WILLIAM A.
STUBBLEFIELD, PH.D.

POLLUTION CONTROL HEARINGS BOARD
FOR THE STATE OF WASHINGTON

AIRPORT COMMUNITIES COALITION and CITIZENS AGAINST SEA-TAC EXPANSION,

Appellants,

v.

DEPARTMENT OF ECOLOGY and THE PORT OF SEATTLE,

Respondents.

No. PCHB 01-160

PREFILED TESTIMONY OF DR. WILLIAM A. STUBBLEFIELD, PH.D.

AR 016689

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ORIGINAL

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1. I have personal knowledge of the facts stated in this testimony, and would be competent to testify to those facts.

2. I have a B.S. (1977) in Biology from Eastern Kentucky University in Richmond, Kentucky; an M.S. (1979) in toxicology/toxicodynamics at the University of Kentucky in Lexington, Kentucky; and a Ph.D. (1987) in environmental toxicology from the University of Wyoming in Laramie, Wyoming.

3. I have approximately 20 years of experience conducting research in the fields of environmental toxicology, ecological risk assessment, and aquatic and wildlife toxicology studies. In my work, I have dealt with a variety of environmental issues, especially those associated with wastewater effluents, the evaluation of impacts to aquatic and terrestrial species as a result of point source and non-point source discharges, the toxicity of various heavy metals and petroleum-derived materials, and the derivation and modification of water quality criteria and/or standards.

4. I am currently Technical Director of Environmental Toxicology at ENSR Corporation. My professional resume is attached as Exhibit A. My testimony address the following issues:

- I explain how Ambient Water Quality Criteria are developed. These Ambient Water Quality Criteria for metals are conservative by design because they are developed applicable in all the waters of the United States. One reason that these criteria are conservative is that they are based on toxicity data developed using laboratory water (not site-specific water) which frequently contains organic ligands (dissolved organic carbon) that bind metals and reduce their biologic availability, and thus their toxicity, to organisms.
- I explain how the Ambient Water Quality Criteria are used in the NPDES process and how their application depends upon an appropriate translator.
- I explain how Water Effect Ratios (WERs) are developed for site-specific conditions. The use of a WER is specifically encouraged by the Environmental Protection Agency and its use is approved in Washington Department of Ecology regulations. The WER essentially produces a site specific ambient water quality standard by comparing the actual effect of site-

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specific water conditions on the toxic substance, such as dissolved metals, and obtaining a standard that is equally protective in the site-specific water as the Ambient Water Quality Criteria are for laboratory water.

- I describe the Port of Seattle's preliminary WER range-finding studies for copper in the streams near the Seattle-Tacoma International Airport. I have reviewed that preliminary information, and those range-finding studies indicated a substantial WER (greater than 6) for copper in those streams. If the final WER is in this range, it would mean that the ambient standard for copper in those streams could be increased by a factor of 6 and still be equally protective of waters of the state. In my opinion, results of definitive WER studies are likely to confirm that the Washington state ambient water quality standard could be significantly increased in those streams and still remain protective of sensitive species.
- I discuss the Port's recent in-stream characterization and stormwater sampling studies. Those studies have been undertaken for zinc and copper after a preliminary screening has shown that all other metals in the list of EPA's 13 priority pollutant metals are not present at concentrations sufficient to be of concern in the Airport's stormwater discharges. The studies have been conducted at various locations in Des Moines, Walker, and Miller Creeks. Preliminary results show no exceedances of chronic water quality standards based on 48-hour average measured concentration for either zinc or copper at any monitoring station in any creek. The results also show no exceedance of acute water quality standards for either zinc or copper in Miller and Walker Creeks. The results show limited exceedances at some locations for some storm events in Des Moines Creek. This basin drains both International Boulevard in the City of SeaTac and other industrial areas, so it is not possible to say whether these exceedances are attributable to the Port. However, the range-finding study for the WER for copper suggests that the WER process required by Ecology will result in a site-specific standard that will be sufficient to account for the observed exceedances. Thus, I am

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confident that, with the development of a site-specific water quality standard, water quality standards can be met even if the copper is attributable to the Airport. A WER analysis for zinc is not yet complete. If results are similar to the WER studies for copper, it will result in an increased site-specific standard, but it is not possible yet to tell the magnitude of the increase. Because the zinc exceedances are infrequent, of short duration, and are not particularly high, however, I am confident that water quality standards for zinc can be met either through a WER or through a WER in combination with water quality BMPs that remove zinc from stormwater and that can be imposed by Ecology during the NPDES process.

5. Water Quality Standards. National Ambient Water Quality Criteria (AWQC) are numeric guideline values intended for the protection of aquatic organisms and their uses throughout the United States. AWQC are developed under a rigorous set of guidelines and are aimed at protecting the majority of aquatic species present in all or almost all bodies of water within the United States (USEPA 1985a). Thus, national criteria define, for a given water body, contaminant concentrations below which detrimental effects to resident species or their intended uses are not expected to occur. State environmental regulatory agencies may adopt and implement national AWQC as state standards affording them the strength of enforcement.

6. AWQC consist of two concentrations: the criterion maximum concentration (CMC) and the criterion continuous concentration (CCC). The CMC and CCC values may be thought of as the acute and chronic criteria, respectively. The criterion is defined by USEPA guidelines (USEPA 1985a) as follows:

> Except where a locally important species is very sensitive, aquatic organisms and their uses should not be affected unacceptably if the 4-day average concentration of the material of interest does not exceed the CCC more than once every 3 years, on the average, and if the 1-hour average concentration does not exceed the CMC more than once every 3 years, on the average.

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Thus, an AWQC consists of three parameters: 1) magnitude – concentration of contaminant, 2) duration – length of exposure period, and 3) frequency – how often an exceedance can occur and still be protective. The duration (1 hour and 4 day average) and frequency (once every three years) terms are consistent for most all contaminants and are mandated in the USEPA guidance document (USEPA 1985).

7. It is important to note that AWQC are intended as threshold values designed to protect against unacceptable effects. This does not mean that any exceedance of AWQC implies adverse effects to exposed aquatic organisms have or will occur; the implications of an exceedance are site-specific. Exceedances can occur without causing unacceptable effects if:

- the magnitude and duration of exposures above the criteria are limited,
- there are compensating periods when exposures are below the AWQC,
- species resident to the water body are either more or less sensitive to a contaminant than species represented in the AWQC database, and
- water quality characteristics in the site water body modify the bioavailability of the contaminant to make it either more or less toxic than was observed in the laboratory toxicity tests used in developing the AWQC.

8. Data Requirements for AWQC Derivation. AWQC are derived from laboratory-based empirical toxicity data developed with a variety of aquatic organisms. Data used in these calculations must be derived only from tests conducted in laboratory dilution water with total organic carbon or particulate matter ≤5 mg/L, thus, these waters are much cleaner than most than "natural" waters.

If test results indicate that toxicity to two or more species is related to some water quality parameter, such as hardness, an equation should be derived predicting the toxic effect concentration based on the measured water quality parameter. Laboratory tests have shown a relationship between the toxicity of metals and water hardness; therefore, the AWQC for the majority of metals are expressed as an equation reflecting the water hardness-toxicity relationship.

9. Total Recoverable vs Dissolved Criteria for Metals. Establishing and implementing metals criteria are complicated: (1) by the chemical form (i.e., speciation) of metals in natural waters, (2)

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by the distinction between total recoverable metals and those metals species/fractions that are bioavailable, which is best approximated by the dissolved metals concentration, and (3) by the complexing of dissolved metal species with organic ligands (i.e., dissolved organic carbon), which can reduce toxicity below even that predicted by the dissolved concentration.

10. Of the analytical methods available, the dissolved method [operationally defined as that portion of metal that will pass through a 0.45 μm filter] better approximates the bioavailable fraction in most waters, as stated in the USEPA policy announcement: "the use of dissolved metal to set and measure compliance with water quality standards is the recommended approach, because dissolved metal more closely approximates the bioavailable fraction of metal in the water column than does total recoverable metal" (USEPA Memorandum from Martha Prothro, Acting Assistant Administrator for Water, October 1, 1993). The State of Washington agrees with this approach and all metals standards in the state are based on dissolved metal concentrations.

11. AWQC/Washington Standards for Copper, Lead, and Zinc. Water quality standards for copper, lead, and zinc in Washington are defined under WAC 173-201A-040. Washington State Standards are derived from USEPA "Gold Book" values based on total recoverable concentrations (USEPA 1986), but have been adjusted to account for dissolved metal concentrations (Prothro letter 1993). National ambient water quality criteria for copper and zinc (but not lead) were revised in 1995 (USEPA 1996). However, Washington State Standards have not been revised to reflect these revisions. The formulas for these standards are given in the following table.

Substance	Washington WQS	National AWQC
Copper – acute	$(0.960)(e^{(0.9422[\ln(\text{hardness})]-1.464)})$	$(0.960)(e^{(0.9422[\ln(\text{hardness})]-1.7)})$
Copper – chronic	$(0.960)(e^{(0.8545[\ln(\text{hardness})]-1.465)})$	$(0.960)(e^{(0.8545[\ln(\text{hardness})]-1.702)})$
Lead - acute[1]	$(0.791)(e^{(1.273[\ln(\text{hardness})]-1.460)})$	$(0.791)(e^{(1.273[\ln(\text{hardness})]-1.460)})$
Lead – chronic[1]	$(0.791)(e^{(1.273[\ln(\text{hardness})]-4.705)})$	$(0.791)(e^{(1.273[\ln(\text{hardness})]-4.705)})$

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Zinc – acute	$(0.978)(e^{(0.8473[\ln(\text{hardness})]+0.8604)})$	$(0.978)(e^{(0.8473[\ln(\text{hardness})]+0.884)})$
Zinc – chronic	$(0.986)(e^{(0.8473[\ln(\text{hardness})]+0.7614)})$	$(0.986)(e^{(0.8473[\ln(\text{hardness})]+0.884)})$

[1]The conversion factor (CF = 0.791) is hardness dependent and was calculated for a hardness of 100. CF is calculated for other hardnesses as follows: CF =1.46203 - [(ln hardness)(0.145712)].

In order to make this comparison more meaningful, Washington water quality standards (WQS) and national ambient water quality criteria (NAWQC) are presented over a range of hardnesses in the following table.

	25 mg/l hardness		50 mg/l hardness		100 mg/l hardness		200 mg/l hardness	
Substance	**WQS**	**AWQC**	**WQS**	**AWQC**	**WQS**	**AWQC**	**WQS**	**AWQC**
Copper – acute	4.61	3.64	8.86	6.99	17.0	13.4	32.7	25.8
Copper – chronic	3.47	2.74	6.28	4.95	11.4	8.96	20.5	16.2
Lead – acute	13.9	13.9	30.1	30.1	64.6	64.6	136	136
Lead – chronic	0.54	0.54	1.17	1.17	2.52	2.52	5.31	5.31
Zinc – acute	35.4	36.2	63.6	65.1	114	117	206	211
Zinc – chronic	32.3	36.5	58.9	65.7	104	118	188	213

This table shows how sensitive the AWQC are to the "hardness" of the waters being evaluated. This refers to the concentrations of certain mineral salts (chiefly calcium and magnesium) in the water. The hardness of streamwater can vary significantly over short periods of time during rainfall events.

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12. Use of Standards in the NDPES Permit Process. As previously discussed, the EPA's Office of Water recommends that dissolved metal concentrations be used for the application of metals aquatic life criteria and that State water quality standards be based on dissolved metals. Because the national AWQC and State water quality standards (WQS) were originally established based on total recoverable metals concentrations, a generic (non site-specific) conversion factor is used to modify total recoverable metal based criteria to dissolved criteria. *Conversion factors* were determined in laboratory waters in which toxicity tests for metals criteria for aquatic life were conducted by comparing the dissolved and total recoverable metals concentrations. For example, the conversion factor for Zn is 0.978 for the acute criterion (CMC) and 0.986 for the chronic criterion (CCC), for Cu the values are 0.960 for both the CMC and CCC.

Chemical-specific limits contained in NPDES discharge permits represent a different issue. By regulation (40 CFR 122.45(c)), NPDES chemical-specific permit limits for metals must be expressed on the basis of total recoverable concentrations. Differences in chemical characteristics (e.g., pH, total suspended solids, dissolved organic carbon) between the discharged effluent and the receiving water can result in changes in partitioning between dissolved and adsorbed forms of metal. This can result in changes in the dissolved proportion of metals found in the receiving stream, thus the use of the total recoverable metals approach for regulating effluent concentrations is warranted. A *metals translator* is used to account for the fraction of metal in the effluent that could be dissolved in the receiving stream.

A recent EPA guidance document (USEPA 1996) has provided three procedures that can be used to determine a metals translator:

1) *Default Translator*: This procedure assumes that the metal in the receiving stream is dissolved to the same extent as it was during criteria development (i.e., the inverse of the conversion factor). This method is conservative however, because the AWQC value was derived from tests conducted in waters with low total suspended solids (TSS) and dissolved organic carbon (DOC) resulting in a minimal amount of bound or particulate metal. Thus, while this method may be the most

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cost-effective, it is extremely conservative in estimating a site-specific translator; the criteria would be the same as those originally determined and thus would provide little indication of the actual dissolved/particulate partitioning in a site water.

2) Direct Measurement of Dissolved and Total Metal: The most direct method for calculating a translator is to determine the fraction of dissolved metal (f_D) by measuring both the concentration of dissolved metal (C_D) and the concentration of total recoverable metal (C_T) in the receiving stream, and thus determine the dissolved fraction as:

$f_D = C_D / C_T$

This method is conducted for several samples (different flows, times, etc), and the translator is then calculated as the geometric mean of the dissolved fractions (C_D/C_T).

3) Partition Coefficient: A partition coefficient may also be derived as a function of TSS, DOC, pH, and related factors. The partition coefficient is the ratio of the particulate-sorbed and dissolved metal species multiplied by the adsorbent concentration, as follows:

$$K_P = C_P / C_D * m$$

where: C_P is the particulate sorbed metal, C_D is the dissolved metal, and m is the adsorbent concentration (i.e., TSS, etc.)

If the permit holder does not develop site-specific data, the conservative "default translator" approach is taken and the laboratory-based conversion factor is used in lieu of a site-specific translator value. Because the regulations only require that total recoverable metals concentrations be reported, the vast majority of dischargers (including STIA) determine only the total recoverable metal concentration in their effluent.

The importance of a site-specific translator can be substantial. For example, data reported by Herrera (Herrera 2001) suggests that mean dissolved concentrations are typically in the range of 38% for Cu and 30% for Zn of total recoverable values. This means that NPDES chemical specific standards for

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Cu and Zn could be increased by a factor of approximately 2.5-3.0 and in-stream dissolved standards would be achieved.

13. Water-Effects Ratios - Background and Derivation. As has been recognized by the USEPA, ambient water quality criteria (AWQC) are inherently conservative and frequently are over-protective when evaluated on a site-specific basis. Consequently, the development of site-specific criteria has been recommended, and numerous guidelines have been distributed for this purpose (i.e., Carlson et al. 1984, USEPA 1992, Prothro 1993, USEPA 1994, USEPA 2001). It is clear from the USEPA's own policy documents that national water quality criteria can be, and in fact are intended to be conservative under certain environmental conditions and for certain priority pollutants, namely metals. Although they successfully set a minimum threshold concentration below which adverse effects to the majority of aquatic species are not anticipated in *any* water body throughout the United States under any circumstances, the criteria fare poorly in quantifying "safe" threshold concentrations or lowest observable effect concentrations that are specific to particular surface waters. This is because the site specific water quality conditions may be quite different from those under which the national criteria were developed (the national criteria are developed using laboratory water).

14. Measurement of the site-specific water-effects ratio (WER)[1] provides the best indication of the metal concentration expected to cause toxicity in the water body under consideration, and circumvents the need to distinguish between criteria values and metals concentrations measured using various analytical methods (i.e., those predicting toxic metals concentrations from either total recoverable, acid soluble, or dissolved measurements). By determining the ratio between metals toxicity in the actual site water and in laboratory water, the national criterion value can be adjusted and the issue of bioavailability addressed directly.

[1] "Water Effect Ratio (WER) is the acute (or chronic) value in site water divided by the acute (or chronic) value in laboratory waters. An acute value is an LC50 or EC50 from a 48-96 hour test, as appropriate for the species. A chronic value is a concentration resulting from hypothesis testing or regression analysis of measurements of survival, growth or reproduction in life cycle, partial life cycle, or early life stage tests with aquatic species." (USEPA 1992)

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15. Beginning with the original "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and their Uses" (Stephan et al. 1985), and followed by the "Guidelines for Deriving Numerical Aquatic Site-Specific Water Quality Criteria by Modifying National Criteria" (Carlson et al. 1984) and the "Interim Guidance on Interpretation and Implementation of Aquatic Life Criteria for Metals" (USEPA 1992), the "Interim Guidance on the Determination and Use of Water-Effect Ratios for Metals" (USEPA 1994), the "Interim Final Rule for the Establishment of Numeric Criteria for Priority Toxic Pollutants" (USEPA 1995) and, most recently, the "Streamlined Water-Effect Ratio Procedure for Discharges of Copper" (USEPA 2001), the Agency has presented a clear policy recognizing the technical value of site-specific criteria modification and has promoted it under specified circumstances.

16. Range-Finding Test Methods and Results at the Airport. In an effort to determine the potential importance of site water quality characteristics on the toxicity of copper in Miller, Walker, and DesMoines Creeks, a series of "range-finding" water-effect ratio tests were conducted. Although these tests are preliminary, they suggest that site-waters in the Miller, Walker, and DesMoines Creek watersheds strongly affect the toxicity of copper.

17. A total of 10 "range-finding" acute toxicity Water-Effect Ratio ("WER") tests were conducted comparing the relative toxicity of copper to organisms held in laboratory reconstituted water to its toxicity in water collected from multiple sites in Miller, Walker, and DesMoines Creeks. Site and laboratory waters were spiked with copper salts, providing paired concentration series that were used to determine comparable toxicity endpoints (i.e., LC_{50} [median lethal concentration] in each water type. Laboratory toxicity tests conducted included:

February 1999 tests with Ceriodaphnia dubia

(Samples collected 21-23 Feb. 1999)

- SDS3 outfall mixed with Miller Ck water (1:5 ratio)
- SDS3 outfall mixed with Walker Ck water (4:1 ratio)

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- West Fork DesMoines Creek (collected at Northwest Ponds outlet)
- Laboratory water

April 2000 tests with Daphnia magna

(Samples collected 15 April 2000)

- Northwest Ponds inlet
- Northwest Ponds outlet
- Miller Creek (below the Lake Reba stormwater detention facility)
- Miller Creedk (upstream of the Lake Reba stormwater detention facility)
- DesMoines Creek weir
- Laboratory water

18. Generally, with the exception of the analytical confirmation of metals concentrations in the exposure solutions, the laboratory tests were conducted in accordance with applicable guidelines on test conduct, analysis, and data interpretation (USEPA 1994, USEPA 1993). Survival in range-finding WER studies was used to calculate the acute EC50 (median effect concentration) for tests performed using copper-spiked site waters, laboratory mixed site waters, and laboratory water. All LC_{50} values were calculated based on nominal copper concentrations. The EC_{50} values were then normalized using the hardness relationship described in the national AWQC document (USEPA 1985) to a hardness of 50 mg/L, and used to calculated WERs using the following formula:

WER = Normalized LC_{50} in site water/Normalized LC_{50} in laboratory water

The calculated EC_{50} s and WERs are summarized in the following table:

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Table 2. Range-finding WER test results

Station	Hardness (mg/L as CaCO3)	Cu LC_{50} (µg Cu/L)	Hardness-Normalized Cu LC_{50}	Calculated WER
February 1999 tests with Ceriodaphnia dubia				
SDS3 outfall mixed with Miller Creek water	44	70.7	79.9	16.0
SDS3 outfall mixed with Walker Creek water	50	33.3	33.3	6.7
DesMoines Creek W (NPout)	60	88.0	74.2	14.9
Laboratory water	96	9.2	4.9	—
April 2000 tests with Daphnia magna				
Northwest Ponds inlet	60	143.9	120.93	28.434
Northwest Ponds outlet	96	132	75.87	17.938
Miller Creek Detention facility	92	168.8	95.03	22.343
Miller Creek upstream	46	11.6	120.72	28.384
DesMoines Creek weir	65	136.6	106.68	25.083
Laboratory water	90	7.4	4.25	—

Copies of the February 1999 and April 2000 preliminary range-finding WER studies are attached as Exhibits C and D.

19. WER Summary and Interpretation. Results of this testing program show that the water quality characteristics of the Miller, Walker, and DesMoines Creek watersheds reduce the bioavailability and thus, the toxicity of copper relative to what would be observed in "clean" laboratory waters, as were used in generating the data used in derivation of national AWQC. Of the 8 WERs calculated for the

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studies conducted, water-effect ratios ranged from a low of 6.6 to a high of 28.4. (Table 2). Toxicity was consistently associated with higher copper concentrations in Miller, Walker, and DesMoines Creek site waters than in comparable laboratory-reconstituted waters.

20. All of these data suggest that the Washington State Standard for copper could be increased significantly and still remain protective of sensitive and important species in the Miller, Walker, and DesMoines Creek systems. Moreover, WERs determined in this testing program were consistent with, although slightly higher than, others that have been presented in the literature. Carlson et al. (1986) report copper WERs ranging from 3.9 to 7.0 for *Ceriodaphnia dubia*, fathead minnow, and *Scapholeberis* sp. (a resident daphnid) in the Naugatuck River, Connecticut, downstream of industrial and municipal discharges; the authors concluded national water quality criteria were overly protective for the site in question. Thursby et al. (1993) reports copper WERs of 1.0 to 5.7 for total recoverable copper and 1.0 to 3.9 for dissolved copper in waters from the Hudson/Raritan Estuary. Brungs (1991), summarizes the results of 10 studies in which copper WERs were determined for several species in varying site and laboratory waters. Values ranged from 1.0 to 15.3 (mean = 5.42), and the single reported rainbow trout WER was 3.2. Thus, data from water-effect ratio studies in other water bodies have shown the protective effects of site water on copper toxicity.

21. The intention of this testing program was not to provide data to be used to invalidate the national ambient water quality criteria or the Washington State Standard for copper, nor was it to question the underlying methodologies used in deriving the national criteria. Rather it was to obtain preliminary data to evaluate the potential importance of site-specific water quality characteristics on the toxicity of copper in Miller, Walker, and DesMoines Creeks. It is important to note that the development of a site-specific standard by use of a WER does not constitute a relaxation of environmental protection. Rather the WER results in a site-specific standard that is equally protective to that originally intended by the USEPA in deriving the national AWQC (USEPA 1994) in laboratory water.

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22. In-stream base/stormflow monitoring in Miller, Walker, and DesMoines Creeks. More recently, the Port initiated a monitoring program in 2001 to characterize in-stream flow, waterborne metals concentrations, and various chemical parameters (e.g., TSS, DOC) in the streams draining the Airport and other uses in the vicinity of the Airport. The program is in its early stages and only about 20% of the sampling events to be monitored have been completed. However, the results to date are interesting and can tell us quite a bit about the status of the streams. The sampling locations have been selected to properly characterize the influence of stormwater discharges from STIA on Miller, Des Moines, and Walker Creeks. The monitoring stations are described below:

Reba Outfall: The Lake Reba Stormwater Detention Facility discharges to Miller Creek. The Lake Reba outfall integrates runoff from subbasins SDN-1, SDN-2, SDN-3,SDN-4 and the north employee parking lot (NEPL) into a single monitoring station prior to discharge to Miller Creek. In addition to the Lake Reba outfall, sampling locations are also located on Miller Creek approximately 30 meters downstream and upstream of the Lake Reba Outfall. Among several non-Port drainage areas, portions of SR518 drain to both Lake Reba and Miller Creek upstream of Lake Reba outfall.

Miller Creek @ 8th: This sampling station is below all current and planned future airport drainage to Miller Creek, including the third runway expansion. This station integrates all flows in the reach downstream of the Lake Reba Outfall, including considerable non-Port portions of the watershed (City of Burien). The station is located at the upstream end of the culvert crossing under 8th Avenue South.

Walker Creek: The primary sampling station is below current Port operations and most of the construction activity related to the SR509 off-ramp construction. This "south" station is approximately 30 meters downstream of the water quality pond and groundwater bypass outlets in Walker Creek near the S 176th St. overpass. An alternative station has been used to capture the remaining SR509 off-ramp drainage area added downgradient of the primary station and draining to the "north" of the existing water quality pond.

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Northwest Ponds Outlet: This sampling station captures discharges from SDS-2, SDS-3, SDS-5, SDS-6, and SDS-7, as well as non-Port commercial areas and roads in the Cities of Burien and SeaTac. The station is located at the Northwest Ponds Outlet to the West Tributary of DesMoines Creek.

Des Moines Creek East Tributary: This sampling station will evaluate water quality downstream of SDS-1, SDE-4, and the City of SEATAC runoff. The station is located 30 meters downstream of SDS-1. The stream at this point also receives drainage from considerable non-Port commercial/residential areas and roads in the City of SeaTac.

Des Moines Creek Weir: This sampling station is below the confluence of the East and West Tributaries of Des Moines Creek and is intended to include discharges from SDS-4 in addition to all other upstream discharges (e.g., SDE4, SDS1, SDS7, City of SeaTac).

Sampling for the Monitoring Program is divided into base flow events and storm events—3 base flow and 2 storm events have been sampled thus far. Each sampling event was up to 48 hours in duration, although the exact duration of monitoring during storm events was determined by the resultant hydrograph at each station. Base flow sampling occurred after at least a 72-hour dry period where no measurable rain was recorded. Base-flow event sampling occurred every 24 hours during the 48-hour sampling period (i.e., at 0, 24, and 48 hours). Base flow samples were collected from nine locations in 2001. Generally, one grab sample was collected each sampling day from each site, however some samples were collected in 12-hour time composites or two grabs on each sampling day. Storm events were generally targeted according to the criteria in the Port's Procedure Manual for NPDES sampling (rainfall >0.20" preceded by not more than 0.10" in the previous 24 hours. One-liter grab samples were collected hourly for up to 48 hours during each sampling event, samples for analysis were selected every 4 hours, in addition to others thought to represent flow-peaks or other periods of interest.

23. This study has multiple objectives: 1) to determine the existing status of compliance with state standards in Miller, Walker, and DesMoines Creeks, and 2) to determine the metals translator for Cu and Zn at the specified sampling locations. The program has focused on copper and zinc because

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subsequent monitoring efforts conducted by the Port at existing stormwater outfalls for the 13 priority pollutant metals listed by EPA has shown that for all the priority pollutants except Cu and Zn, those pollutants are either below detectable levels in the Port's stormwater or those pollutants are seldom present and below levels of concern.

24. Mean concentrations per storm event were calculated and compared to calculated time-weighted chronic water quality standards (standards were time-weighted to reflect storm-related shifts in water hardness). Time-weighted averages were based on three grab samples, collected at 24-hour intervals for base flows (August, September, and October), and on a series of samples (every 4 hours, plus other samples selected during peak flows) taken during a 48-hour period coinciding with rainfall events. Both base and storm water flow sampling occurred over a total of two days (approximately 48 hours). Arithmetic means were calculated for concentrations of Cu, Zn and hardness for each event at each station. Chronic water quality standards were calculated based on these time-weighted hardness means and compared to average metal concentrations.

25. The preliminary testing to date shows that there are no exceedances of the state's chronic water quality criteria based on 48-hour average measured concentration for either Zn or Cu at any of the monitored stations – in Miller Creek, Walker Creek and Des Moines Creek.

26. The results also show no exceedances of acute quality standards for both Zn and Cu copper in Miller and Walker Creeks. This suggests that water quality standards can be met in these creek systems, perhaps even without a WER standard.

27. The results have shown limited exceedances at some locations for some storm events in Des Moines Creek. This is consistent with prior data for this area. It should be noted, however, that this area drains both a section of the City of SeaTac (International Boulevard) to the east and an industrial area to the west, so as yet it is not possible to attribute any exceedance to the Airport.

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28. With respect to copper, however, the range-finding WER studies for copper have indicated that the WER process required by Ecology will result in a WER that will be higher than any of the observed copper exceedances. Thus, I think it is likely that definitive WER studies will confirm the previous range-finding results and, if adopted by Ecology, will set an attainable, site-specific water quality standard for copper, even if the copper concentrations in Des Moines are attributable to the Airport (both zinc and copper are a common constituent of roadway runoff).

29. With respect to zinc, WER studies will be undertaken pursuant to the requirements of Ecology's §401 Certification. If results are similar to the WER studies for copper, it will result in an increased site-specific standard, but it is not possible yet to tell the magnitude of the increase. Because the zinc exceedances are infrequent, of short duration, and are not particularly high, however, I am confident that water quality standards for zinc can be met either through a WER or through a WER in combination with water quality BMPs that remove zinc from stormwater and that can be imposed by Ecology during the NPDES process. I understand that various BMPs for zinc removal are discussed by Dr. Charles Wisdom in his testimony to the Board. I would also note that facilities such as Lake Reba – a Port stormwater management facility located in the Miller Creek basin – have proven to be effective at removing zinc from stormwater.

I declare under penalty of perjury under the laws of the state of Washington that the foregoing is true and correct.

Executed at Kirkland, Washington, this 6 day of March 2002.

William A. Stubblefield, Ph.D.

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PRE-FILED TESTIMONY OF WILLIAM A. STUBBLEFIELD, PH.D.

EXHIBITS

A	Resume
B	References
C	February 1999 preliminary range-finding WER studies
D	April 2000 preliminary range-finding WER studies

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EDUCATION
Ph.D. (Aquatic Toxicology) University of Wyoming, 1987.
M.S. (Toxicology/Toxicodynamics) University of Kentucky, 1979.
B.S. (Biological Sciences/Chemistry) Eastern Kentucky University, 1977.

SCIENTIFIC SOCIETY AFFILIATIONS
Society of Environmental Toxicology and Chemistry
Society of Toxicology
American Society of Testing and Materials
American Chemical Society
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PROFESSIONAL HISTORY
1987-Present ENSR Consulting and Engineering
1998-Present Colorado State University Department of Environmental Health, Affiliate Faculty
1990-Present Colorado State University Department of Fisheries and Wildlife Biology, Affiliate Faculty
1985-1987 Mobay Corporation; Health, Environment, and Safety Division
1983-1985 University of Wyoming, Fish Physiology and Toxicology Laboratory
1979-1983 Exxon Corporation, Research and Environmental Health Division

PROJECT EXPERIENCE

- Exxon Company USA - Evaluation of the Toxicological Effects of the *Exxon Valdez* Crude Oil Spill. Designed and supervised a toxicology testing program to assess the toxicity of spilled crude oil in Prince William Sound, Alaska. This program included evaluation of potential effects to both sediment and water-column dwelling organisms as well as a characterization of the toxicity of weathered crude on terrestrial and avian species. These efforts were conducted in support of a natural resource damage assessment.

- ARCO - Evaluation of Metals Toxicity on Aquatic Organisms in Montana's Clark Fork River. Project manager to evaluate potential effects of metals exposure on aquatic organisms in Montana's Clark Fork River and to support natural resource damage injury claims. This river has received input of heavy metals (e.g., copper, zinc) derived from old mining wastes. The project required the design and conduct of several types of laboratory studies to evaluate the roles of: metals bioavailability, potential metals interactive effects, site-specific water

quality, and metal sensitivity of resident fish species in determining the expected environmental effects of metals contamination.

- Waste-Tech Services, Inc. - Evaluation of Potential Ecological Risk Associated with the Operation of a Hazardous Waste Incinerator and Stabilized Ash Landfill. Project manager for a risk assessment evaluating potential adverse effects to aquatic and terrestrial ecological resources resulting from airborne (stack) and fugitive emissions from a hazardous waste (primarily petroleum-based) incinerator and adjacent landfill. The project included airborne, surface transport, and partitioning modeling to determine maximum environmental exposure concentrations surrounding the proposed facility. Criteria/standard values, background concentrations, and toxicity data were used to determine acceptable environmental concentrations for materials identified as chemicals of concern. Ecological risk was characterized based on a tiered (decreasing uncertainty) comparison of exposure and toxicity.

- Confidential Client - Evaluation of the Aquatic Toxicological Effects of a Variety of Crude Oils and Petroleum-Derived Products. Designed and supervised an aquatic toxicology testing program to assess the toxicity of various crude oils and petroleum-derived products to freshwater and marine organisms. Testing was conducted in accordance with U.S. EPA Good Laboratory Practices using both static and flow-through methods.

- Sante Fe Southern Pacific, Inc. - Salem, Oregon, Gasoline Spill Impact Assessment. Designed and supervised an evaluation of impacts to a lotic environment as a result of a gasoline spill. The client desired a scientifically accurate evaluation of the short- and long-term impacts to exposed organisms in a freshwater stream. This program consisted of stream sampling for fish, water quality, and stream benthic invertebrates as well as toxicity testing of site waters.

- Confidential Client - Drilling Mud Reserve Pit Wastes Risk Assessment. Project manager for a risk assessment of the potential adverse environmental effects that may come about as a result of drilling mud reserve pit waste disposal practices. Overall project approach included estimations of the environmental fate of waste components and estimations of toxicologic consequences of waste exposure.

- ASARCO, Inc. - Evaluation of Heavy Metal Contamination in the Arkansas River, Colorado. Project manager for several types of investigations aimed at evaluating the potential impact of mining-related, heavy metal discharges on the Arkansas River. Studies included a comparison of instream fish population data with those of other rivers in the state, ambient water toxicity studies to evaluate the effect of the discharges on the existing metal contamination, and site-specific water quality criteria evaluations for possible application to the Arkansas River.

- BP Exploration - Evaluation of Bioaccumulation Potential of Drilling Mud Reserve Pit Wastes. Project manager for investigations to evaluate the bioaccumulation potential of drilling reserve pit constituents in tundra on Alaska's North Slope. Contaminant

concentrations in water, soil, phytoplankton, zooplankton, and terrestrial plants were evaluated, and the ecological hazard associated with oil drilling waste disposal/storage was assessed. Subsequent studies addressed issues associated with consumption of reserve pit constituents by caribou using pit areas as refuge from insect irritation.

- Arizona Dept. of Environmental Quality - Surface Water Quality Standards Review Committee. Member of a state-sponsored expert review panel to oversee scientific development of surface water quality standards for the State of Arizona.

- Ashland Oil - Evaluation of the Toxicological Effects of a Large Diesel Fuel Spill. Designed and supervised a large monitoring/laboratory testing program to assess the toxicity and impacts of spilled diesel fuel in the Monongahela and Ohio Rivers. Studies conducted included acute toxicity tests with collected river water samples and detailed analytical evaluation of contaminant concentrations.

- Mercury Marine - Toxicity Identification, Confirmation, and Mitigation. Identified carbon monoxide in toxic concentrations in a receiving stream and confirmed it as the cause of mortalities during *in situ* bioassays and as a contributing factor to fish die-offs in the receiving water. Mapped carbon monoxide concentrations on a lake/riverine system. Assisted Mercury Marine with the design and implementation of mitigative measures.

- ARCO - Ecological Risk Assessment for a Sediments Superfund Site. Evaluated ecological risk associated with exposure of water column, benthic, and soil dwelling organisms to mining-related heavy metals contamination of reservoir sediments. Environmental exposure concentrations were determined and compared against literature-based, regulatory-based, and empirically based benchmarks of toxicity to provide a comprehensive risk characterization for the site. A multitiered approach was taken to identify potential chemicals of concern, screen them for toxicity, and make recommendations about site remediation. Results of the assessment were used to respond to a parallel ecological risk assessment prepared by the USEPA as part of the Remedial Investigation/Feasibility Study for the site.

- ARCO - Development of Site-Specific Water Quality Criteria for Metals in the Upper Clark Fork River, Montana. Developed and conducted a comprehensive testing and analysis program to derive unique water quality criteria for metals in the Clark Fork River that took into account the potential attenuating effects of site-specific water quality characteristics on the toxicity of metals. In accordance with the USEPA's Indicator Species Approach, acute and chronic toxicity tests were conducted in site and laboratory-reconstituted waters with invertebrates and cold/warm water fish species. The relative toxicity of metals in the two water types was evaluated to derive Water-Effect Ratios to be used in criteria development. Results of the studies indicated significantly reduced metals toxicity in site waters and provided the justification for site-specific criteria modification.

- Burlington Northern, Inc. - Evaluation of Natural Resource Injury as a Result of the Nemadji River Derailment. As part of a project investigating potential effects from the spill of a

refined petroleum product into the Nemadji River, Wisconsin, developed and conducted a testing program to evaluate possible toxicity stemming from exposure of benthic organisms to elevated sediment hydrocarbon concentrations. Also evaluated the environmental fate of the spilled product and contributed to a testing program investigating the toxicity of the Water-Soluble Fraction of the spilled product to warm water fish species. Results of these studies were used in the Natural Resources Damage Assessment associated with the incident.

- Aluminum Company of America - Review of Terrestrial Toxicity Testing Methods and Regulatory Status. Conducted a comprehensive literature review and prepared a white paper highlighting the advantages associated with including terrestrial toxicity testing strategies in site assessments and hazardous waste cleanup operations. Demonstrated the utility of substituting toxicity endpoints for chemical standards when setting site cleanup guidelines.

- Navy CLEAN - Lower Sasa Burn Pond Screening Ecological Risk Assessment. Evaluated potential ecological risk associated with elevated concentrations of metals and PAHs in wetland soils. Historic operations at the pond included burning waste oil/water mixtures and discharging them into the wetland. Soil contaminant concentrations were evaluated in light of terrestrial toxicity bench marks, chemical and receptor distribution patterns, site-specific toxicity tests, and PAH tissue residues from site-collected organisms. Analyses indicated that wetland soil contamination was restricted to a limited portion of the area under consideration; minimal adverse effects were indicated for resident ecological receptors and wetland productivity.

- ARCO - Warm Springs Ponds Biomonitoring. Prepared the work plan and oversaw the ensuing field efforts associated with an evaluation of the chemical, toxicological, and ecological status of former metals tailings settling ponds now undergoing closure and conversion to wildlife refuge habitat. Sediment, water, and tissue (fish, invertebrates, waterfowl) metals concentrations were surveyed. Sediment Toxicity and benthic community structure were also evaluated.

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PROFESSIONAL ACTIVITIES

Scientific Society Service
Society of Environmental Toxicology and Chemistry
- Board of Directors (1995-1998, 2001-2004)
- Program Chairman 1994 and 2002 annual meeting
- Chairman Publications Advisory Council (1995-present)
- Member of *Environmental Toxicology and Chemistry* Editorial Board (1994-1997)
- Chairman Professional Opportunities Committee (1992-1995)
- Committee member Publications Committee (1989-1992) and the Nominations Committee (1985-1987)
- Assistant Editor of the Society of Environmental Toxicology and Chemistry Newsletter
- Associate Editor Society of Environmental Toxicology and Chemistry Special Publications.

Invited Conferences and Program Reviews
Surface Water Quality Standards Review Committee for the Arizona Department of Environmental Quality (1989-1990).
U.S. Environmental Protection Agency Workshop on Mesocosms. Duluth, Minnesota, September 14-17, 1987.
U.S. Environmental Protection Agency Complex Effluent Program Review. September 1990.
U.S. Environmental Protection Agency, ECOTOX Database Review, Duluth, Minnesota. August 1994.
U.S. Environmental Protection Agency, Science to Achieve Results (STAR) Fellowship Review, Wasington D.C. 1996, 1997, 1998, 1999.
SETAC Pellston Conference on Environmental Hazard Assessment of Effluents. Cody, Wyoming. August 1982.
SETAC Pellston Conference on Avian Toxicity Testing Methods. Pensacola, Florida, December 1994.
SETAC Pellston Conference on Sediment Risk Assessment, Pacific Grove, California, April 1995.
SETAC Pellston Conference on Reassessment of Metals Criteria for Aquatic Life Protection, Pensacola, Florida, February 1996.
SETAC Pellston Conference on Reevaluation of the State of the Science for Water Quality Criteria Development; Gregson, Montana, June 1998.

SETAC Pellston Conference on Predicting Ecological Impacts frim Laboratory Toxicity Tests; Cornwall, Quebec, Canada, May 1999.

Academic Courses or Professional Continuing Education

University of Wisconsin, Madison - Department of Engineering Professional Development Program. *Understanding Aquatic Toxicity Testing*, October 1992, Anchorage, Alaska.

Colorado State University - Department of Fisheries and Wildlife, *Environmental Toxicology*, Spring 1990.

Colorado State University - Department of Environmental Health, *Environmental Risk Assessment*, Spring 1996/1998.

B

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C

WATER EFFECT RATIO SCREENING STUDY

AT SEATTLE-TACOMA INTERNATIONAL AIRPORT:

TOXICITY EVALUATION OF SITE WATER

Prepared for

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FEBRUARY 1999

TABLE OF CONTENTS

LIST OF TABLES

1. INTRODUCTION

This report summarizes the procedures and results of biological testing conducted on site water from Seattle-Tacoma International Airport (STIA) for the Port of Seattle (POS). The purpose of these tests is to provide screening-level toxicity information in anticipation of formal tests that will be used to set site-specific water quality standards via a water effect ratio. Site water consisted of receiving water, outfall discharge, and a mixture of the two.

All biological testing was conducted by Parametrix's Environmental Toxicology Laboratory in Kirkland, Washington. Analytical chemistry was provided by Aquatic Research Incorporated in Seattle, Washington.

2. SAMPLE SOURCE AND HANDLING

Samples were collected according to the Storm Water Quality Sampling and Analysis Plan (SAP) dated December 11, 1998. Highlights of these procedures, as well as minor deviations from this plan, are described below. Pertinent client and sampling/test information is summarized in Table 1.

Table 1. Screening-level study: summary information.

Client name	Port of Seattle
Parametrix job number	55-2912-01 (61)
Date of sampling	January 14, 1999
Toxicity testing requirements	Acute screening-level *Ceriodaphnia dubia* bioassays
Sample location	Seattle-Tacoma International Airport
Name of receiving water	**Miller Creek Upstream** of Lake Reba **Miller Creek Downstream** (@ 8th Ave. S.) **Lake Reba Outfall** to Miller Creek **Walker Creek** @ SR 509 **East Branch Des Moines Creek** @ fork **West Branch Des Moines Creek** near fork **STIA Outfall SDS-3** (005) **City of Sea-Tac Storm Outfall** to NW Ponds
Samples collected by	Ron Simmons, Justin Kophs

Samples were collected at eight locations (Table 1) during a storm event (as defined in the *POS Procedure Manual for Stormwater Monitoring*) on the morning of 14 January 1999. The antecedent dry period preceding this storm was 86 hours. Precipitation started at 1600 on 13 January and ended at 1600 on 14 January 1999; samples were taken from approximately 0700 to 1000 on 14 January. Approximately 1.18 inches of rain fell at STIA during this 24-hour storm. Rainfall intensity

increased from the beginning of the event through the three-hour period in which the grab samples were collected.

Parametrix staff collected two-liter grab samples at 15-minute intervals over a three-hour period from seven of the eight sampling sites. Field staff approached sampling locations carefully from downstream to avoid stirring up sediment and compromising sample integrity. Water level (stage) was measured in the culvert immediately following each grab sample. Temperature and pH measurements were recorded at least once during the three-hour event at each location. Field data (i.e., date and time) were recorded in field data logbooks currently located in project files at Parametrix.

POS staff collected samples at the eighth location (SDS-3), with an ISCO sampler programmed to take flow-weighted composite samples.

Samples were placed on ice immediately after collection, and delivered to the Parametrix laboratory shortly after collection of the last grab sample at each location. Within 4 hours of receipt by the laboratory, all grab samples were flow-weight-composited into a 10-liter cubitainer based on flow estimates. Flow at each location was estimated by entering stage measurements into the Manning or empirical stage-discharge equations.

Sample water from SDS-3 was mixed with sample water from Miller Creek Downstream and Walker Creek sites to represent the proposed ratio of Third Runway stormwater to receiving water. SDS-3 stormwater, which almost exclusively drains runways, taxiways, and infields, is assumed to be representative of future stormwater from the Third Runway. The proportions of these mixes were estimated to be 1 part SDS-3 to 5 parts Miller Creek Downstream, and 4 parts SDS-3 to 1 part Walker Creek based on hydrographs generated using HSPF.

Subsamples for analytical chemistry were decanted from the ten composited samples into clean bottles provided by Aquatic Research (samples volumes for dissolved analyses were filtered through a 0.45 μm filter), immediately after compositing and mixing. The subsamples were delivered to Aquatic Research with completed chain-of-custody forms on 15 January at 1300, approximately 30 hours after collection.

Two liters of each sample were used by Parametrix for the 48-hour acute screening-level bioassays.

Quality assurance and quality control elements addressed during sample collection included:

- bottles labeled with the location and interval designation,
- bottles rinsed three times with ambient water,
- samples collected in new (or cleaned by the analytical lab) HDPE bottles,
- bottles inverted before being placed in water for rinses and grabs (to minimize collection of surface water),
- interval samples placed in a cooler with ice to maintain the samples at 4°C.

3. SCREENING-LEVEL BIOASSAYS

Two liters of each sample were used by Parametrix for the 48-hour acute screening-level bioassay. Test conditions are summarized in Table 2.

Table 2. Summary of test conditions for the acute screening-level *Ceriodaphnia dubia* bioassay.

Test Dates	15-17 January 1999
Test Protocol	Washington State Department of Ecology, WAC Chapter 173-205, 1993; WDOE Publication No. WQ-R-95-80; and *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms* (USEPA 1993).
Test Material	Composite samples of site water from at Seattle-Tacoma International Airport
Test Organisms/Age	*Ceriodaphnia dubia* (water flea); ≤ 24 hours at initiation
Source of Organisms	In-house cultures
Acclimation Period	None
Number/Test Chamber	5
Volume/Test Chamber	25 mL
Test Concentrations	0 and 100% site water
Replicates	Four
Reference Toxicant	Copper as copper sulfate
Test Duration	48 hours
Control/Dilution Media	Natural spring water; Gold Creek Trout Farm, Woodinville, Washington (80-100 mg/L hardness as $CaCO_3$)
Preparation Date of Control/ Dilution Water	12 January 1999
Pretreatment of Dilution Water	None
Test Chambers	30 mL polypropylene cups
Lighting	Fluorescent bulbs (50-100 foot candles)
Photoperiod	16 hours light; 8 hours dark
Aeration	None
Feeding	None
Renewal	None
Temperature	20 ± 1°C
Chemical Data	Dissolved oxygen, temperature, and pH at test initiation and every 24 hours; conductivity at test initiation and termination; hardness, alkalinity, salinity, ammonia, and residual chlorine at test initiation for 100% site water
Effect Measured	Mortality
Test Acceptability	Control mortality ≤10%
Endpoints reported	Percent survival in 100% site water Lowest observed effect concentration (LOEC) No observed effect concentration (NOEC)

4. RESULTS

Records of biological and chemical data collected during testing and the statistical analyses used for reporting are included in Appendix A of this report. Water quality parameters are reported in Appendix B. Hydrographs for Miller and Walker Creeks were generated using HSPF and are included in Appendix C of this report.

Bioassay results are summarized in Table 3 below. Overall, there was 100% survival in 100% site water for all ten tests, NOECs of 100% site water and LOECs of >100% site water. Control responses and reference toxicant results were within acceptable ranges for all ten tests.

Table 3. Summary of bioassay results.

Sample	Percent Survival 100% Site Water	NOEC	LOEC
Miller Creek Downstream	100	100	<100
Miller Creek Upstream	100	100	<100
STIA Outfall SDS-3	100	100	<100
City of Sea-Tac Storm Outfalls	100	100	<100
Walker Creek	100	100	<100
Des Moines Creek -West	100	100	<100
Des Moines Creek -East	100	100	<100
Lake Reba	100	100	<100
Mixture: SDS-3 + Miller Downstream	100	100	<100
Mixture: SDS-3 + Walker Creek	100	100	<100

5. REFERENCES

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WDOE. 1997. Laboratory guidance and whole effluent toxicity test review criteria. Washington State Department of Ecology, Publication No. WQ-R-95-80. Revised March 1997.

APPENDIX A

ACUTE SCREENING-LEVEL *Ceriodaphnia dubia* BIOASSAY DATA

STATIC ACUTE *Ceriodaphnia dubia* TOXICITY TEST

Client: POS

Sample: MC

Test Dates: 1/15 - 1/17/99

Sample Collection Date: 1/14/99

Test Initiation Time: 1400

Source/Age of Organisms: In house, <24 hours

Temp (°C) Day 0: 20 Day 1: 20 Day 2: 20

Conc.	Rep.	Number of Organisms			pH			Dissolved Oxygen (mg/L)			Specific Conductivity (µS)	
		0	24	48	0	24	48	0	24	48	0	48
Control	A	5	5	5	8.2	8.3	8.4	8.4	8.9	8.7	327	261
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100%	A	5	5	5	7.6	8.3	8.4	8.5	8.8	8.7	131	136
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	Initials	JP	BGB	BGB	HM	BGB	BGB	HM	BGB	BGB	HM	BGB
	Date	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/17

Shading represents areas for which data collection is not required.

NT = Not Taken

Comments

AR 016736

STATIC ACUTE *Ceriodaphnia dubia* TOXICITY TEST

Client: POS
Sample: ~~MGB~~ MC JP 1/15
Test Dates: 1/15-1/17/99

Sample Collection Date: 1/14/99
Test Initiation Time: 1400
Source/Age of Organisms: In house, <24 hours

Temp (°C) Day 0: 20 Day 1: 20 Day 2: 20

Conc.	Rep.	Number of Organisms 0	24	48	pH 0	24	48	Dissolved Oxygen (mg/L) 0	24	48	Specific Conductivity (µS) 0	48
Control	A	5	5	5	8.2	8.3	8.4	8.4	8.9	8.7	327	261
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100%	A	5	5	5	7.8	8.4	8.4	8.7	8.8	8.7	82	163
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
	A											
	B											
	C											
	D											
	A											
	B											
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	D											
	A											
	B											
	C											
	D											
	Initials	JP	BJB	BJB	JP	BJB	BJB	HM	BJB	BJB	JP	BJB
	Date	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/17

Shading represents areas for which data collection is not required.
NT = Not Taken

Comments

2144 JPD

AR 016737

STATIC ACUTE *Ceriodaphnia dubia* TOXICITY TEST

Client POS

Sample SDS3

Test Dates 1-15-99 - 1/17/99

Sample Collection Date 1/14/99

Test Initiation Time 1400

Source/Age of Organisms In house, <24 hours

Temp (°C) Day 0 20 Day 1 20 Day 2 20

Conc.	Rep.	Number of Organisms 0	24	48	pH 0	24	48	Dissolved Oxygen (mg/L) 0	24	48	Specific Conductivity (µS) 0	48
Control	A	5	5	5	8.2	8.2	8.3	8.4	9.0	8.8	327	365
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100%	A	5	5	5	7.5	8.4	8.4	8.9	9.0	8.8	53	108
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
	A											
	B											
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	D											
	A											
	B											
	C											
	D											
	Initials	JC	BDB	BDB	HM	BDB	BDB	HM	BDB	BDB	HM	BDB
	Date	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/17

Shading represents areas for which data collection is not required.

NT = Not Taken

Comments DEO

STATIC ACUTE *Ceriodaphnia dubia* TOXICITY TEST

Client: POS
Sample: ~~MCB~~ MC JP 1/15
Test Dates: 1/15-1/17/99

Sample Collection Date: 1/14/99
Test Initiation Time: 1400
Source/Age of Organisms: In house, <24 hours

Temp (°C) Day 0: 20 Day 1: 20 Day 2: 20

Conc.	Rep.	Number of Organisms 0	24	48	pH 0	24	48	Dissolved Oxygen (mg/L) 0	24	48	Specific Conductivity (µS) 0	48
Control	A	5	5	5	8.2	8.3	8.4	8.4	8.9	8.7	327	261
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100%	A	5	5	5	7.8	8.4	8.4	8.7	8.8	8.7	82	163
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
	A											
	B											
	C											
	D											
	A											
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	D											
	A											
	B											
	C											
	D											
	Initials	JP	BJB	BJB	JP	BJB	BJB	[illegible]	BJB	BJB	JP	BJB
	Date	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/17

Shading represents areas for which data collection is not required.
NT = Not Taken

Comments

2144 DO

AR 016739

STATIC ACUTE *Ceriodaphnia dubia* TOXICITY TEST

Client: POS
Sample: SDS3
Test Dates: 1-15-99 - 1/17/99

Sample Collection Date: 1/14/99
Test Inititation Time: 1400
Source/Age of Organisms: In house, <24 hours

Temp (°C) Day 0: 20 Day 1: 20 Day 2: 20

Conc.	Rep.	Number of Organisms 0	24	48	pH 0	24	48	Dissolved Oxygen (mg/L) 0	24	48	Specific Conductivity (µS) 0	48
Control	A	5	5	5	8.2	8.2	8.3	8.4	9.0	8.8	327	365
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100%	A	5	5	5	7.5	8.4	8.4	8.9	9.0	8.8	53	108
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
	A											
	B											
	C											
	D											
	A											
	B											
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	D											
	A											
	B											
	C											
	D											
	Initials	JC	BDB	BDB	HM	BDB	BDB	HM	BDB	BDB	HM	BDB
	Date	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/17

Shading represents areas for which data collection is not required.

NT = Not Taken

Comments: DED

STATIC ACUTE *Ceriodaphnia dubia* TOXICITY TEST

Client: POS
Sample: STO
Test Dates: 1/15/99 – 1/17/99

Sample Collection Date: 1/14/99
Test Initiation Time: 1400
Source/Age of Organisms: In house, <24 hrs

Temp (°C) Day 0: 20 Day 1: 20 Day 2: 20

Conc.	Rep.	Number of Organisms			pH			Dissolved Oxygen (mg/L)			Specific Conductivity (µS)	
		0	24	48	0	24	48	0	24	48	0	48
Control	A	5	5	5	8.2	8.2	8.3	8.4	9.0	8.8	327	305
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100 %	A	5	5	5	7.5	8.3	8.4	8.3	8.9	8.8	166	77
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	Initials	JP	BJB	BJB	HM	BJB	BJB	HM	BJB	BJB	HM	BJB
	Date	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/17

Shading represents areas for which data collection is not required.

NT = Not Taken

Comments ______________________ JED

AR 016741

STATIC ACUTE *Ceriodaphnia dubia* TOXICITY TEST

Client: POS
Sample: WC
Test Dates: 1/15 - 1/17/99

Sample Collection Date: 1/14/99
Test Initiation Time: 1400
Source/Age of Organisms: In house, <24 hrs

Temp (°C) Day 0: 20 Day 1: 20 Day 2: 20

Conc.	Rep.	Number of Organisms			pH			Dissolved Oxygen (mg/L)			Specific Conductivity (µS)	
		0	24	48	0	24	48	0	24	48	0	48
Control	A	5	5	5	8.2	8.2	8.2	8.4	9.0	9.0	327	399
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100%	A	5	5	5	7.7	8.2	8.2	8.8	9.0	9.0	131	183
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	Initials	JC	BGB	BGB	HM	BGB	BGB	HM	BGB	BGB	HM	BGB
	Date	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/17

Shading represents areas for which data collection is not required.

NT = Not Taken

Comments

AR 016742

STATIC ACUTE *Ceriodaphnia dubia* TOXICITY TEST

Client: POS
Sample: DMC-west
Test Dates: 1/15-1/17/99

Sample Collection Date: 1/14/99
Test Initiation Time: 1400
Source/Age of Organisms: In house, <24 hrs

Temp (°C) Day 0: 20 Day 1: 20 Day 2: 20

Conc.	Rep.	Number of Organisms 0	24	48	pH 0	24	48	Dissolved Oxygen (mg/L) 0	24	48	Specific Conductivity (µS) 0	48
Control	A	5	5	5	8.2	8.2	8.2	8.4	9.0	9.0	327	399
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100%	A	5	5	5	7.4	8.3	8.3	8.6	9.0	9.0	159	89
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	Initials	JC	BJB	BJB	AM	BJB	BJB	AM	BJB	BJB	AM	BJB
	Date	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/17

Shading represents areas for which data collection is not required.
NT = Not Taken

Comments

STATIC ACUTE *Ceriodaphnia dubia* TOXICITY TEST

Client: POS
Sample: DMC-east
Test Dates: 1/15 - 1/17/99

Sample Collection Date: 1/14/99
Test Initiation Time: 1400
Source/Age of Organisms: In house, <24 hours

Temp (°C) Day 0: 20 Day 1: 20 Day 2: 20

Conc.	Rep.	Number of Organisms			pH			Dissolved Oxygen (mg/L)			Specific Conductivity (µS)	
		0	24	48	0	24	48	0	24	48	0	48
Control	A	5	5	5	8.2	8.3	8.2	8.4	9.0	9.1	327	414
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100%	A	5	5	5	7.6	8.4	8.3	8.8	9.0	9.1	52	80
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	Initials	JC	BJB	BJB	HM	BJB	BJB	HM	BJB	BJB	HM	BJB
	Date	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/17

Shading represents areas for which data collection is not required.

NT = Not Taken

Comments

JCO

AR 016744

STATIC ACUTE *Ceriodaphnia dubia* TOXICITY TEST

Client: POS
Sample: LR
Test Dates: 1/15 -1/17/99

Sample Collection Date: 1/14/99
Test Initiation Time: 1400
Source/Age of Organisms: In house, <24 hrs

Temp (°C) Day 0: 20 Day 1: 20 Day 2: 20

Conc.	Rep.	Number of Organisms			pH			Dissolved Oxygen (mg/L)			Specific Conductivity (µS)	
		0	24	48	0	24	48	0	24	48	0	48
Control	A	5	5	5	8.7	8.3	8.2	8.4	9.0	9.1	327	414
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100%	A	5	5	5	7.6	8.5	8.4	8.7	9.0	9.1	251	314
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	Initials	JP	BQB	BQB	HM	BQB	BQB	HM	BQB	BQB	HM	BQB
	Date	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/17

Shading represents areas for which data collection is not required.
NT = Not Taken

Comments

2150

AR 016745

STATIC ACUTE *Ceriodaphnia dubia* TOXICITY TEST

Client: POS
Sample: SDS3 - MC
Test Dates: 1/15/99 - 1/17/99

Sample Collection Date: 1/14/99
Test Initiation Time: 1400
Source/Age of Organisms: In house, <24h

Temp (°C) Day 0: 20 Day 1: 20 Day 2: 20

Conc.	Rep.	Number of Organisms			pH			Dissolved Oxygen (mg/L)			Specific Conductivity (µS)	
		0	24	48	0	24	48	0	24	48	0	48
Control	A	5	5	5	8.2	8.1	8.5	8.4	9.0	9.2	327	319
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100%	A	5	5	5	7.1	8.2	8.5	8.9	8.9	9.2	118	199
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	Initials	fn	BJB	BJB	HM	BJB	BJB	HM	BJB	BJB	HM	BJB
	Date	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/17

Shading represents areas for which data collection is not required.

NT = Not Taken

Comments

STATIC ACUTE *Ceriodaphnia dubia* TOXICITY TEST

Client: IOS
Sample: SDS3-WC
Test Dates: 1-15-99 - 1/17/99

Sample Collection Date: 1/14/99
Test Initiation Time: 1400
Source/Age of Organisms: In house ≤ 24 hrs

Temp (°C) Day 0: 20 Day 1: 20 Day 2: 20

Conc.	Rep.	Number of Organisms			pH			Dissolved Oxygen (mg/L)			Specific Conductivity (µS)	
		0	24	48	0	24	48	0	24	48	0	48
Control	A	5	5	5	8.2	8.1	8.5	8.4	9.0	9.2	327	319
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100%	A	5	5	5	6.9	8.3	8.5	8.9	8.8	9.1	70	107
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	A											
	B											
	C											
	D											
	Initials	Au	BJB	BJB	HM	BJB	BJB	HM	BJB	BJB	HM	BJB
	Date	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/16	1/17	1/15	1/17

Shading represents areas for which data collection is not required.

NT = Not Taken

DD

Comments

AR 016747

APPENDIX B

FIELD-MEASURED WATER QUALITY PARAMETERS

Initial chemical and physical determinations in 100% site water.

Parameter Measured	SDS-3	STO	WC	MC	DMC-W
Temperature (°C)	8	4	4	4	4
Salinity (ppt)	0	0	0	0	0
Dissolved oxygen (mg/L)	11.0	11.0	11.6	11.8	8.5
pH	6.8	8.1	7.8	7.7	7.5
Conductivity (μS)	52	58	130	128	155
Total hardness (mg/L as $CaCO_3$)	20	28	50	56	60
Total alkalinity (mg/L as $CaCO_3$)	22	32	48	48	86
Total residual chlorine (mg/L)	0.04	0.02	0.02	0.05	0.06
Ammonia (mg/L)[1]	<1	<1	<1	<1	<1

[1] La Motte colorimetric test kit, Detection Limit 1 mg/L

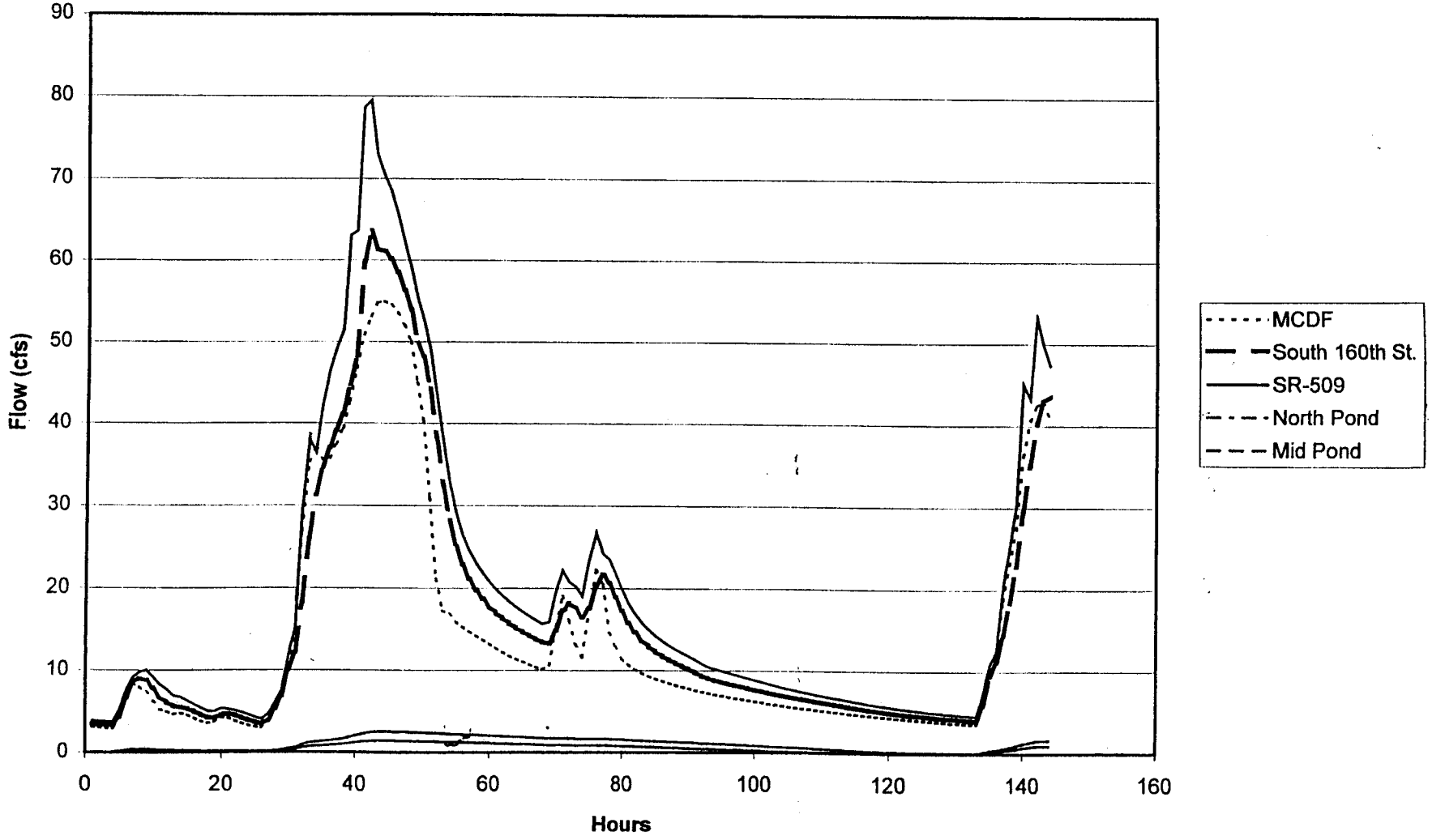
Parameter Measured	DMC-E	LR	MCB	SDS-3 + MC	SDS-3 + WC
Temperature (°C)	4	4	4	4	4
Salinity (ppt)	0	0	0	0	0
Dissolved oxygen (mg/L)	11.7	10.0	11.1	9.2	9.1
pH	7.7	7.4	7.6	6.9	6.9
Conductivity (μS)	49	245	80	123	71
Total hardness (mg/L as $CaCO_3$)	38	112	32	44	26
Total alkalinity (mg/L as $CaCO_3$)	22	112	38	68	30
Total residual chlorine (mg/L)	0.02	0.03	0.03	0.07	0.05
Ammonia (mg/L)[1]	<1	<1	<1	<1	<1

[1] La Motte colorimetric test kit, Detection Limit 1 mg/L

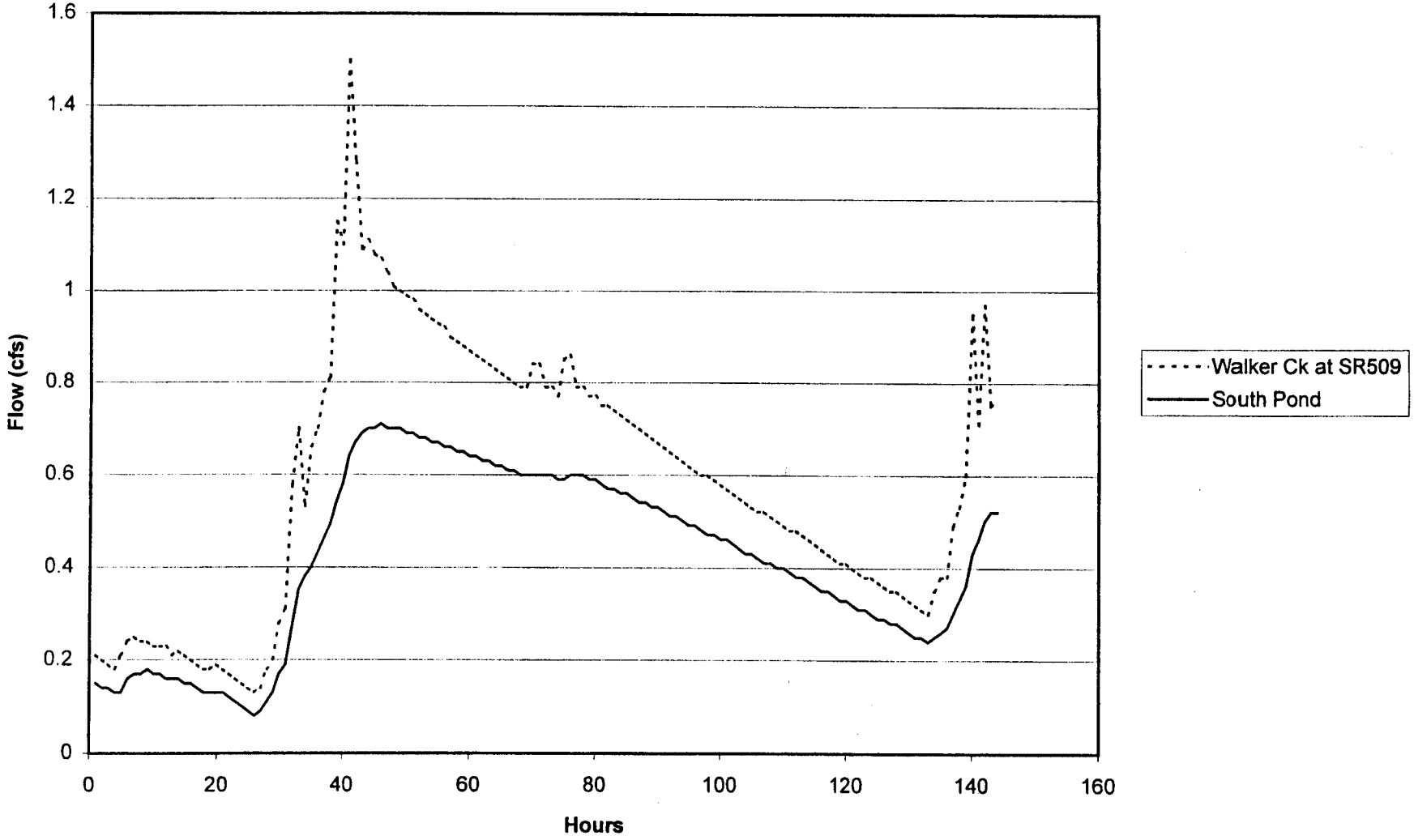
APPENDIX C

MILLER CREEK AND PROPOSED THIRD RUNWAY OUTFALL HYDROGRAPHS, 2-YEAR STORM

Miller Creek 2-Year Flood Event



Walker Creek 2-Year Flood Event



D

DRAFT MEMORANDUM

To: Port of Seattle project files — April 20, 2000

From: Doug Henderson / Linda Logan — 556-2912-001 (61)

Subject: Range-Finding Water-effect ratio results

This memorandum summarizes results of range-finding toxicity tests conducted as part of the water-effect ratio (WER) study for copper in streams receiving STIA stormwater. The purpose of these range-finding WERs is to determine if the final WERs would be robust enough to warrant the expense of conducting definitive studies. Although range-finding WERs were conducted in February 1999, these tests were conducted on simulated receiving water samples that were mixtures of outfall SDS3 stormwater and instream receiving water. Mixture ratios of these two samples were prepared in the laboratory by combining measured volumes of stormwater and upstream receiving water in proportions estimated to occur in the receiving water (based on hydrographs generated using HSPF). In the event that mixing zones cannot be granted for the creeks, it was agreed that two additional types of range-finding WERs be conducted, one without any mixing with stormwater (i.e., receiving water only) and the other one after complete mix, below outfall discharges.

Sampling

Samples were collected at five pre-determined locations during a qualifying storm on the afternoon of 13 April 2000. The storm started at 2:00 PM on 13 April and ended at 1:00 AM on 14 April 2000. The dry antecedent period preceding this storm was 74 hours. Approximately 0.34 inches of rain fell at STIA during 12 hour period of rainfall.

Taylor Associates collected flow-weighted composite samples for 12 hours during the storm event from each of the five sampling sites (Miller Creek Upstream, Miller Creek Detention Facility, Northwest Ponds Outlet, Northwest Ponds Inlet, and Des Moines Creek Weir). ISCO samplers automatically composite samples based on flow.

Quality assurance and quality control elements were followed according to the Port's Procedure Manual for Stormwater Monitoring (POS, 1999).

The samples were delivered to Parametrix's toxicology laboratory with completed chain-of-custody forms in sufficient time to meet the applicable holding times. The synthetic laboratory water was prepared according to U.S. EPA (1993).

Analysis

The procedure for determining a WER involves using an indicator species to evaluate and quantify the toxicity and bioavailability of a compound in a particular site water compared to that in "clean" laboratory water. To accomplish this, the chemical of concern (in this case, copper) is spiked into both the clean laboratory water and site water at known concentrations. A median lethal concentration (LC50) is then determined for each water, and the two are compared to generate a WER:

$$\frac{\text{LC50 Site Water}}{\text{LC50 Laboratory Water}} = \text{WER}$$

The WER is then applied to the generic water quality standard to derive a site-specific standard:

$$\text{WER} * \text{Generic WQS} = \text{Site-specific WQS}$$

For example, if the water quality standard for a chemical is 3 µg/L, and a WER of 3 is derived for a particular site, the resulting site-specific water quality standard would be 9 µg/L.

Nominal copper test concentrations were prepared using a 500 mg/L copper stock solution made from copper sulfate pentahydrate ($CuSO_4 \cdot 5H_20$) (CAS#7758-99-8). Since these were preliminary tests, concentrations were not measured; thus the WERs were calculated using nominal test concentrations. However, the stock solution was analyzed by Battelle and verified to be 500.0 mg/L copper.

The toxicity tests were conducted according to *Short-term Methods for Estimating the Acute Toxicity of Effluents and Receiving Waters to Freshwater Organisms and Marine Organisms*. EPA/600/4-90/027F, August 1993. A summary of test conditions for the *D. magna* toxicity tests is presented in Table 1.

Table 1. Summary of test conditions for the acute *Daphnia magna* toxicity tests.

Job Name: Port of Seattle

Job Number: 556-2912-001 (61)
Date: 15-17 April 2000

Test Protocol:	*Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms* (Fourth Edition), EPA/600/4-90/027F, August 1993.
Test Material:	Copper-spiked site waters Copper-spiked synthetic laboratory water
Test Organisms/age:	*Daphnia magna*; ≤24 hrs old
Source:	In-house culture
Number/Test Chamber:	5
Volume/Test Chamber:	20 mL
Nominal Test Concentrations:	Site water: 0, 12.5, 25, 50, 100, 150, and 200 µg/L copper Synthetic laboratory water: 0, 5, 10, 20, 40, and 80 µg/L copper
Replicates:	Four
Test Duration:	48 hours
Control:	Unspiked synthetic laboratory water Unspiked site water
Test Chambers:	30 mL polystyrene cups
Lighting:	Fluorescent bulbs (50-100 foot candles)
Photoperiod:	16 hours light; 8 hours dark
Aeration:	None
Feeding:	None
Temperature:	25 ± 1°C
Chemical Data:	Dissolved oxygen, temperature, and pH at test initiation and every 24 hours; specific conductivity at test initiation and termination; hardness, alkalinity, ammonia, and residual chlorine at test initiation for 100% site water sample; hardness and alkalinity for laboratory and site water
Effect Measured:	Mortality
Test Acceptability:	Control mortality ≤10%

Results

Results of the range-finding water-effect ratio tests are presented in Table 2. Reference toxicant results were within acceptable ranges. All raw data sheets and statistical analyses are located in the project files at Parametrix.

Table 2. Summary of *Daphnia magna* range-finding water-effect ratio for POS:

Test Water	Hardness (mg/L)	Cu LC50 (µg/L)	Normalized[1] LC50 (µg/L)	WER
Cu-Spiked Northwest Ponds Inlet Site Water	60	143.6	120.93	28.43387
Cu-Spiked Northwest Ponds Outlet Site Water	90	132	75.87	17.83784
Cu-Spiked Miller Creek Detention Facility Site Water	92	168.8	95.03	22.34329
Cu-Spiked Miller Creek Upstream Site Water	46	111.6	120.72	28.38372
Cu-Spiked Des Moines Creek Weir Site Water	65	136.6	106.68	25.08299
Cu-Spiked Laboratory Water	90	7.4	n/a	n/a
Reference Toxicant (LC50) =		Acceptable		

WER = Calculated water effect ratio
n/a = not applicable
[1] LC50 adjusted to a hardness of 50 mg/L

In summary, given the results of the preliminary screening-level bioassays (Parametrix, 1999), and the WERs estimated based on nominal concentrations (17 - 28), we recommend pursuing a definitive WER and application of a site-specific water quality standard for copper.

REFERENCES

Parametrix, Inc. 1999. Water-effect ratio screening study at Seattle-Tacoma International Airport: Toxicity evaluation of site water. Prepared for the Port of Seattle, February 1999.

U.S. EPA. 1993. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. EPA/600/4-90/027F, August 1993. U.S. Environmental Protection Agency, Cincinnati, Ohio.

POS 1999. Procedure Manual for Stormwater Monitoring. Port of Seattle, April 1999.

Site	Hardness (ppm)	LC50 (µg/L)	LC50 Adjusted to 50 ppm Hardness	WER
Miller Creek Upstream	46	111.6	120.72	28.38372
Miller Creek Detention Facility	92	168.8	95.03	22.34329
Northwest Ponds Inlet	60	143.6	120.93	28.43387
Northwest Ponds Outlet	90	132	75.87	17.83784
Des Moines Creek Weir	65	136.6	106.68	25.08299
Lab Water	90	7.4	4.25	

PREPARED BY _____ 4/24/00

CHECKED BY _____ 4/24/00

PARAMETRIX, INC.
Environmental Toxicology Laboratory

STATIC ACUTE *Daphnia magna* TOXICITY TEST

nt	Port of Seattle	Sample Collection Date	4/14/00
ple	Cu in Lab Water	Test Initiation Time	1415
Test Dates	4/15/2000 - 4/17/2000	Source/Age of Organisms	In house cultures / <24 hours
		Dilution Water	EPA synthetic freshwater

Temp (°C) Day 0 25 Day 1 25 Day 2 25

Conc.	Rep.	Number of Organisms 0	24	48	pH 0	24	48	Dissolved Oxygen (mg/L) 0	24	48	Specific Conductivity (µS) 0	48
Control	A	5	5	4-1	7.9	7.6	7.9	8.3	8.1	8.3	251	305
	B	5	5	5								
	C	5	5	3-2								
	D	5	5	5								
5 µg/L	A	5	5	4-1	7.9	7.7	7.9	8.3	8.1	8.3	251	316
	B	5	5	4-1								
	C	5	5	3-2								
	D	5	5	3-2								
10 µg/L	A	5	3-2	0-3	7.9	7.7	7.9	8.3	8.2	8.3	251	390
	B	5	4-1	0-4								
	C	5	5	2-3								
	D	5	2-3	2								
20 µg/L	A	5	1-4	0-1	7.9	7.7	7.9	8.3	8.3	8.3	251	332
	B	5	3-2	0-3								
	C	5	0-5	0								
	D	5	0-5	0								
40 µg/L	A	5	0-5	0	7.9	7.8	8.0	8.3	8.3	8.1	251	318
	B	5	0-5	0								
	C	5	0-5	0								
	D	5	0-5	0								
80 µg/L	A	5	0-5	0	7.9	7.8	8.0	8.3	8.3	8.1	251	293
	B	5	0-5	0								
	C	5	0-5	0								
	D	5	0-5	0								
	A											
	B											
	C											
	D											
	Initials	DH	DH	PM	DH	DH	PM	DH	DH	PM	DH	PM
	Date	4/15	4/16	4/17	4/15	4/16	4/17	4/15	4/16	4/17	4/15	4/17
	QC											

Shading represents areas for which data collection is not required.
NT = Not Taken

Reviewed by: 4/20/00

omments

AR 016759

Test: AD-Acute Daphid
Species: DM-Daphnia magna
Sample ID: WA0024651-Port of Seattle
Start Date: 04/15/2000 14:15 End Date: 04/17/2000

Test ID: 2861
Protocol: EPAA 91-EPA Acute
Sample Type: SRW2-Industrial stormwater
Lab ID: WAPTL-Parametrix Tox Lab

ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
1	1	D-Control	5	5	4			
2	2	D-Control	5	5	5			
3	3	D-Control	5	5	3			
4	4	D-Control	5	5	5			
5	1	5.000	5	5	4			
6	2	5.000	5	5	4			
7	3	5.000	5	5	3			
8	4	5.000	5	5	3			
9	1	10.000	5	3	0			
10	2	10.000	5	4	0			
11	3	10.000	5	5	2			
12	4	10.000	5	2	2			
13	1	20.000	5	1	0			
14	2	20.000	5	3	0			
15	3	20.000	5	0	0			
16	4	20.000	5	0	0			
17	1	40.000	5	0	0			
18	2	40.000	5	0	0			
19	3	40.000	5	0	0			
20	4	40.000	5	0	0			
21	1	80.000	5	0	0			
22	2	80.000	5	0	0			
23	3	80.000	5	0	0			
24	4	80.000	5	0	0			

Comments: Port of Seattle - Cu in Lab Water

PREPARED BY CW 4/20/00

CHECKED BY [illegible] 4/20/00

AR 016760

Test: AD-Acute Daphid | Test ID: 2861
Species: DM-Daphnia magna | Protocol: EPAA 91-EPA Acute
Sample ID: WA0024651-Port of Seattle | Sample Type: SRW2-Industrial stormwater
Start Date: 04/15/2000 14:15 | End Date: 04/17/2000 | Lab ID: WAPTL-Parametrix Tox Lab

s	ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
	1	1	D-Control	5	5	4			
	2	2	D-Control	5	5	5			
	3	3	D-Control	5	5	3			
	4	4	D-Control	5	5	5			
	5	1	5.000	5	5	4			
	6	2	5.000	5	5	4			
	7	3	5.000	5	5	3			
	8	4	5.000	5	5	3			
	9	1	10.000	5	3	0			
	10	2	10.000	5	4	0			
	11	3	10.000	5	5	2			
	12	4	10.000	5	2	2			
	13	1	20.000	5	1	0			
	14	2	20.000	5	3	0			
	15	3	20.000	5	0	0			
	16	4	20.000	5	0	0			
	17	1	40.000	5	0	0			
	18	2	40.000	5	0	0			
	19	3	40.000	5	0	0			
	20	4	40.000	5	0	0			
	21	1	80.000	5	0	0			
	22	2	80.000	5	0	0			
	23	3	80.000	5	0	0			
	24	4	80.000	5	0	0			

Comments: Port of Seattle - Cu in Lab Water

AR 016761

Reviewed by:

Acute Daphid-48 Hr Survival

Start Date:	04/15/2000 14:15	Test ID:	2861	Sample ID:	WA0024651-Port of Seattle
End Date:	04/17/2000	Lab ID:	WAPTL-Parametrix Tox Lab	Sample Type:	SRW2-Industrial stormwater
Sample Date:	04/14/2000	Protocol:	EPAA 91-EPA Acute	Test Species:	DM-Daphnia magna
Comments:	Port of Seattle - Cu in Lab Water				

Conc-ug/L	1	2	3	4
D-Control	0.8000	1.0000	0.6000	1.0000
5	0.8000	0.8000	0.6000	0.6000
10	0.0000	0.0000	0.4000	0.4000
20	0.0000	0.0000	0.0000	0.0000
40	0.0000	0.0000	0.0000	0.0000
80	0.0000	0.0000	0.0000	0.0000

			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-ug/L	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
D-Control	0.8500	1.0000	1.1709	0.8861	1.3453	18.840	4				3	20
5	0.7000	0.8235	0.9966	0.8861	1.1071	12.807	4	1.161	2.180	0.3273	6	20
*10	0.2000	0.2353	0.4551	0.2255	0.6847	58.254	4	4.768	2.180	0.3273	16	20
20	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	4				20	20
40	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	4				20	20
80	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	4				20	20

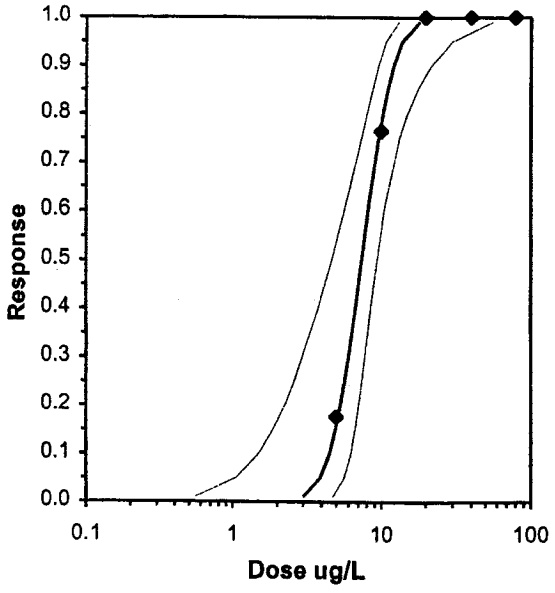
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.88728	0.805	-0.1968	-1.6982
Bartlett's Test indicates equal variances (p = 0.52)	1.29929	9.21035		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	5	10	7.07107		0.29035	0.3422	0.55735	0.04508	0.00262	2, 9

Maximum Likelihood-Probit

Parameter	Value	SE	95% Fiducial Limits		Control	Chi-Sq	Critical	P-value	Mu	Sigma	Iter
Slope	5.93176	1.81345	2.37741	9.48612	0.15	0.13572	7.81472	0.99	0.86892	0.16858	5
Intercept	-0.1542	1.70483	-3.4957	3.18724							
TSCR	0.15469	0.07987	-0.0019	0.31123							

Point	Probits	ug/L	95% Fiducial Limits	
EC01	2.674	2.99733	0.55368	4.72012
EC05	3.355	3.90502	1.05825	5.63791
EC10	3.718	4.49645	1.48967	6.2191
EC15	3.964	4.9453	1.87202	6.65964
EC20	4.158	5.33378	2.24052	7.04519
EC25	4.326	5.69129	2.60919	7.40717
EC40	4.747	6.70207	3.78501	8.50415
EC50	5.000	7.39467	4.67005	9.36801
EC60	5.253	8.15886	5.66233	10.5014
EC75	5.674	9.60787	7.37291	13.432
EC80	5.842	10.2519	8.01687	15.1249
EC85	6.036	11.0572	8.73009	17.5857
EC90	6.282	12.161	9.58322	21.558
EC95	6.645	14.0028	10.8068	29.6849
EC99	7.326	18.2433	13.1615	55.6444



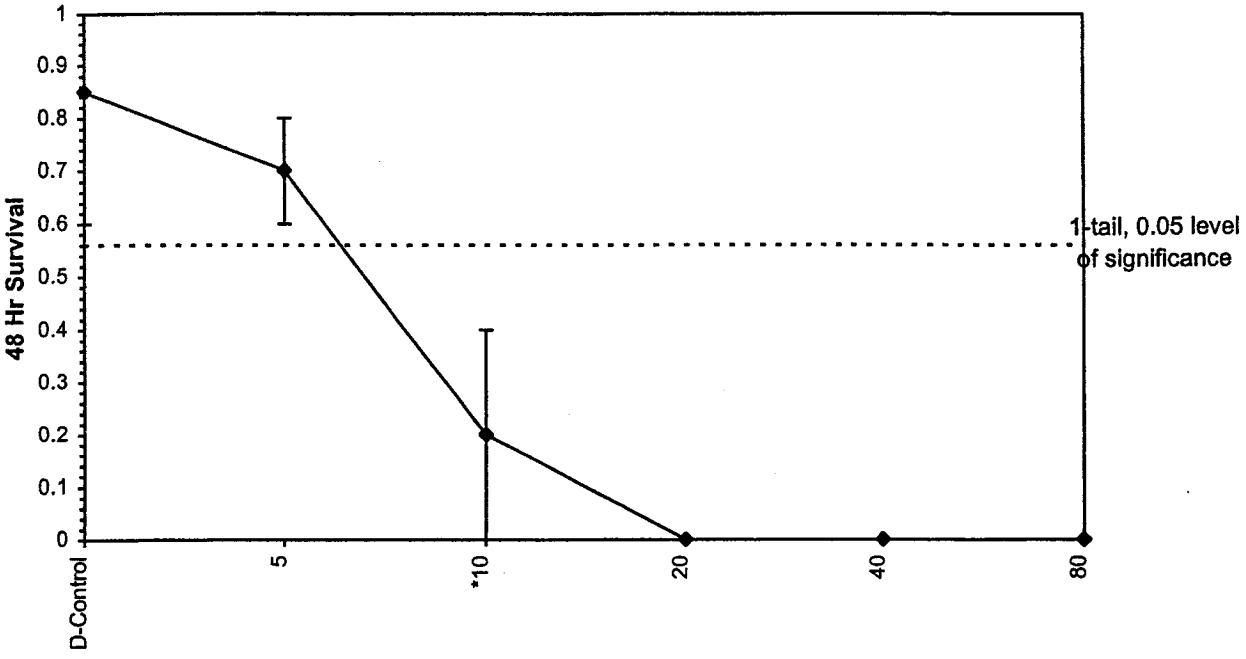
AR 016762

Reviewed by:

Acute Daphid-48 Hr Survival

Start Date:	04/15/2000 14:15	Test ID:	2861	Sample ID:	WA0024651-Port of Seattle
End Date:	04/17/2000	Lab ID:	WAPTL-Parametrix Tox Lab	Sample Type:	SRW2-Industrial stormwater
Sample Date:	04/14/2000	Protocol:	EPAA 91-EPA Acute	Test Species:	DM-Daphnia magna
Comments:	Port of Seattle - Cu in Lab Water				

Dose-Response Plot



AR 016763

PARAMETRIX, INC.
Environmental Toxicology Laboratory

STATIC ACUTE *Daphnia magna* TOXICITY TEST

nt	Port of Seattle	Sample Collection Date	4/14/00
.iple	Cu in Northwest Ponds Inlet Water	Test Initiation Time	1430
Test Dates	4/15/2000 - 4/17/2000	Source/Age of Organisms	In house cultures / <24 hours
		Dilution Water	Northwest Ponds Inlet Water

Temp (°C) Day 0 25 Day 1 25 Day 2 25

Conc.	Rep.	Number of Organisms 0	24	48	pH 0	24	48	Dissolved Oxygen (mg/L) 0	24	48	Specific Conductivity (µS) 0	48
Control	A	5	5	5	7.9	7.8	8.1	8.2	8.0	8.4	157	184
	B	5	5	4-1								
	C	5	5	4-1								
	D	5	5	5								
12.5 µg/L	A	5	5	5	7.9	7.9	8.1	8.2	8.0	8.3	152	187
	B	5	5	5								
	C	5	5	4-1								
	D	5	5	4-1								
25 µg/L	A	5	5	3-2	7.9	7.9	8.1	8.2	8.0	8.3	152	185
	B	5	5	5								
	C	5	4-1	2-2								
	D	5	5	2-3								
50 µg/L	A	5	5	2-3	7.9	7.9	8.1	8.2	8.0	8.2	157	192
	B	5	5	3-2								
	C	5	5	5								
	D	5	5	5								
100 µg/L	A	5	6	5	7.9	7.9	8.1	8.2	8.0	8.2	152	180
	B	5	5	4-1								
	C	5	5	3-2								
	D	5	4-1	3-1								
200 µg/L	A	5	5*	0-5	7.9	7.9	8.1	8.2	8.0	8.0	157	172
	B	5	5*	0-5								
	C	5	5*	1-4								
	D	5	4*-1	0-4								
	A											
	B											
	C											
	D											
	Initials	DH	DH	PM	DH	DH	PM	DH	DH	PM	DH	PM
	Date	4/15	4/16	4/17	4/15	4/16	4/17	4/15	4/16	4/17	4/15	4/17
	QC											

Shading represents areas for which data collection is not required.
NT = Not Taken

Reviewed by: [signature] 4/20/00

Comments * Very limited mobility

Test: AD-Acute Daphid
Species: DM-Daphnia magna
Sample ID: WA0024651-Port of Seattle
Start Date: 04/15/2000 14:30 End Date: 04/17/2000

Test ID: 2862
Protocol: EPAA 91-EPA Acute
Sample Type: SRW2-Industrial stormwater
Lab ID: WAPTL-Parametrix Tox Lab

s	ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
	1	1	D-Control	5	5	5			
	2	2	D-Control	5	5	4			
	3	3	D-Control	5	5	4			
	4	4	D-Control	5	5	5			
	5	1	12.500	5	5	5			
	6	2	12.500	5	5	5			
	7	3	12.500	5	5	4			
	8	4	12.500	5	5	4			
	9	1	25.000	5	5	3			
	10	2	25.000	5	5	5			
	11	3	25.000	5	4	2			
	12	4	25.000	5	5	2			
	13	1	50.000	5	5	2			
	14	2	50.000	5	5	3			
	15	3	50.000	5	5	5			
	16	4	50.000	5	5	5			
	17	1	100.000	5	5	5			
	18	2	100.000	5	5	4			
	19	3	100.000	5	5	3			
	20	4	100.000	5	4	3			
	21	1	200.000	5	5	0			
	22	2	200.000	5	5	0			
	23	3	200.000	5	5	1			
	24	4	200.000	5	4	0			

Comments: POS - Cu in NW Ponds Inlet Water

PREPARED BY Cwd 4/20/00

CHECKED BY JR 4/20/00

AR 016765

Test: AD-Acute Daphid | Test ID: 2862
Species: DM-Daphnia magna | Protocol: EPAA 91-EPA Acute
Sample ID: WA0024651-Port of Seattle | Sample Type: SRW2-Industrial stormwater
Start Date: 04/15/2000 14:30 End Date: 04/17/2000 | Lab ID: WAPTL-Parametrix Tox Lab

ps	ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
	1	1	D-Control	5	5	5			
	2	2	D-Control	5	5	4			
	3	3	D-Control	5	5	4			
	4	4	D-Control	5	5	5			
	5	1	12.500	5	5	5			
	6	2	12.500	5	5	5			
	7	3	12.500	5	5	4			
	8	4	12.500	5	5	4			
	9	1	25.000	5	5	3			
	10	2	25.000	5	5	5			
	11	3	25.000	5	4	2			
	12	4	25.000	5	5	2			
	13	1	50.000	5	5	2			
	14	2	50.000	5	5	3			
	15	3	50.000	5	5	5			
	16	4	50.000	5	5	5			
	17	1	100.000	5	5	5			
	18	2	100.000	5	5	4			
	19	3	100.000	5	5	3			
	20	4	100.000	5	4	3			
	21	1	200.000	5	5	0			
	22	2	200.000	5	5	0			
	23	3	200.000	5	5	1			
	24	4	200.000	5	4	0			

Comments: POS - Cu in NW Ponds Inlet Water

AR 016766

ToxCalc 5.0

Reviewed by:

Acute Daphid-48 Hr Survival

Start Date:	04/15/2000 14:30	Test ID:	2862	Sample ID:	WA0024651-Port of Seattle
End Date:	04/17/2000	Lab ID:	WAPTL-Parametrix Tox Lab	Sample Type:	SRW2-Industrial stormwater
Sample Date:	04/14/2000	Protocol:	EPAA 91-EPA Acute	Test Species:	DM-Daphnia magna
Comments:	POS - Cu in NW Ponds Inlet Water				

Conc-ug/L	1	2	3	4
D-Control	1.0000	0.8000	0.8000	1.0000
12.5	1.0000	1.0000	0.8000	0.8000
25	0.6000	1.0000	0.4000	0.4000
50	0.4000	0.6000	1.0000	1.0000
100	1.0000	0.8000	0.6000	0.6000
200	0.0000	0.0000	0.2000	0.0000

			Transform: Arcsin Square Root						1-Tailed		Number	Total
Conc-ug/L	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Resp	Number
D-Control	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	4				2	20
12.5	0.9000	1.0000	1.2262	1.1071	1.3453	11.212	4	0.000	2.410	0.3863	2	20
25	0.6000	0.6667	0.9002	0.6847	1.3453	34.607	4	2.034	2.410	0.3863	8	20
50	0.7500	0.8333	1.0653	0.6847	1.3453	31.308	4	1.004	2.410	0.3863	5	20
100	0.7500	0.8333	1.0561	0.8861	1.3453	20.748	4	1.061	2.410	0.3863	5	20
*200	0.0500	0.0556	0.2850	0.2255	0.4636	41.771	4	5.872	2.410	0.3863	19	20

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.95795	0.884	0.41562	-0.3207
Bartlett's Test indicates equal variances (p = 0.40)	5.17099	15.0863		

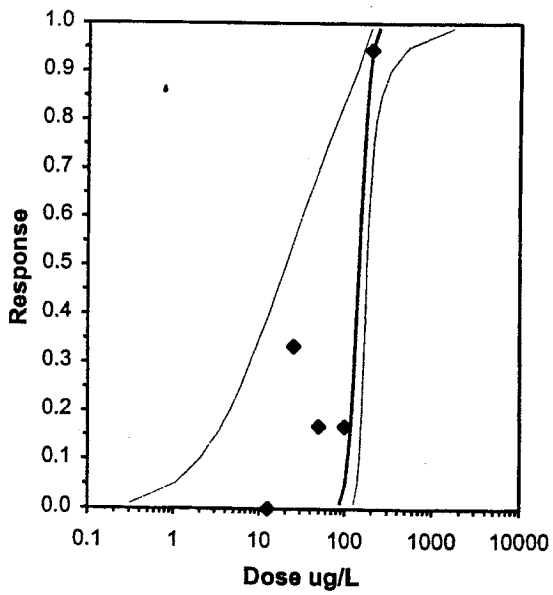
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	100	200	141.421		0.33147	0.37417	0.49698	0.05138	1.3E-04	5, 18

Maximum Likelihood-Probit

Parameter	Value	SE	95% Fiducial Limits	
Slope	10.6117	4.76948	1.26356	19.9599
Intercept	-17.892	10.7861	-39.033	3.24892
TSCR	0.2125	0.04574	0.12286	0.30214

Control	Chi-Sq	Critical	P-value	Mu	Sigma	Iter
0.1	5.88238	7.81472	0.12	2.15722	0.09424	9

Point	Probits	ug/L	95% Fiducial Limits	
EC01	2.674	86.6949	0.30845	127.403
EC05	3.355	100.511	1.0603	138.812
EC10	3.718	108.755	2.0446	145.537
EC15	3.964	114.696	3.18124	150.403
EC20	4.158	119.648	4.51697	154.505
EC25	4.326	124.067	6.09755	158.226
EC40	4.747	135.939	12.9302	168.743
EC50	5.000	143.621	20.2227	176.274
EC60	5.253	151.737	31.4131	185.401
EC75	5.674	166.256	63.181	208.466
EC80	5.842	172.396	81.3097	223.935
EC85	6.036	179.84	105.178	252.51
EC90	6.282	189.664	133.834	319.086
EC95	6.645	205.22	163.273	528.79
EC99	7.326	237.926	193.908	1667.6



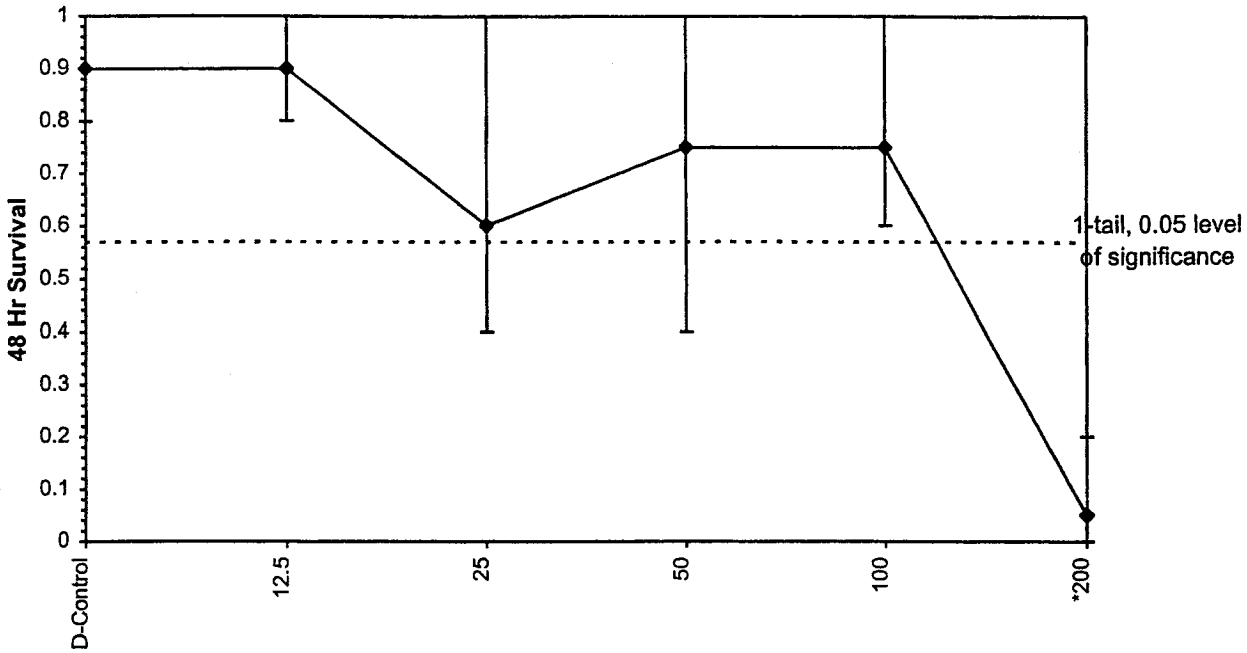
AR 016767

Reviewed by:

Acute Daphid-48 Hr Survival

Start Date:	04/15/2000 14:30	Test ID:	2862	Sample ID:	WA0024651-Port of Seattle
End Date:	04/17/2000	Lab ID:	WAPTL-Parametrix Tox Lab	Sample Type:	SRW2-Industrial stormwater
Sample Date:	04/14/2000	Protocol:	EPAA 91-EPA Acute	Test Species:	DM-Daphnia magna
Comments:	POS - Cu in NW Ponds Inlet Water				

Dose-Response Plot



AR 016768

PARAMETRIX, INC.
Environmental Toxicology Laboratory

STATIC ACUTE *Daphnia magna* TOXICITY TEST

·nt	Port of Seattle	Sample Collection Date	4/14/00
·ple	Cu in Des Moines Creek Weir Water	Test Initiation Time	1530
Test Dates	4/15/2000 - 4/17/2000	Source/Age of Organisms	In house cultures / <24 hours
		Dilution Water	Des Moines Creek Weir Water

Temp (°C) Day 0 25 Day 1 25 Day 2 25

Conc.	Rep.	Number of Organisms 0	24	48	pH 0	24	48	Dissolved Oxygen (mg/L) 0	24	48	Specific Conductivity (µS) 0	48
Control	A	5	5	5	7.9	8.0	8.0	8.3	8.0 8.1	8.4	159	182
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
12.5 µg/L	A	5	5	5	7.9	8.0	8.1	8.3	8.0 8.1	8.4	159	187
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
25 µg/L	A	5	5	5	7.9	8.0	8.1	8.3	8.2	8.4	159	190
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
50 µg/L	A	5	5	5	7.9	8.0	8.1	8.3	8.1	8.2	159	188
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100 µg/L	A	5	5	5	7.9	8.0	8.1	8.3	8.3	8.1	159	187
	B	5	5	5								
	C	5	5	5								
	D	5	5	4-4								
200 µg/L	A	5	4*-1	0-4	7.9	8.0	8.1	8.3	8.3	8.0	159	176
	B	5	5*	0-5								
	C	5	2*-3	0-2								
	D	5	4*-1	0-4								
	A											
	B											
	C											
	D											
	Initials	DH	DH	PM	DH	DH	PM	DH	DH	PM	DH	PM
	Date	4/15	4/16	4/17	4/15	4/16	4/17	4/15	4/16	4/17	4/15	4/17
	QC											

Shading represents areas for which data collection is not required.
NT = Not Taken

Reviewed by: [signature] 4/20/00

Comments * Very limited mobility

Test: AD-Acute Daphid | Test ID: 2864
Species: DM-Daphnia magna | Protocol: EPAA 91-EPA Acute
Sample ID: WA0024651-Port of Seattle | Sample Type: SRW2-Industrial stormwater
Start Date: 04/15/2000 15:30 | End Date: 04/17/2000 | Lab ID: WAPTL-Parametrix Tox Lab

s	ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
	1	1	D-Control	5	5	5			
	2	2	D-Control	5	5	5			
	3	3	D-Control	5	5	5			
	4	4	D-Control	5	5	5			
	5	1	12.500	5	5	5			
	6	2	12.500	5	5	5			
	7	3	12.500	5	5	5			
	8	4	12.500	5	5	5			
	9	1	25.000	5	5	5			
	10	2	25.000	5	5	5			
	11	3	25.000	5	5	5			
	12	4	25.000	5	5	5			
	13	1	50.000	5	5	5			
	14	2	50.000	5	5	5			
	15	3	50.000	5	5	5			
	16	4	50.000	5	5	5			
	17	1	100.000	5	5	5			
	18	2	100.000	5	5	5			
	19	3	100.000	5	5	5			
	20	4	100.000	5	5	4			
	21	1	200.000	5	4	0			
	22	2	200.000	5	5	0			
	23	3	200.000	5	2	0			
	24	4	200.000	5	4	0			

Comments: POS - Cu in Des Moines Creek Weir Water

PREPARED BY cat 4/20/00

CHECKED BY JZ 4/20/00

AR 016770

Test: AD-Acute Daphid | Test ID: 2864
Species: DM-Daphnia magna | Protocol: EPAA 91-EPA Acute
Sample ID: WA0024651-Port of Seattle | Sample Type: SRW2-Industrial stormwater
Start Date: 04/15/2000 15:30 End Date: 04/17/2000 | Lab ID: WAPTL-Parametrix Tox Lab

›s	ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
	1	1	D-Control	5	5	5			
	2	2	D-Control	5	5	5			
	3	3	D-Control	5	5	5			
	4	4	D-Control	5	5	5			
	5	1	12.500	5	5	5			
	6	2	12.500	5	5	5			
	7	3	12.500	5	5	5			
	8	4	12.500	5	5	5			
	9	1	25.000	5	5	5			
	10	2	25.000	5	5	5			
	11	3	25.000	5	5	5			
	12	4	25.000	5	5	5			
	13	1	50.000	5	5	5			
	14	2	50.000	5	5	5			
	15	3	50.000	5	5	5			
	16	4	50.000	5	5	5			
	17	1	100.000	5	5	5			
	18	2	100.000	5	5	5			
	19	3	100.000	5	5	5			
	20	4	100.000	5	5	4			
	21	1	200.000	5	4	0			
	22	2	200.000	5	5	0			
	23	3	200.000	5	2	0			
	24	4	200.000	5	4	0			

Comments: POS - Cu in Des Moines Creek Weir Water

AR 016771

Reviewed by:

Acute Daphid-48 Hr Survival

Start Date:	04/15/2000 15:30	Test ID:	2864	Sample ID:	WA0024651-Port of Seattle
End Date:	04/17/2000	Lab ID:	WAPTL-Parametrix Tox Lab	Sample Type:	SRW2-Industrial stormwater
Sample Date:	04/14/2000	Protocol:	EPAA 91-EPA Acute	Test Species:	DM-Daphnia magna
Comments:	POS - Cu in Des Moines Creek Weir Water				

Conc-ug/L	1	2	3	4
D-Control	1.0000	1.0000	1.0000	1.0000
12.5	1.0000	1.0000	1.0000	1.0000
25	1.0000	1.0000	1.0000	1.0000
50	1.0000	1.0000	1.0000	1.0000
100	1.0000	1.0000	1.0000	0.8000
200	0.0000	0.0000	0.0000	0.0000

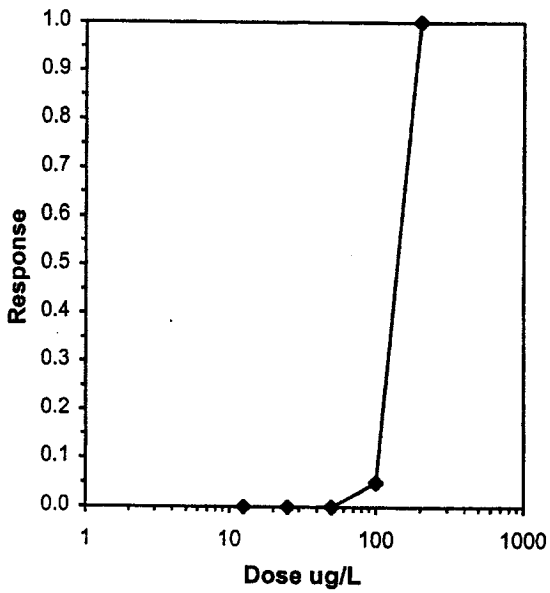
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-ug/L	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
D-Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4			0	20
12.5	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	0	20
25	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	0	20
50	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	0	20
100	0.9500	0.9500	1.2857	1.1071	1.3453	9.261	4	16.00	10.00	1	20
200	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	4			20	20

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.5089	0.868	-2.7962	11.6732
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	200	141.421	

Trimmed Spearman-Karber

Trim Level	EC50	95% CL	
0.0%	136.60	127.68	146.15
5.0%	138.87	133.76	144.16
10.0%	138.87	133.76	144.16
20.0%	138.87	133.76	144.16
Auto-0.0%	136.60	127.68	146.15



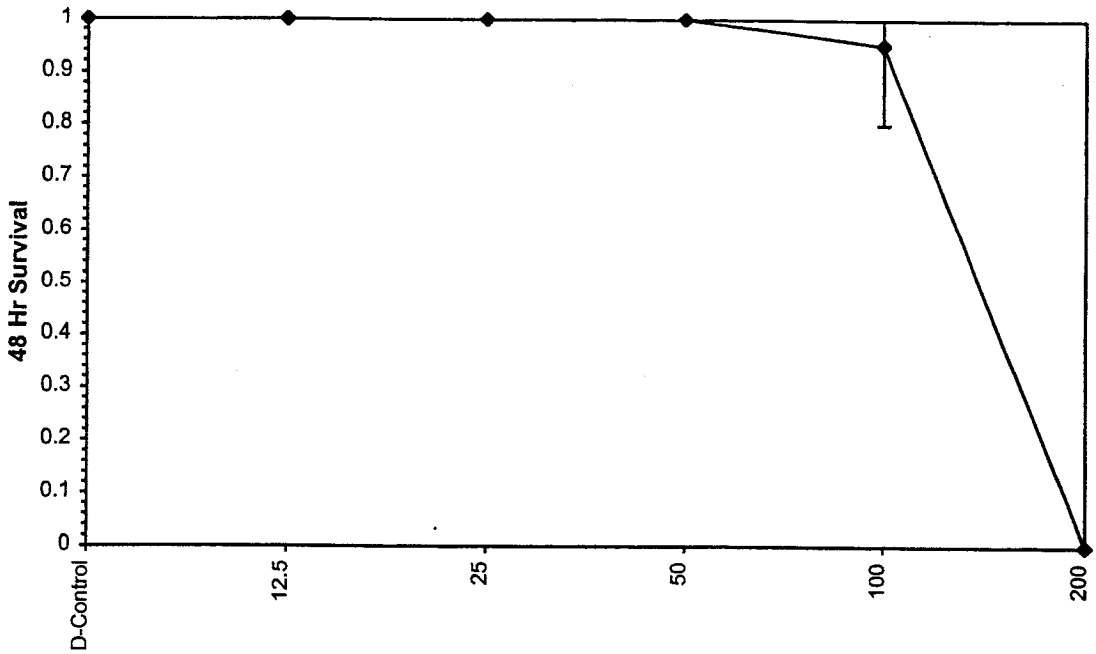
AR 016772

Reviewed by:_____

Acute Daphid-48 Hr Survival

Start Date:	04/15/2000 15:30	Test ID:	2864	Sample ID:	WA0024651-Port of Seattle
End Date:	04/17/2000	Lab ID:	WAPTL-Parametrix Tox Lab	Sample Type:	SRW2-Industrial stormwater
Sample Date:	04/14/2000	Protocol:	EPAA 91-EPA Acute	Test Species:	DM-Daphnia magna
Comments:	POS - Cu in Des Moines Creek Weir Water				

Dose-Response Plot



AR 016773

PARAMETRIX, INC.
Environmental Toxicology Laboratory

STATIC ACUTE *Daphnia magna* TOXICITY TEST

nt	Port of Seattle	Sample Collection Date	4/14/00
ple	Cu in Miller Creek Upstream Water	Test Initiation Time	1500
Test Dates	4/15/2000 - 4/17/2000	Source/Age of Organisms	In house cultures / <24 hours
		Dilution Water	Miller Creek Upstream Water

Temp (°C) Day 0 21 Day 1 20 Day 2 25

Conc.	Rep.	Number of Organisms			pH			Dissolved Oxygen (mg/L)			Specific Conductivity (µS)	
		0	24	48	0	24	48	0	24	48	0	48
Control	A	5	5	4-1	7.7	7.5	7.6	8.3	8.2	8.1	121	147
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
12.5 µg/L	A	5	5	5	7.7	7.5	7.7	8.3	8.2	8.1	121	149
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
25 µg/L	A	5	5	5	7.7	7.6	7.8	8.3	8.3	8.2	121	154
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
50 µg/L	A	5	5	5	7.7	7.6	7.8	8.3	8.3	8.2	121	157
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100 µg/L	A	5	5	3-2	7.7	7.6	7.9	8.3	8.3	8.1	121	152
	B	5	5	3-2								
	C	5	5	4-1								
	D	5	5	3-2								
200 µg/L	A	5	0-5	0	7.7	7.7	7.9	8.3	8.4	8.0	121	155
	B	5	4-1	0-4								
	C	5	5	0-5								
	D	5	5	0-5								
	A											
	B											
	C											
	D											
	Initials	DH	DH	Pm	DH	DH	Pm	DH	DH	Pm	DH	Pm
	Date	4/15	4/16	4/17	4/15	4/16	4/17	4/15	4/16	4/17	4/15	4/17
	QC											

Shading represents areas for which data collection is not required.
NT = Not Taken

Reviewed by: JZ 4/20/00

omments

AR 016774

Test: AD-Acute Daphid | Test ID: 2866
Species: DM-Daphnia magna | Protocol: EPAA 91-EPA Acute
Sample ID: WA0024651-Port of Seattle | Sample Type: SRW2-Industrial stormwater
Start Date: 04/15/2000 15:00 End Date: 04/17/2000 | Lab ID: WAPTL-Parametrix Tox Lab

ɔs	ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
	1	1	D-Control	5	5	4			
	2	2	D-Control	5	5	5			
	3	3	D-Control	5	5	5			
	4	4	D-Control	5	5	5			
	5	1	12.500	5	5	5			
	6	2	12.500	5	5	5			
	7	3	12.500	5	5	5			
	8	4	12.500	5	5	5			
	9	1	25.000	5	5	5			
	10	2	25.000	5	5	5			
	11	3	25.000	5	5	5			
	12	4	25.000	5	5	5			
	13	1	50.000	5	5	5			
	14	2	50.000	5	5	5			
	15	3	50.000	5	5	5			
	16	4	50.000	5	5	5			
	17	1	100.000	5	5	3			
	18	2	100.000	5	5	3			
	19	3	100.000	5	5	4			
	20	4	100.000	5	5	3			
	21	1	200.000	5	0	0			
	22	2	200.000	5	4	0			
	23	3	200.000	5	5	0			
	24	4	200.000	5	5	0			

Comments: POS - Cu in Miller Creek Upstream Water

PREPARED BY Cad 4/20/00

[illegible]ED BY 12 4/20/00

AR 016775

Test: AD-Acute Daphid
Species: DM-Daphnia magna
Sample ID: WA0024651-Port of Seattle
Start Date: 04/15/2000 15:00 End Date: 04/17/2000

Test ID: 2866
Protocol: EPAA 91-EPA Acute
Sample Type: SRW2-Industrial stormwater
Lab ID: WAPTL-Parametrix Tox Lab

›s	ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
	1	1	D-Control	5	5	4			
	2	2	D-Control	5	5	5			
	3	3	D-Control	5	5	5			
	4	4	D-Control	5	5	5			
	5	1	12.500	5	5	5			
	6	2	12.500	5	5	5			
	7	3	12.500	5	5	5			
	8	4	12.500	5	5	5			
	9	1	25.000	5	5	5			
	10	2	25.000	5	5	5			
	11	3	25.000	5	5	5			
	12	4	25.000	5	5	5			
	13	1	50.000	5	5	5			
	14	2	50.000	5	5	5			
	15	3	50.000	5	5	5			
	16	4	50.000	5	5	5			
	17	1	100.000	5	5	3			
	18	2	100.000	5	5	3			
	19	3	100.000	5	5	4			
	20	4	100.000	5	5	3			
	21	1	200.000	5	0	0			
	22	2	200.000	5	4	0			
	23	3	200.000	5	5	0			
	24	4	200.000	5	5	0			

Comments: POS - Cu in Miller Creek Upstream Water

AR 016776

Reviewed by:

Acute Daphid-48 Hr Survival

Start Date:	04/15/2000 15:00	Test ID:	2866	Sample ID:	WA0024651-Port of Seattle
End Date:	04/17/2000	Lab ID:	WAPTL-Parametrix Tox Lab	Sample Type:	SRW2-Industrial stormwater
Sample Date:	04/14/2000	Protocol:	EPAA 91-EPA Acute	Test Species:	DM-Daphnia magna
Comments:	POS - Cu in Miller Creek Upstream Water				

Conc-ug/L	1	2	3	4
D-Control	0.8000	1.0000	1.0000	1.0000
12.5	1.0000	1.0000	1.0000	1.0000
25	1.0000	1.0000	1.0000	1.0000
50	1.0000	1.0000	1.0000	1.0000
100	0.6000	0.6000	0.8000	0.6000
200	0.0000	0.0000	0.0000	0.0000

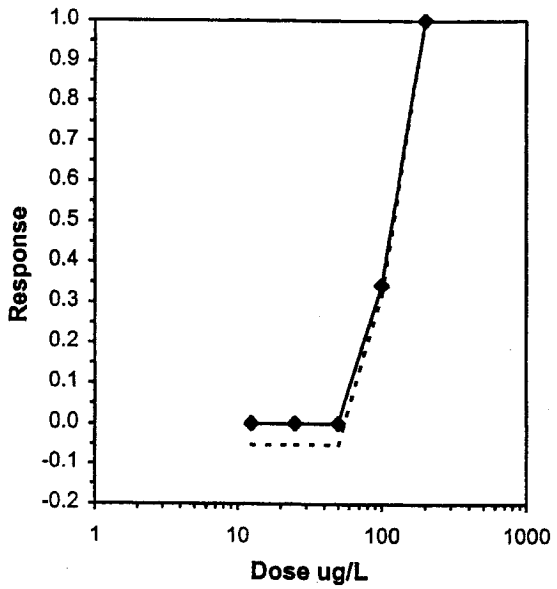
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-ug/L	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
D-Control	0.9500	1.0000	1.2857	1.1071	1.3453	9.261	4			1	20
12.5	1.0000	1.0526	1.3453	1.3453	1.3453	0.000	4	20.00	10.00	0	20
25	1.0000	1.0526	1.3453	1.3453	1.3453	0.000	4	20.00	10.00	0	20
50	1.0000	1.0526	1.3453	1.3453	1.3453	0.000	4	20.00	10.00	0	20
100	0.6500	0.6842	0.9413	0.8861	1.1071	11.742	4	10.50	10.00	7	20
200	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	4			20	20

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.81017	0.868	-0.22	4.10888
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	200	141.421	

Trimmed Spearman-Karber

Trim Level	EC50	95% CL	
0.0%	111.59	96.33	129.27
5.0%	112.81	95.68	133.00
10.0%	114.00	94.32	137.79
20.0%	116.22	88.21	153.11
Auto-0.0%	111.59	96.33	129.27



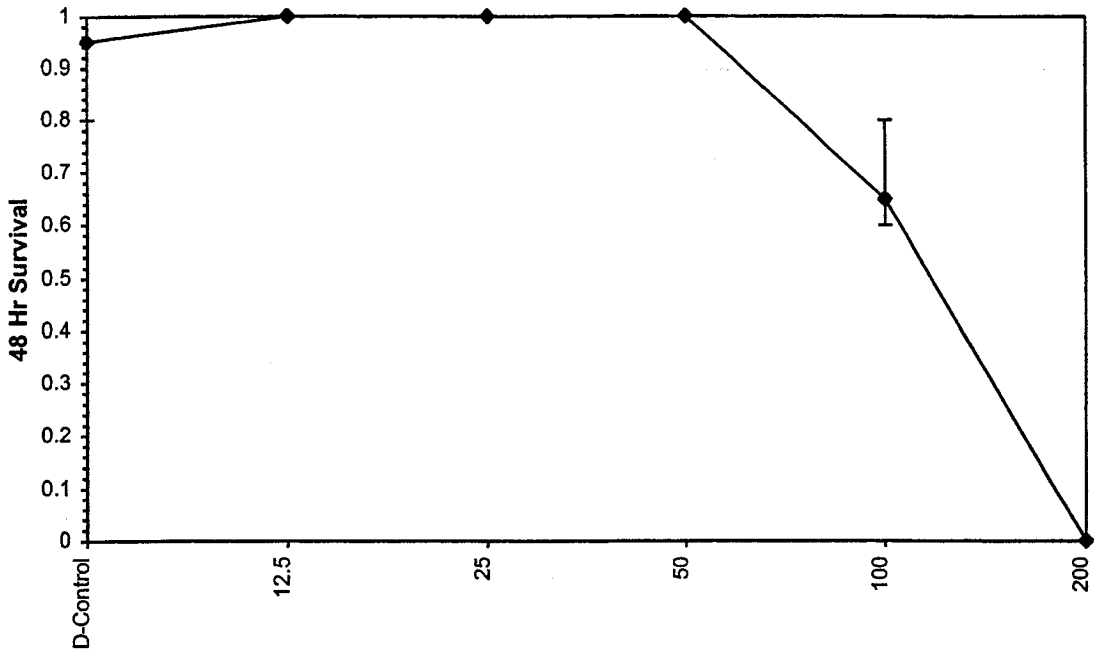
AR 016777

Reviewed by: _____

Acute Daphid-48 Hr Survival

Start Date:	04/15/2000 15:00	Test ID:	2866	Sample ID:	WA0024651-Port of Seattle
End Date:	04/17/2000	Lab ID:	WAPTL-Parametrix Tox Lab	Sample Type:	SRW2-Industrial stormwater
Sample Date:	04/14/2000	Protocol:	EPAA 91-EPA Acute	Test Species:	DM-Daphnia magna
Comments:	POS - Cu in Miller Creek Upstream Water				

Dose-Response Plot



AR 016778

PARAMETRIX, INC.
Environmental Toxicology Laboratory

STATIC ACUTE *Daphnia magna* TOXICITY TEST

·ent	Port of Seattle	Sample Collection Date	4/14/00
·aple	Cu in Miller Creek Detention Facility Water	Test Initiation Time	1515
Test Dates	4/15/2000 - 4/17/2000	Source/Age of Organisms	In house cultures / <24 hours
		Dilution Water	Miller Creek Detention Facility Water

Temp (°C) Day 0 25 Day 1 25 Day 2 25

Conc.	Rep.	Number of Organisms 0	24	48	pH 0	24	48	Dissolved Oxygen (mg/L) 0	24	48	Specific Conductivity (µS) 0	48
Control	A	5	5	5	8.0	8.3	8.3	8.2	8.3	8.3	218	257
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
12.5 µg/L	A	5	5	4-1	8.0	8.3	8.3	8.2	8.3	8.3	218	255
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
25 µg/L	A	5	5	5	8.0	8.3	8.3	8.2	8.3	8.3	218	256
	B	5	5	5								
	C	5	5	4-1								
	D	5	5	4-1								
50 µg/L	A	5	5	5	8.0	8.3	8.3	8.2	8.3	8.2	218	255
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100 µg/L	A	5	5	5	8.0	8.3	8.3	8.2	8.3	8.1	218	251
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
200 µg/L	A	5	5	1-4	8.0	8.3	8.3	8.2	8.3	8.0	218	245
	B	5	4-1	2-2								
	C	5	5	2-3								
	D	5	3-2	2-1								
	A											
	B											
	C											
	D											
	Initials	DH	DH	Pm	DH	DH	Pm	DH	DH	Pm	DH	Pm
	Date	4/15	4/16	4/17	4/15	4/16	4/17	4/15	4/16	4/17	4/15	4/17
	QC											

Shading represents areas for which data collection is not required.
NT = Not Taken

Reviewed by: JZ 4/20/00

·omments

AR 016779

Test: AD-Acute Daphid								Test ID: 2865	
Species: DM-Daphnia magna								Protocol: EPAA 91-EPA Acute	
Sample ID: WA0024651-Port of Seattle								Sample Type: SRW2-Industrial stormwater	
Start Date: 04/15/2000 15:15			End Date: 04/17/2000					Lab ID: WAPTL-Parametrix Tox Lab	
›s	ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
	1	1	D-Control	5	5	5			
	2	2	D-Control	5	5	5			
	3	3	D-Control	5	5	5			
	4	4	D-Control	5	5	5			
	5	1	12.500	5	5	4			
	6	2	12.500	5	5	5			
	7	3	12.500	5	5	5			
	8	4	12.500	5	5	5			
	9	1	25.000	5	5	5			
	10	2	25.000	5	5	5			
	11	3	25.000	5	5	4			
	12	4	25.000	5	5	4			
	13	1	50.000	5	5	5			
	14	2	50.000	5	5	5			
	15	3	50.000	5	5	5			
	16	4	50.000	5	5	5			
	17	1	100.000	5	5	5			
	18	2	100.000	5	5	5			
	19	3	100.000	5	5	5			
	20	4	100.000	5	5	5			
	21	1	200.000	5	5	1			
	22	2	200.000	5	4	2			
	23	3	200.000	5	5	2			
	24	4	200.000	5	3	2			

Comments: POS - Cu in Miller Creek Detention Facility Water

PREPARED BY Cat 4/20/00

CHECKED BY JZ 4/20/00

AR 016780

Test: AD-Acute Daphid | Test ID: 2865
Species: DM-Daphnia magna | Protocol: EPAA 91-EPA Acute
Sample ID: WA0024651-Port of Seattle | Sample Type: SRW2-Industrial stormwater
Start Date: 04/15/2000 15:15 | End Date: 04/17/2000 | Lab ID: WAPTL-Parametrix Tox Lab

s	ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
	1	1	D-Control	5	5	5			
	2	2	D-Control	5	5	5			
	3	3	D-Control	5	5	5			
	4	4	D-Control	5	5	5			
	5	1	12.500	5	5	4			
	6	2	12.500	5	5	5			
	7	3	12.500	5	5	5			
	8	4	12.500	5	5	5			
	9	1	25.000	5	5	5			
	10	2	25.000	5	5	5			
	11	3	25.000	5	5	4			
	12	4	25.000	5	5	4			
	13	1	50.000	5	5	5			
	14	2	50.000	5	5	5			
	15	3	50.000	5	5	5			
	16	4	50.000	5	5	5			
	17	1	100.000	5	5	5			
	18	2	100.000	5	5	5			
	19	3	100.000	5	5	5			
	20	4	100.000	5	5	5			
	21	1	200.000	5	5	1			
	22	2	200.000	5	4	2			
	23	3	200.000	5	5	2			
	24	4	200.000	5	3	2			

Comments: POS - Cu in Miller Creek Detention Facility Water

AR 016781

Reviewed by:

Acute Daphid-48 Hr Survival

Start Date:	04/15/2000 15:15	Test ID:	2865	Sample ID:	WA0024651-Port of Seattle
End Date:	04/17/2000	Lab ID:	WAPTL-Parametrix Tox Lab	Sample Type:	SRW2-Industrial stormwater
Sample Date:	04/14/2000	Protocol:	EPAA 91-EPA Acute	Test Species:	DM-Daphnia magna
Comments:	POS - Cu in Miller Creek Detention Facility Water				

Conc-ug/L	1	2	3	4
D-Control	1.0000	1.0000	1.0000	1.0000
12.5	0.8000	1.0000	1.0000	1.0000
25	1.0000	1.0000	0.8000	0.8000
50	1.0000	1.0000	1.0000	1.0000
100	1.0000	1.0000	1.0000	1.0000
200	0.2000	0.4000	0.4000	0.4000

			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-ug/L	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
D-Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4			0	20
12.5	0.9500	0.9500	1.2857	1.1071	1.3453	9.261	4	16.00	10.00	1	20
25	0.9000	0.9000	1.2262	1.1071	1.3453	11.212	4	14.00	10.00	2	20
50	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	0	20
100	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	0	20
*200	0.3500	0.3500	0.6295	0.4636	0.6847	17.561	4	10.00	10.00	13	20

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.83783	0.884	-0.952	0.83974
Equality of variance cannot be confirmed				

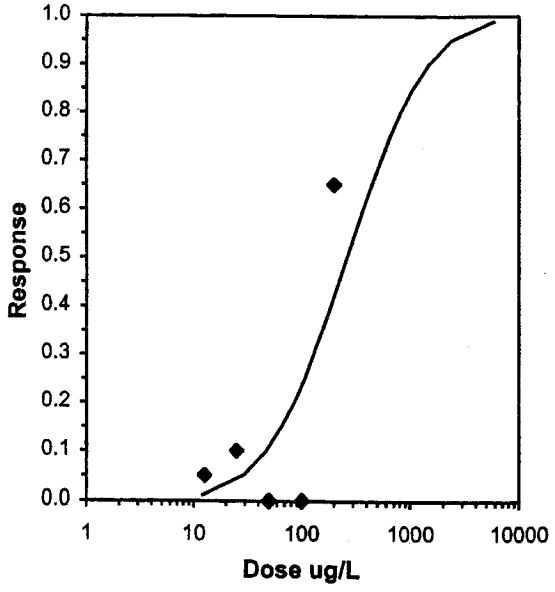
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	200	141.421	

Maximum Likelihood-Probit

Parameter	Value	SE	95% Fiducial Limits		Control	Chi-Sq	Critical	P-value	Mu	Sigma	Iter
Slope	1.71858	1.15876	-1.9691	5.40626	0	17.4984	7.81472	5.6E-04	2.42024	0.58188	5
Intercept	0.84061	2.28474	-6.4305	8.11168							
TSCR											

Point	Probits	ug/L	95% Fiducial Limits
EC01	2.674	11.6574	
EC05	3.355	29.0499	
EC10	3.718	47.2652	
EC15	3.964	65.6401	
EC20	4.158	85.2169	
EC25	4.326	106.605	
EC40	4.747	187.425	
EC50	5.000	263.175	
EC60	5.253	369.539	
EC75	5.674	649.701	
EC80	5.842	812.761	
EC85	6.036	1055.16	
EC90	6.282	1465.37	
EC95	6.645	2384.21	
EC99	7.326	5941.4	

Significant heterogeneity detected (p = 5.58E-04)



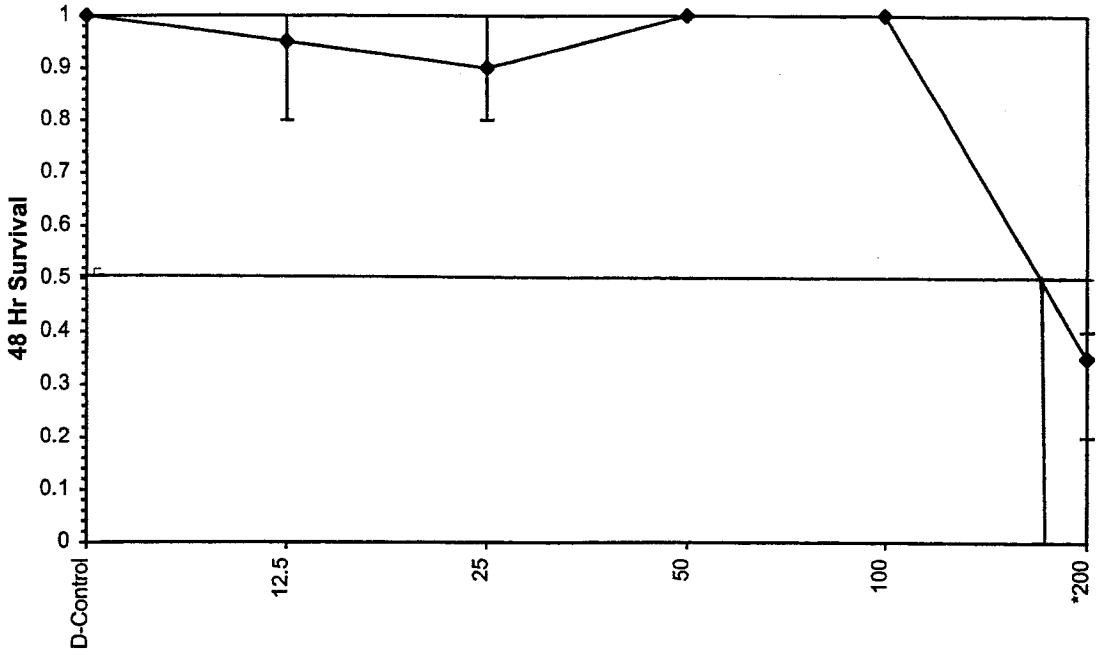
AR 016782

Reviewed by: JJ

Acute Daphid-48 Hr Survival

Start Date:	04/15/2000 15:15	Test ID:	2865	Sample ID:	WA0024651-Port of Seattle
End Date:	04/17/2000	Lab ID:	WAPTL-Parametrix Tox Lab	Sample Type:	SRW2-Industrial stormwater
Sample Date:	04/14/2000	Protocol:	EPAA 91-EPA Acute	Test Species:	DM-Daphnia magna
Comments:	POS - Cu in Miller Creek Detention Facility Water				

Dose-Response Plot



AR 016783

ToxCalc v5.0.23

Reviewed by:

TRIMMED SPEARMAN-KARBER METHOD. MONTANA STATE UNIV

OR REFERENCE, CITE:
HAMILTON, M.A., R.C. RUSSO, AND R.V. THURSTON, 1977.
MMED SPEARMAN-KARBER METHOD FOR ESTIMATING MEDIAN
LETHAL CONCENTRATIONS IN TOXICITY BIOASSAYS.
ENVIRON. SCI. TECHNOL. 11(7): 714-719;
CORRECTION 12(4):417 (1978).

DATE: 4/15/00 TEST NUMBER: POS DURATION: 48 HOURS
CHEMICAL: CU SPECIES: DM

RAW DATA:

CONCENTRATION(UG/L)	12.50	25.00	50.00	100.00	200.00
NUMBER EXPOSED:	20	20	20	20	20
MORTALITIES:	1	2	0	0	13
SPEARMAN-KARBER TRIM:		35.00%			

SPEARMAN-KARBER ESTIMATES: LC50: 168.78
95% LOWER CONFIDENCE: 140.44
95% UPPER CONFIDENCE: 202.83

NOTE: MORTALITY PROPORTIONS WERE NOT MONOTONICALLY INCREASING.
ADJUSTMENTS WERE MADE PRIOR TO SPEARMAN-KARBER ESTIMATION.

PARAMETRIX, INC.
Environmental Toxicology Laboratory

STATIC ACUTE *Daphnia magna* TOXICITY TEST

nt	Port of Seattle	Sample Collection Date	4/14/00
ple	Cu in Northwest Ponds Outlet Water	Test Initiation Time	1445
Test Dates	4/15/2000 - 4/17/2000	Source/Age of Organisms	In house cultures / <24 hours
		Dilution Water	Northwest Ponds Outlet Water

Temp (°C) Day 0 25 Day 1 25 Day 2 25

Conc.	Rep.	Number of Organisms			pH			Dissolved Oxygen (mg/L)			Specific Conductivity (µS)	
		0	24	48	0	24	48	0	24	48	0	48
Control	A	5	5	5	8.0	8.3	8.2	8.3	8.3	7.8	202	213
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
12.5 µg/L	A	5	5	5	8.0	8.3	8.2	8.3	8.3	7.9	202	225
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
25 µg/L	A	5	5	5	8.0	8.3	8.3	8.3	8.3	7.9	202	239
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
50 µg/L	A	5	5	5	8.0	8.4	8.3	8.3	8.3	7.9	202	234
	B	5	5	5								
	C	5	5	5								
	D	5	5	5								
100 µg/L	A	5	5	5	8.0	8.4	8.3	8.3	8.3	7.8	202	225
	B	5	5	5								
	C	5	5	3-2								
	D	5	5	5								
200 µg/L	A	5	5	0-5	8.0	8.4	8.3	8.3	8.3	7.8	202	214
	B	5	5	0-5								
	C	5	5	0-5								
	D	5	5	0-5								
	A											
	B											
	C											
	D											
	Initials	DH	DH	Dm	DH	Pm	Pm	DH	DH	Pm	DH	Pm
	Date	4/15	4/16	4/17	4/15	4/16	4/17	4/15	4/16	4/17	4/15	4/17
	QC											

Shading represents areas for which data collection is not required.
NT = Not Taken

Reviewed by: JL 4/20/00

Comments

Test: AD-Acute Daphid | Test ID: 2863
Species: DM-Daphnia magna | Protocol: EPAA 91-EPA Acute
Sample ID: WA0024651-Port of Seattle | Sample Type: SRW2-Industrial stormwater
Start Date: 04/15/2000 14:45 | End Date: 04/17/2000 | Lab ID: WAPTL-Parametrix Tox Lab

ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
1	1	D-Control	5	5	5			
2	2	D-Control	5	5	5			
3	3	D-Control	5	5	5			
4	4	D-Control	5	5	5			
5	1	12.500	5	5	5			
6	2	12.500	5	5	5			
7	3	12.500	5	5	5			
8	4	12.500	5	5	5			
9	1	25.000	5	5	5			
10	2	25.000	5	5	5			
11	3	25.000	5	5	5			
12	4	25.000	5	5	5			
13	1	50.000	5	5	5			
14	2	50.000	5	5	5			
15	3	50.000	5	5	5			
16	4	50.000	5	5	5			
17	1	100.000	5	5	5			
18	2	100.000	5	5	5			
19	3	100.000	5	5	3			
20	4	100.000	5	5	5			
21	1	200.000	5	5	0			
22	2	200.000	5	5	0			
23	3	200.000	5	5	0			
24	4	200.000	5	5	0			

Comments: POS - Cu in NW Ponds Outlet Water

PREPARED BY cat 4/20/00
CHECKED BY JZ 4/20/00

AR 016786

Test: AD-Acute Daphid
Test ID: 2863
Species: DM-Daphnia magna
Protocol: EPAA 91-EPA Acute
Sample ID: WA0024651-Port of Seattle
Sample Type: SRW2-Industrial stormwater
Start Date: 04/15/2000 14:45
End Date: 04/17/2000
Lab ID: WAPTL-Parametrix Tox Lab

ID	Rep	Group	Start	24 Hr	48 Hr	72 Hr	96 Hr	Notes
1	1	D-Control	5	5	5			
2	2	D-Control	5	5	5			
3	3	D-Control	5	5	5			
4	4	D-Control	5	5	5			
5	1	12.500	5	5	5			
6	2	12.500	5	5	5			
7	3	12.500	5	5	5			
8	4	12.500	5	5	5			
9	1	25.000	5	5	5			
10	2	25.000	5	5	5			
11	3	25.000	5	5	5			
12	4	25.000	5	5	5			
13	1	50.000	5	5	5			
14	2	50.000	5	5	5			
15	3	50.000	5	5	5			
16	4	50.000	5	5	5			
17	1	100.000	5	5	5			
18	2	100.000	5	5	5			
19	3	100.000	5	5	3			
20	4	100.000	5	5	5			
21	1	200.000	5	5	0			
22	2	200.000	5	5	0			
23	3	200.000	5	5	0			
24	4	200.000	5	5	0			

Comments: POS - Cu in NW Ponds Outlet Water

AR 016787

Reviewed by:

Acute Daphid-48 Hr Survival

Start Date:	04/15/2000 14:45	Test ID:	2863	Sample ID:	WA0024651-Port of Seattle
End Date:	04/17/2000	Lab ID:	WAPTL-Parametrix Tox Lab	Sample Type:	SRW2-Industrial stormwater
Sample Date:	04/14/2000	Protocol:	EPAA 91-EPA Acute	Test Species:	DM-Daphnia magna

Comments: POS - Cu in NW Ponds Outlet Water

Conc-ug/L	1	2	3	4
D-Control	1.0000	1.0000	1.0000	1.0000
12.5	1.0000	1.0000	1.0000	1.0000
25	1.0000	1.0000	1.0000	1.0000
50	1.0000	1.0000	1.0000	1.0000
100	1.0000	1.0000	0.6000	1.0000
200	0.0000	0.0000	0.0000	0.0000

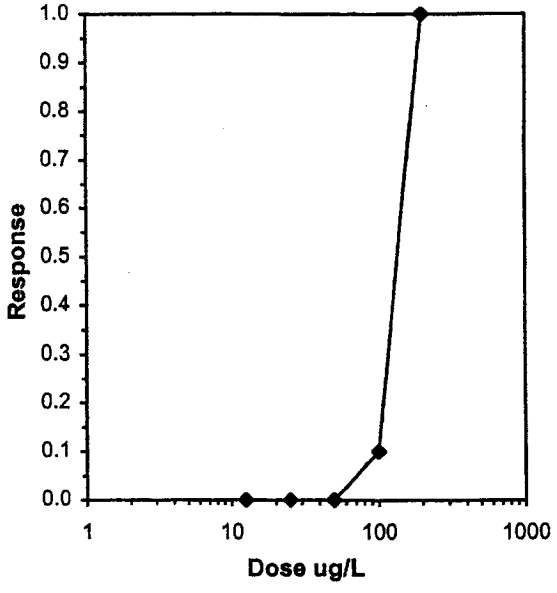
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-ug/L	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
D-Control	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4			0	20
12.5	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	0	20
25	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	0	20
50	1.0000	1.0000	1.3453	1.3453	1.3453	0.000	4	18.00	10.00	0	20
100	0.9000	0.9000	1.2305	0.8861	1.3453	18.660	4	16.00	10.00	2	20
200	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	4			20	20

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.5089	0.868	-2.7962	11.6732
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	200	141.421	

Trimmed Spearman-Karber

Trim Level	EC50	95% CL	
0.0%	131.95	120.23	144.81
5.0%	134.92	120.13	151.53
10.0%	136.08	128.49	144.12
20.0%	136.08	128.49	144.12
Auto-0.0%	131.95	120.23	144.81



AR 016788

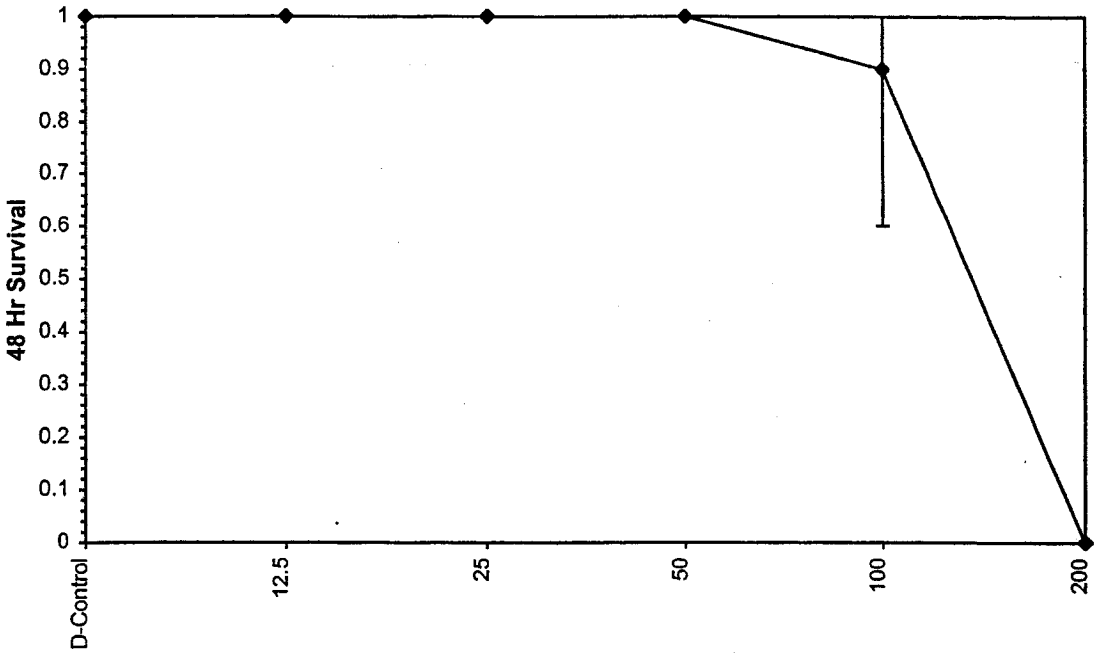
ToxCalc v5.0.23

Reviewed by:

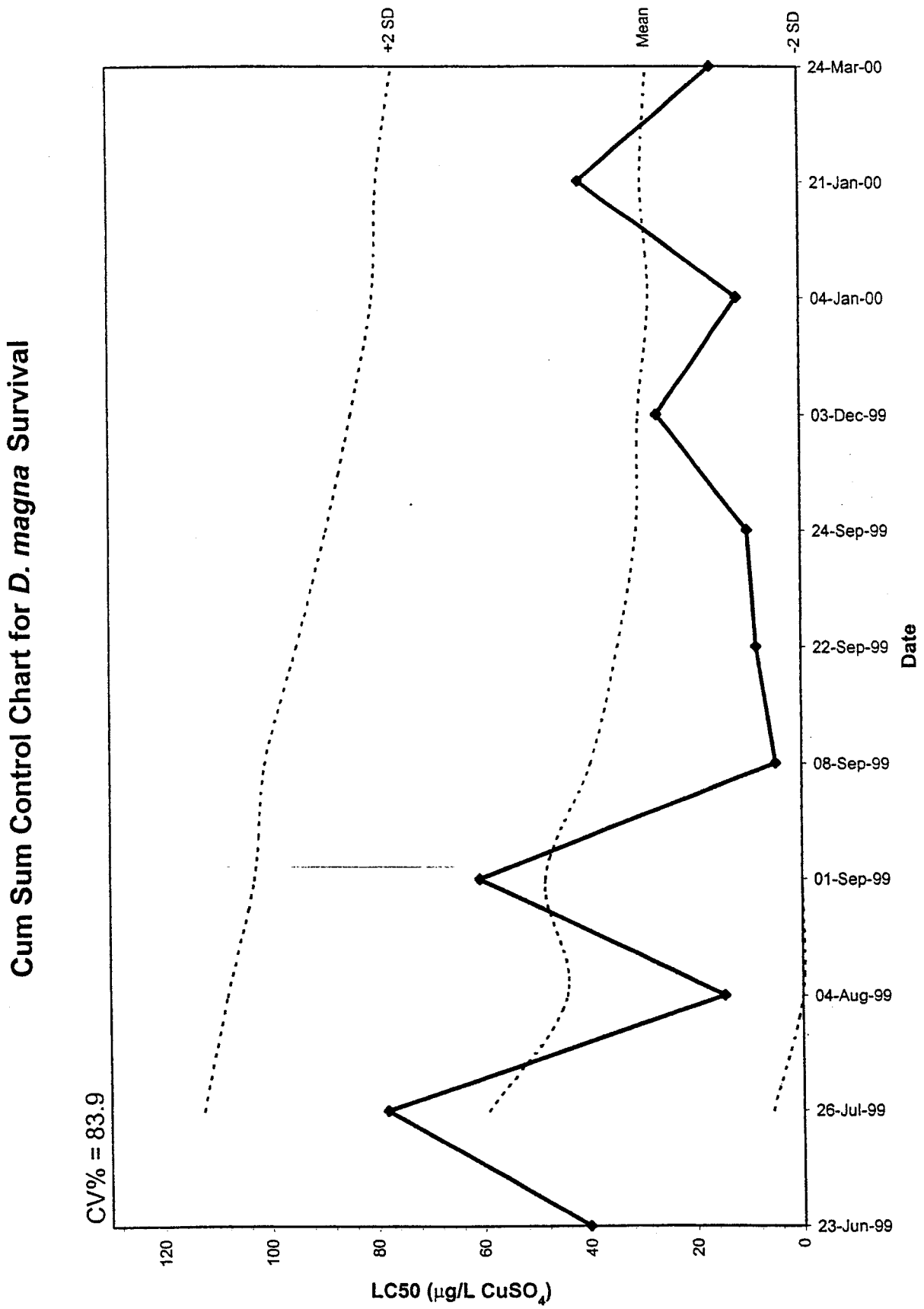
Acute Daphid-48 Hr Survival

Start Date:	04/15/2000 14:45	Test ID:	2863	Sample ID:	WA0024651-Port of Seattle
End Date:	04/17/2000	Lab ID:	WAPTL-Parametrix Tox Lab	Sample Type:	SRW2-Industrial stormwater
Sample Date:	04/14/2000	Protocol:	EPAA 91-EPA Acute	Test Species:	DM-Daphnia magna
Comments:	POS - Cu in NW Ponds Outlet Water				

Dose-Response Plot



AR 016789


Cum Sum Control Chart for D. magna Survival
+2 SD
Mean
-2 SD
24-Mar-00
21-Jan-00
04-Jan-00
03-Dec-99
24-Sep-99
22-Sep-99
08-Sep-99
01-Sep-99
04-Aug-99
26-Jul-99
23-Jun-99
Date
CV% = 83.9
120
100
80
60
40
20
0
LC50 (µg/L CuSO4)

AR 016790