U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES OFFICE

Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products

Part 3: LED Environmental Testing

March 2013

Prepared for:
Solid-State Lighting Program
Building Technologies Office
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Prepared by:
Pacific Northwest National Laboratory

DISCLAIMER

AUTHORS

Jason Tuenge	Brad Hollomon	Heather Dillon	Lesley Snowden-Swan
PNNL	Compa Industries	University of Portland	PNNL

ACKNOWLEDGEMENTS

The authors would like to express their appreciation to the following individuals who provided a review of the report:

Leena Tähkämö	Aalto University and Université Paul Sabatier (Toulouse III)
Jessica Abralind	Arlington County Government
Larry Chrystal	E.S. Babcock & Sons, Inc.
Monica Hansen	LED Lighting Advisors

COMMENTS

Pacific Northwest National Laboratory and the U.S. Department of Energy are interested in receiving feedback on the material presented in this report. Please direct any questions or comments to jason.tuenge@pnnl.gov. .

Table of Contents

Acronyms and Abbreviations

Ag	silver
ANSI	American National Standards Institute
As	arsenic
avg	average
Ba	barium
Be	beryllium
CA	State of California
CCR	California Code of Regulations
Cd	cadmium
CFL	compact fluorescent lamp
CFR	Code of Federal Regulations
Cr	chromium
Co	cobalt
Cu	copper
DOE	U.S. Department of Energy
DTSC	Department of Toxic Substances Control
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
EWRA	Electronic Waste Recycling Act
FRL	Federal Regulatory Level
g	gram(s)
h	hour(s)
HAL	halogen
Hg	mercury
INC	incandescent
ISO	International Standards Organization
kg	kilogram(s)
L	liter(s)
LCA	life-cycle assessment
LED	light emitting diode
lm	lumen(s)
max	maximum
mg	milligram(s)
min	minimum
mm	millimeter(s)
MJ	megajoule(s)
Mo	molybdenum
ND	not detected
NELAP	National Environmental Laboratory Accreditation Program
Ni	nickel
Pb	lead
PNNL	Pacific Northwest National Laboratory
RCRA	Resource Conservation and Recovery Act of 1976
RoHS	Restrictions on the use of certain hazardous substances
Sb	antimony
SDS	safety data sheet
Se	selenium
SOP	standard operating procedure
SSL	solid-state lighting
STLC	Soluble Threshold Limit Concentration
Tl	thallium
TCLP	Toxicity Characteristic Leaching Procedure
TTLC	Total Threshold Limit Concentration
V	vanadium
W	watt(s)
WET	Waste Extraction Test
Zn	zinc

1.0 Executive Summary

This report covers the third part of a larger U.S. Department of Energy (DOE) project to assess the life-cycle environmental and resource impacts associated with the manufacturing, transport, use, and disposal of light-emitting diode (LED) lighting products in relation to incumbent lighting technologies. All three reports are available on the DOE website (www.ssl.energy.gov/tech_reports.html).

Part 1: *Review of the Life-Cycle Energy Consumption of Incandescent, Compact Fluorescent and LED Lamps;*

Part 2: *LED Manufacturing and Performance;*

Part 3: *LED Environmental Testing*.

Parts 1 and 2 were published in February and June 2012, respectively. The Part 1 report included a summary of the life-cycle assessment (LCA) process and methodology, provided a literature review of more than 25 existing LCA studies of various lamp types, and performed a meta-analysis comparing LED lamps with incandescent and compact fluorescent lamps (CFLs). Drawing from the Part 1 findings, Part 2 performed a more detailed assessment of the LED manufacturing process and used these findings to provide a comparative LCA taking into consideration a wider range of environmental impacts. Both reports concluded that the life-cycle environmental impact of a given lamp is dominated by the energy used during lamp operation—the upstream generation of electricity drives the total environmental footprint of the product. However, a more detailed understanding of end-of-life disposal considerations for LED products has become increasingly important as their installation base has grown.

The Part 3 study (reported herein) was undertaken to augment the LCA findings with chemical analysis of a variety of LED, CFL, and incandescent lamps using standard testing procedures. A total of 22 samples, representing 11 different models, were tested to determine whether any of 17 elements were present at levels exceeding California or Federal regulatory thresholds for hazardous waste. Notably, this type of testing does not provide an indication of product safety during use. Key findings include:

- The selected models were generally found to be below thresholds for Federally regulated elements, although volatile mercury in the CFLs is presumed to have escaped detection;
- Nearly all of the lamps (regardless of technology) exceeded at least one California threshold—typically for copper, zinc, antimony, or nickel;
- The greatest contributors were the metal screw bases, drivers, ballasts, and wires or filaments—internal LED light sources generally did not cause LED lamps to exceed thresholds.

This study was exploratory in nature and was not intended to provide a definitive indication of regulatory compliance for any specific lamp model or technology. Further study would be needed to more broadly characterize the various light source technologies; to more accurately and precisely characterize a specific model; or to determine whether product redesign would be appropriate. However, concentrations of regulated elements in LED lamps were found to be comparable to cell phones and other types of electronic devices, which like incandescent lamps and CFLs have also have been shown to exceed the stringent California thresholds for hazardous waste. Although LED lamps offer reduced life-cycle energy and environmental impacts when compared to CFLs and incandescent lamps, recycling will likely gain importance as consumer adoption of this emerging technology continues to increase.

2.0 Introduction

Products utilizing light-emitting diodes (LEDs) for general illumination have recently demonstrated the potential to surpass conventional lighting technologies in terms of energy efficiency, longevity, versatility, and color quality. According to a recent forecast, LED lighting will represent 74 percent of lumen-hour sales in the U.S. general illumination market by 2030 (DOE 2012a). Over the 20-year analysis period, from 2010 to 2030, the cumulative energy savings is estimated to total about 2,700 terawatt-hours, which at current energy prices and electricity generation mix conditions represents approximately $250 billion in savings and a greenhouse gas emission reduction of roughly 1,800 million metric tons of carbon.

The U.S. Department of Energy (DOE) supports the market introduction of new energy efficient products through several programs. The DOE Solid-State Lighting (SSL) program recently completed a 3-part project to assess the life-cycle environmental and resource impacts in the manufacturing, transport, use, and disposal of LED lamps in relation to incandescent and compact fluorescent lamps (CFLs).

The Part 1 report, *Review of the Life-Cycle Energy Consumption of Incandescent, Compact Fluorescent and LED Lamps*, was published in February 2012 (DOE 2012b). The report included a summary of the life-cycle assessment (LCA) process and methodology, and provided a literature review of more than 25 LCA studies pertaining to lighting products. Figure 2-1 summarizes findings from a meta-analysis that was performed, focusing on the energy consumed in manufacturing and use of the lamps studied, based on data from 10 key studies and a functional unit of 20 million lumen-hours.

The report concluded that the life-cycle energy consumption of LED lamps and CFLs is similar at approximately 3,900 MJ per 20 million lumen-hours of lighting service. Incandescent lamps were found to consume roughly four times more energy (approximately 15,100 MJ per 20 million lumen-hours). The use phase was also determined to be the largest component of energy consumption, followed by manufacturing phase.

One key issue identified in the report was the high uncertainty associated with the energy used during the manufacturing process—reflecting differences among the various studies surveyed—with estimates ranging from 0.1% to 27% of the total energy use. The manufacturing process for LEDs had only been analyzed in two prior studies. The first involved a simple unit process for LEDs used by the electronic industry for indicator lights and the second was an LCA performed by a manufacturer. After identifying limitations to these studies, the second part of the project was undertaken to explore the LED manufacturing process in an effort to address the high uncertainty in the literature.

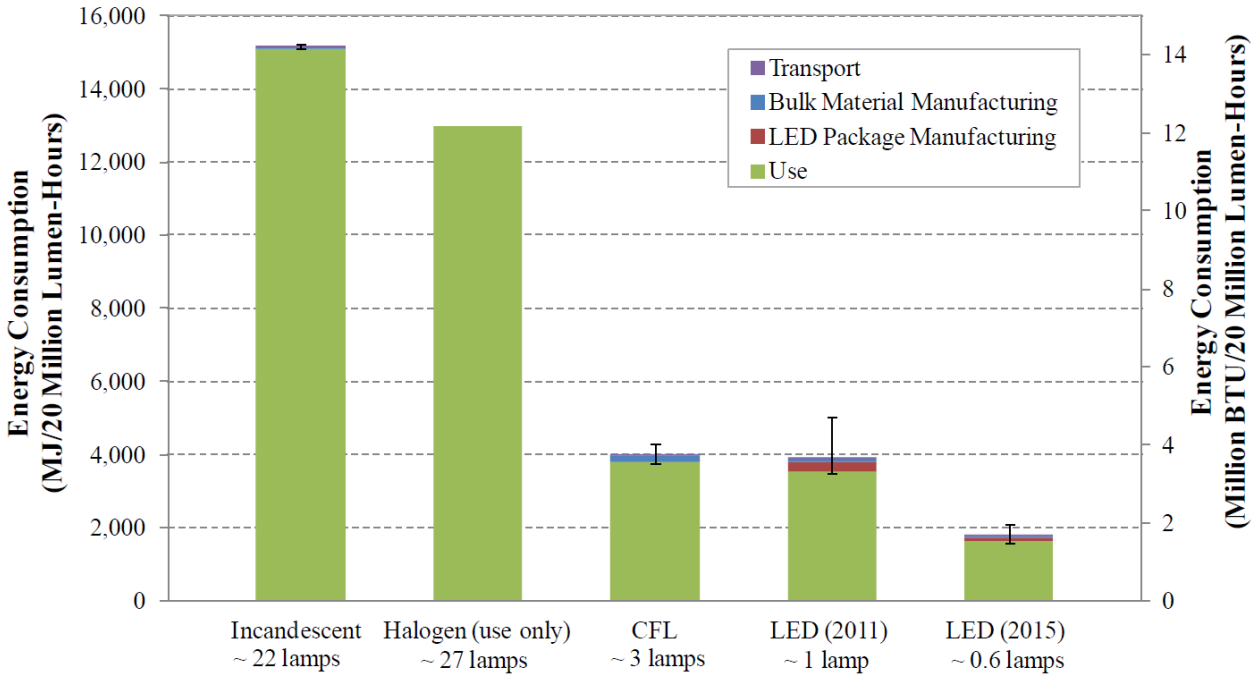


Figure 2-1. Life-cycle energy of incandescent lamps, CFLs, and LED lamps (DOE 2012b)

The Part 2 report, *LED Manufacturing and Performance*, was published in June 2012 (DOE 2012c). The report produced a more detailed analysis of the LED manufacturing process and provided a comparative LCA with other lamp technologies, taking into consideration a broader range of environmental impacts. The comparison took into account an LED lamp as it was in 2012 and then projected forward to what it might be in 2017, accounting for some of the anticipated improvements in LED manufacturing, performance and driver electronics.

The study confirmed that energy-in-use is the dominant environmental impact, with 15-watt CFL and 12.5-watt LED lamps performing better than a 60-watt incandescent lamp. These three omnidirectional lamps all produced approximately the same light output (~850 lumens), but the environmental impacts associated with the incandescent lamp were markedly more significant than the CFL and LED lamps because of the energy-in-use phase of the life-cycle.

The Part 2 report used spider graphs to illustrate the relative impacts of each lamp type across fifteen impact measures of interest, again accounting for the lumen-hours of lighting service offered by each technology. The lamp type having the greatest impact defined the scale represented by the outer circle. The impacts of the other products were then normalized to that impact, so the distance from the center denotes the severity of the impact relative to the incandescent lamp.

As shown in Figure 2-2, the plots representing LED and CFL technology fell well within the outer circle, indicating that the incandescent lamp had the highest impact per unit lighting service of the lamps considered. This finding was not a simple function of material content, as the incandescent lamp had the lowest mass and was the least complex technology. Rather, it reflected the lower luminous efficacy and many replacements required to span the longer rated life of a CFL or LED lamp, resulting in larger quantities of energy required to produce equivalent light over time. Due to this greater energy use, the incandescent lamp was found to be the most environmentally harmful across all fifteen impact measures.

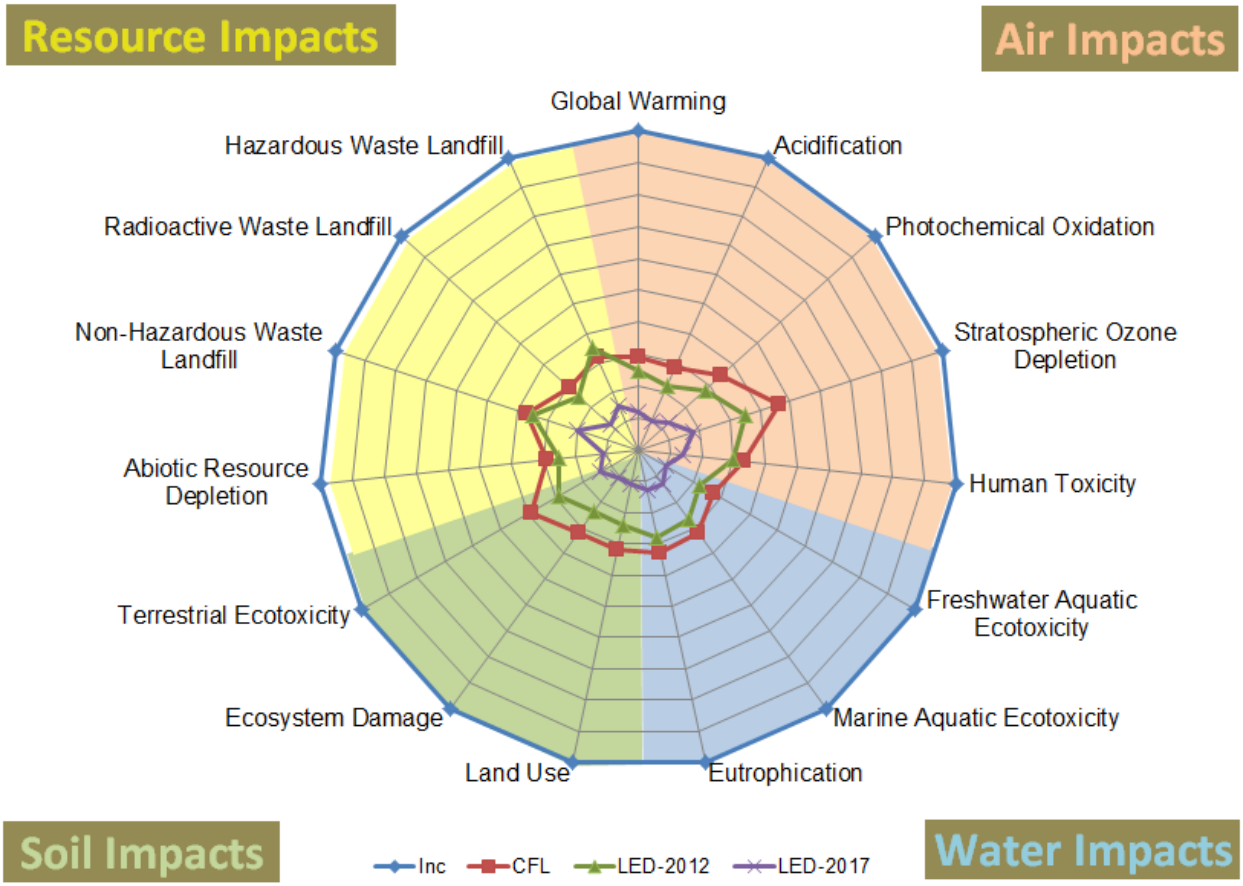


Figure 2-2. Life-cycle impacts relative to incandescent lamps (DOE 2012c)

The Part 2 study conservatively assumed relatively low rates of recycling for LED lamps. The 2012 version of the LED lamp slightly exceeded the CFL in one category—Hazardous Waste Landfill—primarily due to the upstream energy and environment impacts from the manufacturing of aluminum from raw materials. Most of this aluminum was located in the heat sink, which could be more extensively recycled or reduced in size as the technology improves and more of the input wattage is converted to useful light (instead of waste heat).

As with incandescent lamps and CFLs, the life-cycle environmental impact of LED lamps is dominated by the energy used during lamp operation—the upstream generation of electricity drives the total environmental footprint of the product. However, a more detailed understanding of end-of-life considerations for LED products has become increasingly important as their installation base has grown. CFLs received similar scrutiny as these products gained market share (Engelhaupt 2008).

When toxic wastes are disposed of in landfills, contaminated liquid might drain (i.e., leach) from the waste and pollute ground water. A number of test methods and regulations have been developed at the state and Federal level to identify such hazardous waste for proper treatment. Although current regulations may not explicitly list LED lamps as hazardous waste, these products do merit evaluation.

The Part 3 study (reported herein) was conducted to augment the LCA results with chemical analysis and comparison of a variety of incandescent lamps, CFLs, and LED lamps using standard testing procedures from the U.S. Environmental Protection Agency (EPA) and the State of California (CA). The focus of this work is on end-of-life disposal considerations and entailed the purchase, disassembly, and chemical testing of LED and conventional lamps to ascertain whether potentially toxic elements are present in concentrations that exceed regulatory thresholds for hazardous waste.

3.0 Methodology

The following sections provide an overview of the products selected for testing, and the relevant procedures and criteria used to evaluate their material content.

3.1 Regulations and Test Methods

The Resource Conservation and Recovery Act (RCRA) governs Federal management of hazardous wastes. Solid wastes are deemed hazardous by the EPA if they are specifically listed in the Code of Federal Regulations (CFR) Title 40, Part 261, Subpart D. Solid wastes not specifically listed (e.g., lamps) are deemed hazardous if they exhibit any of four characteristics addressed in Subpart C. Toxicity is determined through EPA Method 1311, the Toxicity Characteristic Leaching Procedure (TCLP). Definitions for this and related test methods for evaluating solid waste are provided in EPA publication SW-846 (EPA 2008).

The TCLP is not expected to result in complete digestion of a given test sample, but rather provides an indication of the extent to which soluble contaminants might leach out of the sample in a landfill. A solid waste is deemed hazardous if one or more contaminants are present in concentrations exceeding the corresponding Federal Regulatory Level (FRL) specified in 40 CFR Part 261.24. Generators are responsible for characterizing their waste and must determine whether a waste exhibits a characteristic by either testing or applying knowledge of the hazardous characteristics of the waste. Although lamps as "articles" are considered exempt from the hazard communication requirements of 29 CFR Part 1910.1200, some manufacturers voluntarily publish safety data sheets (SDS) providing such information (GE 2007).

Alternative regulations provided in 40 CFR Part 273 were developed to facilitate environmentally sound collection and proper recycling or treatment of federally designated "universal wastes." Fluorescent light sources are included here in a partial list of widely generated universal waste lamps; incandescent lamps and LED lamps are not explicitly included or excluded. Any lamp—fluorescent or otherwise—which does not exhibit one or more of the characteristics identified in 40 CFR Part 261, Subpart C, is not considered hazardous waste by the Federal government.

Most states are authorized to operate their own hazardous waste programs and may have more stringent rules than those of the Federal program. Such states can impose more stringent regulations for hazardous waste identification or identify state-specific hazardous wastes. For example, CA has established unique procedures and restrictions to supplement the EPA test methods and Federal regulations. For the purpose of this report, it is assumed that most lamp manufacturers will develop products which can be sold nationwide, rather than offering lamps for sale—and disposal—exclusively outside CA.

Similar to Federal regulations, lamps are listed in California Code of Regulations (CCR) Section 66261.9 as being subject to the universal waste regulations provided in CCR Chapter 23. FRLs are supplemented with CA-specific criteria for two additional tests in CCR Chapter 11, Article 3. The Waste Extraction Test (WET) is used to evaluate products against Soluble Threshold Limit Concentration (STLC) values in a manner analogous to TCLP, whereby test samples may only be partially digested. By contrast, EPA Method 3050 is used to evaluate products against Total Threshold Limit Concentration (TTLC) values, typically resulting in complete or near-complete digestion of test samples. By design, elements bound in

silicate structures are not normally dissolved as they are not usually mobile in the environment (EPA 1996).

Table 3-1 compares CA and Federal criteria for the set of 17 elements investigated as part of this study. Compounds containing hexavalent chromium were not isolated for evaluation in this study; total chromium is reported instead. Note that due to differences in the corresponding test methods, STLCs cannot be compared directly with FRLs.

Table 3-1. CA and Federal limits for 17 investigated elements

Element	Symbol	TTLC (mg/kg)	STLC (mg/L)	FRL (mg/L)
Antimony	Sb	500	15	n/a
Arsenic*	As	500	5	5
Barium*	Ba	10,000	100	100
Beryllium	Be	75	0.75	n/a
Cadmium*	Cd	100	1	1
Chromium*	Cr	2,500	5	5
Cobalt	Co	8,000	80	n/a
Copper	Cu	2,500	25	n/a
Lead*	Pb	1,000	5	5
Mercury*	Hg	20	0.2	0.2
Molybdenum	Mo	3,500	350	n/a
Nickel	Ni	2,000	20	n/a
Selenium*	Se	100	1	1
Silver*	Ag	500	5	5
Thallium	Tl	700	7	n/a
Vanadium	V	2,400	24	n/a
Zinc	Zn	5,000	250	n/a

* Federally regulated element.

The CA Electronic Waste Recycling Act of 2003 (EWRA) established a statewide program to promote and fund the collection and recycling of hazardous electronic devices. The EWRA was signed into law in 2003 with SB 20, and was amended in 2004 with SB 50. The regulations include requirements for testing certain new products—rather than waste—for compliance with restrictions modeled after the European Union's RoHS Directive, which provided restrictions on the use of certain hazardous substances in electrical and electronic equipment (DOC 2013). RoHS includes restrictions for the elements cadmium, lead, and mercury, with special exceptions given for specific lamp types; hexavalent chromium and two other types of compounds are also addressed.

RoHS is not included in Federal regulations. However, at the time of publication, the draft ENERGY STAR® specification for lamps (EPA 2012a) included RoHS criteria and test procedures established by the International Electrotechnical Commission. ENERGY STAR is a voluntary program.

3.2 Test Specification

The CA Department of Toxic Substances Control (DTSC) tested a variety of products listed as electronic devices by the EWRA, to determine the total and soluble concentrations of regulated elements for comparison with CA and Federal hazardous waste criteria. An "e-waste" (i.e., electronic waste) report published in January 2004 evaluated cell phones and six other types of electronic devices (DTSC 2004a). A subsequent "SB 20" study evaluated four more types of electronic devices (DTSC 2004b). Lamps were not specifically addressed in the EWRA or the DTSC reports.

For the Part 3 study, DOE subcontracted two independent laboratories to perform the CA and EPA tests per a test specification modeled after the procedure used in the DTSC's SB 20 study. The laboratories, designated herein as Lab A and Lab B, were selected based on the following criteria:

- Accredited through the National Environmental Laboratory Accreditation Program (NELAP) or the CA Environmental Laboratory Accreditation Program (ELAP);
- Certified to perform the TCLP, WET, and Method 3050;
- Capable of analyzing all 17 elements targeted for investigation;
- Past experience testing lamps or e-waste;
- Past experience with disassembly and milling of products in-house;
- Acceptable turnaround time;
- Competitively priced services.

A somewhat abbreviated version of the Part 3 test specification is provided in Appendix A for reference. Some flexibility was provided in the specification to allow refined direction by DOE based on input from each test laboratory. The testing logic for a given product sample is illustrated in Figure 3-1, and can be summarized in greater detail as follows:

1. Photograph and weigh a lamp sample. This enables evaluation of the product as a whole.
2. Disassemble lamp into distinct components or groups, each to be photographed and weighed separately. This enables isolation of elements to specific components, allows weighting on the basis of relative component mass, and can improve homogeneity across tests.
3. Separately mill each component sample to an adequate fineness as required for reliable digestion and homogeneity, and then subdivide each milled pile into three component subsamples for testing via one or more of the three methods. The resulting particle size should be small enough to ensure homogeneity across the three component subsamples, thereby ensuring consistent results across the test methods; smaller or more complex component samples may require finer milling.
4. Run Method 3050 for one subsample of each component.
    a. If a given element (from the list of 17 investigated) is found to be present in a concentration greater than or equal to its TTLC when components are summed and compared against the overall mass of the lamp, no further testing is conducted for that element.
    b. If instead the concentration is below the TTLC but numerically greater than 10 times the STLC (i.e., disregarding units), run the WET for any components that together are theoretically capable of causing the lamp to exceed the STLC (i.e., assuming 100% of the element will be extracted).

1. If the element is found to be present in a WET concentration greater than or equal to its STLC when components are summed and compared against the overall mass of the lamp (assuming 100% extraction for components not tested), no further testing is conducted for that element.
2. If instead the concentration is below the STLC, but the Method 3050 concentration is numerically greater than 20 times the FRL (again disregarding units), run TCLP for any components that together are theoretically capable of causing the lamp to exceed the FRL (again assuming 100% of the element will be extracted).

Lamps were not operated prior to testing. Most of the product samples were disassembled before testing; some duplicate product samples were tested without disassembly for comparison. Other duplicate product samples were tested to provide a sense of repeatability across and within labs; such analysis, however, is limited by unknown manufacturing tolerances.

Method 3050 test results can be used to calculate theoretical limits for WET and TCLP concentrations—assuming complete digestion—since the corresponding volumes can be determined (Lincoln et al. 2006, EPA 2012b). However, WET and TCLP must be performed to determine actual concentrations.

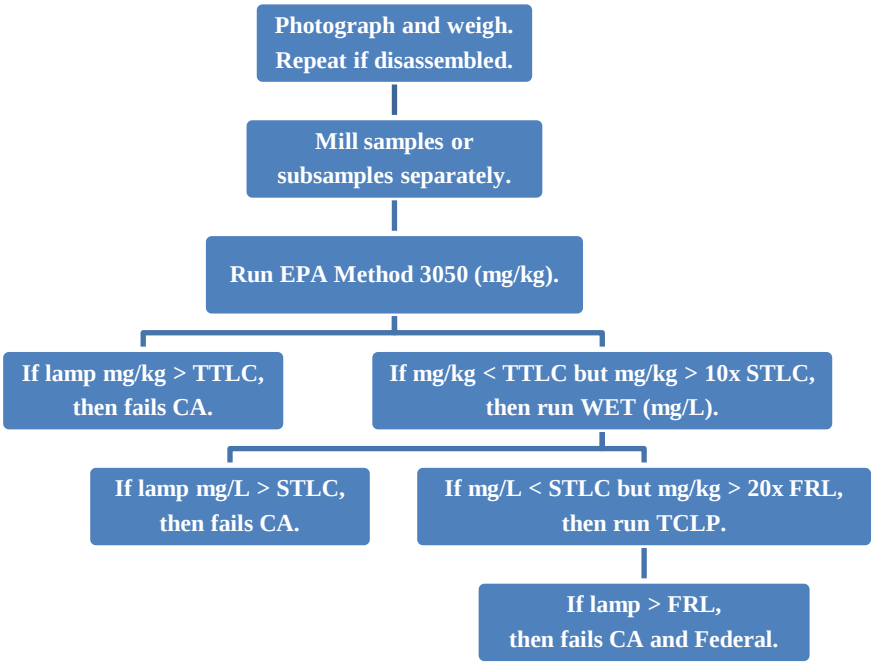


Figure 3-1. Testing logic.

3.3 Product Selection

A multitude of product types could be tested for hazardous material content. Integrated lamps (i.e., lamps not requiring an external ballast or driver) were chosen for this study because of their ubiquity, off-the-shelf availability, and one-for-one interchangeability. Notably, when evaluating concentrations relative to regulatory thresholds for hazardous waste, testing of integrated lamps is more relevant than testing of the non-replaceable LED light sources contained therein (Lim et al. 2010, Lim et al. 2012). Table 3-2 and Table 3-3 summarize models selected and acquired off-the-shelf by DOE for testing.

Omnidirectional lamps emit light in all directions, and were selected for lumen output comparable to a typical 60 W frosted incandescent A19 "light bulb." Directional lamps focus all or nearly all emitted light into a single hemisphere, and were selected for light output (measured in lumens, lm) and luminous intensity distribution comparable to a 65 W incandescent BR30 lamp commonly used in residential downlights. One directional product, LED-4, featured an integral downlight trim.

Four models (INC-1, CFL-1, LED-1, and LED-2) were acquired in late January 2012; the others were initially acquired in mid-late April 2012. A supplemental sample of LED-1(a) was acquired in late June 2012 to provide additional material for TCLP testing. A replacement sample of LED-4(a) was acquired in late October 2012 after it was discovered the first sample weighed substantially less following disassembly and its light source was not visible in photographs taken by Lab A before milling.

Incandescent lamps featuring halogen (HAL) technology were included for comparison with their less efficient traditional incandescent (INC) counterparts.

Table 3-2. Omnidirectional lamps selected for testing

Model	Sample	Test lab	Disassembled	Rated output (lm)	Rated input (W)	Rated life (h)
INC-1	(a)	A	✓	860	60	1,000
	(b)	B	✓			
	(c)	A	-			
	(d)	A	✓			
HAL-1	(a)	A	✓	785	43	1,000
	(b)	A	✓			
CFL-1	(a)	A	✓	825	13	8,000
	(b)	A	✓			
CFL-2	(a)	A	✓	900	14	10,000
	(b)	A	-			
	(c)	A	✓			
LED-1	(a)	A	✓	850	13.5	50,000
	(b)	A	-			
LED-2	(a)	A	✓	800	12.5	25,000
	(b)	A	✓			

Table 3-3. Directional lamps selected for testing

Model	Sample	Test lab	Disassembled	Rated output (lm)	Rated input (W)	Rated life (h)
INC-2	(a)	A	✓	635	65	2,000
HAL-2	(a)	A	✓	600	40	3,000
CFL-3	(a)	A	✓	720	15	6,000
LED-3	(a)	A	✓	600	12	35,000
	(b)	B	✓			
LED-4	(a)	A	✓	575	10.5	50,000
	(b)	B	✓			

4.0 Results

Testing was conducted on the basis of overall lamp composition since lamps are not designed to enable replacement of components. Consequently, high concentrations of certain elements in a relatively small component might be rendered insignificant when evaluated relative to the overall mass of the lamp. However, results were recorded for each component to enable determination of relative contributions of each component to the overall outcome for the lamp.

Photographs, masses, and tabulated results by component are provided in Appendix B. Original test data from Lab A and Lab B are provided in Appendices C and D, respectively.

4.1 Whole-lamp Analysis

Figure 4-1 illustrates total concentrations for all 22 lamp samples relative to TTLC thresholds for each element. The chart incorporates the following techniques for improved legibility:

- Lamps are grouped and color-coded by technology, combining halogen with incandescent;
- Values are indicated as percentages, effectively normalizing for the substantial differences in regulatory thresholds between elements (e.g., 20 mg/kg for mercury, vs. 10,000 mg/kg for barium);
- A base-10 log scale was used to compress the range of values.

Most of the lamps were found to be well above the CA threshold for copper, regardless of technology, and some approached or exceeded the threshold for nickel. A number of CFLs and LED lamps were also found to exceed CA thresholds for antimony and zinc. Other instances of high concentrations were more isolated (e.g., chromium for one LED lamp sample, lead for one CFL sample, and zinc for one incandescent lamp sample). The selected models were generally found to be below thresholds for Federally regulated elements. However, volatile mercury in the CFLs is presumed to have escaped detection, and several CFLs exceeded a threshold for lead (TTLC, STLC, or FRL).

Table 4-1, Table 4-2, and Table 4-3 clarify which lamp samples exceeded TTLC, STLC, or FRL. If an STLC was exceeded for a given sample, it can be inferred that the TTLC for that element was not exceeded. Similarly, if an FRL is indicated as having been exceeded, it can be inferred that the STLC and TTLC were not exceeded.

Samples exceeding a TTLC received no subsequent testing for that element; similarly, samples found below a TTLC but exceeding the corresponding STLC were not tested for that element to determine compliance with the FRL. For example, the concentration of lead in lamp CFL-2(b) was below the TTLC but approached this value and was subsequently found to exceed the STLC; the TCLP was not performed for this sample since it was found to exceed the CA hazardous waste threshold for lead.

Some leachate tests called for by the testing logic were not conducted; these data gaps were due to inadequate remaining material, sometimes resulting from TCLP testing mistakenly performed out of sequence. The corresponding fields are identified with a question mark following the threshold not evaluated. For example, the concentration of lead in lamp CFL-2(a) was found to be below the STLC but inadequate material remained for further TCLP testing.

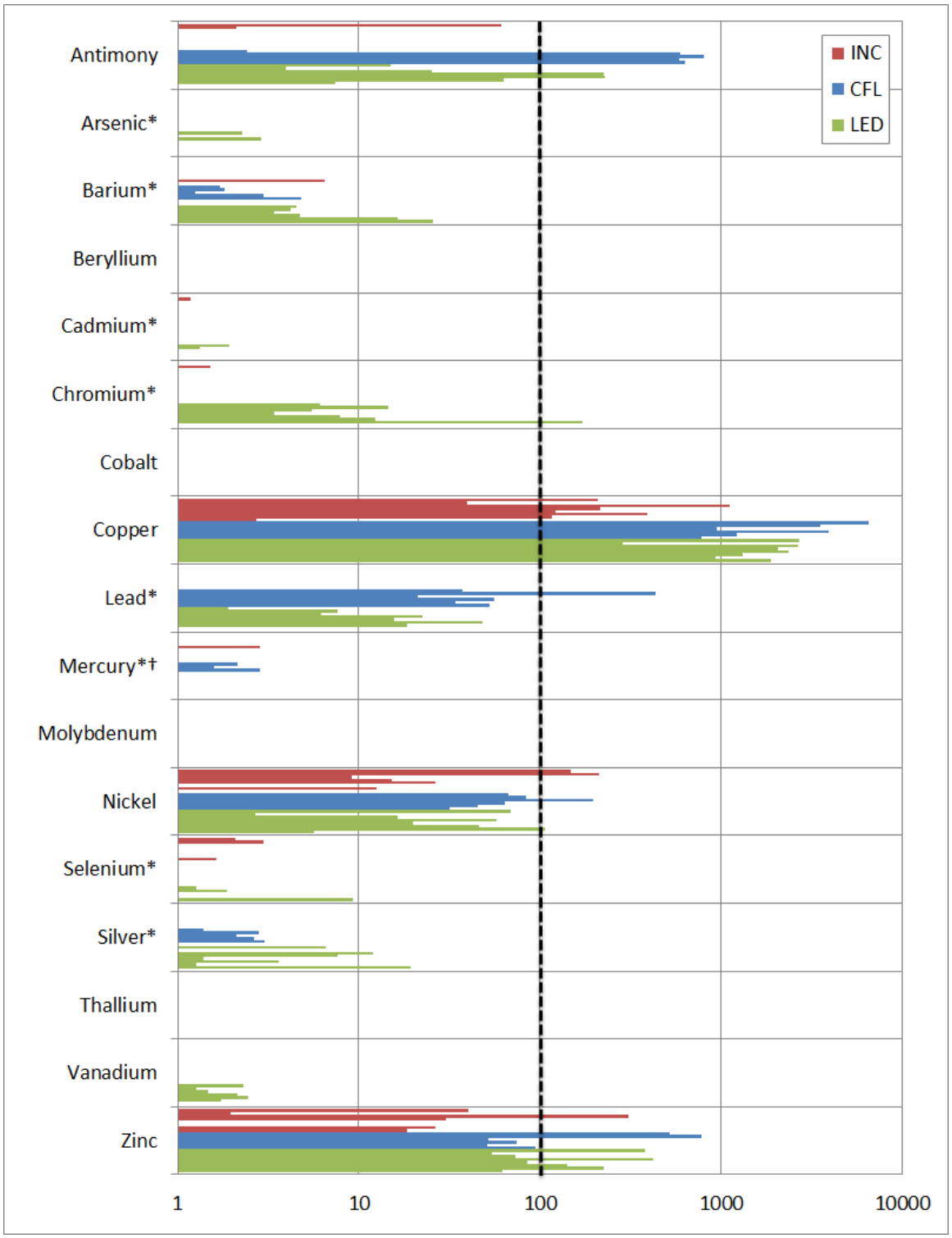


Figure 4-1. Percentage of TTLC for whole lamp sample (log scale). Vertical dashed line indicates TTLC.

*Federally regulated element.

† Some mercury in CFLs is presumed to have escaped detection. See section 5.3.1.

Table 4-1. Incandescent lamp samples exceeding TTLC, STLC or FRL

Element	INC-1				INC-2	HAL-1		HAL-2
	(a)	(b)‡	(c)	(d)	(a)	(a)	(b)	(a)
Antimony	-	-	-	-	-	-	-	-
Arsenic*	-	-	-	-	-	-	-	-
Barium*	-	-	-	-	-	-	-	-
Beryllium	-	-	-	-	-	-	-	-
Cadmium*	-	-	-	-	-	-	-	-
Chromium*	-	-	-	-	-	-	-	-
Cobalt	-	-	-	-	-	-	-	-
Copper	TTLC	TTLC	TTLC	TTLC	-	TTLC	-	TTLC
Lead*	-	-	-	-	-	-	-	-
Mercury*	-	-	-	-	-	-	-	-
Molybdenum	-	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	TTLC	TTLC	-
Selenium*	-	-	-	-	-	-	-	-
Silver*	-	-	-	-	-	-	-	-
Thallium	-	-	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-	-	-
Zinc	-	-	-	-	-	-	-	TTLC

* Federally regulated element.
‡ Lamp sample tested by Lab B.

Table 4-2. CFL samples exceeding TTLC, STLC or FRL

Element	CFL-1		CFL-2			CFL-3
	(a)	(b)	(a)	(b)	(c)	(a)
Antimony	-	-	TTLC	TTLC	TTLC	TTLC
Arsenic*	-	-	-	-	-	-
Barium*	-	-	-	-	-	-
Beryllium	-	-	-	-	-	-
Cadmium*	-	-	-	-	-	-
Chromium*	-	-	-	-	-	-
Cobalt	-	-	-	-	-	-
Copper	TTLC	TTLC	TTLC	TTLC	TTLC	TTLC
Lead*	*STLC?*	TTLC	*FRL?*	STLC	*FRL?*	FRL
Mercury*†	-	-	-	-	-	-
Molybdenum	-	-	-	-	-	-
Nickel	*STLC?*	STLC	TTLC	STLC	STLC	STLC
Selenium*	-	-	-	-	-	-
Silver*	-	-	-	-	-	-
Thallium	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-
Zinc	TTLC	TTLC	-	-	-	-

* Federally regulated element.

† Some mercury is presumed to have escaped detection. See section 5.3.1.

Table 4-3. LED lamp samples exceeding TTLC, STLC or FRL

Element	LED-1		LED-2		LED-3		LED-4	
	(a)	(b)	(a)	(b)	(a)	(b)‡	(a)	(b)‡
Antimony	-	-	-	TTLC	TTLC	-	-	-
Arsenic*	-	-	-	-	-	-	-	-
Barium*	-	-	-	-	-	-	-	-
Beryllium	-	-	-	-	-	-	-	-
Cadmium*	-	-	-	-	-	-	-	-
Chromium*	-	-	-	-	-	-	-	TTLC
Cobalt	-	-	-	-	-	-	-	-
Copper	TTLC	TTLC	TTLC	TTLC	TTLC	TTLC	TTLC	TTLC
Lead*	-	-	-	STLC	-	-	-	-
Mercury*	-	-	-	-	-	-	-	-
Molybdenum	-	-	-	-	-	-	-	-
Nickel	*STLC?*	-	-	-	-	-	-	TTLC
Selenium*	-	-	-	-	-	-	STLC	-
Silver*	-	-	-	-	-	-	-	-
Thallium	-	-	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-	-	-
Zinc	TTLC	-	-	TTLC	-	TTLC	-	TTLC

* Federally regulated element.
‡ Lamp sample tested by Lab B.

4.2 Analysis by Lamp Component

Following is a brief summary of apparent trends that were observed among the 19 lamps that were disassembled for testing, focusing on elements found to exceed thresholds in more than one lamp.

4.2.1 Antimony

In most of the CFLs (3 of 5), plastic materials were found to contain levels of antimony causing the lamp to exceed the TTLC for this element; some of the LED lamps (2 of 7) were also found to exceed or nearly exceed the threshold due to such materials.

4.2.2 Copper

In most cases (13 of 19), the screw base—or metal component samples which included the screw base—were found to contain levels of copper that caused the lamp to exceed the TTLC for this element.

In all of the CFLs and LED lamps (12 of 12), the ballast or driver was found to contain levels of copper that caused the lamp to exceed the TTLC for this element.

4.2.3 Lead

The ballast was the primary contributor in both of the disassembled CFLs exceeding thresholds for lead. In addition, the test specification called for WET on the metal screw base in CFL-1(a) and TCLP on the ballasts in CFL-2(a) and CFL-2(c) but inadequate material remained.

4.2.4 Nickel

In the two duplicate HAL-1 samples (a, b), the wires were found to contain levels of nickel that caused the lamp to exceed the TTLC for this element.

In most of the CFLs (3 of 5), the screw base was found to contain levels of nickel that caused the lamp to exceed the STLC for this element; in addition, the test specification called for such testing of CFL-1(a) but inadequate material remained.

4.2.5 Zinc

In many cases (6 of 19), the screw base—or metal component samples which included the screw base—were found to contain levels of zinc that caused the lamp to exceed the TTLC for this element.

5.0 Discussion

This exploratory study is intended to serve as a reference for future investigations that might provide a more definitive characterization of light source technologies or specific lamp models. To this end, this section offers discussions of similar work by others, data quality, study limitations, and the significance of product weight and longevity.

5.1 Similar Investigations of Lamps

A recent unrelated study performed a similar analysis of three different lamp models—one incandescent, one LED, and one CFL (Lim et al. 2012). This study included analysis of a number of unregulated elements (e.g., aluminum) but excluded beryllium, cadmium, molybdenum, selenium, thallium, and vanadium. The reported chromium is presumed to be total (i.e., not specifically hexavalent). Further, although Method 3050 and the TCLP were implemented, the WET was not.

In spite of these differences, the 10-element overlap between studies enables useful comparisons. Table 5-1, Table 5-2, and Table 5-3 show that with a few minor exceptions, the lamps selected for the Lim (2012) study were found to fall within the range of lamps evaluated in this study. The most dramatic difference was for nickel in CFLs—concentrations were consistently higher in this (DOE) study.

Elements reported as not detected (ND) were assigned a concentration of zero; actual concentrations might be as high as the reportable detection limit (RDL) indicated in the respective laboratory reports.

Table 5-1. Comparison with Lim (2012) incandescent

(Expressed as a percentage of TTLC)

Element	DOE-tested lamps			Lim (2012) lamp
	max	min	avg	
Antimony	62%	0%	8%	0%
Arsenic*	1%	0%	0%	0%
Barium*	6%	0%	1%	0%
Chromium*	2%	0%	0%	0%
Copper	1106%	3%	275%	38%
Lead*	0%	0%	0%	1%
Mercury*	3%	0%	0%	1%
Nickel	210%	0%	53%	9%
Silver*	0%	0%	0%	3%
Zinc	307%	0%	53%	6%

* Federally regulated element.

Table 5-2. Comparison with Lim (2012) CFL

(Expressed as a percentage of TTLC)

Element	DOE-tested lamps			Lim (2012) lamp
	max	min	avg	
Antimony	800%	0%	434%	23%
Arsenic*	0%	0%	0%	1%
Barium*	5%	0%	2%	0%
Chromium*	0%	0%	0%	0%
Copper	6522%	776%	2807%	4440%
Lead*	433%	21%	106%	386%
Mercury*†	3%	0%	1%	92%
Nickel	196%	32%	81%	6%
Silver*	3%	1%	2%	2%
Zinc	773%	51%	260%	690%

* Federally regulated element.

† Some mercury is presumed to have escaped detection. See section 5.3.1.

Table 5-3. Comparison with Lim (2012) LED

(Expressed as a percentage of TTLC)

Element	DOE-tested lamps			Lim (2012) lamp
	max	min	avg	
Antimony	227%	1%	71%	25%
Arsenic*	3%	0%	1%	0%
Barium*	26%	0%	8%	4%
Chromium*	171%	0%	28%	5%
Copper	2698%	284%	1765%	1264%
Lead*	48%	0%	15%	2%
Mercury*	0%	0%	0%	2%
Nickel	105%	3%	40%	8%
Silver*	19%	0%	6%	32%
Zinc	421%	54%	180%	91%

* Federally regulated element.

5.2 Similar Investigations of Electronic Devices

Figure 5-1 compares the tested lamps with findings from two prior studies of another ubiquitous consumer product—cell phones (DTSC 2004a, Lincoln et al. 2007). Method 3050 testing of the selected lamps and cell phones indicated similar concentrations of antimony, copper, and nickel. Zinc exceeded the TTLC in the more recent cell phone study but was undetected in the other; both found lead to exceed the TTLC. Mercury was not investigated in the DTSC study.

Batteries were removed and excluded from the analysis in both cell phone studies; the DTSC study also excluded capacitors. The DTSC extrapolated results to the entire phone based on relative weights of components, thereby assuming the non-millable components (batteries and capacitors) did not contain any regulated elements. The lamp test data can be considered relatively conservative since all such components were included in the analysis.

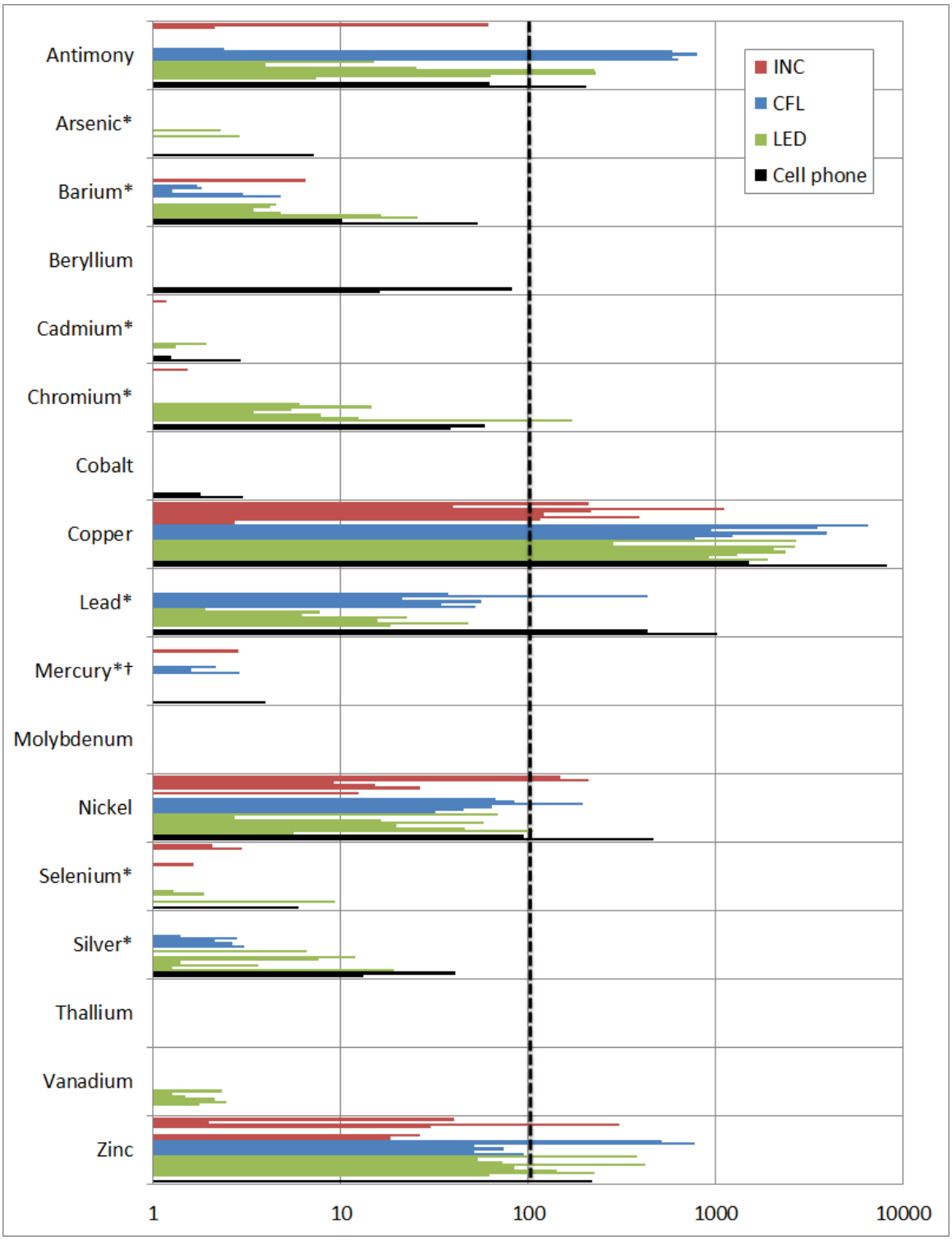


Figure 5-1. Percentage of TTLC for whole lamps and cell phones with batteries removed (log scale). Vertical dashed line indicates TTLC. Cell phone data are averages from two independent studies (DTSC 2004a, Lincoln et al. 2007).

*Federally regulated element.

† Some mercury in CFLs is presumed to have escaped detection. See section 5.3.1.

5.3 Data Quality

As noted previously, DOE subcontracted two independent laboratories to implement a test specification modeled after the procedure used for the DTSC's SB 20 report. The laboratories were selected based on a number of qualifications, including certification for the relevant tests and experience performing similar work in-house. Following is a discussion of known uncertainties stemming from procedural design or implementation.

5.3.1 Mercury in CFLs

Consistent with the SB 20 report, the Part 3 test specification called for adherence to CA Procedural Standard Operating Procedure (SOP) 914-S to prevent mercury from escaping undetected (DTSC 2004b). However, the results for the CFLs indicate mercury levels well below values reported on typical SDS published by manufacturers, suggesting mercury may have escaped detection (TCP 2005, GE 2007, Philips 2011). Comparable models sold in Europe and complying with RoHS criteria effective in 2012 would contain no more than 3.5 mg of mercury (EC 2011). Results are also below levels reported for CFLs in other studies, which indicate more than 1 mg/lamp on average for similar models (Singhvi et al. 2011, Rosillo et al. 2012, Lim et al. 2012). Measured values, CA restrictions, and values estimated from SDS are compared in Table 5-4. It is presumed that most of the mercury in the Part 3 CFLs escaped detection, e.g., through evaporation (Johnson et al. 2008).

Table 5-4. Total mercury relative to TTLC threshold and SDS figures

Model	Sample	Total concentration (mg/kg)		Mass (mg/lamp)		Percentage of lamp weight	
		TTLC	Measured	Example SDS	Measured	Example SDS	Measured
CFL-1	(a)	20	0.2	≤ 5	0.01	0.025%	0.0000%
	(b)		0.1		0.00		0.0000%
CFL-2	(a)	20	0.4	≤ 5	0.02	0.025%	0.0000%
	(b)		0.3		0.02		0.0000%
	(c)		0.6		0.03		0.0001%
CFL-3	(a)	20	0.1	≤ 5	0.01	0.025%	0.0000%

5.3.2 Homogeneity across Component Subsamples

Subsamples of a given component must be consistent to ensure test results are representative across the different tests. Homogeneity is accomplished by milling components to a maximum particulate size. If two subsamples of a given component are inhomogeneous, one or both may not be representative of the component; for example, if the WET was applied to both subsamples, one might exceed the STLC for a given element while the other is found to be well below the threshold.

Generally speaking, particle size becomes more important with decreasing subsample size or increasing component complexity. Taking an extreme example to illustrate the concept—if a sample is so small (relative to particle size) that it contains only four particles of a given element, one of three subsamples

would have twice the number of particles (and twice the apparent concentration) of the other two subsamples when digested in equal volumes of acid. The test methods specify particle size as follows:

- Method 3050 indicates a sample size of 1-2 g, and indicates a USS #10 sieve (maximum particle size of 2.0 mm) if appropriate and necessary.
- The WET indicates a sample size of 50 g, and indicates the sample shall be passed directly—or shall be milled to pass—through a #10 (2.0 mm) standard sieve.
- The TCLP recommends a sample size of 100 g, and indicates that particles should be capable of passing through a 9.5 mm standard sieve.
- SOP 914-S indicates samples known or suspected to contain mercury (e.g., CFLs) should be passed through a 1 mm sieve for Method 3050, and a 2 mm (#10) sieve for WET and TCLP.

Both Lab A and Lab B indicated components were milled to pass a 2.0 mm sieve. However, most of the incandescent lamps were less than 50 g in mass, and all of the CFLs were below 100 g. In addition, quantities of duplicate lamps were limited by available budget and the desire to evaluate a variety of products of each technology type. Consequently, component subsample sizes were in some cases smaller than prescribed. Component mass ranged from less than a gram for the filament and other wires in INC-1(b), to over 250 g of metal objects in LED-4(b). Components were rendered even smaller when they were partitioned into component subsamples, reserving material for possible WET and TCLP testing after Method 3050 had been performed.

Although the Part 3 test specification effectively assumed subsamples were homogeneous, possible inhomogeneity can be detected when a WET or TCLP concentration for a given element exceeds the theoretical limit calculated from the corresponding Method 3050 concentration (Lincoln et al. 2006, EPA 2012b). For example, consider the following scenario: A component known to contain exactly 100 mg/kg cadmium (theoretical maximum WET concentration of 10 mg/L) is milled and inadvertently partitioned into three inhomogeneous subsamples containing 50, 100, and 150 mg/kg cadmium. If the 50 mg/kg subsample is randomly selected for Method 3050 testing (indicating a theoretical maximum WET concentration of 5 mg/L), and the 150 mg/kg subsample is randomly selected for WET (actual theoretical maximum of 15 mg/L), the WET concentration could exceed the theoretical maximum.

Instances of such inhomogeneity were found among the data reported by both Lab A and Lab B. In these cases, Lab A indicated that the calculated theoretical limits did not necessarily reveal inhomogeneity, since Method 3050 was intended for use on sediments, soils, and sludges (EPA 2008). By contrast, Lab B discarded preliminary Method 3050 data and implemented the following revised procedure to obtain more accurate results:

1. Residual subsample solids not fully digested during WET were removed by filter and weighed.
2. Method 3050 was then applied to these removed WET solids.
3. Last, the actual “total” (mg/kg) concentration was calculated by multiplying the WET concentration (mg/L) by 10 and adding this quantity to the Method 3050 concentration from Step 2. These concentrations were summed on a weighted basis to account for the differing solid masses.

The above procedure was essentially used to provide mass balance for a given subsample when a WET concentration was found to exceed the theoretical maximum calculated from Method 3050 testing. It may

also yield more representative data since subsamples used for WET were typically larger than those used for Method 3050.

Conversely, it is possible for inhomogeneity to escape detection during WET or TCLP analysis if the concentration of a given element in the subsample used for Method 3050 is greater than the concentration in the component (and the other subsamples). Returning to the previous example, this would happen if instead the 150 mg/kg subsample was randomly selected for Method 3050 testing, and the 50 mg/kg subsample was randomly selected for WET.

Duplicate testing was performed for all lamp samples except INC-2(a), HAL-2(a), and CFL-3(a). Homogeneity cannot be verified for these three lamp samples, but as shown in Table 5-5 through Table 5-8, duplicate tests of the other lamps can be compared for this purpose—assuming manufacturing tolerances are negligible. These tables show that although some results differ widely, few of these cases (e.g., copper in the duplicate HAL-1 samples) straddle the corresponding TTLC threshold. With a few notable exceptions, the discrepancies between measurements appear comparable to those observed in similar work on cell phones (Lincoln et al. 2007).

Lab B tested duplicate lamps INC-1(b), LED-3(b), and LED-4(b). Table 5-5 shows agreement across all four samples of model INC-1, including those tested by different laboratories. There is also general inter-laboratory agreement for models LED-3 and LED-4, though some differences straddle TTLCs. However, two dramatic exceptions can be seen in LED-4, where chromium and nickel barely registered (if at all) during testing by Lab A but were found by Lab B to exceed the TTLCs. These discrepancies appear to be attributable to the aforementioned six-month period between acquisition of the original LED-4(a) sample and its replacement—these nominally identical products may in fact represent successive generations of the same model, and as such would not be accurately characterized as duplicates.

Table 5-5. Differing concentrations between duplicate INC lamp samples

(Expressed as a percentage of TTLC)

Element	INC-1(a,b,c,d)‡			HAL-1(a,b)		
	max	min	avg	max	min	avg
Antimony	1%	1%	1%	62%	2%	32%
Arsenic*	1%	0%	0%	0%	0%	0%
Barium*	0%	0%	0%	0%	0%	0%
Beryllium	1%	1%	1%	1%	1%	1%
Cadmium*	1%	1%	1%	1%	1%	1%
Chromium*	0%	0%	0%	2%	1%	1%
Cobalt	0%	0%	0%	0%	0%	0%
Copper	392%	117%	211%	208%	40%	124%
Lead*	0%	0%	0%	0%	0%	0%
Mercury*	3%	1%	1%	1%	1%	1%
Molybdenum	0%	0%	0%	1%	0%	0%
Nickel	26%	0%	14%	210%	148%	179%
Selenium*	1%	0%	1%	3%	2%	3%
Silver*	0%	0%	0%	0%	0%	0%
Thallium	0%	0%	0%	0%	0%	0%
Vanadium	1%	0%	0%	0%	0%	0%
Zinc	30%	0%	14%	40%	2%	21%

* Federally regulated element.

‡ Sample “b” tested at Lab B.

Table 5-6. Differing concentrations between duplicate CFL samples

(Expressed as a percentage of TTLC)

Element	CFL-1(a,b)			CFL-2(a,b,c)		
	max	min	avg	max	min	avg
Antimony	2%	1%	2%	800%	583%	657%
Arsenic*	0%	0%	0%	0%	0%	0%
Barium*	2%	0%	1%	3%	1%	2%
Beryllium	1%	1%	1%	1%	1%	1%
Cadmium*	1%	0%	0%	1%	0%	0%
Chromium*	0%	0%	0%	0%	0%	0%
Cobalt	0%	0%	0%	0%	0%	0%
Copper	6522%	3494%	5008%	3880%	948%	2016%
Lead*	433%	37%	235%	56%	21%	37%
Mercury*†	1%	0%	1%	3%	2%	2%
Molybdenum	0%	0%	0%	0%	0%	0%
Nickel	84%	67%	75%	196%	45%	102%
Selenium*	1%	1%	1%	1%	1%	1%
Silver*	3%	1%	2%	3%	2%	3%
Thallium	0%	0%	0%	1%	0%	0%
Vanadium	0%	0%	0%	0%	0%	0%
Zinc	773%	515%	644%	74%	51%	59%

* Federally regulated element.

† Some mercury is presumed to have escaped detection. See section 5.3.1.

Table 5-7. Differing concentrations between duplicate LED lamp samples

(Expressed as a percentage of TTLC)

Element	LED-1(a,b)			LED-2(a,b)		
	max	min	avg	max	min	avg
Antimony	15%	4%	9%	224%	25%	125%
Arsenic*	2%	0%	1%	3%	0%	2%
Barium*	1%	0%	1%	4%	4%	4%
Beryllium	1%	1%	1%	1%	1%	1%
Cadmium*	1%	1%	1%	2%	0%	1%
Chromium*	15%	6%	10%	5%	3%	4%
Cobalt	0%	0%	0%	0%	0%	0%
Copper	2698%	284%	1491%	2643%	2036%	2340%
Lead*	8%	2%	5%	23%	6%	14%
Mercury*	1%	1%	1%	1%	0%	0%
Molybdenum	0%	0%	0%	0%	0%	0%
Nickel	69%	3%	36%	57%	16%	37%
Selenium*	1%	1%	1%	1%	0%	1%
Silver*	7%	0%	3%	12%	8%	10%
Thallium	0%	0%	0%	1%	0%	0%
Vanadium	2%	1%	2%	1%	1%	1%
Zinc	378%	54%	216%	421%	73%	247%

* Federally regulated element.

Table 5-8. Differing concentrations between duplicate LED lamps

(Expressed as a percentage of TTLC)

Element	LED-3(a,b)‡			LED-4(a,b)‡§		
	max	min	avg	max	min	avg
Antimony	227%	63%	145%	7%	1%	4%
Arsenic*	0%	0%	0%	0%	0%	0%
Barium*	5%	3%	4%	26%	16%	21%
Beryllium	1%	1%	1%	1%	1%	1%
Cadmium*	1%	1%	1%	1%	1%	1%
Chromium*	12%	8%	10%	171%	0%	86%
Cobalt	0%	0%	0%	1%	0%	0%
Copper	2343%	1306%	1825%	1888%	922%	1405%
Lead*	48%	16%	32%	18%	0%	9%
Mercury*	1%	1%	1%	1%	1%	1%
Molybdenum	0%	0%	0%	0%	0%	0%
Nickel	46%	20%	33%	105%	6%	56%
Selenium*	2%	1%	1%	9%	1%	5%
Silver*	4%	1%	3%	19%	1%	10%
Thallium	0%	0%	0%	0%	0%	0%
Vanadium	2%	2%	2%	2%	0%	1%
Zinc	141%	84%	113%	224%	62%	143%

* Federally regulated element.
‡ Sample "b" tested at Lab B.
§ Samples were acquired six months apart and thus may differ in content.

5.4 Limitations of the Study

Apparent trends noted in this report should not be extrapolated to products that were not selected for testing, nor should they be interpreted as an absolute indication of regulatory compliance for those products tested. In addition, end-of-life product testing does not provide an indication of product safety during use.

5.4.1 Technology Characterization

Findings for lamps of a given technology (e.g., CFLs) should not be interpreted as representative of that technology overall. As an emerging technology, LED products remain particularly diverse, and it is likely that more than a handful of distinct lamps would be needed to obtain a clear picture of the broader market.

Integrated lamps were selected for testing because products in this category are directly interchangeable and thus directly comparable. However, it should be noted that outcomes may differ for luminaires since they—unlike integrated lamps—often feature replaceable components.

5.4.2 Model Characterization

Findings for a given model lamp should not be interpreted as representative of other nominally-identical samples produced by the same manufacturer. It is likely that more than two samples of the lamp would be needed to obtain adequate data for accurate estimation of average values (NEMA 2012). In addition, samples acquired on a certain date may not be representative of samples acquired just a few months later, which may incorporate design changes or different components. This is particularly relevant for LED and other emerging technologies and may explain the discrepancies observed between measurements by the two laboratories for nominally identical samples of model LED-4.

Chapter 9 of SW-846 offers guidance for development of a scientifically credible sampling plan. The document addresses both sampling accuracy and sampling precision, and discusses the required degree of each to ensure reliable characterization relative to regulatory thresholds for hazardous waste. Accuracy is typically achieved through random sampling, whereas precision is typically achieved by acquiring an adequate number of appropriately-sized samples.[1] Values of the sample mean and sample variance should be estimated prior to sample acquisition, based on available data (e.g., reported manufacturing tolerances). Extra samples should be stored until analysis of a smaller subset is completed, when it can be determined if the cost of analyzing additional samples is statistically warranted.

In the Part 3 study, duplicate samples of a given model were acquired anonymously and simultaneously through a single distributor, providing a degree of randomness. However, no more than four—and typically just two—duplicate samples of a given model were acquired and tested. The small sample quantity (a single distributor) and size (four or fewer lamps) limit both sampling precision and sampling accuracy.

5.4.3 Sample Characterization

No single test result can be regarded with absolute confidence. Measurement error must be considered—including possible error associated with sample partitioning (i.e., subsampling) as detailed in the preceding section on homogeneity. Laboratory detection limits and quality-control data are reported in Appendices C and D, for reference.

5.4.4 Contaminants not Investigated

Federal and CA regulations for hazardous waste address a variety of substances, including but not limited to the 17 elements investigated in this study. A number of regulated compounds (e.g., hexavalent chromium) were not specifically investigated as part of this study. Consequently, test data gleaned from testing of the selected samples cannot be used to determine overall compliance with regulations for hazardous waste.

[1] Note that the term “sample” is generally used herein to refer to an instance of a given model. However, from a statistical perspective this term may also refer to a set of nominally duplicate lamps acquired simultaneously from a single distributor; in this scenario, sample size would refer to the number of lamps in the set.

5.5 Rated Life versus Analyte Concentrations

Regulatory thresholds for hazardous waste are determined based on extractable concentrations of contaminants; they are not, for example, simple restrictions on the mass of a given element contained in a product. However, to better gauge the long-term contribution of regulated elements to landfills, the service life of a product also merits consideration. For example, if 25 incandescent lamps (each rated 1,000 hours) would be required to span the life of one LED lamp (rated 25,000 hours), a lower concentration of a regulated element in the incandescent lamps might in fact result in greater amount (i.e., mass) of hazardous waste. Although this effect can be offset to some extent by the relatively greater mass of typical LED lamps, heat sinks are expected to diminish in size as successive generations of this emerging technology continue to improve in efficacy, thereby lessening thermal management demands (DOE 2011, 2012c). Table 5-9 summarizes the calculation of cumulative mass for the selected omnidirectional lamps over a 25,000 hour period, based on assumed lamp life and recorded sample mass.

Table 5-9. Cumulative lamp mass over a 25,000 hour period

Model	Sample	Assumed lamp life (h)	Lamps used per 25,000 h	Mass per lamp (g)	Cumulative lamp mass per 25,000 h (g)
INC-1	(a)	1,000	25	27.6	690
	(b)			27.1	679
	(c)			27.6	690
	(d)			25.4	635
HAL-1	(a)	1,000	25	37.0	925
	(b)			36.6	915
CFL-1	(a)	8,000	3.1	59.4	186
	(b)			56.8	178
CFL-2	(a)	10,000	2.5	49.7	124
	(b)			48.5	121
	(c)			48.3	121
LED-1	(a)	25,000	1.0	166	166
	(b)			161	161
LED-2	(a)	25,000	1.0	178	178
	(b)			180	180

For the purpose of this analysis, all of the selected omnidirectional lamps were assumed to emit an equal number of lumens (i.e., they are essentially interchangeable). Rated life for CFLs was assumed accurate; no adjustment was made to account for frequency of switching. In addition, due to uncertainties in the estimated useful life of LED products, all LED lamps are conservatively assumed to last 25,000 hours (the selected models are rated at or above this value). Although lumen maintenance can vary widely across LED products, some may outperform other technologies in this regard. For example, the L Prize lamp has been shown to maintain initial output after 18,000 hours of operation, and it was projected to exhibit 97% lumen maintenance at 25,000 hours (DOE 2012d).

A set of life-adjusted limits for 25,000 hours of lamp operation is presented in Table 5-10. These criteria differ from TTLCs in that they account for longevity, thus limiting cumulative mass rather than concentrations. To determine these values, a hypothetical benchmark lamp was first defined to weigh 50 g and last for 10,000 hours, loosely based on the mass and assumed life of a typical CFL. Life-adjusted limits were then calculated for a given element by taking the product of cumulative mass for the benchmark lamp (0.125 kg) and the corresponding TTLC.

Table 5-10. Life-adjusted limits on cumulative mass for 25,000 hours of lamp use

Element	TTLC (mg/kg)	Maximum elemental mass (mg)
Antimony	500	63
Arsenic*	500	63
Barium*	10,000	1,250
Beryllium	75	9
Cadmium*	100	13
Chromium*	2,500	313
Cobalt	8,000	1,000
Copper	2,500	313
Lead*	1,000	125
Mercury*	20	3
Molybdenum	3,500	438
Nickel	2,000	250
Selenium*	100	13
Silver*	500	63
Thallium	700	88
Vanadium	2,400	300
Zinc	5,000	625

* Federally regulated element.

Figure 5-2 illustrates the relative contributions of the investigated elements from each omnidirectional lamp sample, determined by taking the product of cumulative lamp mass and measured concentrations from Method 3050 testing; values are shown on a base-10 log scale as a percentage of the life-adjusted limits. Although the disproportionately greater number of replacements yields relatively higher quantities of regulated elements from the incandescent lamps (e.g., nickel), the greater mass of the LED lamps appears to generally offset the longer assumed lifetime to some degree. However, consideration of product weight and longevity in this manner could help to discourage the addition of filler material to reduce concentrations of contaminants in lamps.

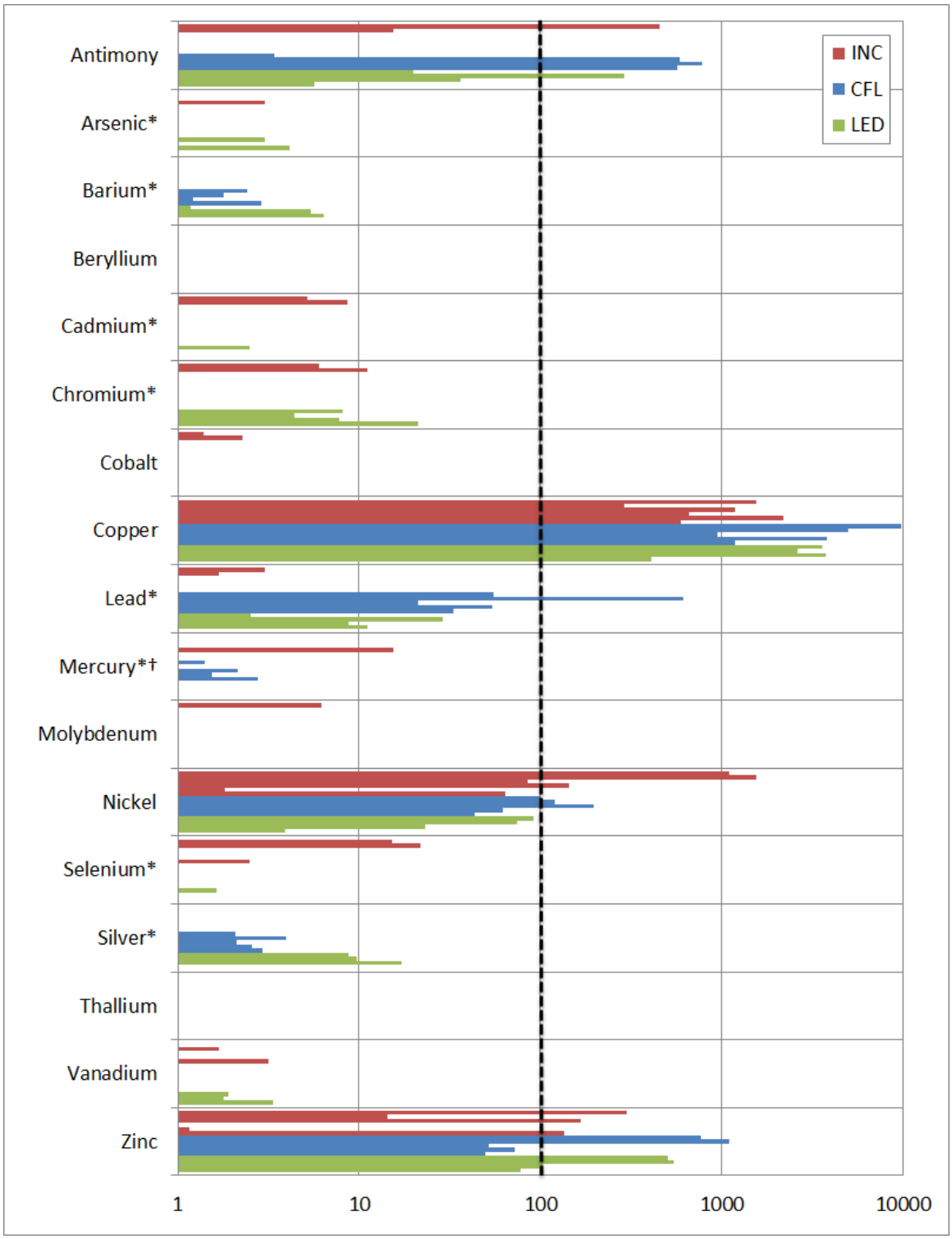


Figure 5-2. Cumulative mass for 25,000 hours of omnidirectional lamp operation, as a percentage of life-adjusted limits derived from TTLC thresholds (log scale). Whereas the concentration of a given element is restricted in regulations, its cumulative mass must be evaluated when accounting for lamp longevity.

*Federally regulated element.

† Some mercury in CFLs is presumed to have escaped detection. See section 5.3.1.

6.0 Conclusions and Recommendations

Two prior studies conducted by the DOE provided a comprehensive analysis of existing LCA literature and a new LCA using a detailed model of the manufacturing process to compare LED lamps with equivalent incandescent lamps and CFLs. The third study, reported herein, focused on end-of-life disposal considerations for these lamp types. Parts 1 and 2 found that energy in use is the most important parameter when evaluating lighting products on a life-cycle basis; consequently, luminous efficacy merits a high priority when making purchasing decisions. However, the Part 3 findings suggest responsible end-of-life disposal (e.g., by recycling) should also be given due consideration.

Lamps selected for this study were milled prior to testing, thereby exposing previously encapsulated materials which might not otherwise be environmentally available. Milled samples were then primarily assessed using EPA Method 3050, typically resulting in complete digestion. In addition, whereas all types of millable components were included in this analysis, components like batteries and capacitors are often removed and excluded in other studies (DTSC 2004b). Consequently, the test results generally represent a worst-case scenario for the investigated elements leaching from these lamps after disposal in a landfill.

The selected models were generally found to be below thresholds for Federally regulated elements. However, volatile mercury in the CFLs is presumed to have escaped detection, and several CFLs exceeded a threshold for lead (TTLC, STLC, or FRL). In addition, most of these products were found to be well above the CA threshold for copper—regardless of technology—and some approached or exceeded the threshold for nickel. A number of CFLs and LED lamps were also found to exceed CA thresholds for antimony and zinc. Examination of components in these above-threshold lamps revealed that the greatest contributors were the screw bases, drivers, ballasts, and wires or filaments. Concentrations in LED lamps were comparable to other types of electronic devices, and were generally attributable to components other than internal LED light sources.

This study was not intended to provide a definitive indication of regulatory compliance for any specific lamp model or technology, and its findings should be interpreted accordingly. Further study would be needed to more broadly characterize various light source technologies; to more accurately and precisely characterize a specific model lamp; or to determine whether product redesign would be appropriate.

6.1 Managing Solid Waste

End-of-life disposal is only one of several sources of environmental impact. Applicable regulations for hazardous waste do not differentiate among lighting products on the basis of performance, and hence do not provide a direct incentive for reduced life-cycle energy or environmental impacts achieved through improved efficacy or longevity.

6.1.1 Characterizing Waste at End-of-Life

Solid waste generators are responsible for characterizing their waste, and SDS voluntarily published by manufacturers can be helpful in this regard. Regulators and future LCA studies would also benefit from an improved understanding of the hazardous waste characteristics of lighting products. Following is a brief summary of “lessons learned” in the course of this project, intended to facilitate any future work by other independent investigators:

- Test specifications must emphasize the identification and appropriate handling—before, during, and after disassembly—of CFLs and other products known or suspected to contain mercury or other volatile substances.
- Complex components (e.g., ballasts, LED drivers, and LED light sources) require special care to ensure homogeneity across subsamples. Multiple samples of a given model should be acquired, disassembled in an identical manner, and combined to yield sufficient material for each test.
- Nominally duplicate product samples should be acquired simultaneously to reduce the potential for differences in composition resulting from successive design changes. This is particularly important for emerging technologies such as LED lamps, which may be revised more than once in a year.
- Milling should only be performed after disassembly is reviewed and deemed sufficient.
- All test data should be provided in a single document for easy reference, completeness, and consistency. Test specifications should require that test reports include sample photographs, weights, and descriptive text (e.g., "LED driver" or "LED light source"). Subsample mass should be reported for every set of corresponding concentration measurements, and samples should be arranged alphabetically and/or numerically.
- Concentrations from WET and TCLP testing should be reviewed to ensure they do not exceed theoretical limits calculated from EPA Method 3050 test results. If inhomogeneity is detected in this manner, a modified procedure and/or acquisition of additional samples may be warranted. Similarly, some seemingly redundant WET or TCLP testing (based on EPA Method 3050 test results) might be considered as a check on subsample homogeneity.

6.1.2 Recycling

The Part 2 study conservatively assumed minimal recycling, and indicated that aluminum recycling would be particularly beneficial in terms of life-cycle impacts for LED lighting products; this can be achieved by increasing recycled content and by reclaiming recyclable material at end of life. For many LED products, recycling costs might be offset by the value of recovered aluminum. The Part 3 findings provide further impetus for lamp recycling, to ensure compliance with stringent regulations for hazardous waste disposal.

Requirements and capabilities vary by locality, but qualified mail-in programs may present a viable option in areas with limited access to suitable recycling facilities. The EPA provides online guidance for responsible recycling of lamps (http://www.epa.gov/osw/hazard/wastetypes/universal/lamps/index.htm) and electronics (http://www.epa.gov/wastes/conserve/materials/ecycling/index.htm).

6.2 Optimizing Product Design

Many lighting manufacturers modified product designs to comply with RoHS criteria, indicating some flexibility in this regard (ELC 2009). However, a number of often competing factors must be considered when designing a lighting product, including but not limited to: luminous efficacy, lighting quality, longevity, initial cost, and safety. Environmental impacts should be assessed on a life-cycle basis using reliable data applicable to the products under consideration. If, for example, a reduction in hazardous waste content would result in significantly lower efficacy, the desired end-of-life benefits might be overshadowed by increased energy use and life-cycle environmental impacts.

7.0 References

DOC (2013). *RoHS – Restriction of Hazardous Substances Directive*. U.S. Commercial Service, International Trade Administration, U.S. Department of Commerce. Accessed February 21, 2013 at http://export.gov/europeanunion/weeerohs/rohsinformation/index.asp.

DOE (2011). *LED Frequently Asked Questions*. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Washington, D.C. May 2011. Retrieved from http://www1.eere.energy.gov/buildings/ssl/factsheets.html.

DOE (2012a). *Energy Savings Potential of Solid-State Lighting in General Illumination Applications*. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Washington, DC. January 2012. Retrieved from http://www1.eere.energy.gov/buildings/ssl/tech_reports.html.

DOE (2012b). *Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products, Part 1: Review of the Life-Cycle Energy Consumption of Incandescent, Compact Fluorescent, and LED Lamps*. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Washington, DC. February 2012. Retrieved from http://www1.eere.energy.gov/buildings/ssl/tech_reports.html.

DOE (2012c). *Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products, Part 2: LED Manufacturing and Performance*. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Washington, DC. June 2012. Retrieved from http://www1.eere.energy.gov/buildings/ssl/tech_reports.html.

DOE (2012d). *Lumen Maintenance Testing of the Philips 60-Watt Replacement Lamp L Prize Entry*. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Washington, DC. July 2012. Retrieved from http://www.lightingprize.org/60watttest.stm.

DTSC (2004a.) *E-waste Report: Determination of regulated elements in seven types of discarded consumer electronic products*. Hazardous Material Laboratory, California Department of Toxic Substances Control. Sacramento, CA. January 2004. Retrieved from http://www.dtsc.ca.gov/HazardousWaste/EWaste/MoreInfo.cfm.

DTSC (2004b.) *SB 20 Report: Determination of regulated elements in discarded laptop computers , LCD monitors , Plasma TVs and LCD TVs*. Hazardous Material Laboratory, California Department of Toxic Substances Control. Sacramento, CA. December 2004. Retrieved from http://www.dtsc.ca.gov/HazardousWaste/EWaste/MoreInfo.cfm.

EC (2011). "Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast)." Retrieved from http://ec.europa.eu/environment/waste/rohs_eee/legis_en.htm.

ELC (2009). *Environmental aspects of lamps, Second Edition*. European Lamp Companies Federation. Brussels, Belgium. April 2009.

Engelhaupt, E. (2008). "Do compact fluorescent bulbs reduce mercury pollution?" Environmental Science & Technology 42(22): 8176-8176.

EPA (1996). *EPA Method 3050B, Revision 2: Acid Digestion Of Sediments, Sludges, And Soils*. U.S. Environmental Protection Agency. Washington, DC. December 1996. Retrieved from http://www.epa.gov/osw/hazard/testmethods/sw846/online/3_series.htm.

EPA (2008.) *EPA Publication SW-846, Third Edition: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*. U.S. Environmental Protection Agency, Office of Solid Waste. Washington, DC. Retrieved from http://www.epa.gov/osw/hazard/testmethods/sw846/online/.

EPA (2012a). ENERGY STAR Program Requirements Product Specification for Lamps (Light Bulbs) Eligibility Criteria Version 1.0, DRAFT 3. U.S. Environmental Protection Agency. Washington, DC. December 2012. Retrieved from https://energystar.gov/products/specs/node/273.

EPA (2012b). *Frequent Questions—TCLP, Total Constituent Analysis Instead of TCLP Analysis*. U.S. Environmental Protection Agency, Methods Information Communication Exchange (MICE) Service. Washington, D.C. Last updated November 15, 2012. Accessed March 20, 2013 at http://www.epa.gov/osw/hazard/testmethods/faq/faq_tclp.htm.

GE (2007). *Compact Fluorescent Lamps – Lamp Material Information Sheet*. GE Lighting, GE Consumer and Industrial. Cleveland, OH. September 2007. Accessed August 2, 2012 at http://www.geconsumerandindustrial.com/environmentalinfo/regulations_resources/msds.htm.

Johnson, N. C., S. Manchester, L. Sarin, Y. Gao, I. Kulaots and R. H. Hurt (2008). "Mercury Vapor Release from Broken Compact Fluorescent Lamps and In Situ Capture by New Nanomaterial Sorbents." Environmental Science & Technology **42**(15): 5772-5778.

Lim, S.-R., D. Kang, O. A. Ogunseitan and J. M. Schoenung (2010). "Potential Environmental Impacts of Light-Emitting Diodes (LEDs): Metallic Resources, Toxicity, and Hazardous Waste Classification." Environmental Science & Technology **45**(1): 320-327.

Lim, S.-R. and J. M. Schoenung (2010). "Toxicity potentials from waste cellular phones, and a waste management policy integrating consumer, corporate, and government responsibilities." Waste Management **30**(8–9): 1653-1660.

Lincoln, J. D., O. A. Ogunseitan and A. A. Shapiro (2006). Meta-analysis of Hazard Criteria Designation for Electronic Waste. Proceedings of the 2006 IEEE International Symposium on Electronics and the Environment.

Lincoln, J. D., O. A. Ogunseitan, A. A. Shapiro and J.-D. M. Saphores (2007). "Leaching Assessments of Hazardous Materials in Cellular Telephones." Environmental Science & Technology **41**(7): 2572-2578.

NEMA (2012). *LSD 63-2012, Measurement Methods and Performance Variation for Verification Testing of General Purpose Lamps and Systems.* Lamp and Ballast Sections, National Electrical Manufacturers Association. Rosslyn, Virginia. September 2012.

Philips (2011). *Lamp Material Data Sheet (LMDS) # CFI – 08100B, Philips Compact Fluorescent Lamps CFL-i – All Types.* Philips Lighting Company. Somerset, NJ. March 15, 2011. Accessed August 2, 2012 at http://www.usa.lighting.philips.com/connect/tools_literature/msds_sheets.wpd.

Rosillo, F. G., F. Castejón and M. A. Egido (2012). "Emissions and economic costs of cycling compact fluorescent lamps with integrated ballasts." Lighting Research and Technology.

Singhvi, R., A. Taneja, J. R. Patel, V. Kansal, C. J. Gasser and D. J. Kalnicky (2011). "Determination of Total Metallic Mercury in Compact Fluorescent Lamps (CFLs)." Environmental Forensics **12**(2): 143-148.

TCP (2005). *MSDS-001, Compact Fluorescent Safety Specifications*. TCP North America. Aurora ,OH. January 2005. Accessed August 6, 2012 at http://www.tcpi.com/specSheets/default.aspx?categoryid=179.

Appendix A: Test Specification

STATEMENT OF WORK

Destructive Testing of Lighting Products to Assess Hazardous Metals Content

Background

Battelle is undertaking for the U.S. Dept. of Energy an assessment of the life-cycle environmental and resource costs in the manufacture, use and disposal of solid state lighting products in relation to comparable alternatives embodying traditional technology. The assessment consists of three elements: 1) a life-cycle econometric and environmental analysis of the direct and indirect material and process inputs to fabricate the products; 2) Evaluation of the comparative environmental impacts of supplying the energy consumed by the products in typical use; and 3) disassembly and chemical testing to determine what potentially hazardous metals are present and their concentrations relative to hazardous waste regulatory thresholds. The results of the three analyses will be normalized by lumen-hours so as to be comparable across products and technologies. The tasks enumerated below constitute the third element of the assessment, involving disassembly and chemical testing.

Approach

Battelle anticipates replicating, to a significant degree, the analysis performed on electronic display products in December 2004 by the California Department of Toxic Substances Control's Environmental Chemistry Laboratory as described in their SB 20 Report, *Determination of Regulated Elements in Discarded Laptop Computers, LCD monitors, Plasma TVs and LCD TVs.* To this end, Battelle has selected representative lighting products to be tested, and the contractor shall disassemble the products into as nearly homogenous components as practical and safe; grind and prepare them for established leaching, acid digestion and extraction procedures; apply the procedures; and analyze the resulting materials for toxic elements contained in them.

Task 1

The Contractor shall receive from PNNL sample lighting products from among those listed in Attachment 1 and disassemble them according to instructions in Section 5.1. of Attachment 2:

Photograph and weigh each lamp sample and record on the specified form; dismantle and separate each lamp into its major components listed below, photograph them individually, and record their weights in appropriate columns on the form specified in the instructions.

a. Homogeneous metal components
b. Homogeneous plastic components
c. Homogeneous glass components
d. Electronic circuit boards, including wires, semiconductor devices and other components, except light-emitting diodes

e. Light-emitting diode “packages” (See Figure 1 for an illustration of a typical LED package. Battelle will not request disassembly of this unit.

f. Remaining materials after removing a.-e.

Photographs and weights called for in the procedure shall be submitted to the Battelle point of contact electronically as they are developed.

The Contractor shall also recommend any components of the disassembled products for exclusion from testing based on known composition. The purpose of disassembly will be to achieve greater degrees of homogeneity for testing and correspondingly more uniform results, as well as to elucidate contributions of specific components. The Contractor’s recommendations shall be communicated by e-mail memorandum, followed by a remote videoconference to discuss them.

Task 2

After receiving the Contractor’s recommendation, Battelle will indicate to the Contractor the subset of components selected by Battelle for testing. The Contractor shall then prepare the selected components for digestion according to the procedure given in Attachment 2, unless, as in the case of compact fluorescent tubes, they are deemed likely to contain mercury. Mercury-containing components shall be prepared according to Procedural SOP No. 914-S in Appendix A2 of the SB 20 Report referred to above. Three separate samples shall be prepared for each individual component for replication.

Task 3

To each of the samples prepared in Task 2, the Contractor shall apply EPA Method 3050B Acid Digestion of Sediments, Sludges, and Soils and shall determine Total Threshold Limit Concentration (TTLC) levels for the metallic elements listed in California Code of Regulations, Title 22, Division 4.5, Chapter 11, Article 3, §66261.20 et seq. (See Table 1.) The Contractor shall report all TTLC levels in tabular form to PNNL and shall alert Battelle electronically if the value for any element exceeds the corresponding STLC/TCLP regulatory limit in Table 1 by more than a factor of 10.

Task 4

If the TTLC value from Task 3 exceeds any STLC/TCLP regulatory limit in Table 1 by more than a factor of 10 for any element, and Battelle determines that the sample will be so tested, the Contractor shall apply the California Waste Extraction Test Procedure (WET) described in California Code of Regulations, Title 22, Division 4.5, Chapter 11, Appendix II, and shall determine the corresponding soluble threshold limit concentration (STLC) values for those elements. The Contractor shall report all STLC levels in tabular form to Battelle and shall alert Battelle electronically if the STLC value for an EPA Hazardous Waste number from D004 to D011 from any sample falls below the STLC regulatory limit in Table 1, and the TTLC exceeds the STLC/TCLP regulatory limit for any element by more than a factor of 20.

Task 5

If the STLC value from Task 4 for an EPA Hazardous Waste number from D004 to D011 from any sample from Task 4 falls below the STLC regulatory limit in Table 1, and the TTLC exceeds the STLC/TCLP regulatory limit for any element by more than a factor of 20, and if PNNL determines that the sample will be so tested, the Contractor shall apply EPA Method 1311, Toxicity Characteristic Leaching Procedure, and shall determine the corresponding TCLP values for those elements.

Task 6

The Contractor shall present the test results with their regulatory maximum concentrations as listed in California Code of Regulations, Title 22, Division 4.5, Chapter 11, Article 3, §66261.24 (a) (1) (B) Table I - *Maximum Concentration of Contaminants for the Toxicity Characteristic* and (a) (2) (A) Table II - *List of Inorganic Persistent and Bioaccumulative Toxic Substances and Their Soluble Threshold Limit Concentration.*

Task 7

After performing the procedures and tests in Tasks 1-6, the Contractor shall safely dispose of all samples, spent reagents and other wastes in accordance with applicable State and Federal regulations.

Task 8

The Contractor shall prepare a comprehensive written report describing the methodology, procedure and results of the analysis along with observations to aid interpretation. The report shall be submitted to Battelle in draft form for comments, and the final version shall be submitted within three weeks of receiving comments from the Battelle point of contact.

Schedule

Task 1 – Two weeks from receipt of products from Battelle

Tasks 2 and 3 – Two weeks from receipt of list of components selected for testing by Battelle.

Task 4 – Two weeks from Battelle order to proceed with California WET procedure

Task 5 – Two weeks from Battelle order to proceed with EPA TCLP testing

Task 6 – Electronic summary two weeks from completion of Task 5

Task 7 – As wastes are generated in Tasks 1-5

Task 8 – Draft report four weeks from completion of Task 5; Final report three weeks from receipt of comments from Battelle

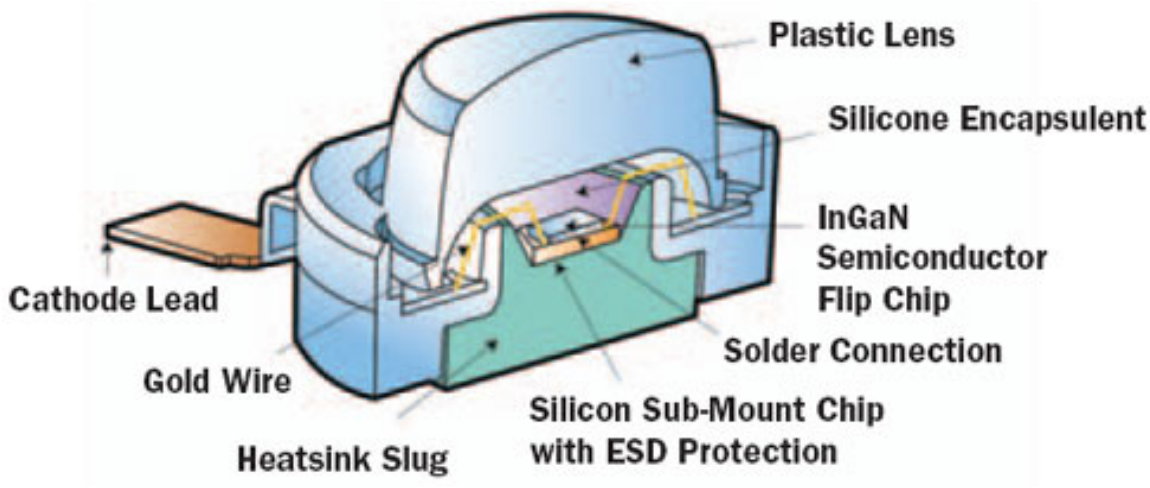


Figure A-1. Typical LED "Package"

Table 1. Elements to be Assessed and Threshold Values

TTLC/STLC/TCLP Limits

Element	EPA HW No.	TTLC Limit (mg/kg)	STLC/TCLP Limit (mg/L)	Run STLC if TTLC over:	Run TCLP if TTLC over:
Ag	D011	500	5	50	100
As	D004	500	5	50	100
Ba	D005	10,000	100	1,000	2,000
Be		75	0.75	7.5	--
Cd	D006	100	1	10	20
Co		8,000	80	800	--
Cr	D007	2,500	5	50	100
Cu		2,500	25	250	--
Hg	D009	20	0.2	2	4
Mo		3,500	350	3,500	--
Ni		2,000	20	200	--
Pb	D008	1,000	5	50	100
Sb		500	15	150	--
Se	D010	100	1	10	20
Tl		700	7	70	--
V		2,400	24	240	--
Zn		5,000	250	2,500	--

California Code of Regulations, Title 22, Division 4.5, Chapter 11, Article 3, §66261.24. *Characteristic of Toxicity*

Attachment 1
Possible Lamp Products to be Tested (make/model info removed for inclusion in appendix)

Table 2. Candidate A-lamp products for toxic leachability testing

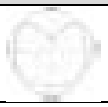
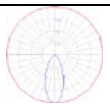
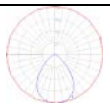
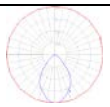
Make/Model	Initial output (lm)	Input power (W)	CCT (K)	CRI	ENERGY STAR	Candela plot	Notes
	860	60	2700	100			INC CALiPER
	850	60	2850	100			INC
	820	60					INC Retail 1500 h
	750	43		100			HAL EISA 2007
	785	43	2900	100			HAL EISA 2007
	825	13	2700	82	✓		CFL CALiPER
	900	14	2700		✓		CFL CR A2
	900	13	2700		✓		CFL CR A3
	800	12.5	2700	80	✓		LED CR B1 Lighting Facts
	800	12.5	2700	80	✓		LED CALiPER Lighting Facts
	850	13.5	2700	85			LED Lighting Facts

Table 3. Candidate residential downlight products for toxic leachability testing

Make/Model	Initial output (lm)	Input power (W)	CCT (K)	CRI	ENERGY STAR	Candela plot	Notes
	755	65					INC
	620	65	2850	100			INC
	635	65					INC 55° beam
	585	50	2800	100			HAL EISA 2007
	600	40					HAL EISA 2007
	720	15	2700	82	✓		CFL CR D2
	750	15	2700		✓		CFL CR D3
	600	12	2700	94	✓		LED 50° beam Lighting Facts
	700	15	2700	84	✓		LED 40° beam Lighting Facts
	575	10.5	2700		✓		LED 81° beam CALiPER CR D1
	616	12	2700	90	✓		LED 72° beam Lighting Facts

Attachment 2
Procedure for Preparation of Lamp Products (LED, INC, HAL, and CFL) for Metals Analyses including the TTLC, WET and TCLP

This procedure is predominantly based upon Procedural SOP No. 916-S and SOP No. 733-S developed by the California Department of Toxic Substances Control's Environmental Chemistry Laboratory as described in their SB 20 Report, *Determination of Regulated Elements in Discarded Laptop Computers, LCD monitors, Plasma TVs and LCD TVs* and the report, *Sample Preparation of Electronic Waste (E-waste) Samples for the Analysis of Semivolatiles and Metals*.

1. Scope and Application

1.1. This procedure is applicable to the preparation of lighting products, including LED, INC, HAL and CFL, to determine the total metal content for TTLC, the California Waste extraction test (WET) and Toxicity Characteristic Leaching Procedure (TCLP) extractable metals in various components. For Hg testing (e.g., fluorescent tubes), use Procedural SOP No. 914-S in Appendix A2 of DTSC's SB 20 Report.

1.2. This test plan describes the procedure to disassemble waste products, segregate components, and prepare samples prior to digestion and extraction procedures for subsequent analyses.

1.3. This procedure is recommended for use by laboratory assistants and/or technicians working under the close supervision of chemists experienced in the sample preparation requirements for inorganic analyses.

2. Summary

2.1. Several light source types are identified in this procedure: light-emitting diode (LED), compact fluorescent (CFL), halogen and incandescent.

2.2. As described in Section 5, below, the total weight of each device (sample) is recorded, and the samples are then photographed, disassembled, and segregated into component fractions for subsequent preparation and analysis.

2.3. After careful disassembly, each component fraction is photographed, weighed and stored in separate labeled containers.

2.4. The required component fraction of a sample is reduced in particle size through crushing, grinding, shredding, milling, etc. An appropriate shredder and mill or grinder is used for this process. As indicated in Section 5, the sample particle size should be reduced to pass through a 9.5 mm sieve for TCLP and a 2 mm (No. 10) sieve for TTLC and WET analysis. The sample is then mixed for homogeneity and sub-sampled to obtain aliquots for analysis. Note that it may not be possible to grind certain component matrices, such as metals and plastics. In this case, the procedure outlined in Section 6 applies.

2.5. Interferences from carry-over from one sample to another must be minimized by cleaning the equipment with dry wood chips and pressurized air. All containers must be clean and free of organic and inorganic substances. Cleaning of small milling and grinding units will be performed per DTSC's HML SOP 704-S.

3. Safety

3.1. Sample preparation should be performed in a well-ventilated high ceiling room.

3.2. Nitrile gloves may be worn for hand protection, but must not come in contact with the sample, or the interior of the sample containers, to avoid contamination.

3.3. Use safety glasses or goggles when reducing particle size of the sample (crushing, shredding, milling, grinding, cutting).

3.4. The operator must wear a dust mask and coveralls if necessary during the process

3.5. The working area (counters, equipment, tools, etc.) should be kept clean at all times.

3.6. Operating instructions must be followed while using the shredder and/or grinder.

4. Apparatus and Materials

4.1. Hand tools for dismantling e.g. special screwdrivers, electric drill/saw, hammer, cutters and pliers, etc.

4.2. Rotary mill or an automatic grinder capable of grinding small pieces of plastic and printed circuit boards.

4.3. Electric cutter or a shredding machine capable of reducing particle size into small pieces

4.4. Top loading scale 15 kg capacity (accurate to +/- 30 g

4.5. Top loading balance 1 kg capacity (accurate to +/- 0.2 g)

4.6. Dust masks, face shields or eye goggles.

4.7. Nitrile gloves

4.8. Teflon or glass containers of appropriate size for storing the prepared samples.

4.9. Liquid nitrogen

4.10. Deionized water

4.11. Nitric acid, 5 percent

4.12. Acetone

5. **Disassembly/Separation Procedure**

5.1. Photograph and weigh each lamp sample and record on Form 1. Dismantle and separate each lamp into its major components listed below, photograph them individually, and record their weights in appropriate columns on Form 1.

5.1.1. Homogeneous metal components

5.1.2. Homogeneous plastic components

5.1.3. Homogeneous glass components

5.1.4. Electronic circuit boards, including wires, semiconductor devices and other components, except light-emitting diodes

5.1.5. Light-emitting diode “packages” (See Figure 1 for an illustration of a typical LED package. Battelle will not request disassembly of this unit.)

5.1.6. Remaining materials after removing a.-e.

5.2. Each component is passed through the cutter/shredder to break down into small pieces. After this preliminary preparation step, component samples are ground in a mill or grinder to a fine particle size, where appropriate (semiconductors and light-emitting diodes). Metals and certain plastics may not be appropriate for grinding. In this case, see Section 6 for an alternative procedure for further particle size reduction.

5.3. Clean the equipment after processing each component. Pass dried wood chips through the shredder/cutter and mill/grinder. Inspect equipment for leftover wood chips, then blast pressurized air through the equipment to ensure it is completely free of sample particles or wood chips. **Wear masks and goggles.**

5.4. The entire sample is sieved through the 9.5 mm and 2 mm sieves sequentially to meet the TTLC, WET and TCLP requirements. If sample is scarce, it may not be possible to prepare samples of both particle sizes, and in that case, 2 mm can be used for both the TCLP and the WET analyses.

5.5. Record the weight of each fraction and store in a glass container properly labeled at 4 °C.

5.6. Repeat the cleaning process as in step c after all samples have been processed.

6. Alternative Procedure

6.1. In the case the above procedure is not possible to reduce the particle size of the samples, e.g., with metals and certain plastic materials, the following alternative approach may be substituted.

6.2. Weigh and record the total weight of each lamp sample. Dismantle and separate each lamp into its major components, such as plastic, metals, glass, and circuit boards. Photograph, weigh and record them as described in Section 5.

6.3. If the metal or plastic is of known homogeneous composition (for example a large aluminum heat sink) it may be weighed and considered separately from the tested materials.

6.4. Cut remaining components (e.g., metals, plastics) into smaller pieces by using all mechanical means like the electric drill and/or diamond saw, cutters, pliers and hammers. Sometimes plastic is hard to cut but breaking with a hammer and a cutter may work out.

6.5. Small cut pieces of each component sample may be collected at random from the pile of broken pieces and frozen separately in liquid nitrogen for 2 hours to facilitate further breaking and crushing.

6.6. The frozen pieces are crushed into smaller size by using cutters, hammers, mortar and pestle and a hydraulic press if necessary to achieve the finer particle size. Record the final weight of the sample prepared by this procedure and store in a glass or Teflon container at 4 ° C. It is desirable to collect at least 1 gram for the TTLC, at least 50 grams for the WET analysis and at least 100 grams for the TCLP analysis. Although the regulations specify these amounts for the WET and TCLP methods, PNNL may allow as little as 2 grams for each of these procedures if it proves difficult or costly to acquire adequately-sized samples or to prepare them.

6.7. Clean all equipment by rinsing with DI water, 5% nitric acid, DI water and acetone in series and air dry before using for the next sample.

6.8. Sieved portions of the sample should be used to perform the analyses.

7. Quality Control

7.1. Although most of the QC requirements are defined in the respective analytical procedures, at a minimum, the following quality checks are required. A sample batch is defined as a group of 10 samples or fewer that is processed together and comprised of

samples of similar matrix [excluding lab control sample (LCS), matrix spike (MS) and matrix spike duplicate (MSD)].

7.2. A sample batch must consist of samples of the same matrix processed and digested/extracted and analyzed at the same time. Any other type of matrix QC included with the samples is not acceptable.

7.3. Each batch shall contain one method blank. The blank shall contain all reagents processed with that batch.

7.4. Each batch must include a replicate (sample duplicate or triplicate).

7.5. Each batch shall contain an MS and an MSD.

7.6. Each batch shall contain a method standard or LCS containing all elements/compounds of concern. Standards from the same vendor must be used as that used for MS and MSD. Spiking standards must be acquired from the vendor other than the calibrating standard (or different lot#, at a minimum).

Form 1. Weights of Entire Device and Components in Grams

Sample ID#	Device (before disassembly)	Metals	Plastics	Glass	Circuits	Light-Emitting Diode Packages	Remaining materials	Sum of Components	NOTES

Appendix B: Results by Lamp Component

The following tables clarify which component(s) caused a lamp to exceed thresholds for a given element; actual concentrations are given in Appendices C and D. Evaluation is cumulative and relative to overall lamp mass; components are not evaluated directly against thresholds for lamps. For example, the 3,100 mg/kg concentration of copper measured for the INC-1(a) metals component “C” was not compared directly with the 2,500 mg/kg TTLC for this element. The measured value was instead combined with the base (18,000 mg/kg) and the glass (29.1 mg/kg) components as a weighted average to yield 5,365 mg/kg overall for the lamp.

Components confirmed to be below STLC or FRL are also indicated to clarify which additional tests were performed after comparing EPA Method 3050 results with TTLCs; elements measured below TTLCs are not indicated.

Photographs show whole lamps or components exposed by disassembly, prior to milling.

Table B-1. INC-1(a)

Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Glass 16.4 g			
 B	Base 7.5 g	Cu		Ni < STLC
 C	Wire 3.2 g			
 (whole)	Lamp 27.6 g	Notes:		

Table B-2. INC-1(b)

Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A1	Base 1.3 g			
 A2	Wire 0.2 g	Cu		Ni < STLC
 B	Plastic 1.8 g			
 C	Glass 21.5 g			
 F	Misc. 1.4 g			
 (whole)	Lamp 27.1 g	Notes:		

Table B-3. INC-1(c)

Component ID	Description	
 (whole)	Lamp 27.6 g	Notes: Lamp tested without disassembly—components were not tested in isolation.

Table B-4. INC-1(d)

Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Glass 16.0 g			
 B	Base 3.9 g	Cu		Ni < STLC
 C	Wire 5.4 g			
 (whole)	Lamp 25.4 g	Notes:		

Table B-5. INC-2(a)

Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Glass 42.0 g			
 B	Base 3.5 g			
 C	Wire 7.0 g			
 (whole)	Lamp 52.7 g	Notes:		

Table B-6. HAL-1(a)

Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Glass 24.9 g			Sb < STLC
 B	Base 3.6 g	Cu		
 C	Wire 7.9 g	Ni		
 (whole)	Lamp 37.0 g	Notes:		

Table B-7. HAL-1(b)

Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Glass 24.6 g			
 B	Base 3.7 g			Cu < STLC
 C	Wire 8.7 g	Ni		Cu < STLC
 (whole)	Lamp 36.6 g	Notes:		

Table B-8. HAL-2(a)

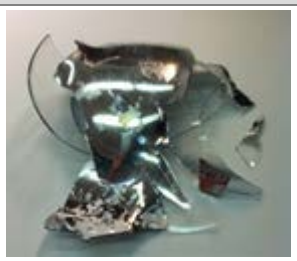
Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Glass 46.6 g			
 B	Base 5.9 g	Cu Zn		
 C	Wire 9.6 g			
 D	Cloth 0.3 g			
 (whole)	Lamp 62.5 g	Notes: Inadequate material for cloth Hg; assumed ND.		

Table B-9. CFL-1(a)

Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Glass 20.5 g			
 B	Plastic 14.6 g		Ni? (STLC)	
 C	Base 8.7 g	Cu Zn	Pb? (STLC) Ni? (STLC)	
 D	Ballast 15.0 g	Cu		
 (whole)	Lamp 59.4 g	Notes: Lamp was damaged prior to disassembly. WET was not performed. TCLP was not performed.		

Table B-10. CFL-1(b)

Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Ballast 14.7 g	Cu Pb		
 B	Glass 21.3 g			
 C	Base 9.4 g	Cu Zn	Ni > STLC	
 D	Plastic 11.2 g			
 (whole)	Lamp 56.8 g	Notes: Ni was 84% of TTLC, mostly found in base (C).		

Table B-11. CFL-2(a)

Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Ballast 14.1 g	Cu Ni	Pb? (FRL)	Pb < STLC Zn < STLC
 B	Glass 18.2 g			
 C	Base 5.3 g	Sb		
 D	Plastic 11.9 g	Sb		
 (whole)	Lamp 49.7 g	Notes: Inadequate material for Pb TCLP on ballast. Cu in base (C) alone would yield 84% of TTLC. Ni in base (C) alone would yield 73% of TTLC.		

Table B-12. CFL-2(b)

Component ID	Description	
 (whole)	Lamp 48.5 g	Notes: Lamp tested without disassembly—components were not tested in isolation. WET concentration for nickel was 36% over theoretical limit derived from Method 3050, but Lab A indicated subsamples were homogenous.

Table B-13. CFL-2(c)

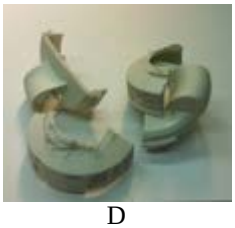
Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Ballast 14.2 g	Cu	Pb? (FRL)	Pb < STLC Zn < STLC
 B	Glass 16.2 g			
 C	Base 4.5 g		Ni > STLC	
 D	Plastic 13.2 g	Sb		
 (whole)	Lamp 48.3 g	Notes: Inadequate material for Pb TCLP on ballast. Sb was mostly in plastic (D), but base (C) alone would yield 89% of TTLC.		

Table B-14. CFL-3(a)

Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Ballast 31.0 g	Cu	Pb > FRL	Pb < STLC Zn < STLC
 B	Glass 55.2 g			
 C	Base 4.7 g		Ni > STLC	
 D	Plastic 28.7 g	Sb		Zn < STLC
 (whole)	Lamp 119.8 g	Notes: Pb in ballast below STLC but above FRL. WET concentration for nickel in ballast was more than twice the theoretical limit derived from Method 3050, but Lab A indicated subsamples were homogenous.		

Table B-15. LED-1(a)

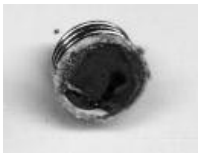
Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Metal 65.6 g			Cr < STLC Cr < FRL
 B	Base 22.2 g	Cu Zn	Ni? (STLC)	
 C	Plastic 13.1 g			
 D	Source 5.0 g			
 E	Sheath 11.3 g			
 F	Driver 47.4 g	Cu		Ni < STLC
 (whole)	Lamp 166.2 g	Notes: First sample was supplemented by another (two months between acquisitions) to enable TCLP testing. Sheath was not tested. Cu was primarily in base (B) and driver (F), but source (D) alone would yield 85% of TTLC.		

Table B-16. LED-1(b)

Component ID	Description	
 (whole)	Lamp 160.7 g	Notes: Lamp tested without disassembly—components were not tested in isolation.

Table B-17. LED-2(a)

Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Metal 68.2 g			Cr < STLC Pb < STLC Zn < STLC Cr < FRL Pb < FRL
 B	Base 15.3 g	Cu		
 C	Plastic 16.1 g			
 D	Source 6.9 g			
 E	Driver 43.7 g	Cu		Ni < STLC
 F	Rubber 25.2 g			
 (whole)	Lamp 177.6 g	Notes: Rubber material was not tested. Cu was primarily in base (B) and driver (E), but metal (A) alone would yield 96% of TTLC.		

Table B-18. LED-2(b)

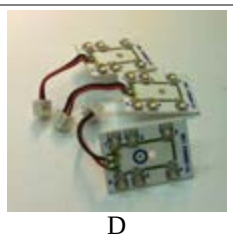
Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Driver 50.1 g	Sb Cu		
 B	Plastic 16.2 g			
 C	Metal 81.5 g	Cu Zn	Pb > STLC	Cr < STLC Ni < STLC
 D	Source 6.5 g	Cu		
 E	Rubber 25.5 g			
 (whole)	Lamp 180.1 g	Notes: Wires on source were moved to driver after photographs were taken. Sb was primarily in driver (A), but plastic (B) alone would yield 94% of TTLC.		

Table B-19. LED-3(a)

Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Metal 199.1 g	Cu		Cr < STLC Pb < STLC Ni < STLC Zn < STLC Cr < FRL Pb < FRL
 B	Plastic 83.0 g	Sb		
 C	Driver+Source 37.7 g	Cu		Ni < STLC
 D	Screws 1.3 g			
 (whole)	Lamp 323.0 g	Notes: Light source was tested with driver, as shown in photograph. Screws were deemed not millable; they were not subjected to Method 3050, and were assigned zero mass when evaluating lamp relative to TTLCs.		

Table B-20. LED-3(b)

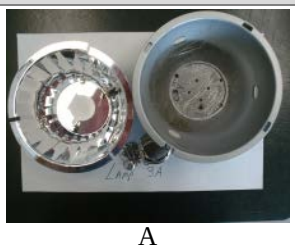
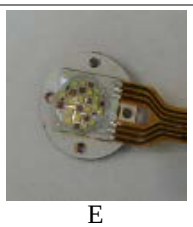
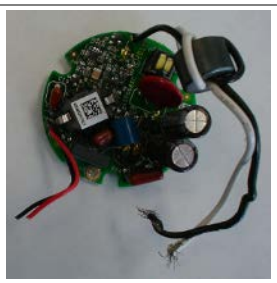
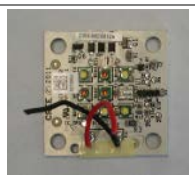
Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Metal 190.2 g	Cu Zn		Cr < STLC Pb < STLC Ni < STLC Cr < FRL Pb < FRL
 B	Plastic 91.1 g			Sb < STLC
 D	Driver 33.2 g	Cu		Pb < STLC Ni < STLC Pb < FRL
 E	Source 4.1 g			
 F	Misc. 3.7 g			
 (whole)	Lamp 323.9 g	Notes: Inhomogeneity detected in driver and source; subsequently ran Method 3050 on WET residue and combined results to provide mass balance.		

Table B-21. LED-4(a)

Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Metal 245.6 g			Ba < STLC Ba < FRL
 B	Base 11.0 g	Cu		Zn < STLC
 C	Source 6.3 g			
 D	Driver 39.2 g	Cu	Se > STLC	
 E	Plastic 60.1 g			
 F	Paper 2.6 g			
 G	Screws 3.8 g			
 (whole)	Lamp 370.4 g	Notes: First sample was replaced by another sample (six months between acquisitions) upon discovering lamp weighed less after disassembly. Screws were deemed not millable; they were not subjected to Method 3050, and were assigned zero mass when evaluating lamp relative to TTLCs.		

Table B-22. LED-4(b)

Component ID	Description	Measured > threshold		Measured < STLC or FRL
		TTLC	STLC or FRL	
 A	Metal 257.2 g	Cr Cu Ni		Ba < STLC Pb < STLC Pb < FRL
 B	Plastic 66.4 g			
 D	Driver 39.4 g	Cu Ni Zn		Ba < STLC Pb < STLC Pb < FRL
 E	Source 6.0 g			
 F	Misc. 4.4 g			
 (whole)	Lamp 374.5 g	Notes: Inhomogeneity detected in driver and source; subsequently ran Method 3050 on WET residue and combined results to provide mass balance. Ni was 5% over TTLC; 75% was found in metal (A), 25% in driver (C).		

Appendix C: Lab A Original Test Data

The following pages contain original test data from Lab A. Product photos and weights were provided in separate files and spreadsheets; see Appendix B.

Associated Laboratories
806 N. Batavia - Orange, CA 92868
Tel (714)771-6900 Fax (714)538-1209
www.associatedlabs.com
Info@associatedlabs.com

ACCREDITED IN ACCORDANCE WITH nelac 04232CA

Client:	Battelle PNNL	Lab Request:	301646
Address:	Battelle Boulevard, K7-84	Report Date:	02/26/2013
	P.O. Box 999	Date Received:	03/26/2012
	Richland, WA 99352-0999		
Attn:	Heather Dillon	Client ID:	14171

Comments: P.O. #176398, Lighting Product LCA

Added STLC Chromium to sample LED01-A; STLC Chromium & Lead to LED02-A on 2/15/13.

This laboratory request covers the following listed samples which were analyzed for the parameters indicated on the attached Analytical Result Report. All analyses were conducted using the appropriate methods. Methods accredited by NELAC are indicated on the report. This cover letter is an integral part of the final report.

Sample #	Client Sample ID
301646-001	LED01-A
301646-002	LED02-A
301646-003	INC01-A
301646-004	CFL01-A
301646-005	LED01-B
301646-006	LED01-C
301646-007	LED01-D
301646-008	LED01-F
301646-009	LED02-B
301646-010	LED02-C
301646-011	LED02-D
301646-012	LED02-E
301646-013	INC01-B
301646-014	INC01-C
301646-015	CFL01-B
301646-016	CFL01-C
301646-017	CFL01-D

Notes of clarification by PNNL:
Sample LED-1(a) was designated "LED01" here.
Sample LED-2(a) was designated "LED02" here.
Sample INC-1(a) was designated "INC01" here.
Sample CFL-1(a) was designated "CFL01" here.

Thank you for the opportunity to be of service to your company. Please feel free to call if there are any questions regarding this report or if we can be of further service.

ASSOCIATED LABORATORIES by,

Nina Prasad
President

NOTE: Unless notified in writing , all samples will be discarded by appropriate disposal protocol 45 days from date reported.

TESTING & CONSULTING
Chemical
Microbiological
Environmental

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** client
Sampled: 03/23/2012	**Site:**	**Notes:**
Sample #: 301646-001	**Client Sample #:** LED01-A	

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1126567	
Antimony	ND	1	3	mg/Kg	05/29/12	kedy	
Arsenic	**25.5**	1	1	mg/Kg	05/29/12	kedy	
Barium	**12.4**	1	1	mg/Kg	05/29/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Chromium	**346**	1	1	mg/Kg	05/29/12	kedy	
Cobalt	**0.5**	1	0.5	mg/Kg	05/29/12	kedy	
Copper	**780**	1	1	mg/Kg	05/29/12	kedy	
Lead	**47.7**	1	0.5	mg/Kg	05/29/12	kedy	
Molybdenum	**2.94**	1	1	mg/Kg	05/29/12	kedy	
Nickel	**42.4**	1	1.5	mg/Kg	05/29/12	kedy	
Selenium	ND	1	1	mg/Kg	05/29/12	kedy	
Silver	**0.5**	1	0.5	mg/Kg	05/29/12	kedy	
Thallium	**5.63**	1	1	mg/Kg	05/29/12	kedy	
Vanadium	**24.5**	1	0.5	mg/Kg	05/29/12	kedy	
Zinc	**1200**	1	5	mg/Kg	05/29/12	kedy	
Method: EPA 6010 *NELAC* **Prep Method:** EPA 1311/3010A						**QCBatchID:** QC1127136	
Chromium	**0.063**	1	0.05	mg/L	06/18/12	nina	
Method: EPA 6010 *NELAC* **Prep Method:** STLC						**QCBatchID:** QC1127139	
Chromium	**0.565**	10	0.1	mg/L	06/18/12	nina	
Copper	**0.161**	10	0.1	mg/L	06/18/12	nina	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1126590	
Mercury	ND	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** client
Sampled: 03/23/2012	**Site:**	**Notes:**
Sample #: 301646-002	**Client Sample #:** LED02-A	

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1126567	
Antimony	**204**	1	3	mg/Kg	05/29/12	kedy	
Arsenic	**37.0**	1	1	mg/Kg	05/29/12	kedy	
Barium	**12.1**	1	1	mg/Kg	05/29/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Chromium	**350**	1	1	mg/Kg	05/29/12	kedy	
Cobalt	**2.37**	1	0.5	mg/Kg	05/29/12	kedy	
Copper	**6190**	1	1	mg/Kg	05/29/12	kedy	
Lead	**152**	1	0.5	mg/Kg	05/29/12	kedy	
Molybdenum	**6.24**	1	1	mg/Kg	05/29/12	kedy	
Nickel	**167**	1	1.5	mg/Kg	05/29/12	kedy	
Selenium	ND	1	1	mg/Kg	05/29/12	kedy	
Silver	**4.51**	1	0.5	mg/Kg	05/29/12	kedy	
Thallium	**9.40**	1	1	mg/Kg	05/29/12	kedy	
Vanadium	**50.1**	1	0.5	mg/Kg	05/29/12	kedy	
Zinc	**4440**	1	5	mg/Kg	05/29/12	kedy	
Method: EPA 6010 *NELAC* **Prep Method:** EPA 1311/3010A						**QCBatchID:** QC1127092	
Chromium	ND	1	0.05	mg/L	06/15/12	nina	J
Lead	**1.426**	1	0.05	mg/L	06/15/12	nina	
Method: EPA 6010 *NELAC* **Prep Method:** STLC						**QCBatchID:** QC1127139	
Antimony	ND	10	0.3	mg/L	06/18/12	nina	J
Chromium	**0.845**	10	0.1	mg/L	06/18/12	nina	
Lead	**5.61**	10	0.05	mg/L	06/18/12	nina	
Zinc	**5.04**	10	0.2	mg/L	06/18/12	nina	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1126590	
Mercury	ND	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** client	
Sampled: 03/23/2012	**Site:**	**Notes:**	
Sample #: 301646-003	**Client Sample #:** INC01-A		

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1126567	
Antimony	ND	1	3	mg/Kg	05/29/12	kedy	
Arsenic	ND	1	1	mg/Kg	05/29/12	kedy	
Barium	ND	1	1	mg/Kg	05/29/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Chromium	**1.03**	1	1	mg/Kg	05/29/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	05/29/12	kedy	
Copper	**29.1**	1	1	mg/Kg	05/29/12	kedy	
Lead	ND	1	0.5	mg/Kg	05/29/12	kedy	
Molybdenum	ND	1	1	mg/Kg	05/29/12	kedy	
Nickel	ND	1	1.5	mg/Kg	05/29/12	kedy	
Selenium	ND	1	1	mg/Kg	05/29/12	kedy	
Silver	ND	1	0.5	mg/Kg	05/29/12	kedy	
Thallium	ND	1	1	mg/Kg	05/29/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Zinc	**6.49**	1	5	mg/Kg	05/29/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1126590	
Mercury	ND	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** client	
Sampled: 03/23/2012	**Site:**	**Notes:**	
Sample #: 301646-004	**Client Sample #:** CFL01-A		

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:**	QC1126567
Antimony	ND	1	3	mg/Kg	05/29/12	kedy	
Arsenic	ND	1	1	mg/Kg	05/29/12	kedy	
Barium	**12.1**	1	1	mg/Kg	05/29/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Chromium	ND	1	1	mg/Kg	05/29/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	05/29/12	kedy	
Copper	**22.3**	1	1	mg/Kg	05/29/12	kedy	
Lead	ND	1	0.5	mg/Kg	05/29/12	kedy	
Molybdenum	ND	1	1	mg/Kg	05/29/12	kedy	
Nickel	ND	1	1.5	mg/Kg	05/29/12	kedy	
Selenium	ND	1	1	mg/Kg	05/29/12	kedy	
Silver	ND	1	0.5	mg/Kg	05/29/12	kedy	
Thallium	ND	1	1	mg/Kg	05/29/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Zinc	**20.0**	1	5	mg/Kg	05/29/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:**	QC1126590
Mercury	**0.23**	1	0.14	mg/Kg	05/30/12	BradB	R

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: client
Sampled: 03/23/2012 | Site: | Notes:
Sample #: 301646-005 | Client Sample #: LED01-B

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1126567	
Antimony	ND	50	150	mg/Kg	05/29/12	kedy	
Arsenic	ND	50	50	mg/Kg	05/29/12	kedy	
Barium	**82.5**	50	50	mg/Kg	05/29/12	kedy	
Beryllium	ND	50	25	mg/Kg	05/29/12	kedy	
Cadmium	ND	50	25	mg/Kg	05/29/12	kedy	
Chromium	ND	50	50	mg/Kg	05/29/12	kedy	
Cobalt	ND	50	25	mg/Kg	05/29/12	kedy	
Copper	**290000**	50	50	mg/Kg	05/29/12	kedy	
Lead	ND	50	25	mg/Kg	05/29/12	kedy	
Molybdenum	ND	50	50	mg/Kg	05/29/12	kedy	
Nickel	**6030**	50	75	mg/Kg	05/29/12	kedy	
Selenium	ND	50	50	mg/Kg	05/29/12	kedy	
Silver	ND	50	25	mg/Kg	05/29/12	kedy	J
Thallium	ND	50	50	mg/Kg	05/29/12	kedy	
Vanadium	ND	50	25	mg/Kg	05/29/12	kedy	
Zinc	**112000**	50	250	mg/Kg	05/29/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1126590	
Mercury	ND	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** client	
Sampled: 03/23/2012	**Site:**	**Notes:**	
Sample #: 301646-006	**Client Sample #:** LED01-C		

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:**	QC1126567
Antimony	ND	20	60	mg/Kg	05/29/12	kedy	
Arsenic	ND	20	20	mg/Kg	05/29/12	kedy	
Barium	**90.8**	20	20	mg/Kg	05/29/12	kedy	
Beryllium	ND	20	10	mg/Kg	05/29/12	kedy	
Cadmium	ND	20	10	mg/Kg	05/29/12	kedy	
Chromium	ND	20	20	mg/Kg	05/29/12	kedy	J
Cobalt	ND	20	10	mg/Kg	05/29/12	kedy	
Copper	ND	20	20	mg/Kg	05/29/12	kedy	
Lead	ND	20	10	mg/Kg	05/29/12	kedy	
Molybdenum	ND	20	20	mg/Kg	05/29/12	kedy	
Nickel	ND	20	30	mg/Kg	05/29/12	kedy	J
Selenium	ND	20	20	mg/Kg	05/29/12	kedy	
Silver	ND	20	10	mg/Kg	05/29/12	kedy	
Thallium	ND	20	20	mg/Kg	05/29/12	kedy	
Vanadium	**11.4**	20	10	mg/Kg	05/29/12	kedy	
Zinc	**630**	20	100	mg/Kg	05/29/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:**	QC1126590
Mercury	ND	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** client	
Sampled: 03/23/2012	**Site:**	**Notes:**	
Sample #: 301646-007	**Client Sample #:** LED01-D		

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1126567	
Antimony	ND	1	3	mg/Kg	05/29/12	kedy	
Arsenic	**42.5**	1	1	mg/Kg	05/29/12	kedy	
Barium	**75.2**	1	1	mg/Kg	05/29/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Chromium	**9.09**	1	1	mg/Kg	05/29/12	kedy	
Cobalt	**43.3**	1	0.5	mg/Kg	05/29/12	kedy	
Copper	**69600**	25	25	mg/Kg	05/29/12	kedy	
Lead	ND	1	0.5	mg/Kg	05/29/12	kedy	
Molybdenum	**14.2**	1	1	mg/Kg	05/29/12	kedy	
Nickel	**924**	1	1.5	mg/Kg	05/29/12	kedy	
Selenium	ND	1	1	mg/Kg	05/29/12	kedy	
Silver	**408**	1	0.5	mg/Kg	05/29/12	kedy	
Thallium	**16.6**	1	1	mg/Kg	05/29/12	kedy	
Vanadium	**66.6**	1	0.5	mg/Kg	05/29/12	kedy	
Zinc	**7120**	1	5	mg/Kg	05/29/12	kedy	
Method: EPA 6010 *NELAC* **Prep Method:** STLC						**QCBatchID:** QC1127103	
Nickel	**59.3**	10	0.2	mg/L	06/15/12	nina	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1126590	
Mercury	ND	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** client
Sampled: 03/23/2012	**Site:**	**Notes:**
Sample #: 301646-008	**Client Sample #:** LED01-F	

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1126567	
Antimony	**260**	25	75	mg/Kg	05/29/12	kedy	
Arsenic	ND	25	25	mg/Kg	05/29/12	kedy	
Barium	**218**	25	25	mg/Kg	05/29/12	kedy	
Beryllium	ND	25	12.5	mg/Kg	05/29/12	kedy	
Cadmium	ND	25	12.5	mg/Kg	05/29/12	kedy	
Chromium	**47.1**	25	25	mg/Kg	05/29/12	kedy	
Cobalt	**55.5**	25	12.5	mg/Kg	05/29/12	kedy	
Copper	**90000**	25	25	mg/Kg	05/29/12	kedy	
Lead	ND	25	12.5	mg/Kg	05/29/12	kedy	
Molybdenum	ND	25	25	mg/Kg	05/29/12	kedy	
Nickel	**1780**	25	37.5	mg/Kg	05/29/12	kedy	
Selenium	ND	25	25	mg/Kg	05/29/12	kedy	
Silver	**70.5**	25	12.5	mg/Kg	05/29/12	kedy	
Thallium	ND	25	25	mg/Kg	05/29/12	kedy	
Vanadium	**13.0**	25	12.5	mg/Kg	05/29/12	kedy	
Zinc	**10600**	25	125	mg/Kg	05/29/12	kedy	
Method: EPA 6010 *NELAC* **Prep Method:** STLC						**QCBatchID:** QC1127103	
Antimony	ND	10	0.3	mg/L	06/15/12	nina	
Nickel	**17.7**	10	0.2	mg/L	06/15/12	nina	
Silver	ND	10	0.05	mg/L	06/15/12	nina	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1126590	
Mercury	ND	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** client	
Sampled: 03/23/2012	**Site:**	**Notes:**	
Sample #: 301646-009	**Client Sample #:** LED02-B		

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1126567
Antimony	ND	50	150	mg/Kg	05/29/12	kedy	
Arsenic	ND	50	50	mg/Kg	05/29/12	kedy	
Barium	**177**	50	50	mg/Kg	05/29/12	kedy	
Beryllium	ND	50	25	mg/Kg	05/29/12	kedy	
Cadmium	ND	50	25	mg/Kg	05/29/12	kedy	
Chromium	ND	50	50	mg/Kg	05/29/12	kedy	J
Cobalt	ND	50	25	mg/Kg	05/29/12	kedy	J
Copper	**208000**	50	50	mg/Kg	05/29/12	kedy	
Lead	ND	50	25	mg/Kg	05/29/12	kedy	
Molybdenum	ND	50	50	mg/Kg	05/29/12	kedy	
Nickel	**626**	50	75	mg/Kg	05/29/12	kedy	
Selenium	ND	50	50	mg/Kg	05/29/12	kedy	
Silver	**217**	50	25	mg/Kg	05/29/12	kedy	
Thallium	ND	50	50	mg/Kg	05/29/12	kedy	
Vanadium	ND	50	25	mg/Kg	05/29/12	kedy	
Zinc	**19000**	50	250	mg/Kg	05/29/12	kedy	
Method: EPA 6010 *NELAC*	**Prep Method:** EPA 1311/3010A					**QCBatchID:**	QC1127092
Silver	ND	1	0.05	mg/L	06/15/12	nina	
Method: EPA 6010 *NELAC*	**Prep Method:** STLC					**QCBatchID:**	QC1127103
Nickel	**46.4**	10	0.2	mg/L	06/15/12	nina	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1126590
Mercury	ND	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** client
Sampled: 03/23/2012	**Site:**	**Notes:**
Sample #: 301646-010	**Client Sample #:** LED02-C	

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1126567	
Antimony	**520**	1	3	mg/Kg	05/29/12	kedy	
Arsenic	ND	1	1	mg/Kg	05/29/12	kedy	J
Barium	**5.53**	1	1	mg/Kg	05/29/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Cadmium	**0.5**	1	0.5	mg/Kg	05/29/12	kedy	
Chromium	**6.21**	1	1	mg/Kg	05/29/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	05/29/12	kedy	J
Copper	**87.6**	1	1	mg/Kg	05/29/12	kedy	
Lead	ND	1	0.5	mg/Kg	05/29/12	kedy	
Molybdenum	ND	1	1	mg/Kg	05/29/12	kedy	J
Nickel	**5.50**	1	1.5	mg/Kg	05/29/12	kedy	
Selenium	**2.87**	1	1	mg/Kg	05/29/12	kedy	
Silver	ND	1	0.5	mg/Kg	05/29/12	kedy	
Thallium	ND	1	1	mg/Kg	05/29/12	kedy	
Vanadium	**0.8**	1	0.5	mg/Kg	05/29/12	kedy	
Zinc	**321**	1	5	mg/Kg	05/29/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1126590	
Mercury	ND	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: client
Sampled: 03/23/2012 | Site: | Notes:
Sample #: 301646-011 | Client Sample #: LED02-D

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1126567	
Antimony	ND	1	3	mg/Kg	05/29/12	kedy	
Arsenic	**2.21**	1	1	mg/Kg	05/29/12	kedy	
Barium	**16.8**	1	1	mg/Kg	05/29/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Chromium	**11.2**	1	1	mg/Kg	05/29/12	kedy	
Cobalt	**1.75**	1	0.5	mg/Kg	05/29/12	kedy	
Copper	**36200**	25	25	mg/Kg	05/29/12	kedy	
Lead	**69.8**	1	0.5	mg/Kg	05/29/12	kedy	
Molybdenum	**5.36**	1	1	mg/Kg	05/29/12	kedy	
Nickel	**1680**	1	1.5	mg/Kg	05/29/12	kedy	
Selenium	ND	1	1	mg/Kg	05/29/12	kedy	
Silver	**557**	1	0.5	mg/Kg	05/29/12	kedy	
Thallium	ND	1	1	mg/Kg	05/29/12	kedy	
Vanadium	**3.87**	1	0.5	mg/Kg	05/29/12	kedy	
Zinc	**155**	1	5	mg/Kg	05/29/12	kedy	
Method: EPA 6010 *NELAC* **Prep Method:** STLC						**QCBatchID:** QC1127103	
Lead	**16.0**	10	0.05	mg/L	06/15/12	nina	
Nickel	**32.8**	10	0.2	mg/L	06/15/12	nina	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1126590	
Mercury	ND	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** client
Sampled: 03/23/2012	**Site:**	**Notes:**
Sample #: 301646-012	**Client Sample #:** LED02-E	

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:**	QC1126567
Antimony	ND	50	150	mg/Kg	05/29/12	kedy	J
Arsenic	ND	50	50	mg/Kg	05/29/12	kedy	
Barium	**1720**	50	50	mg/Kg	05/29/12	kedy	
Beryllium	ND	50	25	mg/Kg	05/29/12	kedy	
Cadmium	ND	50	25	mg/Kg	05/29/12	kedy	
Chromium	ND	50	50	mg/Kg	05/29/12	kedy	
Cobalt	ND	50	25	mg/Kg	05/29/12	kedy	
Copper	**177000**	50	50	mg/Kg	05/29/12	kedy	
Lead	ND	50	25	mg/Kg	05/29/12	kedy	
Molybdenum	ND	50	50	mg/Kg	05/29/12	kedy	
Nickel	**563**	50	75	mg/Kg	05/29/12	kedy	
Selenium	ND	50	50	mg/Kg	05/29/12	kedy	
Silver	**69.4**	50	25	mg/Kg	05/29/12	kedy	
Thallium	ND	50	50	mg/Kg	05/29/12	kedy	
Vanadium	**43.0**	50	25	mg/Kg	05/29/12	kedy	
Zinc	**900**	50	250	mg/Kg	05/29/12	kedy	
Method: EPA 6010 *NELAC* **Prep Method:** STLC						**QCBatchID:**	QC1127103
Barium	**6.49**	10	0.1	mg/L	06/15/12	nina	
Nickel	**4.91**	10	0.2	mg/L	06/15/12	nina	
Silver	ND	10	0.05	mg/L	06/15/12	nina	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:**	QC1126590
Mercury	**0.15**	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid	**Client:** Battelle PNNL		**Collector:** client		
Sampled: 03/23/2012	**Site:**		**Notes:**		
Sample #: 301646-013	**Client Sample #:** INC01-B				

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:**	QC1126567
Antimony	ND	1	3	mg/Kg	05/29/12	kedy	
Arsenic	**9.96**	1	1	mg/Kg	05/29/12	kedy	
Barium	**2.83**	1	1	mg/Kg	05/29/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Chromium	**6.90**	1	1	mg/Kg	05/29/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	05/29/12	kedy	J
Copper	**18000**	1	1	mg/Kg	05/29/12	kedy	
Lead	**2.44**	1	0.5	mg/Kg	05/29/12	kedy	
Molybdenum	**1.03**	1	1	mg/Kg	05/29/12	kedy	
Nickel	**1010**	1	1.5	mg/Kg	05/29/12	kedy	
Selenium	ND	1	1	mg/Kg	05/29/12	kedy	
Silver	**2.02**	1	0.5	mg/Kg	05/29/12	kedy	
Thallium	ND	1	1	mg/Kg	05/29/12	kedy	
Vanadium	**12.8**	1	0.5	mg/Kg	05/29/12	kedy	
Zinc	**5040**	1	5	mg/Kg	05/29/12	kedy	
Method: EPA 6010 *NELAC* **Prep Method:** STLC						**QCBatchID:**	QC1127103
Nickel	**0.483**	10	0.2	mg/L	06/15/12	nina	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:**	QC1126590
Mercury	ND	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** client	
Sampled: 03/23/2012	**Site:**	**Notes:**	
Sample #: 301646-014	**Client Sample #:** INC01-C		

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1126567	
Antimony	ND	1	3	mg/Kg	05/29/12	kedy	
Arsenic	ND	1	1	mg/Kg	05/29/12	kedy	J
Barium	**2.94**	1	1	mg/Kg	05/29/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Chromium	**1.15**	1	1	mg/Kg	05/29/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	05/29/12	kedy	
Copper	**3100**	1	1	mg/Kg	05/29/12	kedy	
Lead	ND	1	0.5	mg/Kg	05/29/12	kedy	
Molybdenum	ND	1	1	mg/Kg	05/29/12	kedy	
Nickel	**218**	1	1.5	mg/Kg	05/29/12	kedy	
Selenium	ND	1	1	mg/Kg	05/29/12	kedy	
Silver	ND	1	0.5	mg/Kg	05/29/12	kedy	J
Thallium	ND	1	1	mg/Kg	05/29/12	kedy	
Vanadium	**1.80**	1	0.5	mg/Kg	05/29/12	kedy	
Zinc	**984**	1	5	mg/Kg	05/29/12	kedy	
Method: EPA 6010 *NELAC* **Prep Method:** STLC						**QCBatchID:** QC1127103	
Nickel	**29.2**	10	0.2	mg/L	06/15/12	nina	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1126590	
Mercury	ND	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** client	
Sampled: 03/23/2012	**Site:**	**Notes:**	
Sample #: 301646-015	**Client Sample #:** CFL01-B		

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1126567	
Antimony	ND	1	3	mg/Kg	05/29/12	kedy	
Arsenic	ND	1	1	mg/Kg	05/29/12	kedy	
Barium	**9.99**	1	1	mg/Kg	05/29/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Chromium	**2.22**	1	1	mg/Kg	05/29/12	kedy	
Cobalt	**0.9**	1	0.5	mg/Kg	05/29/12	kedy	
Copper	**2630**	1	1	mg/Kg	05/29/12	kedy	
Lead	**3.28**	1	0.5	mg/Kg	05/29/12	kedy	
Molybdenum	ND	1	1	mg/Kg	05/29/12	kedy	
Nickel	**3740**	1	1.5	mg/Kg	05/29/12	kedy	
Selenium	ND	1	1	mg/Kg	05/29/12	kedy	
Silver	ND	1	0.5	mg/Kg	05/29/12	kedy	
Thallium	ND	1	1	mg/Kg	05/29/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	05/29/12	kedy	
Zinc	**76.2**	1	5	mg/Kg	05/29/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1126590	
Mercury	**0.44**	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** client	
Sampled: 03/23/2012	**Site:**	**Notes:**	
Sample #: 301646-016	**Client Sample #:** CFL01-C		

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:**	QC1126567
Antimony	ND	50	150	mg/Kg	05/29/12	kedy	
Arsenic	ND	50	50	mg/Kg	05/29/12	kedy	
Barium	ND	50	50	mg/Kg	05/29/12	kedy	
Beryllium	ND	50	25	mg/Kg	05/29/12	kedy	
Cadmium	ND	50	25	mg/Kg	05/29/12	kedy	
Chromium	ND	50	50	mg/Kg	05/29/12	kedy	
Cobalt	ND	50	25	mg/Kg	05/29/12	kedy	
Copper	**270000**	50	50	mg/Kg	05/29/12	kedy	
Lead	**2510**	50	25	mg/Kg	05/29/12	kedy	
Molybdenum	ND	50	50	mg/Kg	05/29/12	kedy	
Nickel	**2600**	50	75	mg/Kg	05/29/12	kedy	
Selenium	ND	50	50	mg/Kg	05/29/12	kedy	
Silver	ND	50	25	mg/Kg	05/29/12	kedy	J
Thallium	ND	50	50	mg/Kg	05/29/12	kedy	
Vanadium	ND	50	25	mg/Kg	05/29/12	kedy	
Zinc	**164000**	50	250	mg/Kg	05/29/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:**	QC1126590
Mercury	ND	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** client	
Sampled: 03/23/2012	**Site:**	**Notes:**	
Sample #: 301646-017	**Client Sample #:** CFL01-D		

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:**	QC1126567
Antimony	ND	50	150	mg/Kg	05/29/12	kedy	J
Arsenic	ND	50	50	mg/Kg	05/29/12	kedy	
Barium	**83.2**	50	50	mg/Kg	05/29/12	kedy	
Beryllium	ND	50	25	mg/Kg	05/29/12	kedy	
Cadmium	ND	50	25	mg/Kg	05/29/12	kedy	
Chromium	ND	50	50	mg/Kg	05/29/12	kedy	
Cobalt	ND	50	25	mg/Kg	05/29/12	kedy	
Copper	**480000**	50	50	mg/Kg	05/29/12	kedy	
Lead	ND	50	25	mg/Kg	05/29/12	kedy	
Molybdenum	ND	50	50	mg/Kg	05/29/12	kedy	
Nickel	**101**	50	75	mg/Kg	05/29/12	kedy	
Selenium	ND	50	50	mg/Kg	05/29/12	kedy	
Silver	**27.4**	50	25	mg/Kg	05/29/12	kedy	
Thallium	ND	50	50	mg/Kg	05/29/12	kedy	
Vanadium	ND	50	25	mg/Kg	05/29/12	kedy	
Zinc	**5730**	50	250	mg/Kg	05/29/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:**	QC1126590
Mercury	ND	1	0.14	mg/Kg	05/30/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #301646

QCBatchID: QC1126567 **Analyst:** nina **Method:** EPA 6010B
Matrix: Solid **Analyzed:** 05/29/2012 **Instrument:** AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1126567MB1						
Antimony	ND	mg/Kg		3		
Arsenic	ND	mg/Kg		1		
Barium	ND	mg/Kg		1		
Beryllium	ND	mg/Kg		0.5		
Cadmium	ND	mg/Kg		0.5		
Chromium	ND	mg/Kg		1		
Cobalt	ND	mg/Kg		0.5		
Copper	ND	mg/Kg		1		
Lead	ND	mg/Kg		0.5		
Molybdenum	ND	mg/Kg		1		
Nickel	ND	mg/Kg		1.5		
Selenium	ND	mg/Kg		1		
Silver	ND	mg/Kg		0.5		
Thallium	ND	mg/Kg		1		
Vanadium	ND	mg/Kg		0.5		
Zinc	ND	mg/Kg		5		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1126567LCS1											
Antimony	200		169		mg/Kg	85			80-120		
Arsenic	200		165		mg/Kg	83			80-120		
Barium	200		188		mg/Kg	94			80-120		
Beryllium	200		163		mg/Kg	82			80-120		
Cadmium	200		181		mg/Kg	91			80-120		
Chromium	200		192		mg/Kg	96			80-120		
Cobalt	200		187		mg/Kg	94			80-120		
Copper	200		225		mg/Kg	113			80-120		
Lead	200		182		mg/Kg	91			80-120		
Molybdenum	200		190		mg/Kg	95			80-120		
Nickel	200		187		mg/Kg	94			80-120		
Selenium	200		160		mg/Kg	80			80-120		
Silver	100		82.0		mg/Kg	82			80-120		
Thallium	200		173		mg/Kg	87			80-120		
Vanadium	200		188		mg/Kg	94			80-120		
Zinc	200		178		mg/Kg	89			80-120		

ND = Not Detected or < RDL **MDL = Method Detection Limit** **RDL = Reporting Detection Limit** **DF = Dilution Factor**

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #301646

QCBatchID: QC1126567 **Analyst:** nina **Method:** EPA 6010B
Matrix: Solid **Analyzed:** 05/29/2012 **Instrument:** AAICP (group)

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1126567MS1, QC1126567MSD1												**Source: 304814-004**
Antimony	ND	100	100	80.9	81.3	mg/Kg	81	81	0.5	75-125	20	
Arsenic	4.21	100	100	92.9	92.5	mg/Kg	89	88	0.4	75-125	20	
Barium	107	100	100	195	186	mg/Kg	88	79	4.7	75-125	20	
Beryllium	0.4	100	100	87.8	81.7	mg/Kg	87	81	7.2	75-125	20	
Cadmium	ND	100	100	87.4	83.9	mg/Kg	87	84	4.1	75-125	20	
Chromium	16.2	100	100	105	102	mg/Kg	89	86	2.9	75-125	20	
Cobalt	7.90	100	100	91.7	88.4	mg/Kg	84	81	3.7	75-125	20	
Copper	55.8	100	100	123	112	mg/Kg	67	56	9.4	75-125	20	M
Lead	9.43	100	100	87.2	86.8	mg/Kg	78	77	0.5	75-125	20	
Molybdenum	0.8	100	100	81.1	80.8	mg/Kg	80	80	0.4	75-125	20	
Nickel	16.3	100	100	99.8	95.7	mg/Kg	84	79	4.2	75-125	20	
Selenium	ND	100	100	64.7	63.6	mg/Kg	65	64	1.7	75-125	20	M
Silver	ND	50	50	43.1	38.9	mg/Kg	86	78	10.2	75-125	20	
Thallium	ND	100	100	82.2	81.6	mg/Kg	82	82	0.7	75-125	20	
Vanadium	34.0	100	100	122	117	mg/Kg	88	83	4.2	75-125	20	
Zinc	56.8	100	100	141	136	mg/Kg	84	79	3.6	75-125	20	

ND = Not Detected or < RDL **MDL = Method Detection Limit** **RDL = Reporting Detection Limit** **DF = Dilution Factor**

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #301646

QCBatchID: QC1126590 **Analyst:** BradB **Method:** EPA 7471A
Matrix: Solid **Analyzed:** 05/30/2012 **Instrument:** AAICP-HG1

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1126590MB1						
Mercury	ND	mg/Kg		0.14		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1126590LCS1											
Mercury	0.83		0.73		mg/Kg	88			80-120		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1126590MS1, QC1126590MSD1												**Source: 301646-006**
Mercury	ND	0.83	0.83	0.72	0.75	mg/Kg	87	90	4.1	75-125	20	

ND = Not Detected or < RDL **MDL = Method Detection Limit** **RDL = Reporting Detection Limit** **DF = Dilution Factor**

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #301646

QCBatchID: QC1127092 **Analyst:** metha **Method:** EPA 6010B
Matrix: Solid **Analyzed:** 06/15/2012 **Instrument:** AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1127092MB1						
Chromium	ND	mg/L		0.05		
Lead	ND	mg/L		0.05		
Silver	ND	mg/L		0.05		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1127092LCS1											
Chromium	2		2.08		mg/L	104			80-120		
Lead	2		2.19		mg/L	110			80-120		
Silver	1		0.956		mg/L	96			80-120		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1127092MS1, QC1127092MSD1												**Source: 303655-001**
Chromium	0.027	1	1	0.910	0.982	mg/L	88			75-125	20	
Lead	0.041	1	1	0.928	0.926	mg/L	89			75-125	20	
Silver	0.003	0.5	0.5	0.445	0.477	mg/L				75-125	20	

ND = Not Detected or < RDL **MDL = Method Detection Limit** **RDL = Reporting Detection Limit** **DF = Dilution Factor**

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #301646

QCBatchID: QC1127103	**Analyst:** metha	**Method:** EPA 6010B
Matrix: Solid	**Analyzed:** 06/15/2012	**Instrument:** AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1127103MB1						
Antimony	ND	mg/L		0.03		
Barium	0.016	mg/L		0.01		
Lead	0.018	mg/L		0.005		
Nickel	ND	mg/L		0.02		
Silver	ND	mg/L		0.005		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1127103MS1, QC1127103MSD1												**Source: 301646-010**
Antimony	ND	10	10	8.14	8.19	mg/L	81	82	0.6	75-125	20	
Barium	0.078	10	10	9.06	9.52	mg/L	90	94	5.0	75-125	20	
Lead	0.063	10	10	9.17	9.20	mg/L	91	91	0.3	75-125	20	
Nickel	0.150	10	10	8.55	9.02	mg/L	84	89	5.4	75-125	20	
Silver	ND	5	5	4.13	4.37	mg/L	83	87	5.6	75-125	20	

ND = Not Detected or < RDL **MDL = Method Detection Limit** **RDL = Reporting Detection Limit** **DF = Dilution Factor**

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #301646

QCBatchID: QC1127136 **Analyst:** metha **Method:** EPA 6010B
Matrix: Solid **Analyzed:** 06/18/2012 **Instrument:** AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1127136MB1						
Antimony	ND	mg/L		0.05		
Arsenic	ND	mg/L		0.05		
Barium	ND	mg/L		0.1		
Beryllium	ND	mg/L		0.05		
Cadmium	ND	mg/L		0.05		
Chromium	ND	mg/L		0.05		
Cobalt	ND	mg/L		0.05		
Copper	ND	mg/L		0.05		
Lead	ND	mg/L		0.05		
Molybdenum	ND	mg/L		0.05		
Nickel	ND	mg/L		0.05		
Selenium	ND	mg/L		0.05		
Silver	ND	mg/L		0.05		
Thallium	ND	mg/L		0.05		
Vanadium	ND	mg/L		0.05		
Zinc	ND	mg/L		0.05		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1127136LCS1											
Arsenic	2		2.20		mg/L	110			80-120		
Barium	2		1.998		mg/L	100			80-120		
Cadmium	2		2.09		mg/L	105			80-120		
Chromium	2		1.964		mg/L	98			80-120		
Lead	2		2.04		mg/L	102			80-120		
Selenium	2		2.16		mg/L	108			80-120		
Silver	1		1.025		mg/L	103			80-120		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1127136MS1, QC1127136MSD1												**Source: 305763-001**
Arsenic	0.016	1	1	1.110	1.101	mg/L	109	109	0.8	75-125	20	
Barium	0.902	1	1	1.726	1.706	mg/L	82	80	1.2	75-125	20	
Cadmium	ND	1	1	0.974	0.954	mg/L	97	95	2.1	75-125	20	
Chromium	0.004	1	1	0.918	0.911	mg/L	91	91	0.8	75-125	20	
Lead	0.129	1	1	1.059	1.042	mg/L	93	91	1.6	75-125	20	
Selenium	ND	1	1	1.055	1.038	mg/L	106	104	1.6	75-125	20	
Silver	ND	0.5	0.5	0.484	0.475	mg/L	97	95	1.9	75-125	20	

ND = Not Detected or < RDL **MDL = Method Detection Limit** **RDL = Reporting Detection Limit** **DF = Dilution Factor**

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #301646

QCBatchID: QC1127139 **Analyst:** metha **Method:** EPA 6010B
Matrix: Solid **Analyzed:** 06/18/2012 **Instrument:** AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1127139MB1						
Antimony	0.086	mg/L		0.03		
Arsenic	0.044	mg/L		0.01		
Copper	0.011	mg/L		0.01		
Lead	0.023	mg/L		0.005		
Zinc	0.022	mg/L		0.02		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1127139MS1, QC1127139MSD1												**Source: 305701-001**
Arsenic	0.702	10	10	11.7	11.9	mg/L	110	112	1.7	75-125	20	
Copper	0.314	10	10	10.5	10.2	mg/L	102	99	2.9	75-125	20	
Lead	0.438	10	10	10.1	10.4	mg/L	97	100	2.9	75-125	20	

ND = Not Detected or < RDL **MDL = Method Detection Limit** **RDL = Reporting Detection Limit** **DF = Dilution Factor**

Notes and Defintions

B	Analyte was present in an associated method blank. Associated sample data was reported with qualifier.
C	Laboratory Contamination.
D	The sample duplicate RPD was not within control limits, the sample data was reported without further clarification.
DF	Dilution Factor
J	Reported value is estimated
L	The laboratory control sample (LCS) or laboratory control sample duplicate (LCSD) was out of control limits. Associated sample data was reported with qualifier.
M	The matrix spike (MS) or matrix spike duplicate (MSD) was not within control limits due to matrix interference. The associated LCS and/or LCSD was within control limits and the sample data was reported without further clarification.
MDL	Method Detection Limit
N	The analyte concentration in the sample exceeded the spike level by a factor of four or greater, spike recovery and limits do not apply.
ND	Analyte was not detected or was less than the detection limit.
P	Sample was received without proper preservation according to EPA guidelines.
RDL	Reporting Detection Limit
S	The surrogate recovery was out of control limits due to matrix interference. The associated method blank surrogate recovery was within control limits and the sample data was reported without further clarification.
T	Sample was extracted/analyzed past the holding time.

Associated Laboratories
806 N. Batavia - Orange, CA 92868
Tel (714)771-6900 Fax (714)538-1209
www.associatedlabs.com
Info@associatedlabs.com

ACCREDITED IN ACCORDANCE WITH nelac 04232CA

Client:	Battelle PNNL	Lab Request:	306237
Address:	Battelle Boulevard, K7-84	Report Date:	07/31/2012
	P.O. Box 999	Date Received:	06/26/2012
	Richland, WA 99352-0999		
Attn:	Heather Dillon	Client ID:	14171

Comments: P.O. #176398
Lighting Product LCA
Silver was not included in the MS/MSD because it was requested after the extraction was performed. The LCS was spiked with Silver and within control, the sample data was reported without further clarification.

This laboratory request covers the following listed samples which were analyzed for the parameters indicated on the attached Analytical Result Report. All analyses were conducted using the appropriate methods indicated on the attached report and all NELAC criteria. This cover letter is an integral part of the final report.

Sample #	Client Sample ID
306237-001	LED01-Retest

Note of clarification by PNNL:
Component LED-1(a)D was designated "LED01" here.

Thank you for the opportunity to be of service to your company. Please feel free to call if there are any questions regarding this report or if we can be of further service.

ASSOCIATED LABORATORIES by,

Edward S. Behare, Ph.D.
Lab Director

NOTE: Unless notified in writing , all samples will be discarded by appropriate disposal protocol 45 days from date reported.

TESTING & CONSULTING
Chemical
Microbiological
Environmental

Matrix: Water	**Client:** Battelle PNNL		
Sampled: 06/25/2012 15:06	**Site:**		
Sample #: 306237-001	**Client Sample #:** LED01-Retest	**Collector:** Client	

Analyte	Result	DF	RDL	Units	Analyzed	By
Method: EPA 6010B	Prep Method: TCLP/EPA 1311				QCBatchID	QC1127757
Selenium	ND	1	0.05	mg/L	07/12/12	nina
Silver	ND	1	0.05	mg/L	07/12/12	nina

ND = Not Detected or < RDL **RDL = Reporting Detection Limit** **DF = Dilution Factor**

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #306237

QCBatchID: QC1127757 **Analyst:** metha **Method:** EPA 6010B
Matrix: Water **Analyzed:** 07/11/2012 **Instrument:** AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1127757MB1						
Lead	ND	mg/L		0.05		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1127757LCS1											
Lead	2		1.637		mg/L	82			80-120		
Selenium	2		1.750		mg/L	88			80-120		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1127757MS1, QC1127757MSD1												**Source: 306424-002**
Lead	0.044	1	1	0.914	0.893	mg/L	87	85	2.3	75-125	20	

ND = Not Detected or < RDL **MDL = Method Detection Limit** **RDL = Reporting Detection Limit** **DF = Dilution Factor**

Notes and Defintions

B	Analyte was present in an associated method blank. Associated sample data was reported with qualifier.
C	Laboratory Contamination.
D	The sample duplicate RPD was not within control limits, the sample data was reported without further clarification.
DF	Dilution Factor
J	Reported value is estimated
L	The laboratory control sample (LCS) or laboratory control sample duplicate (LCSD) was out of control limits. Associated sample data was reported with qualifier.
M	The matrix spike (MS) or matrix spike duplicate (MSD) was not within control limits due to matrix interference. The associated LCS and/or LCSD was within control limits and the sample data was reported without further clarification.
MDL	Method Detection Limit
N	The analyte concentration in the sample exceeded the spike level by a factor of four or greater, spike recovery and limits do not apply.
ND	Analyte was not detected or was less than the detection limit.
P	Sample was received without proper preservation according to EPA guidelines.
RDL	Reporting Detection Limit
S	The surrogate recovery was out of control limits due to matrix interference. The associated method blank surrogate recovery was within control limits and the sample data was reported without further clarification.
T	Sample was extracted/analyzed past the holding time.

Associated Laboratories
806 N. Batavia - Orange, CA 92868
Tel (714)771-6900 Fax (714)538-1209
www.associatedlabs.com
Info@associatedlabs.com

ACCREDITED IN ACCORDANCE WITH nelac 04232CA

Client: Battelle PNNL
Address: Battelle Boulevard, K7-84
P.O. Box 999
Richland, WA 99352-0999
Attn: Jason Tuenge

Lab Request: 311812
Report Date: 02/26/2013
Date Received: 10/10/2012

Client ID: 14171

Comments: LCA Part 3
The components were milled to pass through a 2.0 mm sieve but the samples were not sieved prior to analysis.

This laboratory request covers the following listed samples which were analyzed for the parameters indicated on the attached Analytical Result Report. All analyses were conducted using the appropriate methods. Methods accredited by NELAC are indicated on the report. This cover letter is an integral part of the final report.

Sample #	Client Sample ID	Sample #	Client Sample ID	Sample #	Client Sample ID
311812-003	CFL-02(b)	311812-030	CFL-03(a) C	311812-047	LED-03(a) C
311812-009	INC-01(c)	311812-031	CFL-03(a) D	311812-053	HAL-01(a)C
311812-013	LED-01(b)	311812-032	HAL-01(b) A	311812-054	HAL-01(b)C
311812-016	CFL-01(b) A	311812-033	HAL-01(b) B	311812-055	Inc-01(d)C
311812-017	CFL-01(b) B	311812-034	HAL-02(a) A	311812-056	Inc-02(a)C
311812-018	CFL-01(b) C	311812-035	HAL-02(a) B	311812-057	LED-03(a)&LED-04(a)A
311812-019	CFL-01(b) D	311812-036	INC-01(d) A		
311812-020	CFL-02(a) A	311812-037	INC-01(d) B	311812-058	HAL-01(a)A
311812-021	CFL-02(a) B	311812-038	INC-02(a) A	311812-059	HAL-01(a)B
311812-022	CFL-02(a) C	311812-039	INC-02(a) B	311812-060	HAL-02(a)C
311812-023	CFL-02(a) D	311812-040	LED-02(b) A	311812-061	HAL-02(a)D
311812-024	CFL-02(c) A	311812-041	LED-02(b) B	311812-062	CFL-02(b)-STLCRes.TTLC
311812-025	CFL-02(c) B	311812-042	LED-02(b) C		
311812-026	CFL-02(c) C	311812-043	LED-02(b) D	311812-063	CFL-03(a)C-STLCRes.TTLC
311812-027	CFL-02(c) D	311812-044	LED-02(b) E		
311812-028	CFL-03(a) A	311812-045	LED-03(a) A	311812-064	CFL-02(b)-TCLPRes.TTLC
311812-029	CFL-03(a) B	311812-046	LED-03(a) B		

Thank you for the opportunity to be of service to your company. Please feel free to call if there are any questions regarding this report or if we can be of further service.

ASSOCIATED LABORATORIES by,

Nina Prasad
President

Note of clarification by PNNL:
Results for three samples designated "Res.TTLC" were disregarded per guidance from Associated Laboratories.

NOTE: Unless notified in writing , all samples will be discarded by appropriate disposal protocol 45 days from date reported.

TESTING & CONSULTING
Chemical
Microbiological
Environmental

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** Client
Sampled: 10/03/2012	**Site:**	**Notes:**
Sample #: 311812-003	**Client Sample #:** CFL-02(b)	

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1131045	
Antimony	**4000**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**126**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**12.4**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**5.99**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**97000**	100	100	mg/Kg	11/01/12	kedy	
Lead	**559**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**1280**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**13.2**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	**4.74**	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**7.93**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**3710**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC* **Prep Method:** EPA 1311/3010A						**QCBatchID:** QC1132663	
Nickel	**49.4**	1	0.05	mg/L	12/27/12	nina	
Method: EPA 6010 *NELAC* **Prep Method:** STLC						**QCBatchID:** QC1132091	
Antimony	ND	10	0.3	mg/L	12/10/12	nina	
Arsenic	ND	10	0.1	mg/L	12/10/12	nina	
Barium	**2.40**	10	0.1	mg/L	12/10/12	nina	
Beryllium	ND	1	0.005	mg/L	12/10/12	nina	
Cadmium	ND	10	0.05	mg/L	12/10/12	nina	
Chromium	**0.134**	10	0.1	mg/L	12/10/12	nina	
Cobalt	ND	10	0.05	mg/L	12/10/12	nina	
Copper	**1.01**	10	0.1	mg/L	12/10/12	nina	
Lead	**7.46**	10	0.05	mg/L	12/10/12	nina	
Molybdenum	ND	10	0.1	mg/L	12/10/12	nina	
Nickel	**174**	10	0.2	mg/L	12/10/12	nina	
Selenium	**0.11**	10	0.1	mg/L	12/10/12	nina	
Silver	ND	10	0.05	mg/L	12/10/12	nina	B
Thallium	ND	10	0.05	mg/L	12/10/12	nina	
Vanadium	ND	10	0.05	mg/L	12/10/12	nina	
Zinc	**9.25**	10	0.2	mg/L	12/10/12	nina	
Method: EPA 7470 *NELAC* **Prep Method:** STLC / 7470A						**QCBatchID:** QC1133004	
Mercury	ND	20	0.2	mg/L	01/10/13	BradB	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1131028	
Mercury	**0.32**	1	0.14	mg/Kg	11/01/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-009 | Client Sample #: INC-01(c)

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1131045	
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**2.28**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**1.86**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**9800**	1	1	mg/Kg	11/01/12	kedy	
Lead	**1.10**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**6.60**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**0.7**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**13.7**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**10.5**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1131028	
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-013 | Client Sample #: LED-01(b)

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1131045	
Antimony	**19.7**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**31.8**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**364**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**0.9**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**7100**	1	1	mg/Kg	11/01/12	kedy	
Lead	**76.8**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	**1.77**	1	1	mg/Kg	11/01/12	kedy	
Nickel	**54.0**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**1.59**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**55.7**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**2700**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC* **Prep Method:** EPA 1311/3010A						**QCBatchID:** QC1132663	
Chromium	ND	1	0.05	mg/L	12/27/12	nina	
Method: EPA 6010 *NELAC* **Prep Method:** STLC						**QCBatchID:** QC1132091	
Chromium	**0.201**	10	0.1	mg/L	12/10/12	nina	
Lead	**0.897**	10	0.05	mg/L	12/10/12	nina	
Zinc	**135**	10	0.2	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1131028	
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-016 | Client Sample #: CFL-01(b) A

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131002
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**106**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	**1.74**	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**25.9**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**4.18**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**107000**	100	100	mg/Kg	11/01/12	kedy	
Lead	**16600**	100	50	mg/Kg	11/01/12	kedy	
Molybdenum	**2.26**	1	1	mg/Kg	11/01/12	kedy	
Nickel	**85.4**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**42.3**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	**1.99**	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**20.3**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**8590**	100	500	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1130978
Mercury	ND	1	0.14	mg/Kg	10/31/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-017 | Client Sample #: CFL-01(b) B

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131002
Antimony	**18.9**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**368**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	ND	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**263**	1	1	mg/Kg	11/01/12	kedy	
Lead	**17.4**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**17.7**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	**1.73**	1	1	mg/Kg	11/01/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**137**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1130978
Mercury	**0.15**	1	0.14	mg/Kg	10/31/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-018 | Client Sample #: CFL-01(b) C

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131002
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**3.44**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	ND	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**9.57**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**358000**	100	100	mg/Kg	11/01/12	kedy	
Lead	**77.9**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**9920**	100	150	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**18.3**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**219000**	100	500	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC*	**Prep Method:** STLC					**QCBatchID:**	QC1132091
Nickel	**238**	100	2	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1130978
Mercury	ND	1	0.14	mg/Kg	10/31/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-019 | Client Sample #: CFL-01(b) D

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131002
Antimony	**24.7**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**19.5**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	ND	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**18.9**	1	1	mg/Kg	11/01/12	kedy	
Lead	**6.75**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**1.76**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**35.0**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1130978
Mercury	ND	1	0.14	mg/Kg	10/31/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-020 | Client Sample #: CFL-02(a) A

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:** QC1131002	
Antimony	**220**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**358**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	**1.32**	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**20.9**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**26.6**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**75800**	100	100	mg/Kg	11/01/12	kedy	
Lead	**722**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**8460**	100	150	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**31.7**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	**8.85**	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**9.41**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**8170**	100	500	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC*	**Prep Method:** STLC					**QCBatchID:** QC1132091	
Lead	**10.3**	10	0.05	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:** QC1130978	
Mercury	ND	1	0.14	mg/Kg	10/31/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-021 | Client Sample #: CFL-02(a) B

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:** QC1131002	
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**28.6**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	ND	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	ND	1	1	mg/Kg	11/01/12	kedy	
Lead	**2.52**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	ND	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	ND	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:** QC1130978	
Mercury	**1.17**	1	0.14	mg/Kg	10/31/12	BradB	

Note of clarification by PNNL:
WET concentration of 17.9 mg/L for zinc in sample CFL-2(a)A, although communicated by email, was omitted from report.

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-022 | Client Sample #: CFL-02(a) C

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131002
Antimony	**6890**	100	300	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**363**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**7.85**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**1.43**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**19600**	100	100	mg/Kg	11/01/12	kedy	
Lead	**20.1**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**13600**	100	150	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**7.30**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**19.0**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**756**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1130978
Mercury	ND	1	0.14	mg/Kg	10/31/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-023 | Client Sample #: CFL-02(a) D

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131002
Antimony	**8930**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	**5.27**	1	1	mg/Kg	11/01/12	kedy	
Barium	**125**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**6.45**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**1.0**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**65.7**	1	1	mg/Kg	11/01/12	kedy	
Lead	**12.8**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	**1.33**	1	1	mg/Kg	11/01/12	kedy	
Nickel	**37.7**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**3.30**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**3.36**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**754**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1130978
Mercury	ND	1	0.14	mg/Kg	10/31/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-024 | Client Sample #: CFL-02(c) A

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:** QC1131002	
Antimony	**84.4**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**696**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	**1.13**	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**20.0**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**19.1**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**103000**	100	100	mg/Kg	11/01/12	kedy	
Lead	**1140**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**132**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**51.2**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	**4.03**	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**17.0**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**7730**	100	500	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC*	**Prep Method:** STLC					**QCBatchID:** QC1132091	
Lead	**9.85**	10	0.05	mg/L	12/10/12	nina	
Zinc	**14.0**	10	0.2	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:** QC1130978	
Mercury	**1.44**	1	0.14	mg/Kg	10/31/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-025 | Client Sample #: CFL-02(c) B

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:** QC1131002	
Antimony	**11.5**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**34.5**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	ND	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**5.62**	1	1	mg/Kg	11/01/12	kedy	
Lead	**5.72**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**12.0**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	**1.31**	1	1	mg/Kg	11/01/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	ND	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:** QC1130978	
Mercury	**0.44**	1	0.14	mg/Kg	10/31/12	BradB	

ND = Not Detected or < RDL RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-026 | Client Sample #: CFL-02(c) C

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131002
Antimony	**4770**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**557**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**8.37**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**1.42**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**461**	1	1	mg/Kg	11/01/12	kedy	
Lead	**23.5**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**8960**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**0.6**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**25.9**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**681**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC*	**Prep Method:** STLC					**QCBatchID:**	QC1132091
Nickel	**669**	100	2	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1130978
Mercury	ND	1	0.14	mg/Kg	10/31/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-027 | Client Sample #: CFL-02(c) D

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131002
Antimony	**8890**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	**4.64**	1	1	mg/Kg	11/01/12	kedy	
Barium	**108**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**4.96**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**1.15**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**76.0**	1	1	mg/Kg	11/01/12	kedy	
Lead	**4.52**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**79.2**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**2.35**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**755**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1130978
Mercury	ND	1	0.14	mg/Kg	10/31/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-028 | Client Sample #: CFL-03(a) A

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131002
Antimony	**1090**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**1390**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	**1.36**	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**26.3**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**6.88**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**73700**	100	100	mg/Kg	11/01/12	kedy	
Lead	**2010**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	**1.41**	1	1	mg/Kg	11/01/12	kedy	
Nickel	**216**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**15.3**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	**3.87**	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**31.9**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**7640**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC*	**Prep Method:** EPA 1311/3010A					**QCBatchID:**	QC1132663
Lead	**20.2**	1	0.05	mg/L	12/27/12	nina	
Method: EPA 6010 *NELAC*	**Prep Method:** STLC					**QCBatchID:**	QC1132091
Lead	**10.2**	10	0.05	mg/L	12/10/12	nina	
Zinc	**560**	10	0.2	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1130978
Mercury	ND	1	0.14	mg/Kg	10/31/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-029 | Client Sample #: CFL-03(a) B

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131002
Antimony	**8.01**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**3.93**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	ND	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**1.35**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**3.22**	1	1	mg/Kg	11/01/12	kedy	
Lead	**2.80**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	ND	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**9.18**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1130978
Mercury	**0.17**	1	0.14	mg/Kg	10/31/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** Client
Sampled: 10/03/2012	**Site:**	**Notes:**
Sample #: 311812-030	**Client Sample #:** CFL-03(a) C	

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1131002	
Antimony	**2910**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**273**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**5.29**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**6.29**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**7390**	1	1	mg/Kg	11/01/12	kedy	
Lead	**13.8**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**14700**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**0.7**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**25.0**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**8030**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC* **Prep Method:** STLC						**QCBatchID:** QC1132091	
Antimony	ND	1000	30	mg/L	12/10/12	nina	
Arsenic	ND	1000	10	mg/L	12/10/12	nina	
Barium	ND	1000	10	mg/L	12/10/12	nina	
Cadmium	ND	1000	5	mg/L	12/10/12	nina	
Chromium	ND	1000	10	mg/L	12/10/12	nina	
Cobalt	ND	1000	5	mg/L	12/10/12	nina	
Copper	ND	1000	10	mg/L	12/10/12	nina	
Lead	**6.16**	1000	5	mg/L	12/10/12	nina	
Molybdenum	ND	1000	10	mg/L	12/10/12	nina	
Nickel	**3180**	1000	20	mg/L	12/10/12	nina	
Selenium	ND	1000	10	mg/L	12/10/12	nina	
Silver	**5.47**	1000	5	mg/L	12/10/12	nina	B
Thallium	ND	1000	5	mg/L	12/10/12	nina	
Vanadium	ND	1000	5	mg/L	12/10/12	nina	
Zinc	**99.5**	1000	20	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1130978	
Mercury	ND	1	0.14	mg/Kg	10/31/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-031 | Client Sample #: CFL-03(a) D

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:** QC1131002	
Antimony	**11500**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	**10.3**	1	1	mg/Kg	11/01/12	kedy	
Barium	**443**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**1.37**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**6.38**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**10.8**	1	1	mg/Kg	11/01/12	kedy	
Lead	**3.18**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	**1.27**	1	1	mg/Kg	11/01/12	kedy	
Nickel	ND	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	**1.14**	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**0.9**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**10100**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC*	**Prep Method:** STLC					**QCBatchID:** QC1132091	
Zinc	**1.799**	10	0.2	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:** QC1130978	
Mercury	ND	1	0.14	mg/Kg	10/31/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-032 | Client Sample #: HAL-01(b) A

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:** QC1131002	
Antimony	**3.72**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	ND	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	ND	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**4.19**	1	1	mg/Kg	11/01/12	kedy	
Lead	ND	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**4.22**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	ND	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:** QC1131020	
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-033 | Client Sample #: HAL-01(b) B

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:**	QC1131002
Antimony	**81.4**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**5.04**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**91.4**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**0.8**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**1830**	1	1	mg/Kg	11/01/12	kedy	
Lead	**19.4**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**5500**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**0.5**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**36.4**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**970**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC* **Prep Method:** STLC						**QCBatchID:**	QC1132091
Copper	**6.20**	10	0.1	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:**	QC1131020
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-034 | Client Sample #: HAL-02(a) A

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:**	QC1131002
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	ND	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	ND	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**37.8**	1	1	mg/Kg	11/01/12	kedy	
Lead	**0.6**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**3.40**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**0.5**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**21.1**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:**	QC1131020
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-035 | Client Sample #: HAL-02(a) B

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:**	QC1131045
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**5.72**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	ND	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**292000**	100	100	mg/Kg	11/01/12	kedy	
Lead	**17.6**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	**1.33**	1	1	mg/Kg	11/01/12	kedy	
Nickel	**81.2**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**10.8**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**162000**	100	500	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:**	QC1131028
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-036 | Client Sample #: INC-01(d) A

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:**	QC1131017
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	ND	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	ND	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**20.7**	1	1	mg/Kg	11/01/12	kedy	
Lead	ND	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**3.02**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**12.2**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:**	QC1131020
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-037 | Client Sample #: INC-01(d) B

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131017
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**1.44**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**5.63**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**18800**	1	1	mg/Kg	11/01/12	kedy	
Lead	**8.48**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**1450**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**1.16**	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**14.0**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**8520**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC*	**Prep Method:** STLC					**QCBatchID:**	QC1132091
Nickel	**2.90**	10	0.2	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131020
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-038 | Client Sample #: INC-02(a) A

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131017
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	ND	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	ND	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**8.52**	1	1	mg/Kg	11/01/12	kedy	
Lead	ND	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	ND	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	**1.31**	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	ND	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131020
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-039 | Client Sample #: INC-02(a) B

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1131017	
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**4100**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**9.30**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**772**	1	1	mg/Kg	11/01/12	kedy	
Lead	**7.47**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**44.2**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**13.2**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**2460**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1131020	
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-040 | Client Sample #: LED-02(b) A

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1131017	
Antimony	**2310**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**1460**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**6.84**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**49.8**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**51800**	50	50	mg/Kg	11/01/12	kedy	
Lead	**8.67**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	**1.16**	1	1	mg/Kg	11/01/12	kedy	
Nickel	**293**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**98.4**	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	**1.06**	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**12.4**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**4270**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1131020	
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-041 | Client Sample #: LED-02(b) B

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131017
Antimony	**5200**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	**4.30**	1	1	mg/Kg	11/01/12	kedy	
Barium	**100**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**2.22**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**1.20**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**76.0**	1	1	mg/Kg	11/01/12	kedy	
Lead	**3.55**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**3.73**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	**3.36**	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**2.05**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**1760**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131020
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-042 | Client Sample #: LED-02(b) C

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131017
Antimony	**10.3**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**1.0**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	**4.26**	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**176**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**4.50**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**74800**	50	50	mg/Kg	11/01/12	kedy	
Lead	**448**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	**2.56**	1	1	mg/Kg	11/01/12	kedy	
Nickel	**2240**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	**2.14**	1	1	mg/Kg	11/01/12	kedy	
Silver	**6.50**	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**67.4**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**43400**	50	250	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC*	**Prep Method:** STLC					**QCBatchID:**	QC1132091
Chromium	**0.376**	10	0.1	mg/L	12/10/12	nina	
Lead	**6.32**	10	0.05	mg/L	12/10/12	nina	
Nickel	**7.97**	10	0.2	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131020
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-043 | Client Sample #: LED-02(b) D

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1131017	
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**71.3**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**96.5**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**10.4**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**70500**	50	50	mg/Kg	11/01/12	kedy	
Lead	**533**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	**46.8**	1	1	mg/Kg	11/01/12	kedy	
Nickel	**1420**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**209**	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	**1.21**	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**32.5**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**993**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1131020	
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-044 | Client Sample #: LED-02(b) E

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1131017	
Antimony	**12.5**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	**7.17**	1	1	mg/Kg	11/01/12	kedy	
Barium	**13.3**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**1.69**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**1.27**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**80.7**	1	1	mg/Kg	11/01/12	kedy	
Lead	**1.95**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**4.18**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**0.7**	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**1.20**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**57.8**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1131020	
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** Client
Sampled: 10/03/2012	**Site:**	**Notes:**
Sample #: 311812-045	**Client Sample #:** LED-03(a) A	

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:** QC1131017	
Antimony	**11.9**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	ND	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	**2.12**	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**308**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**2.93**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**8110**	1	1	mg/Kg	11/01/12	kedy	
Lead	**240**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	**4.07**	1	1	mg/Kg	11/01/12	kedy	
Nickel	**231**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	**2.20**	1	1	mg/Kg	11/01/12	kedy	
Silver	**4.25**	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**79.7**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**4370**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC*	**Prep Method:** EPA 1311/3010A					**QCBatchID:** QC1132663	
Chromium	ND	1	0.05	mg/L	12/27/12	nina	
Lead	**1.138**	1	0.05	mg/L	12/27/12	nina	
Method: EPA 6010 *NELAC*	**Prep Method:** STLC					**QCBatchID:** QC1132091	
Chromium	**0.547**	10	0.1	mg/L	12/10/12	nina	
Lead	**3.04**	10	0.05	mg/L	12/10/12	nina	
Nickel	**2.79**	10	0.2	mg/L	12/10/12	nina	
Zinc	**1.414**	10	0.2	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:** QC1131020	
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-046 | Client Sample #: LED-03(a) B

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:** QC1131017	
Antimony	**4110**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	**3.63**	1	1	mg/Kg	11/01/12	kedy	
Barium	**12.1**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**2.48**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**0.6**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**36.9**	1	1	mg/Kg	11/01/12	kedy	
Lead	ND	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**1.99**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	**1.93**	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**0.6**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**43.9**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:** QC1131020	
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-047 | Client Sample #: LED-03(a) C

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:** QC1131017	
Antimony	**536**	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**2880**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**27.1**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**48.2**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**454000**	100	100	mg/Kg	11/01/12	kedy	
Lead	**57.7**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	**3.59**	1	1	mg/Kg	11/01/12	kedy	
Nickel	**2150**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**36.9**	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**11.9**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**12600**	100	500	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC*	**Prep Method:** STLC					**QCBatchID:** QC1132091	
Nickel	**16.3**	10	0.2	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:** QC1131020	
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-053 | Client Sample #: HAL-01(a)C

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1131017	
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**12.4**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	**3.21**	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**65.8**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**69.5**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**3170**	1	1	mg/Kg	11/01/12	kedy	
Lead	**2.10**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	**133**	1	1	mg/Kg	11/01/12	kedy	
Nickel	**13600**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	**9.52**	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**1.36**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**14.5**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1131020	
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-054 | Client Sample #: HAL-01(b)C

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1131017	
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**19.4**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	**5.02**	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**122**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**106**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**3440**	1	1	mg/Kg	11/01/12	kedy	
Lead	**1.53**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	**3.97**	1	1	mg/Kg	11/01/12	kedy	
Nickel	**15500**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	**12.7**	1	1	mg/Kg	11/01/12	kedy	
Silver	**0.5**	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**8.01**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**5.98**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC* **Prep Method:** STLC						**QCBatchID:** QC1132091	
Copper	**1.709**	10	0.1	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1131020	
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-055 | Client Sample #: Inc-01(d)C

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:**	QC1131017
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**7.44**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	ND	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**11.3**	1	1	mg/Kg	11/01/12	kedy	
Lead	ND	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	**114**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	**2.28**	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**6.22**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:**	QC1131020
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-056 | Client Sample #: Inc-02(a)C

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:**	QC1131017
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**2780**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**2.84**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**71.0**	1	1	mg/Kg	11/01/12	kedy	
Lead	**1.04**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	**1.31**	1	1	mg/Kg	11/01/12	kedy	
Nickel	**21.0**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	**4.42**	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**6.13**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**5700**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:**	QC1131020
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-057 | Client Sample #: LED-03(a)&LED-04(a)A

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:** STLC					**QCBatchID:**	QC1132091
Antimony	ND	10	0.3	mg/L	12/10/12	nina	
Arsenic	ND	10	0.1	mg/L	12/10/12	nina	
Barium	ND	10	0.1	mg/L	12/10/12	nina	
Beryllium	ND	10	0.05	mg/L	12/10/12	nina	
Cadmium	ND	10	0.05	mg/L	12/10/12	nina	
Chromium	**0.299**	10	0.1	mg/L	12/10/12	nina	
Cobalt	ND	10	0.05	mg/L	12/10/12	nina	
Copper	ND	10	0.1	mg/L	12/10/12	nina	
Lead	**0.088**	10	0.05	mg/L	12/10/12	nina	
Molybdenum	ND	10	0.1	mg/L	12/10/12	nina	
Nickel	ND	10	0.2	mg/L	12/10/12	nina	
Selenium	ND	10	0.1	mg/L	12/10/12	nina	
Silver	**0.166**	10	0.05	mg/L	12/10/12	nina	B
Thallium	ND	10	0.05	mg/L	12/10/12	nina	
Vanadium	ND	10	0.05	mg/L	12/10/12	nina	
Zinc	ND	10	0.2	mg/L	12/10/12	nina	
Method: EPA 7470 *NELAC*	**Prep Method:** STLC / 7470A					**QCBatchID:**	QC1132557
Mercury	ND	20	0.2	mg/L	12/21/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-058 | Client Sample #: HAL-01(a)A

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131017
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	ND	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	ND	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**5.21**	1	1	mg/Kg	11/01/12	kedy	
Lead	**1.37**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/01/12	kedy	
Nickel	ND	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	ND	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131020
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-059 | Client Sample #: HAL-01(a)B

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131017
Antimony	**3110**	50	150	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**30.4**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**60.8**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**45600**	50	50	mg/Kg	11/01/12	kedy	
Lead	**27.0**	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	**2.81**	1	1	mg/Kg	11/01/12	kedy	
Nickel	**25.3**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	ND	1	1	mg/Kg	11/01/12	kedy	
Silver	**4.40**	1	0.5	mg/Kg	11/01/12	kedy	L
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	**18.0**	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**20300**	50	250	mg/Kg	11/01/12	kedy	
Method: EPA 6010 *NELAC*	**Prep Method:** STLC					**QCBatchID:**	QC1132091
Antimony	**110**	100	3	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131028
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-060 | Client Sample #: HAL-02(a)C

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131045
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	**4.12**	1	1	mg/Kg	11/01/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	**1.84**	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	**27.7**	1	1	mg/Kg	11/01/12	kedy	
Cobalt	**3.64**	1	0.5	mg/Kg	11/01/12	kedy	
Copper	**26.2**	1	1	mg/Kg	11/01/12	kedy	
Lead	ND	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	**2.21**	1	1	mg/Kg	11/01/12	kedy	
Nickel	**1130**	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	**3.46**	1	1	mg/Kg	11/01/12	kedy	
Silver	**0.6**	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	**6.83**	1	5	mg/Kg	11/01/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1131028
Mercury	ND	1	0.14	mg/Kg	11/01/12	BradB	

ND = Not Detected or < RDL | RDL = Reporting Detection Limit | DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-061 | Client Sample #: HAL-02(a)D

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:** EPA 3050B					**QCBatchID:**	QC1131045
Antimony	ND	1	3	mg/Kg	11/01/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/01/12	kedy	
Barium	127	1	1	mg/Kg	11/01/12	kedy	
Beryllium	0.9	1	0.5	mg/Kg	11/01/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/01/12	kedy	
Chromium	194	1	1	mg/Kg	11/01/12	kedy	
Cobalt	3.33	1	0.5	mg/Kg	11/01/12	kedy	
Copper	20.9	1	1	mg/Kg	11/01/12	kedy	
Lead	12.2	1	0.5	mg/Kg	11/01/12	kedy	
Molybdenum	5.26	1	1	mg/Kg	11/01/12	kedy	
Nickel	12.8	1	1.5	mg/Kg	11/01/12	kedy	
Selenium	1.55	1	1	mg/Kg	11/01/12	kedy	
Silver	0.7	1	0.5	mg/Kg	11/01/12	kedy	
Thallium	ND	1	1	mg/Kg	11/01/12	kedy	
Vanadium	56.9	1	0.5	mg/Kg	11/01/12	kedy	
Zinc	25.1	1	5	mg/Kg	11/01/12	kedy	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-062 | Client Sample #: CFL-02(b)-STLCRes.TTLC

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1132630
Antimony	655	1	3	mg/Kg	12/26/12	kedy	
Arsenic	ND	1	1	mg/Kg	12/26/12	kedy	
Barium	12.9	1	1	mg/Kg	12/26/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	12/26/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	12/26/12	kedy	
Chromium	6.40	1	1	mg/Kg	12/26/12	kedy	
Cobalt	0.7	1	0.5	mg/Kg	12/26/12	kedy	
Copper	17300	1	1	mg/Kg	12/26/12	kedy	
Lead	1.53	1	0.5	mg/Kg	12/26/12	kedy	
Molybdenum	ND	1	1	mg/Kg	12/26/12	kedy	
Nickel	75.0	1	1.5	mg/Kg	12/26/12	kedy	
Selenium	ND	1	1	mg/Kg	12/26/12	kedy	
Silver	ND	1	0.5	mg/Kg	12/26/12	kedy	
Thallium	ND	1	1	mg/Kg	12/26/12	kedy	
Vanadium	7.21	1	0.5	mg/Kg	12/26/12	kedy	
Zinc	138	1	5	mg/Kg	12/26/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1132637
Mercury	0.83	1	0.14	mg/Kg	12/27/12	BradB	

Note of clarification by PNNL:
Results for sample "CFL-02(b)-STLCRes.TTLC" were disregarded per guidance from Associated Laboratories.

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-063 | Client Sample #: CFL-03(a)C-STLCRes.TTLC

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1132630
Antimony	**630**	1	3	mg/Kg	12/26/12	kedy	
Arsenic	**2.36**	1	1	mg/Kg	12/26/12	kedy	
Barium	**12.0**	1	1	mg/Kg	12/26/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	12/26/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	12/26/12	kedy	
Chromium	**3.15**	1	1	mg/Kg	12/26/12	kedy	
Cobalt	**0.8**	1	0.5	mg/Kg	12/26/12	kedy	
Copper	**61.4**	1	1	mg/Kg	12/26/12	kedy	
Lead	ND	1	0.5	mg/Kg	12/26/12	kedy	
Molybdenum	ND	1	1	mg/Kg	12/26/12	kedy	
Nickel	**2240**	1	1.5	mg/Kg	12/26/12	kedy	
Selenium	ND	1	1	mg/Kg	12/26/12	kedy	
Silver	ND	1	0.5	mg/Kg	12/26/12	kedy	
Thallium	ND	1	1	mg/Kg	12/26/12	kedy	
Vanadium	**26.0**	1	0.5	mg/Kg	12/26/12	kedy	
Zinc	**1470**	1	5	mg/Kg	12/26/12	kedy	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1132666
Mercury	**0.39**	1	0.14	mg/Kg	12/27/12	BradB	

Matrix: Solid | Client: Battelle PNNL | Collector: Client
Sampled: 10/03/2012 | Site: | Notes:
Sample #: 311812-064 | Client Sample #: CFL-02(b)-TCLPRes.TTLC

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1132687
Antimony	**1170**	1	3	mg/Kg	12/31/12	nina	
Arsenic	ND	1	1	mg/Kg	12/31/12	nina	
Barium	**12.6**	1	1	mg/Kg	12/31/12	nina	
Beryllium	ND	1	0.5	mg/Kg	12/31/12	nina	
Cadmium	**1.0**	1	0.5	mg/Kg	12/31/12	nina	
Chromium	**5.89**	1	1	mg/Kg	12/31/12	nina	
Cobalt	**2.07**	1	0.5	mg/Kg	12/31/12	nina	
Copper	**19400**	100	100	mg/Kg	12/31/12	nina	
Lead	**2.89**	1	0.5	mg/Kg	12/31/12	nina	
Molybdenum	ND	1	1	mg/Kg	12/31/12	nina	
Nickel	**9090**	1	1.5	mg/Kg	12/31/12	nina	
Selenium	ND	1	1	mg/Kg	12/31/12	nina	
Silver	ND	1	0.5	mg/Kg	12/31/12	nina	
Thallium	ND	1	1	mg/Kg	12/31/12	nina	
Vanadium	**2.87**	1	0.5	mg/Kg	12/31/12	nina	
Zinc	**108**	1	5	mg/Kg	12/31/12	nina	
Method: EPA 7471 *NELAC*	**Prep Method:**					**QCBatchID:**	QC1132666
Mercury	ND	1	0.14	mg/Kg	12/27/12	BradB	

Note of clarification by PNNL:
Results for samples "CFL-03(a)C-STLCRes.TTLC" and "CFL-02(b)-TCLPRes.TTLC" were disregarded per guidance from Associated Laboratories.

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1130978	**Analyst:** BradB	**Method:** EPA 7471A
Matrix: Solid	**Analyzed:** 10/30/2012	**Instrument:** AAICP-HG1

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1130978MB1						
Mercury	ND	mg/Kg		0.14		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1130978LCS1											
Mercury	0.83		0.84		mg/Kg	101			80-120		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1130978MS1, QC1130978MSD1												**Source: 312818-001**
Mercury	ND	0.83	0.83	0.87	0.85	mg/Kg	105	102	2.3	75-125	20	

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1131002	Analyst: metha	Method: EPA 6010B
Matrix: Solid	Analyzed: 10/31/2012	Instrument: AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1131002MB1						
Antimony	ND	mg/Kg		3		
Arsenic	ND	mg/Kg		1		
Barium	ND	mg/Kg		1		
Beryllium	ND	mg/Kg		0.5		
Cadmium	ND	mg/Kg		0.5		
Chromium	ND	mg/Kg		1		
Cobalt	ND	mg/Kg		0.5		
Copper	ND	mg/Kg		1		
Lead	ND	mg/Kg		0.5		
Molybdenum	ND	mg/Kg		1		
Nickel	ND	mg/Kg		1.5		
Selenium	ND	mg/Kg		1		
Silver	ND	mg/Kg		0.5		
Thallium	ND	mg/Kg		1		
Vanadium	ND	mg/Kg		0.5		
Zinc	ND	mg/Kg		5		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1131002LCS1											
Antimony	200		176		mg/Kg	88			80-120		
Arsenic	200		178		mg/Kg	89			80-120		
Barium	200		199		mg/Kg	100			80-120		
Beryllium	200		179		mg/Kg	90			80-120		
Cadmium	200		186		mg/Kg	93			80-120		
Chromium	200		201		mg/Kg	101			80-120		
Cobalt	200		195		mg/Kg	98			80-120		
Copper	200		194		mg/Kg	97			80-120		
Lead	200		193		mg/Kg	97			80-120		
Molybdenum	200		185		mg/Kg	93			80-120		
Nickel	200		196		mg/Kg	98			80-120		
Selenium	200		171		mg/Kg	86			80-120		
Silver	100		91.0		mg/Kg	91			80-120		
Thallium	200		186		mg/Kg	93			80-120		
Vanadium	200		194		mg/Kg	97			80-120		
Zinc	200		189		mg/Kg	95			80-120		

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1131002	**Analyst:** metha	**Method:** EPA 6010B
Matrix: Solid	**Analyzed:** 10/31/2012	**Instrument:** AAICP (group)

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1131002MS1, QC1131002MSD1												**Source: 312871-001**
Antimony	ND	100	100	88.3	88.3	mg/Kg	89	89	0.0	75-125	20	
Arsenic	1.08	100	100	94.3	93.3	mg/Kg	93	92	1.1	75-125	20	
Barium	62.2	100	100	151	158	mg/Kg	89	96	4.5	75-125	20	
Beryllium	ND	100	100	92.8	90.4	mg/Kg	93	90	2.6	75-125	20	
Cadmium	0.3	100	100	92.6	91.8	mg/Kg	92	92	0.9	75-125	20	
Chromium	6.13	100	100	107	106	mg/Kg	101	100	0.9	75-125	20	
Cobalt	2.10	100	100	99.2	98.2	mg/Kg	97	96	1.0	75-125	20	
Copper	31.4	100	100	130	131	mg/Kg	99	100	0.8	75-125	20	
Lead	101	100	100	97.1	97.4	mg/Kg	0	0	0.3	75-125	20	M
Molybdenum	1.79	100	100	91.4	90.7	mg/Kg	90	89	0.8	75-125	20	
Nickel	5.68	100	100	104	104	mg/Kg	98	98	0.0	75-125	20	
Selenium	ND	100	100	91.0	90.6	mg/Kg	94	94	0.4	75-125	20	
Silver	ND	50	50	47.0	46.6	mg/Kg	94	93	0.9	75-125	20	
Thallium	ND	100	100	98.6	98.4	mg/Kg	100	100	0.2	75-125	20	
Vanadium	9.30	100	100	102	102	mg/Kg	93	93	0.0	75-125	20	
Zinc	188	100	100	273	312	mg/Kg	85	124	13.3	75-125	20	

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1131017	**Analyst:** metha	**Method:** EPA 6010B
Matrix: Solid	**Analyzed:** 10/31/2012	**Instrument:** AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1131017MB1						
Antimony	ND	mg/Kg		3		
Arsenic	ND	mg/Kg		1		
Barium	ND	mg/Kg		1		
Beryllium	ND	mg/Kg		0.5		
Cadmium	ND	mg/Kg		0.5		
Chromium	ND	mg/Kg		1		
Cobalt	ND	mg/Kg		0.5		
Copper	ND	mg/Kg		1		
Lead	ND	mg/Kg		0.5		
Molybdenum	ND	mg/Kg		1		
Nickel	ND	mg/Kg		1.5		
Selenium	ND	mg/Kg		1		
Silver	ND	mg/Kg		0.5		
Thallium	ND	mg/Kg		1		
Vanadium	ND	mg/Kg		0.5		
Zinc	ND	mg/Kg		5		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1131017LCS1											
Antimony	200		201		mg/Kg	101			80-120		
Arsenic	200		201		mg/Kg	101			80-120		
Barium	200		204		mg/Kg	102			80-120		
Beryllium	200		192		mg/Kg	96			80-120		
Cadmium	200		187		mg/Kg	94			80-120		
Chromium	200		206		mg/Kg	103			80-120		
Cobalt	200		198		mg/Kg	99			80-120		
Copper	200		207		mg/Kg	104			80-120		
Lead	200		197		mg/Kg	99			80-120		
Molybdenum	200		191		mg/Kg	96			80-120		
Nickel	200		198		mg/Kg	99			80-120		
Selenium	200		191		mg/Kg	96			80-120		
Silver	100		79.3		mg/Kg	79			80-120		L
Thallium	200		202		mg/Kg	101			80-120		
Vanadium	200		203		mg/Kg	102			80-120		
Zinc	200		193		mg/Kg	97			80-120		

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1131017	Analyst: metha	Method: EPA 6010B
Matrix: Solid	Analyzed: 10/31/2012	Instrument: AAICP (group)

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1131017MS1, QC1131017MSD1												**Source: 311812-044**
Antimony	12.5	100	100	128	112	mg/Kg	116	100	13.3	75-125	20	
Arsenic	7.17	100	100	106	112	mg/Kg	99	105	5.5	75-125	20	
Barium	13.3	100	100	120	120	mg/Kg	107	107	0.0	75-125	20	
Beryllium	ND	100	100	98.5	106	mg/Kg	99	106	7.3	75-125	20	
Cadmium	ND	100	100	98.8	101	mg/Kg	100	102	2.2	75-125	20	
Chromium	1.69	100	100	110	113	mg/Kg	108	111	2.7	75-125	20	
Cobalt	1.27	100	100	109	111	mg/Kg	108	110	1.8	75-125	20	
Copper	80.7	100	100	168	161	mg/Kg	87	80	4.3	75-125	20	
Lead	1.95	100	100	109	113	mg/Kg	107	111	3.6	75-125	20	
Molybdenum	0.6	100	100	96.5	99.1	mg/Kg	96	99	2.7	75-125	20	
Nickel	4.18	100	100	114	116	mg/Kg	110	112	1.7	75-125	20	
Selenium	ND	100	100	96.1	102	mg/Kg	96	102	6.0	75-125	20	
Silver	0.7	50	50	43.7	45.1	mg/Kg	86	89	3.2	75-125	20	
Thallium	ND	100	100	109	113	mg/Kg	110	114	3.6	75-125	20	
Vanadium	1.20	100	100	101	109	mg/Kg	100	108	7.6	75-125	20	
Zinc	57.8	100	100	173	150	mg/Kg	115	92	14.2	75-125	20	

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1131020	**Analyst:** BradB	**Method:** EPA 7471A
Matrix: Solid	**Analyzed:** 10/31/2012	**Instrument:** AAICP-HG1

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1131020MB1						
Mercury	ND	mg/Kg		0.14		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1131020LCS1											
Mercury	0.83		0.95		mg/Kg	114			80-120		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1131020MS1, QC1131020MSD1												**Source: 311812-032**
Mercury	ND	0.83	0.83	0.86	0.82	mg/Kg	104	99	4.8	75-125	20	

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1131028	**Analyst:** BradB	**Method:** EPA 7471A
Matrix: Solid	**Analyzed:** 10/31/2012	**Instrument:** AAICP-HG1

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1131028MB1						
Mercury	ND	mg/Kg		0.14		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1131028LCS1											
Mercury	0.83		0.88		mg/Kg	106			80-120		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1131028MS1, QC1131028MSD1												**Source: 311812-003**
Mercury	0.32	0.83	0.83	1.22	1.20	mg/Kg	108	106	1.7	75-125	20	

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1131045	**Analyst:** metha	**Method:** EPA 6010B
Matrix: Solid	**Analyzed:** 11/01/2012	**Instrument:** AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1131045MB1						
Antimony	ND	mg/Kg		3		
Arsenic	ND	mg/Kg		1		
Barium	ND	mg/Kg		1		
Beryllium	ND	mg/Kg		0.5		
Cadmium	ND	mg/Kg		0.5		
Chromium	ND	mg/Kg		1		
Cobalt	ND	mg/Kg		0.5		
Copper	ND	mg/Kg		1		
Lead	ND	mg/Kg		0.5		
Molybdenum	ND	mg/Kg		1		
Nickel	ND	mg/Kg		1.5		
Selenium	ND	mg/Kg		1		
Silver	ND	mg/Kg		0.5		
Thallium	ND	mg/Kg		1		
Vanadium	ND	mg/Kg		0.5		
Zinc	ND	mg/Kg		5		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1131045LCS1											
Antimony	200		181		mg/Kg	91			80-120		
Arsenic	200		183		mg/Kg	92			80-120		
Barium	200		195		mg/Kg	98			80-120		
Beryllium	200		189		mg/Kg	95			80-120		
Cadmium	200		184		mg/Kg	92			80-120		
Chromium	200		198		mg/Kg	99			80-120		
Cobalt	200		191		mg/Kg	96			80-120		
Copper	200		203		mg/Kg	102			80-120		
Lead	200		182		mg/Kg	91			80-120		
Molybdenum	200		178		mg/Kg	89			80-120		
Nickel	200		192		mg/Kg	96			80-120		
Selenium	200		178		mg/Kg	89			80-120		
Silver	100		85.7		mg/Kg	86			80-120		
Thallium	200		194		mg/Kg	97			80-120		
Vanadium	200		188		mg/Kg	94			80-120		
Zinc	200		187		mg/Kg	94			80-120		

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1131045	**Analyst:** metha	**Method:** EPA 6010B
Matrix: Solid	**Analyzed:** 11/01/2012	**Instrument:** AAICP (group)

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1131045MS1, QC1131045MSD1												**Source: 312919-001**
Antimony	ND	100	100	84.0	83.1	mg/Kg	84	83	1.1	75-125	20	
Arsenic	2.56	100	100	94.3	93.0	mg/Kg	92	90	1.4	75-125	20	
Barium	190	100	100	311	321	mg/Kg	121	131	3.2	75-125	20	
Beryllium	0.5	100	100	95.2	91.0	mg/Kg	95	91	4.5	75-125	20	
Cadmium	0.4	100	100	92.2	93.3	mg/Kg	92	93	1.2	75-125	20	
Chromium	16.6	100	100	114	115	mg/Kg	97	98	0.9	75-125	20	
Cobalt	6.47	100	100	101	101	mg/Kg	95	95	0.0	75-125	20	
Copper	9.08	100	100	105	105	mg/Kg	96	96	0.0	75-125	20	
Lead	2.84	100	100	89.2	87.7	mg/Kg	86	85	1.7	75-125	20	
Molybdenum	0.7	100	100	86.2	85.5	mg/Kg	86	85	0.8	75-125	20	
Nickel	12.6	100	100	107	110	mg/Kg	94	97	2.8	75-125	20	
Selenium	ND	100	100	83.8	84.9	mg/Kg	84	85	1.3	75-125	20	
Silver	ND	50	50	47.0	47.0	mg/Kg	94	94	0.0	75-125	20	
Thallium	ND	100	100	86.2	85.4	mg/Kg	86	85	0.9	75-125	20	
Vanadium	28.8	100	100	122	123	mg/Kg	93	94	0.8	75-125	20	
Zinc	34.4	100	100	128	130	mg/Kg	94	96	1.6	75-125	20	

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1132091	**Analyst:** metha	**Method:** EPA 6010B
Matrix: Solid	**Analyzed:** 12/07/2012	**Instrument:** AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1132091MB1						
Antimony	ND	mg/L		0.03		
Arsenic	ND	mg/L		0.01		
Barium	0.016	mg/L		0.01		
Beryllium	ND	mg/L		0.005		
Cadmium	ND	mg/L		0.005		
Chromium	0.012	mg/L		0.01		
Cobalt	ND	mg/L		0.005		
Copper	ND	mg/L		0.01		
Lead	ND	mg/L		0.005		
Molybdenum	ND	mg/L		0.01		
Nickel	ND	mg/L		0.02		
Selenium	ND	mg/L		0.01		
Silver	ND	mg/L		0.005		
Thallium	ND	mg/L		0.005		
Vanadium	0.016	mg/L		0.005		
Zinc	0.028	mg/L		0.02		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132091MS1, QC1132091MSD1												**Source: 311812-031**
Antimony	1.414	10	10	9.99	10.1	mg/L	86	87	1.1	75-125	20	
Arsenic	0.103	10	10	9.85	9.90	mg/L	97	98	0.5	75-125	20	
Barium	0.432	10	10	9.71	9.46	mg/L	93	90	2.6	75-125	20	
Beryllium	ND	10	10	9.55	10.1	mg/L	96	101	5.6	75-125	20	
Cadmium	ND	10	10	9.12	8.86	mg/L	91	89	2.9	75-125	20	
Chromium	0.044	10	10	9.25	9.08	mg/L	92	90	1.9	75-125	20	
Cobalt	0.116	10	10	8.45	8.49	mg/L	83	84	0.5	75-125	20	
Copper	0.309	10	10	8.78	8.58	mg/L	85	83	2.3	75-125	20	
Lead	ND	10	10	8.02	8.16	mg/L	80	82	1.7	75-125	20	
Molybdenum	0.062	10	10	8.92	8.96	mg/L	89	89	0.4	75-125	20	
Nickel	0.289	10	10	8.66	8.45	mg/L	84	82	2.5	75-125	20	
Selenium	0.074	10	10	9.57	9.77	mg/L	95	97	2.1	75-125	20	
Silver	0.172	5	5	5.32	5.07	mg/L	103	98	4.8	75-125	20	
Thallium	ND	10	10	7.93	7.98	mg/L	79	80	0.6	75-125	20	
Vanadium	ND	10	10	9.38	9.16	mg/L	94	92	2.4	75-125	20	
Zinc	1.799	10	10	11.2	10.9	mg/L	94	91	2.7	75-125	20	

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1132557	**Analyst:** BradB	**Method:** EPA 7470A
Matrix: Solid	**Analyzed:** 12/21/2012	**Instrument:** AAICP-HG1

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1132557MB1						
Mercury	ND	mg/L		0.01		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132557LCS1											
Mercury	100		102		ug/L	102			80-120		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132557MS1, QC1132557MSD1												**Source: 311812-057**
Mercury	ND	100	100	99.4	100	ug/L	99	100	0.6	75-125	20	

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1132630	Analyst: nina	Method: EPA 6010B
Matrix: Solid	Analyzed: 12/26/2012	Instrument: AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1132630MB1						
Antimony	ND	mg/Kg		3		
Arsenic	ND	mg/Kg		1		
Barium	ND	mg/Kg		1		
Beryllium	ND	mg/Kg		0.5		
Cadmium	ND	mg/Kg		0.5		
Chromium	ND	mg/Kg		1		
Cobalt	ND	mg/Kg		0.5		
Copper	ND	mg/Kg		1		
Lead	ND	mg/Kg		0.5		
Molybdenum	ND	mg/Kg		1		
Nickel	ND	mg/Kg		1.5		
Selenium	ND	mg/Kg		1		
Silver	ND	mg/Kg		0.5		
Thallium	ND	mg/Kg		1		
Vanadium	ND	mg/Kg		0.5		
Zinc	ND	mg/Kg		5		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132630LCS1											
Antimony	200		176		mg/Kg	88			80-120		
Arsenic	200		181		mg/Kg	91			80-120		
Barium	200		183		mg/Kg	92			80-120		
Beryllium	200		184		mg/Kg	92			80-120		
Cadmium	200		169		mg/Kg	85			80-120		
Chromium	200		184		mg/Kg	92			80-120		
Cobalt	200		174		mg/Kg	87			80-120		
Copper	200		180		mg/Kg	90			80-120		
Lead	200		172		mg/Kg	86			80-120		
Molybdenum	200		180		mg/Kg	90			80-120		
Nickel	200		174		mg/Kg	87			80-120		
Selenium	200		170		mg/Kg	85			80-120		
Silver	100		90.7		mg/Kg	91			80-120		
Thallium	200		182		mg/Kg	91			80-120		
Vanadium	200		182		mg/Kg	91			80-120		
Zinc	200		165		mg/Kg	83			80-120		

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1132630	**Analyst:** nina	**Method:** EPA 6010B
Matrix: Solid	**Analyzed:** 12/26/2012	**Instrument:** AAICP (group)

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132630MS1, QC1132630MSD1												**Source: 315755-005**
Antimony	ND	100	100	89.6	88.5	mg/Kg	90	89	1.2	75-125	20	
Arsenic	ND	100	100	91.4	90.8	mg/Kg	91	91	0.7	75-125	20	
Barium	43.2	100	100	136	133	mg/Kg	93	90	2.2	75-125	20	
Beryllium	0.7	100	100	94.2	94.6	mg/Kg	94	94	0.4	75-125	20	
Cadmium	0.3	100	100	88.0	86.4	mg/Kg	88	86	1.8	75-125	20	
Chromium	17.1	100	100	109	108	mg/Kg	92	91	0.9	75-125	20	
Cobalt	9.15	100	100	96.0	94.2	mg/Kg	87	85	1.9	75-125	20	
Copper	10.4	100	100	98.3	96.3	mg/Kg	88	86	2.1	75-125	20	
Lead	2.09	100	100	83.6	84.2	mg/Kg	82	82	0.7	75-125	20	
Molybdenum	0.5	100	100	86.6	86.7	mg/Kg	86	86	0.1	75-125	20	
Nickel	10.0	100	100	97.1	95.2	mg/Kg	87	85	2.0	75-125	20	
Selenium	ND	100	100	83.2	81.7	mg/Kg	83	82	1.8	75-125	20	
Silver	ND	50	50	48.4	47.0	mg/Kg	97	94	2.9	75-125	20	
Thallium	ND	100	100	80.3	80.2	mg/Kg	80	80	0.1	75-125	20	
Vanadium	37.1	100	100	128	126	mg/Kg	91	89	1.6	75-125	20	
Zinc	35.7	100	100	121	120	mg/Kg	85	84	0.8	75-125	20	

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1132637	**Analyst:** BradB	**Method:** EPA 7471A
Matrix: Solid	**Analyzed:** 12/26/2012	**Instrument:** AAICP-HG1

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1132637MB1						
Mercury	ND	mg/Kg		0.14		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132637LCS1											
Mercury	0.83		0.88		mg/Kg	106			80-120		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132637MS1, QC1132637MSD1												**Source: 315755-005**
Mercury	ND	0.83	0.83	0.89	0.87	mg/Kg	107	105	2.3	75-125	20	

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1132663	**Analyst:** metha	**Method:** EPA 6010B
Matrix: Solid	**Analyzed:** 12/27/2012	**Instrument:** AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1132663MB1						
Antimony	ND	mg/L		0.05		
Arsenic	ND	mg/L		0.05		
Barium	ND	mg/L		0.1		
Beryllium	ND	mg/L		0.05		
Cadmium	ND	mg/L		0.05		
Chromium	ND	mg/L		0.05		
Cobalt	ND	mg/L		0.05		
Copper	ND	mg/L		0.05		
Lead	ND	mg/L		0.05		
Molybdenum	ND	mg/L		0.05		
Nickel	ND	mg/L		0.05		
Selenium	ND	mg/L		0.05		
Silver	ND	mg/L		0.05		
Thallium	ND	mg/L		0.05		
Vanadium	ND	mg/L		0.05		
Zinc	ND	mg/L		0.05		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132663LCS1											
Antimony	2		1.76		mg/L	88			80-120		
Arsenic	2		2.04		mg/L	102			80-120		
Barium	2		1.832		mg/L	92			80-120		
Beryllium	2		1.72		mg/L	86			80-120		
Cadmium	2		1.911		mg/L	96			80-120		
Chromium	2		1.804		mg/L	90			80-120		
Cobalt	2		1.74		mg/L	87			80-120		
Copper	2		1.69		mg/L	85			80-120		
Lead	2		1.795		mg/L	90			80-120		
Molybdenum	2		1.80		mg/L	90			80-120		
Nickel	2		1.79		mg/L	90			80-120		
Selenium	2		2.03		mg/L	102			80-120		
Silver	1		0.886		mg/L	89			80-120		
Thallium	2		1.65		mg/L	83			80-120		
Vanadium	2		1.83		mg/L	92			80-120		
Zinc	2		1.979		mg/L	99			80-120		

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1132663	**Analyst:** metha	**Method:** EPA 6010B
Matrix: Solid	**Analyzed:** 12/27/2012	**Instrument:** AAICP (group)

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132663MS1, QC1132663MSD1												**Source: 315856-001**
Antimony	ND	1	1	0.903	0.884	mg/L	90	88	2.1	75-125	20	
Arsenic	0.014	1	1	1.092	1.077	mg/L	108	106	1.4	75-125	20	
Barium	0.268	1	1	1.122	1.072	mg/L	85	80	4.6	75-125	20	
Beryllium	ND	1	1	0.970	0.915	mg/L	97	92	5.8	75-125	20	
Cadmium	ND	1	1	0.980	0.919	mg/L	98	92	6.4	75-125	20	
Chromium	0.020	1	1	0.954	0.896	mg/L	93	88	6.3	75-125	20	
Cobalt	0.003	1	1	0.905	0.852	mg/L	90	85	6.0	75-125	20	
Copper	1.00	1	1	1.99	1.87	mg/L	99	87	6.2	75-125	20	
Lead	ND	1	1	0.917	0.895	mg/L	92	90	2.4	75-125	20	
Molybdenum	ND	1	1	0.922	0.904	mg/L	92	90	2.0	75-125	20	
Nickel	1.08	1	1	2.09	1.96	mg/L	101	88	6.4	75-125	20	
Selenium	ND	1	1	1.017	0.966	mg/L	102	97	5.1	75-125	20	
Silver	ND	0.5	0.5	0.458	0.434	mg/L	92	87	5.4	75-125	20	
Thallium	ND	1	1	0.834	0.815	mg/L	83	82	2.3	75-125	20	
Vanadium	ND	1	1	0.955	0.910	mg/L	96	91	4.8	75-125	20	
Zinc	13.2	1	1	15.9	14.9	mg/L	270	170	6.5	75-125	20	NC

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1132666	**Analyst:** BradB	**Method:** EPA 7471A
Matrix: Solid	**Analyzed:** 12/27/2012	**Instrument:** AAICP-HG1

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1132666MB1						
Mercury	ND	mg/Kg		0.14		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132666LCS1											
Mercury	0.83		0.91		mg/Kg	110			80-120		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132666MS1, QC1132666MSD1												**Source: 315958-001**
Mercury	ND	0.83	0.83	0.89	0.92	mg/Kg	107	111	3.3	75-125	20	

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1132687	**Analyst:** BradB	**Method:** EPA 6010B
Matrix: Solid	**Analyzed:** 12/28/2012	**Instrument:** AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1132687MB1						
Antimony	ND	mg/Kg		3		
Arsenic	ND	mg/Kg		1		
Barium	ND	mg/Kg		1		
Beryllium	ND	mg/Kg		0.5		
Cadmium	ND	mg/Kg		0.5		
Chromium	ND	mg/Kg		1		
Cobalt	ND	mg/Kg		0.5		
Copper	ND	mg/Kg		1		
Lead	ND	mg/Kg		0.5		
Molybdenum	ND	mg/Kg		1		
Nickel	ND	mg/Kg		1.5		
Selenium	ND	mg/Kg		1		
Silver	ND	mg/Kg		0.5		
Thallium	ND	mg/Kg		1		
Vanadium	ND	mg/Kg		0.5		
Zinc	ND	mg/Kg		5		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132687LCS1											
Antimony	200		191		mg/Kg	96			80-120		
Arsenic	200		199		mg/Kg	100			80-120		
Barium	200		200		mg/Kg	100			80-120		
Beryllium	200		181		mg/Kg	91			80-120		
Cadmium	200		191		mg/Kg	96			80-120		
Chromium	200		203		mg/Kg	102			80-120		
Cobalt	200		200		mg/Kg	100			80-120		
Copper	200		191		mg/Kg	96			80-120		
Lead	200		198		mg/Kg	99			80-120		
Molybdenum	200		199		mg/Kg	100			80-120		
Nickel	200		205		mg/Kg	103			80-120		
Selenium	200		184		mg/Kg	92			80-120		
Silver	100		89.8		mg/Kg	90			80-120		
Thallium	200		201		mg/Kg	101			80-120		
Vanadium	200		198		mg/Kg	99			80-120		
Zinc	200		192		mg/Kg	96			80-120		

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1132687	Analyst: BradB	Method: EPA 6010B
Matrix: Solid	Analyzed: 12/28/2012	Instrument: AAICP (group)

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132687MS1, QC1132687MSD1												**Source: 315958-001**
Antimony	2.26	100	100	96.2	94.6	mg/Kg	94	92	1.7	75-125	20	
Arsenic	ND	100	100	104	102	mg/Kg	104	102	1.9	75-125	20	
Barium	79.3	100	100	202	186	mg/Kg	123	107	8.2	75-125	20	
Beryllium	0.8	100	100	105	94.9	mg/Kg	104	94	10.1	75-125	20	
Cadmium	0.7	100	100	103	94.6	mg/Kg	102	94	8.5	75-125	20	
Chromium	22.0	100	100	134	124	mg/Kg	112	102	7.8	75-125	20	
Cobalt	13.0	100	100	109	109	mg/Kg	96	96	0.0	75-125	20	
Copper	19.5	100	100	127	118	mg/Kg	108	99	7.3	75-125	20	
Lead	10.8	100	100	105	105	mg/Kg	94	94	0.0	75-125	20	
Molybdenum	ND	100	100	101	100	mg/Kg	101	100	1.0	75-125	20	
Nickel	15.0	100	100	113	113	mg/Kg	98	98	0.0	75-125	20	
Selenium	ND	100	100	85.7	88.4	mg/Kg	86	88	3.1	75-125	20	
Silver	ND	50	50	51.1	47.4	mg/Kg	102	95	7.5	75-125	20	
Thallium	ND	100	100	91.6	92.2	mg/Kg	92	92	0.7	75-125	20	
Vanadium	43.9	100	100	162	150	mg/Kg	118	106	7.7	75-125	20	
Zinc	60.4	100	100	152	151	mg/Kg	92	91	0.7	75-125	20	

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #311812

QCBatchID: QC1133004	**Analyst:** BradB	**Method:** EPA 7470A
Matrix: Solid	**Analyzed:** 01/10/2013	**Instrument:** AAICP-HG1

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1133004MB1						
Mercury	ND	mg/L		0.01		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1133004LCS1											
Mercury	100		101		ug/L	101			80-120		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1133004MS1, QC1133004MSD1												**Source: 311812-003**
Mercury	ND	100	100	108	110	ug/L	108	110	1.8	75-125	20	

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

Notes and Definitions

B	Analyte was present in an associated method blank. Associated sample data was reported with qualifier.
C	Laboratory Contamination.
D	The sample duplicate RPD was not within control limits, the sample data was reported without further clarification.
DF	Dilution Factor
DW	Sample result is calculated on a dry weigh basis
J	Reported value is estimated
L	The laboratory control sample (LCS) or laboratory control sample duplicate (LCSD) was out of control limits. Associated sample data was reported with qualifier.
M	The matrix spike (MS) or matrix spike duplicate (MSD) was not within control limits due to matrix interference. The associated LCS and/or LCSD was within control limits and the sample data was reported without further clarification.
MDL	Method Detection Limit
NC	The analyte concentration in the sample exceeded the spike level by a factor of four or greater, spike recovery and limits do not apply.
ND	Analyte was not detected or was less than the detection limit.
P	Sample was received without proper preservation according to EPA guidelines.
RDL	Reporting Detection Limit
S	The surrogate recovery was out of control limits due to matrix interference. The associated method blank surrogate recovery was within control limits and the sample data was reported without further clarification.
T	Sample was extracted/analyzed past the holding time.
T2	Sample was analyzed ASAP but received and analyzed past the 15 minute holding time.

Associated Laboratories
806 N. Batavia - Orange, CA 92868
Tel (714)771-6900 Fax (714)538-1209
www.associatedlabs.com
Info@associatedlabs.com

ACCREDITED IN ACCORDANCE WITH nelac
04232CA

Client: Battelle PNNL
Address: Battelle Boulevard, K7-84
P.O. Box 999
Richland, WA 99352-0999
Attn: Jason Tuenge

Lab Request: 313201
Report Date: 01/24/2013
Date Received: 11/02/2012

Client ID: 14171

This laboratory request covers the following listed samples which were analyzed for the parameters indicated on the attached Analytical Result Report. All analyses were conducted using the appropriate methods. Methods accredited by NELAC are indicated on the report. This cover letter is an integral part of the final report.

Sample #	Client Sample ID
313201-002	LED-04(c) A
313201-003	LED-04(c) B
313201-004	LED-04(c) C
313201-005	LED-04(c) D
313201-006	LED-04(c) E
313201-007	LED-04(c) F

Note of clarification by PNNL:
Replacement sample LED-4(a) was designated LED-04(c) here.

Thank you for the opportunity to be of service to your company. Please feel free to call if there are any questions regarding this report or if we can be of further service.

ASSOCIATED LABORATORIES by,

NINA PRASAD
Edward S. Behare, Ph.D.
Lab Director

NOTE: Unless notified in writing , all samples will be discarded by appropriate disposal protocol 45 days from date reported.

TESTING & CONSULTING
Chemical
Microbiological
Environmental

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** Client	
Sampled: 11/02/2012	**Site:**	**Notes:**	
Sample #: 313201-002	**Client Sample #:** LED-04(c) A		

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC*	**Prep Method:** EPA 1311/3010A					**QCBatchID:**	QC1132663
Barium	**3.11**	1	0.1	mg/L	12/27/12	nina	
Method: EPA 6010 *NELAC*	**Prep Method:** EPA 3050B					**QCBatchID:**	QC1131426
Antimony	ND	100	300	mg/Kg	11/16/12	kedy	
Arsenic	ND	100	100	mg/Kg	11/16/12	kedy	
Barium	**3690**	100	100	mg/Kg	11/16/12	kedy	
Beryllium	ND	100	50	mg/Kg	11/16/12	kedy	
Cadmium	ND	100	50	mg/Kg	11/16/12	kedy	
Chromium	ND	100	100	mg/Kg	11/16/12	kedy	
Cobalt	ND	100	50	mg/Kg	11/16/12	kedy	
Copper	**1820**	100	100	mg/Kg	11/16/12	kedy	
Lead	ND	100	50	mg/Kg	11/16/12	kedy	
Molybdenum	ND	100	100	mg/Kg	11/16/12	kedy	
Nickel	ND	100	150	mg/Kg	11/16/12	kedy	
Selenium	ND	100	100	mg/Kg	11/16/12	kedy	
Silver	ND	100	50	mg/Kg	11/16/12	kedy	
Thallium	ND	100	100	mg/Kg	11/16/12	kedy	
Vanadium	ND	100	50	mg/Kg	11/16/12	kedy	
Zinc	**1290**	100	500	mg/Kg	11/16/12	kedy	
Method: EPA 6010 *NELAC*	**Prep Method:** STLC					**QCBatchID:**	QC1132091
Barium	**4.85**	10	0.1	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC*	**Prep Method:** EPA 7471A					**QCBatchID:**	QC1131443
Mercury	ND	1	0.14	mg/Kg	11/16/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** Client
Sampled: 11/02/2012	**Site:**	**Notes:**
Sample #: 313201-003	**Client Sample #:** LED-04(c) B	

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1131426	
Antimony	ND	100	300	mg/Kg	11/16/12	kedy	
Arsenic	ND	100	100	mg/Kg	11/16/12	kedy	
Barium	ND	100	100	mg/Kg	11/16/12	kedy	
Beryllium	ND	100	50	mg/Kg	11/16/12	kedy	
Cadmium	ND	100	50	mg/Kg	11/16/12	kedy	
Chromium	ND	100	100	mg/Kg	11/16/12	kedy	
Cobalt	ND	100	50	mg/Kg	11/16/12	kedy	
Copper	**88300**	100	100	mg/Kg	11/16/12	kedy	
Lead	**58.1**	100	50	mg/Kg	11/16/12	kedy	
Molybdenum	ND	100	100	mg/Kg	11/16/12	kedy	
Nickel	**1960**	100	150	mg/Kg	11/16/12	kedy	
Selenium	**172**	100	100	mg/Kg	11/16/12	kedy	
Silver	ND	100	50	mg/Kg	11/16/12	kedy	
Thallium	ND	100	100	mg/Kg	11/16/12	kedy	
Vanadium	ND	100	50	mg/Kg	11/16/12	kedy	
Zinc	**49300**	100	500	mg/Kg	11/16/12	kedy	
Method: EPA 6010 *NELAC* **Prep Method:** STLC						**QCBatchID:** QC1132091	
Zinc	**188**	100	2	mg/L	12/10/12	nina	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1131443	
Mercury	ND	1	0.14	mg/Kg	11/16/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** Client	
Sampled: 11/02/2012	**Site:**	**Notes:**	
Sample #: 313201-004	**Client Sample #:** LED-04(c) C		

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1131426	
Antimony	ND	100	300	mg/Kg	11/16/12	kedy	
Arsenic	ND	100	100	mg/Kg	11/16/12	kedy	
Barium	**606**	100	100	mg/Kg	11/16/12	kedy	
Beryllium	ND	100	50	mg/Kg	11/16/12	kedy	
Cadmium	ND	100	50	mg/Kg	11/16/12	kedy	
Chromium	**646**	100	100	mg/Kg	11/16/12	kedy	
Cobalt	ND	100	50	mg/Kg	11/16/12	kedy	
Copper	**41700**	100	100	mg/Kg	11/16/12	kedy	
Lead	ND	100	50	mg/Kg	11/16/12	kedy	
Molybdenum	ND	100	100	mg/Kg	11/16/12	kedy	
Nickel	**252**	100	150	mg/Kg	11/16/12	kedy	
Selenium	**227**	100	100	mg/Kg	11/16/12	kedy	
Silver	**112**	100	50	mg/Kg	11/16/12	kedy	
Thallium	ND	100	100	mg/Kg	11/16/12	kedy	
Vanadium	ND	100	50	mg/Kg	11/16/12	kedy	
Zinc	ND	100	500	mg/Kg	11/16/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1131443	
Mercury	ND	1	0.14	mg/Kg	11/16/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid	**Client:** Battelle PNNL		**Collector:** Client
Sampled: 11/02/2012	**Site:**		**Notes:**
Sample #: 313201-005	**Client Sample #:** LED-04(c) D		

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1131426	
Antimony	ND	100	300	mg/Kg	11/16/12	kedy	
Arsenic	ND	100	100	mg/Kg	11/16/12	kedy	
Barium	**647**	100	100	mg/Kg	11/16/12	kedy	
Beryllium	ND	100	50	mg/Kg	11/16/12	kedy	
Cadmium	ND	100	50	mg/Kg	11/16/12	kedy	
Chromium	ND	100	100	mg/Kg	11/16/12	kedy	
Cobalt	ND	100	50	mg/Kg	11/16/12	kedy	
Copper	**396000**	100	100	mg/Kg	11/16/12	kedy	
Lead	ND	100	50	mg/Kg	11/16/12	kedy	
Molybdenum	ND	100	100	mg/Kg	11/16/12	kedy	
Nickel	**447**	100	150	mg/Kg	11/16/12	kedy	
Selenium	ND	100	100	mg/Kg	11/16/12	kedy	
Silver	**874**	100	50	mg/Kg	11/16/12	kedy	
Thallium	ND	100	100	mg/Kg	11/16/12	kedy	
Vanadium	ND	100	50	mg/Kg	11/16/12	kedy	
Zinc	**6870**	100	500	mg/Kg	11/16/12	kedy	
Method: EPA 6010 *NELAC* **Prep Method:** STLC						**QCBatchID:** QC1132091	
Silver	ND	10	0.05	mg/L	12/10/12	nina	B
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1131443	
Mercury	ND	1	0.14	mg/Kg	11/16/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** Client	
Sampled: 11/02/2012	**Site:**	**Notes:**	
Sample #: 313201-006	**Client Sample #:** LED-04(c) E		

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1131426	
Antimony	ND	1	3	mg/Kg	11/16/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/16/12	kedy	
Barium	**13.8**	1	1	mg/Kg	11/16/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/16/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/16/12	kedy	
Chromium	**1.65**	1	1	mg/Kg	11/16/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/16/12	kedy	
Copper	**275**	1	1	mg/Kg	11/16/12	kedy	
Lead	**1.0**	1	0.5	mg/Kg	11/16/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/16/12	kedy	
Nickel	**8.11**	1	1.5	mg/Kg	11/16/12	kedy	
Selenium	**1.10**	1	1	mg/Kg	11/16/12	kedy	
Silver	**2.23**	1	0.5	mg/Kg	11/16/12	kedy	
Thallium	ND	1	1	mg/Kg	11/16/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/16/12	kedy	
Zinc	**104**	1	5	mg/Kg	11/16/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1131443	
Mercury	ND	1	0.14	mg/Kg	11/16/12	BradB	

ND = Not Detected or < RDL **RDL = Reporting Detection Limit DF = Dilution Factor**

Matrix: Solid	**Client:** Battelle PNNL	**Collector:** Client	
Sampled: 11/02/2012	**Site:**	**Notes:**	
Sample #: 313201-007	**Client Sample #:** LED-04(c) F		

Analyte	Result	DF	RDL	Units	Analyzed	By	Notes
Method: EPA 6010 *NELAC* **Prep Method:**						**QCBatchID:** QC1131426	
Antimony	**401**	1	3	mg/Kg	11/16/12	kedy	
Arsenic	ND	1	1	mg/Kg	11/16/12	kedy	
Barium	**10.5**	1	1	mg/Kg	11/16/12	kedy	
Beryllium	ND	1	0.5	mg/Kg	11/16/12	kedy	
Cadmium	ND	1	0.5	mg/Kg	11/16/12	kedy	
Chromium	**1.71**	1	1	mg/Kg	11/16/12	kedy	
Cobalt	ND	1	0.5	mg/Kg	11/16/12	kedy	
Copper	**27.8**	1	1	mg/Kg	11/16/12	kedy	
Lead	ND	1	0.5	mg/Kg	11/16/12	kedy	
Molybdenum	ND	1	1	mg/Kg	11/16/12	kedy	
Nickel	ND	1	1.5	mg/Kg	11/16/12	kedy	
Selenium	**1.33**	1	1	mg/Kg	11/16/12	kedy	
Silver	ND	1	0.5	mg/Kg	11/16/12	kedy	
Thallium	ND	1	1	mg/Kg	11/16/12	kedy	
Vanadium	ND	1	0.5	mg/Kg	11/16/12	kedy	
Zinc	**24.7**	1	5	mg/Kg	11/16/12	kedy	
Method: EPA 7471 *NELAC* **Prep Method:**						**QCBatchID:** QC1131443	
Mercury	ND	1	0.14	mg/Kg	11/16/12	BradB	

ND = Not Detected or < RDL

RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #313201

QCBatchID: QC1131426	**Analyst:** metha	**Method:** EPA 6010B
Matrix: Solid	**Analyzed:** 11/14/2012	**Instrument:** AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes
QC1131426MB1					
Antimony	ND	mg/Kg		3	
Arsenic	ND	mg/Kg		1	
Barium	ND	mg/Kg		1	
Beryllium	ND	mg/Kg		0.5	
Cadmium	ND	mg/Kg		0.5	
Chromium	ND	mg/Kg		1	
Cobalt	ND	mg/Kg		0.5	
Copper	ND	mg/Kg		1	
Lead	ND	mg/Kg		0.5	
Molybdenum	ND	mg/Kg		1	
Nickel	ND	mg/Kg		1.5	
Selenium	ND	mg/Kg		1	
Silver	ND	mg/Kg		0.5	
Thallium	ND	mg/Kg		1	
Vanadium	ND	mg/Kg		0.5	
Zinc	ND	mg/Kg		5	

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1131426LCS1											
Antimony	200		210		mg/Kg	105			80-120		
Arsenic	200		212		mg/Kg	106			80-120		
Barium	200		219		mg/Kg	110			80-120		
Beryllium	200		198		mg/Kg	99			80-120		
Cadmium	200		214		mg/Kg	107			80-120		
Chromium	200		224		mg/Kg	112			80-120		
Cobalt	200		213		mg/Kg	107			80-120		
Copper	200		209		mg/Kg	105			80-120		
Lead	200		216		mg/Kg	108			80-120		
Molybdenum	200		211		mg/Kg	106			80-120		
Nickel	200		216		mg/Kg	108			80-120		
Selenium	200		197		mg/Kg	99			80-120		
Silver	100		83.6		mg/Kg	84			80-120		
Thallium	200		211		mg/Kg	106			80-120		
Vanadium	200		220		mg/Kg	110			80-120		
Zinc	200		214		mg/Kg	107			80-120		

ND = Not Detected or < RDL **MDL = Method Detection Limit** **RDL = Reporting Detection Limit** **DF = Dilution Factor**

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #313201

QCBatchID: QC1131426	**Analyst:** metha	**Method:** EPA 6010B
Matrix: Solid	**Analyzed:** 11/14/2012	**Instrument:** AAICP (group)

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1131426MS1, QC1131426MSD1											**Source: 313613-001**	
Antimony	ND	100	100	77.7	75.9	mg/Kg	78	76	2.3	75-125	20	
Arsenic	ND	100	100	102	96.8	mg/Kg	102	97	5.2	75-125	20	
Barium	75.6	100	100	195	186	mg/Kg	114	105	4.7	75-125	20	
Beryllium	0.6	100	100	98.7	95.8	mg/Kg	98	95	3.0	75-125	20	
Cadmium	0.5	100	100	101	98.5	mg/Kg	100	98	2.5	75-125	20	
Chromium	16.0	100	100	122	119	mg/Kg	105	102	2.5	75-125	20	
Cobalt	9.02	100	100	104	100	mg/Kg	95	91	3.9	75-125	20	
Copper	11.6	100	100	111	107	mg/Kg	99	95	3.7	75-125	20	
Lead	3.84	100	100	103	99.3	mg/Kg	99	95	3.7	75-125	20	
Molybdenum	1.11	100	100	95.9	92.1	mg/Kg	95	91	4.0	75-125	20	
Nickel	11.1	100	100	106	102	mg/Kg	95	91	3.8	75-125	20	
Selenium	ND	100	100	82.8	78.2	mg/Kg	83	78	5.7	75-125	20	
Silver	ND	50	50	6.00	6.00	mg/Kg	12	12	0.0	75-125	20	M
Thallium	ND	100	100	86.7	82.4	mg/Kg	87	82	5.1	75-125	20	
Vanadium	31.9	100	100	143	140	mg/Kg	109	106	2.1	75-125	20	
Zinc	52.9	100	100	155	156	mg/Kg	98	99	0.6	75-125	20	

ND = Not Detected or < RDL **MDL = Method Detection Limit** **RDL = Reporting Detection Limit** **DF = Dilution Factor**

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #313201

QCBatchID: QC1131443	**Analyst:** BradB	**Method:** EPA 7471A
Matrix: Solid	**Analyzed:** 11/15/2012	**Instrument:** AAICP-HG1

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1131443MB1						
Mercury	ND	mg/Kg		0.14		

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1131443LCS1											
Mercury	0.83		0.87		mg/Kg	105			80-120		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1131443MS1, QC1131443MSD1												**Source: 313522-001**
Mercury	0.80	0.83	0.83	1.96	1.87	mg/Kg	140	129	4.7	75-125	20	M

ND = Not Detected or < RDL **MDL = Method Detection Limit** **RDL = Reporting Detection Limit** **DF = Dilution Factor**

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #313201

QCBatchID: QC1132091	Analyst: metha	Method: EPA 6010B
Matrix: Solid	Analyzed: 12/07/2012	Instrument: AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes	
QC1132091MB1						
Antimony	ND	mg/L		0.03		
Arsenic	ND	mg/L		0.01		
Barium	0.016	mg/L		0.01		
Beryllium	ND	mg/L		0.005		
Cadmium	ND	mg/L		0.005		
Chromium	0.012	mg/L		0.01		
Cobalt	ND	mg/L		0.005		
Copper	ND	mg/L		0.01		
Lead	ND	mg/L		0.005		
Molybdenum	ND	mg/L		0.01		
Nickel	ND	mg/L		0.02		
Selenium	ND	mg/L		0.01		
Silver	ND	mg/L		0.005		
Thallium	ND	mg/L		0.005		
Vanadium	0.016	mg/L		0.005		
Zinc	0.028	mg/L		0.02		

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132091MS1, QC1132091MSD1												**Source: 311812-031**
Antimony	1.414	10	10	9.99	10.1	mg/L	86	87	1.1	75-125	20	
Arsenic	0.103	10	10	9.85	9.90	mg/L	97	98	0.5	75-125	20	
Barium	0.432	10	10	9.71	9.46	mg/L	93	90	2.6	75-125	20	
Beryllium	ND	10	10	9.55	10.1	mg/L	96	101	5.6	75-125	20	
Cadmium	ND	10	10	9.12	8.86	mg/L	91	89	2.9	75-125	20	
Chromium	0.044	10	10	9.25	9.08	mg/L	92	90	1.9	75-125	20	
Cobalt	0.116	10	10	8.45	8.49	mg/L	83	84	0.5	75-125	20	
Copper	0.309	10	10	8.78	8.58	mg/L	85	83	2.3	75-125	20	
Lead	ND	10	10	8.02	8.16	mg/L	80	82	1.7	75-125	20	
Molybdenum	0.062	10	10	8.92	8.96	mg/L	89	89	0.4	75-125	20	
Nickel	0.289	10	10	8.66	8.45	mg/L	84	82	2.5	75-125	20	
Selenium	0.074	10	10	9.57	9.77	mg/L	95	97	2.1	75-125	20	
Silver	0.172	5	5	5.32	5.07	mg/L	103	98	4.8	75-125	20	
Thallium	ND	10	10	7.93	7.98	mg/L	79	80	0.6	75-125	20	
Vanadium	ND	10	10	9.38	9.16	mg/L	94	92	2.4	75-125	20	
Zinc	1.799	10	10	11.2	10.9	mg/L	94	91	2.7	75-125	20	

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #313201

QCBatchID: QC1132663 **Analyst:** metha **Method:** EPA 6010B
Matrix: Solid **Analyzed:** 12/27/2012 **Instrument:** AAICP (group)

Blank Summary

Analyte	Blank Result	Units		RDL	Notes
QC1132663MB1					
Antimony	ND	mg/L		0.05	
Arsenic	ND	mg/L		0.05	
Barium	ND	mg/L		0.1	
Beryllium	ND	mg/L		0.05	
Cadmium	ND	mg/L		0.05	
Chromium	ND	mg/L		0.05	
Cobalt	ND	mg/L		0.05	
Copper	ND	mg/L		0.05	
Lead	ND	mg/L		0.05	
Molybdenum	ND	mg/L		0.05	
Nickel	ND	mg/L		0.05	
Selenium	ND	mg/L		0.05	
Silver	ND	mg/L		0.05	
Thallium	ND	mg/L		0.05	
Vanadium	ND	mg/L		0.05	
Zinc	ND	mg/L		0.05	

Lab Control Spike/ Lab Control Spike Duplicate Summary

Analyte	Spike Amount LCS	Spike Amount LCSD	Spike Result LCS	Spike Result LCSD	Units	Recoveries LCS	Recoveries LCSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132663LCS1											
Antimony	2		1.76		mg/L	88			80-120		
Arsenic	2		2.04		mg/L	102			80-120		
Barium	2		1.832		mg/L	92			80-120		
Beryllium	2		1.72		mg/L	86			80-120		
Cadmium	2		1.911		mg/L	96			80-120		
Chromium	2		1.804		mg/L	90			80-120		
Cobalt	2		1.74		mg/L	87			80-120		
Copper	2		1.69		mg/L	85			80-120		
Lead	2		1.795		mg/L	90			80-120		
Molybdenum	2		1.80		mg/L	90			80-120		
Nickel	2		1.79		mg/L	90			80-120		
Selenium	2		2.03		mg/L	102			80-120		
Silver	1		0.886		mg/L	89			80-120		
Thallium	2		1.65		mg/L	83			80-120		
Vanadium	2		1.83		mg/L	92			80-120		
Zinc	2		1.979		mg/L	99			80-120		

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

ASSOCIATED LABORATORIES QC SUMMARY FOR LAB REQUEST #313201

QCBatchID: QC1132663	**Analyst:** metha	**Method:** EPA 6010B
Matrix: Solid	**Analyzed:** 12/27/2012	**Instrument:** AAICP (group)

Matrix Spike/Matrix Spike Duplicate Summary

Analyte	Sample Amount	Spike Amount MS	Spike Amount MSD	Spike Result MS	Spike Result MSD	Units	Recoveries MS	Recoveries MSD	RPD	Limits %Rec	Limits RPD	Notes
QC1132663MS1, QC1132663MSD1												**Source: 315856-001**
Antimony	ND	1	1	0.903	0.884	mg/L	90	88	2.1	75-125	20	
Arsenic	0.014	1	1	1.092	1.077	mg/L	108	106	1.4	75-125	20	
Barium	0.268	1	1	1.122	1.072	mg/L	85	80	4.6	75-125	20	
Beryllium	ND	1	1	0.970	0.915	mg/L	97	92	5.8	75-125	20	
Cadmium	ND	1	1	0.980	0.919	mg/L	98	92	6.4	75-125	20	
Chromium	0.020	1	1	0.954	0.896	mg/L	93	88	6.3	75-125	20	
Cobalt	0.003	1	1	0.905	0.852	mg/L	90	85	6.0	75-125	20	
Copper	1.00	1	1	1.99	1.87	mg/L	99	87	6.2	75-125	20	
Lead	ND	1	1	0.917	0.895	mg/L	92	90	2.4	75-125	20	
Molybdenum	ND	1	1	0.922	0.904	mg/L	92	90	2.0	75-125	20	
Nickel	1.08	1	1	2.09	1.96	mg/L	101	88	6.4	75-125	20	
Selenium	ND	1	1	1.017	0.966	mg/L	102	97	5.1	75-125	20	
Silver	ND	0.5	0.5	0.458	0.434	mg/L	92	87	5.4	75-125	20	
Thallium	ND	1	1	0.834	0.815	mg/L	83	82	2.3	75-125	20	
Vanadium	ND	1	1	0.955	0.910	mg/L	96	91	4.8	75-125	20	
Zinc	13.2	1	1	15.9	14.9	mg/L	270	170	6.5	75-125	20	NC

ND = Not Detected or < RDL MDL = Method Detection Limit RDL = Reporting Detection Limit DF = Dilution Factor

Notes and Definitions

B	Analyte was present in an associated method blank. Associated sample data was reported with qualifier.
C	Laboratory Contamination.
D	The sample duplicate RPD was not within control limits, the sample data was reported without further clarification.
DF	Dilution Factor
DW	Sample result is calculated on a dry weigh basis
J	Reported value is estimated
L	The laboratory control sample (LCS) or laboratory control sample duplicate (LCSD) was out of control limits. Associated sample data was reported with qualifier.
M	The matrix spike (MS) or matrix spike duplicate (MSD) was not within control limits due to matrix interference. The associated LCS and/or LCSD was within control limits and the sample data was reported without further clarification.
MDL	Method Detection Limit
NC	The analyte concentration in the sample exceeded the spike level by a factor of four or greater, spike recovery and limits do not apply.
ND	Analyte was not detected or was less than the detection limit.
P	Sample was received without proper preservation according to EPA guidelines.
RDL	Reporting Detection Limit
S	The surrogate recovery was out of control limits due to matrix interference. The associated method blank surrogate recovery was within control limits and the sample data was reported without further clarification.
T	Sample was extracted/analyzed past the holding time.
T2	Sample was analyzed ASAP but received and analyzed past the 15 minute holding time.

Appendix D: Lab B Original Test Data

The following pages contain original test data from Lab B. Product photos and weights were provided in separate files and spreadsheets; see Appendix B.

E.S.BABCOCK&Sons,Inc.
Environmental Laboratories est 1906

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

The lamps submitted for this project were each disassembled into major component subsections. These subsections were identified as subsections A through F, following the protocol described in the PNNL LED Test Specification: STATEMENT OF WORK Contract No. 176398 Destructive Testing of Lighting Products to Assess Hazardous Metals Content.

A. Homogeneous metal components
B. Homogeneous plastic components
C. Homogeneous glass components
D. Electronic circuit boards (Drivers), including wires, semiconductor devices and other components, except LEDs.
E. Light-emitting diode (LED) "packages" Battelle did not request disassembly of this unit.
F. Remaining materials after removing A.-E.

The weights of the lamps before disassembly and the weights of each subsection after disassembly were recorded.

Total metals were determined by acid digestion of a portion the subsection using EPA Method 3050B. Extractable metals were determined using the California Waste Extraction Test Procedure (WET) described in California Code of Regulations, Title 22, Division 4.5, Chapter 11, Appendix II and EPA Method 1311, Toxicity Characteristic Leaching Procedure. The extractable analyses were not determined on every subcomponent, but were determined on those subcomponents selected by PNNL after consultation with Babcock Laboratories.

Because of the limited amount of sample available after disassembly, the WET and TCLP analyses were modifications of the published methods. The modification entailed using a reduced amount of material. The WET specifies 50 grams and the TCLP specifies 100 grams.

Each subsection was milled to pass a 2mm sieve, as specified in the WET method. This particle size also meets the requirement for the TCLP (which is < 9.5 mm). However, this size reduction procedure did not appear to be adequate to thoroughly homogenize the multi-component drivers. Due to poor homogenization and limited sample size, preliminary results indicated that non-representative subsampling for the drivers was occurring. It was decided that a larger sample size would provide a more representative subsample.

In order to obtain the largest available subsample for both the driver and the LED, the remaining portions of subcomponents LED-4(b): D, LED-4(b): E, LED 3(b): D and LED 3(b): E were first extracted using the WET procedure and then brought through the total acid digest (EPA 3050B) procedure. The metal content derived from each procedure was mathematically combined for each subcomponent, respectively, to obtain the total metal concentrations used to compare against the TTLC.

The results for these analyses are presented in this report.

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

INC-1(b): A-1

B2I0463-01

Total Metals

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020	ND	10	mg/kg	10/03/2012	KRV	
Arsenic	EPA 6020	ND	10	mg/kg	10/03/2012	KRV	
Barium	EPA 6020	ND	10	mg/kg	10/03/2012	KRV	
Beryllium	EPA 6020	ND	5.0	mg/kg	10/03/2012	KRV	
Cadmium	EPA 6020	ND	5.0	mg/kg	10/03/2012	KRV	
Cobalt	EPA 6020	ND	10	mg/kg	10/03/2012	KRV	
Copper	EPA 6020	46	10	mg/kg	10/03/2012	KRV	
Lead	EPA 6020	ND	10	mg/kg	10/03/2012	KRV	
Mercury	EPA 200.8	ND	0.20	mg/kg	10/03/2012	KRV	
Molybdenum	EPA 6020	ND	10	mg/kg	10/03/2012	KRV	
Nickel	EPA 6020	20	10	mg/kg	10/03/2012	KRV	
Selenium	EPA 6020	ND	10	mg/kg	10/03/2012	KRV	
Silver	EPA 6020	ND	10	mg/kg	10/03/2012	KRV	
Thallium	EPA 6020	ND	50	mg/kg	10/03/2012	KRV	
Total Chromium	EPA 6020	25	10	mg/kg	10/05/2012	KRV	
Vanadium	EPA 6020	69	10	mg/kg	10/03/2012	KRV	
Zinc	EPA 6020	55	10	mg/kg	10/03/2012	KRV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

INC-1(b): A-2

B2I0463-02

Total Metals

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Arsenic	EPA 6020	11	10	mg/kg	10/04/2012	KRV	
Barium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Beryllium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cadmium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cobalt	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Copper	EPA 6020	470000	10000	mg/kg	10/04/2012	KRV	
Lead	EPA 6020	10	10	mg/kg	10/04/2012	KRV	
Mercury	EPA 200.8	ND	0.20	mg/kg	10/04/2012	KRV	
Molybdenum	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Nickel	EPA 6020	82000	10000	mg/kg	10/04/2012	KRV	
Selenium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Silver	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Thallium	EPA 6020	ND	50	mg/kg	10/04/2012	KRV	
Total Chromium	EPA 6020	56	10	mg/kg	10/05/2012	KRV	
Vanadium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Zinc	EPA 6020	46	10	mg/kg	10/04/2012	KRV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

INC-1(b): A-2

B2J2282-01

California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020A	ND	1.5	mg/L	10/24/2012	AAV	
Arsenic	EPA 6020A	ND	0.50	mg/L	10/24/2012	AAV	
Barium	EPA 6020A	ND	10	mg/L	10/24/2012	AAV	
Beryllium	EPA 6020A	ND	0.50	mg/L	10/24/2012	AAV	N_RLdil
Cadmium	EPA 6020A	ND	0.50	mg/L	10/24/2012	AAV	N_RLdil
Cobalt	EPA 6020A	ND	8.0	mg/L	10/24/2012	AAV	
Copper	EPA 6020A	20	2.5	mg/L	10/24/2012	AAV	
Lead	EPA 6020A	ND	0.50	mg/L	10/24/2012	AAV	
Mercury	EPA 6020A	ND	0.23	mg/L	10/24/2012	aav	N_RLdil
Molybdenum	EPA 6020A	ND	150	mg/L	10/24/2012	AAV	N_RLdil
Nickel	EPA 6020A	12	2.0	mg/L	10/24/2012	AAV	
Selenium	EPA 6020A	ND	0.75	mg/L	10/24/2012	AAV	N_RLdil
Silver	EPA 6020	ND	0.50	mg/L	10/24/2012	AAV	
Thallium	EPA 6020A	ND	0.70	mg/L	10/24/2012	AAV	
Total Chromium	EPA 6020A	ND	2.5	mg/L	10/24/2012	AAV	N_RLdil
Vanadium	EPA 6020A	ND	2.4	mg/L	10/24/2012	AAV	
Zinc	EPA 6020A	ND	25	mg/L	10/24/2012	AAV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

INC-1(b): B

B2I0463-03

Total Metals

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Arsenic	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Barium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Beryllium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cadmium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cobalt	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Copper	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Lead	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Mercury	EPA 200.8	ND	0.20	mg/kg	10/04/2012	KRV	
Molybdenum	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Nickel	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Selenium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Silver	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Thallium	EPA 6020	ND	50	mg/kg	10/04/2012	KRV	
Total Chromium	EPA 6020	ND	10	mg/kg	10/05/2012	KRV	
Vanadium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Zinc	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

INC-1(b): C

B2I0463-04

Total Metals

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Arsenic	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Barium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Beryllium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cadmium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cobalt	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Copper	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Lead	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Mercury	EPA 200.8	0.69	0.20	mg/kg	10/04/2012	KRV	
Molybdenum	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Nickel	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Selenium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Silver	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Thallium	EPA 6020	ND	50	mg/kg	10/04/2012	KRV	
Total Chromium	EPA 6020	ND	10	mg/kg	10/05/2012	KRV	
Vanadium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Zinc	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

INC-1(b): F

B2I0463-05

Total Metals

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Arsenic	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Barium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Beryllium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cadmium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cobalt	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Copper	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Lead	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Mercury	EPA 200.8	ND	0.20	mg/kg	10/04/2012	KRV	
Molybdenum	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Nickel	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Selenium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Silver	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Thallium	EPA 6020	ND	50	mg/kg	10/04/2012	KRV	
Total Chromium	EPA 6020	ND	10	mg/kg	10/05/2012	KRV	
Vanadium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Zinc	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

LED-3(b): A

B2I0463-11

Total Metals

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Arsenic	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Barium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Beryllium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cadmium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cobalt	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Copper	EPA 6020	19000	1000	mg/kg	10/04/2012	KRV	
Lead	EPA 6020	640	10	mg/kg	10/04/2012	KRV	
Mercury	EPA 200.8	ND	0.20	mg/kg	10/04/2012	KRV	
Molybdenum	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Nickel	EPA 6020	540	10	mg/kg	10/04/2012	KRV	
Selenium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Silver	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Thallium	EPA 6020	ND	50	mg/kg	10/04/2012	KRV	
Total Chromium	EPA 6020	520	10	mg/kg	10/05/2012	KRV	
Vanadium	EPA 6020	100	10	mg/kg	10/04/2012	KRV	
Zinc	EPA 6020	10000	1000	mg/kg	10/04/2012	KRV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

LED-3(b): A

B2J2282-04 — **California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics**

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020A	ND	1.5	mg/L	10/24/2012	AAV	
Arsenic	EPA 6020A	ND	0.50	mg/L	10/24/2012	AAV	
Barium	EPA 6020A	ND	10	mg/L	10/24/2012	AAV	
Beryllium	EPA 6020A	ND	0.075	mg/L	10/24/2012	AAV	
Cadmium	EPA 6020A	ND	0.10	mg/L	10/24/2012	AAV	
Cobalt	EPA 6020A	ND	8.0	mg/L	10/24/2012	AAV	
Copper	EPA 6020A	ND	2.5	mg/L	10/24/2012	AAV	
Lead	EPA 6020A	ND	0.50	mg/L	10/24/2012	AAV	
Mercury	EPA 6020A	ND	0.020	mg/L	10/24/2012	aav	
Molybdenum	EPA 6020A	ND	35	mg/L	10/24/2012	AAV	
Nickel	EPA 6020A	ND	2.0	mg/L	10/24/2012	AAV	
Selenium	EPA 6020A	ND	0.20	mg/L	10/24/2012	AAV	N_RLdil
Silver	EPA 6020	ND	0.50	mg/L	10/24/2012	AAV	
Thallium	EPA 6020A	ND	0.70	mg/L	10/24/2012	AAV	
Total Chromium	EPA 6020A	1.3	0.50	mg/L	10/24/2012	AAV	
Vanadium	EPA 6020A	ND	2.4	mg/L	10/24/2012	AAV	
Zinc	EPA 6020A	26	25	mg/L	10/24/2012	AAV	

B2K0209-03 — **Toxicity Characteristic Leaching Procedure (EPA Method 1311); Metals**

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Arsenic	EPA 6020A	ND	0.50	mg/L	11/14/2012	AAV	
Barium	EPA 6020A	ND	10	mg/L	11/14/2012	AAV	
Cadmium	EPA 6020A	ND	0.10	mg/L	11/14/2012	AAV	
Lead	EPA 6020A	2.9	0.50	mg/L	11/14/2012	AAV	
Mercury	EPA 7470A	ND	0.020	mg/L	11/15/2012	SS	N_HTu
Selenium	EPA 6020A	ND	0.10	mg/L	11/14/2012	AAV	
Silver	EPA 6020A	ND	0.50	mg/L	11/14/2012	AAV	
Total Chromium	EPA 6020A	0.54	0.50	mg/L	11/14/2012	AAV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

LED-3(b): B

B2I0463-12

Total Metals

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020	990	10	mg/kg	10/04/2012	KRV	
Arsenic	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Barium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Beryllium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cadmium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cobalt	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Copper	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Lead	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Mercury	EPA 200.8	ND	0.20	mg/kg	10/04/2012	KRV	
Molybdenum	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Nickel	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Selenium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Silver	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Thallium	EPA 6020	ND	50	mg/kg	10/04/2012	KRV	
Total Chromium	EPA 6020	ND	10	mg/kg	10/05/2012	KRV	
Vanadium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Zinc	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

LED-3(b): B

B2J2282-05

California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020A	5.1	1.5	mg/L	10/24/2012	AAV	
Arsenic	EPA 6020A	ND	0.50	mg/L	10/24/2012	AAV	
Barium	EPA 6020A	ND	10	mg/L	10/24/2012	AAV	
Beryllium	EPA 6020A	ND	0.075	mg/L	10/24/2012	AAV	
Cadmium	EPA 6020A	ND	0.10	mg/L	10/24/2012	AAV	
Cobalt	EPA 6020A	ND	8.0	mg/L	10/24/2012	AAV	
Copper	EPA 6020A	ND	2.5	mg/L	10/24/2012	AAV	
Lead	EPA 6020A	ND	0.50	mg/L	10/24/2012	AAV	
Mercury	EPA 6020A	ND	0.020	mg/L	10/24/2012	aav	
Molybdenum	EPA 6020A	ND	35	mg/L	10/24/2012	AAV	
Nickel	EPA 6020A	ND	2.0	mg/L	10/24/2012	AAV	
Selenium	EPA 6020A	ND	0.20	mg/L	10/24/2012	AAV	N_RLdil
Silver	EPA 6020	ND	0.50	mg/L	10/24/2012	AAV	
Thallium	EPA 6020A	ND	0.70	mg/L	10/24/2012	AAV	
Total Chromium	EPA 6020A	ND	0.50	mg/L	10/24/2012	AAV	
Vanadium	EPA 6020A	ND	2.4	mg/L	10/24/2012	AAV	
Zinc	EPA 6020A	ND	25	mg/L	10/24/2012	AAV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

LED-3(b): D

B2K2555-05

Total Metals

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020	350	100	mg/kg	12/12/2012	AAV	
Arsenic	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Barium	EPA 6020	4600	500	mg/kg	12/12/2012	AAV	
Beryllium	EPA 6020	ND	5.0	mg/kg	12/06/2012	krv	
Cadmium	EPA 6020	ND	5.0	mg/kg	12/06/2012	krv	
Cobalt	EPA 6020	56	10	mg/kg	12/06/2012	krv	
Copper	EPA 6020	200000	100	mg/kg	12/06/2012	krv	NOcal
Lead	EPA 6020	990	10	mg/kg	12/06/2012	krv	
Mercury	EPA 200.8	ND	2.0	mg/kg	12/06/2012	AAV	
Molybdenum	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Nickel	EPA 6020	5800	100	mg/kg	12/06/2012	krv	
Selenium	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Silver	EPA 6020	170	10	mg/kg	12/06/2012	krv	
Thallium	EPA 6020	ND	50	mg/kg	12/06/2012	krv	
Total Chromium	EPA 6020	27	10	mg/kg	12/06/2012	krv	
Vanadium	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Zinc	EPA 6020	11000	500	mg/kg	12/12/2012	AAV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

LED-3(b): D

B2K2555-06 **California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics**

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020A	3.7	1.5	mg/L	12/06/2012	krv	
Arsenic	EPA 6020A	ND	0.50	mg/L	12/06/2012	krv	
Barium	EPA 6020A	16	10	mg/L	12/06/2012	krv	
Beryllium	EPA 6020A	ND	0.075	mg/L	12/06/2012	krv	
Cadmium	EPA 6020A	ND	0.10	mg/L	12/06/2012	krv	NMout
Cobalt	EPA 6020A	ND	8.0	mg/L	12/06/2012	krv	
Copper	EPA 6020A	ND	2.5	mg/L	12/06/2012	krv	
Lead	EPA 6020A	9.0	0.50	mg/L	12/06/2012	krv	
Mercury	EPA 7470A	ND	0.010	mg/L	12/06/2012	SS	
Molybdenum	EPA 6020A	ND	35	mg/L	12/06/2012	krv	NMout
Nickel	EPA 6020A	14	2.0	mg/L	12/06/2012	krv	
Selenium	EPA 6020A	ND	0.10	mg/L	12/06/2012	krv	
Silver	EPA 6020	ND	0.50	mg/L	12/06/2012	krv	NMout
Thallium	EPA 6020A	ND	0.70	mg/L	12/06/2012	krv	
Total Chromium	EPA 6020A	ND	0.50	mg/L	12/06/2012	krv	
Vanadium	EPA 6020A	ND	2.4	mg/L	12/06/2012	krv	
Zinc	EPA 6020A	380	25	mg/L	12/07/2012	krv	

B2K0209-04 **Toxicity Characteristic Leaching Procedure (EPA Method 1311); Metals**

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Arsenic	EPA 6020A	ND	0.50	mg/L	11/14/2012	AAV	
Barium	EPA 6020A	ND	10	mg/L	11/14/2012	AAV	
Cadmium	EPA 6020A	ND	0.10	mg/L	11/14/2012	AAV	
Lead	EPA 6020A	11	0.50	mg/L	11/14/2012	AAV	
Mercury	EPA 7470A	ND	0.020	mg/L	11/15/2012	SS	N_HTu
Selenium	EPA 6020A	ND	0.10	mg/L	11/14/2012	AAV	
Silver	EPA 6020A	ND	0.50	mg/L	11/14/2012	AAV	
Total Chromium	EPA 6020A	ND	0.50	mg/L	11/14/2012	AAV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

LED-3(b): E

B2K2555-07

Total Metals

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Arsenic	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Barium	EPA 6020	110	10	mg/kg	12/06/2012	krv	
Beryllium	EPA 6020	ND	5.0	mg/kg	12/06/2012	krv	
Cadmium	EPA 6020	ND	5.0	mg/kg	12/06/2012	krv	
Cobalt	EPA 6020	15	10	mg/kg	12/06/2012	krv	
Copper	EPA 6020	67000	160	mg/kg	12/07/2012	krv	
Lead	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Mercury	EPA 200.8	ND	2.0	mg/kg	12/06/2012	AAV	
Molybdenum	EPA 6020	39	11	mg/kg	12/06/2012	krv	
Nickel	EPA 6020	100	10	mg/kg	12/06/2012	krv	
Selenium	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Silver	EPA 6020	42	10	mg/kg	12/06/2012	krv	
Thallium	EPA 6020	ND	50	mg/kg	12/06/2012	krv	
Total Chromium	EPA 6020	57	11	mg/kg	12/06/2012	krv	
Vanadium	EPA 6020	19	10	mg/kg	12/06/2012	krv	
Zinc	EPA 6020	99	13	mg/kg	12/06/2012	krv	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

LED-3(b): E

B2K2555-08

California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020A	ND	1.5	mg/L	12/06/2012	krv	
Arsenic	EPA 6020A	ND	0.50	mg/L	12/06/2012	krv	
Barium	EPA 6020A	ND	10	mg/L	12/06/2012	krv	
Beryllium	EPA 6020A	ND	0.075	mg/L	12/06/2012	krv	
Cadmium	EPA 6020A	ND	0.10	mg/L	12/06/2012	krv	
Cobalt	EPA 6020A	ND	8.0	mg/L	12/06/2012	krv	
Copper	EPA 6020A	3800	5.0	mg/L	12/07/2012	krv	
Lead	EPA 6020A	ND	0.50	mg/L	12/06/2012	krv	
Mercury	EPA 7470A	ND	0.010	mg/L	12/06/2012	SS	
Molybdenum	EPA 6020A	ND	35	mg/L	12/06/2012	krv	
Nickel	EPA 6020A	6.0	2.0	mg/L	12/06/2012	krv	
Selenium	EPA 6020A	ND	0.15	mg/L	12/06/2012	krv	
Silver	EPA 6020	ND	0.50	mg/L	12/06/2012	krv	
Thallium	EPA 6020A	ND	0.70	mg/L	12/06/2012	krv	
Total Chromium	EPA 6020A	5.3	0.50	mg/L	12/06/2012	krv	
Vanadium	EPA 6020A	ND	2.4	mg/L	12/06/2012	krv	
Zinc	EPA 6020A	ND	25	mg/L	12/06/2012	krv	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

LED-3(b): F

B2I0463-15

Total Metals

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Arsenic	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Barium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Beryllium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cadmium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cobalt	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Copper	EPA 6020	25	10	mg/kg	10/04/2012	KRV	
Lead	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Mercury	EPA 200.8	ND	0.20	mg/kg	10/04/2012	KRV	
Molybdenum	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Nickel	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Selenium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Silver	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Thallium	EPA 6020	ND	50	mg/kg	10/04/2012	KRV	
Total Chromium	EPA 6020	ND	10	mg/kg	10/05/2012	KRV	
Vanadium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Zinc	EPA 6020	14	10	mg/kg	10/04/2012	KRV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

LED-4(b): A

B2I0463-06

Total Metals

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Arsenic	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Barium	EPA 6020	1400	100	mg/kg	10/04/2012	KRV	
Beryllium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cadmium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cobalt	EPA 6020	61	10	mg/kg	10/04/2012	KRV	
Copper	EPA 6020	9900	100	mg/kg	10/04/2012	KRV	
Lead	EPA 6020	160	10	mg/kg	10/04/2012	KRV	
Mercury	EPA 200.8	ND	0.20	mg/kg	10/04/2012	KRV	
Molybdenum	EPA 6020	25	10	mg/kg	10/04/2012	KRV	
Nickel	EPA 6020	2300	100	mg/kg	10/04/2012	KRV	
Selenium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Silver	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Thallium	EPA 6020	ND	50	mg/kg	10/04/2012	KRV	
Total Chromium	EPA 6020	6200	100	mg/kg	10/05/2012	KRV	
Vanadium	EPA 6020	61	10	mg/kg	10/04/2012	KRV	
Zinc	EPA 6020	4000	100	mg/kg	10/04/2012	KRV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

LED-4(b): A

B2J2282-02 **California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics**

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020A	ND	1.5	mg/L	10/24/2012	AAV	
Arsenic	EPA 6020A	ND	0.50	mg/L	10/24/2012	AAV	
Barium	EPA 6020A	13	10	mg/L	10/24/2012	AAV	
Beryllium	EPA 6020A	ND	0.075	mg/L	10/24/2012	AAV	
Cadmium	EPA 6020A	ND	0.10	mg/L	10/24/2012	AAV	
Cobalt	EPA 6020A	ND	8.0	mg/L	10/24/2012	AAV	
Copper	EPA 6020A	ND	2.5	mg/L	10/24/2012	AAV	
Lead	EPA 6020A	ND	0.50	mg/L	10/24/2012	AAV	
Mercury	EPA 6020A	ND	0.020	mg/L	10/24/2012	aav	
Molybdenum	EPA 6020A	ND	35	mg/L	10/24/2012	AAV	
Nickel	EPA 6020A	ND	2.0	mg/L	10/24/2012	AAV	
Selenium	EPA 6020A	ND	0.20	mg/L	10/24/2012	AAV	N_RLdil
Silver	EPA 6020	ND	0.50	mg/L	10/24/2012	AAV	
Thallium	EPA 6020A	ND	0.70	mg/L	10/24/2012	AAV	
Total Chromium	EPA 6020A	0.76	0.50	mg/L	10/24/2012	AAV	
Vanadium	EPA 6020A	ND	2.4	mg/L	10/24/2012	AAV	
Zinc	EPA 6020A	ND	25	mg/L	10/24/2012	AAV	

B2K0209-01 **Toxicity Characteristic Leaching Procedure (EPA Method 1311); Metals**

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Arsenic	EPA 6020A	ND	0.50	mg/L	11/14/2012	AAV	
Barium	EPA 6020A	ND	10	mg/L	11/14/2012	AAV	
Cadmium	EPA 6020A	ND	0.10	mg/L	11/14/2012	AAV	
Lead	EPA 6020A	0.71	0.50	mg/L	11/14/2012	AAV	
Mercury	EPA 7470A	ND	0.020	mg/L	11/15/2012	SS	N_HTu
Selenium	EPA 6020A	ND	0.10	mg/L	11/14/2012	AAV	
Silver	EPA 6020A	ND	0.50	mg/L	11/14/2012	AAV	
Total Chromium	EPA 6020A	ND	0.50	mg/L	11/14/2012	AAV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

LED-4(b): B

B2I0463-07

Total Metals

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Arsenic	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Barium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Beryllium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cadmium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cobalt	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Copper	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Lead	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Mercury	EPA 200.8	ND	0.20	mg/kg	10/04/2012	KRV	
Molybdenum	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Nickel	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Selenium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Silver	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Thallium	EPA 6020	ND	50	mg/kg	10/04/2012	KRV	
Total Chromium	EPA 6020	ND	10	mg/kg	10/05/2012	KRV	
Vanadium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Zinc	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

LED-4(b): D

B2K2555-01

Total Metals

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020	350	100	mg/kg	12/12/2012	AAV	
Arsenic	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Barium	EPA 6020	5500	500	mg/kg	12/12/2012	AAV	
Beryllium	EPA 6020	ND	5.0	mg/kg	12/06/2012	krv	
Cadmium	EPA 6020	ND	5.0	mg/kg	12/06/2012	krv	
Cobalt	EPA 6020	24	10	mg/kg	12/06/2012	krv	
Copper	EPA 6020	150000	100	mg/kg	12/06/2012	krv	NOcal
Lead	EPA 6020	700	10	mg/kg	12/06/2012	krv	
Mercury	EPA 200.8	ND	2.0	mg/kg	12/06/2012	AAV	
Molybdenum	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Nickel	EPA 6020	4900	500	mg/kg	12/12/2012	AAV	
Selenium	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Silver	EPA 6020	60	10	mg/kg	12/06/2012	krv	
Thallium	EPA 6020	ND	50	mg/kg	12/06/2012	krv	
Total Chromium	EPA 6020	34	10	mg/kg	12/06/2012	krv	
Vanadium	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Zinc	EPA 6020	80000	2500	mg/kg	12/12/2012	AAV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

LED-4(b): D

B2K2555-02 **California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics**

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020A	6.1	1.5	mg/L	12/06/2012	krv	
Arsenic	EPA 6020A	ND	0.50	mg/L	12/06/2012	krv	
Barium	EPA 6020A	21	10	mg/L	12/06/2012	krv	
Beryllium	EPA 6020A	ND	0.075	mg/L	12/06/2012	krv	
Cadmium	EPA 6020A	0.18	0.10	mg/L	12/06/2012	krv	
Cobalt	EPA 6020A	ND	8.0	mg/L	12/06/2012	krv	
Copper	EPA 6020A	ND	2.5	mg/L	12/06/2012	krv	
Lead	EPA 6020A	27	0.50	mg/L	12/06/2012	krv	
Mercury	EPA 7470A	ND	0.010	mg/L	12/06/2012	SS	
Molybdenum	EPA 6020A	ND	35	mg/L	12/06/2012	krv	
Nickel	EPA 6020A	33	2.0	mg/L	12/06/2012	krv	
Selenium	EPA 6020A	ND	0.10	mg/L	12/06/2012	krv	
Silver	EPA 6020	ND	0.50	mg/L	12/06/2012	krv	
Thallium	EPA 6020A	ND	0.70	mg/L	12/06/2012	krv	
Total Chromium	EPA 6020A	0.99	0.50	mg/L	12/06/2012	krv	
Vanadium	EPA 6020A	ND	2.4	mg/L	12/06/2012	krv	
Zinc	EPA 6020A	500	25	mg/L	12/07/2012	krv	

B2K0209-02 **Toxicity Characteristic Leaching Procedure (EPA Method 1311); Metals**

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Arsenic	EPA 6020A	ND	0.50	mg/L	11/14/2012	AAV	
Barium	EPA 6020A	ND	10	mg/L	11/14/2012	AAV	
Cadmium	EPA 6020A	ND	0.10	mg/L	11/14/2012	AAV	
Lead	EPA 6020A	ND	0.50	mg/L	11/14/2012	AAV	
Mercury	EPA 7470A	ND	0.020	mg/L	11/15/2012	SS	N_HTu
Selenium	EPA 6020A	ND	0.10	mg/L	11/14/2012	AAV	
Silver	EPA 6020A	ND	0.50	mg/L	11/14/2012	AAV	
Total Chromium	EPA 6020A	ND	0.50	mg/L	11/14/2012	AAV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

LED-4(b): E

B2K2555-03

Total Metals

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Arsenic	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Barium	EPA 6020	5600	500	mg/kg	12/06/2012	krv	
Beryllium	EPA 6020	ND	5.0	mg/kg	12/06/2012	krv	
Cadmium	EPA 6020	ND	5.0	mg/kg	12/06/2012	krv	
Cobalt	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Copper	EPA 6020	25000	100	mg/kg	12/07/2012	krv	
Lead	EPA 6020	39	10	mg/kg	12/06/2012	krv	
Mercury	EPA 200.8	ND	2.0	mg/kg	12/06/2012	AAV	
Molybdenum	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Nickel	EPA 6020	510	10	mg/kg	12/06/2012	krv	
Selenium	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Silver	EPA 6020	ND	30	mg/kg	12/07/2012	krv	
Thallium	EPA 6020	ND	50	mg/kg	12/06/2012	krv	
Total Chromium	EPA 6020	180	10	mg/kg	12/06/2012	krv	
Vanadium	EPA 6020	ND	10	mg/kg	12/06/2012	krv	
Zinc	EPA 6020	24	10	mg/kg	12/06/2012	krv	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

LED-4(b): E

B2K2555-04

California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020A	ND	1.5	mg/L	12/06/2012	krv	
Arsenic	EPA 6020A	ND	0.50	mg/L	12/06/2012	krv	
Barium	EPA 6020A	ND	10	mg/L	12/06/2012	krv	
Beryllium	EPA 6020A	ND	0.075	mg/L	12/06/2012	krv	
Cadmium	EPA 6020A	ND	0.10	mg/L	12/06/2012	krv	
Cobalt	EPA 6020A	ND	8.0	mg/L	12/06/2012	krv	
Copper	EPA 6020A	3.3	2.5	mg/L	12/06/2012	krv	
Lead	EPA 6020A	1.2	0.50	mg/L	12/06/2012	krv	
Mercury	EPA 7470A	ND	0.010	mg/L	12/06/2012	SS	
Molybdenum	EPA 6020A	ND	35	mg/L	12/06/2012	krv	
Nickel	EPA 6020A	8.5	2.0	mg/L	12/06/2012	krv	
Selenium	EPA 6020A	ND	0.10	mg/L	12/06/2012	krv	
Silver	EPA 6020	ND	0.50	mg/L	12/06/2012	krv	
Thallium	EPA 6020A	ND	0.70	mg/L	12/06/2012	krv	
Total Chromium	EPA 6020A	2.2	0.50	mg/L	12/06/2012	krv	
Vanadium	EPA 6020A	ND	2.4	mg/L	12/06/2012	krv	
Zinc	EPA 6020A	ND	25	mg/L	12/06/2012	krv	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

LED-4(b): F

B2I0463-10

Total Metals

	Method	Result	RDL	Units	Analyzed	Analyst	Flag
Antimony	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Arsenic	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Barium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Beryllium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cadmium	EPA 6020	ND	5.0	mg/kg	10/04/2012	KRV	
Cobalt	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Copper	EPA 6020	27	10	mg/kg	10/04/2012	KRV	
Lead	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Mercury	EPA 200.8	ND	0.20	mg/kg	10/04/2012	KRV	
Molybdenum	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Nickel	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Selenium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Silver	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Thallium	EPA 6020	ND	50	mg/kg	10/04/2012	KRV	
Total Chromium	EPA 6020	ND	10	mg/kg	10/05/2012	KRV	
Vanadium	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	
Zinc	EPA 6020	ND	10	mg/kg	10/04/2012	KRV	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

Batch 12J0252 - EPA 200.2 SOP M02C

Metals and Metalloids; EPA SW846 Series - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Blank (12J0252-BLK1)					Prepared & Analyzed: 10/03/12						
Antimony	ND	10		mg/kg							
Arsenic	ND	10		mg/kg							
Barium	ND	10		mg/kg							
Beryllium	ND	5.0		mg/kg							
Cadmium	ND	5.0		mg/kg							
Cobalt	ND	10		mg/kg							
Copper	ND	10		mg/kg							
Lead	ND	10		mg/kg							
Mercury	ND	0.20		mg/kg							
Molybdenum	ND	10		mg/kg							
Nickel	ND	10		mg/kg							
Selenium	ND	10		mg/kg							
Silver	ND	10		mg/kg							
Thallium	ND	50		mg/kg							
Total Chromium	ND	10		mg/kg							
Vanadium	ND	10		mg/kg							
Zinc	ND	10		mg/kg							
LCS (12J0252-BS1)					Prepared & Analyzed: 10/03/12						
Antimony	102	10		mg/kg	100		103	80-125			
Arsenic	107	10		mg/kg	100		107	75-125			
Barium	103	10		mg/kg	100		103	79-123			
Beryllium	100	5.0		mg/kg	100		100	73-129			
Cadmium	99.1	5.0		mg/kg	100		99.1	75-123			
Cobalt	102	10		mg/kg	100		102	71.7-129			
Copper	111	10		mg/kg	100		111	76-122			
Lead	95.7	10		mg/kg	100		95.8	76-124			
Mercury	0.408	0.20		mg/kg	0.400		102	85-115			
Molybdenum	98.0	10		mg/kg	100		98.1	78-127			
Nickel	102	10		mg/kg	100		102	78-125			
Selenium	106	10		mg/kg	100		106	69.3-126			
Thallium	92.0	50		mg/kg	100		92.1	62-127			
Total Chromium	98.4	10		mg/kg	100		98.4	74-127			
Vanadium	95.4	10		mg/kg	100		95.5	73-133			

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

Batch 12J0252 - EPA 200.2 SOP M02C

Metals and Metalloids; EPA SW846 Series - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
LCS (12J0252-BS1)					Prepared & Analyzed: 10/03/12						
Zinc	104	10		mg/kg	100		104	77-126			
LCS Dup (12J0252-BSD1)					Prepared & Analyzed: 10/03/12						
Antimony	103	10		mg/kg	100		103	80-125	0.144	200	
Arsenic	103	10		mg/kg	100		103	75-125	3.82	200	
Barium	102	10		mg/kg	100		102	79-123	0.562	200	
Beryllium	99.1	5.0		mg/kg	100		99.1	73-129	1.18	200	
Cadmium	101	5.0		mg/kg	100		101	75-123	1.62	200	
Cobalt	97.1	10		mg/kg	100		97.2	71.7-129	4.72	200	
Copper	106	10		mg/kg	100		106	76-122	4.10	200	
Lead	94.5	10		mg/kg	100		94.5	76-124	1.32	200	
Mercury	0.389	0.20		mg/kg	0.400		97.3	85-115	4.74	20	
Molybdenum	99.3	10		mg/kg	100		99.3	78-127	1.25	200	
Nickel	100	10		mg/kg	100		100	78-125	2.00	200	
Selenium	102	10		mg/kg	100		102	69.3-126	3.71	200	
Thallium	90.6	50		mg/kg	100		90.6	62-127	1.64	200	
Total Chromium	98.2	10		mg/kg	100		98.2	74-127	0.221	200	
Vanadium	93.5	10		mg/kg	100		93.5	73-133	2.08	200	
Zinc	101	10		mg/kg	100		101	77-126	3.50	200	
Reference (12J0252-SRM1)					Prepared & Analyzed: 10/03/12						
Antimony	28.2	10		mg/kg	12.5		225	60-140			QLCSD
Arsenic	73.1	10		mg/kg	66.9		109	60-140			
Barium	12.3	10		mg/kg	11.9		104	60-140			
Beryllium	6.85	5.0		mg/kg	6.36		108	60-140			
Cadmium	107	5.0		mg/kg	109		97.8	60-140			
Cobalt	13.5	10		mg/kg	12.6		107	60-140			
Copper	66.5	10		mg/kg	60.6		110	60-140			
Lead	122	10		mg/kg	133		91.4	60-140			
Mercury	4.71	0.20		mg/kg	5.00		94.1	60-140			QOcal
Molybdenum	54.8	10		mg/kg	51.0		107	60-140			
Nickel	47.6	10		mg/kg	44.9		106	60-140			
Selenium	108	10		mg/kg	106		102	60-140			
Silver	17.5	10		mg/kg	20.3		86.4	60-140			
Thallium	48.3	50		mg/kg	50.8		95.1	60-140			
Total Chromium	63.5	10		mg/kg	50.9		125	60-140			

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

Batch 12J0252 - EPA 200.2 SOP M02C

Metals and Metalloids; EPA SW846 Series - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Reference (12J0252-SRM1)					Prepared & Analyzed: 10/03/12						
Vanadium	59.9	10		mg/kg	62.8		95.4	60-140			
Zinc	587	10		mg/kg	613		95.8	60-140			

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

Batch 12J2230 - EPA 200.2 WET E02

California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Blank (12J2230-BLK1)					Prepared & Analyzed: 10/24/12						
Antimony	ND	1.5		mg/L							
Arsenic	ND	0.50		mg/L							
Barium	ND	10		mg/L							
Beryllium	ND	0.075		mg/L							
Cadmium	ND	0.10		mg/L							
Cobalt	ND	8.0		mg/L							
Copper	ND	2.5		mg/L							
Lead	ND	0.50		mg/L							
Mercury	ND	0.020		mg/L							
Molybdenum	ND	35		mg/L							
Nickel	ND	2.0		mg/L							
Selenium	ND	0.10		mg/L							
Silver	ND	0.50		mg/L							
Thallium	ND	0.70		mg/L							
Total Chromium	ND	0.50		mg/L							
Vanadium	ND	2.4		mg/L							
Zinc	ND	25		mg/L							
Blank (12J2230-BLK2)					Prepared & Analyzed: 10/24/12						
Antimony	ND	1.5		mg/L							
Arsenic	ND	0.50		mg/L							
Barium	ND	10		mg/L							
Beryllium	ND	0.075		mg/L							
Cadmium	ND	0.10		mg/L							
Cobalt	ND	8.0		mg/L							
Copper	ND	2.5		mg/L							
Lead	ND	0.50		mg/L							
Mercury	ND	0.020		mg/L							
Molybdenum	ND	35		mg/L							
Nickel	ND	2.0		mg/L							
Selenium	ND	0.10		mg/L							
Silver	ND	0.50		mg/L							
Thallium	ND	0.70		mg/L							
Total Chromium	ND	0.50		mg/L							
Vanadium	ND	2.4		mg/L							

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

Batch 12J2230 - EPA 200.2 WET E02

California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Blank (12J2230-BLK2)					Prepared & Analyzed: 10/24/12						
Zinc	ND	25		mg/L							
LCS (12J2230-BS1)					Prepared & Analyzed: 10/24/12						
Antimony	4.65	1.5		mg/L	4.00		116	82.2-134			
Arsenic	4.74	0.50		mg/L	4.00		119	81.9-136			
Barium	4.41	10		mg/L	4.00		110	82.5-120			
Beryllium	4.02	0.075		mg/L	4.00		101	70.1-126			
Cadmium	4.29	0.10		mg/L	4.00		107	80.3-119			
Cobalt	4.38	8.0		mg/L	4.00		110	79.7-125			
Copper	4.34	2.5		mg/L	4.00		108	79.5-150			
Lead	4.18	0.50		mg/L	4.00		105	77-117			
Mercury	0.0175	0.020		mg/L	0.0167		105	80-120			
Molybdenum	4.76	35		mg/L	4.00		119	84.7-136			
Nickel	4.27	2.0		mg/L	4.00		107	78.1-123			
Selenium	4.61	0.10		mg/L	4.00		115	78.3-139			
Silver	3.91	0.50		mg/L	4.00		97.8	74.2-118			
Thallium	4.06	0.70		mg/L	4.00		101	76.9-115			
Total Chromium	4.73	0.50		mg/L	4.00		118	81.8-154			
Vanadium	4.86	2.4		mg/L	4.00		122	84-147			
Zinc	4.18	25		mg/L	4.00		104	72.8-129			
Matrix Spike (12J2230-MS1)		**Source: B2J2135-01**			Prepared & Analyzed: 10/24/12						
Antimony	5.19	1.5		mg/L	4.00	0.335	121	83.1-137			
Arsenic	4.75	0.50		mg/L	4.00	0.0659	117	86.8-135			
Barium	5.45	10		mg/L	4.00	0.827	115	77.2-127			
Beryllium	4.19	0.075		mg/L	4.00	ND	105	67.2-131			
Cadmium	4.43	0.10		mg/L	4.00	0.0175	110	79.8-120			
Cobalt	4.69	8.0		mg/L	4.00	0.224	112	80.4-125			
Copper	6.10	2.5		mg/L	4.00	1.67	111	71.5-150			
Lead	7.03	0.50		mg/L	4.00	2.36	117	72.9-123			
Mercury	0.0182	0.020		mg/L	0.0167	ND	109	75-125			
Molybdenum	5.28	35		mg/L	4.00	0.313	124	84.7-136			
Nickel	6.40	2.0		mg/L	4.00	1.96	111	71.2-133			
Selenium	4.51	0.10		mg/L	4.00	ND	113	78.3-139			
Silver	4.05	0.50		mg/L	4.00	ND	101	72-121			
Thallium	4.17	0.70		mg/L	4.00	ND	104	76.9-115			

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

Batch 12J2230 - EPA 200.2 WET E02

California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Matrix Spike (12J2230-MS1)		**Source: B2J2135-01**			Prepared & Analyzed: 10/24/12						
Total Chromium	21.8	0.50		mg/L	4.00	15.3	162	68.9-154			QM-3x
Vanadium	5.29	2.4		mg/L	4.00	0.356	123	80.7-147			
Zinc	11.7	25		mg/L	4.00	6.70	124	62.1-139			
Matrix Spike Dup (12J2230-MSD1)		**Source: B2J2135-01**			Prepared & Analyzed: 10/24/12						
Antimony	4.76	1.5		mg/L	4.00	0.335	111	83.1-137	8.64	20	
Arsenic	4.33	0.50		mg/L	4.00	0.0659	107	86.8-135	9.22	20	
Barium	4.98	10		mg/L	4.00	0.827	104	77.2-127	8.88	20	
Beryllium	3.93	0.075		mg/L	4.00	ND	98.2	67.2-131	6.33	20	
Cadmium	4.06	0.10		mg/L	4.00	0.0175	101	79.8-120	8.54	20	
Cobalt	4.17	8.0		mg/L	4.00	0.224	98.7	80.4-125	11.7	20	
Copper	5.56	2.5		mg/L	4.00	1.67	97.3	71.5-150	9.25	20	
Lead	6.44	0.50		mg/L	4.00	2.36	102	72.9-123	8.81	20	
Mercury	0.0162	0.020		mg/L	0.0167	ND	97.2	75-125	11.5	20	
Molybdenum	4.76	35		mg/L	4.00	0.313	111	84.7-136	10.3	20	
Nickel	5.84	2.0		mg/L	4.00	1.96	97.1	71.2-133	9.02	20	
Selenium	4.15	0.10		mg/L	4.00	ND	104	78.3-139	8.17	20	
Silver	3.74	0.50		mg/L	4.00	ND	93.6	72-121	7.77	20	
Thallium	3.79	0.70		mg/L	4.00	ND	94.7	76.9-115	9.49	20	
Total Chromium	20.2	0.50		mg/L	4.00	15.3	122	68.9-154	7.60	20	
Vanadium	4.90	2.4		mg/L	4.00	0.356	114	80.7-147	7.51	20	
Zinc	10.8	25		mg/L	4.00	6.70	104	62.1-139	7.16	20	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

Batch 12K1222 - EPA 200.2 TCLP E01

Toxicity Characteristic Leaching Procedure (EPA Method 1311); Metals - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Blank (12K1222-BLK1)					Prepared & Analyzed: 11/14/12						
Arsenic	ND	0.50		mg/L							
Barium	ND	10		mg/L							
Cadmium	ND	0.10		mg/L							
Lead	ND	0.50		mg/L							
Selenium	ND	0.10		mg/L							
Silver	ND	0.50		mg/L							
Total Chromium	ND	0.50		mg/L							
LCS (12K1222-BS1)					Prepared & Analyzed: 11/14/12						
Arsenic	1.10	0.50		mg/L	1.00		110	82-128			
Barium	0.988	10		mg/L	1.00		98.8	77-131			
Cadmium	1.05	0.10		mg/L	1.00		105	80-120			
Lead	1.04	0.50		mg/L	1.00		104	74-117			
Selenium	1.08	0.10		mg/L	1.00		108	82-123			
Silver	0.870	0.50		mg/L	1.00		87.0	71-120			
Total Chromium	1.06	0.50		mg/L	1.00		106	83-128			
Matrix Spike (12K1222-MS1)		**Source: B2K0209-04**			Prepared & Analyzed: 11/14/12						
Arsenic	4.43	2.0		mg/L	4.00	ND	111	82-130			
Barium	10.6	40		mg/L	4.00	6.10	113	68-142			
Cadmium	4.18	0.40		mg/L	4.00	0.00306	104	80-120			
Lead	16.4	2.0		mg/L	4.00	11.3	127	70-120			QM-3x
Selenium	4.44	0.40		mg/L	4.00	ND	111	79-128			
Silver	3.52	2.0		mg/L	4.00	ND	88.0	71-121			
Total Chromium	4.28	2.0		mg/L	4.00	ND	107	80-132			
Matrix Spike Dup (12K1222-MSD1)		**Source: B2K0209-04**			Prepared & Analyzed: 11/14/12						
Arsenic	4.35	2.0		mg/L	4.00	ND	109	82-130	1.86	20	
Barium	10.6	40		mg/L	4.00	6.10	112	68-142	0.152	20	
Cadmium	4.27	0.40		mg/L	4.00	0.00306	107	80-120	2.18	20	
Lead	16.7	2.0		mg/L	4.00	11.3	134	70-120	1.84	20	QM-3x
Selenium	4.35	0.40		mg/L	4.00	ND	109	79-128	2.03	20	
Silver	3.59	2.0		mg/L	4.00	ND	89.7	71-121	1.93	20	
Total Chromium	4.17	2.0		mg/L	4.00	ND	104	80-132	2.44	20	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

Batch 12K1501 - EPA 7470A/SM 3112B

Toxicity Characteristic Leaching Procedure (EPA Method 1311); Metals - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Blank (12K1501-BLK1)					Prepared & Analyzed: 11/15/12						
Mercury	ND	0.010		mg/L							
LCS (12K1501-BS1)					Prepared & Analyzed: 11/15/12						
Mercury	0.00970	0.010		mg/L	0.00952		102	75-122			
Matrix Spike (12K1501-MS1)		**Source: B2K0209-04**			Prepared & Analyzed: 11/15/12						
Mercury	0.0387	0.040		mg/L	0.0381	ND	102	75-125			
Matrix Spike Dup (12K1501-MSD1)		**Source: B2K0209-04**			Prepared & Analyzed: 11/15/12						
Mercury	0.0387	0.040		mg/L	0.0381	ND	102	75-125	0.171	20	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

Batch 12L0305 - EPA 200.2 WET E02

California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Blank (12L0305-BLK1)						Prepared: 12/05/12		Analyzed: 12/06/12			
Antimony	ND	1.5		mg/L							
Arsenic	ND	0.50		mg/L							
Barium	ND	10		mg/L							
Beryllium	ND	0.075		mg/L							
Cadmium	ND	0.10		mg/L							
Cobalt	ND	8.0		mg/L							
Copper	ND	2.5		mg/L							
Lead	ND	0.50		mg/L							
Molybdenum	ND	35		mg/L							
Nickel	ND	2.0		mg/L							
Selenium	ND	0.10		mg/L							
Silver	ND	0.50		mg/L							
Thallium	ND	0.70		mg/L							
Total Chromium	ND	0.50		mg/L							
Vanadium	ND	2.4		mg/L							
Zinc	ND	25		mg/L							
LCS (12L0305-BS1)						Prepared: 12/05/12		Analyzed: 12/06/12			
Antimony	4.30	1.5		mg/L	4.00		107	82.2-134			
Arsenic	4.35	0.50		mg/L	4.00		109	81.9-136			
Barium	4.13	10		mg/L	4.00		103	82.5-120			
Beryllium	3.78	0.075		mg/L	4.00		94.4	70.1-126			
Cadmium	3.84	0.10		mg/L	4.00		96.0	80.3-119			
Cobalt	3.98	8.0		mg/L	4.00		99.4	79.7-125			
Copper	4.01	2.5		mg/L	4.00		100	79.5-150			
Lead	3.99	0.50		mg/L	4.00		99.8	77-117			
Molybdenum	4.21	35		mg/L	4.00		105	84.7-136			
Nickel	3.94	2.0		mg/L	4.00		98.6	78.1-123			
Selenium	4.21	0.10		mg/L	4.00		105	78.3-139			
Silver	3.72	0.50		mg/L	4.00		93.0	74.2-118			
Thallium	3.88	0.70		mg/L	4.00		97.0	76.9-115			
Total Chromium	4.20	0.50		mg/L	4.00		105	81.8-154			
Vanadium	4.36	2.4		mg/L	4.00		109	84-147			
Zinc	3.78	25		mg/L	4.00		94.5	72.8-129			

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

Batch 12L0305 - EPA 200.2 WET E02

California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Matrix Spike (12L0305-MS1)		**Source: B2K2555-06**			Prepared: 12/05/12			Analyzed: 12/06/12			
Antimony	8.78	1.5		mg/L	4.00	3.74	126	83.1-137			
Arsenic	4.55	0.50		mg/L	4.00	0.0983	111	86.8-135			
Barium	18.1	10		mg/L	4.00	15.7	60.4	77.2-127			QM-3x
Beryllium	3.80	0.075		mg/L	4.00	ND	95.0	67.2-131			
Cadmium	5.03	0.10		mg/L	4.00	0.0200	125	79.8-120			QMout
Cobalt	5.64	8.0		mg/L	4.00	1.62	100	80.4-125			
Copper	4.79	2.5		mg/L	4.00	0.859	98.4	71.5-150			
Lead	12.1	0.50		mg/L	4.00	9.01	77.1	72.9-123			
Molybdenum	5.57	35		mg/L	4.00	0.0686	138	84.7-136			QMout
Nickel	16.5	2.0		mg/L	4.00	13.9	65.6	71.2-133			QM-3x
Selenium	4.30	0.10		mg/L	4.00	ND	107	78.3-139			
Silver	4.87	0.50		mg/L	4.00	ND	122	72-121			QMout
Thallium	3.83	0.70		mg/L	4.00	ND	95.8	76.9-115			
Total Chromium	4.50	0.50		mg/L	4.00	0.300	105	68.9-154			
Vanadium	4.68	2.4		mg/L	4.00	0.0890	115	80.7-147			
Zinc	397	25		mg/L	4.00	433	-905	62.1-139			QM-3x, QOcal
Matrix Spike Dup (12L0305-MSD1)		**Source: B2K2555-06**			Prepared: 12/05/12			Analyzed: 12/06/12			
Antimony	7.67	1.5		mg/L	4.00	3.74	98.4	83.1-137	13.5	20	
Arsenic	4.40	0.50		mg/L	4.00	0.0983	108	86.8-135	3.35	20	
Barium	17.2	10		mg/L	4.00	15.7	37.1	77.2-127	5.28	20	QM-3x
Beryllium	3.68	0.075		mg/L	4.00	ND	91.9	67.2-131	3.28	20	
Cadmium	4.40	0.10		mg/L	4.00	0.0200	110	79.8-120	13.3	20	
Cobalt	5.43	8.0		mg/L	4.00	1.62	95.2	80.4-125	3.71	20	
Copper	4.67	2.5		mg/L	4.00	0.859	95.4	71.5-150	2.55	20	
Lead	11.5	0.50		mg/L	4.00	9.01	63.2	72.9-123	4.71	20	QMSD
Molybdenum	4.83	35		mg/L	4.00	0.0686	119	84.7-136	14.2	20	
Nickel	15.9	2.0		mg/L	4.00	13.9	50.9	71.2-133	3.64	20	QM-3x
Selenium	4.15	0.10		mg/L	4.00	ND	104	78.3-139	3.46	20	
Silver	4.32	0.50		mg/L	4.00	ND	108	72-121	12.0	20	
Thallium	3.66	0.70		mg/L	4.00	ND	91.5	76.9-115	4.53	20	
Total Chromium	4.39	0.50		mg/L	4.00	0.300	102	68.9-154	2.49	20	
Vanadium	4.52	2.4		mg/L	4.00	0.0890	111	80.7-147	3.36	20	
Zinc	386	25		mg/L	4.00	433	-1160	62.1-139	2.62	20	QM-3x, QOcal

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

Batch 12L0421 - EPA 200.2 SOP M02C

Metals and Metalloids - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Blank (12L0421-BLK1)						Prepared & Analyzed: 12/06/12					
Mercury	ND	20		mg/kg							
Blank (12L0421-BLK2)						Prepared & Analyzed: 12/06/12					
Mercury	ND	20		mg/kg							
LCS (12L0421-BS1)						Prepared & Analyzed: 12/06/12					
Mercury	ND	20		mg/kg				85-115			
Matrix Spike (12L0421-MS1)		**Source: B2K2721-01**				Prepared & Analyzed: 12/06/12					
Mercury	ND	20		mg/kg		ND		70-130			
Matrix Spike Dup (12L0421-MSD1)		**Source: B2K2721-01**				Prepared & Analyzed: 12/06/12					
Mercury	ND	20		mg/kg		ND		70-130		20	
Reference (12L0421-SRM1)						Prepared & Analyzed: 12/06/12					
Mercury	4.04	20		mg/kg	5.00		80.8	60-140			

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

Batch 12L0421 - EPA 200.2 SOP M02C

Metals and Metalloids; EPA SW846 Series - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Blank (12L0421-BLK1)					Prepared & Analyzed: 12/06/12						
Antimony	ND	10		mg/kg							
Arsenic	ND	10		mg/kg							
Barium	ND	10		mg/kg							
Beryllium	ND	5.0		mg/kg							
Cadmium	ND	5.0		mg/kg							
Cobalt	ND	10		mg/kg							
Copper	ND	10		mg/kg							
Lead	ND	10		mg/kg							
Molybdenum	ND	10		mg/kg							
Nickel	ND	10		mg/kg							
Selenium	ND	10		mg/kg							
Silver	ND	10		mg/kg							
Thallium	ND	50		mg/kg							
Total Chromium	ND	10		mg/kg							
Vanadium	ND	10		mg/kg							
Zinc	ND	10		mg/kg							
Blank (12L0421-BLK2)					Prepared & Analyzed: 12/06/12						
Antimony	ND	10		mg/kg							
Arsenic	ND	10		mg/kg							
Barium	ND	10		mg/kg							
Beryllium	ND	5.0		mg/kg							
Cadmium	ND	5.0		mg/kg							
Cobalt	ND	10		mg/kg							
Copper	ND	10		mg/kg							
Lead	ND	10		mg/kg							
Molybdenum	ND	10		mg/kg							
Nickel	ND	10		mg/kg							
Selenium	ND	10		mg/kg							
Silver	ND	10		mg/kg							
Thallium	ND	50		mg/kg							
Total Chromium	ND	10		mg/kg							
Vanadium	ND	10		mg/kg							
Zinc	ND	10		mg/kg							

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

Batch 12L0421 - EPA 200.2 SOP M02C

Metals and Metalloids; EPA SW846 Series - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
LCS (12L0421-BS1)					Prepared & Analyzed: 12/06/12						
Antimony	111	10		mg/kg	100		111	80-125			
Arsenic	116	10		mg/kg	100		116	75-125			
Barium	111	10		mg/kg	100		111	79-123			
Beryllium	99.2	5.0		mg/kg	100		99.2	73-129			
Cadmium	110	5.0		mg/kg	100		110	75-123			
Cobalt	109	10		mg/kg	100		109	71.7-129			
Copper	109	10		mg/kg	100		109	76-122			
Lead	114	10		mg/kg	100		114	76-124			
Molybdenum	105	10		mg/kg	100		105	78-127			
Nickel	110	10		mg/kg	100		110	78-125			
Selenium	116	10		mg/kg	100		116	69.3-126			
Silver	103	10		mg/kg	100		103	68-127			
Thallium	103	50		mg/kg	100		103	62-127			
Total Chromium	109	10		mg/kg	100		109	74-127			
Vanadium	112	10		mg/kg	100		112	73-133			
Zinc	114	10		mg/kg	100		114	77-126			
Matrix Spike (12L0421-MS1)		**Source: B2K2721-01**			Prepared & Analyzed: 12/06/12						
Antimony	102	10		mg/kg	100	ND	102	68-130			
Arsenic	112	10		mg/kg	100	2.45	109	77-128			
Barium	95.6	10		mg/kg	100	2.56	93.1	56-146			
Beryllium	70.2	5.0		mg/kg	100	0.483	69.7	64-125			
Cadmium	98.7	5.0		mg/kg	100	0.818	97.9	75-125			
Cobalt	101	10		mg/kg	100	3.00	98.3	69-130			
Copper	145	10		mg/kg	100	53.1	91.8	45-140			
Lead	95.3	10		mg/kg	100	1.28	94.1	66-130			
Molybdenum	100	10		mg/kg	100	0.765	99.7	78-128			
Nickel	117	10		mg/kg	100	21.4	96.0	68-128			
Selenium	113	10		mg/kg	100	ND	113	72-133			
Silver	92.3	10		mg/kg	100	ND	92.3	68-127			
Thallium	89.8	50		mg/kg	100	ND	89.8	60-126			
Total Chromium	1080	10		mg/kg	100	1040	35.7	60-139			QM-3x
Vanadium	228	10		mg/kg	100	121	107	57-151			
Zinc	137	10		mg/kg	100	43.9	93.1	36-151			

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

Batch 12L0421 - EPA 200.2 SOP M02C

Metals and Metalloids; EPA SW846 Series - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Matrix Spike Dup (12L0421-MSD1)		**Source: B2K2721-01**				Prepared & Analyzed: 12/06/12					
Antimony	116	10		mg/kg	100	ND	116	68-130	12.9	20	
Arsenic	125	10		mg/kg	100	2.45	122	77-128	11.0	20	
Barium	107	10		mg/kg	100	2.56	105	56-146	11.6	20	
Beryllium	78.3	5.0		mg/kg	100	0.483	77.8	64-125	10.9	20	
Cadmium	113	5.0		mg/kg	100	0.818	112	75-125	13.3	20	
Cobalt	113	10		mg/kg	100	3.00	110	69-130	11.1	20	
Copper	156	10		mg/kg	100	53.1	103	45-140	7.36	20	
Lead	106	10		mg/kg	100	1.28	105	66-130	10.9	20	
Molybdenum	116	10		mg/kg	100	0.765	115	78-128	14.5	20	
Nickel	130	10		mg/kg	100	21.4	109	68-128	10.2	20	
Selenium	126	10		mg/kg	100	ND	126	72-133	10.7	20	
Silver	99.4	10		mg/kg	100	ND	99.4	68-127	7.37	20	
Thallium	103	50		mg/kg	100	ND	103	60-126	13.6	20	
Total Chromium	1300	10		mg/kg	100	1040	264	60-139	19.2	20	QM-3x, QOcal
Vanadium	258	10		mg/kg	100	121	137	57-151	12.4	20	
Zinc	149	10		mg/kg	100	43.9	105	36-151	8.08	20	
Reference (12L0421-SRM1)						Prepared & Analyzed: 12/06/12					
Antimony	34.3	10		mg/kg	12.5		274	60-140			QLout
Arsenic	72.2	10		mg/kg	66.9		108	60-140			
Barium	10.9	10		mg/kg	11.9		91.5	60-140			
Beryllium	6.19	5.0		mg/kg	6.36		97.3	60-140			
Cadmium	91.4	5.0		mg/kg	109		83.8	60-140			
Cobalt	12.4	10		mg/kg	12.6		98.3	60-140			
Copper	60.9	10		mg/kg	60.6		101	60-140			
Lead	127	10		mg/kg	133		95.5	60-140			
Molybdenum	53.0	10		mg/kg	51.0		104	60-140			
Nickel	44.9	10		mg/kg	44.9		100	60-140			
Selenium	112	10		mg/kg	106		106	60-140			
Silver	18.9	10		mg/kg	20.3		93.0	60-140			
Thallium	50.8	50		mg/kg	50.8		100	60-140			
Total Chromium	53.1	10		mg/kg	50.9		104	60-140			
Vanadium	60.2	10		mg/kg	62.8		95.9	60-140			
Zinc	602	10		mg/kg	613		98.2	60-140			

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

Batch 12L0604 - EPA 7470A/SM 3112B

California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Blank (12L0604-BLK1)					Prepared & Analyzed: 12/06/12						
Mercury	ND	0.010		mg/L							
LCS (12L0604-BS1)					Prepared & Analyzed: 12/06/12						
Mercury	0.0199	0.010		mg/L	0.0190		104	80-120			
Matrix Spike (12L0604-MS1)		**Source: B2K2555-04**			Prepared & Analyzed: 12/06/12						
Mercury	0.0161	0.010		mg/L	0.0190	ND	84.6	75-125			
Matrix Spike Dup (12L0604-MSD1)		**Source: B2K2555-04**			Prepared & Analyzed: 12/06/12						
Mercury	0.0164	0.010		mg/L	0.0190	ND	86.1	75-125	1.70	20	

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**

Report Date: **04-Mar-2013**

Batch 12L0748 - EPA 200.2 WET E02

California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Blank (12L0748-BLK1)						Prepared: 12/05/12		Analyzed: 12/07/12			**QBLK**
Copper	ND	2.5		mg/L							
Zinc	ND	25		mg/L							
LCS (12L0748-BS1)						Prepared: 12/05/12		Analyzed: 12/07/12			
Copper	5.53	2.5		mg/L	4.00		138	79.5-150			
Zinc	3.60	25		mg/L	4.00		90.1	72.8-129			

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

Batch 12L0752 - EPA 200.2 SOP M02C

Metals and Metalloids; EPA SW846 Series - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Blank (12L0752-BLK1)					Prepared: 12/06/12 Analyzed: 12/07/12						
Copper	ND	10		mg/kg							
Silver	ND	10		mg/kg							
Blank (12L0752-BLK2)					Prepared: 12/06/12 Analyzed: 12/07/12						
Copper	ND	10		mg/kg							
Silver	ND	10		mg/kg							
LCS (12L0752-BS1)					Prepared: 12/06/12 Analyzed: 12/07/12						
Copper	89.3	10		mg/kg	100		89.3	76-122			
Silver	22.3	10		mg/kg	100		22.3	68-127			A-01, QLout

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

Batch 12L1155 - EPA 200.2 SOP M02C

Metals and Metalloids; EPA SW846 Series - Batch Quality Control

Analyte(s)	Result	RDL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Blank (12L1155-BLK1)						Prepared: 12/06/12 Analyzed: 12/12/12					
Antimony	ND	10		mg/kg							
Barium	ND	10		mg/kg							
Nickel	ND	10		mg/kg							
Zinc	ND	10		mg/kg							
LCS (12L1155-BS1)						Prepared: 12/06/12 Analyzed: 12/12/12					
Antimony	106	10		mg/kg	100		106	80-125			
Barium	98.3	10		mg/kg	100		98.3	79-123			
Nickel	101	10		mg/kg	100		101	78-125			
Zinc	104	10		mg/kg	100		104	77-126			
Reference (12L1155-SRM1)						Prepared: 12/06/12 Analyzed: 12/12/12					
Antimony	36.3	10		mg/kg	12.5		290	0-200			QLout
Barium	11.2	10		mg/kg	11.9		93.8	0-200			
Nickel	46.5	10		mg/kg	44.9		104	0-200			
Zinc	618	10		mg/kg	613		101	0-200			

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

Notes and Definitions

A-01	LCS recovery biased low; however analysis of associated sample reproduced result in triplicate.
N_HTu	Analysis may or may not have been analyzed within EPA recommended holding time because sample time was not provided.
N_RLdil	The reporting limit has been raised due to sample dilution.
NMout	The matrix spike and/or matrix spike duplicate performed on this sample did not meet laboratory acceptance criteria.
NOcal	The concentration indicated for this analyte is an estimated value above the calibration range of the instrument.
QBLK	The method blank did not meet laboratory acceptance criteria.
QLCSD	Batch acceptance based on LCS recovery. The LCSD did not meet laboratory acceptance criteria.
QLout	The LCS and/or LCSD recovery did not meet laboratory acceptance criteria.
QM-3x	Due to analyte concentration greater than or equal to 3 times the spike concentration, recoveries for the metal MS and/or MSD did not meet laboratory acceptance criteria.
QMout	MS and/or MSD recovery did not meet laboratory acceptance criteria.
QMSD	The MS recovery and MS/MSD RPD met laboratory acceptance criteria. MSD recovery was not within range. MSD performed to assess precision data only.
QOcal	The concentration indicated for this analyte is an estimated value above the calibration range of the instrument.
Blank:	A Quality Control Sample consisting of a "clean" lab-prepared sample having a similar matrix to the field test sample.
LCS:	A Laboratory Control Sample consisting of a "clean" sample having a similar matrix to the field test sample and fortified with a "known" amount of target analyte(s).
LCSD:	A separately prepared Dulpicate of a Laboratory Control Sample consisting of a "clean" sample having a similar matrix to the field test sample and fortified with a "known" amount of target analyte(s).
MS:	A field test sample (project sample) of a specific Matrix fortified with a "known" amount of target analyte(s).
MSD:	A separately prepared Duplicate of a field test sample (project sample) of a specific Matrix fortified with a "known" amount of target analyte(s).
Reference:	A second source quality control sample of a specific Matrix containing a certified "known" amount of target analyte(s).
ND:	Analyte NOT DETECTED at or above the Method Detection Limit **(if MDL is reported)**, otherwise at or above the Reportable Detection Limit (RDL)
NR:	Not Reported

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102

E.S.BABCOCK&Sons,Inc.
Environmental Laboratories est 1906

Pacific Northwest National Laboratories
902 Batelle Blvd. PO Box 999 MS P7-22
Richland, WA 99352

Project: **Lamp Toxicity Characteristics**
Report Date: **04-Mar-2013**

RDL: Reportable Detection Limit (also called MRL, RL, EQL, PQL)

MDL: Method Detection Limit

* / ''' : NELAP does not offer accreditation for this analyte/method/matrix combination

Enclosed are the analytical results for the submitted sample(s). Babcock Laboratories certify the data presented as part of this report meet the minimum quality standards in the referenced analytical methods. Any exceptions have been noted. Babcock Laboratories and its officers and employees assume no responsibility and make no warranty, express or implied, for uses or interpretations made by any recipients, intended or unintended, of this report.

Lawrence J. Chrystal

Digitally signed by Lawrence J. Chrystal
DN: cn=Lawrence J. Chrystal, o=Babcock Labs, ou=Admin, email=lchrystal@babcocklabs.com, c=US
Date: 2013.03.04 16:38:50 -08'00'

Lawrence J. Chrystal For
Joseph D. Morrison

mailing
P.O. Box 432
Riverside, CA 92502-0432

location
6100 Quail Valley Court
Riverside, CA 92507-0704

P 951 653 3351
F 951 653 1662
www.babcocklabs.com

NELAP no. 02101CA
CA Elap no. 2698
EPA no. CA00102