Local Hazardous Waste Management Program in King County, Washington

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Final Report

The Aquatic Toxicity of Perchloroethylene Dry Cleaning Solvent

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Research Services Team

This report was prepared by the Local Hazardous Waste Management Program in King County (LHWMP), Washington, a coalition of local governments. Our customers are residents, businesses and institutions with small quantities of hazardous wastes. LHWMP's mission is: to protect and enhance public health and environmental quality in King County by reducing the threat posed by the **production**, **use, storage** and **disposal** of hazardous materials.

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ACRONYMS AND ABBREVIATIONS

CAS	Chemical Abstract Service
CFR	Code of Federal Regulations
DW	Dangerous Waste
Ecology	Washington State Department of Ecology
EHW	Extremely Hazardous Waste
GC/MS/EI	Gas chromatography/electron impact mass spectrometry
KCEL	King County Environmental Laboratory
LC_{50}	The median lethal test concentration that kills 50 percent of test organisms
LHWMP	Local Hazardous Waste Management Program in King County
mg/L	Milligrams per liter
MSDS	Material Safety Data Sheet
PERC	Perchloroethylene
ppm	Parts per million
QEL	Quantity exclusion limit
RDL	Reporting Detection Limit
SDS	Safety Data Sheet
U.S. EPA	United States Environmental Protection Agency
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compounds
WAC	Washington Administrative Code

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EXECUTIVE SUMMARY

Perchloroethylene (PERC) is the most frequently used dry cleaning solvent in King County, Washington and nationwide. Although the aquatic toxicity of pure PERC is well-described in the literature, the potency of commercial PERC dry cleaning solvent has not been previously evaluated. Such an assessment is of particular importance in Washington state because the Department of Ecology (Ecology) stipulates that a fish bioassay may be used to designate dangerous wastes according to "state-only" toxicity criteria.

A sample of commercial PERC product (R.R. Street's PerSec®) was evaluated using Ecology's standard fish toxicity test for designating dangerous wastes (i.e., *Part A: Method 80-12*). In addition, a static-renewal fish bioassay was conducted to derive an LC_{50} for this product. (The LC_{50} is defined as the median lethal concentration of solvent that kills 50 percent of the test fish within 96 hours.) The test species for both bioassays was juvenile rainbow trout (*Oncorhynchus mykiss).*

In the standard dangerous waste fish bioassay, the PerSec® killed rainbow trout at a nominal concentration of 100 mg/L but failed to kill fish at 10 mg/L. Consequently, unused or off-specification PerSec® that requires disposal has the waste code WT02 for toxicity criteria in Washington state.

The 96 hour static-renewal test, with five test concentrations, resulted in a 96 hour LC_{50} of 3.61 mg/L for PerSec® (based on the measured PERC concentration in the test vessels). Consequently, PerSec® is more toxic to rainbow trout than two dry cleaning solvent alternatives to PERC that were tested previously using the same methodology: DF2000™ (LC_{50} >5000 mg/L nominal concentration) and Solvon K4™ (LC_{50} = 45.7 mg/L measured concentration). The LC_{50} for PerSec® identified in this study is similar to that derived for PERC in published aquatic toxicity studies.

In conclusion, this study suggests that PERC is the most toxic of the dry cleaning solvents that have been tested in a fish bioassay. Because the still bottoms from PERC machines are more toxic in fish bioassays, other components of PERC still bottoms may act in concert with residual PERC dry cleaning solvent to enhance the toxicity of this waste towards rainbow trout.

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INTRODUCTION

Perchloroethylene in dry cleaning

Worldwide, perchloroethylene (PERC) has been the most frequently used dry cleaning solvent since the 1960s. Although several alternatives are currently available to PERC, this chlorinated hydrocarbon is still regarded as one of the most efficient dry cleaning solvents.[1] PERC is also known as tetrachloroethylene or "PCE". The Chemical Abstract Service (CAS) number is 127-18-4.

In 2010, the Local Hazardous Waste Management Program in King County (LHWMP) conducted a survey of the dry cleaning industry, which revealed that PERC is still the most commonly-used solvent in King County.[2] Sixty-nine percent of survey respondents reported that they used PERC. Although PERC has been the subject of regulatory scrutiny by numerous health and environmental agencies, its use persists in the industry, in part because of its excellent ability to clean fabric without causing shrinkage or wrinkling. In addition, the costs of switching to an alternative solvent are substantial because purchase of a new dry cleaning machine is typically required.

According to the Material Safety Data Sheet (MSDS) for the dry cleaning solvent evaluated in this study (see Appendix A), PERC is a colorless, clear, volatile liquid with a mildly sweet, ethereal odor. The odor threshold is approximately 50 ppm. Solubility in water is reportedly 0.015 g/100g at 25 °C. PERC is non-flammable, having no measurable flash point or flammable limits in air.

Human health effects

The human health effects associated with exposure to PERC have been described previously.[2,3] Most notably, the U.S. EPA recently upgraded its classification of PERC from a "possible" to "probable" human carcinogen.[4] An independent review of the U.S. EPA's assessment by the National Research Council concurred with the new classification.[5] The International Agency for Research on Cancer has considered PERC to be a "probable" human carcinogen since 1995.[6]

Aquatic toxicity

The toxicity of pure PERC towards fish and other aquatic species is well-documented. The MSDS for the dry cleaning solvent evaluated in this study (see Appendix A) states that PERC is "Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment." The acute LC_{50} values described on the MSDS are summarized in Table 1 (note that the units "ppm" and "mg/L" are equivalent). Rainbow trout were more sensitive to PERC than the other species tested, which is consistent with the findings presented in the U.S. EPA report, *Toxicity and Metabolism Studies with EPA Priority Pollutants and Related Chemicals in Freshwater Organisms*.[7]

Table 1. Aquatic toxicity of PERC from product MSDS		
Species	**Test condition**	**LC_{50} (ppm)[a]**
Fathead minnow	Flow-through	18.4
Bluegill	Static	12.9
Rainbow trout	Static	5
Mysid (shrimp)	Static	10.2
Sheepshead minnow	Not specified	29.4 – 52.2
[a] Derived from acute (96 hour) bioassays		

The acute LC_{50} for rainbow trout (*Oncorhynchus mykiss*) reported on this MSDS is consistent with values presented on Safety Data Sheets (SDSs) for PERC from Fisher Scientific (4.73 – 5.27 mg/L)[8] and Sigma-Aldrich (5 mg/L).[9]

A review of the U.S. EPA's ECOTOX database revealed that the LC_{50} values for PERC in rainbow trout ranged from 4.99 to 15 mg/L; the median value was 5.95 mg/L.[10]

Dangerous waste designation

The term "dangerous waste" encompasses federally-regulated "hazardous wastes" and those identified as dangerous waste only by Washington state's regulations.[11] Washington state further divides all federal and state-only dangerous wastes into two categories: DW (Dangerous Waste) and EHW (Extremely Hazardous Waste). Several factors can cause a waste to be regarded as dangerous waste. The definition of hazardous waste, based on the Resource Conversation and Recovery Act (RCRA), is presented in Title 40 of the Code of Federal Regulations (CFR), Part 261 and is incorporated into Washington State Code (WAC) Title 173 Chapter 303 (WAC 173-303). In Washington state, generators must follow these federal rules and additional state-only rules.[11] Washington state's dangerous waste regulations are more stringent than the federal hazardous waste rules, and include "state-only" toxicity and persistence criteria.

Generators must determine whether their wastes are dangerous wastes as described in WAC 173-303-070. If the waste is dangerous waste, it is assigned all appropriate "waste codes", a Quantity Exclusion Limit (QEL), and identified as either DW or EHW. Wastes may be evaluated for "state-only" toxicity using Ecology's *Biological Testing Methods for the Designation of Dangerous Waste*.[12] Specifically, *Part A: Method 80-12* involves exposing juvenile rainbow trout to a test substance for 96 hours at two concentrations (100 mg/L and 10 mg/L) in a non-renewal static acute fish toxicity bioassay.

Rationale for the current study

A previous evaluation of PERC still bottom wastes according to *Part A: Method 80-12* revealed that three of four samples were DW (waste code WT02) and a fourth sample was EHW (waste code WT01).[13] However, the contribution of residual PERC to the toxicity of this chemically-complex waste is unclear. Consequently, we considered it important to evaluate the potency of a typical PERC dry cleaning solvent product in fish bioassays.

The goal of this study was to 1) evaluate a commercial PERC dry cleaning solvent in Ecology's standard fish toxicity test for designating dangerous wastes (i.e., *Part A: Method 80-12*) and 2) derive an LC_{50} for this product in a 96 hour static-renewal fish bioassay.

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METHODS

Sample collection and storage

A sample of R.R. Street's PerSec® dry cleaning solvent was collected from a local supply company on June 25th, 2015. The solvent was contained in a sealed 30-gallon drum that is used to distribute the product via R.R. Street's CARE*fill*™ delivery system (lot number *53130*). A hose was attached to the valve located on the top of the drum and the solvent was pumped into pre-cleaned 250 ml-capacity I-CHEM jars (see Figure 1). The LHWMP-assigned sample number was *SW062515-P01*.

Figure 1. Collecting the sample of PERC dry cleaning solvent

The filled containers were placed on freezer blocks in a cooler and delivered to the LHWMP laboratory for storage at 4 °C. A 40-ml aliquot was subsequently transferred to a 40-ml capacity VOA vial and delivered to the King County Environmental Laboratory (KCEL) on June 29th, 2015. The sample container was refrigerated in the dark at 4 ± 2.0 °C until test initiation. Copies of the chain-of custody forms are included in Appendices B and C.

According to the MSDS for PerSec® (presented in Appendix A), this dry cleaning solvent is comprised of >99% PERC. Therefore, for the purpose of this investigation, PerSec® was assumed to be 100% PERC.

Method 80-12 fish bioassay

In January 2016, LHWMP and KCEL conducted a fish toxicity test on a sample of PerSec® according to Ecology's *Biological Testing Methods for the Designation of Dangerous Waste*.[12] This test involved exposing juvenile rainbow trout (*Oncorhynchus mykiss*) to PerSec® for 96 hours at two concentrations (100 mg/L and 10 mg/L nominal concentrations) in a non-renewal static acute fish toxicity bioassay (i.e., Part A: *Method 80-12*). Complete methodological details are provided in KCEL's report, which is provided in Appendix B.

The results of the fish bioassay were evaluated according to the criteria presented in Table 2.

Table 2. Evaluation criteria for the Method 80-12 fish bioassay

Survival at 10 mg/L	Survival at 100 mg/L	Waste code
100%	100%	None
100%	0%	WT02
0%	0%	WT01

Static renewal acute toxicity test

Between September 21st and September 25th, 2015, testing was conducted using juvenile rainbow trout in a 96-hour static renewal acute toxicity test. The experimental protocol (KCEL Standard Operating Procedure 406v2) was derived from the United States Environmental Protection Agency's (U.S. EPA's) *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms*.[14] This protocol differed from the standard Ecology waste designation method in that six concentrations of PerSec® (five test solutions and one control) were measured analytically and the test solutions were renewed after 48 hours. In addition, test solutions were not extracted overnight.

Complete methodological details are provided in KCEL's report, which is provided in Appendix C.

Briefly, the test was conducted using a serial dilution of PerSec® with nominal concentrations of 0 (control), 33, 50, 75, 113, and 170 mg/L. Ten rainbow trout were placed randomly into each test jar; duplicates were prepared at each test concentration. After 48 hours, fish were transferred to vessels containing new test solution (i.e., "renewal").

Samples of test solution were collected for chemical analysis for a suite of volatile organic compounds (VOCs), including PERC, at 0, 24 hours (before 48 hour renewal),

and 96 hours (after 48 hour renewal renewal). Note that samples were not collected after 24 hours at test concentrations that resulted in 100% mortality.

Survival was monitored during the test and recorded at 0, 24, 48, 72, and 96 hours. Dissolved oxygen, temperature and pH were recorded for the samples and controls at 0, 24, 48, 72 and 96 hours.

Chemical analysis of test water samples

All organic analyses were conducted by KCEL staff. Samples were analyzed for volatile organics by gas chromatography/electron impact mass spectrometry (GC/MS/EI) via purge-and trap using EPA Method 5030. Analytical details are provided in Appendix C.

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RESULTS

Method 80-12 fish bioassay

PerSec® elicited 0% survival in rainbow trout at a nominal concentration of 100 mg/L and 100% survival at 10 mg/L. Consequently, unused or off-specification PerSec® has the waste code WT02 for Washington state toxicity criteria.

Static renewal fish bioassay

As shown in Table 3, by 24 hours there was 0% survival at nominal PERC concentrations of 75, 113 and 170 mg/L. At 96 hours, survival at nominal concentrations of 0, 33, and 50 mg/L was 100, 90, and 95%, respectively.

Table 3. Fish toxicity testing results for PERC solvent

Nominal Conc. (mg/L)	Measured Conc. (mg/L) at 0 h	Measured Conc. (mg/L) at 24/96 h	Percent Fish Survival				Percent Fish Survival at Test End
			0 h	24 h	48 h	96 h	
0	<RDL	<RDL[a]	100	100	100	100	100
33	0.813	1.78[a]	100	100	90	90	90
50	0.770	3.2[a]	100	100	95	95	95
75	1.63	4.17[b]	100	0	0	0	0
113	2.34	5.4[b]	100	0	0	0	0
170	2.45	5.36[b]	100	0	0	0	0

RDL = Reporting Detection Limit for PERC – 0.002 mg/L in the control; 0.05-0.2 mg/L in the test solutions.
[a] Sample collected at 96 h
[b] Sample collected at 24 h

Chemical analysis of the test solutions at test initiation (i.e., t = 0 hours) revealed that the measured concentrations were 1.4 to 2.5 percent of the nominal concentrations. The measured PERC concentration increased up to four-fold over the test period (24 hours or 96 hours). This finding is consistent with the observation that the PERC formed an immiscible layer at the bottom of the test vessel, where it likely dissolved into the test solution over the course of the experiment. The limit of PERC's solubility in 12 °C well-water was reached at a nominal concentration of 113 mg/L, where the measured concentration was 2.34 mg/L (the measured concentration at 170 mg/L was 2.45 mg/L).

An LC_{50} was calculated using Comprehensive Environmental Toxicity Information System (CETIS^{TM}) software, version 1.8.7 (Endpoint: 96 h survival rate; Analysis: Trimmed Spearman-Kärber). The LC_{50} was 3.61 mg/L; the lower-and upper-95 percent confidence limits on the LC_{50} were 3.55 and 3.68 mg/L, respectively.

Note that because the PERC concentrations increased over time, the LC_{50} was calculated from the measured concentrations at the end of the respective exposure period (i.e., 24 or 96 hours, depending on the concentration), rather than at test initiation (t = 0 hours). In addition, the 170 mg/L nominal concentration was excluded from the calculation because the limit of PERC's solubility was reached at 113 mg/L.

With a single exception, no other VOCs were present above their respective RDLs in any samples. (RDLs ranged from 0.002 to 0.01 mg/L in the controls and from 0.05 to 1.0 mg/L in the test solutions.) Acetone was detected at 0.0044 mg/L in one control sample and was likely a laboratory contaminant.

Dangerous waste designation

Based on our knowledge of this solvent, in addition to WT02, other applicable waste codes are U210, D039, and WP01. Consequently, the waste is EHW and the QEL is 220 pounds per month.

CONCLUSIONS

The results of the Method 80-12 fish bioassay suggest that unused or off-specification PERC dry cleaning solvent that requires disposal would be assigned waste code WT02. Additional knowledge of this waste suggests that the waste codes U210, D039, and WP01 also apply. Consequently, the waste is EHW with a QEL of 220 pounds per month.

The LC_{50} derived for PerSec® in this study (3.6 mg/L) is consistent with published toxicity data for perchloroethylene.

In collaboration with KCEL, LHWMP has also evaluated the aquatic toxicity of two additional dry cleaning solvents: Solvon K4™ and DF-2000™. The LC_{50} for Solvon K4™ was a measured concentration of 45.7 mg/L;[15] an LC_{50} for DF-2000™ could not be derived because this solvent failed to kill fish at the highest nominal test concentration of 5000 mg/L.[16] Consequently, this study confirms that the potency of unused dry cleaning solvent products towards rainbow trout is: PERC > Solvon K4™ > DF-2000™.

In conclusion, this study suggests that PERC is the most toxic of the dry cleaning solvents that have been tested in a fish bioassay. Because the still bottoms from PERC machines are more toxic in fish bioassays, other components of PERC still bottoms may act in concert with residual PERC dry cleaning solvent to enhance the toxicity of this waste towards rainbow trout.

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Jeffrey Gutschmidt (Ecology) reviewed this document for consistency with Washington state's dangerous waste regulations.

Alice Chapman, PE (Engineer, LHWMP) provided a detailed technical review of this document.

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APPENDIX A:

MATERIAL SAFETY DATA SHEET FOR PERSEC®

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MATERIAL SAFETY DATA SHEET

Date Issued: 06/10/2005
PerSec

SECTION 1 CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME

PerSec

MANUFACTURER

R. R. Street & Co. Inc.
184 Shuman Boulevard
Naperville, IL 60563

Product Information: 800-323-7206 (USA & Canada only) **or** 630-416-4244

24 HR. EMERGENCY TELEPHONE NUMBERS

Medical Emergency: 866-303-6947 (USA & Canada only) **or** 651-632-9272

Transportation Emergency: 800-424-9300 (USA & Canada only) **or** 703-527-3887

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS#	% RANGE
Perchloroethylene, stabilized	127-18-4	>99

Perchloroethylene is a chemical subject to reporting requirements of Section 313 of Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA) and 40 CFR part 372.

SECTION 3 HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Harmful by inhalation. High exposures by inhalation will cause anesthetic effects. This may result in loss of consciousness and could prove fatal if exposure has been severe.

May be harmful if ingested. Large amounts may cause internal irritation, nausea, vomiting and may lead to drowsiness and unconsciousness. This material can get into the lungs during swallowing or vomiting. Small amounts in the lungs may cause lung damage, possibly leading to death.

Repeated and/or prolonged skin contact may cause reddening, burning and blisters. Repeated exposure to levels well above the occupational exposure limit may produce adverse effects on the liver and kidneys.

Perchloroethylene has been shown to cause cancer in rodents. While human data are limited and inconclusive, and have not established an association between perchloroethylene exposure and cancer, perchloroethylene should be considered to pose a cancer risk pending the availability of further scientific evidence.

Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Perchloroethylene released into the environment through spills or through improper handling, storage or disposal of drycleaning process wastes containing perchloroethylene can cause contamination. Such contamination may require expensive remediation under Federal, state or local laws.

POTENTIAL HEALTH EFFECTS

INHALATION

In susceptible individuals, cardiac sensitization to circulating epinephrine-like compounds can result in sudden, fatal cardiac arrhythmias. In confined or poorly ventilated areas vapors can readily accumulate and can cause unconsciousness and death. Dizziness may occur at 200 ppm perchloroethylene; progressively higher levels may also cause nasal irritation, nausea, incoordination, drunkenness; and over 1000 ppm, unconsciousness and death. A single brief (minutes) inhalation exposure to levels above 6000 ppm perchloroethylene may be immediately fatal. Based on structural analogy and/or equivocal data in animals, excessive exposure may potentially increase sensitivity to epinephrine and increase myocardial irritability (irregular heartbeats).

SKIN

Irritating to skin. Will remove the natural skin oils resulting in dryness, cracking and dermatitis. Repeated and/or prolonged skin contact may cause reddening, burning and blisters. Permanent damage is unlikely. Can be absorbed through skin but not in sufficient amounts to cause adverse effects.

EYE

Liquid splashes and high concentrations of vapor may cause irritation with tearing, redness, or a stinging or burning feeling. Effects may become more serious with repeated or prolonged contact.

INGESTION

The swallowing of small amounts is unlikely to cause any adverse effects. Large amounts may cause internal irritation, nausea, vomiting and may lead to drowsiness and unconsciousness. This material can get into the lungs during swallowing or vomiting. Small amounts in the lungs may cause lung damage, possibly leading to death.

SIGNS AND SYMPTOMS OF EXPOSURE

Depending upon level and duration of exposure, other possible signs and symptoms from breathing, swallowing, and/or entry of this material though the skin may include: irritation of the nose, throat, airways, and lungs with cough, stomach or intestinal upset with pain, nausea, vomiting, and/or diarrhea, central nervous system depression with nausea, headache, dizziness, fatigue, drowsiness, or unconsciousness, anesthesia, confusion, temporary changes in mood or behavior, irregular heartbeats (which may lead to loss of consciousness and death) and visual disturbances.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE

Preexisting disorders of the following organs or systems which may be aggravated by exposure to this material include: liver, kidney, heart, and nervous system.

INTERACTIONS WITH OTHER CHEMICALS WHICH ENHANCE TOXICITY

Consumption of alcoholic beverages may increase potential for development of toxic effects resulting from exposure to this product.

EFFECTS FOLLOWING REPEATED EXPOSURE

This material may cause the following effects: lung damage, nervous system effects, liver damage, kidney damage, and skin effects. Observations in animal studies include: endocrine system effects, immune system effects, and blood disorders. The relevance of these observations to humans is not clear at this time.

CHRONIC EFFECTS

Repeated exposure to levels well above the occupational exposure limit may produce adverse effects on the lungs, liver, kidneys and skin. Observations in animal studies include: endocrine system effects, immune system effects, and blood disorders. The relevance of these observations to humans is not clear at this time. Perchloroethylene has been associated with cancer in rodents. Extensive evaluations of possible mechanisms have led to the conclusion that they are of little, if any, relevance to man even at high exposure levels.

CARCINOGENICITY

Perchloroethylene is listed on the IARC and NTP carcinogen lists. See Section 11 for additional information.

For hazard communication purposes under OSHA Standard 29 CFR Part 1910.1200, this chemical is listed as a potential carcinogen by IARC and NTP. Perchloroethylene has been shown to increase the incidence of tumors in certain strains of mice and rats. Other long-term inhalation studies in rats failed to show tumorigenic response. Human data are limited and have not established an association between perchloroethylene exposure and cancer. While perchloroethylene is not believed to pose a measurable carcinogenic risk to man when handled as recommended, perchloroethylene should be considered to pose a cancer risk pending the availability of further scientific evidence.

MUTAGENICITY

See Section 11 for additional toxicological information

SECTION 4 FIRST AID MEASURES

INHALATION

Remove individual to fresh air and get immediate medical attention. DO NOT walk patient about. Keep warm and at rest. If breathing is difficult, give oxygen. If breathing stops or shows signs of failing, give artificial respiration. During resuscitation, care must be taken to avoid contamination by the substance from the patient.

SKIN

Wash exposed skin well with plenty of soap and water. Remove contaminated clothing and shoes. Wash clothing and thoroughly clean shoes before reuse. If symptoms develop get medical attention.

EYES

Hold the eyelids apart and flush the eye gently with eyewash solution or a large amount of water. After initial flushing remove any contact lenses and continue flushing for at least 15 minutes. Get medical attention if irritation persists or if there are any effects on vision.

INGESTION

Do not induce vomiting --- this material is an aspiration hazard. Provided the patient is conscious, wash out mouth with water and give 8 fluid ounces (200 or 300 mL) of water to drink. Get immediate medical attention. Never give anything by mouth to an unconscious person.

NOTES TO PHYSICIAN

This material is an aspiration hazard. Risk of aspiration must be weighted against possible toxicity of the material (see “ingestion”) when determining whether to induce emesis or to perform gastric lavage. Gastric lavage may be effective and should preferably be undertaken within 1 hour. This material sensitizes the heart to the effects of sympathomimetic amines. Adrenaline, epinephrine and similar sympathomimetic drugs should be avoided following exposure as cardiac arrhythmia may result with possible subsequent cardiac arrest. Following ingestion adsorbents such as activated charcoal may be of value.

SECTION 5 FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES

FLASH POINT

None (TCC, TOC, COC).

AUTOIGNITION TEMPERATURE

None.

FLAMMABLE LIMITS IN AIR (PERCENT BY VOLUME)

None.

HAZARDOUS COMBUSTION PRODUCTS

Hydrogen chloride, phosgene, chlorine.

EXTINGUISHING MEDIA

Nonflammable, use agent suitable for surrounding fire.

Keep fire exposed containers cool by spraying with water.

FIRE FIGHTING INSTRUCTIONS

Approach fire from upwind to avoid hazardous vapors and toxic decomposition products. Use flooding quantities of water as fog or spray to keep fire-exposed containers of perchloroethylene cool. Containers may burst if overheated. Firefighters should wear self-contained, positive-pressure breathing apparatus and full protective clothing.

Contain fire water run-off if possible. Fire water run-off, if not contained may cause environmental contamination.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Evacuate the area, ventilate, and avoid breathing vapors. If spill occurs indoors, turn off heating and/or air conditioning systems to prevent vapors from contaminating entire building. Provided it is safe to do so, dike area to contain spill. Ensure suitable personal protection (including respiratory protection) during removal of spills.

Small spills: Absorb spills onto absorbent material. Transfer to a container for disposal or recovery.

Large spills: Contain spills. Transfer to properly labeled closed metal containers. Do not allow to enter drains, sewers, ground water or waterways. Material is heavier than water and has limited water solubility. It will collect on the lowest surface.

All spills or leaks of this material must be handled and disposed of in accordance with Federal, state, and local regulations.

Notify National Response Center (800/424-8802), and any state and local agencies as applicable, of uncontained releases to the environment in excess of the EPA Reportable Quantity (RQ). See Section 15 for regulatory information.

For all transportation accidents, call CHEMTREC at 800/424-9300.

SECTION 7 HANDLING AND STORAGE OF PERCHLOROETHYLENE

HANDLING

Avoid contact with eyes, skin and clothing. Do not breathe vapor. Do not taste or swallow. Do not eat, drink or smoke in work area. Wash hands prior to eating, drinking, or using restroom. Any clothing or shoes that become contaminated with perchloroethylene should be removed immediately and thoroughly cleaned before wearing again.

Carefully monitor handling, use and storage to avoid spills and leaks. Follow protective controls set forth in Section 8 when handling this product. Do not use in poorly ventilated or confined spaces. The vapor is heavier than air and may reach dangerously high concentrations in tanks, and other confined spaces. Do not enter confined spaces without following proper entry procedures as required by 29 CFR 1910.46

Avoid contact with open flames and hot surfaces as toxic and corrosive decomposition products (hydrogen chloride) can be formed.

To avoid uncontrolled emissions vent vapor from container to storage tank. Containers, even those that have been emptied, can contain vapors. Do not cut, drill, grind, weld, or perform similar operations on or near empty containers.

STORAGE AND DELIVERY

PerSec perchloroethylene is sold and is to be delivered only in sealed CARE*fill*™ drums, and introduced into the drycleaning machine via the CARE*fill* closed loop delivery system and custom fittings installed on the drycleaning machine.

Store labeled, sealed drums in a cool, dry, well-ventilated area away from direct sunlight or ultraviolet sources, and sources of ignition. Keep drums tightly closed when not in use. Do not store in open, unlabeled or mislabeled drums. Do not remove or deface label. Do not allow water or moist air to enter storage tanks or drums.

Empty CARE*fill* drums must not be reused or refilled except by R. R. Street & Co. Inc.'s authorized filling facilities. Do not use cutting or welding torches, open flames, or electric arcs on empty or full containers.

Do not use aluminum or its alloys in the construction of storage vessels, pipe work and ancillary equipment including internal components, e.g. pump impellers. Use of galvanized components should be avoided because of the risk of producing highly toxic dichloroacetylene.

SHELF LIFE LIMITATIONS

Perchloroethylene has an indefinite shelf life when stored under recommended conditions.

SECTION 8 EXPOSURE CONTROLS AND PERSONAL PROTECTION

ENGINEERING CONTROLS

VENTILATION

Do not use in poorly ventilated or confined spaces. Open doors and/or windows. Use ventilation to maintain exposure levels below 25 ppm time-weighted average (TWA). Lethal concentrations may exist in areas with poor ventilation.

Monitoring should be performed regularly to determine exposure level(s). See Exposure Guidelines below.

PERSONAL PROTECTIVE EQUIPMENT

EYE AND FACE PROTECTION

Wear safety glasses. Contact lenses should not be worn without chemical goggles or safety glasses with side shields. Facial protection, such as chemical goggles and face shields, should be worn where splashing is possible. If vapor exposure causes eye discomfort, use a full-face respirator.

SKIN PROTECTION

Wear solvent-resistant gloves such as Viton or equivalent. Solvent-resistant boots, aprons and facial protection should be worn where splashing is possible.

RESPIRATORY PROTECTION

Where vapor concentration exceeds or is likely to exceed 25 ppm, a NIOSH approved organic vapor type half-mask respirator is acceptable. A NIOSH approved self-contained breathing apparatus or airline respirator, with full-facepiece, is required for vapor concentrations above 150 ppm and for spills and/or emergencies. Follow any applicable respirator use standards or regulations.

GENERAL

Safety shower and eyewash station should be available. Protective equipment and clothing should be selected, used, and maintained according to applicable standards and regulations. For further information contact the clothing or equipment manufacturer.

EXPOSURE GUIDELINES

ACGIH: 25 ppm TWA (8 hr), 100 ppm 15 min STEL A3

(Based on irritation and CNS effects)

OSHA PEL: 25 ppm TWA (8 hr)

PELs are in accord with those recommended by OSHA, as in the 1989 revision of PELs.

ACGIH Biological Exposure Indices:

Exhaled Air: 5 ppm, Blood: 0.5 mg/L,
Urine: 3.5 mg/L

IMMEDIATELY DANGEROUS TO LIFE OR HEALTH

150 ppm

ODOR THRESHOLD

Odor threshold is approximately 50 ppm. May cause olfactory fatigue (temporary loss of odor perception for this product).

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE AND ODOR

Colorless, clear, volatile liquid, mildly sweet, ethereal odor

SPECIFIC GRAVITY

1.623 (20°C/20°C)

VAPOR PRESSURE

14.7 mm Hg @ 20°C

VOLATILES, PERCENT BY VOLUME

100

BOILING POINT

250°F (121.1°C)

VAPOR DENSITY

5.83 (Air = 1) at 74°C

EVAPORATION RATE

(ether = 1): 0.1

SOLUBILITY IN WATER

0.015 gm/100gm @ 25°C

SOLUBILITY (OTHER)

Miscible with most organic solvents

MELTING POINT

-22.4°C

SECTION 10 STABILITY AND REACTIVITY

CHEMICAL STABILITY

Stable under recommended conditions.

CONDITIONS TO AVOID

Avoid contact with open flame, welding arcs, electric arcs, or other hot surfaces that may cause thermal decomposition.

INCOMPATIBILITY WITH OTHER MATERIALS

May react violently with metals such as sodium, potassium, magnesium, zinc, lithium, barium, strong bases, and strong oxidizers, particularly if they are finely divided. May react with freshly galvanized surfaces to produce highly toxic dichloroacetylene. Avoid unintended contact with amines. Avoid prolonged contact with or storage in aluminum or its alloys.

HAZARDOUS DECOMPOSITION PRODUCTS

Contact with red hot surfaces, sparks or open flames may generate toxic fumes of hydrogen chloride, phosgene and chlorine.

HAZARDOUS POLYMERIZATION

Will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

ANIMAL TOXICOLOGY

Inhalation LC_{50}: 34, 200 mg/m^3 – 8 hours (rat)

Dermal LD_{50}: >3,228 mg/kg (rabbit)

Oral LD_{50}: >2,629 mg/kg (rat)

ACUTE TOXICITY

Exposure to 100-200 ppm has been reported to cause irritation to the eyes, throat and nose, headache, light-headedness, and dizziness after several hours exposure. Exposure to concentrations of the order of 500 ppm for short periods of time (e.g. 5 minutes) may lead to lightheadedness or dizziness. Exposure to levels of 1000 ppm or higher may cause intense respiratory irritation and anesthetic effects. Exposure to high concentrations or prolonged over-exposure (500 ppm or greater) has caused unconsciousness and death. Deaths are generally attributed to ventricular fibrillation and central nervous system depression. Liver and kidney damage have been reported in cases of accidental excessive overexposure to perchloroethylene. Acute and short-term over-exposure to perchloroethylene has been associated with changes in electroencephalographic scores.

EFFECTS OF FOLLOWING PROLONGED OR REPEATED EXPOSURE

Immunological effects related specifically to perchloroethylene exposure have not been reported in humans. One study, severely limited by technical deficiencies, suggests an association between long-term exposure to solvent-contaminated well water, and changes in immune parameters, and increased infections. The well water was also contaminated with other chemicals in addition to perchloroethylene. Enhanced susceptibility to infection was reported in one animal study but this study was compromised by high mortality among control animals. Other studies have not shown adverse effects on the immune system in animals exposed to perchloroethylene.

A study of human volunteers associated repeated exposure to 100 ppm perchloroethylene with changes in electroencephalographic scores. Some studies have associated repeated exposure with changes in visual-evoked potential and changes in color vision. Overall, studies in dry cleaning workers have not shown evidence of adverse effects on the nervous system. Several studies suggestive of adverse neurological effects in dry cleaning workers were limited by small group size, as well as biased and subjective measurement methods. In view of these shortcomings the significance of these observations is questionable.

One animal study associated perchloroethylene exposure with increased latency in visual-evoked potential. Findings from animal studies have shown alterations in the biochemistry of some neurological tissues following repeated exposure but no evidence of pathology (brain lesions). The relevance of these observations to humans is not clear at this time.

Repeated exposure to levels well above the occupational exposure limit may produce adverse effects on the liver and kidneys. Exposure to perchloroethylene has been associated with changes in urinary and serum indicators of renal function and liver function. Findings from animal studies indicate the liver and kidney are target organs. Elevated prolactin levels were reported in some female workers exposed to perchloroethylene but these levels were within the normal clinical range. It is unlikely that these observations are biologically relevant. Changes in some blood parameters and evidence of reduced erythropoiesis have been observed in subchronic animal studies. Forestomach ulcers were observed in one animal study following prolonged exposure to perchloroethylene. Adrenal gland hyperplasia was observed in one animal study following prolonged exposure to perchloroethylene. Other animal studies indicated no evidence of adverse effects on the blood, stomach or adrenal glands.

CARCINOGENICITY

An increased incidence of some forms of cancers have been observed in various epidemiology studies of workers in the dry cleaning industry and other workers potentially exposed to chemicals including perchloroethylene. Smoking, alcohol consumption, diet and other factors are known to increase the risk of cancer and may have been confounding factors in these studies. These studies were also limited by the lack of exposure measurements or other valid indicators of potential exposure to perchloroethylene, and potential exposure to other chemicals. The current epidemiological evidence does not support a conclusion that occupational exposure to perchloroethylene is a risk factor for cancer of any specific site.

Animal studies have shown increases in liver cancer in mice, and renal cancer and mononuclear cell leukemia in rats. The relevance of these observations to humans is not clear at this time.

The International Agency for Research on Cancer (IARC) has concluded there is sufficient evidence of carcinogenicity to experimental animals and limited evidence of carcinogenicity to humans (Group 2A a substance probably carcinogenic to humans). NTP has classified perchloroethylene as reasonable anticipated to be a human carcinogen. The ACGIH classifies perchloroethylene in category A3 – Confirmed Animal Carcinogen with Unknown Relevance to Humans.

GENOTOXICITY

A few tests have shown positive findings, but the overall weight of evidence indicates that perchloroethylene is not mutagenic or genotoxic.

REPRODUCTIVE TOXICITY

One study reported a slight increase in miscarriages for operators of dry cleaning equipment but study authors concluded the increased miscarriages could not be specifically attributed to perchloroethylene exposure. Occupational exposure to perchloroethylene has been associated with taking slightly longer for women to become pregnant and with menstrual disorders. These studies were limited by other potential risk factors and small sample size. Other studies have not found an association between miscarriages and exposure to perchloroethylene. One study suggested that it may take slightly longer for wives of laundry and dry cleaning workers to become pregnant. Sample size for this study was very small and most of the workers were not exposed to perchloroethylene. Animal studies have not shown evidence of adverse effect on reproductive parameters following repeated exposure to perchloroethylene levels up to 300 ppm.

DEVELOPMENTAL EFFECTS

Increased resorptions, minor skeletal anomalies and subcutaneous edema have been reported in rodent studies. Hyperactivity was observed in adult mice exposed to perchloroethylene *in utero*. Findings from animal studies indicate perchloroethylene is not teratogenic.

SECTION 12 ECOLOGICAL INFORMATION

ENVIRONMENTAL FATE

Water: Persists in ground water, but slow biodegradation may occur in groundwater where acclimated populations of microorganisms exist. Perchloroethylene does not significantly bioconcentrate in aquatic organisms or adsorb to sediment. Perchloroethylene in water is subject to volatilization, with half-life estimates ranging from less than one day to several weeks.

Bioconcentration factor (BCF) is 38.9 in trout.

Octanol/Water Partition Coefficient (log K_{OW}) is 2.88.

Henry's Law Constant (H) is 1.49E-02 atm-m3/mol.

Log air/water partition coefficient (log Kaw) is estimated to be -0.30 to 0.37.

Soil: Perchloroethylene can leach rapidly through soil to reach groundwater. Soil adsorption potential is low. Will not significantly hydrolyze in soil or water under normal environmental conditions. Potential for mobility in soil is medium (Koc between 150 and 500). Log soil organic carbon partition coefficient (log Koc) is estimated to be 2.1-3.2.

Air: The substance is degraded fairly rapidly in the lower atmosphere (troposphere). Vapors in air are subject to photooxidation, but do not contribute to tropospheric ozone formation. Half-life estimates ranges from 2 months to less than 1 hour. Does not deplete ozone layer (stratosphere).

ENVIRONMENTAL CONTAMINATION

Perchloroethylene released into the environment through spills or through improper handling, storage or disposal of drycleaning process wastes containing perchloroethylene can cause contamination. Such contamination may require expensive remediation under Federal, state or local laws.

ECOTOXICITY

Biodegradation under aerobic conditions is below detectable limits. Theoretical oxygen demand (ThOD) is calculated to be 0.19 p/p. Biodegradation may occur under anaerobic conditions (in the absence of oxygen). Degradation is expected in the atmospheric environment within days to weeks. Biodegradation rate may increase in soil and/or water with acclimation.

Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Acute LC_{50} (96 Hours, flow-through) for Fathead Minnow:	18.4 ppm
Acute LC_{50} (96 Hours, static) for Bluegill:	12.9 ppm
Acute LC_{50} (96 Hours, static) for Rainbow Trout:	5 ppm
Acute LC_{50} (96 Hours, static) for Mysid:	10.2 ppm
Acute LC_{50} (96 Hours) for Sheepshead Minnow:	29.4 – 52.2 ppm

EFFECT ON EFFLUENT TREATMENT

The product is anticipated to be substantially removed in biological treatment processes.

SECTION 13 DISPOSAL CONSIDERATIONS

Drycleaning equipment using perchloroethylene generates process waste streams that contain perchloroethylene thereby rendering them hazardous wastes under various Federal, state and local laws. These hazardous wastes include but are not limited to spent filter cartridges, filter powder, distillation residues and contact water.

All disposals of these wastes must be done in accordance with Federal, state and local regulations. Regulations may vary in different locations. Waste characterization and compliance with disposal regulations are the responsibilities of the waste generator. However, in no event should these hazardous wastes be placed onto land or into drains, sewers or septic tank systems.

RESIDUES OF PERCHLOROETHYLENE SPILLS

Transfer solvent residues to a labeled, sealed container for disposal or recovery. Solvent residues must not be allowed to enter drains, sewers, or watercourses or to contaminate the ground. Recovered liquids may be sent to an EPA permitted reclaimer or incineration facility. Contaminated material must be disposed of in a permitted waste management facility.

SECTION 14 TRANSPORT INFORMATION

DOT/TDG IDENTIFICATION NO.

UN 1897

DOT/TDG SHIPPING DESCRIPTION (49 CFR 172.101)

Tetrachloroethylene, 6.1, UN 1897, PG III, RQ, Marine Pollutant

HAZARDOUS SUBSTANCES (RQ) 100 lbs / 45.4 kg

PLACARD

POISON, 1897, Class 6.1

LABEL REQUIRED

POISON, Class 6

Label as required by OSHA Hazard Communication Standard and any applicable state and local regulations.

AIR

ICAO/IATA
primary: 6.1
Packing group Air: III

SEA

IMO Requirements
EmS No.: 6.1-02
IMDG
primary: 6.1
Marine Pollutant: Classified as a Marine Pollutant (P)
U.N. Packing group Sea: III
Proper Shipping Name: Tetrachloroethylene

ROAD/RAIL

ADR/RID Class: 6.1
ADR Sin: 1897

SECTION 15 REGULATORY INFORMATION (Not meant to be all-inclusive—selected regulations represented)

NOTICE: The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations. See other sections for health and safety information.

U S FEDERAL REGULATIONS

CERCLA REPORTABLE QUANTITY (RQ)

This material is listed in Table 302.4 of 40 CFR Part 302 as a hazardous substance with a Reportable Quantity of 100 lbs. Releases to air, land or water which exceed the RQ must be reported to the National Response Center, 800-424-8802.

TOXIC SUBSTANCES CONTROL ACT

Listed on TSCA Inventory

SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) TITLE III

Perchloroethylene is subject to the reporting requirements of Section 313 of Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA) and 40 CFR Part 372.

SARA HAZARD CATEGORIES SECTIONS 311/312(40 CFR 370.2)

HEALTH: Immediate Health, Delayed Health

OSHA HAZARD COMMUNICATION STANDARD

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

INTERNATIONAL REGULATIONS

CANADA

WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS) CLASSIFICATION

WHMIS Classifications applicable to this product:

D-1B (Toxic Material causing immediate and serious toxic effects) based on assignment to TDG Class 6.1, PG III

D-2A (Very Toxic Material causing other toxic effects) based on classification as 2A carcinogen by IARC

D-2B (Eye or Skin Irritant)

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA)

ALL COMPONENTS OF THIS PRODUCT ARE ON THE DOMESTIC SUBSTANCES LIST (DSL).

HAZARDOUS PRODUCTS ACT

This product has been classified in accordance with the hazard criteria of the Canadian Controlled Products Regulations (CPR) and this MSDS (Material Safety Data Sheet) contains all the information required by the CPR.

EUROPE

EINECS No.: 204-825-9

INVENTORY STATUS

United States, Australia, Canada, China, EU, Korea, Philippines

STATE REGULATIONS

CALIFORNIA PROPOSITION 65

The State of California has listed perchloroethylene under Proposition 65 as a chemical known to the state to cause cancer.

STATE RIGHT-TO-KNOW: The following product components are cited on certain state lists as mentioned. Non-listed components may be shown in the composition section of the MSDS.

CHEMICAL NAME	CAS NUMBER	LIST
PERCHLOROETHYLENE	000127-18-4	MA NJ1 NJ2 NJ3 PA1 PA2 PA3

MA=Massachusetts Substance List (present at greater than or equal to 1.0%)
NJ1=New Jersey Special Health Hazard Substance (present at greater than or equal to 0.1%).
NJ2=New Jersey Environmental Hazardous Substance (present at greater than or equal to 1.0%).
NJ3=New Jersey Workplace Hazardous Substance (present at greater than or equal to 1.0%).
PA1=Pennsylvania Hazardous Substance (present at greater than or equal to 1.0%).
PA2=Pennsylvania Special Hazardous Substance (present at greater than or equal to 0.01%).
PA3=Pennsylvania Environmental Hazardous Substance (present at greater than or equal to 1.0%).

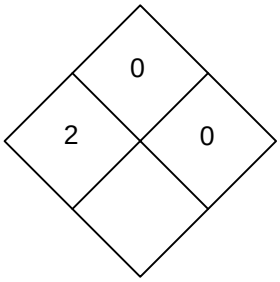
SECTION 16 OTHER INFORMATION

R.R. Street & Co. Inc. only approves the use of this product in professional drycleaning applications where there is no likelihood of:

- soil or ground water contamination (direct applications to the ground, sink drains, sewers, or septic tanks).
- overexposure (small rooms or confined space, or where there would be inadequate ventilation).
- skin contact (adhesive tape removal from skin or as hand cleaner to remove oils and greases).
- direct food contact.
- vapor concentrations in the flammable range.
- disposal of waste that would pose an environmental or health risk.
- chemical reactivity that poses a danger (contact with strong alkali, or in areas where welding is done).

HMIS RATINGS	
HEALTH	3
FLAMMABILITY	0
REACTIVITY	0
PERSONAL PROTECTION	H

NFPA RATINGS



APPENDIX B:

KCEL'S REPORT ON TOXICITY TESTS FOR THE DESIGNATION OF DANGEROUS WASTE (METHOD DOE 80-12) CONDUCTED ON DRY CLEANING SAMPLE OF PERCHLOROETHYLENE SOLVENT

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February 11, 2016

Steve Whittaker
Local Hazardous Waste Management Program
CNK-PH-1100
401 Fifth Avenue, Suite 1100
Seattle, WA 98101-1818

Dear Steve:

Attached is a report on the toxicity test (Method DOE 80-12) initiated on 1-18-16 on Dry Cleaning Sample SW062515_P01 (perchloroethylene solvent).

Detailed findings are in the Results section of the attached report. The table below shows a summary of the test results. Sample SW062515_P01 had 100% mortality in the 100 mg/L test concentration and 100% survival in the 10 mg/L test concentration. Hence, this sample designates as a "Hazardous Waste" according to DOE 80-12 criteria.

Rainbow Trout

Sample	Sample Concentration mg/L	Percent Survival %	Designation	Designation (Yes/No)
SW062515_P01	10	100	Extremely Hazardous Waste	No
	100	0	Dangerous Waste	Yes

Well Water

Due to the Fremont Siphon Construction Project (located adjacent to KCEL) which required the dewatering of the ground water, unexpected impacts to the well water source were observed. The last known hardness of 109 mg/L as $CaCO_3$ was taken in October 2015. Water from the well since that time had not been pumped due to the dewatering efforts of the construction. Therefore, the hardness taken in October was used as an estimate. To keep the hardness within the moderately hard range of 80 - 100 mg/L as $CaCO_3$ the well water was further diluted 20% with DI water. Unexpectedly, the well water hardness had decreased from 109 to 62 mg/L as $CaCO_3$. Therefore, it should be noted that this test was conducted at a different hardness than previous tests.

If you would like additional information, please call Francis Sweeney at 477-7117.

Sincerely,

Gary Yoshida

Gary Yoshida
King County Environmental Laboratory

REPORT ON
TOXICITY TESTS FOR THE
DESIGNATION OF DANGEROUS WASTE
(METHOD DOE 80-12)
CONDUCTED ON DRY CLEANING SAMPLE OF
PERCHLOROETHYLENE SOLVENT

KING COUNTY DEPARTMENT OF NATURAL RESOURCES AND PARKS
WATER AND LAND RESOURCES DIVISION
ENVIRONMENTAL LABORATORY SECTION
322 WEST EWING STREET
SEATTLE, WASHINGTON 98119

Test Date: January 18, 2016
KCEL Test Numbers: #7861 (*Oncorhynchus mykiss*: DOE 80-12, 96-Hour Acute Test)
Report Date: February 11, 2016

SAMPLE

Sample SW062515_P01 was received by the King County Environmental Laboratory (KCEL), Aquatic Toxicology Section on 6-29-15. The sample was collected on 6-25-15 and was delivered in a 40 mL wide mouth glass jar and refrigerated in the dark at 4 ± 2.0°C until test initiation.

CONTROL WATER

The control water for the test with rainbow trout is freshwater obtained from a 95-ft. deep well located at the KCEL. Stock cultures of trout are acclimated in a flow-through system of well water (WW).

The WW was analyzed for metals 1-16 and organics was measured before dewatering (last analyzed on 3-15). Hardness, alkalinity, conductivity and pH are measured at the beginning of each test.

Physical-chemical characteristics of the undiluted WW (taken in January 2016, organics March 2015) are listed in the following table:

Parameter	Value	Units
Conductivity	160	µmhos/cm
pH	7.81	
Total Hardness (calc.)	62	mg/L as $CaCO_3$
Total Alkalinity	54	mg/L as $CaCO_3$
Total Cd	< 2	µg/L
Total Cr	< 3	µg/L
Total Cu	< 4	µg/L
Total Ni	< 5	µg/L
Total Pb	< 20	µg/L
Total Zn	< 5	µg/L
Total Mercury	< 0.05	µg/L (measured 2-2015)
Volatile Organics	45 cmpds not detectable	
Organic Analysis (BNA'S): Bis(2-Ethylhexyl)Phthalate	69 cmpds not detectable 0.49	µg/L
Pesticides & PCB's:	28 cmpds not detected	

METHODS

The acute toxicity test #7861 was conducted as outlined in Washington State Department of Ecology, Publication 80-12, Part A: Static Acute Fish Toxicity Test Protocol (Revised June 2009). The test was conducted at 10 mg/L and 100 mg/L to determine if the sample designates as "Extremely Hazardous Waste" or "Dangerous Waste", respectively.

Test Organisms

Swim-up (swim-up on 12-18-15) rainbow trout (*Oncorhynchus mykiss*) were purchased from Trout Lodge located in Sumner, Washington on 1-11-16. The trout were acclimated for a period of 7 days in well water chilled to a mean temperature of 12.8 °C, a minimum of 12.7 °C and a maximum of 12.9 °C in a flow-through system at KCEL. During acclimation the fish were fed Ziegler Salmon Starter twice daily. Feed was withheld 48 hours prior to the start of the test.

Physical data (based on a randomly chosen control jar at the end of the test) on trout used in the tests is shown in the table below.

Test #	Age (days-post swim-up at start of test)	Mean Standard Length (cm)	Mean Weight (grams)	Loading Wt./Vol. (g/L)
7861	31	3.2	0.34	0.57

As indicated in the table the mean weight of the trout used in the test was 0.34 g with a mean standard length of 3.2 cm. The loading in each test jar was 0.57 g/L.

Extraction

Three aliquots of 0.10 g (test concentration 10 mg/L) and three aliquots of 1.0 g (test concentration 100 mg/L) of the sample were weighed and each placed into a 1L, wide-mouth glass extraction jar (total 6 jars). 200 mL of well water (diluted 20% with DI water) was added to each jar. The jars were then closed with a teflon lined cap and extracted on a rotary agitator for 16.5 hours.

Rainbow Trout – 96-Hour Static Acute Toxicity Tests

The test jars were 2-gal, glass wide mouth jars with inside measurements of 25 cm (height) and 23.8 cm (dia.). The liquid level at a volume of 6 L was 15 cm. The jar opening was partially covered during the test.

Well water (diluted 20% with DI water) was measured (9.6 L for test and control jars) into each replicate. The solutions were maintained at 12 ± 1.0°C in an environmental chamber (Hotpack Model 06082, s/n 79718). The D.O. at the start of the test (10.2 - 10.6 mg/L) was > 80% saturation (>8.6 mg/L).

The extracted sample was added to the test jars followed by a 200 mL WW (diluted 20% with DI) rinse of the extraction jar bringing the total volume in the test chambers to 6 L. The extraction jar (laid on its side) and teflon liner were placed on the bottom of the test chamber. Ten rainbow trout were placed randomly into each test jar.

Mortality was monitored during the test and recorded at 24, 48, 72, and 96 hours. Dissolved oxygen, temperature and pH were recorded in each test and control jar at 0, 24, 48, 72 and 96 hours. The photoperiod was 16h L:8h D. The test was initiated at 0745 h on 1-18-16 and ended at 0755 h on 1-22-16.

Quality Assurance

The reference toxicant testing for the lot of fish used in this test was conducted on 1-18-16 (Test #7862). Cadmium nitrate was used as a reference toxicant for rainbow trout. The precision table located at the end of this report is maintained to monitor the sensitivity of these organisms to the reference toxicant and thereby provide an indication of their overall sensitivity to other compounds. The LC50 for the reference toxicant test (#7862) was 1.35 µg Cd/L which is within the control limits (mean ± 2 SD) of 1.21 – 3.10 µg/L Cd.

Temperature, pH and dissolved oxygen measurements remained within acceptable limits (USEPA, 2002) throughout the reference toxicant test for rainbow trout (#7862) and sample test (#7861). The test met acceptability criteria regarding control survival (≥ 90%).

Dilution water hardness (diluted 20% with DI = 45 mg/L as $CaCO_3$) was below the lower limit for moderately hard dilution water (80 mg/L as $CaCO_3$), but did exceed the 40 mg/L as $CaCO_3$ limit for hardness.

Physical-chemical methods are outlined in the table below:

Parameter	Method
Water Quality Tests	APHA (1992); US EPA (1991).
Temperature	Standard Mercury Thermometer (calibrated with a certified thermometer traceable to NBS records) and Onset, Tidbit (v2) UTBI-001 Temperature Logger (KCEL #436v1).
Dissolved Oxygen	YSI membrane electrode method (Method #4500-0 G; KCEL #434).
pH	Beckman 690 meter with automatic temperature compensation and Ross combination electrode (Method #4500-H; APHA 1992; KCEL #433).
Total Alkalinity	Potentiometric Method (Method #2320 B; KCEL #319v4).
Total Hardness	By calculation (Method #2340 B; KCEL #612v4).
Conductivity	Orion Model #122 Meter with 012210 conductivity cell (Method 2510B; KCEL #435).
Pesticides and PCB's	Continuous liquid extraction method (EPA Method #608; KCEL #733).
Organic Analysis	Continuous liquid extraction method for BNA's (EPA Method #625; KCEL #731).
Volatile Organics	Purge and trap method (EPA Method #624; KCEL #732).
Total Metals	ICP for Cd, Cr, Cu, Ni, Pb and Zn (EPA Method #200.7; KCEL #612v4); for Hg analysis (KCEL #604v5, 601v4, 605v0).

RESULTS

Rainbow trout

The following table contains survival percentages at 24-hour intervals during the 96-hour test in which rainbow trout were exposed to dilution water (controls) or to 10 and 100 mg/L sample concentrations.

	Sample	Percentage Survival (%)				Number	Number of
	mg/L	24 h	48 h	72 h	96 h	Dead	Fish Tested
WW (control)	0	100	100	100	100	0	30
SW062515_P01	10	100	100	100	100	0	30
	100	0*	0	0	0	30	30

* All dead within 2.75 hours of test initiation

Sample

As the table above shows for sample SW062515_P01 there was 100% mortality (all dead within 2.75 hours of test initiation) in the 100 mg/L test concentration. There was 100% survival in the 10 mg/L test concentration. Hence, this sample designates as a "Hazardous Waste" according to DOE 80-12 criteria.

WATER QUALITY

The following table contains measurements of temperature, pH and dissolved oxygen taken throughout the 96 hour test. Measurement of Total Hardness, Total Alkalinity and Conductivity are taken from samples collected at the beginning (0-h) and end (96-h) of the test.

Parameter	Sample:	Control 0 mg/L	SW062515_P01 10 mg/L	SW062515_P01 100 mg/L
Temperature (°C)	**Mean**	**12.0**	**11.9**	**11.9**
	Min.	11.4	11.1	11.2**
	Max.	12.5	12.4	12.3**
pH	**Mean**	**7.62**	**7.66**	**7.91**
	Min.	7.45	7.50	7.90**
	Max.	7.90	7.92	7.91**
D.O. (mg/L)	**Mean**	**8.3**	**8.0**	**10.2**
	Min.	9.1	8.9	10.2**
	Max.	10.3	10.3	10.2**
Tot. Hard (mg/L as $CaCO_3$)	0h	45	45	46
	96h	45	44	*
Tot. Alk (mg/L as $CaCO_3$)	0h	42	42	43
	96h	45	45	*
Cond (µmhos/cm)	0h	125	125	125
	96h	135	133	126$^{\Psi}$

* Not taken since all dead within 2.75 hours of test initiation
** Based on 0 hour readings only
$^{\Psi}$ Taken after all dead within 2.75 hours of test initiation

Additional water quality and QC data are listed on the attached photocopied pages from the laboratory notebook.

TESTED BY:
King County Environmental Laboratory
322 West Ewing Street
Seattle WA 98119

REFERENCES

APHA. 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition. American Public Health Association, American Waterworks Association, Water Pollution Control Association. Washington D.C.

U.S. E.P.A. 1991. Code of Federal Regulations, 40CFR, Appendix A, July 1991. U.S. Environmental Protection Agency, Office of Federal Registry, Washington, D.C.

Washington State Department of Ecology. Biological Testing Methods for the designation of Dangerous Waste. DOE 80-12, revised June 2009.

US EPA. 2002. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. 5th edition. EPA-821-02-012, October 2002. US Environmental Protection Agency, Office of Water (4303T), Washington, DC.

DOE 80-12 Toxicity Test:

Bench Sheets

Chain of Custody

Public Health
Seattle & King County

SAMPLE CHAIN OF CUSTODY

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SAMPLERS *(signature)* S. G. Whittaker

PROJECT NAME/NO. Dry Cleaning

PO#

REMARKS Fish bioassay
PERC sludge

Page # 1 of 1

TURNAROUND TIME
☐ Standard (2 Weeks)
☐ RUSH
Rush charges authorized by

SAMPLE DISPOSAL
☐ Dispose after 30 days
☐ Return samples
☐ Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	ANALYSES REQUESTED: TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by8260	SVOCs by 8270	HFS							Notes
SW062615-04-SB(m)		6/26/15		PERC sludge	1													Fish bioassay
SW062715-01SB(m)		6/27/15		"	1													"
SW062515-P01		6/25/15		PERC solvent	1													"

SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by: S. G. Whittaker	Steve Whittaker	PHSKC	6/29/15	10AM
Received by:	Jason Kinnard	KCEL	6/29/15	1000
Relinquished by:				
Received by:				

Friedman & Bruya, Inc.
3012 16th Avenue West
Seattle, WA 98119-2029
Ph. (206) 285-8282
Fax (206) 283-5044

FORMS\COC\COC.DOC

DOE 80-12 Hazardous Waste Test, Project # 421193 **Test #:** 7861
Rainbow Trout **96-Hour Static Acute Test** **Test Date:** 1-18-16

ORGANISMS

300 fish received from Trout Lodge Lot # (Swim-up date): 12-28-15 (18 dph) Shipped via Pick up Arrived at KCEL at 1330 h on 1-11-16 in 1 box double Plastic Bag. 0 dead removed. *At Arrival:* pH —, D.O. ≥ 20 mg/L, Temp 9.0 °C. Into Tank # 1 Hold in tank with new well water and aeration for 7 days. Feed 2X/day with Zieglers Salmon Starter Refer to culture log for feeding & holding information.

DILUTION WATER/SAMPLE

1. New Well Water (NWW) 1-17-16, filtered through nylon netting. Hardness must be between 80-100 mg/L. At start TH ≈ 109 mg/L. Dilute 20% w/ MilliQ DI.
   Want D.O. @ 90-100% saturation (9.8-10.7 mg/L) before add sample. Aerate with O_2.

2. Hazardous waste samples from Perchloroethylene
   LIMS RBT80-12 Sample #: — Wkgp #: —

	Sample 1	Sample 2
Sample #:	SW06251 5-P01	
Sample Site:		
Collect Date:	6/25/15 to —	to
Collect Time:	— h to — h	h to h
Collected by:	Steve Whittaker	
Delv'd to KCEL:	1000 h on 6-29-15	h on
By:	Steve Whittaker	
Rec'd by:	JK	
Sample Container:	40 ml glass Vial	
Sample Volume:	40ml	
Sample Description:	Perchloroethylene Solvent	
pH (at arrival):	—	
DO (mg/L) (at arrival):	—	
Temp (°C) (at arrival):	—	
Storage:	In dark at 4 ± 2°C	In dark at 4 ± 2°C

PROCEDURE

1) Sample Extraction (Rotary Agitation)
   a) Cut, crush or break solid samples into approx. 1-1.7 cm pieces. Used: —
   b) Use sample and NWW volumes in table below:
      For 10 ppm: weigh 0.60 g of sample into each of 4 – 1L blue cap wide mouth bottles (Reps A-C for fish plus 1 for WQ).
      For 100 ppm: weigh 6.0 g of sample into each of 4 – 1L blue cap wide mouth bottles (Reps A-C for fish plus 1 for WQ).
   c) Add 200 mL of NWW to each bottle and cap with lid and teflon liner (avoid caps with adhesive on liner).
   d) Mix samples on rotary agitator for 18 ± 2 h at 23 ± 2°C:
   e) Start extraction at 1420 h on 1-17-16
   f) End extraction at 0650 h on 1-18-16.

DOE 80-12 Hazardous Waste Test, Project # 42193 **Test #:** 7661
Rainbow Trout **96-Hour Static Acute Test** **Test Date:** 1-18-16

Treatment	Sample Conc (mg/L)	Code	Rep	Random #	NWW (L) Final Vol.	Sample (g)
Control	0	Blue	A	9	6	0
			B	2	6	0
			C	3	6	0
Sample 1	10	Green	A	4	6	0.06
			B	8	6	0.06
			C	7	6	0.06
Sample 1	100	Yellow	A	1	6	0.6
			B	5	6	0.6
			C	6	6	0.6
			A			
			B			
			C			
			A			
			B			
			C			

2) Test Jars
a. Fill test jars with 5.6 L of NWW and place randomly into EC # 8555, West & —
shelf.
b. Measure D.O. 10.2 - 10.6 mg/L at 12°C. Aerate if < 80% saturation (8.6 mg/L).
Aerate w/ O_2 @ — L/min for — sec per jar.

AERATION	Before Aeration	Aeration		After Aeration
	D.O. (mg/L)	Start Date/Time	End Date/Time	D.O. (mg/L)
Before Add Sample:		/	/	

CA

3) Extraction bottles:
a. Rinse outside of extraction bottle with DW
b. Pour contents into assigned jar
c. Rinse extraction bottle with 200 mL NWW and pour into test jar, bringing total volume to 6 L.
4) Place extraction bottle into test jar on its side, remove liner and place at bottom of test jar (prevent from floating). **Setup** at — h.
5) Take 0h sample for pH, DO, Temp, Tot. Alk, Tot. Hard, Cond.
6) Add 10 fish per jar, one at a time to randomize, using dip net.
7) Counts verified by GY & —.
8) **Start** test at 0745 h on 1-18-16. Place Tidbit temp recorder (SN 10468449, West shelf; SN —, — shelf) in jar w/water into EC.
9) Measure pH, DO, Temp, cumulative survival and mortality (# Dead) daily in all reps/trtmt.
10) **End** test at 0755 h on 1-22-16 by GY.
11) Take 96h samples for pH, DO, Temp, Tot Alk, Tot Hard, Cond.

DOE 80-12 Hazardous Waste Test, Project # 421193 **Test #:** 7861
Rainbow Trout 96-Hour Static Acute Test **Test Date:** 1-18-16

MEASUREMENTS

Treatment	Sample Conc (mg/L)	Code	Rep	Cumulative Survival (# Alive/Rep) 24 h	48 h	72 h	96 h	Tot # Alive
Control	0	Blue	A	10	10	10	10	10
			B	10	10	10	10	10
			C	10	10	10	10	10
Sample 1	10	Green	A	10	10	10	10	10
			B	10	10	10	10	10
			C	10	10	10	10	10
Sample 1	100	Yellow *	A	0	0	0	0	0
			B	0	0	0	0	0
			C	0	0	0	0	0
			A					
			B					
			C					
			A					
			B					
			C					
			Analyst:	GY	GY	GY	GY	

s = stressed * All Dead 1-18-16 1030

Jar #	Fish #→	1	2	3	4	5	6	7	8	9	10
		Mortality (#Dead/Rep)									
Yell A	Date	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16
	Time	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030
Yell B	Date	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16
	Time	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030
Yell C	Date	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16	1-18-16
	Time	1030	1030	1030	1030	1030	1030	1030	1030	1030	1030
	Date										
	Time										
	Date										
	Time										
	Date										
	Time										

DOE 80-12 Hazardous Waste Test, Project # 421193 **Test #:** 7661
Rainbow Trout 96-Hour Static Acute Test **Test Date:** 4-8-16

Chemistry

Treatment	Sample Conc (mg/L)	Code	Rep	pH					D. O. (mg/L)				
				0 h	24 h	48 h	72 h	96 h	0 h	24 h	48 h	72 h	96 h
Control	0	Blue	A	7.809	7.534	7.487	7.446	7.501	10.3	9.6	9.8	9.1	9.4
			B	7.874	7.568	7.598	7.526	7.673	10.2	9.4	9.8	9.1	9.4
			C	7.904	7.585	7.628	7.516	7.617	10.2	9.4	9.8	9.2	9.3
Sample 1	10	Green	A	7.910	7.624	7.633	7.575	7.628	10.3	9.3	9.6	9.0	9.2
			B	7.920	7.581	7.618	7.499	7.629	10.3	9.2	9.6	8.9	9.1
			C	7.913	7.592	7.617	7.511	7.613	10.2	9.2	9.5	8.9	9.0
Sample 1	100	Yellow	A	7.902	–	–	–	–	10.2	–	–	–	–
			B	7.905	–	–	–	–	10.2	–	–	–	–
			C	7.914	–	–	–	–	10.2	–	–	GY	–
Sample 2	10	Orange	A										
			B										
			C										
Sample 2	100	Red	A										
			B										
			C										
			Analyst:	GY	GY	GY	GY		GY	GY	GY	GY	GY

Code	Trtmt	Sample Conc (mg/L)	Sample #		T. Alkalinity (mg/L as $CaCO_3$)		T. Hardness (mg/L as $CaCO_3$)		Conductivity (µmhos/cm)	
			0 h	96 h	0 h	96 h	0 h	96 h	0 h	96 h
Blue	Control	0	64641-1	-4	41.8	45.4	44.7	45.1	124.9	135.1
Green	Sample 1	10	-2	-5	41.9	44.7	44.8	44	125.3	133.1
Yellow	Sample 1	100	-3	-6	42.5	–	46	–	125.2	126.0 *
Orange	Sample 2	10								
Red	Sample 2	100								
								Analyst:	JA	

* Taken after all mort on Day 0

DOE 80-12 Hazardous Waste Test, Project # 421193 **Test #:** 7861
Rainbow Trout **96-Hour Static Acute Test** **Test Date:** 1-18-96

Treatment	Sample Conc (mg/L)	Code	Rep	Temperature °C (SN 150104270) 0 h	24 h	48 h	72 h	96 h
Control	0	Blue	A	11.4	11.6	11.9	12.1	11.9
			B	12.0	11.9	12.3	12.5	12.3
			C	11.7	11.7	12.0	12.3	12.0
Sample 1	10	Green	A	11.1	11.3	11.8	12.2	11.8
			B	11.8	11.8	12.1	12.3	12.1
			C	11.9	12.0	12.3	12.4	12.3
Sample 1	100	Yellow	A	12.1	—	—	—	—
			B	11.2	—	—	—	—
			C	12.3	—	—	—	—
			A					
			B					
			C					
			A					
			B					
			C					
			Analyst:	GY	GY	GY	GY	GY

Test Organism Data at 96 Hours

Sampled From: Control **Rep** A

Fish	Length (cm)	Weight (g)	
1	3.2	0.392	
2	3.1	0.292	
3	3.1	0.335	
4	3.3	0.371	
5	3.0	0.313	
6	3.3	0.385	
7	3.1	0.301	
8	3.1	0.315	
9	3.2	0.373	
10	3.1	0.320	
Mean:	3.2	0.340	**Load Rate:**

Load Rate = [(Wt)(# Fish)]/ Vol
Where:
Wt = Mean Wt in g
Vol = Total Test Vol in L
# Fish = # Fish/Rep

(0.340 g)(10)/ 6 L
= 0.57 g/L

NOTES

Day 0 0820 N yellow (100 mg/L) fish losing equilibrium
Day 0 1030 all dead in yellow

Reference Toxicant Test:

Bench Sheets

Precision Table

Reference Toxicant, Cd, 96-Hour Acute Static Renewal Test
Rainbow Trout

Test #: 7862
Test Date: 1-18-16

ORGANISMS

300 fish received from Trout Lodge Lot # (Swim-up date): 12-28-15 (18) Shipped via Pick up Arrived at KCEL at 1330 h on 1-11-16 in 1 Box, double Plastic Bag. 0 dead removed. *At Arrival:* pH —, D.O. >20 mg/L, Temp 9.0 °C. Into Tank # 1 Hold in tank with new well water and aeration for 7 days. Feed 2X/day with Zeigler #1 Salmon Starter. Refer to culture log for feeding & holding information.

DILUTION WATER/TOXICANT

1. New Well Water (NWW) 1-17-16, filtered through nylon netting. Dilute 20% w/ MilliQ
2. Cd Stock Soln: Nominal 20 mg Cd/L, Measured 20.3 mg/L on 12-20-12 Prep 12-5-12 # _____ by add _____ g $Cd(NO_3)_2 \cdot 4H_2O$ (mfr Baker # 1-6226, rec'd —, opened —, lot # 049130) ⊆ 1L DW.

LIMS RTA Sample #: WG144171-1 Wkgp #: WG144171

SOLUTIONS					
Cd Trtmt (µg/L)	**Code**	**Cd Stock (mL/ jar)**	**NWW (L/ jar)**	**Sample #**	**Cd (µg/L) (Measured)**
0	Blue	0 (NWW only)	6 L (NWW only)		
0.75	Green	0.22	⊆ 6L		
1.5	Yellow	0.45	↓		
3.0	Orange	0.89	↓	* 646474	3.3
6.0	Red	1.78	↓		
12.0	White	3.55	↓		

PROCEDURE

1. Add 6 L NWW to each of 2 jars/trtmt; place in 12°C EC #8556, East & West shelf. Bring to 12°C. **Setup** at — h.
2. Measure DO; if DO << saturation, aerate until DO ≥ 9 mg/L. Stop aeration.
3. Measure Temp, pH & DO. in all trtmts. Take at 48h
4. Add Cd stock soln to jars: ✓ Mix: ✓ Sample for Cd: ✓ Acidify: ✓ Analyst: GY
5. Add 10 fish/jar, one at a time to randomize, using dip net. Start count verified by GY & —.
6. **Start** test at 0805 h on 1-18-16. Place Tidbit temp recorder (SN 10680548, East shelf; SN 10680549, West shelf) in beaker w/WW into EC.
7. Remove dead fish daily; record #/ weight/ length/ time dead. Record survival daily. Measure Temp, pH & DO daily in all trtmts.
8. Renew solns (≈ 80%) at 48h:
   a) Siphon 4.8 L from each jar.
   b) Filter NWW into 4L graduated cylinder.
   c) Add Cd stock soln ⊆ 4L aliquot during filling as below:

Cd (µg/L):	0	0.75	1.5	3	6	12
mL Cd Stock:	0	0.15	0.30	0.60		

   d) Replace ⊆ 6 L/jar with fresh soln by pouring through funnel and tubing into jar.
9. **End** test at 0810 h on 1-22-16. Measure Temp, pH and DO in all trtmts.

Reference Toxicant, Cd, 96-Hour Acute Static Renewal Test
Rainbow Trout

Test #: 7862
Test Date: 1-18-16

MEASUREMENTS

Code	Cumulative Survival (#Alive/Rep)						Tot # Alive
	Cd (µg/L)	Rep	24 h	48 h	72 h	96 h	
Blue	0	A	10	10	10	10	10
	0	B	10	10	10	10	10
Green	0.75	A	10	10	10	10	10
	0.75	B	10	10	10	10	10
Yellow	1.5	A	10	8	3	3	3
	1.5	B	9	7	4	4	4
Orange	3	A	2	0	0	0	0
	3	B	4	1	0	0	0
Red	6	A	5	0	0	0	0
	6	B	0	0	0	0	0
White	12	A	0	0	0	0	0
	12	B	0	0	0	0	0
		Analyst:	GY	GY	GY	GY	

s = stressed

Code	Rep		Daily #Dead/Rep										Mean
			1	2	3	4	5	6	7	8	9	10	
white	A	Date	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-19	
		Time	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	
		cm	3.0	3.4	3.2	3.4	3.1	3.3	3.0	3.0	3.3	3.0	3.2
		g	0.331	0.531	0.415	0.480	0.436	0.516	0.322	0.292	0.507	0.355	0.419
white	B	Date	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-19	
		Time	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	
Red	A	Date	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-20	
		Time	1000	1000	1000	1000	1000	1540	1540	1540	1540	0925	
Red	B	Date	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-19	
		Time	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	
orange	A	Date	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-20	
		Time	1000	1000	1000	1000	1000	1000	1000	1000	1540	0925	
orange	B	Date	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-19	1-20	1-21	
		Time	1000	1000	1000	1000	1000	1000	1540	1540	0925	0925	
Yellow	A	Date	~~1-19~~ GY	← 1-19	← 1-20 *	1-21	1-21	1-21	1-21				
		Time	~~1000~~ GY	← 1540	← 0925	0925	0925	0925	0925				
Yellow	B	Date	~~1-20~~ GY	1-19	1-20	1-21	1-21	1-21					
		Time	1000	0925	0925	0925	0925	0925					
		Date											
		Time											
		Date											
		Time											

Load Rate = [(Wt)(# Fish)]/ Vol = (0.419 g)(10)/ 6 L = 0.70 g/L

* Yell A Fish 3 1-21 0925

Where: Wt = Mean Wt in g; Vol = Total Test Vol in L; # Fish = #Fish/Rep

Reference Toxicant, Cd, 96-Hour Acute Static Renewal Test
Rainbow Trout

Test #: 7862
Test Date: 1-18-16

Chemistry

Code	Rep	Temp (°C) SN: 150 104 270					pH					D.O. (mg/L)				
		0h	24h	48h	72h	96h	0h	24h	48h	72h	96h	0h	24h	48h	72h	96h
Blue	A	12.4	12.1	12.2	12.2	12.3	7.850	7.453	7.577	7.553 ~~7.446~~	7.655	10.2	9.2	9.5	9.1	9.6
	B	12.2	12.1	12.0	12.1	12.2	7.899	7.539	7.597	7.581	7.694	10.3	9.5	9.5	9.4	9.7
Grn	A	12.2	12.3	12.3	12.3	12.3	7.901	7.520	7.618	7.547	7.672	10.3	9.4	9.4	9.2	9.7
	B	12.3	12.1	12.2	12.2	12.2	7.912	7.549	7.632	7.590	7.701	10.3	9.4	9.4	9.3	9.6
Yell	A	12.3	12.1	12.1	12.1	12.2	7.926	7.551	7.592	7.677	7.764	10.2	9.1	9.4	9.4	10.0
	B	12.4	12.1	12.2	12.2	12.3	7.936	7.573	7.591	7.646	7.740	10.1	9.1	9.3	9.3	9.8
Orng	A	12.2	12.1	11.9	—	—	7.934	7.498	7.643	—	—	10.1	9.1	9.6	—	—
	B	12.1	11.9	11.8	12.0	—	7.933	7.506	7.654	7.842	—	10.1	8.9	9.6	9.8	—
Red	A	12.1	11.7	11.9	—	—	7.929	7.534	7.669	—	—	10.1	9.1	9.7	—	—
	B	11.9	11.9	—	—	—	7.928	7.545	—	—	—	10.1	9.1	—	—	—
Wht	A	12.1	11.9	—	—	—	7.932	7.568	—	—	—	10.0	9.1	—	—	—
	B	12.5	12.1	—	—	—	7.930	7.577	—	—	—	10.0	9.3	—	—	—
Analyst:		GY	GY	GY	GY	GY	GY	GY	GY	GY	GY	GY	GY	GY	GY	GY

Random # Beaker Position					
Code	Rep	Random Jar #	Code	Rep	Random Jar #
Blue	A	8	Orange	A	4
	B	5		B	1
Green	A	7	Red	A	3
	B	10		B	6
Yellow	A	11	White	A	2
	B	9		B	12

NOTES

CETIS Analytical Report

Fish 96-h Acute Survival Test — **King County Metro Services, WQ Lab**

Analysis ID:	04-2283-0560	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	26 Jan-16 6:44	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes
Batch ID:	20-5525-4477	**Test Type:**	Survival (96h)	**Analyst:**	GY
Start Date:	18 Jan-16 08:05	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Well Water
Ending Date:	22 Jan-16 08:10	**Species:**	Oncorhynchus mykiss	**Brine:**	Not Applicable
Duration:	4d 0h	**Source:**	Trout Lodge Fish Farm	**Age:**	31d
Sample ID:	05-1514-6782	**Code:**	WG144171-1	**Client:**	Internal Lab
Sample Date:	18 Jan-16 07:30	**Material:**	Cadmium nitrate	**Project:**	Reference Toxicant
Receive Date:		**Source:**	Reference Toxicant		
Sample Age:	35m	**Station:**			

Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	0.00%	0.1309	0.03211	1.352	1.166	1.567

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

96h Survival Rate Summary

			Calculated Variate(A/B)								
C-µg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Dilution Water	2	1	1	1	0	0	0.0%	0.0%	20	20
0.75		2	1	1	1	0	0	0.0%	0.0%	20	20
1.5		2	0.35	0.3	0.4	0.05	0.07071	20.2%	65.0%	7	20
3		2	0	0	0	0	0		100.0%	0	20
6		2	0	0	0	0	0		100.0%	0	20
12		2	0	0	0	0	0		100.0%	0	20

96h Survival Rate Detail

C-µg/L	Control Type	Rep 1	Rep 2
0	Dilution Water	1	1
0.75		1	1
1.5		0.3	0.4
3		0	0
6		0	0
12		0	0

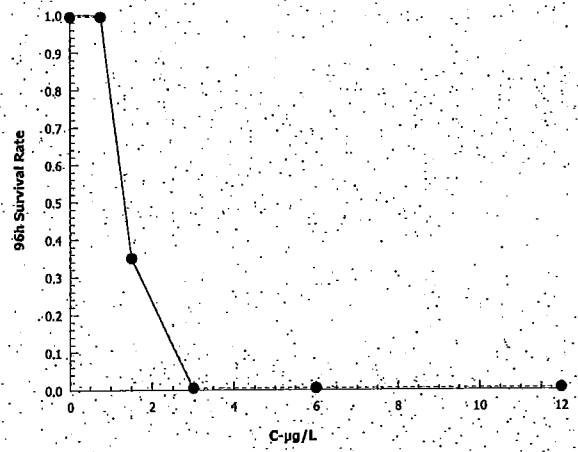
96h Survival Rate Binomials

C-µg/L	Control Type	Rep 1	Rep 2
0	Dilution Water	10/10	10/10
0.75		10/10	10/10
1.5		3/10	4/10
3		0/10	0/10
6		0/10	0/10
12		0/10	0/10

Fish 96-h Acute Survival Test — King County Metro Services, WQ Lab

Analysis ID:	04-2283-0560	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	26 Jan-16 6:44	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Graphics



CETIS Summary Report

Fish 96-h Acute Survival Test — **King County Metro Services, WQ Lab**

Batch ID:	20-5525-4477	**Test Type:**	Survival (96h)	**Analyst:**	GY
Start Date:	18 Jan-16 08:05	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Well Water
Ending Date:	22 Jan-16 08:10	**Species:**	Oncorhynchus mykiss	**Brine:**	Not Applicable
Duration:	4d 0h	**Source:**	Trout Lodge Fish Farm	**Age:**	31d

Sample ID:	05-1514-6782	**Code:**	WG144171-1	**Client:**	Internal Lab
Sample Date:	18 Jan-16 07:30	**Material:**	Cadmium nitrate	**Project:**	Reference Toxicant
Receive Date:		**Source:**	Reference Toxicant		
Sample Age:	35m	**Station:**			

Point Estimate Summary

Analysis ID	Endpoint	Level	µg/L	95% LCL	95% UCL	TU	Method
04-2283-0560	96h Survival Rate	EC50	1.352	1.166	1.567		Spearman-Kärber

Test Acceptability

Analysis ID	Endpoint	Attribute	Test Stat	TAC Limits	Overlap	Decision
04-2283-0560	96h Survival Rate	Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

96h Survival Rate Summary

C-µg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Dilution Water	2	1	1	1	1	1	0	0	0.0%	0.0%
0.75		2	1	1	1	1	1	0	0	0.0%	0.0%
1.5		2	0.35	0	0.9853	0.3	0.4	0.05	0.07071	20.2%	65.0%
3		2	0	0	0	0	0	0	0		100.0%
6		2	0	0	0	0	0	0	0		100.0%
12		2	0	0	0	0	0	0	0		100.0%

96h Survival Rate Detail

C-µg/L	Control Type	Rep 1	Rep 2
0	Dilution Water	1	1
0.75		1	1
1.5		0.3	0.4
3		0	0
6		0	0
12		0	0

96h Survival Rate Binomials

C-µg/L	Control Type	Rep 1	Rep 2
0	Dilution Water	10/10	10/10
0.75		10/10	10/10
1.5		3/10	4/10
3		0/10	0/10
6		0/10	0/10
12		0/10	0/10

Rainbow Trout (*Onchorhyncus mykiss*), Acute Test Precision

96-Hour Exposure to Reference Toxicant, Cd, µg/L

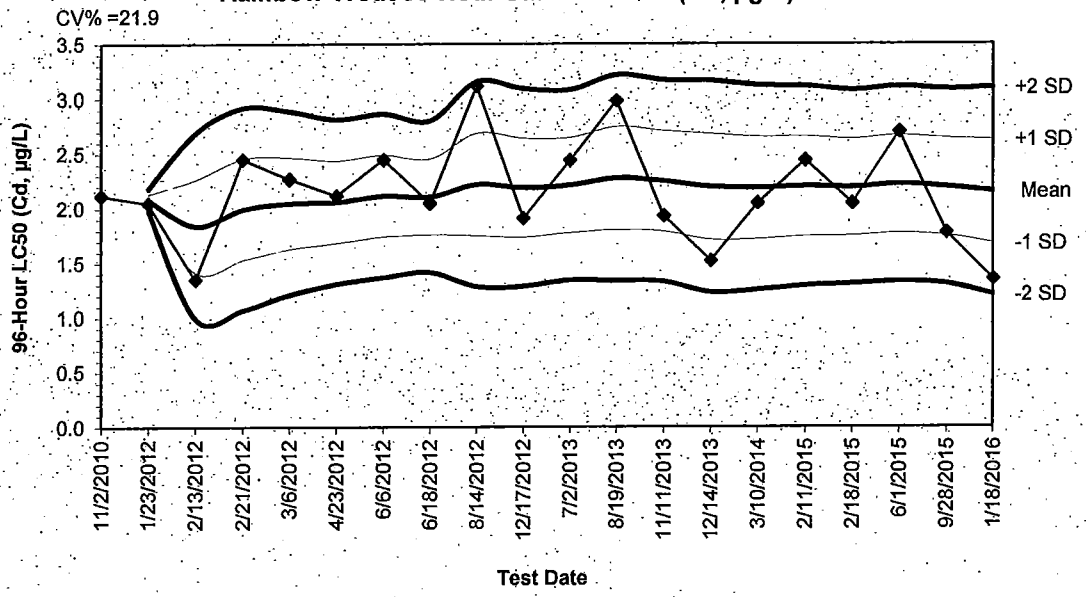
Table 3 of 3

Date	Test #	Rainbow Trout Lot #	Dilution Series, Cd, µg/L	Ref. Tox. Lot #	Water	Control Mortality, %	Pass/ Fail	Survival LC50	Stats	Control Limits	% COV
060424	3826	060317	.75 1.5 3 6 12	991020#6	NWW	0	P	1.5	SK	0.9 – 4.2	33
060809	3932	060714	.75 1.5 3 6 12	991020#6	NWW	0	P	1.26	SK	0.72 – 4.23	35.5
070305	4049	070209	.75 1.5 3 6 12	991020#6	NWW	0	P	1.31	SK	0.61 – 4.12	37.2
070904	4222	070813	.75 1.5 3 6 12	991020#6	NWW	0	P	1.31	SK	0.51 – 4.02	38.8
080421	4357	080320	.75 1.5 3 6 12	991020#6	NWW	0	P	1.78	SK	0.46 – 3.99	39.7
081208	4635	081110	.75 1.5 3 6 12	080228#1	NWW	0	P	1.90	PA	0.54 – 3.71	37.3
091214	5077	091117	.75 1.5 3 6 12	080228#1	NWW	0	P	2.03	PA	0.55 – 3.61	36.8
101102	5550	101018	.75 1.5 3 6 12	080228#1	NWW	0	P	2.12	SK	0.57 – 3.51	36.1
120123	6104	111226	.75 1.5 3 6 12	080228#1	NWW	0	P	2.05	PA	0.60 – 3.51	35.4
120213	6116	111226 (49d old)	.75 1.5 3 6 12	080228#1	NWW	0	P	1.35	PA	0.53 – 3.45	36.6
120212	6118	111226	.75 1.5 3 6 12	080228#1	NWW	0	P	2.45	PA	0.61 – 3.29	34.3
120306	6124	120125 (41d old)	.75 1.5 3 6 12	080228#1	NWW	0	P	2.27	SK	0.61 – 3.27	34.3
120423	6159	120321 (33d old)	.75 1.5 3 6 12	080228#1	NWW	0	P	2.12	PA	0.88 – 2.82	26.2
120606	6211	120420 (47d old)	.75 1.5 3 6 12	080228#1	NWW	0	P	2.45	PA	1.02 – 2.60	21.8
120618	6226	120511 (38d old)	.75 1.5 3 6 12	080228#1	NWW	0	P	2.05	PA	1.04 – 2.63	21.7
120814	6338	120608 (67d old)	.75 1.5 3 6 12	080228#1	NWW	0	P	3.12*	PA	0.92 – 2.88	25.7
121217	6539	121121 (26d old)	.75 1.5 3 6 12	080228#1	NWW	0	P	1.91	SK	0.99 – 2.87	24.4
130702	6706	130520 (43d old)	.75 1.5 3 6 12	121205	NWW	0	P	2.44	SK	0.98 – 2.89	24.7
130819	6774	130710 (40d old)	.75 1.5 3 6 12	121205	NWW	0	P	2.98	TSK	0.96 – 3.06	26.2
131111	6926	131011 (31d old)	.75 1.5 3 6 12	121205	NWW	0	P	1.93	TSK	0.97 – 3.06	25.8
131214	6972	131118 (26d old)	.75 1.5 3 6 12	121205	NWW	0	P	1.52	PA	0.98 – 3.06	25.8
140310	7007	140212 (26d old)	.75 1.5 3 6 12	121205	NWW	0	P	2.05	SK	1.08 – 3.03	23.8
150211	7439	150116 (26d old)	.75 1.5 3 6 12	121205	NWW	0	P	2.44	SK	1.19 – 3.04	21.9
150218	7440	150116 (33d old)	.75 1.5 3 6 12	121205	NWW	0	P	2.05	SK	1.31 – 3.00	19.6
150601	7538	150501 (31d old)	.75 1.5 3 6 12	121205	NWW	0	P	2.70	SK	1.34 – 3.06	19.6
150928	7757	150821(38d old)	.75 1.5 3 6 12	121205	NWW	0	P	1.78	SK	1.32 – 3.06	19.9
160118	7862	151218 (31d old)	.75 1.5 3 6 12	121205	NWW	0	P	1.35	SK	1.21 – 3.10	21.9

PA = Probit Analysis
MA = Moving Average
(T)SK = (Trimmed) Spearman Karber
GI = Graphical Interpolation

RW = Reconstituted Water
WW = Well Water
* = Value Outside Control Limits

Control Chart for Acute Reference Toxicant Tests with Rainbow Trout 96-Hour Survival LC50 (Cd, µg/L)



Dates	Values	Mean	-1 SD	-2 SD	+1 SD	+2 SD
11/2/2010	2.12					
1/23/2012	2.05	2.0850	2.0355	1.9860	2.1345	2.1840
2/13/2012	1.35	1.8400	1.4142	0.9884	2.2658	2.6916
2/21/2012	2.45	1.9925	1.5300	1.0675	2.4550	2.9175
3/6/2012	2.27	2.0480	1.6287	1.2094	2.4673	2.8866
4/23/2012	2.12	2.0600	1.6838	1.3076	2.4362	2.8124
6/6/2012	2.45	2.1157	1.7420	1.3683	2.4894	2.8631
6/18/2012	2.05	2.1075	1.7607	1.4140	2.4543	2.8010
8/14/2012	3.12	2.2200	1.7519	1.2838	2.6881	3.1562
12/17/2012	1.91	2.1890	1.7369	1.2848	2.6411	3.0932
7/2/2013	2.44	2.2118	1.7763	1.3408	2.6473	3.0829
8/19/2013	2.98	2.2758	1.8051	1.3343	2.7466	3.2173
11/11/2013	1.93	2.2492	1.7884	1.3276	2.7100	3.1708
12/14/2013	1.52	2.1971	1.7134	1.2297	2.6809	3.1646
3/10/2014	2.05	2.1873	1.7197	1.2520	2.6550	3.1227
2/11/2015	2.44	2.2031	1.7469	1.2907	2.6593	3.1155
2/18/2015	2.05	2.1941	1.7508	1.3075	2.6374	3.0807
6/1/2015	2.70	2.2222	1.7759	1.3297	2.6685	3.1148
9/28/2015	1.78	2.1989	1.7535	1.3081	2.6444	3.0898
1/18/2016	1.35	2.1565	1.6832	1.2100	2.6298	3.1030

APPENDIX C:

KCEL'S REPORT ON LC50 TOXICITY TESTING CONDUCTED ON PERCHLOROETHYLENE DRY CLEANING SOLVENT

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December 2, 2015

Steve Whittaker
Public Health Researcher
Local Hazardous Waste Management Program
Public Health-Seattle & King County
CNK-PH-1100
401 Fifth Avenue, Suite 1100
Seattle, WA 98104

Dear Steve:

Attached is a report on the 96-hour acute-renewal toxicity test initiated on 9-21-15 on Perchloroethylene Dry Cleaning Solvent (SW062515-P01) at an attempt to determine an LC50 under static renewal conditions. Detailed findings are in the "Results" section of the attached report. The table below shows a summary of the test results.

Nominal Concentration (mg/L)	Measured Concentration (mg/L) 0 hr	Measured Concentration (mg/L) 24/96 hr	% Survival (2 reps/conc, 10 fish/rep)				% Survival at Test End
			0 h	24 h	48 h	96 h	
0	< MDL	<MDL*	100	100	100	100	100
33	0.813	1.78*	100	100	90	90	90
50	0.770	3.2*	100	100	95	95	95
75	1.63	4.17**	100	0	0	0	0
113	2.34	5.4**	100	0	0	0	0
170	2.45	5.36**	100	0	0	0	0

*Taken at 96 hours **taken at 24 hours Note: fish transferred to new solution at 48 hours

Using the measured concentration of perchloroethylene at 24/96 hours, the LC50 was calculated as 3.61 mg/L.

Organics methods and analysis provided by Jack Gudeman of the Trace Organics Section of KCEL.

If you would like additional information, please call Francis Sweeney at 477-7117.

Sincerely,

Gary Yoshida

Gary Yoshida
King County Environmental Laboratory

REPORT ON LC50 TOXICITY TESTING

CONDUCTED ON PERCHLOROETHYLENE

DRY CLEANING SOLVENT

KING COUNTY DEPARTMENT OF NATURAL RESOURCES AND PARKS
WATER AND LAND RESOURCES DIVISION
ENVIRONMENTAL LABORATORY SECTION
322 WEST EWING STREET
SEATTLE, WASHINGTON 98119

Test Date: September 21, 2015
KCEL Test Numbers: #7745 (*Oncorhynchus mykiss*: 96-Hour Acute Renewal Toxicity Test)

Report Date: December 2, 2015

INTRODUCTION

Perchloroethylene is a solvent used in the dry cleaning of clothes. An attempt was made to estimate the rainbow trout LC50 under static renewal conditions for this dry cleaning fluid.

Sample

A sample of perchloroethylene Dry Cleaning Solvent, SW062515-P01 collected on 6/25/15 was received by the King County Environmental Laboratory (KCEL), Aquatic Toxicology Section on 6/29/15. The sample was delivered in 40 mL glass vial and was refrigerated in the dark at 4 ± 2.0°C until test initiation. A copy of the chain-of custody is included as an Appendix to this report.

CONTROL WATER

The control water for the test with rainbow trout is freshwater obtained from a 95 ft. deep well located at the KCEL. Stock cultures of rainbow trout are held and acclimated in a flow-through system of well water (WW) for at least 7 days prior to use in tests.

The WW is analyzed for metals monthly (last analyzed 9-15) and organics are measured annually (last analyzed on 3-15). Hardness, alkalinity, conductivity and pH are measured monthly.

Physical-chemical characteristics of the WW are listed in the following table:

Parameter	Value	Units
Conductivity	271	µmhos/cm
pH	7.94	
Total Hardness (calc.)	109	mg/L as $CaCO_3$
Total Alkalinity	80	mg/L as $CaCO_3$
Total Cd	< 2	µg/L
Total Cr	< 3	µg/L
Total Cu	< 4	µg/L
Total Ni	< 5	µg/L
Total Pb	< 20	µg/L
Total Zn	< 5	µg/L
Total Mercury	< 0.05	µg/L (measured 2-10)
Volatile Organics	45 cmpds not detectable	
Organic Analysis (BNA'S): Bis(2-Ethylhexyl)Phthalate	68 cmpds not detectable 0.49	µg/L
Pesticides & PCB's:	29 cmpds not detected	

METHODS

The acute toxicity test #7745 was conducted using the general guidelines in US EPA -821-02-012 (October 2002, 5th edition) "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms". The test was conducted using a serial dilution with nominal concentrations of: 0 (well water control), 33, 50, 75, 113 and 170 mg/L perchloroethylene.

Test Organisms

Swim-up (swim-up on 8-21-15) rainbow trout (*Oncorhynchus mykiss*) were purchased from Trout Lodge located in Sumner, Washington on 9-10-15. The trout were acclimated for a period of 11 days in well water with a mean temperature of 13.9°C, a minimum of 13.8°C and a maximum of 14.0°C in a flow-through system at KCEL. During acclimation the fish were fed Zieglers Salmon Starter twice daily. Feed was withheld 48 hours prior to the start of the test.

Physical data (based on a randomly chosen control jar at the end of the test) on trout used in the tests is shown in the table below.

Test #	Age (days-post swim-up at start of test)	Mean Standard Length (cm)	Mean Weight (grams)	Loading Wt./Vol. (g/L)
7745	31	3.5	0.45	0.56

As indicated in the table the mean weight of the trout used in the test was 0.45 g with a mean standard length of 3.5 cm. The loading in each jar was 0.56 g/L.

Rainbow Trout – 96-Hour Static Renewal Acute Toxicity Test

For test #7745, test chambers were 2-gallon glass wide-mouth jars (Anchor Hocking-Heritage Hill) with inside measurements of 25 cm (height) and 23.8 cm (dia.). The liquid level at a volume of 8 L was 20 cm. The test solutions were maintained at 12 ± 1.0°C for 96-hours in an environmental chamber (Hotpack Model 08082, s/n 79719).

Ten rainbow trout were placed into the test chamber. Assignment of fish to the test chamber was random, as was placement of the test chambers in the environmental chamber. The fish were transferred to new solution at 48 hours.

Survival was monitored during the test and recorded at 0, 24, 48, 72, and 96 hours. Dissolved oxygen, temperature and pH were recorded for the samples and controls at 0, 24, 48, 72 and 96 hours. These values can be found on the attached photocopied pages from the laboratory notebook in the "Bench Sheets" section of this report. Temperature of the environmental chamber was monitored at 15-minute intervals using an Onset Tidbit data logger. The photoperiod was 16h L:8h D. The test was initiated at 1010 h on 9-21-15 and ended at 1010 h on 9-25-15.

Test Solution Prep

Test solution preparation followed the general guidelines of US EPA 712-C-96-118 (April 1996). Perchloroethylene has low solubility in water and because it is denser than water formed an immiscible portion on the bottom of the test chamber. In order to obtain large volumes of test solution sufficient for accommodating fish loading rates and maximum saturation the perchloroethylene was stirred into solution by hand. Test solutions were prepared at 0 and 48 hours (renewal) of the 96 hour static-renewal exposure period. The amount of perchloroethylene added for each test concentration was based on weight (mg/L).

On Day 0 the appropriate amount of perchloroethylene was added to the glass test chamber (2 gal.) containing 8 L of well water as indicated below (2 reps per test concentration). The solution was hand mixed for 1 minute and left undisturbed until the addition of 10 rainbow trout.

Nominal Sample Conc (mg/L)	WW (L/ test chamber)	mg Perc/ test chamber)*	Number of Reps
0	8	0	2
33	↓	264	2
50	↓	400	2
75	↓	600	2
113	↓	904	2
170	↓	1360	2

48 Hour Renewal

The fish were transferred to new test solution at 48-hours. New solution was prepared by 1 minute of hand mixing of the appropriate amount of perchloroethylene into 8 L of well water followed by 1 minute of settling. The fish were then transferred by net to the new solution.

Sampling of Test Solutions for Perchloroethylene

Samples for organic analysis were taken at 0 and 96 hours. The samples taken at 96 hours were in reality only 48 hours old because the test concentrations were renewed at 48 hours. At 24 hours there was 100% mortality in the three highest test concentrations so samples for organic analysis were taken in these samples.

Samples for 0 hours were taken after 1 minute of hand mixing the appropriate amount of the perchloroethylene into the test chamber then left undisturbed for 1 minute to allow the solution to cease spinning. Samples were taken at mid depth in the test chamber by pipette. The samples taken after 0 hours were taken without any hand mixing of the test solution to avoid reintroduction of any perchloroethylene that had settled out to the bottom of the test chamber. The samples were stored in the dark at 4 ± 2.0°C until analyzed.

Organic Analysis

Aqueous samples were analyzed for volatile organics by gas chromatography/electron impact mass spectrometry (GC/MS/EI) using EPA Method 8260C. Samples were introduced into the GC/MS system via purge-and-trap using EPA Method 5030. The instrument was calibrated using perchloroethylene (i.e., tetrachloroethylene) concentrations from 5 – 400 µg/L (ppb). Positive results for tetrachloroethylene displayed the correct retention time and mass spectra as compared to the calibration standards. For results where tetrachloroethylene exceeded the calibration range, the original sample was diluted with reagent laboratory water (cleaned via reverse osmosis and purged with nitrogen gas to remove volatile organics analytes) and re-analyzed.

Zero hour samples were analyzed in two (2) analytical batches (WG141016 and WG141858). The 24 hour samples (where 100% mortality was observed) were analyzed in a single analytical batch in combination with the majority of the zero hour samples (WG141858). The remaining 96 hour samples (48 hours in real time) were analyzed in a single analytical batch (WG141986).

All samples in each of the analytical batches were spiked with surrogates. In addition, spike blank (SB), matrix spike (MS) and duplicate matrix spike (MSD) samples were spiked with tetrachloroethylene - along with other volatile analytes – to determine the precision and accuracy for each batch.

Although WG141016 included additional samples not related to this study, the only sample related to this perchloroethylene study was the zero hour well water control. QC for WG141016 consisted of a method blank (MB), SB, MS and MSD. Because WG141016 included only the well water control study, the MS

and MSD were prepared using a sample not related to this perchloroethylene study. The MB was free of tetrachloroethylene and recoveries of surrogates and tetrachloroethylene were within control limits. The relative percent difference (RPD) for tetrachloroethylene for the MS and MSD was within acceptance limits.

QC for WG141858 included a MB, SB, MS and MSD. The MS and MSD were prepared using the zero hour 50 mg/L nominal tetrachloroethylene sample. The MB was free of tetrachloroethylene and recoveries of surrogates and tetrachloroethylene were within control limits. The relative percent difference (RPD) for tetrachloroethylene for the MS and MSD was within acceptance limits.

QC for WG141986 included a MB, SB, MS and MSD. The MS and MSD were prepared using the 96 hour 50 mg/L nominal tetrachloroethylene sample. The MB was free of tetrachloroethylene and recoveries of surrogates and tetrachloroethylene were within control limits. The relative percent difference (RPD) for tetrachloroethylene for the MS and MSD was within acceptance limits.

Quality Assurance

The reference toxicant testing for the lot of fish used in this test was conducted on 9-28-15 (Test #7757). Cadmium nitrate was used as a reference toxicant for rainbow trout. The precision table located at the end of this report is maintained to monitor the sensitivity of these organisms to the reference toxicant and thereby provide an indication of their overall sensitivity to other compounds. The LC50 for the reference toxicant test (#7757) was 1.78 µg Cd/L. The LC50 was within the control limits of 1.32 to 3.06 µg Cd/L).

Temperature, pH and dissolved oxygen measurements remained within acceptable limits (USEPA, 2002) throughout the reference toxicant test for rainbow trout (#7757) and sample test (#7745). The test met acceptability criteria regarding control mortality.

Physical-chemical methods are outlined in the table below:

Parameter	Method
Water Quality Tests	APHA (1992); US EPA (1991).
Temperature	Standard Mercury Thermometer (calibrated with a certified thermometer traceable to NBS records) and Onset, Tidbit (v2) UTBI-001 Temperature Logger (KCEL #436v1).
Dissolved Oxygen	YSI membrane electrode method (Method #4500-0 G; KCEL #434).
pH	Beckman 690 meter with automatic temperature compensation and Ross combination electrode (Method #4500-H; APHA 1992; KCEL #433).
Total Alkalinity	Potentiometric Method (Method #2320 B; KCEL #319v4).
Total Hardness	By calculation (Method #2340 B; KCEL #612v4).
Conductivity	Orion Model #122 Meter with 012210 conductivity cell (Method 2510B; KCEL #435).
Total Ammonia	Phenate Method (Standard Methods SM 4500 - NH_3-G; KCEL #330v4).
Unionized Ammonia	Calculated from total ammonia, pH and ionization constants (APHA Method #417 G).
Pesticides and PCB's	Continuous liquid extraction method (EPA Method #608; KCEL #733).
Organic Analysis	Continuous liquid extraction method for BNA's (EPA Method #625; KCEL #731).
Volatile Organics	Purge and trap method (EPA Method #624; KCEL #732).
Total Metals	ICP for Cd, Cr, Cu, Ni, Pb and Zn (EPA Method #200.7; KCEL #612v4); for Hg analysis (KCEL #604v5, 601v4, 605v0).

RESULTS

Organic Analysis Results

Results of the organic analysis of test solutions for perchloroethylene is shown in the table below.

Nominal Concentration (mg/L)	Measured Concentration (mg/L) 0 hr	Measured Concentration (mg/L) 24 hr	Measured Concentration (mg/L) 96 hr
0	< MDL	--	<MDL
33	0.813	--	1.78
50	0.770	--	3.2
75	1.63	4.17	--
113	2.34	5.4	--
170	2.45	5.36	--

At 24 hours there was 100% mortality in the 75, 113 and 170 mg/L test concentrations, therefore samples were taken for organic analysis at that time. However, samples were not taken for analysis in the 0, 33, and 50 mg/L test concentrations at 24 as there was no mortality. New test solutions for the 0, 33 and 50 mg/L concentrations were prepared at 48 hours. As a result the samples taken at 96 hours are in real time only 48 hours old. The 96 hours only refers to the total duration of the fish test.

The 0 hour measured concentrations of perchloroethylene shows that a much lower amount went into solution as compared to the expected nominal concentration. It also appears that over time more perchloroethylene had gone into solution as compared to the 0 hour measured concentrations. The solubility of perchloroethylene in well water at 12°C conducted under the procedures of this test appears to have reached a maximum at the 113 mg/L test concentration.

Rainbow Trout Survival

The following table contains 24-hour survival percentages for rainbow trout exposed to various concentrations of perchloroethylene during the 96-hour test.

Nominal Concentration (mg/L)	Measured Concentration (mg/L) 0 hr	Measured Concentration (mg/L) 24/96 hr	% Survival (2 reps/conc, 10 fish/rep)				% Survival at Test End
			0 h	24 h	48 h	96 h	
0	< MDL	<MDL*	100	100	100	100	100
33	0.813	1.78*	100	100	90	90	90
50	0.770	3.2*	100	100	95	95	95
75	1.63	4.17**	100	0	0	0	0
113	2.34	5.4**	100	0	0	0	0
170	2.45	5.36**	100	0	0	0	0

*Taken at 96 hours **taken at 24 hours Note: fish transferred to new solution at 48 hours

As the table above shows for perchloroethylene sample SW062515-P01 there was 100% mortality in the 75, 113 and 170 mg/L concentrations by 24 hours. The 0, 33 and 50 mg/L test concentrations had 100, 90 and 95% survival, respectively at the end of the 96 hour exposure.

Measured rather than nominal test concentrations were used to determine the LC50 due to the large difference between the measured and expected concentrations. Measured values were used at time of death 24 hours or at 96 hours for the remaining survivors in the calculation. The 0 hour measured concentrations were not used to calculate the LC50 since more perchloroethylene appears to have gone into solution as time progressed. These final exposure values were deemed more relevant to the calculation.

For this test the LC50 was determined to be 3.61 mg/L (Trimmed Spearman-Karber). The 170 mg/L nominal concentration was excluded from the calculation as the measured concentration (2.34 mg/L) was about the same as the measured value (2.45 mg/L) for the 113 mg/L nominal concentration.

Water Quality

The following table contains measurements of temperature, pH and dissolved oxygen taken throughout the 96 h test. Measurement of total hardness, total alkalinity and conductivity are taken from samples collected at the beginning (0-h) and end (96-h) of the test unless noted otherwise.

Parameter		0 mg/L	33 mg/L	50 mg/L	75 mg/L	113 mg/L	170 mg/L
Temperature (°C)	Mean	**11.6**	**11.5**	**11.5**	**11.5**	**11.5**	**11.5**
	Min.	11.3	11.1	11.1	11.3	11.0	11.3
	Max.	11.8	11.8	11.7	11.9	11.9	11.7
pH	Mean	**7.58**	**7.58**	**7.59**	**7.86**	**7.93**	**7.95**
	Min.	7.31	7.31	7.29	7.66	7.81	7.83
	Max.	7.99	8.01	8.02	8.04	8.04	8.05
D.O. (mg/L)	Mean	**8.7**	**8.7**	**8.8**	**9.5**	**9.8**	**9.8**
	Min.	8.2	7.9	8.3	9.1	9.6	9.7
	Max.	9.9	9.9	10.0	10.0	10.0	9.9
Tot. Hard (mg/L as $CaCO_3$)	0h	89	89	88	89	89	91
	96h	88	88	87	86*	87*	88*
Tot. Alk (mg/L as $CaCO_3$)	0h	64	65	65	64	65	65
	96h	65	65	66	66*	65*	65*
Cond (µmhos/cm)	0h	218	220	220	219	221	221
	96h	222	223	224	226*	222*	222*

*taken at 24 hours

Additional water quality and QC data are listed on the attached photocopied pages from the laboratory notebook.

TESTED BY:
King County Environmental Laboratory
322 West Ewing Street
Seattle WA 98119

REFERENCES

APHA. 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition. American Public Health Association, American Waterworks Association, Water Pollution Control Association. Washington D.C.

U.S. E.P.A. 1991. Code of Federal Regulations, 40CFR, Appendix A, July 1991 U.S. Environmental Protection Agency, Office of Federal Registry, Washington, D.C.

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US EPA. 2002. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. 5th edition. EPA-821-02-012, October 2002. US Environmental Protection Agency, Office of Water (4303T), Washington, DC.

US EPA. 1996 (April). Ecological Effects Test Guidelines: OPPTS 850.1000 Special Considerations for Conducting Aquatic Laboratory Studies.

Bench Sheets

Chain-of-Custody

Supporting Chemistry

Public Health
Seattle & King County

SAMPLE CHAIN OF CUSTODY

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Public Health Researcher
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TTY Relay: 711

SAMPLERS *(signature)* S. G. Whittaker

PROJECT NAME/NO. Dry Cleaning

PO#

REMARKS Fish bioassay
PERC sludge

Page # 1 of 1

TURNAROUND TIME
☐ Standard (2 Weeks)
☐ RUSH
Rush charges authorized by

SAMPLE DISPOSAL
☐ Dispose after 30 days
☐ Return samples
☐ Will call with instructions

Sample ID	Lab ID	Date Sampled	Time Sampled	Sample Type	# of containers	ANALYSES REQUESTED: TPH-Diesel	TPH-Gasoline	BTEX by 8021B	VOCs by 8260	SVOCs by 8270	HFS							Notes
SW062615-04-SBC(m)		6/26/15		PERC sludge	1													Fish bioassay
SW062715-01SBC(m)		6/27/15		"	7B													"
SW062515-P01		6/25/15		PERC solvent	1													"

SIGNATURE	PRINT NAME	COMPANY	DATE	TIME
Relinquished by: S. G. Whittaker	Steve Whittaker	PHSKC	6/29/15	10AM
Received by:	Jason Kinnard	KCEL	6/29/15	1000
Relinquished by:				
Received by:				

Friedman & Bruya, Inc.
3012 16th Avenue West
Seattle, WA 98119-2029
Ph. (206) 285-8282
Fax (206) 283-5044

FORMS\COC\COC.DOC

Perc 96-Hour Acute Static Renewal Test
Rainbow Trout

Test #: 7745
Test Date: 9-21-15

ORGANISMS

400 fish received from Trout Lodge Lot # (Swim-up date): 8-21-15 Shipped via Pick up Arrived at KCEL at 1405 h on 9-10-15 in 1 Box double poly. ____ dead removed. *At Arrival:* pH –, D.O. > 20 mg/L, Temp 18.7 °C. Into Tank # 1 Hold in tank with new well water and aeration for 11 days. Feed 2X/day with Ziegles #1. Refer to culture log for feeding & holding information.

DILUTION WATER/TOXICANT

1. New Well Water (NWW) 9-20-15, filtered through nylon netting. Hardness should be between 80-100 mg/L. At start TH ≈ 115 mg/L. Dilute 20% w/ MilliQ DI.
2. Perchloroethylene: Sample #S0062515_P01 Collected on 6-25-15 By Steve Whitaker Rec'd by KCEL 6-29-15 Stored in the dark at 4 ± 2°C

SOLUTIONS

Code	Sample Conc (mg/L)	NWW (L/ jar)	g Perc/ jar)	Sample #		Perc mg/L 0 h	Perc mg/L 24/96 h	µl perc
Blue	0	8 L NWW	0 (NWW only)	L63780 -1	L63781 -1	<MDL	<MDL *	–
Green	33	↓	0.264	-2	-2	0.813	1.78 *	≈ 167
Yellow	50	↓	0.400	-3	-3	0.770	3.2 *	≈ 250
Orange	75	↓	0.600	-4	-4	1.63	4.17 **	≈ 377
Red	113	↓	0.904	-5	-5	2.34	5.4 **	≈ 565
White	170	↓	1.36	-6	-6	2.45	5.32 **	≈ 850

* Taken at 96h ** Taken at 24h

PROCEDURE

1. Add 8 L NWW to each of 2 jars/trtmt; place in 12°C EC # 8554, East & West shelf. Bring to 12°C.
2. Add Perc to jars and hand mix for 2 min
3. Add 10 fish/jar, one at a time to randomize, using dip net. Start count verified by GY & –.
4. Place lid with gasket on jar. Seal lip with stretch wrap.
5. **Start** test at 1010 h on 9-21-15. Place Tidbit temp recorder (SN 9716078, West shelf; SN 10689548, East shelf) in beaker w/WW into EC.
6. Remove dead fish daily; record #/~~weight/length/~~ time dead. Record survival daily. Measure Temp, pH & DO daily in all trtmts.
7. Transfer fish by net to new solution as indicated above.
8. **End** test at 1010 h on 9-25-15. Measure Temp, pH and DO in all trtmts. Sample for Tot. Alk, Tot. Hard, Cond.

Perc 96-Hour Acute Static Renewal Test
Rainbow Trout

Test #: 7745
Test Date: 9-21-15

Perc Sampling

1. Sample Perc solution from each test jar at 0 and 96 h. Place sample in 40 mL glass vial with septa cap.

0 hour sampled at 0930 on 9-21-15
96 hour sampled at 1000 on 9-25-15

OR → white sampled 9-22

MEASUREMENTS

Code	Sample Conc (mg/L)	Rep	Cumulative Survival (#Alive/Rep) 24 h	48 h	72 h	96 h	Tot # Alive
Blue	0	A	10	10	10	10	
		B	10	10	10	10	
Green	33	A	10	8	8	8	
		B	10	10	10	10	
Yellow	50	A	10	10	10	10	
		B	10	9	9	9	
Orange	75	A	0	0	0	0	
		B	0	0	0	0	
Red	113	A	0	0	0	0	
		B	0	0	0	0	
White	170	A	0	0	0	0	
		B	0	0	0	0	
		Analyst:	GY	GY	GY	GY	

s = stressed

Code	Rep		Daily #Dead/Rep 1	2	3	4	5	6	7	8	9	10	Mean
White	A	Date	9-22	9-22	9-22	9-22	9-22	9-22	9-22	9-22	9-22	9-22	
		Time	0540	0540	0540	0540	0540	0540	0540	0540	0540	0540	
White	B	Date	9-22	9-22	9-22	9-22	9-22	9-22	9-22	9-22	9-22	9-22	
		Time	0540	0540	0540	0540	0540	0540	0540	0540	0540	0540	
Red	A	Date	9-22	9-22	9-22	9-22	9-22	9-22	9-22	9-22	9-22	9-22	
		Time	0540	0540	0540	0540	0540	0540	0540	0540	0540	0540	
Red	B	Date	9-22	9-22	9-22	9-22	9-22	9-22	9-22	8-22	9-22	9-22	
		Time	0540	0540	0540	0540	0540	0540	0540	0540	0540	0540	
Orange	A	Date	9-22	9-22	9-22	9-22	9-22	9-22	9-22	9-22	9-22	9-22	
		Time	0540	0540	0540	0540	0540	0540	0540	0540	0540	0540	
Orange	B	Date	9-22	9-22	9-22	9-22	9-22	9-22	9-22	9-22	9-22	9-22	
		Time	0540	0540	0540	0540	0540	0540	0540	0540	0540	0540	
Yellow	B	Date	9-23										
		Time	0900										
Green	A	Date	9-23	9-23									
		Time	0900	0900									

Perc 96-Hour Acute Static Renewal Test
Rainbow Trout

Test #: 7745
Test Date: 9-21-15

Chemistry

Code	Rep	Temp (°C) SN: 150104270					pH					D.O. (mg/L)				
		0h	24h	48h	72h	96h	0h	24h	48h	72h	96h	0h	24h	48h	72h	96h
Blue	A	11.4	11.7	11.7	11.7	11.8	7.947 7.952	7.486	7.375	7.479	7.308	9.8	8.6	8.5	8.2	8.5
	B	11.3	11.4	11.6	11.6	11.6	7.992	7.532	7.398	7.589	7.345	9.9	8.5	8.4	8.3	8.5
Grn	A	11.3	11.6	11.5	11.6	11.7	8.009	7.553	7.314	7.618	7.449	9.9	8.3	7.9	8.6	9.0
	B	11.1	11.5	11.5	11.6	11.8	8.013	7.594	7.337	7.571	7.359	9.9	8.4	8.4	8.3	8.4
Yell	A	11.1	11.6	11.5	11.6	11.6	8.015	7.598	7.423	7.602	7.388	10.0	8.6	8.4	8.4	8.7
	B	11.4	11.5	11.5	11.6	11.7	8.024	7.642	7.320	7.630	7.288	9.9	8.6	8.3	8.5	8.7
Orng	A	11.3	11.9	–	–	–	8.031	7.661	–	–	–	10.0	9.1	–	–	–
	B	11.3	11.5	–	–	–	8.041	7.701	–	–	–	9.9	9.1	–	–	–
Red	A	11.5	11.5	–	–	–	8.042	7.822	–	–	–	9.9	9.6	–	–	–
	B	11.0	11.9	–	–	–	8.040	7.812	–	–	–	10.0	9.6	–	–	–
Wht	A	11.4	11.6	–	–	–	8.038	7.825	–	–	–	9.9	9.7	–	–	–
	B	11.3	11.7	–	–	–	8.045	7.889	–	–	–	9.9	9.7	–	–	–
Analyst:		GY	GY	GY	GY	GY	GY	GY	GY	GY	GY	GY	GY	GY	GY	GY

Taken in Surrogate jar ok Taken in Test jar 24h/96h

Code	Sample Conc (mg/L)	Sample # 0 h	Sample # 96 h	T. Alkalinity (mg/L as $CaCO_3$) 0 h	T. Alkalinity (mg/L as $CaCO_3$) 96 h	T. Hardness (mg/L as $CaCO_3$) 0 h	T. Hardness (mg/L as $CaCO_3$) 96 h	Conductivity (µmhos/cm) 0 h	Conductivity (µmhos/cm) 96 h
Blue	0	13783-1	-7	64.4	65.1	88.7	88	218	222
Green	33	-2	-8	64.6	65.4	89.1	87.8	220	223
Yellow	50	-3	-9	64.7	66.2	88.4	87.3	220	224
Orange	75	-4	-10*	64.4	66	89.4	85.8	219	226 *
Red	113	-5	-11*	64.8	65	87.3	87.4	221	222 *
White	170	-6	-12*	65.1	65.1	90.6	87.5	221	222 *
							Analyst:	GY	GY

* Taken at 24h

Perc 96-Hour Acute Static Renewal Test
Rainbow Trout

Test #: 7745
Test Date: 9-21-15

Test Organism Data at 96 Hours			
Sampled From: Control **Rep** A			
Fish	**Length (cm)**	**Weight (g)**	
1	3.6	0.589	
2	3.7	0.577	
3	3.3	0.457	
4	3.2	0.356	
5	3.4	0.418	
6	3.8	0.546	
7	3.5	0.415	
8	3.4	0.343	
9	3.4	0.330	
10	3.5	0.460	
Mean:	3.5	0.449	**Load Rate:**
Load Rate = [(Wt)(# Fish)]/ Vol Where: Wt = Mean Wt in g Vol = Total Test Vol in L # Fish = # Fish/Rep			(0.449 g)(10)/ 8 L = 0.56 g/L

Random # Beaker Position					
Code	**Rep**	**Random Jar #**	**Code**	**Rep**	**Random Jar #**
Blue	A	6	Orange	A	5
	B	3		B	8
Green	A	10	Red	A	9
	B	7		B	1
Yellow	A	4	White	A	11
	B	12		B	2

GY
~~East~~ West
Blue A, B
Yellow A
or A
Red B
White B

East
Green A, B
Yellow B
orange B
Red A
White A

NOTES

Perc ~~beads~~ GY Beads up on bottom ~~off~~ GY of test jar.

CETIS Analytical Report

Fish 96-h Acute Survival Test — **King County Metro Services, WQ Lab**

Analysis ID:	18-9964-2376	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	28 Oct-15 12:08	**Analysis:**	Trimmed Spearman-Kärber	**Official Results:**	Yes
Batch ID:	10-2651-2670	**Test Type:**	Survival (96h)	**Analyst:**	GY
Start Date:	21 Sep-15 10:10	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Well Water
Ending Date:	25 Sep-15 10:10	**Species:**	Oncorhynchus mykiss	**Brine:**	Not Applicable
Duration:	96h	**Source:**	Trout Lodge Fish Farm	**Age:**	
Sample ID:	06-2783-2187	**Code:**	256BF57B	**Client:**	Internal Lab
Sample Date:	21 Sep-15 10:00	**Material:**	Perchloroethylene	**Project:**	Dry Cleaners
Receive Date:		**Source:**	Public Health		
Sample Age:	10m	**Station:**			

Trimmed Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	7.50%	0.558	0.003957	3.614	3.549	3.68

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

96h Survival Rate Summary

			Calculated Variate(A/B)								
C-mg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Dilution Water	2	1	1	1	0	0	0.0%	0.0%	20	20
1.78		2	0.9	0.8	1	0.1	0.1414	15.71%	10.0%	18	20
3.2		2	0.95	0.9	1	0.05	0.07071	7.44%	5.0%	19	20
4.17		2	0	0	0	0	0		100.0%	0	20
5.4		2	0	0	0	0	0		100.0%	0	20

96h Survival Rate Detail

C-mg/L	Control Type	Rep 1	Rep 2
0	Dilution Water	1	1
1.78		0.8	1
3.2		1	0.9
4.17		0	0
5.4		0	0

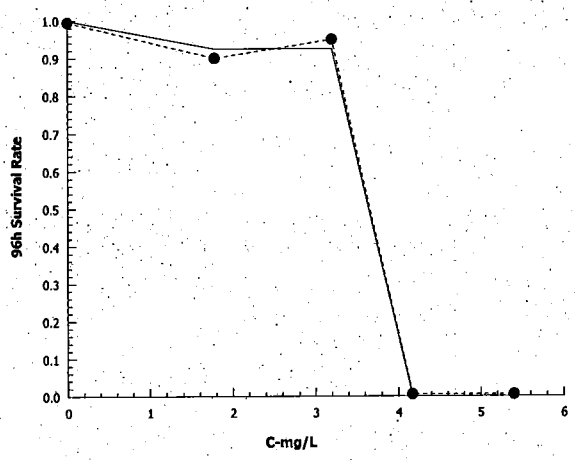
96h Survival Rate Binomials

C-mg/L	Control Type	Rep 1	Rep 2
0	Dilution Water	10/10	10/10
1.78		8/10	10/10
3.2		10/10	9/10
4.17		0/10	0/10
5.4		0/10	0/10

Fish 96-h Acute Survival Test — **King County Metro Services, WQ Lab**

Analysis ID:	18-9964-2376	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	28 Oct-15 12:08	**Analysis:**	Trimmed Spearman-Kärber	**Official Results:**	Yes

Graphics



CETIS Summary Report

Fish 96-h Acute Survival Test — **King County Metro Services, WQ Lab**

Batch ID:	10-2651-2670	**Test Type:**	Survival (96h)	**Analyst:**	GY
Start Date:	21 Sep-15 10:10	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Well Water
Ending Date:	25 Sep-15 10:10	**Species:**	Oncorhynchus mykiss	**Brine:**	Not Applicable
Duration:	96h	**Source:**	Trout Lodge Fish Farm	**Age:**	
Sample ID:	06-2783-2187	**Code:**	256BF57B	**Client:**	Internal Lab
Sample Date:	21 Sep-15 10:00	**Material:**	Perchloroethylene	**Project:**	Dry Cleaners
Receive Date:		**Source:**	Public Health		
Sample Age:	10m	**Station:**			

Point Estimate Summary

Analysis ID	Endpoint	Level	mg/L	95% LCL	95% UCL	TU	Method
18-9964-2376	96h Survival Rate	EC50	3.614	3.549	3.68		Trimmed Spearman-Kärber

Test Acceptability

Analysis ID	Endpoint	Attribute	Test Stat	TAC Limits	Overlap	Decision
18-9964-2376	96h Survival Rate	Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

96h Survival Rate Summary

C-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Dilution Water	2	1	1	1	1	1	0	0	0.0%	0.0%
1.78		2	0.9	0	1	0.8	1	0.1	0.1414	15.71%	10.0%
3.2		2	0.95	0.3147	1	0.9	1	0.05	0.07071	7.44%	5.0%
4.17		2	0	0	0	0	0	0	0		100.0%
5.4		2	0	0	0	0	0	0	0		100.0%

96h Survival Rate Detail

C-mg/L	Control Type	Rep 1	Rep 2
0	Dilution Water	1	1
1.78		0.8	1
3.2		1	0.9
4.17		0	0
5.4		0	0

96h Survival Rate Binomials

C-mg/L	Control Type	Rep 1	Rep 2
0	Dilution Water	10/10	10/10
1.78		8/10	10/10
3.2		10/10	9/10
4.17		0/10	0/10
5.4		0/10	0/10

King County Environmental Lab Analytical Report

Project:	421193					Project:	421193					Project:	421193				
Locator:	LAB					Locator:	LAB					Locator:	LAB				
Sample:	L63780-1					Sample:	L63780-2					Sample:	L63780-3				
Matrix:	LK FRESH WTR					Matrix:	LK FRESH WTR					Matrix:	LK FRESH WTR				
ColDate:	9/21/15 0:00					ColDate:	9/21/15 0:00					ColDate:	9/21/15 0:00				
WET Weight Basis						WET Weight Basis						WET Weight Basis					
Parameters	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units		Value	Qual	MDL	RDL	Units	
OR EPA 624/SW846 5030C*8260C																	
Tetrachloroethylene		**<MDL**	**1**	**2**	**ug/L**	**813**		**25**	**50**	**ug/L**		**770**		**25**	**50**	**ug/L**	
Acetone		**<MDL**	**2.5**	**10**	**ug/L**		**<MDL**	**63**	**250**	**ug/L**			**<MDL**	**63**	**250**	**ug/L**	
1,1,1-Trichloroethane		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
1,1,2,2-Tetrachloroethane		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
1,1,2-Trichloroethane		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
1,1,2-Trichloroethylene		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
1,1-Dichloroethane		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
1,1-Dichloroethylene		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
1,2-Dibromoethane		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
1,2-Dichlorobenzene		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
1,2-Dichloroethane		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
1,2-Dichloropropane		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
1,3-Dichlorobenzene		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
1,4-Dichlorobenzene		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
2-Butanone (MEK)		<MDL	5	10	ug/L		<MDL	130	250	ug/L			<MDL	130	250	ug/L	
2-Chloroethylvinyl ether		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
2-Hexanone		<MDL	5	10	ug/L		<MDL	130	250	ug/L			<MDL	130	250	ug/L	
4-Methyl-2-Pentanone (MIBK)		<MDL	5	10	ug/L		<MDL	130	250	ug/L			<MDL	130	250	ug/L	
Acrolein		<MDL	5	10	ug/L		<MDL	130	250	ug/L			<MDL	130	250	ug/L	
Acrylonitrile		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Benzene		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Bromodichloromethane		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Bromoform		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Bromomethane		<MDL	5	10	ug/L		<MDL	130	250	ug/L			<MDL	130	250	ug/L	
Carbon Disulfide		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Carbon Tetrachloride		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Chlorobenzene		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Chlorodibromomethane		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Chloroethane		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Chloroform		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Chloromethane		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Cis-1,3-Dichloropropene		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Ethylbenzene		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
M/P Xylenes		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Methylene Chloride		<MDL	5	10	ug/L		<MDL	130	250	ug/L			<MDL	130	250	ug/L	
Methyl-t-butyl Ether (MTBE)		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
O-Xylene		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Styrene		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Toluene		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Total Xylenes		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Trans-1,2-Dichloroethylene		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Trans-1,3-Dichloropropene		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Trichlorofluoromethane		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	
Vinyl Acetate		<MDL	5	10	ug/L		<MDL	130	250	ug/L			<MDL	130	250	ug/L	
Vinyl Chloride		<MDL	1	2	ug/L		<MDL	25	50	ug/L			<MDL	25	50	ug/L	

King County Environmental Lab Analytical Report

	Project: 421193 Locator: LAB Sample: L63780-4 Matrix: LK FRESH WTR ColDate: 9/21/15 0:00 WET Weight Basis					Project: 421193 Locator: LAB Sample: L63780-5 Matrix: LK FRESH WTR ColDate: 9/21/15 0:00 WET Weight Basis					Project: 421193 Locator: LAB Sample: L63780-6 Matrix: LK FRESH WTR ColDate: 9/21/15 0:00 WET Weight Basis				
Parameters	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units	Value	Qual	MDL	RDL	Units
OR EPA 624/SW846 5030C*8260C															
Tetrachloroethylene	1630		25	50	ug/L	2340		25	50	ug/L	2450		50	100	ug/L
Acetone		<MDL	63	250	ug/L		<MDL	63	250	ug/L		<MDL	130	500	ug/L
1,1,1-Trichloroethane		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
1,1,2,2-Tetrachloroethane		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
1,1,2-Trichloroethane		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
1,1,2-Trichloroethylene		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
1,1-Dichloroethane		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
1,1-Dichloroethylene		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
1,2-Dibromoethane		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
1,2-Dichlorobenzene		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
1,2-Dichloroethane		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
1,2-Dichloropropane		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
1,3-Dichlorobenzene		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
1,4-Dichlorobenzene		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
2-Butanone (MEK)		<MDL	130	250	ug/L		<MDL	130	250	ug/L		<MDL	250	500	ug/L
2-Chloroethylvinyl ether		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
2-Hexanone		<MDL	130	250	ug/L		<MDL	130	250	ug/L		<MDL	250	500	ug/L
4-Methyl-2-Pentanone (MIBK)		<MDL	130	250	ug/L		<MDL	130	250	ug/L		<MDL	250	500	ug/L
Acrolein		<MDL	130	250	ug/L		<MDL	130	250	ug/L		<MDL	250	500	ug/L
Acrylonitrile		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Benzene		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Bromodichloromethane		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Bromoform		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Bromomethane		<MDL	130	250	ug/L		<MDL	130	250	ug/L		<MDL	250	500	ug/L
Carbon Disulfide		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Carbon Tetrachloride		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Chlorobenzene		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Chlorodibromomethane		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Chloroethane		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Chloroform		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Chloromethane		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Cis-1,3-Dichloropropene		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Ethylbenzene		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
M/P Xylenes		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Methylene Chloride		<MDL	130	250	ug/L		<MDL	130	250	ug/L		<MDL	250	500	ug/L
Methyl-t-butyl Ether (MTBE)		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
O-Xylene		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Styrene		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Toluene		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Total Xylenes		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Trans-1,2-Dichloroethylene		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Trans-1,3-Dichloropropene		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Trichlorofluoromethane		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L
Vinyl Acetate		<MDL	130	250	ug/L		<MDL	130	250	ug/L		<MDL	250	500	ug/L
Vinyl Chloride		<MDL	25	50	ug/L		<MDL	25	50	ug/L		<MDL	50	100	ug/L

King County Environmental Lab Analytical Report

	Project: 421193 Locator: LAB Sample: L63781-1 Matrix: LK FRESH WTR ColDate: 9/25/15 0:00 WET Weight Basis					Project: 421193 Locator: LAB Sample: L63781-2 Matrix: LK FRESH WTR ColDate: 9/25/15 0:00 WET Weight Basis					Project: 421193 Locator: LAB Sample: L63781-3 Matrix: LK FRESH WTR ColDate: 9/25/15 0:00 WET Weight Basis				
Parameters	**Value**	**Qual**	**MDL**	**RDL**	**Units**	**Value**	**Qual**	**MDL**	**RDL**	**Units**	**Value**	**Qual**	**MDL**	**RDL**	**Units**
OR EPA 624/SW846 5030C*8260C															
Tetrachloroethylene		<MDL	1	2	ug/L	1780		100	200	ug/L	3200		100	200	ug/L
Acetone	4.4	<RDL	2.5	10	ug/L		<MDL	250	1000	ug/L		<MDL	250	1000	ug/L
1,1,1-Trichloroethane		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
1,1,2,2-Tetrachloroethane		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
1,1,2-Trichloroethane		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
1,1,2-Trichloroethylene		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
1,1-Dichloroethane		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
1,1-Dichloroethylene		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
1,2-Dibromoethane		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
1,2-Dichlorobenzene		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
1,2-Dichloroethane		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
1,2-Dichloropropane		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
1,3-Dichlorobenzene		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
1,4-Dichlorobenzene		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
2-Butanone (MEK)		<MDL	5	10	ug/L		<MDL	500	1000	ug/L		<MDL	500	1000	ug/L
2-Chloroethylvinyl ether		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
2-Hexanone		<MDL	5	10	ug/L		<MDL	500	1000	ug/L		<MDL	500	1000	ug/L
4-Methyl-2-Pentanone (MIBK)		<MDL	5	10	ug/L		<MDL	500	1000	ug/L		<MDL	500	1000	ug/L
Acrolein		<MDL	5	10	ug/L		<MDL	500	1000	ug/L		<MDL	500	1000	ug/L
Acrylonitrile		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Benzene		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Bromodichloromethane		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Bromoform		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Bromomethane		<MDL	5	10	ug/L		<MDL	500	1000	ug/L		<MDL	500	1000	ug/L
Carbon Disulfide		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Carbon Tetrachloride		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Chlorobenzene		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Chlorodibromomethane		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Chloroethane		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Chloroform		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Chloromethane		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Cis-1,3-Dichloropropene		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Ethylbenzene		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
M/P Xylenes		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Methylene Chloride		<MDL	5	10	ug/L		<MDL	500	1000	ug/L		<MDL	500	1000	ug/L
Methyl-t-butyl Ether (MTBE)		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
O-Xylene		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Styrene		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Toluene		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Total Xylenes		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Trans-1,2-Dichloroethylene		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Trans-1,3-Dichloropropene		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Trichlorofluoromethane		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L
Vinyl Acetate		<MDL	5	10	ug/L		<MDL	500	1000	ug/L		<MDL	500	1000	ug/L
Vinyl Chloride		<MDL	1	2	ug/L		<MDL	100	200	ug/L		<MDL	100	200	ug/L

King County Environmental Lab Analytical Report

	Project: 421193 Locator: LAB Sample: L63781-4 Matrix: LK FRESH WTR ColDate: 9/22/15 0:00 WET Weight Basis					Project: 421193 Locator: LAB Sample: L63781-5 Matrix: LK FRESH WTR ColDate: 9/22/15 0:00 WET Weight Basis					Project: 421193 Locator: LAB Sample: L63781-6 Matrix: LK FRESH WTR ColDate: 9/22/15 0:00 WET Weight Basis				
Parameters	**Value**	**Qual**	**MDL**	**RDL**	**Units**	**Value**	**Qual**	**MDL**	**RDL**	**Units**	**Value**	**Qual**	**MDL**	**RDL**	**Units**
OR EPA 624/SW846 5030C*8260C															
Tetrachloroethylene	4170		50	100	ug/L	5400		50	100	ug/L	5360		50	100	ug/L
Acetone		<MDL	130	500	ug/L		<MDL	130	500	ug/L		<MDL	130	500	ug/L
1,1,1-Trichloroethane		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
1,1,2,2-Tetrachloroethane		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
1,1,2-Trichloroethane		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
1,1,2-Trichloroethylene		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
1,1-Dichloroethane		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
1,1-Dichloroethylene		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
1,2-Dibromoethane		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
1,2-Dichlorobenzene		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
1,2-Dichloroethane		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
1,2-Dichloropropane		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
1,3-Dichlorobenzene		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
1,4-Dichlorobenzene		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
2-Butanone (MEK)		<MDL	250	500	ug/L		<MDL	250	500	ug/L		<MDL	250	500	ug/L
2-Chloroethylvinyl ether		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
2-Hexanone		<MDL	250	500	ug/L		<MDL	250	500	ug/L		<MDL	250	500	ug/L
4-Methyl-2-Pentanone (MIBK)		<MDL	250	500	ug/L		<MDL	250	500	ug/L		<MDL	250	500	ug/L
Acrolein		<MDL	250	500	ug/L		<MDL	250	500	ug/L		<MDL	250	500	ug/L
Acrylonitrile		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Benzene		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Bromodichloromethane		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Bromoform		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Bromomethane		<MDL	250	500	ug/L		<MDL	250	500	ug/L		<MDL	250	500	ug/L
Carbon Disulfide		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Carbon Tetrachloride		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Chlorobenzene		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Chlorodibromomethane		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Chloroethane		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Chloroform		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Chloromethane		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Cis-1,3-Dichloropropene		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Ethylbenzene		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
M/P Xylenes		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Methylene Chloride		<MDL	250	500	ug/L		<MDL	250	500	ug/L		<MDL	250	500	ug/L
Methyl-t-butyl Ether (MTBE)		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
O-Xylene		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Styrene		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Toluene		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Total Xylenes		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Trans-1,2-Dichloroethylene		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Trans-1,3-Dichloropropene		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Trichlorofluoromethane		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L
Vinyl Acetate		<MDL	250	500	ug/L		<MDL	250	500	ug/L		<MDL	250	500	ug/L
Vinyl Chloride		<MDL	50	100	ug/L		<MDL	50	100	ug/L		<MDL	50	100	ug/L

Reference Toxicant Test:

Bench Sheets

Precision Table

Reference Toxicant, Cd, 96-Hour Acute Static Renewal Test
Rainbow Trout

Test #: 7757
Test Date: 9-28-15

ORGANISMS

400 fish received from Trout Lodge Lot # (Swim-up date): 8-24-15 Shipped via Pick up Arrived at KCEL at 1405 h on 9-10-15 in 1 Box Double poly. ____ dead removed. *At Arrival:* pH —, D.O. ≥20 mg/L, Temp 8.7 °C. Into Tank # 1 Hold in tank with new well water and aeration for 18 days. Feed 2X/day with Ziegler's #1. Refer to culture log for feeding & holding information.

DILUTION WATER/TOXICANT

1. New Well Water (NWW) 9-27-15, filtered through nylon netting.
2. Cd Stock Soln: Nominal 20 mg Cd/L, Measured 20.3 mg/L on 12-20-12 Prep 12-5-12 # — by add ____ g $Cd(NO_3)_2 \cdot 4H_2O$ (mfr Baker # I-1226, rec'd —, opened —, lot # 049130) ⊆ 1L DW.

LIMS RTA Sample #: WG142235-1 Wkgp #: WG142235

SOLUTIONS

Cd Trtmt (µg/L)	Code	Cd Stock (mL/ jar)	NWW (L/ jar)	Sample #	Cd (µg/L) (Measured)
0	Blue	0 (NWW only)	12 L (NWW only)		
0.75	Green	0.44	⊆ 12L		
1.5	Yellow	0.89	↓		
3.0	Orange	1.77	↓	*63946-1	3.02
6.0	Red	3.55	↓		
12.0	White	7.10	↓		

PROCEDURE

1. Add 12 L NWW to each of 2 jars/trtmt; place in 12°C EC # 8556, East & West shelf. Bring to 12°C. **Setup** at — h.
2. Measure DO; if DO << saturation, aerate until DO ≥ 9 mg/L. Stop aeration.
3. Measure Temp, pH & DO. in all trtmts.
4. Add Cd stock soln to jars: ✓ Mix: ✓ Take at 48h Sample for Cd: ✓ Acidify: ✓ Analyst: GY
5. Add 10 fish/jar, one at a time to randomize, using dip net. Start count verified by GY & —.
6. **Start** test at 1000 h on 9-28-15. Place Tidbit temp recorder (SN 9716078, West shelf; SN 10680548, East shelf) in beaker w/WW into EC.
7. Remove dead fish daily; record #/ weight/ length/ time dead. Record survival daily. Measure Temp, pH & DO daily in all trtmts.
8. Renew solns (≈ 80%) at 48h:
   a) Siphon 9.6 L from each jar.
   b) Filter NWW into 4L graduated cylinder.
   c) Add Cd stock soln ⊆ 4L aliquot during filling as below:

Cd (µg/L):	0	0.75	1.5	3	6	12
mL Cd Stock:	0	0.15	0.30	0.60	—	—

   d) Replace ⊆ 64/12 L/jar with fresh soln by pouring through funnel and tubing into jar.
9. **End** test at 1005 h on 10-2-15. Measure Temp, pH and DO in all trtmts.

Reference Toxicant, Cd, 96-Hour Acute Static Renewal Test
Rainbow Trout

Test #: 7757
Test Date: 9-28-05

MEASUREMENTS

Code	Cd (µg/L)	Rep	Cumulative Survival (#Alive/Rep) 24 h	48 h	72 h	96 h	Tot # Alive
Blue	0	A	10	10	10	10	10
	0	B	10	10	10	10	10
Green	0.75	A	10	10	10	10	10
	0.75	B	10	10	10	10	10
Yellow	1.5	A	10	10	6	6	6
	1.5	B	10	9	8	8	8
Orange	3	A	6	6 ~~5~~ 4	1	1	1
	3	B	5	1	0	0	0
Red	6	A	0	0	0	0	0
	6	B	2	0	0	0	0
White	12	A	0	0	0	0	0
	12	B	0	0	0	0	0
		Analyst:	GY	GY	GY	GY	

s = stressed

Code	Rep		Daily #Dead/Rep 1	2	3	4	5	6	7	8	9	10	Mean
White	B	Date	9-29	9-29	9-29	9-29	9-29	9-29	9-29	9-29	9-29	9-29	
		Time	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	
		cm	3.8	3.8	3.8	3.6	4.2	3.6	3.9	4.0	3.8	3.3	3.8
		g	0.778	0.876	0.966	0.758	1.054	0.851	0.987	1.058	0.967	0.464	0.876
White	A	Date	9-29	9-29	9-29	9-29	9-29	9-29	9-29	9-29	9-29	9-29	
		Time	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	
Red	A	Date	9-29	9-29	9-29	9-29	9-29	9-29	9-29	9-29	9-29	9-29	
		Time	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	
Red	B	Date	9-29	9-29	9-29	9-29	9-29	9-29	9-29	9-29	9-30	9-30	
		Time	1400	1400	1400	1400	1400	1400	1400	1400	0855	0855	
OR	A	Date	9-29	9-29	9-29	9-29	9-30	9-30	10-1	10-1	10-1		
		Time	1400	1400	1400	1400	0855	1050	0900	0900	0900		
OR	B	Date	9-29	9-29	9-29	9-29	9-29	9-30	9-30	9-30	9-30	10-1	
		Time	1400	1400	1400	1400	1400	0855	0855	0855	0855	0900	
Yell	B	Date	9-30	10-1									
		Time	0855	0900									
Yell	A	Date	10-1	10-1	10-1	10-1							
		Time	0900	0900	0900	0900							
		Date											
		Time											
		Date											
		Time											

Load Rate = [(Wt)(# Fish)]/ Vol = (0.876 g)(10)/ 12 L = 0.73 g/L

Where: Wt = Mean Wt in g; Vol = Total Test Vol in L; # Fish = #Fish/Rep

Reference Toxicant, Cd, 96-Hour Acute Static Renewal Test
Rainbow Trout

Test #: 7757
Test Date: 9-28-15

Chemistry

Code	Rep	Temp (°C) SN: 150104270					pH					D.O. (mg/L)				
		0h	24h	48h	72h	96h	0h	24h	48h	72h	96h	0h	24h	48h	72h	96h
Blue	A	11.7	11.6	11.6	11.6	11.7	7.884	7.511	7.526	7.628	7.510	9.7	7.9	8.1	8.5	7.7
	B	11.8	11.8	11.6	11.8	11.8	7.952	7.590	7.614	7.682	7.589	9.8	8.3	8.4	8.7	8.0
Grn	A	11.6	11.6	11.6	11.5	11.7	7.977	7.638	7.659	7.699	7.629	9.8	8.4	8.5	8.6	8.0
	B	11.7	11.6	11.6	11.6	11.7	7.991	7.668	7.669	7.735	7.655	9.8	8.7	8.6	9.0	8.7
Yell	A	11.7	11.5	11.5	11.6	11.5	8.001	7.654	7.598	7.684 ~~7.932~~ GY	7.683	9.8	8.1	8.1	8.4	8.7
	B	11.8	11.7	11.8	11.9	11.9	8.007	7.588	7.597	7.712	7.716	9.8	8.1	8.2	8.8	8.5
Orng	A	11.8	11.6	11.7	11.7	11.8	8.011	7.535	7.632	7.841	7.853	9.8	7.6	8.3	9.7	9.8
	B	11.6	11.6	11.7	11.6	–	8.007	7.570	7.666	7.955	–	9.8	7.9	8.7	10.2	–
Red	A	11.7	11.6	–	–	–	8.006	7.595	–	–	–	9.8	7.7	–	–	–
	B	11.6	11.7	11.7	–	–	8.008	7.605	7.715	–	–	9.8	8.0	8.8	–	–
Wht	A	11.4	11.6	–	–	–	8.013	7.589	–	–	–	9.8	8.1	–	–	–
	B	11.7	11.6	–	–	–	8.016	7.584	–	–	–	9.8	8.0	–	–	–
Analyst:		GY	GY	GY	GY	GY	GY	GY	GY	GY	GY	GY	GY	GY	GY	GY

Random # Beaker Position					
Code	Rep	Random Jar #	Code	Rep	Random Jar #
Blue	A	11	Orange	A	2
	B	1		B	6
Green	A	7	Red	A	8
	B	10		B	5
Yellow	A	12	White	A	3
	B	4		B	9

NOTES

Rainbow Trout (*Onchorhyncus mykiss*), Acute Test Precision

96-Hour Exposure to Reference Toxicant, Cd, µg/L

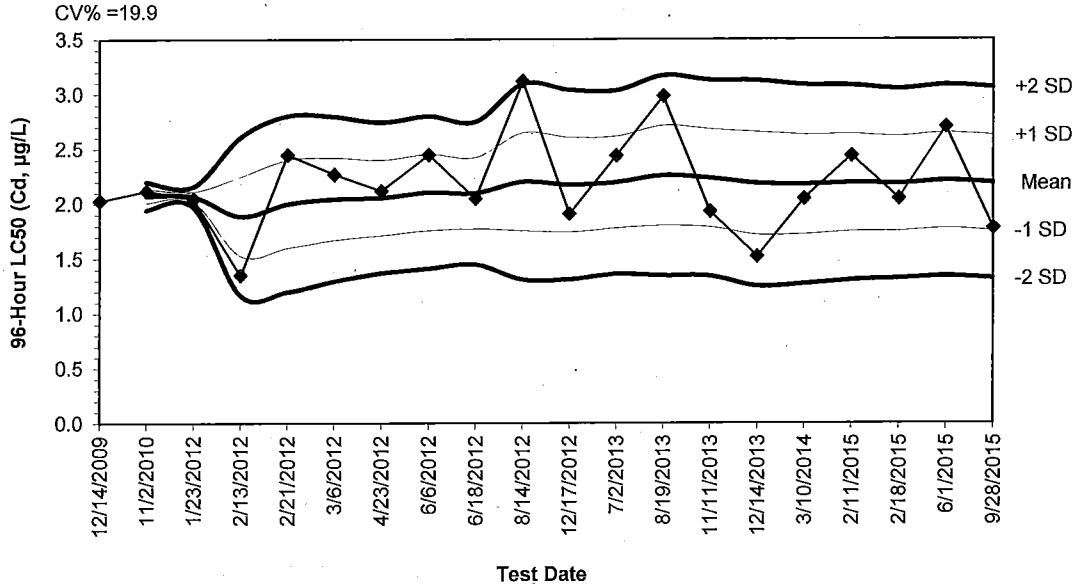
Table 3 of 3

Date	Test #	Rainbow Trout Lot #	Dilution Series, Cd, µg/L	Ref. Tox. Lot #	Water	Control Mortality, %	Pass/ Fail	Survival LC50	Stats	Control Limits	% COV
060424	3826	060317	.75 1.5 3 6 12	991020#6	NWW	0	P	1.5	SK	0.9 – 4.2	33
060809	3932	060714	.75 1.5 3 6 12	991020#6	NWW	0	P	1.26	SK	0.72 – 4.23	35.5
070305	4049	070209	.75 1.5 3 6 12	991020#6	NWW	0	P	1.31	SK	0.61 – 4.12	37.2
070904	4222	070813	.75 1.5 3 6 12	991020#6	NWW	0	P	1.31	SK	0.51 – 4.02	38.8
080421	4357	080320	.75 1.5 3 6 12	991020#6	NWW	0	P	1.78	SK	0.46 – 3.99	39.7
081208	4635	081110	.75 1.5 3 6 12	080228#1	NWW	0	P	1.90	PA	0.54 – 3.71	37.3
091214	5077	091117	.75 1.5 3 6 12	080228#1	NWW	0	P	2.03	PA	0.55 – 3.61	36.8
101102	5550	101018	.75 1.5 3 6 12	080228#1	NWW	0	P	2.12	SK	0.57 – 3.51	36.1
120123	6104	111226	.75 1.5 3 6 12	080228#1	NWW	0	P	2.05	PA	0.60 – 3.51	35.4
120213	6116	111226 (49d old)	.75 1.5 3 6 12	080228#1	NWW	0	P	1.35	PA	0.53 – 3.45	36.6
120212	6118	111226	.75 1.5 3 6 12	080228#1	NWW	0	P	2.45	PA	0.61 – 3.29	34.3
120306	6124	120125 (41d old)	.75 1.5 3 6 12	080228#1	NWW	0	P	2.27	SK	0.61 – 3.27	34.3
120423	6159	120321 (33d old)	.75 1.5 3 6 12	080228#1	NWW	0	P	2.12	PA	0.88 – 2.82	26.2
120606	6211	120420 (47d old)	.75 1.5 3 6 12	080228#1	NWW	0	P	2.45	PA	1.02 – 2.60	21.8
120618	6226	120511 (38d old)	.75 1.5 3 6 12	080228#1	NWW	0	P	2.05	PA	1.04 – 2.63	21.7
120814	6338	120608 (67d old)	.75 1.5 3 6 12	080228#1	NWW	0	P	3.12*	PA	0.92 – 2.88	25.7
121217	6539	121121 (26d old)	.75 1.5 3 6 12	080228#1	NWW	0	P	1.91	SK	0.99 – 2.87	24.4
130702	6706	130520 (43d old)	.75 1.5 3 6 12	121205	NWW	0	P	2.44	SK	0.98 – 2.89	24.7
130819	6774	130710 (40d old)	.75 1.5 3 6 12	121205	NWW	0	P	2.98	TSK	0.96 – 3.06	26.2
131111	6926	131011 (31d old)	.75 1.5 3 6 12	121205	NWW	0	P	1.93	TSK	0.97 – 3.06	25.8
131214	6972	131118 (26d old)	.75 1.5 3 6 12	121205	NWW	0	P	1.52	PA	0.98 – 3.06	25.8
140310	7007	140212 (26d old)	.75 1.5 3 6 12	121205	NWW	0	P	2.05	SK	1.08 – 3.03	23.8
150211	7439	150116 (26d old)	.75 1.5 3 6 12	121205	NWW	0	P	2.44	SK	1.19 – 3.04	21.9
150218	7440	150116 (33d old)	.75 1.5 3 6 12	121205	NWW	0	P	2.05	SK	1.31 – 3.00	19.6
150601	7538	150501 (31d old)	.75 1.5 3 6 12	121205	NWW	0	P	2.70	SK	1.34 – 3.06	19.6
150928	7757	150821(38d old)	.75 1.5 3 6 12	121205	NWW	0	P	1.78	SK	1.32 – 3.06	19.9

PA = Probit Analysis
MA = Moving Average
(T)SK = (Trimmed) Spearman Karber
GI = Graphical Interpolation

RW = Reconstituted Water
WW = Well Water
* = Value Outside Control Limits

Control Chart for Acute Reference Toxicant Tests with Rainbow Trout 96-Hour Survival LC50 (Cd, µg/L)



Dates	Values	Mean	-1 SD	-2 SD	+1 SD	+2 SD
12/14/2009	2.03					
11/2/2010	2.12	2.0750	2.0114	1.9477	2.1386	2.2023
1/23/2012	2.05	2.0667	2.0194	1.9722	2.1139	2.1612
2/13/2012	1.35	1.8875	1.5271	1.1667	2.2479	2.6083
2/21/2012	2.45	2.0000	1.5991	1.1983	2.4009	2.8017
3/6/2012	2.27	2.0450	1.6699	1.2948	2.4201	2.7952
4/23/2012	2.12	2.0557	1.7121	1.3685	2.3993	2.7429
6/6/2012	2.45	2.1050	1.7577	1.4104	2.4523	2.7996
6/18/2012	2.05	2.0989	1.7735	1.4481	2.4243	2.7497
8/14/2012	3.12	2.2010	1.7556	1.3102	2.6464	3.0918
12/17/2012	1.91	2.1745	1.7430	1.3114	2.6061	3.0377
7/2/2013	2.44	2.1967	1.7781	1.3596	2.6152	3.0338
8/19/2013	2.98	2.2569	1.8011	1.3452	2.7128	3.1686
11/11/2013	1.93	2.2336	1.7870	1.3404	2.6802	3.1267
12/14/2013	1.52	2.1860	1.7179	1.2498	2.6541	3.1222
3/10/2014	2.05	2.1775	1.7240	1.2704	2.6310	3.0846
2/11/2015	2.44	2.1929	1.7492	1.3055	2.6367	3.0804
2/18/2015	2.05	2.1850	1.7532	1.3214	2.6168	3.0486
6/1/2015	2.70	2.2121	1.7762	1.3402	2.6480	3.0840
9/28/2015	1.78	2.1905	1.7553	1.3202	2.6257	3.0608

7757RTA QC

CETIS Analytical Report

A/P 10-14-15

Report Date: 09 Oct-15 06:07 (p 1 of 2)
Test Code: 7757RTAQC | 00-2842-3543

Fish 96-h Acute Survival Test

King County Metro Services, WQ Lab

Analysis ID:	10-6563-0345	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Oct-15 13:47	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes
Batch ID:	01-1688-0167	**Test Type:**	Survival (96h)	**Analyst:**	GY
Start Date:	28 Sep-15 10:00	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Well Water
Ending Date:	02 Oct-15 10:05	**Species:**	Oncorhynchus mykiss	**Brine:**	Not Applicable
Duration:	4d 0h	**Source:**	Trout Lodge Fish Farm	**Age:**	
Sample ID:	21-0759-7768	**Code:**	WG142235-1	**Client:**	Internal Lab
Sample Date:	28 Sep-15 09:30	**Material:**	Cadmium nitrate	**Project:**	Reference Toxicant
Receive Date:		**Source:**	Reference Toxicant		
Sample Age:	30m	**Station:**			

Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	0.00%	0.2513	0.03416	1.784	1.524	2.088

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits	Overlap	Decision
Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

96h Survival Rate Summary

			Calculated Variate(A/B)								
C-µg/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Dilution Water	2	1	1	1	0	0	0.0%	0.0%	20	20
0.75		2	1	1	1	0	0	0.0%	0.0%	20	20
1.5		2	0.7	0.6	0.8	0.1	0.1414	20.2%	30.0%	14	20
3		2	0.05	0	0.1	0.05	0.07071	141.4%	95.0%	1	20
6		2	0	0	0	0	0		100.0%	0	20
12		2	0	0	0	0	0		100.0%	0	20

96h Survival Rate Detail

C-µg/L	Control Type	Rep 1	Rep 2
0	Dilution Water	1	1
0.75		1	1
1.5		0.6	0.8
3		0.1	0
6		0	0
12		0	0

96h Survival Rate Binomials

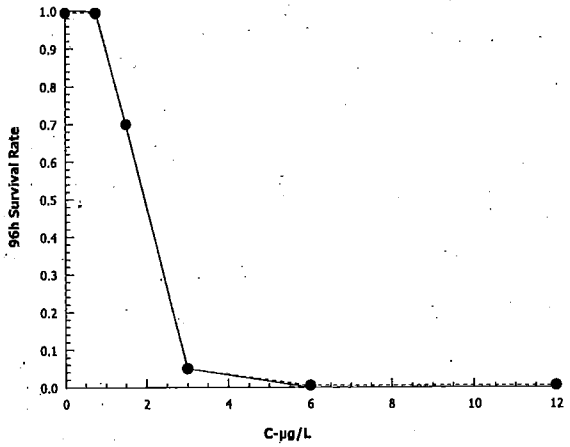
C-µg/L	Control Type	Rep 1	Rep 2
0	Dilution Water	10/10	10/10
0.75		10/10	10/10
1.5		6/10	8/10
3		1/10	0/10
6		0/10	0/10
12		0/10	0/10

Analyst: GY QA: Checked 10-9-15

Fish 96-h Acute Survival Test — **King County Metro Services, WQ Lab**

Analysis ID:	10-6563-0345	**Endpoint:**	96h Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Oct-15 13:47	**Analysis:**	Untrimmed Spearman-Kärber	**Official Results:**	Yes

Graphics



CETIS Summary Report

Test Code: 7757RTAQC | 00-2842-3543

Fish 96-h Acute Survival Test — **King County Metro Services, WQ Lab**

Batch ID:	01-1688-0167	**Test Type:**	Survival (96h)	**Analyst:**	GY
Start Date:	28 Sep-15 10:00	**Protocol:**	EPA/821/R-02-012 (2002)	**Diluent:**	Well Water
Ending Date:	02 Oct-15 10:05	**Species:**	Oncorhynchus mykiss	**Brine:**	Not Applicable
Duration:	4d 0h	**Source:**	Trout Lodge Fish Farm	**Age:**	
Sample ID:	21-0759-7768	**Code:**	WG142235-1	**Client:**	Internal Lab
Sample Date:	28 Sep-15 09:30	**Material:**	Cadmium nitrate	**Project:**	Reference Toxicant
Receive Date:		**Source:**	Reference Toxicant		
Sample Age:	30m	**Station:**			

Point Estimate Summary

Analysis ID	Endpoint	Level	µg/L	95% LCL	95% UCL	TU	Method
10-6563-0345	96h Survival Rate	EC50	1.784	1.524	2.088		Spearman-Kärber

Test Acceptability

Analysis ID	Endpoint	Attribute	Test Stat	TAC Limits	Overlap	Decision
10-6563-0345	96h Survival Rate	Control Resp	1	0.9 - NL	Yes	Passes Acceptability Criteria

96h Survival Rate Summary

C-µg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Dilution Water	2	1	1	1	1	1	0	0	0.0%	0.0%
0.75		2	1	1	1	1	1	0	0	0.0%	0.0%
1.5		2	0.7	0	1	0.6	0.8	0.1	0.1414	20.2%	30.0%
3		2	0.05	0	0.6853	0	0.1	0.05	0.07071	141.4%	95.0%
6		2	0	0	0	0	0	0	0		100.0%
12		2	0	0	0	0	0	0	0		100.0%

96h Survival Rate Detail

C-µg/L	Control Type	Rep 1	Rep 2
0	Dilution Water	1	1
0.75		1	1
1.5		0.6	0.8
3		0.1	0
6		0	0
12		0	0

96h Survival Rate Binomials

C-µg/L	Control Type	Rep 1	Rep 2
0	Dilution Water	10/10	10/10
0.75		10/10	10/10
1.5		6/10	8/10
3		1/10	0/10
6		0/10	0/10
12		0/10	0/10