sample Calculation: 57.6 mg/L * 4.66 L = 268.4 mg

268.4 mg NH_3-N/10 ml NH_4Cl stock = **26.84 g/L**

Using molecular weights, the concentration of NH_3-N required by the exposure-system (i.e., 26.84 g/L) was converted to the concentration of NH_4Cl needed to prepare the NH_4Cl-stock.

Sample Calculation:

Molecular weight of N = 14.01μ
Molecular weight of NH_4CL = 53.49μ

$\frac{26.84\ \text{g/L of N}}{x\ \text{g/L of } NH_4Cl} = \frac{14.01\mu}{53.49\mu}$ $\quad x = 102.5$ g NH_4Cl/L stock

Therefore, 102.5 g of NH_4Cl were dissolved in each litre of deionised water required to supply the exposure-system with 14.4 L of NH_4Cl-stock per day at a concentration of 57.6 mg/L.

During the 2000 testing-program, changes were made to the nominal NH_3-N exposure-concentrations which included reducing the highest total-ammonia concentration from 16.0 mg/L to 8.0 mg/L and adding a 6.0 mg/L exposure-concentration (i.e., dilution factor = 0.25). To accommodate for these changes, the flow rates of ammonia-stock and river water entering the mixing-chamber, the flow rates through the secondary diluters at each test-concentration, and the ammonia-stock concentrations were adjusted accordingly.

TABLE G-2: Summary of changes made to the test-system between 1999 and 2000.

	1999	**2000**
Flow-rate of ammonia-stock entering the mixing-chamber	10 ml/min	12 ml/min
Flow-rate of river-water entering the mixing-chamber	4650 ml/min	5400 ml/min
Flow-rates through diluter at control-table (ammonia-stock; river-water)	no change	no change
Flow-rates through diluter at conc.1-table (ammonia-stock; river-water)	31 ml/min; 3569 ml/min	63 ml/min; 3537 ml/min
Flow-rates through diluter at conc.2-table (ammonia-stock; river-water)	63 ml/min; 3537 ml/min	125 ml/min; 3475 ml/min
Flow-rates through diluter at conc.3-table (ammonia-stock; river-water)	125 ml/min; 3475 ml/min	250 ml/min; 3350 ml/min
Flow-rates through diluter at conc.4-table (ammonia-stock; river-water)	250 ml/min; 3350 ml/min	500 ml/min; 3100 ml/min
Flow-rates through diluter at conc.5-table (ammonia-stock; river-water)	500 ml/min; 3100 ml/min	750 ml/min; 2850 ml/min
Flow-rates through diluter at conc.6-table (ammonia-stock; river-water)	no change	no change
Ammonia-stock NH_3-N concentration	26.84 g/L	12.99 g/L
Mass of NH_4Cl dissolved in every 20L of deionised water	102.5 g	992 g

APPENDIX H

DRAFT FINAL REPORT FOR *IN SITU* CAGED MUSSEL STUDY PREPARED BY APPLIED BIOMONITORING (1999)
(to be included later)

APPENDIX I

COPY OF FINAL REPORTS FOR *Ceriodaphnia dubia* TESTS PREPARED BY E.S.G. INTERNATIONAL

COPY - AP
- 27/09/99 -

Sample Number : 03991036

Sample Identification

Company	: TetrES Consultants Inc.	Date Received	: 08/04/99
Location	: Winnipeg	Temp. On Arrival (C°)	: not measured
Substance	: Ammonia Spiked Effluent	Date Tested	: 08/04/99
Sample Method	: grab	Date Test Completed	: 08/11/99
Sampled By	: not given	Shipped By	: Courier
Initial Collection Date	: 08/03/99	Lab Storage	: 6 °C

Results (based on total ammonia concentrations)

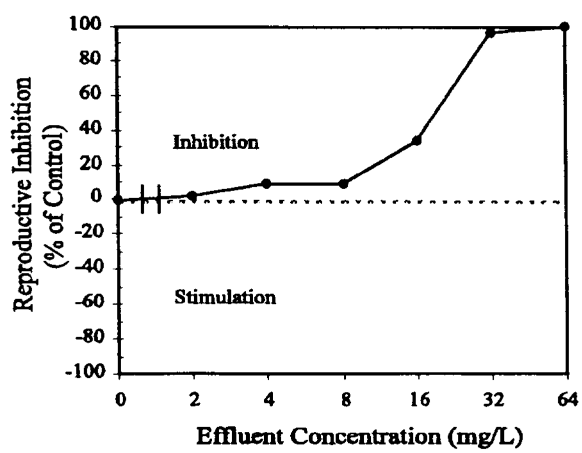
Survival

LC50 (95% Confidence Limits)	: 32 mg/L (16 - 64)
Statistical Method	: binomial (Stephan) [a]

Reproduction

IC50 (95% Confidence Limits)	: 19.2 mg/L (16.3 - 20.9)
Statistical Method	: linear interpolation (Toxstat 3.5) [b]
IC25 (95% Confidence Limits)	: 12.5 mg/L (8.0 16.6)
Statistical Method	: linear interpolation (Toxstat 3.5) [b]
NOEC	: 8 mg/L
LOEC	: 16 mg/L

Ceriodaphnia dubia Reproductive Inhibition



ESG INTERNATIONAL Mailing Address: 361 Southgate Drive Guelph, Ontario Canada N1G 3M5 Voice (519) 836-6050 Fax (519) 763-4419 Internet www.esg.net
Shipping Address: 11B Nicholas Beaver Road RR#3 Guelph, Ontario Canada N1H 6H9

Sample Number : 03991036

Test Conditions

Test Organism	*Ceriodaphnia dubia*	Test Type	Static Renewal
Source	E.S.G. stock	Test Volume Per Replicate	15 mL
Life Stage	Neonate(<24 h)	Test Vessel	15 mL polystyrene vial
Mean Young Produced (previous 7 d)	≥15.0	Depth of Test Solution	4.5 cm
# Young in Previous Brood	≥6.0	# Replicates	10
Previous 7d culture mortality (%)	0	# Organisms per Replicate	1
pH Adjustment	none	Renewal Method[c]	transfer
Sample Filtration	none	Renewal Period	24 h intervals
Hardness Adjustment	none	Feeding Rate	0.2 mL YCT and algae
Total Pre-aeration Time (min)	20	Feeding Frequency	once daily
Pre-aeration Rate (if applicable)	≤100 bubbles/min	Photoperiod (h) light/dark	16/8
Test Aeration	none	Temperature	25 ± 1°C
Control/Dilution Water	river water		

c Renewal and Spiking: Fresh effluent was received on Day 0, 1, 2 and 6. Sufficient effluent was sent on Day 2 for renewals on Days 3-5 (weekend). The effluent was stored at 6 °C. On a daily basis, immediately prior to renewal of the test solutions, the concentration of total ammonia in the effluent was adjusted to approximately 64 mg/L using a stock solution of NH_4Cl. This solution (64 mg/L) was used as the highest exposure concentration. Lower concentrations were prepared by dilution of the 64 mg/L solution with unspiked river water. Spiking procedures were consistent through out the study. Total ammonia concentrations were measured using the HACH Nessler method.

Test Protocol: Biological Test Method: Test of Reproduction and Survival using the Cladoceran *Ceriodaphnia dubia*. Environment Canada, Conservation and Protection. Ottawa, Ontario. Report EPS 1/RM/21 (including November 1997 amendments).

Test Organisms: No organisms exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in the test. No ephippia were present in cultures. All organisms were within 12 hours of the same age. The organisms were acclimated in receiving water prior to test initiation. Upon receipt of the receiving water, neonate Ceriodaphnids (<24 hours old) were collected and placed in 20% receiving water mixed with 80% laboratory dilution water. The proportion of receiving water to dilution water was increased every day by 20% (at each renewal period) until the animals were acclimated to full strength receiving water after approximately 5 days. Toxicity tests were performed with neonates from this culture maintained in 100% river water.

Comments

There were no unusual conditions or deviations from the test protocol.

Sample Number : 03991036

Reference Toxicant Data

Substance	:	Sodium Chloride
Test Date	:	08/23/99
IC25 Reproduction (95% confidence limits)	:	0.8 g/L (0.6 - 1.4)
Test Duration	:	7 days
Historical Mean IC25	:	1.2 g/L
Warning Limits (± 2 SD)	:	0.8 - 1.9
Statistical Method	:	Linear Interpolation (Toxstat 3.5) [a]

References

a Stephan, C.E. 1977. Methods for calculating an LC50. P. 65-84. In: P.L .Mayer and J.L. Hamelink (eds.), Aquatic Toxicology and Hazard Evaluation. Amer. Soc. Testing and Material, Philadelphia PA. ASTM STP 634.

b West, Inc. and D. Gulley. 1996. Toxstat Release 3.5. Western Ecosystems Technology. Cheyenne, WY, U.S.A.

Date: September 7, 1999

Approved by: Shawna Kirkpatrick
Shawna Kirkpatrick, Assistant Laboratory Supervisor

Ceriodaphnia dubia Survival and Reproduction

Sample Number **03991036**

Start Date: **04-Aug-99** C. dubia Batch # **Cd99-08A** Previous 7d culture mortality (%) **0**

[illegible]	Day	1	2	3	4	5	6	7	8	9	10	% Mortality	Mean # Young	
05/08/99	1	0	0	0	0	0	0	0	0	0	0	0	0	sk
06/08/99	2	0	0	0	0	0	0	0	0	0	0	0	0	vh
07/08/99	3	0	0	0	0	0	0	0	0	0	0	0	0	vh
08/08/99	4	6	6	6	5	6	6	0	0	6	7	0	4.8	vh
09/08/99	5	16	15	12	14	14	12	4	4	0	0	0	9.1	vh
10/08/99	6	18	19	0	0	0	0	7	9	15	16	0	8.4	vh
11/08/99	7	0	0	20	17	20	18	0	13	16	18	0	12.2	kd
	8													
Total neonates		40	40	38	36	40	36	11	26	37	41			

Mean # young: 34.5
Total adult mortality: 0

Concentration	Day	Replicate 1	2	3	4	5	6	7	8	9	10	% Mortality	Mean # Young
	1	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0
2 mg/L	4	6	6	5	6	4	6	0	0	6	0	0	3.9
	5	10	14	13	15	12	11	7	5	0	5	0	9.2
	6	16	16	0	0	0	0	13	12	16	11	0	8.4
	7	0	0	18	20	15	17	15	0	19	17	0	12.1
	8												
Total neonates		32	36	36	41	31	34	35	17	41	33		

Mean # young: 33.6
Total adult mortality: 0

Concentration	Day	Replicate 1	2	3	4	5	6	7	8	9	10	% Mortality	Mean # Young
	1	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0
4 mg/L	4	7	6	6	5	5	4	0	0	6	0	0	3.9
	5	14	14	13	13	14	10	6	7	0	6	0	9.7
	6	16	19	0	0	0	0	13	14	12	11	0	8.5
	7	0	0	0	15	10	8	16	16	17	11	0	9.3
	8												
Total neonates		37	39	19	33	29	22	35	37	35	28		

Mean # young: 31.4
Total adult mortality: 0

Concentration	Day	Replicate 1	2	3	4	5	6	7	8	9	10	% Mortality	Mean # Young
	1	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0
8 mg/L	4	5	4	3	6	4	4	0	3	4	6	0	3.9
	5	13	12	8	11	9	13	5	0	0	0	0	7.1
	6	14	17	0	0	0	0	14	11	12	14	0	8.2
	7	0	0	10	16	13	20	17	14	16	16	0	12.2
	8												
Total neonates		32	33	21	33	26	37	36	28	32	36		

Mean # young: 31.4
Total adult mortality: 0

Test Conducted By: S. Kripalu

Ceriodaphnia dubia Survival and Reproduction

Concentration	Day	Replicate 1	2	3	4	5	6	7	8	9	10	% Mortality	Mean # Young
16mg/L	1	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0
	4	5	1	3	3	4	0	0	0	0	0	0	1.6
	5	13	10	12	9	12	6	4	1	3	4	0	7.4
	6	0	0	0	0	0	0	10	11	11	9	0	4.1
	7	11	14	13	9	13	6	11	0	14	5	0	9.6
	8												
Total neonates		29	25	28	21	29	12	25	12	28	18		

Mean # young: 22.7
Total adult mortality: 0

Concentration	Day	Replicate 1	2	3	4	5	6	7	8	9	10	% Mortality	Mean # Young
32mg/L	1	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0 x	0	1	0	0	0	0	10	0.1
	5	6	0	0		0	0	0	0 x	0 x	0	30	0.7
	6	0	0	0		0	4	0 x			0	40	0.6
	7	0	0	2		0	0				0 x	50	0.3
	8												
Total neonates		6	0	2	0 x	0	5	0 x	0 x	0 x	0 x		

Mean # young: 1.3
Total adult mortality: 5

Concentration	Day	Replicate 1	2	3	4	5	6	7	8	9	10	% Mortality	Mean # Young
64mg/L	1	0 x	0	0	0	0	0	0	0	0	0	10	0
	2		0 x	0	0	0 x	0 x	0	0 x	0 x	0 x	70	0
	3			0	0 x			0				80	0
	4			0 x				0 x				100	0
	5												
	6												
	7												
	8												
Total neonates		0 x	0 x	0 x	0 x	0 x	0 x	0 x	0 x	0 x	0 x		

Mean # young: 0
Total adult mortality: 10

Concentration	Day	Replicate 1	2	3	4	5	6	7	8	9	10	% Mortality	Mean # Young
Untreated Effluent	1	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0
	4	0 x	0	0	0	0	0	0	0	0	0	10	0
	5		0	0	0	5	0	0	0 x	0	0	20	0.6
	6		0	0 x	0	0	0	7		7	4	30	2.3
	7		0 x		0	0	0	0		6	0	40	0.9
	8												
Total neonates		0 x	0 x	0 x	0	5	0	7	0 x	13	4		

Mean # young: 2.9
Total adult mortality: 4

Test Conducted By: S. Kupiliew

Ceriodaphnia dubia Survival and Reproduction
Water Chemistry Data

Sample #: **03991036**

Initial Parameters:	Temp.	pH	D.O.	Cond.
	24.0	7.2	7.0	1362

			Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Preaeration (≤100 bubbles/min):			y	y	y	y	y	y	n
Control	**Untreated River**								
Temp. (°C)		Initial:	23.5	24.0	24.0	24.0	24.0	24.5	24.0
		Final:	23.5	24.0	24.0	24.0	24.0	24.0	24.0
D.O.		Initial:	8.9	9.0	9.0	9.2	9.6	9.7	9.5
		Final:	8.0	7.8	7.8	7.9	7.9	7.9	7.8
pH		Initial:	8.3	8.3	8.4	8.3	8.3	8.3	8.3
		Final:	8.5	8.5	8.5	8.5	8.5	8.5	8.3
Conductivity		Initial:	717	707	740	730	730	762	742
Low	**2 mg/L**								
Temp. (°C)		Initial:	23.5	24.0	24.0	24.0	24.0	24.5	24.0
		Final:	23.5	24.0	24.0	24.0	24.0	24.0	24.0
D.O.		Initial:	8.5	8.4	8.8	9.0	9.1	9.2	9.0
		Final:	8.0	7.6	7.6	7.9	7.9	7.8	7.6
pH		Initial:	8.3	8.3	8.4	8.3	8.3	8.3	8.3
		Final:	8.5	8.5	8.5	8.5	8.5	8.5	8.4
Conductivity		Initial:	751	744	764	757	754	759	754
Middle	**8 mg/L**								
Temp. (°C)		Initial:	23.5	24.0	24.0	24.0	24.0	24.5	24.0
		Final:	23.5	24.0	24.0	24.0	24.0	24.0	24.0
D.O.		Initial:	8.6	8.6	8.6	8.9	9.1	9.2	9.0
		Final:	8.1	7.6	7.5	7.8	7.9	7.8	7.6
pH		Initial:	8.2	8.2	8.2	8.2	8.2	8.1	8.2
		Final:	8.4	8.5	8.5	8.5	8.5	8.4	8.3
Conductivity		Initial:	768	831	821	823	821	823	801
	16 mg/L								
Temp. (°C)		Initial:	23.5	24.0	24.0	24.0	24.0	24.5	24.0
		Final:	23.5	24.0	24.0	24.0	24.0	24.0	24.0
D.O.		Initial:		8.7					
		Final:							
pH		Initial:		8.3					
		Final:							
Conductivity		Initial:		906					
	32 mg/L								
Temp. (°C)		Initial:	23.5	24.0	24.0	24.0	24.0	24.5	24.0
		Final:	23.5	24.0	24.0	24.0	24.0	24.0	24.0
D.O.		Initial:						9.1	8.6
		Final:					7.8	7.7	7.4
pH		Initial:						7.7	7.6
		Final:					8.3	8.3	8.2
Conductivity		Initial:						1078	982

Ceriodaphnia dubia Survival and Reproduction
Water Chemistry Data

High	**64 mg/L**							
Temp. (°C)	Initial:	23.5	24.0	24.0	24.0	24.0	24.5	24.0
	Final:	23.5	24.0	24.0	24.0	24.0	24.0	24.0
D.O.	Initial:	7.6		8.3	8.6	8.8		
	Final:	7.7	7.4					
pH	Initial:	7.1		7.3	7.4	7.3		
	Final:	8.1	8.3					
Conductivity	Initial:	1253		1390	1402	1410		
	Untreated Effluent							
Temp. (°C)	Initial:	23.5	24.0	24.0	24.0	24.0	24.5	24.0
	Final:	23.5	24.0	24.0	24.0	24.0	24.0	24.0
D.O.	Initial:	8.6	8.0	8.1	8.5	8.6	8.9	6.9
	Final:	8.1	7.4	7.5	7.8	8.0	7.7	7.1
pH	Initial:	7.4	7.4	7.2	7.4	7.4	7.3	7.1
	Final:	8.2	8.4	8.3	8.4	8.4	8.3	8.1
Conductivity	Initial:	946	1164	1156	1160	1149	1152	890
Ammonia (mg/L)	prespike	nm	26.0	29.0	29.0	36.0	21.0	20.0
	postspike	64.0	62.0	64.0	66.0	66.0	64.0	64.0

nm = not measured

ESG INTERNATIONAL

COPY - AP
- 27/09/99 -

Sample Number : 03991035

Sample Identification

Company	:	TetrES Consultants Inc.	Date Received	:	08/04/99
Location	:	Winnipeg	Temp. On Arrival (C°)	:	not measured
Substance	:	Ammonia Spiked River Water	Date Tested	:	08/04/99
Sample Method	:	grab	Date Test Completed	:	08/11/99
Sampled By	:	not given	Shipped By	:	Courier
Initial Collection Date:		08/03/99	Lab Storage	:	6 °C

Results (based on total ammonia concentrations)

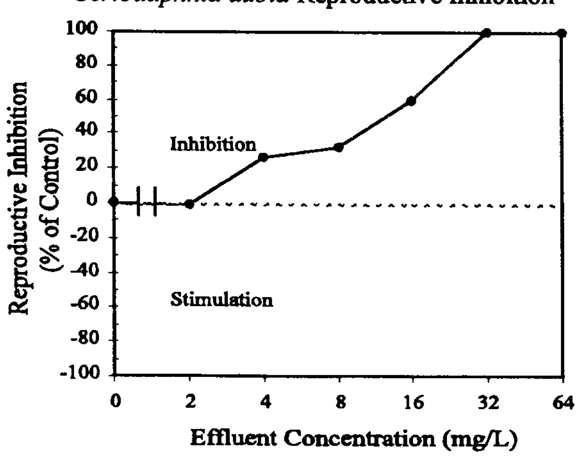
Survival

LC50 (95% Confidence Limits)	:	21.0 mg/L (16 - 32)
Statistical Method	:	non-linear interpolation (Stephan) [a]

Reproduction

IC50 (95% Confidence Limits)	:	12.6 mg/L (7.1 - 15.2)
Statistical Method	:	linear interpolation (Toxstat 3.5) [b]
IC25 (95% Confidence Limits)	:	3.9 mg/L (2.9 -9.1)
Statistical Method	:	linear interpolation (Toxstat 3.5) [b]
NOEC	:	2 mg/L
LOEC	:	4 mg/L

Ceriodaphnia dubia Reproductive Inhibition



ESG INTERNATIONAL Mailing Address: 361 Southgate Drive Guelph, Ontario Canada N1G 3M5 Voice (519) 836-6050 Fax (519) 763-4419 Internet *www.esg.net*
Shipping Address: 11B Nicholas Beaver Road RR#3 Guelph, Ontario Canada N1H 6H9

Sample Number : 03991035

Test Conditions

Test Organism	*Ceriodaphnia dubia*	Test Type	Static Renewal
Source	E.S.G. stock	Test Volume Per Replicate	15 mL
Life Stage	Neonate(<24 h)	Test Vessel	15 mL polystyrene vial
Mean Young Produced (previous 7 d)	≥15.0	Depth of Test Solution	4.5 cm
# Young in Previous Brood	≥6.0	# Replicates	10
Previous 7d culture mortality (%)	0	# Organisms per Replicate	1
pH Adjustment	none	Renewal Method[c]	transfer
Sample Filtration	none	Renewal Period	24 h intervals
Hardness Adjustment	none	Feeding Rate	0.2 mL YCT and algae
Total Pre-aeration Time (min)	20	Feeding Frequency	once daily
Pre-aeration Rate (if applicable)	≤100 bubbles/min	Photoperiod (h) light/dark	16/8
Test Aeration	none	Temperature	25 ± 1°C
Control/Dilution Water	river water		

c Renewal and Spiking: At the start of the study, two batches of river water were received and composited. The river water was stored at 6 °C. On a daily basis, immediately prior to renewal of the test solutions, the concentration of total ammonia in the river water was adjusted to approximately 64 mg/L using a stock solution of NH_4Cl. This solution (64 mg/L) was used as the highest exposure concentration. Lower concentrations were prepared by dilution of the 64 mg/L solution with unspiked river water. Spiking procedures were consistent through out the study. Total ammonia concentrations were measured using the HACH Nessler method.

Test Protocol: Biological Test Method: Test of Reproduction and Survival using the Cladoceran *Ceriodaphnia dubia*. Environment Canada, Conservation and Protection. Ottawa, Ontario. Report EPS 1/RM/21 (including November 1997 amendments).

Test Organisms: No organisms exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in the test. No ephippia were present in cultures. All organisms were within 12 hours of the same age. The organisms were acclimated in receiving water prior to test initiation. Upon receipt of the receiving water, neonate Ceriodaphnids (<24 hours old) were collected and placed in 20% receiving water mixed with 80% laboratory dilution water. The proportion of receiving water to dilution water was increased every day by 20% (at each renewal period) until the animals were acclimated to full strength receiving water after approximately 5 days. Toxicity tests were performed with neonates from this culture maintained in 100% river water.

Comments

There were no unusual conditions or deviations from the test protocol.

Sample Number : 03991035

Reference Toxicant Data

Substance	:	Sodium Chloride
Test Date	:	08/23/99
IC25 Reproduction (95% confidence limits)	:	0.8 g/L (0.6 - 1.4)
Test Duration	:	7 days
Historical Mean IC25	:	1.2 g/L
Warning Limits (± 2 SD)	:	0.8 - 1.9
Statistical Method	:	Linear Interpolation (Toxstat 3.5) [a]

References

a Stephan, C.E. 1977. Methods for calculating an LC50. P. 65-84. In: P.L .Mayer and J.L. Hamelink (eds.), Aquatic Toxicology and Hazard Evaluation. Amer. Soc. Testing and Material, Philadelphia PA. ASTM STP 634.

b West, Inc. and D. Gulley. 1996. Toxstat Release 3.5. Western Ecosystems Technology. Cheyenne, WY, U.S.A.

Date: September 7, 1999

Approved by: Shawna Kirkpatrick
Shawna Kirkpatrick, Assistant Laboratory Supervisor

Ceriodaphnia dubia Survival and Reproduction

Sample Number **03991035**

Start Date: **04-Aug-99** C. dubia Batch # **Cd99-08A** Previous 7d culture mortality (%): **0**

	Day	1	2	3	4	5	6	7	8	9	10	% Mortality	Mean # Young	Init
05/08/99	1	0	0	0	0	0	0	0	0	0	0	0	0	sk
06/08/99	2	0	0	0	0	0	0	0	0	0	0	0	0	kd
07/08/99	3	0	0	0	0	0	0	0	0	0	0	0	0	vh
08/08/99	4	0	3	6	0	0	6	6	5	6	6	0	3.8	vh
09/08/99	5	7	0	0	3	5	11	11	14	13	12	0	7.6	vh
10/08/99	6	14	14	11	7	15	0	0	0	0	0	0	6.1	vh
11/08/99	7	18	17	15	0	20	19	23	20	19	20	0	17.1	kd
	8													
Total neonates		39	34	32	10	40	36	40	39	38	38			

Mean # young: 34.6
Total adult mortality: 0

Concentration	Day	1	2	3	4	5	6	7	8	9	10	% Mortality	Mean # Young
	1	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0
2 mg/L	4	0	5	8	0	0	4	5	6	6	6	0	4
	5	5	0	0	6	6	13	11	13	11	12	0	7.7
	6	12	9	15	12	12	0	0	0	0	0	0	6
	7	17	19	20	16	15	18	16	18	17	18	0	17.4
	8												
Total neonates		34	33	43	34	33	35	32	37	34	36		

Mean # young: 35.1
Total adult mortality: 0

Concentration	Day	1	2	3	4	5	6	7	8	9	10	% Mortality	Mean # Young
	1	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0
4 mg/L	4	0	5	6	0	0	3	6	4	6	5	0	3.5
	5	4	0	0	5	6	7	12	7	11	9	0	6.1
	6	8	10	7	10	14	0	0	0	0	0	0	4.9
	7	2	15	17	0	0	8	18	16	19	17	0	11.2
	8												
Total neonates		14	30	30	15	20	18	36	27	36	31		

Mean # young: 25.7
Total adult mortality: 0

Concentration	Day	1	2	3	4	5	6	7	8	9	10	% Mortality	Mean # Young
	1	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0
8 mg/L	4	1	4	0	0	0	4	5	6	4	5	0	2.9
	5	0	0	7	2	4	13	3	13	8	12	0	6.2
	6	10	13	11	4	4	0	8	0	0	0	0	5
	7	2 x	12	12	0	0	12	14	16	12	15	10	9.5
	8												
Total neonates		13 x	29	30	6	8	29	30	35	24	32		

Mean # young: 23.6
Total adult mortality: 1

Test Conducted By: Shauna McPail

Ceriodaphnia dubia Survival and Reproduction

Concentration	Day	Replicates 1	2	3	4	5	6	7	8	9	10	% Mortality	Mean # Young
16mg/L	1	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	1	1	0	0	3	4	3	4	2	0	1.8
	5	3	0	0	4	5	0	0	6	0	0	0	1.8
	6	12	9	6	9	12	0	8	0	10	3	0	6.9
	7	0	9	8	0	0	0	10	4	0 x	5	10	3.6
	8												
Total neonates		15	19	15	13	17	3	22	13	14 x	10		

Mean # young: 14.1
Total adult mortality: 1

Concentration	Day	Replicates 1	2	3	4	5	6	7	8	9	10	% Mortality	Mean # Young
32mg/L	1	0	0	0	0	0 x	0 x	0	0	0	0	20	0
	2	0	0	0	0			0	0 x	0 x	0 x	30	0
	3	0 x	0	0 x	0			0				20	0
	4		0 x		0 x			0 x				30	0
	5												
	6												
	7												
	8												
Total neonates		0 x	0 x	0 x	0 x	0 x	0 x	0 x	0 x	0 x	0 x		

Mean # young: 0
Total adult mortality: 10

Concentration	Day	Replicates 1	2	3	4	5	6	7	8	9	10	% Mortality	Mean # Young
64mg/L	1	0 x	0 x	0 x	0 x	0 x	0 x	0 x	0 x	0 x	0 x	100	0
	2												
	3												
	4												
	5												
	6												
	7												
	8												
Total neonates		0 x	0 x	0 x	0 x	0 x	0 x	0 x	0 x	0 x	0 x		

Mean # young: 0
Total adult mortality: 10

Test Conducted By: Shauna [signature]

Ceriodaphnia dubia Survival and Reproduction
Water Chemistry Data

Sample #: **03991035**

Initial Parameters:	Temp.	pH	D.O.	Cond.
	24.0	9.3	8.0	1236

			Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Preaeration (≤100 bubbles/min):			y	y	y	y	y	y	y
Control	**Untreated River**								
Temp. (°C)		Initial:	23.5	24.0	24.0	24.0	24.0	24.5	24.5
		Final:	23.5	24.0	24.0	24.0	24.0	24.0	24.0
D.O.		Initial:	8.8	9.0	9.0	9.5	9.6	9.8	9.7
		Final:	8.9	7.8	7.8	7.8	8.0	8.0	8.0
pH		Initial:	8.3	8.3	8.4	8.4	8.3	8.3	8.2
		Final:	8.4	8.5	8.5	8.5	8.5	8.5	8.4
Conductivity		Initial:	714	707	740	730	728	743	751
Low	**2 mg/L**								
Temp. (°C)		Initial:	23.5	24.0	24.0	24.0	24.0	24.5	24.5
		Final:	23.5	24.0	24.0	24.0	24.0	24.0	24.0
D.O.		Initial:	8.6	8.7	8.7	9.0	9.2	8.4	9.2
		Final:	7.9	7.7	7.6	7.8	7.9	8.0	7.9
pH		Initial:	8.3	8.3	8.4	8.4	8.4	8.3	8.3
		Final:	8.3	8.5	8.4	8.5	8.5	8.5	8.4
Conductivity		Initial:	716	738	759	749	753	760	759
	4 mg/L								
Temp. (°C)		Initial:	23.5	24.0	24.0	24.0	24.0	24.5	24.5
		Final:	23.5	24.0	24.0	24.0	24.0	24.0	24.0
D.O.		Initial:		8.7					
		Final:							
pH		Initial:		8.4					
		Final:							
Conductivity		Initial:		737					
Middle	**8 mg/L**								
Temp. (°C)		Initial:	23.5	24.0	24.0	24.0	24.0	24.5	24.5
		Final:	23.5	24.0	24.0	24.0	24.0	24.0	24.0
D.O.		Initial:	8.6	8.8	8.6	9.1	9.1	9.3	9.2
		Final:	8.1	7.5	7.6	7.8	7.9	7.9	7.7
pH		Initial:	8.3	8.3	8.4	8.3	8.3	8.3	8.3
		Final:	8.4	8.4	8.4	8.5	8.5	8.5	8.4
Conductivity		Initial:	734	767	802	798	802	804	803
	16 mg/L								
Temp. (°C)		Initial:	23.5	24.0	24.0	24.0	24.0	24.5	24.5
		Final:	23.5	24.0	24.0	24.0	24.0	24.0	24.0
D.O.		Initial:		8.7			7.9	9.3	9.1
		Final:						8.0	7.7
pH		Initial:		8.3			8.4	8.3	8.2
		Final:						8.5	8.4
Conductivity		Initial:		813				870	866

Ceriodaphnia dubia Survival and Reproduction
Water Chemistry Data

32 mg/L

Temp. (°C)	Initial:	23.5	24.0	24.0	24.0	24.0	24.5	24.5
	Final:	23.5	24.0	24.0	24.0	24.0	24.0	24.0
D.O.	Initial:		8.7	8.5	9.0	9.0		
	Final:		7.6	7.8	7.9			
pH	Initial:		8.2	8.2	8.2	8.2		
	Final:		8.4	8.4	8.4			
Conductivity	Initial:		932	986	979	984		

High **64 mg/L**

Temp. (°C)	Initial:	23.5	24.0	24.0	24.0	24.0	24.5	24.5
	Final:	23.5	24.0	24.0	24.0	24.0	24.0	24.0
D.O.	Initial:	9.1						
	Final:	8.2						
pH	Initial:	8.0						
	Final:	8.2						
Conductivity	Initial:	1148						
Ammonia (mg/L)	prespike	nd	nd	nd	nd	nd	nd	nd
	postspike	66.0	62.0	66.0	64.0	64.0	66.0	62.0

nd = not detected

APPENDIX J

SUMMARY OF TEST-ACCEPTABILITY CRITERIA FOR ACUTE AND CHRONIC-EXPOSURE TESTS CONDUCTED ON FISH

TABLE J-1
SUMMARY OF TEST-ACCEPTABILITY CRITERIA FOR
ACUTE-EXPOSURE TESTING WITH FISH

Test Condition	Recommended	Source	Satisfied	Comments
Test Type	Static, static-renewal, or flow through	EPA[1]	Y	T1A, T1B – static T2A, T2B, T3A-96hr, T3B-96hr, T4A, T4B, T6A, T6B – static-renewal
Test Duration	24, 48 or 96 h	EPA[1]	T1A, T1B – Y T2A, T2B – Y T3A, T3B – Y T4A, T4B – Y T6A, T6B – N	T6A/6B duration = 72 hr
Temperature[2]	20+/- 1°C; or 25+/- 1°C	EPA[1]	T1A, T1B – N T2A, T2B– N T3A, T3B - N T4A, T4B – N T6A, T6B – Y	Tap water was used to maintain temp. of H_2O bath at: T1A, T1B, T2A, T2B – 15.5°C T3A, T3B – 17°C T4A, T4B – 18.5°C T6A, T6B – 21°C
Light quality	Ambient lab illumination	EPA[1]	Y	
Photoperiod	16h light, 8h dark	EPA[1]	Y	Lights controlled manually therefore photoperiod may have varied b/w 1-2 h daily.
Test chamber size	250 ml (min)	EPA[1]	Y	
Test chamber volume	250 ml (min)	EPA[1]	Y	
Renewal of test solution	Static tests – None Static-renewal tests - Daily	EPA[3]	Y	
Age of test organisms	1-14 days	EPA[1]	T1A –Y T1B – N T2A, T2B– N T3A, T3B - N T4A, T4B – N T6A, T6B – Y	Age of fish-fry was dictated by availability T1B – 18 days old T2A, T2B– 24 days T3A, T3B – 29 days T4A, T4B – 39 days
No. organisms/ test chamber	10 (minimum)	EPA[1]	Y	
No. replicate chambers/conc.	2 (minimum)	EPA[1]	Y	3 or 4 replicates were used depending on the quantity of fish-at-hand at test-start
No. organisms per conc.	20 (minimum)	EPA[1]	Y	30 or 40 organisms were used per concentration depending on the quantity of fish-at-had at test-start

Table J-1 (cont'd)

Test Condition	Recommended	Source	Satisfied	Comments
Feeding regime	Static: Not fed during test; fed while holding prior to use in the test Static-renewal: Feed (min) 0.15ml newly hatched brine shrimp nauplii 2X daily	EPA[3]	T1A, T1B – N T2A, T2B – N T3A – N, T3B– Y T4A –Y, T4B – Y T6A – Y, T6B– Y	T1A, T1B - Fish were fed 1 drop of liquid baby fish food on day 3 of the test because they were losing their yolk sacs. Alternately, they were not fed prior to test start because they had yolk sacs. T2A, T2B – Fish were not actively feeding and were therefore not fed.
Cleaning of test chambers	Cleaning not required	EPA[1]	Y	
Aeration[3]	None unless DO<40%; rate should not exceed 100 ml/min	EPA[1]	Y	See Table L-1, Appendix L
Dilution water	Moderately hard synthetic water is prepared using MILLIPORE MILLI-Q[R] or equivalent deionized water and reagent grade chemicals or 20% DMW.	EPA[1]	N	Red River water was used to better represent *in situ* conditions, a key objective in site-specific testing.
Test Concentrations	5 exposure concentrations (min) plus a control group	EPA[1]	Y	6-8 exposure-concentrations were used for each test
Dilution Factor	$\geq$ 0.5	EPA[1]	Y	
Endpoint	Survival	EPA[1]	Y	
Test acceptability criterion	90% or greater survival in the controls	EPA[1]	T1A, T2A, T2B – N T1B, T3A, T3B, T4A, T4B, T6A, T6B – Y	T1A had 70% survival in the control group and T2A and T2B had 77% survival in the control group. The datasets were smoothed and adjusted for control mortality before statistical analysis (Appendix F).

Notes:

1) [1] Source = USEPA *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms*, (1993).
2) [2] Temperatures are reported as test-means +/- test-standard deviations
3) [3] Source = USEPA *Manual for the Evaluation of Laboratories Performing Aquatic Toxicity Tests,* (1991).
4) T1A = 96 hr, static test using walleye fry; treatment: river water (RW) spiked with ammonia
5) T1B = 96 hr, static test using white sucker fry; treatment: RW spiked with ammonia
6) T2A = 96 hr, static-renewal test using white sucker fry; treatment: RW spiked with ammonia
7) T2B = 96 hr, static-renewal test using white sucker fry; treatment: E spiked with ammonia
8) T3A = 96 hr (10 day), static-renewal test using white sucker fry; treatment: RW spiked with ammonia
9) T3B = 96 hr (10 day), static-renewal test using white sucker fry; treatment: E spiked with ammonia
10) T4A = 96 hr, static-renewal test using white sucker fry; treatment: E spiked with ammonia
11) T4B = 96 hr, static-renewal test using fathead minnow fry; treatment: E spiked with ammonia
12) T6A = 72 hr, static-renewal test using fathead minnow fry; treatment: RW spiked with ammonia
13) T6B = 72 hr, static-renewal test using fathead minnow fry; treatment: E spiked with ammonia

TABLE J-2
SUMMARY OF TEST-ACCEPTABILITY CRITERIA FOR CHRONIC-EXPOSURE TESTING WITH FISH

Test condition	Recommended	Source	Satisfied	Comments
Test Type	Static-renewal or Flow-through	EPA[1]	Y	
Test Duration	Static-renewal – 7 days Flow-through -28-120 days	EPA[2] ASTM[3]	T3A, T3B –N T8, T9, T11, T20, T21 – Y T14, T15, T18 - N	T3A, T3B – 10 days; the tests were extended to generate better growth data T14 – 5 days; the test were terminated early due to a pump failure T15 – 13 days; the test was terminated early because control mortality was approaching 20% T18 – 12 days; the test was terminated early because the control mortality was approaching 20% and fish were becoming cannibalistic
Temperature	25 +/- 1°C	EPA[1]	N	T3A, T3B – Tap water was used to maintain temp. of H_2O-bath at: 17°C T8, T9, T11, T14, T15, T18, T20, T21 - Temperatures varied consistently with ambient river water temperatures. This effect more closely simulated *in situ* conditions and allowed for cold water and warm water testing, a key component of site-specific testing. T8, T9 mean test temp.= 8.5°C; T11=7.0°C; T14=14.4 °C; T15=16.1 °C; T18=16.8 °C; T20=17.7 °C; T21=17.8 °C
Light quality	Ambient lab illumination	EPA[1]	Y	
Photoperiod	16h light, 8h dark	EPA[1]	Y	T3A, T3B – Lights controlled manually so photoperiod may have varied b/w 1-2 h daily. T8, T9, T11, T14, T15, T18, T20, T21- Lights controlled with an automatic timer.
Test chamber volume	1L (min) for every 10 grams of biological tissue (i.e. fish)	ASTM[3]	Y	
Flow rates through test chambers	Static-renewal tests – n/a Flow-through tests - 1L (min.) for every 1 gram of biological tissue (i.e. fish); or min. of 10 L per day whichever is less	ASTM[3]	Y	

Table J-2 (cont'd)

Test condition	Recommended	Source	Satisfied	Comments
No. organisms/ test chamber	Static-renewal: 10 (minimum) Flow-through: 20 (minimum)	EPA[1] ASTM[3]	T3A, T3B - Y T8, T11, T14–N T9, T15, T18, T20, T21 – Y	 T8- 15/test chamber; satisfies ASTM[3] recommendation that no more than 10 grams of biological tissue (i.e. fish) per liter of test solution can be used. T11 – 15/test chamber; used maximum number of available fish T14 – 12/testchamber; used maximum number of available fish
No. replicate chambers/ conc.	Static-renewal: 3 (minimum) Flow-through: (2 minimum)	EPA[1] EPA[2]	Y	
Feeding regime	Static-renewal: Feed (min) 0.15 ml newly hatched brine shrimp nauplii 2X daily Flow-through: Channel catfish (i.e., brood stock) - food that will support growth/survival; 1x/day Fathead minnow - newly hatched brine shrimp 2x/day Whitefish – no recommended feeding regime Northern pike – live brine shrimp nauplii 3X daily Lake Tout – live brine shrimp nauplii or starter-grade commercial trout food 4X daily Walleye – no recommended feeding regime	EPA[2] ASTM[3] ASTM[3] --- ASTM[3] ASTM[3] ---	Y T8 –Y T9 – N T11- Y T14, T15 – n/a T18 – N T20 – N T21 – n/a	T9 – Fed local fathead minnow 1.0-1.5 g of trout chow 1x/day because they were approximately 3 months old and would not have fed as effectively on live brine shrimp. --- T18 – fed northern pike 2.6g of live daphnia 3X daily T20 – fed lake trout 2.6g of live daphnia or 1.7g of trout chow 3X daily ---
DO concentration	DO>60% saturation	ASTM[3]	Y	See Table L-2, Appendix L

Table J-2 (cont'd)

Test condition	Recommended	Source	Satisfied	Comments
Dilution water	Moderately hard synthetic water is prepared using MILLIPORE MILLI-Q[R] or equivalent deionized water and reagent grade chemicals or 20% DMW.	EPA[1]	N	Red River water was used to better represent *in situ* conditions, a key component of site-specific testing.
Test Concentrations	5 exposure concentrations (min) plus a control group	EPA[1]	Y	
Dilution Factor	$\geq$ 0.5	EPA[1]	Y	
Endpoint	Survival	EPA[1]	Y	Growth was also measured (based on dry tissue weights at test-termination).
Test acceptability criterion	Static-renewal: control survival must equal 80% or greater Flow-through: Channel catfish – control survival must be 65% or greater; Fathead minnow control survival must be greater than 70% Whitefish – no recommended % control survival Northern pike – control survival must be 70% or greater Lake trout – control survival must be 70% or greater Walleye – no recommended % control survival	EPA[1] ASTM[3] ASTM[3] --- ASTM[3] ASTM[3] ---	T3A, T3B – Y T8 – Y T9, T11 - Y T14, T15 – n/a T18 –Y T20 - Y T21 – n/a	

Notes:
1) [1] Source = USEPA (1993).
2) [2] Source = USEPA (1991).
3) [3] Source = ASTM (1996).
4) T3A = 10 day (96 hr), static-renewal test using white sucker fry; treatment: RW spiked with ammonia
5) T3B = 10 day (96 hr), static-renewal test using white sucker fry; treatment: E spiked with ammonia
6) T8 = 30 day, flow-through test using juvenile channel catfish; treatment: RW spiked with ammonia
7) T9 = 30 day, flow-through test using juvenile fathead minnow; treatment: RW spiked with ammonia
8) T11 = 29 day, flow-through test using juvenile fathead minnow; treatment: RW spiked with ammonia
9) T14 = 5 day, flow-through test using lake whitefish fry; treatment: RW spiked with ammonia
10) T15 = 13 day, flow-through test using lake whitefish fry; treatment: RW spiked with ammonia
11) T18 = 12 day, flow-through test using northern pike fry; treatment: RW spiked with ammonia
12) T20 = 30 day, flow-through test using juvenile lake trout; treatment: RW spiked with ammonia
13) T21 = 30 day, flow-through test using juvenile walleye; treatment: RW spiked with ammonia

APPENDIX K

LETHAL AND EFFECTIVE CONCENTRATIONS OF NH_3 FOR ALL ACUTE-EXPOSURE TESTS CONDUCTED ON FISH

TABLE K-1: LETHAL CONCENTRATIONS OF NH_3 FOR TEST-POPULATIONS OF FISH AFTER ACUTE-EXPOSURE

	Pooled LC_{50} values (mg NH_3/L)		Pooled LC_{20} values (mg NH_3/L)	
Test Species	**River Water Spiked with NH_3**	**Effluent Spiked with NH_3**	**River Water Spiked with NH_3**	**Effluent Spiked with NH_3**
Walleye	0.337 (1A – 96 hrs)		0.269 (1A – 96 hrs)	
White Sucker	0.496 (1B – 96 hrs) 0.218 (2A – 96 hrs) 0.525 (3A – 96 hrs)	0.196 (2B – 96 hrs) 0.321 (3B – 96 hrs) 0.419 (4A – 96 hrs)	0.443 (1B – 96 hrs) 0.137 (2A – 96 hrs) 0.234 (3A – 96 hrs)	0.157 (2B – 96 hrs) 0.285 (3B – 96 hrs) 0.387 (4A – 96 hrs)
Fathead Minnow	0.569 (6A – 72 hrs)	0.385 (4B – 96 hrs) 0.214 (6B – 72 hrs)	0.272 (6A – 72 hrs)	0.309 (4B – 96 hrs) 0.211 (6B – 72 hrs)

Notes:

1. *Pooled* refers to the average percent-response of test-organisms in *n* replicate exposure vessels (where *n* = the number of replicates as given in Appendix A).
2. LC_x = the concentration of a stressor that is estimated to be lethal to *x*% of test-organisms over a specific time interval (e.g., 96 hr LC_{50}).
3. NH_3 = unionized ammonia (i.e., stressor)
4. Test number and duration are given in brackets.
5. Reported $LC_{50/20}$ values were derived via linear interpolation using the ICPIN program described in Appendices F and F-1.

APPENDIX L

DISSOLVED OXYGEN CONCENTRATIONS

TABLE L-1

DISSOLVED OXYGEN CONCENTRATIONS FOR ACUTE-EXPOSURE TESTS WITH FISH

TEST NO.	TEST SPECIES	TEST TYPE	TEST DURATION	AERATED? (Y/N)	MEAN % SATURATION	SD (%)
1A	Walleye	Static	96-hr	N	78	17
1B	White Sucker	Static	96-hr	N	77	15
2A	White Sucker	Semi-static	96-hr	N	62	5
2B	White Sucker	Semi-static	96-hr	N	62	3
3A	White Sucker	Semi-static	96-hr	N	76	5
3B	White Sucker	Semi-static	96-hr	N	73	5
4A	White Sucker	Semi-static	96-hr	N	81	10
4B	Fathead Minnow	Semi-static	96-hr	N	80	10
6A	Fathead Minnow	Semi-static	72-hr	Y	93	5
6B	Fathead Minnow	Semi-static	72-hr	Y	92	4

Notes:

1. *mean % saturation* = the average dissolved oxygen (DO) concentration of all exposure-vessels for each test; expressed as a percent of the DO concentration at 100% saturation. Average test-temperatures (reported in Appendix F) were used to determine oxygen solubility in water when chlorinity = 0 (Clesceri et al., 1998 Table 4500-0).
2. SD = standard deviation

TABLE L-2

DISSOLVED OXYGEN CONCENTRATIONS FOR CHRONIC-EXPOSURE TESTS WITH FISH

TEST NO.	TEST SPECIES	TEST TYPE	TEST DURATION	AERATED? (Y/N)	MEAN % SATURATION[a]	SD (%)[b]
3A	White Sucker	Semi-static	10-day	N	69	9
3B	White Sucker	Semi-static	10-day	N	67	9
8	Channel Catfish	Flow-through	30-day	N	103	6
9	Fathead Minnow	Flow-through	30-day	N	104	6
11	Fathead Minnow	Flow-through	29-day	N	108	6
14	Whitefish	Flow-through	5-day	N	99	8
15	Whitefish	Flow-through	13-day	N	100	14
18	Northern Pike	Flow-through	12-day	N	103	7
20	Lake Trout	Flow-through	30-day	Y[c]	90	8
21	Walleye	Flow-through	30-day	Y[c]	87	6

Notes:

a. *mean % saturation* = the average dissolved oxygen (DO) concentration of all exposure-vessels for each test; expressed as a percent of the DO concentration at 100% saturation. Average test-temperatures (reported in Appendix F) were used to determine oxygen solubility in water when chlorinity = 0 (Clesceri et al., 1998 Table 4500-0).

b. SD = standard deviation

c. test chambers were aerated continuously following Day 13 of T-20 and Day 9 of T-21 to ensure that sufficient dissolved oxygen concentrations would be maintained in all test chambers in the event of a pump failure.

TABLE L-3

DISSOLVED OXYGEN CONCENTRATIONS FOR TESTS CONDUCTED ON INVERTEBRATES

TEST NO.	TEST SPECIES	TEST TYPE	TEST DURATION	AERATED? (Y/N)	MEAN % SATURATION	SD (%)
5A	Floater Mussels	Semi-static	66-day	Y	94	8
5B	Fingernail Clams	Semi-static	8-day	Y	93	6
12A	*Ceriodaphnia dubia*	Semi-static	7-day	N	100	7
12B	*Ceriodaphnia dubia*	Semi-static	7-day	N	99	8
22	*Hyalella azteca*	Semi-static	28-day	N	77	23
23	*Hyalella azteca*	Semi-static	96-hour	N	90	13

Notes:

1. *mean % saturation* = the average dissolved oxygen (DO) concentration of all exposure-vessels for each test; expressed as a percent of the DO concentration at 100% saturation. Average test-temperatures (reported in Appendix F) were used to determine oxygen solubility in water when chlorinity = 0 (Clesceri et al., 1998 Table 4500-0).
2. SD = standard deviation